APPENDIX A

Engineering Field Trip Report

Friant Dam Enlargement

APPENDIX A.1

Study Team Field Trip Report

(June 12, 2002)

Field Trip Log			
Trip Log Number:	10	**Project No.:**	1003032.01180502
Dates:	6/12/02	**Times:**	~1425-1530
Site Name:	Friant	**Location:**	Friant
Prepared By:	DKR/JMH/WAM	**Reviewed By:**	
Date:	6/12/02	**Date:**	

Attendees/Visitors Name	**Organization/Phone/Email**
DKR	MWH, 925.685.6275 x125, david.k.rogers@mwhglobal.com
JMH	MWH, 925.685.6275 x143, james.m.herbert@mwhglobal.com
WAM	MWH, 425.602.4025 x1060, william.a.moler@mwhglobal.com
William Swanson	MWHA
Stephen Osgood/Yung-Hsin	MWHA
Jason Phillips	USCOE
Bill Luce/Greg Mongano/ Joel Sturm	USBR
Clarence Duster/Gary Turlington/Steve Harrington	USBR
Waiman Yip	DWR
	USFG

Weather Conditions:

Clear with slight haze, warm (80s), light breeze

Access Route (attach map):

Highway 99, State highway 145 (E) through Madera, to Friant Road (S), to Lake Millerton Boat Ramp.

Attachments:	Yes	No
Photo Log	✓	
Photos	✓	
Video Log (available)	✓	
Dictation Log (available)	✓	
Topographic Map	✓	

Purpose:

Initial site visit for project team familarity with Friant Dam, Millerton Lake, and Temperance Flat and Fine Gold Creek sites.

Field Observations:

Existing Structures/Cultural Features:

Friant Dam is a 319-ft high concrete gravity dam on the San Joaquin River, about 20-miles north of Fresno. The dam was built in 1942 and has a 3,488 ft long by 20-ft wide crest. The spillway is an ogee type and is gated with 100 ft wide by 18 ft high drum gates. The reservoir, Lake Millerton, has a storage capacity of ~520,500 ac-ft at maximum pool elevation of 578 ft (URS, 2000). Deterioration of concrete in the dam and spillway resulting from reactive aggregate reaction has been identified (USBR, 1989). In about 2000, rubber gates were installed.

Scattered residential development surrounds the main portion of the lake (below Fine Gold). The previously relocated historic Millerton County Courthouse is located on a point adjacent to the Millerton Boat Ramp. Millerton Marina is located on the south shore in Winchell Cove. There are three campgrounds (North Shore, and North Fine Gold and Temperance Flat Boat Camps) and a number of picnic areas along the present shoreline.

Kerckhoff Dam and Powerhouse are located upstream of Friant Dam. Pool elevations above 620 would impact the powerhouse, penstock, tramway, and several other structures. Approximately 1-mile of high voltage transmission lines would also have to be relocated (URS, 2000).

Right of Way/Access Restrictions:

Public roads lead to the Friant Dam area. A number of paved and unpaved roads rim the lower portion of Millerton Lake, around the Friant Dam area.

Overhead/Buried Utilities:

Overhead and underground utilities provide services to the properties and enterprises that surround the dam area and the lower, main portion of the lake.

Description of Proposed Structures (attached a field sketch or sketch on a topo map):

Proposed Friant Dam modifications include 20-, 60- and 140-foot raises, with the 20-foot raise being the most feasible. Any raise above 60 feet would require construction of an approximately 3,000-foot long dike across a low ridge saddle at the southwest margin of the existing reservoir.

A 1952 set of documents provided by the USBR summarize the raising of Friant Dam 60 feet (USBR, 1952). A 20-ft raise of the 20-ft wide dam crest is described in 2000 by URS. The 20-ft raise would increase the pool elevation to 598 feet and the storage capacity ~105,000 ac-ft (URS, 2000).

