Central Arizona Project Fund Transfer Program
Task 4-35. Upper Gila Basin New Mexico Fish Barriers Feasibility Study

Submitted To:

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I. INTRODUCTION

The upper Gila River basin of New Mexico supports diverse assemblages of native fishes that are threatened by existing populations of non-native fishes and other aquatic biota. Avenues of impact include hybridization, predation, competition, and transmission of parasites and disease. Non-native fishes are increasingly considered among the most serious factors preventing conservation and recovery of native forms. The U.S. Bureau of Reclamation, in concert with U.S. Fish and Wildlife Service, Gila National Forest, and New Mexico Department of Game and Fish is evaluating the feasibility of installing fish barriers in the New Mexico portion of the basin to ameliorate or prevent these negative influences to native fishes.

These investigations were conducted as a result of the U.S. Fish and Wildlife Service Gila River Biological Opinion relating to the Central Arizona Project (CAP) Canal. The Biological Opinion concluded that CAP deliveries are likely to jeopardize native fish populations. Although the New Mexico Gila basin streams are isolated from the CAP system by Coolidge Dam, fish barriers on upper Gila Basin streams qualify as mitigation for CAP impacts that cannot be prevented at other sites.

Seven potential fish barrier sites were visited from August 14 to 16, 2002. The participants involved were Dave Propst, New Mexico Department of Game and Fish; Art Telles, U.S. Forest Service - Gila National Forest; Paul Marsh of Arizona State University; and Rob Clarkson and Jeff Riley of the U.S. Bureau of Reclamation's Phoenix office.

The investigations focused primarily on streams containing desert (warm-water) fishes, although two trout streams were evaluated. The primary factors that were considered at each site were: potential for native fish protection/enhancement, presence or threat of non-native fishes, length of stream the barrier would protect, cost to construct the barrier structure, construction access to the site, flooding impacts, and risk to existing property and infrastructure.

Based on these criteria in total, Little Creek and Saliz Canyon are recommended as preferred sites for fish barriers. Willow Creek, Turkey Creek, and Dry Blue Creek are also possible candidates for barriers. West Fork Gila River and Frieborn Canyon do not appear to be good candidates for fish barriers, and have been eliminated from consideration at this time.

II. LITTLE CREEK

A. General - Little Creek enters the West Fork Gila River about 44 miles north of Silver City, New Mexico on State Route 15 (USGS Gila Hot Springs quadrangle; Map 1). The stream is a rather broad, shallow, alluvial channel with gravel and silt banks. The most likely location for a fish barrier in this reach would be to incorporate the barrier into the box culvert crossing on State Route 15, located about 100 yards upstream of the confluence of Little Creek with the West Fork of the Gila River (Photo 1).

This site was visited on August 14, 2002 by Propst, Marsh, Clarkson, and Riley. The site was located by GPS at UTM (Universal Transverse Mercator) coordinates 759,556 E 3,677,275 N (meters), approximate elevation 5,580 feet. All sites described within this report are within Zone 12.

Streamflow appears to be intermittent upstream of the crossing. There was a shallow pool of fresh water that stretched across the 50-foot width of the channel just upstream of the crossing. An estimated flow of about 10 gallons per minute was observed passing through the box culverts.

The potential for flows in the West Fork Gila River to inundate the fish barrier during flood events needs to be evaluated. There does not appear to be any property improvements upstream of the potential fish barrier site that would be impacted by flooding.

B. Biological considerations - Four miles of stream would be protected by a fish barrier located at or near the crossing. There is an existing fish barrier to protect Gila trout (*Oncorhynchus gilae*) at the upper end of the 4-mile reach. Brown trout (*Salmo trutta*) is the only known non-native fish that currently inhabits the lower reach, but black (*Ameiurus melas*) and yellow (*A. natalis*) bullheads and several centrarchids (e.g., smallmouth bass (*Micropterus dolomieu*) and green sunfish *Lepomis cyanellus*) occur in the West Fork Gila River at the confluence with Little Creek. Longfin dace (*Agosia chrysogaster*), speckled dace (*Rhinichthys osculus*), desert sucker (*Pantosteus clarki*) and Sonora sucker (*Catostomus insignis*) are native fishes that inhabit lower Little Creek.

In addition to protecting existing species of native fishes, the proposed fish barrier would protect potentially repatriated stocks of loach minnow (*Tiaroga cobitis*) and Gila chub (*Gila intermedia*). The primary option to rid the stream of brown trout is mechanical removal (electrofishing).

C. Construction considerations - The stream channel upstream of the road crossing meanders through an alluvial floodplain that extends up to 200 feet on each side of the stream. The floodplain terraces are 3-5 feet higher that the stream thalweg, and show clear evidence of inundation. The stream channel characteristics would necessitate a substantial fish barrier structure to prevent upstream fish movement over the terraces during high flows.

The box culvert crossing could be modified or rebuilt to perform as a fish barrier. Either option involves raising the road approximately the height of the barrier drop, or adding more boxes. A 4- to 5-foot drop was discussed, with a sloping apron. This could result in a total vertical change in road height of about 2 feet. The length of road that would need to be raised is dependant upon the lateral distance to adequately high tie-in points, thus ensuring that all flows pass through box culvert, not over the road. It appeared the right side embankment would be able to tie to high ground within 100 feet. The left abutment rise is not as obvious and would require surveying to determine the tie-in point. The box culvert consists of six 8-foot-wide by 6-foot-high concrete boxes, approximately 50 feet long. The piers are 6 inches wide, except the middle pier which is 1 foot. There is an apron of unknown thickness and a 2.5-foot thick roadway slab.

Any change to the existing box culvert would require reevaluation of the stream hydrology. The original discharge capacity of the box culvert would need to be compared with the State's current design flood criteria standards to determine if additional boxes are required.

Because the barrier crest would be about 6 feet higher than the existing channel thalweg, there would be considerable sedimentation and flooding effects to the channel. These effects could extend an estimated quarter of a mile upstream of the barrier and would require further evaluation.

The proposed site has excellent vehicular access. Water is available for construction from Little Creek and West Fork Gila River. Concrete is available from ready-mix plants in Silver City. Transit mixers should have no problem negotiating the road to the site.

Any work performed below the thalweg will require dewatering. Stream diversion will be minimal.

D. Construction cost estimate

Assumptions: Existing capacity of box culvert is 100-year flood.
100-year flood is current standard.
Use a 4-foot concrete drop structure.
Use existing box culvert structure as much as possible.
Raise road slab 2 feet.
Add 2 new boxes 8 feet wide by 8 feet high.
High flows in the West Fork Gila River do not inundate fish barrier.

Estimated cost = $190,000

III. WEST FORK GILA RIVER

A. General - The proposed site is located at the State Route 15 bridge on the West Fork Gila River about 45 miles north of Silver City near the entrance to the Gila Cliff

Dwellings National Monument (USGS Gila Hot Springs quadrangle; Map 1a). The site was visited on August 14, 2002 by Propst, Clarkson, Marsh, and Riley. The UTM position was 756,245 E 3,679,515 N, approximate elevation 5,640 ft.

The West Fork Gila River is a perennial stream at this site, and exhibited an estimated flow of 40 cfs. The floodplain is estimated to be about 1000 feet wide with a relatively low gradient. The channel materials are alluvial, bounded by rock canyon walls. In recent years, the channel has shifted from the west side of the floodplain to the east side.

The channel shift forced the streamflows to the base of the upstream roadway embankment (Photo 2), potentially threatening the roadway itself. The flows were entering the bridge area at a less than desirable angle, raising concerns about the alignment of the bridge. Since our visit, the New Mexico Highway Department excavated a new channel to the west to temporarily address this concern. Apparently there have been discussions regarding the replacement of the bridge because of the alignment concerns. The Forest Service wants to see additional spans incorporated into the bridge. If the bridge is replaced, a fish barrier could be incorporated into the design. However, a decision on the bridge does not appear to be imminent. Reclamation cannot justify replacement of the bridge to construct a fish barrier without the majority of the cost being contributed by the other involved agencies (Forest Service, State of New Mexico, and Park Service). The existing structure could theoretically be modified to incorporate a fish barrier, contingent on bridge capacity hydraulics and the future of the current bridge.

B. Biological considerations - The native fish fauna is intact upstream of the bridge, and includes longfin dace, headwater chub (*Gila nigra*), spikedace (*Meda fulgida*), speckled dace, loach minnow, desert sucker, and Sonora sucker. Non-native species that have been recorded from the reach include black and yellow bullheads, mosquitofish (*Gambusia affinis*), fathead minnow (*Pimephales promelas*), brown trout, rainbow trout (*Oncorhynchus mykiss*), and several species of centrarchids. With the exception of the trouts, non-natives are rare in the upstream reach, invading only seasonally. However, permanent establishment of warmwater non-natives may only be a matter of time. As chemical and mechanical renovation of the reach above the barrier site is considered infeasible, emplacement of a barrier in the near future is biologically imperative

C. Construction considerations - Because of the wide floodplain, the only economically feasible site for a fish barrier is at the bridge. The bridge concentrates the flow by means of abutment embankments that were built to lessen the span and increase the bridge height.

Access for construction equipment is excellent. Water is available for construction from the West Fork Gila River. Ready-mix plants in Silver City could provide the required concrete. Transit mixers should have no problem negotiating the road to the site.

Increased upstream flooding effects resulting from the barrier may necessitate raising a portion of the road to the Gila Cliff Dwelling National Monument.

Any work will require substantial dewatering effort. Stream diversion is another critical activity.

D. Construction cost estimate

Assumptions: Bridge is replaced.
New bridge has adequate capacity for inclusion of a fish barrier.
Fish barrier associated with a new bridge is 100 feet across.
Estimate is for fish barrier component of bridge construction only.
5-foot high concrete fish barrier structure.

Estimated cost = $390,000

Our opinion is that this site is too expensive to seriously consider, and is complicated by the politics surrounding the future of the bridge. If the politics get resolved and bridge modification or reconstruction plans proceed, that might provide an opportunity to reassess a fish barrier at the site.

IV. TURKEY CREEK

A. General - Turkey Creek enters the Gila River about 8 miles upstream of the towns of Gila and Cliff, New Mexico on State Route 293 (USGS Canyon Hill quadrangle; Map 2). The stream has a relatively steep gradient within a narrow canyon. The stream channel is dominated by boulders and cobbles, with pools separated by riffles and 1 to 2-foot waterfalls. The stream was carrying an estimated 10 cfs.

The area was visited on August 14, 2002 by Propst, Marsh, Clarkson, and Riley. Two potential sites were discovered about 1 mile upstream from the mouth of Turkey Creek and approximately ¼ mile from each other. Both sites are within the Gila Wilderness Area. The lower site UTM coordinates were 734,701 E and 3,664,225 N, approximate elevation 4,900 ft.

At the lower site, the stream constricts to a width of about 24 feet between two 20-foot boulders (Photo 3). Bedrock is not exposed in the active channel, and the foundation consists of moveable bed materials; cobbles, sand, and gravel. A fish barrier would involve anchoring a drop structure to the boulders.

The upper site also narrows between two boulders to a width of about 22 feet (Photo 4). The foundation is alluvial, consisting of large cobbles, sand, and gravel. Again, the drop structure would anchor to the boulders.

B. Biological considerations - The lower 5 miles of Turkey Creek stream contain the only known New Mexico population of Gila chub. Speckled dace, desert sucker, and Sonora sucker comprise the rest of the native assemblage, while rainbow trout and

smallmouth bass (*Micropterus dolomieu*) are non-native inhabitants. There is a natural waterfall on Turkey Creek near the Skeleton Canyon confluence, about 1 mile upstream of the potential barrier sites, that serves as an effective fish barrier. The rather limited length of stream that would be protected by a new fish barrier (about 1 mile) reduces the biological benefit of a Turkey Creek fish barrier, but protection of the chub population downstream is needed. Chemical renovation is the preferred method of removing the non-natives from this stream.

C. Construction considerations - Because the sites lie with the Gila Wilderness Area, access is a primary concern. Using existing roads, vehicles can get no closer to the lower site than ½ mile. The road involves crossing the Gila River five times and Turkey Creek four times. These crossings can be made with 4-wheel drive, but would be impassable during high flows. There is a well- defined foot path along the stream to the sites. Assuming no new road construction will be allowed, construction materials will need to be brought in with pack animals or by helicopter.

Because the barriers would tie into boulders and rest on moveable bed foundations, it would be best to use gabions for the structure materials. A gabion would be better suited to withstand some movement of the abutment boulders, or foundation undercutting, than concrete, which would crack. However, gabions would be expected to rust and fail over a period of 15-20 years.

Preferably, the foundation would be excavated down to a level where scour action becomes minimal. However, without vehicular access, excavation is difficult. The structure could be designed such that the dimension of the structure in the direction of flow is large enough to prevent complete undercutting.

Assuming minor excavation, dewatering requirements would be minimal. Stream diversion would be the principal water-related activity. Ample water is available for construction needs.

D. Construction cost estimate

Assumptions: Road cannot be built to site.
Transport materials ½ mile by mule or helicopter, personnel by foot.
5-foot high gabion fish barrier structure.

Estimated cost = $160,000

V. SOUTH FORK WILLOW CREEK

A. General - Willow Creek is located about 26 miles east of Alma, New Mexico on State Route 159 (USGS Grouse Mountain quadrangle; Map 3). The fish barrier site identified is located about 3 miles upstream of the junction of Willow Creek and Little Turkey Creek by vehicle, then about 1/3 mile on a well defined foot path. The South Fork and

the West Fork join about 200 feet downstream of the proposed fish barrier site. The reach under consideration has a relatively steep gradient with riffles and pools. The site itself is a bedrock outcrop over which the stream drops 3-4 vertical feet over a distance of about 25 feet (Photo 5). The perennial flow was estimated at 1 cfs.

The site was visited on August 15, 2002 by Telles, Propst, Marsh, Clarkson, and Riley. The GPS position was UTM 720,225 E and 3,695,162 N. The elevation is about 8,400 feet.

B. Biological considerations - Currently, the stream contains rainbow trout, brown trout, and speckled dace. If the browns and rainbows were removed with chemical piscicide, the stream would probably be restored with Gila trout, speckled dace, and desert sucker. A fish barrier at this location would protect 3 to 4 miles of stream.