Description of Appurtenant Features (spillways, tunnels, pumping plants, flood routing/coffer dams/dewatering during construction, outlet works, switch yards, transformer yards, transmission lines, conveyance pipelines/canals, access roads, security, operation/maintenance):

In the USBR documents, it appears that the general design and operation of the dam as it is now would be maintained in the 60-foot raise. These documents suggest that an 8,500-foot long dike would also be required (USBR, 1952). The URS document discuss raising the dam crest and modifying the spillway and spillway chute (URS, 2000)

Briefly Describe Geologic/Geotechnical Site Conditions:

Friant Dam is located at the boundary of the Sierra Nevada foothills and the Great Valley. A 1930 Geological Report on Friant, Fort Miller and Temperance Flat Damsites by Hyde Forbes (Forbes, 1930), and observations made indicate that both abutments are underlain by metamorphic rock. Forbes described the rock at Friant Dam as consisting of complex metamorphic mica-schist. The rocks are apparently intruded by Mesozoic granitic rocks that have altered some of the meta-sediments to gneisses and schists. Forbes described the materials as being “perfectly crystalline”, with a “strong fabric of interlocking crystals without any apparent textural weaknesses” (Forbes, 1930).

State geologic maps show pre-Cretaceous meta-sedimentary and metamorphic rocks, and pre-Cenozoic and Mesozoic granitic rocks around the lake. Pliocene pyroclastic volcanic rocks cap many of the surrounding ridges creating tablelands or buttes. Rocks beneath Friant Dam are shown as pre-Cretaceous meta-sedimentary rocks. Immediately downstream of the dam are Pleistocene and Recent river alluvium deposits of sand, gravel, and possible silt (CDMG, 1965 and 1967).

As with most sites in the region, studies indicate that there are no faults in the area capable of producing ground motions greater than those generated by four known regional sources that include the San Andreas fault system, the Sierra Frontal fault system, the White Wolf fault, and the Garlock fault (USCOE, 1990).

Location/Description of Nearest Borrow Areas (attach map or show on topo map):

Borrow sites in close proximity were not noted, but may be present downstream of Friant Dam.

Location/Description of Equipment/Material Staging and Lay Down Areas (attach map or show on topo map):

Potential staging and laydown areas are present downstream of the existing dam.

Identification of Environmental Sensitive Areas (wetlands, springs, rivers, streams, endangered/threatened species habitats, etc.):

An oak woodland habitat covers the riverbank slopes.

Description of Mining or Other Anthropologic Activities:

None were noted, except for a gravel pit shown on the shore of Winchell Cove.

Action Items/Data Needs (list who has responsibility and schedule for completion):