C. Construction considerations - The bedrock outcrop provides an excellent foundation for a concrete or gabion structure. Excavation would be so minimal that there would be no need for a backhoe, or the associated road construction disturbances. The construction materials would be transported to the site using pack animals along the 1/3-mile footpath.

The Gila Wilderness Area boundary is about 500 feet upstream of the site, which may be close enough to trigger noise restrictions. Generators and drills for anchor bars would be the principal noise producers.

Dave Propst indicated he wanted the drop to be as high as possible. It appeared that a 7.5- to 8-foot drop could be constructed. This requires the structure to extend well up on the abutments, resulting in a crest length of about 38 feet. The left abutment rock is good up to this level. The right abutment is good rock, but may not extend to the full 8-foot drop height. The right end of the structure may need to tie into a boulder to achieve the 8-foot drop.

The stream would need to be diverted during the work. Ample water is available for construction needs.

D. Construction cost estimate

Assumptions: 8-foot high gabion fish barrier structure.
Road cannot be built to site.
Transport materials 1/3 mile by mule, personnel by foot.

Estimated cost = $38,000

The estimated cost of constructing with concrete instead of gabions would be nearly the same.

VI. SALIZ CANYON

A. General - Saliz Canyon enters the San Francisco River about 12 miles northeast of Alma, New Mexico (USGS O Block Canyon quadrangle; Map 4). The site can be reached by driving 10 miles north of Alma on Federal Highway 180, turning east onto a gravel road at Gut Ache Mesa. The three-mile road leads to the San Francisco River and the L Kelly Ranch, at which point access is restricted through a private gate. The road continues for 3 more miles to the mouth of Saliz Canyon, but prior arrangements with the landowner are necessary to access this reach. Alternative access from upstream (but not to the mouth) is via a stream-bottom road taken off US 180 near the confluence with Gordon Canyon. Road access from this direction ends approximately 2 miles above the confluence with San Francisco River. This route also requires permission from a local landowner in Saliz Canyon.

Saliz Canyon was visited on August 15, 2002 by Propst, Marsh, Clarkson, Telles, and Riley. The UTM coordinates near at the mouth of the stream are approximately 698,400E and 3,713,300N, elevation 5,370.

We hiked ½ mile downstream from the road access, but did not hike the full 2 miles to the mouth because of time and daylight constraints. The section of Saliz Canyon that we hiked was characterized by a wide alluvial canyon bottom, with thick vegetation, and no roads or paths. The distance between the canyon walls was estimated at 300 to 600 feet. The stream is perennial in this reach, with an observed flow estimated to be about 1 cfs.

Judging from the quadrangle map, the canyon may narrow to about 200 feet near the mouth. This apparent narrow area is where we are focusing our attention for a possible fish barrier site.

B. Biological considerations - A fish barrier at the mouth of Saliz Canyon would protect approximately 11 miles of stream. The stream is in need of a thorough fish survey, but is know to support the natives speckled dace, desert sucker, and Sonora sucker, and the non-native fathead minnow. Longfin dace may inhabit the stream near its terminus. Saliz Canyon appears suitable for repatriation of loach minnow as well. Currently there are few non-natives in the San Francisco River near Saliz Canyon (only mosquitofish and fathead minnow), but a barrier would provide needed security should additional, more noxious, non-natives establish in the future.

From a biological standpoint, Saliz Canyon is one of the best candidates for a fish barrier discussed in this report, in that a barrier site at the mouth would protect the longest reach of stream. The stream may not need to be chemically renovated prior to repatriation with loach minnow and perhaps other native species.

C. Construction considerations - The key to a fish barrier at the mouth of Saliz Canyon is whether the L Kelly Ranch owners will allow access through their land along the San Francisco River to the mouth of the stream. From the upstream direction there is not a road the last 2 miles to the site. A road could be graded in, but would require vegetation clearing, and there may be opposition to such a disturbance. Access to a new road to the

site would be from the 3-mile long Saliz Canyon road to the north. There are quite a few residences along this road. The residents may not be willing to endure the construction traffic this project would generate. The size of the structure makes helicopter construction cost prohibitive.

Since we did not physically reach the proposed site, some of the construction considerations discussed below may ultimately prove to be inaccurate.

The site will likely consist of an alluvial channel bounded by rock canyon walls. It has been our experience that the alluvium in these types of channels is usually too deep to consider resting the structure on bedrock. The structure would likely tie to rock only at the ends and would need to be keyed down to prevent scour undercutting, similar to the Aravaipa Creek fish barrier. A concrete structure would be appropriate at this site.

Significant excavation would be required for the scour keys. To perform this excavation, a considerable amount of effort would need to be given to dewatering to provide stable slopes and a dry area to work. Well points would probably be needed at 50-foot intervals, both upstream and downstream of the excavation.

Stream diversion will be a concern, especially during storms. But judging by the 1 cfs flow we witnessed, base flow should be relatively easy to divert.

The flood stages of the San Francisco River will need to be evaluated to ensure that the fish barrier is not inundated by San Francisco flows.

The road from Federal Highway 180 gets rough and steep as it descends into the San Francisco River channel. Grading, soil binder, or paving at the steep sections may be necessary to provide safe access for transit mixers.

There appears to be ample construction water from Saliz Canyon and the San Francisco River.

From a construction standpoint, Saliz Canyon is a viable location. However, if the L Kelly Ranch owners do not grant permission for access, this site would be considered infeasible. If our assumptions of the site are reasonably accurate, the construction would involve an operation similar in scope to the Aravaipa Creek fish barriers.

D. Construction cost estimate

Assumptions: Vehicular access to site.
Fish barrier structure would be 200 feet across
Transit mixers are able to reach the site.
5-foot high concrete fish barrier structure.

Estimated cost = $770,000

VII. FRIEBORN CREEK

A. General - Frieborn Canyon is in New Mexico near the Arizona border about 9 miles northeast of the town of Blue, Arizona. The stream drains into Dry Blue Creek (USGS Maness Peak, Arizona and New Mexico quadrangle; Map 5) about ½ mile below the potential fish barrier site.

This site was visited on August 16, 2002 by Propst, Telles, Marsh, Clarkson, and Riley. The site was located by GPS at UTM coordinates 682,157E and 3,732,375N, approximate elevation 6,450 ft.

The stream is perennial at the potential fish barrier site, with a flow estimated at less than 1 cfs. The alluvial channel is armored with cobbles up to 1 foot in diameter and is about 20 feet wide. The banks are stable and vegetated. The overbank terraces are narrow as the ground appears to rise above the flood prone elevations within 30 to 40 feet laterally.

B. Biological considerations – Two to three miles of stream would be protected above the proposed fish barrier site. The only native fish present in the stream is speckled dace, but others such as loach minnow and Gila trout could potentially be repatriated. Non-native brown trout also inhabits the stream, and a barrier would protect natives against this species and rainbow trout. Mechanical removal of brown trout might be possible, otherwise chemical renovation would be considered.

C. Construction considerations - There are no existing roads to the site. Access is along a foot path, shown as a pack trail on the quadrangle. Unless a road is constructed, pack animals or helicopter would need to be used to transport construction materials.

There are several inhabited dwellings near the confluence with Dry Blue Creek. Without support from these landowners, it may be difficult to obtain access for construction personnel and equipment. One landowner we met appeared to be somewhat sympathetic to the concept.

At the site, the stream is at the base of an 8-foot high bedrock outcrop on the right abutment (Photo 6). The bedrock offers an excellent anchorage for the right end of the structure. It appears that the nearly vertical bedrock face would continue to extend below ground for an unknown depth, so the middle of the structure would be built on alluvium.

Excavating the alluvium would require a backhoe, which in turn would necessitate vehicular access. A backhoe could probably access the site without a road and without much disturbance to the stream or vegetation. The well-armored channel may resist scour, making deep excavation unnecessary.

To the left is a stable 2-foot high stream bank. Beyond the bank, the ground rises fairly uniformly at a slope of about 3 vertical feet to 40 horizontal feet. Junipers and pines take hold about 30 feet from the channel, indicating that the floodplain is limited laterally. A five foot-high fish barrier would be about 60 to 70 feet long. An 8-foot high barrier, as discussed for trout would probably be as long as 120 feet.

There is water available in the stream for construction purposes. Excavation would require dewatering. Stream diversion will be relatively easy except during runoff events.

Because of access issues and the short length of stream above the site, this site is not under serious consideration at this time.

D. Construction cost estimate

Assumptions: Road cannot be built to site.
Fish barrier structure would be 70 feet across
5-foot high gabion fish barrier structure

Estimated cost = $149,000

VIII. DRY BLUE CREEK

A. General - Dry Blue Creek flows into the Blue River about 9 miles northeast of the town of Blue, Arizona (USGS Maness Peak, Arizona and New Mexico quadrangle; Map 5). The site is located about 1 mile from the confluence with the Blue River.

This site was visited on August 16, 2002 by Propst, Telles, Marsh, Clarkson, and Riley. A potential fish barrier site was located by GPS at UTM coordinates 682,283E and 3,734,584N, approximate elevation 6,460 ft.

The channel is characterized by a wide (250 to 400 feet) low gradient floodplain bounded by steep rocky slopes or rock canyon walls. The 20-foot wide active channel is contained within 2-foot high banks. The stream is perennial with an estimated flow of 1 cfs at the time of our visit.

B. Biological considerations - Known native species within the stream are loach minnow, speckled dace, desert sucker, and Sonora sucker, and it is thought that brown trout is the primary non-native invasive species. If after a thorough inventory, no additional non-native fishes (particularly centrarchids or ictalurids) were found, chemical renovation might not be needed. A fish barrier at the lower end of Dry Blue Creek would protect 3 to 4 miles of stream against non-native species that occur in the Arizona portion of the drainage.

C. Construction considerations - Starting about ½ mile upstream of the mouth of Dry Blue Creek, vehicular access is prohibited. The most promising site is located another ½

mile beyond the vehicle restriction. Although vehicular access is not currently allowed, there is an abandoned road that would provide good access if opened for construction.

There are several inhabited dwellings near the confluence with Frieborn Canyon. Without support from these landowners, it may be difficult to obtain access for construction personnel and equipment.

The distance between the canyon walls was measured at 250 feet. The left abutment is made up of a 25-foot high rock face, which would provide excellent anchorage for the left end of the structure. We assume the alluvium in the channel is too deep to construct the fish barrier on rock, so the structure would need to be keyed down to prevent undercutting from scour. The right abutment is steeply sloping rocky ground that would provide adequate anchorage for the right end of the barrier.

There is water available in the stream for construction purposes. Excavation would be straightforward, provided vehicles are allowed upstream. Dewatering will be necessary to stabilize the excavated slopes. Stream diversion will be relatively easy except during runoff events.

To eliminate driving a full ½ mile into the restricted area, the barrier could be built just upstream of the vehicle closure fence. The width of this location was not measured, but did not look appreciably wider than the preferred site. The abutments are steep rocky slopes that would provide adequate anchorage.

The width of the canyon makes this fish barrier site costly. Assuming vehicles will be allowed to access the fish barrier site, the cost is estimated at $960,000. Because of the cost, the short length of stream above the site, and the access unknowns, this site is not under serious consideration at this time.

D. Construction cost estimate

Assumptions: Vehicular access to site.
Fish barrier structure would be 250 feet across
Transit mixers are able to reach the site.
5-foot high concrete fish barrier structure.

Estimated cost = $960,000

IX. ENVIRONMENTAL COMPLIANCE

Consideration of possible fish barriers on Gila River basin New Mexico streams beyond the feasibility stage must include provisions for compliance with National Environmental Policy Act (NEPA), Endangered Species Act (ESA), and Clean Water Act (CWA). Reclamation ultimately will be the action agency for potential fish barrier projects in New Mexico, and it is likely that compliance with NEPA provisions would be performed

by them or outsourced to a private consultant. The NEPA process entails writing draft and final Environmental Assessments of the preferred project and its considered alternatives, and presenting the preferred and alternative projects at public meetings. The NEPA process would require an estimated 12 months to complete, but could be longer depending on site complexities and support or opposition from other agencies. Reclamation estimates that its performance of all NEPA-required activities would cost approximately $40,000, but could vary up or down depending on the site chosen.

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, further processing of a 404 permit application, and identification of possible mitigation for certain impacts to "waters of the US." Processing time for compliance with CWA can take 6-12 months. Reclamation estimates that compliance costs associated with CWA regulations would be an additional $30,000.

ESA compliance likely will involve writing a Biological Assessment that determines effects of the project to federally-listed species and potentially designated critical habitat. As any project will be for the benefit of threatened or endangered native fishes, consultation with FWS should proceed smoothly, as it did recently with Reclamation's Aravaipa Creek fish barrier project. Reclamation estimates that ESA compliance activities should not take more than 3-6 months, depending on the priority it receives from FWS. Estimated cost for ESA compliance by Reclamation is approximately $10,000, but it is possible that FWS could undertake that function if benefits under ESA are sufficient.

X. CONCLUSIONS

With consideration to the principle criteria (potential for native fish protection/enhancement, presence or threat of non-native fishes, length of stream the barrier would protect, cost to construct the barrier structure, construction access to the site, flooding impacts, and risk to existing property and infrastructure), Little Creek and Saliz Creek are the preferred fish barrier sites at this time. However, there are still significant unknowns associated with Saliz Creek, which could affect its standing with respect to the other potential sites.