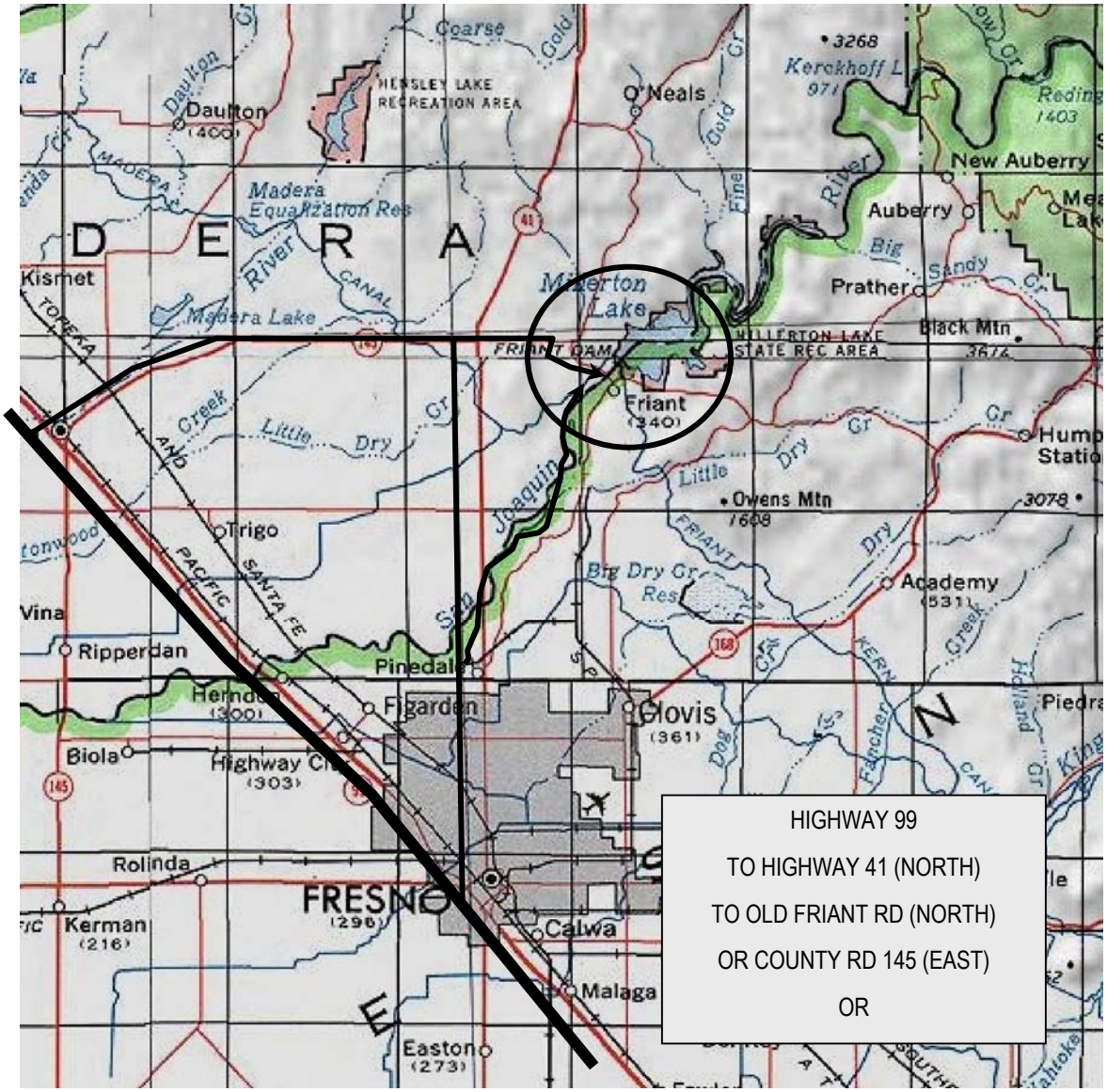
USBR to prepare draft Technical Memorandum and regional seismicity / faulting by August 23, 2002.

Routing:

MWH-5

USBR-3

DWR-2


HIGHWAY 99
TO HIGHWAY 41 (NORTH)
TO OLD FRIANT RD (NORTH)
OR COUNTY RD 145 (EAST)
OR
Daulton
O'Neals
New Auberry
Auberry
Prather
Kismet
Madera Lake
Friant
Trigo
Ripperdan
Pinedale
Figarden
Glovis
Biola
Rolinda
FRESNO
Kerman
Calwa
Malaga
Easton
Academy
Owens Mtn
Black Mtn
Hillerton Lake
Madera Equalization Res
Big Dry Cr Res
Kerckhoff L
Hensley Lake Recreation Area
Friant Dam
Hillerton Lake State Rec Area
San Joaquin
Little Dry Cr
Big Sandy Cr
Coarse Gold
Fine Gold
Dry Creek
Fancher Creek
Dog Cr
Holland Cr
Piedra
Vina
Hernden
Highway City
Santa Fe
Pacific
Topeka
Madera Canal
Madera River
Fresno River
Kern Canal
Friant Dam
Hillerton Lake State Rec Area
Big Dry Cr Res
Madera Equalization Res
Madera Lake
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Hump Station
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Owens Mtn
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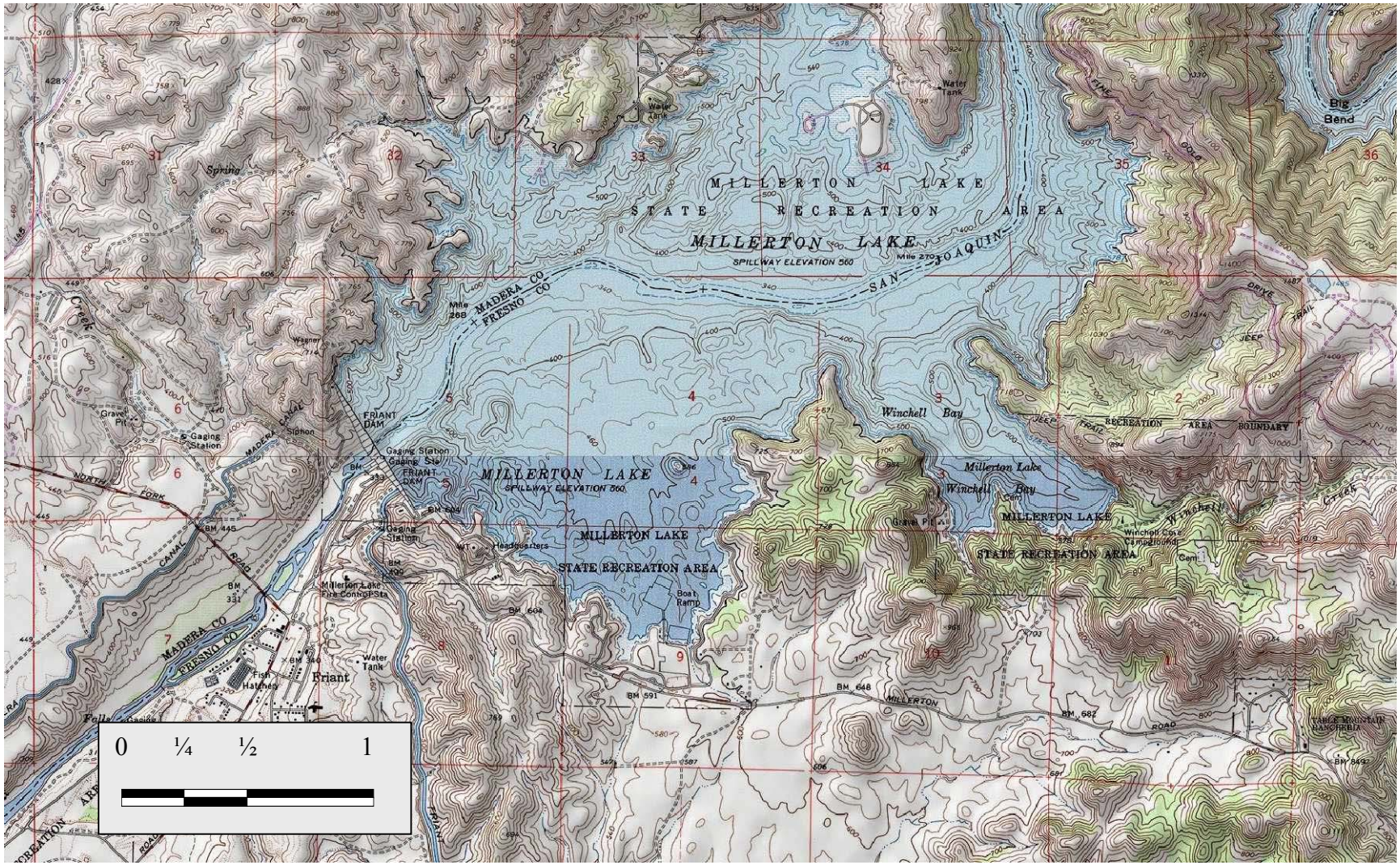
MILLERTON LAKE
STATE RECREATION AREA
MILLERTON LAKE
SPILLWAY ELEVATION 560
SAN JOAQUIN
MADERA CO
FRESNO CO
FRIANT DAM
Winchell Bay
Millerton Lake
Winchell Bay
MILLERTON LAKE
STATE RECREATION AREA
RECREATION AREA BOUNDARY
Big Bend
Friant
Fish Hatchery
Water Tank
Boat Ramp
Headquarters
Gaging Station
Gravel Pit
Spring
0 ¼ ½ 1

Friant Dam/ Lake Millerton – Southwesterly view, toward the dam.