XI. MAPS

Map 1 - Little Creek

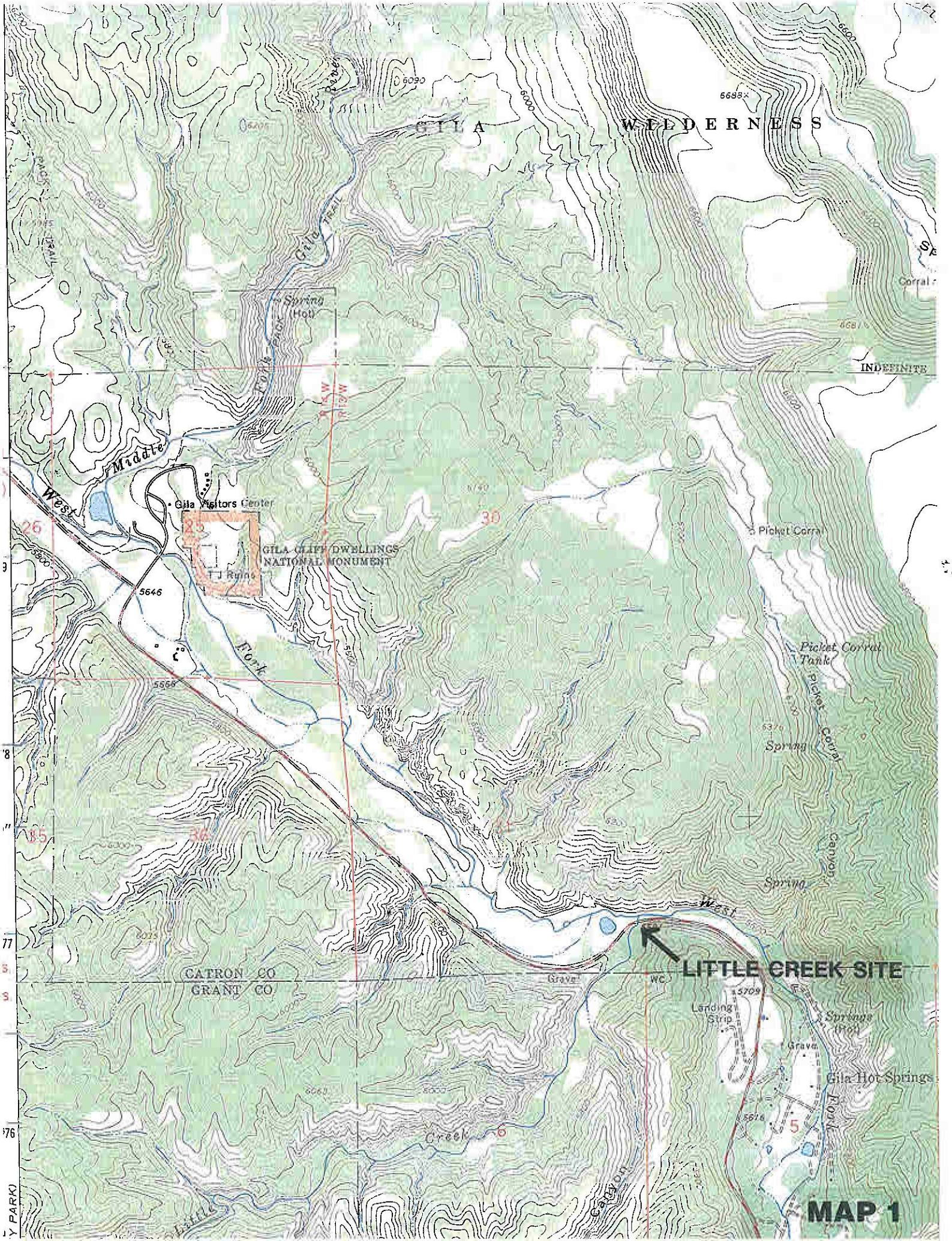
Map 1a - West Fork Gila River

Map 2 - Turkey Creek

Map 3 - South Fork Willow Creek

Map 4 - Saliz Canyon

Map 5 - Frieborn Canyon
Dry Blue Creek


GILA WILDERNESS
INDEFINITE
Gila Trail
Spring (Hot)
Middle Fork
West Fork
Gila Visitors Center
GILA CLIFF DWELLINGS NATIONAL MONUMENT
T J Ruins
Picket Corral
Picket Corral Tank
Spring