Southerly view of the low-lying area east of the dam.

Southerly view of the low-lying area east of the dam.

Southerly view of homes near shore just upstream of Winchell Bay.

Southerly view of homes near shore upstream of Winchell Bay.

Southerly view of homes near shore upstream of Winchell Bay.

Northerly view of homes near shore downstream of Fine Gold.

Northerly view of homes near shore downstream of Fine Gold. Lowest home on lake is at left.

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APPENDIX A.2

Reclamation Field Trip Report

June 12-14, 2002

Upper San Joaquin River Storage Investigation
Field Trip Logs

August 2002

Prepared By U.S. Bureau of Reclamation
Mid-Pacific Regional Office - Sacramento, California and
Technical Service Center - Denver, Colorado

Bureau of Reclamation personnel from the Mid-Pacific Region, Sacramento, California, and the Technical Services Center, Denver, Colorado prepared this report. This report contains the following attachments:

ATTACHMENT 1 - General Information and Field Trip Log for Friant Dam Raise

ATTACHMENT 2 - Photographs 1 – 6, 27 – 28

Note: This page has been modified from the original provided by Reclamation to reflect the exclusion of materials pertaining specifically to Fine Gold Creek Damsite and Temperance Flat Damsite, which are contained in the appendices of their respective Technical Memoranda.

ATTACHMENT 1 – GENERAL INFORMATION AND FIELD TRIP LOGS

Site Review - Temperance Flat and Fine Gold Damsites, and Friant Dam Raise

Reclamation Inspection Team

Name	Title	Location	Phone Number
Clarence Duster	Civil Engineer	Denver, CO	(303) 445-2993
Gary Turlington	Geologist	Denver, CO	(303) 445-3203
Steve Higinbotham	Civil Engineer	Denver, CO	(303) 445-2491
Greg Mongano	Geologist	Sacramento, CA	(916) 978-5331
Joel Sturm	Geologist	Sacramento, CA	(916) 978-5305

Field Trip Itinerary

6/12: The inspection team participated in a boat trip to the three Temperance Flat Damsites (MP 274, MP 279, and MP 280), Fine Gold Damsite and Millerton Lake. The boat, provided by California State Parks, carried 21 passengers from California DWR, Montgomery, Watson, Harza Engineers and Reclamation. The inspection team also inspected the crest of Friant Dam and traveled to Wishon Powerhouse (upstream end of Kerckhoff Lake), and Kerckhoff Powerhouses No. 1 and No. 2.

6/13: The inspection team drove to Temperance Flat and hiked to the left abutments of MP 279 Damsite and MP 280 Damsite (located about 1 mi. upstream of MP 279 Damsite) and drove to Fine Gold Recreation area (located about 1 mi. downstream of MP 274 Damsite) via Sky Harbor Dr.

6/14: The inspection team drove to the upper right abutment of Fine Gold Damsite and drove through the Fine Gold Reservoir area via Road 210. The team briefly stopped at the Vulcan aggregate pit and plant located in the San Joaquin River channel, about 1 mi. downstream of Friant Dam.

Weather Conditions

Warm to hot and clear. Daily highs in the mid- to upper-90s.

Friant Reservoir (Millerton Lake) Conditions on June 12, 2002

Water Surface: El. 573.8 (Max water surface: El. 580)
Reservoir Volume: 501,022 acre-feet (Max capacity: 520,000 a-f)
Inflow: 2,901 cubic feet per second (cfs)

General Right of Way/Access Restrictions

The majority of the travel during the June 12-14, 2002 field trip was on paved or well maintained dirt public roads and trails. All roads traveled were passable to two-wheel drive vehicles. The use of private roads and crossing of private property was only required to access the two Kerckhoff Powerplants. Information on specific private roads, access restrictions and owner contacts is described separately in the Access Route section for each feature. Future fieldwork will require that formal requests for Right of Entry (ROE) be made.

General Comments on Materials/Aggregate Suppliers

The inspection team briefly visited one aggregate processing operation, Vulcan aggregate pit and plant located in the San Joaquin River channel, about 1 mi. downstream of Friant Dam. Based on discussions with the operator, the following information on local sand and gravel processing operations are provided:

The Vulcan pit has 2 to 3 years of materials remaining under current permitting. Application for new permits that would allow deeper (35 feet) excavation has been submitted. Without approval of the new permits, Vulcan could cease operations in 2 to 3 years. Several sand and gravel operations in the Fresno area have ceased operation the past two years due to permit restrictions. Vulcan knows of only one operation in the area that crushes rock to make concrete aggregate.

Miscellaneous Contacts

Name	Agency	Title	Location	Phone Number
Gerry Pretzer	USBR	Operator	Friant Dam	(559) 822-2211
Tony Buelna	USBR	Sup.Civil Eng.	Fresno, CA	(559) 487-5117
Bob Epperson	USBR	Realty Spec.	Fresno, CA	(559) 487-5408
Paul Linderman	PG&E	Hydraulic Struct.	Auberry, CA	(559) 855-6007
Ted Jackson	CA State Parks	Dist. Super.	Millerton Lake	(559) 822-2332
Kevin Forester	CA State Parks	Chief Ranger	Millerton Lake	(559) 822-2332
Tom Christensen	Millerton Marina	Manager	Millerton Lake Marina	(559) 822-2264
Dave Johnson	BLM	Ranger	Kerckhoff No. 2	

MWH
MONTGOMERY WATSON HARZA

MWH ENERGY & INFRASTRUCTURE, INC.

Field Trip Log

Trip Log Number:		**Project No.:**	
Dates:	June 12, 2002	**Times:**	
Site Name:	Friant Dam Raise	**Location:**	
Prepared By:	U. S. Bureau of Reclamation	**Reviewed By:**	
Date:	June 17, 2002	**Date:**	

Attendees/Visitors Name	**Organization/Phone/Email**	
Clarence Duster, Civil Engineer	TSC, Denver, CO	303-445-2993
Steve Higinbotham, Civil Engineer	TSC, Denver, CO	303-445-2491
Joel Sturm, Geologist	MP Region, Sacramento, CA	916-978-5303
Gary Turlington, Geologist	TSC, Denver, CO	303-445-3203
Greg Mongano, Geologist	MP Region, Sacramento, CA	916-978-5331

Weather Conditions:

Warm to hot and clear. Daily highs in the mid to upper 90s.

Access Route (attach map):

See **Attachment 2 – Figure 1** for site locations and access routes.

Site Access

- From Hwy 99, exit at Hwy 41 North
- 8 mi. north on Hwy 41 to Friant Rd. exit
- 12 mi. northeast on Friant Rd. to Friant Dam

	Yes	No
Photo Log		X
Photos	X	
Video Log (available)		
Dictation Log (available)		X
Topographic Map	X	

Purpose:

Site review to determine site geologic and topographic conditions, existing structure conditions, potential structure types and locations, access, and further design data needs for Phase 1 Studies

Field Observations:

1. Existing Structures/Cultural Features:

Increasing the storage capacity in Millerton Lake will require extensive modifications to the existing Friant Dam and appurtenant structures, and will impact numerous recreation facilities, and possibly private residences, around the reservoir area, and along the proposed alignment for the dam raise and dikes.

Existing Friant Dam is a concrete gravity structure with a structural height of 319 feet, crest length of 3,448 feet, crest width of 20 feet, and maximum base width of 267 feet. Three saddle dams (dikes) are located in the Millerton Recreation Area along the left side of the existing reservoir.

The spillway consists of an ogee overflow section, chute and stilling basin at the center of the dam. The spillway is controlled by one 18-foot-high by 100-foot-wide drum gate, and two comparably sized Obermeyer gates. The Madera Canal and outlets are located on the right abutment; the Friant-Kern Canal and outlets is located on the left abutment. A river outlet works is located to the left of the spillway within the lower portion of the dam.