Cave
Spring
West Fork
LITTLE CREEK SITE
CATRON CO
GRANT CO
Landing Strip
Springs (Hot)
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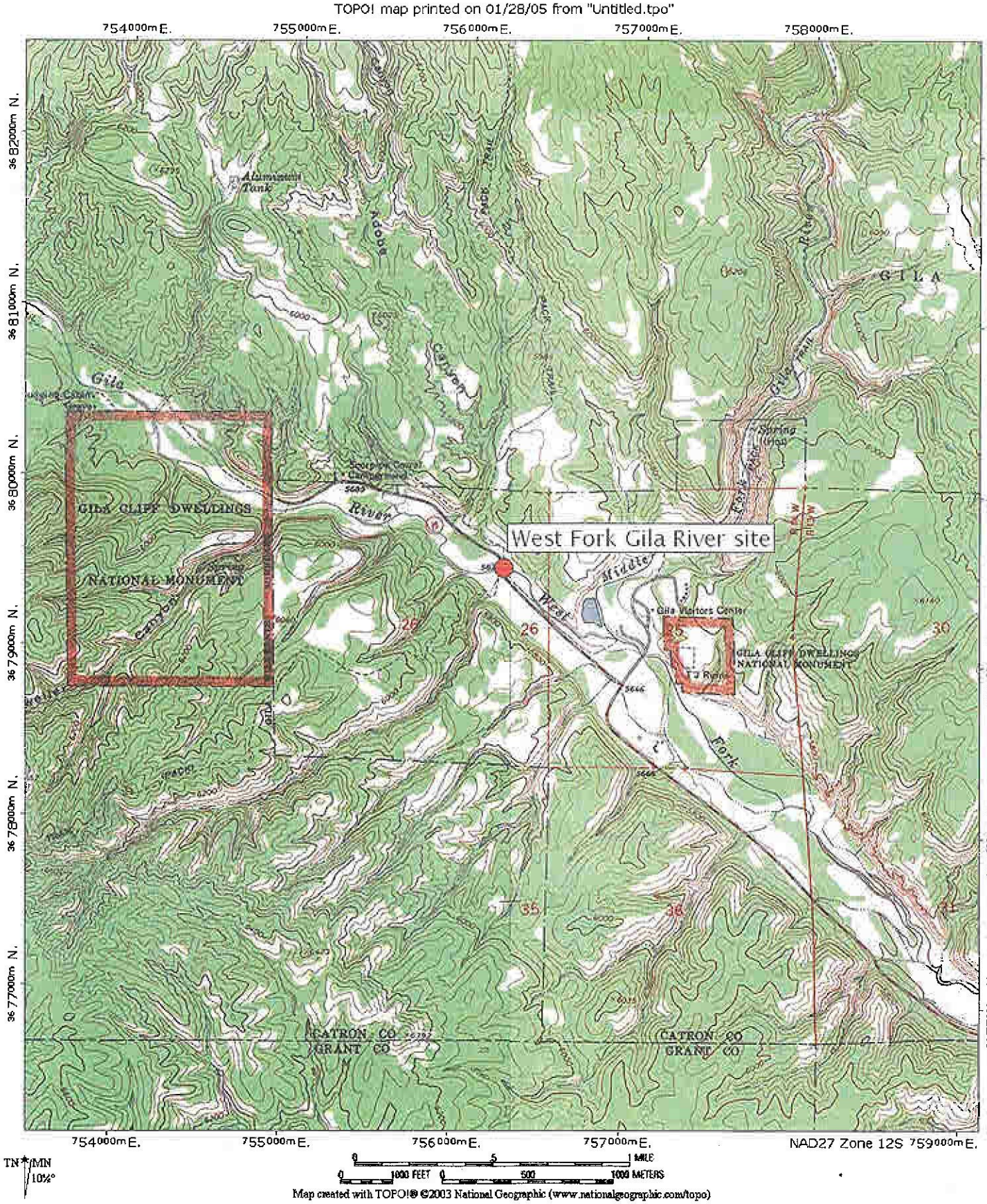
Gila Hot Springs
Creek
Little
Canyon
MAP 1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West Fork Gila River site
GILA CLIFF DWELLINGS NATIONAL MONUMENT
Gila Visitors Center
Scorpion Cover Campground
Adobe
Canyon
Middle
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Fork
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TN 10½°
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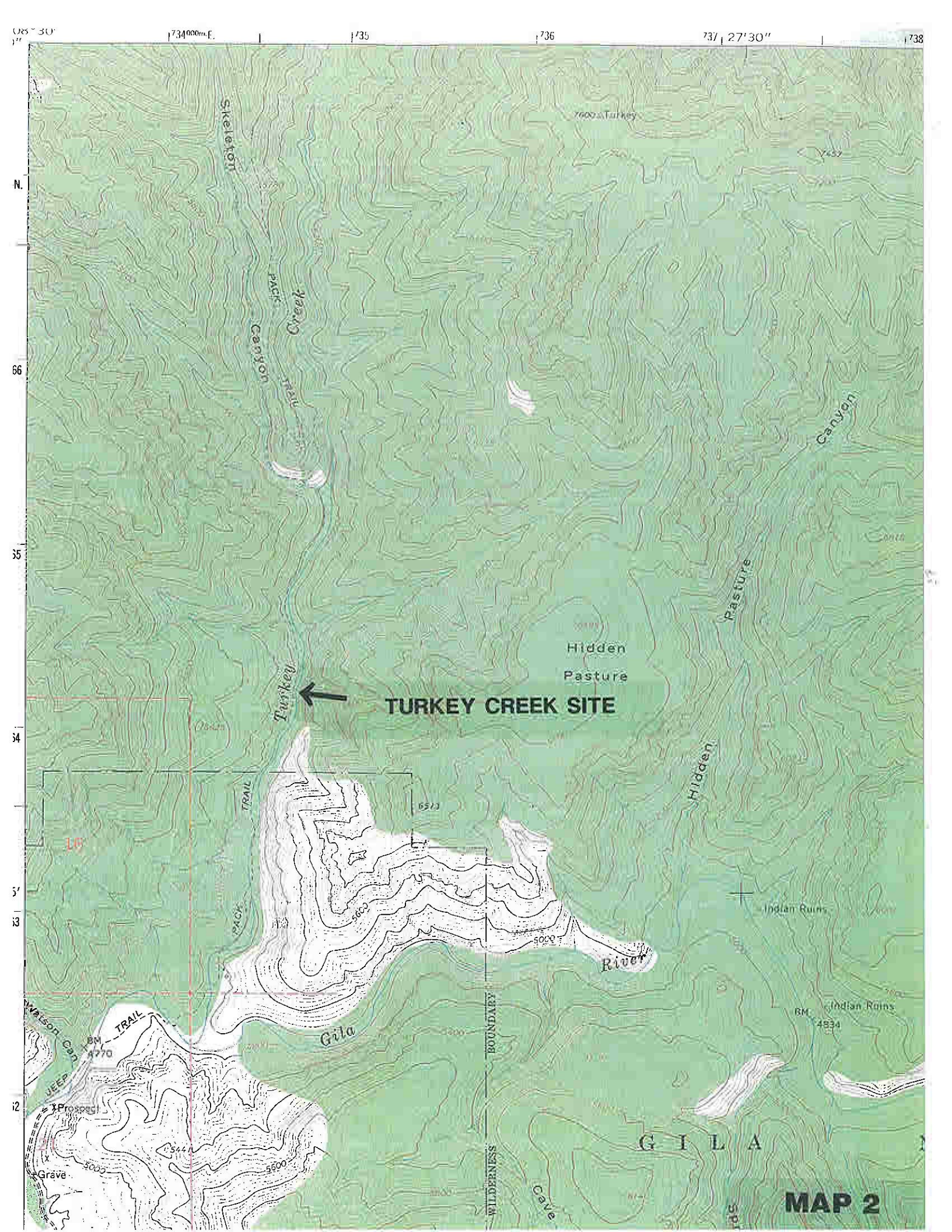
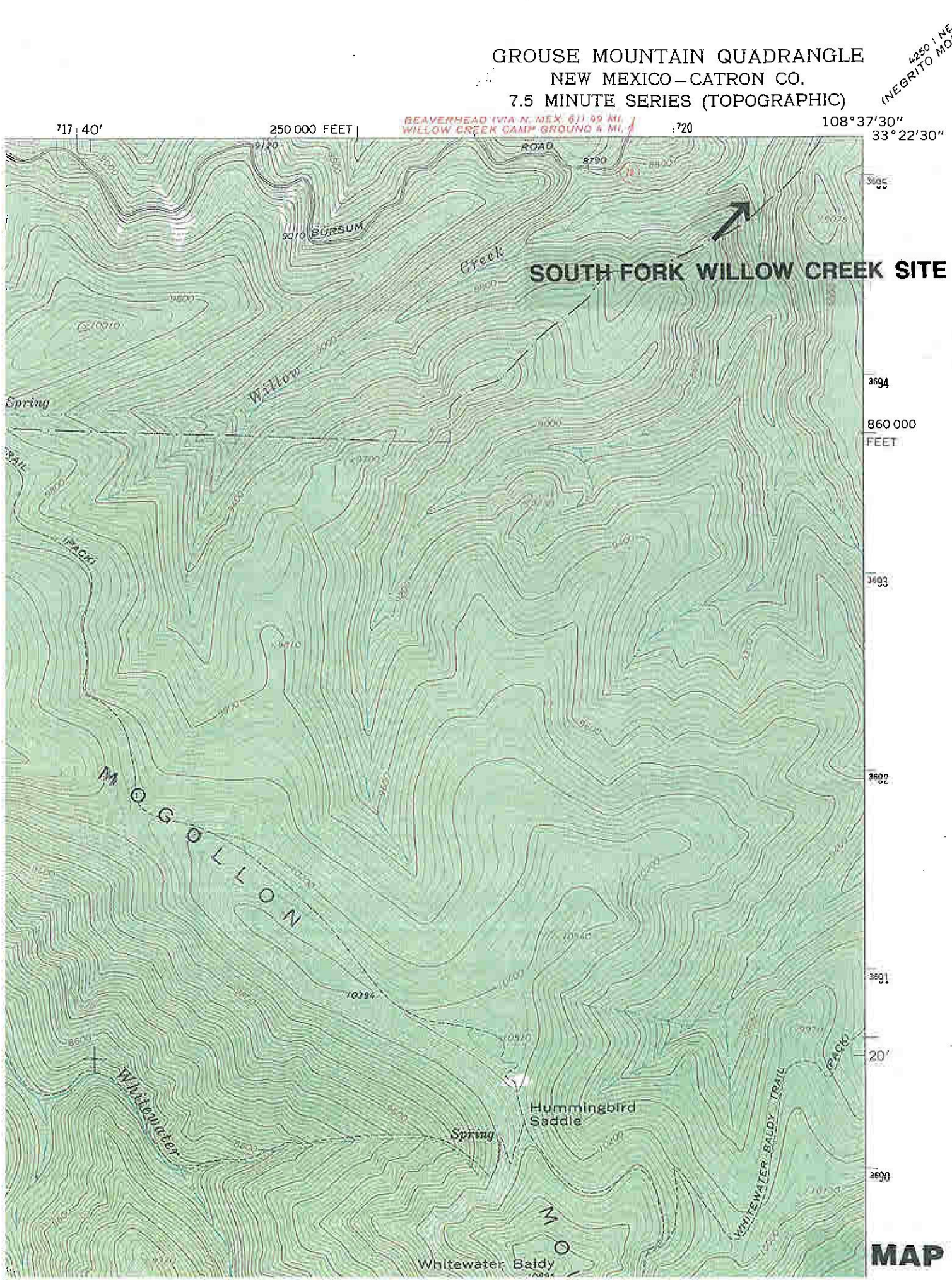
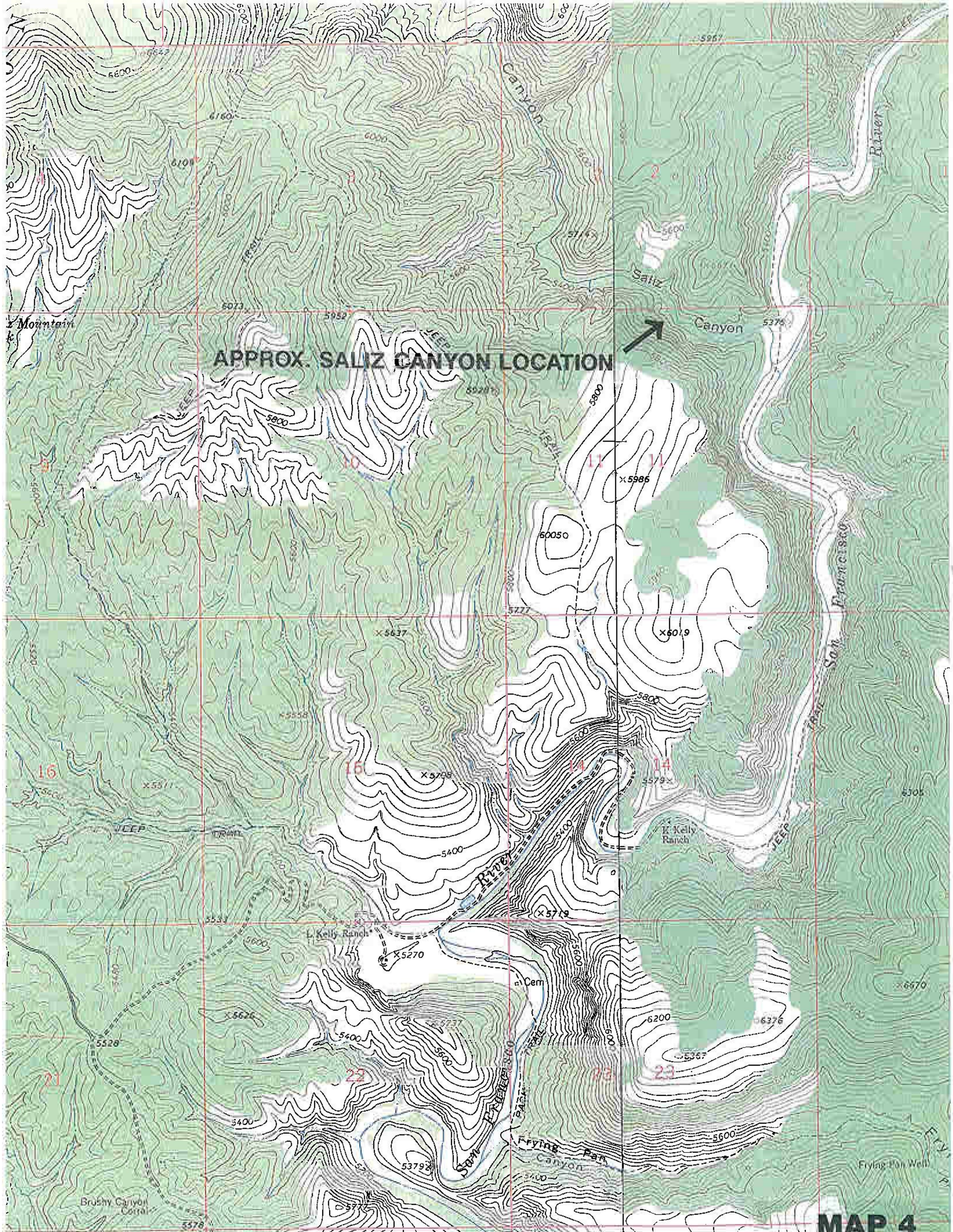
500
1000 METERS
Map created with TOPO!® ©2003 National Geographic (www.nationalgeographic.com/topo)

MAP 1a


Skeleton Canyon Trail
Pack Creek
Turkey
Hidden Pasture
TURKEY CREEK SITE
Hidden
Pasture
Canyon
Indian Ruins
Indian Ruins
BM 4834
Gila River
BOUNDARY
WILDERNESS
TRAIL
JEEP
BM 4770
Prospect
Grave
Cave
GILA
MAP 2

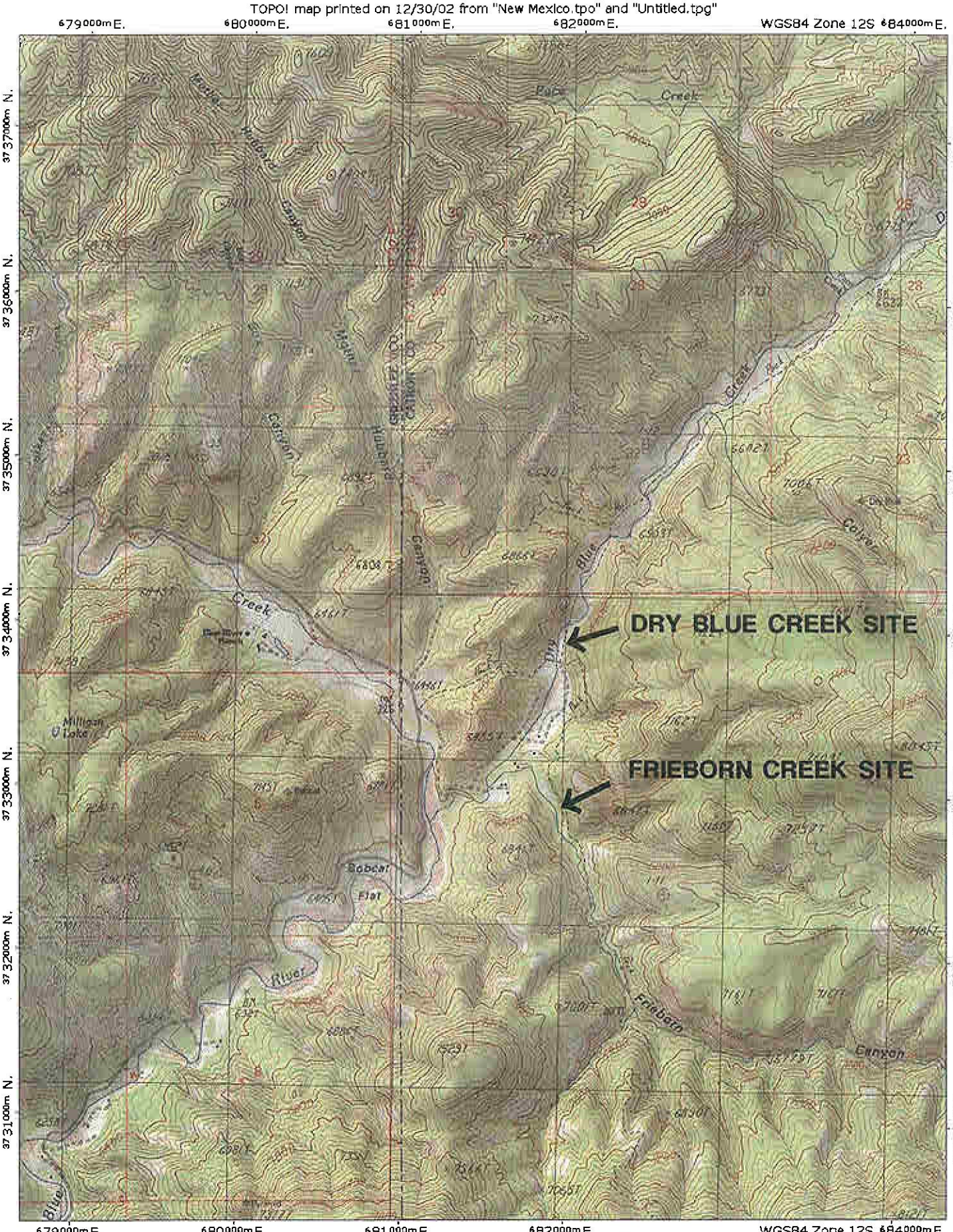

GROUSE MOUNTAIN QUADRANGLE
NEW MEXICO—CATRON CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
4250 I NE
(NEGRITO MOUNTAIN)
717 | 40'
250 000 FEET
BEAVERHEAD (VIA N. MEX. 61) 49 MI.
WILLOW CREEK CAMP GROUND 4 MI.
720
108°37'30"
33°22'30"
ROAD
9790
9270
BURSUM
Creek
SOUTH FORK WILLOW CREEK SITE
Willow
Spring
3694
860 000
FEET
TRAIL
PACK
3693
MOGOLLON
10394
3692
3691
20'
Whitewater
Spring
Hummingbird
Saddle
PACK
WHITEWATER BALDY TRAIL
3690
Whitewater Baldy

MAP 3


APPROX. SALIZ CANYON LOCATION
Saliz
Canyon
Canyon
San Francisco
River
JEEP
TRAIL
K Kelly Ranch
L Kelly Ranch
Cem
Frying Pan
Canyon
Frying Pan Well
Brushy Canyon Corral
5986
6005
6019
5637
5705
5719
5270
5626
5528
5578
5379
6376
6670
6305
5952
6073
5928
5375
5777
5579
5737
5367
6200
5600
5400
5800

MAP 4

TOPO! map printed on 12/30/02 from "New Mexico.tpo" and "Untitled.tpg"



MAP 5

XII. PHOTOS

Photo 1	Little Creek - Looking downstream at State Route 15 box culvert crossing.
Photo 2	West Fork Gila River - Looking downstream at State Route 15 bridge. Streamflows can be seen at the far right side of the channel below the bridge.
Photo 3	Turkey Creek - Looking upstream at lower site.
Photo 4	Turkey Creek - Looking downstream at upper site.
Photo 5	South Fork Willow Creek - Looking upstream at proposed fish barrier location.
Photo 6	Frieborn Canyon - Looking downstream at proposed fish barrier site.
Photo 7	Dry Blue Creek - Looking upstream at the proposed site about ½ mile above the vehicular restriction.

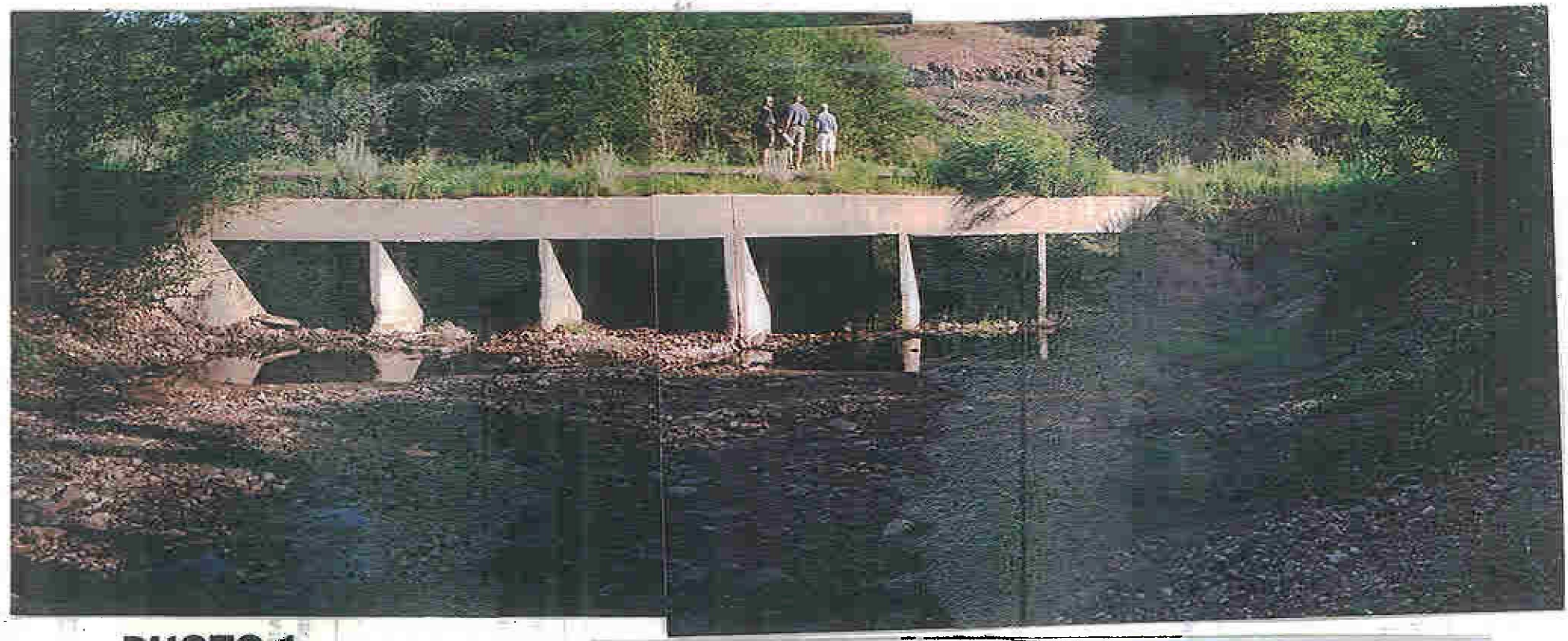


PHOTO 1

PHOTO 2

PHOTO 3

PHOTO 4

PHOTO 5

PHOTO 6

PHOTO 7