Millerton Lake Recreation Area facilities, including a boat ramp, marina, camping and day use facilities, and other structures are located at various locations along the left side of the reservoir. Private residences are also located along the reservoir, some within about 25 to 30 feet vertically from the current normal reservoir levels.

2. Right of Way/Access Restrictions:

See Site Access above and **Attachment 1 – General Information**

3. Overhead/Buried Utilities:

Two hydroelectric powerplants are located on the left abutment of Friant Dam. Overhead power lines originate from these powerplants. Types and locations of utilities in the area of the proposed dike site were not identified.

4. Description of Proposed Structures (See **Attachment 2, Figure 1**):

Previous studies (Most recent study - Friant Dam Enlargement Study, Technical

Memorandum No. FR-8130-TM-97-2, Bureau of Reclamation, October, 1997) have considered the feasibility of raising the existing Friant Dam by 60 feet and 140 feet to provide additional storage capacity in Millerton Lake. The current study will consider raising the existing dam by about 20 feet and 40 feet, and reassess the previous raise options.

The proposed structures for the smaller raises are similar to those considered previously. Raising the existing concrete gravity dam would be accomplished by an overlay on the downstream face of the dam and extending the top of the dam vertically, with either conventional mass concrete or Roller Compacted Concrete (RCC). The spillway for the raised structure would be configured essentially the same as the existing spillway. The two Obermeyer gates would likely be removed and reinstalled at the top of the raised dam, and the remaining drum gate would be replaced with a third Obermeyer gate. Extensive modification and replacement of the existing canal outlet works, river outlet works, and powerplant will be necessary, however, the new structures would likely be configured much the same as currently exists.

An embankment or RCC dike will be needed to close off a low area along the left side of the reservoir. The height and length of the dike will depend upon the dam raise considered.

5. Description of Appurtenant Features (spillways, tunnels, pumping plants, flood routing/coffer dams/dewatering during construction, outlet works, switch yards, transformer yards, transmission lines, conveyance pipelines/canals, access roads, security, operation/maintenance):

See 4. Description of Proposed Structures

6. Briefly Describe Geologic/Geotechnical Site Conditions:

General Area Geologic/Geotechnical Conditions - The dam sites associated with the Upper San Joaquin River Study include 1) raising the existing Friant Dam and Dike, 2) four potential new damsites on the Upper Sam Joaquin River (MP 274, MP 279, MP 280, and Kerckhoff), and 3) a new potential offstream dam site (Fine Gold) on the Fine Gold Creek drainage. These damsites are located along the western border of the central portion of the Sierra Nevada province at its boundary with the eastern edge of the Great Valley province of California. Friant Dam is founded on metamorphic rocks consisting of quartz biotite schist, intruded by aplite and pegmatite dikes and by inclusions of dioritic rocks. The contact of these metamorphic rocks with the Sierra Nevada batholith lies just east of the dam in Millerton Lake. The Sierra Nevada batholith is comprised of primarily intrusive rocks, including granite and granodiorite, with some metamorphosed granite including granite gneiss. The intrusive Sierra Nevada batholith rocks underlie

most of Millerton Lake and the MP 274, MP 279, MP 280, Kerckhoff, and Fine Gold dam sites. Occasional remnants of lava flows and layered tuff are present in the Millerton Lake area at the highest elevations.

The central Sierra Nevada has a complex history of uplift and erosion. The most recent uplift tilted the western flank of the Sierra Nevada to the west. At the western border, rocks of the Sierra Nevada are overlapped by alluvium and sedimentary rocks of the Great Valley Province. The metamorphic rocks in the Friant Dam area dip steeply downstream to the west, and strike northwesterly. Erosion has resulted in thin alluvial cover.

Friant Dam - Friant Dam and Dikes are founded on metamorphic rock consisting of hard quartz biotite schist, transected by many varying granitic (probably dioritic) dikes. These dikes are mostly aphanitic, but include pegmatitic and porphyritic varieties. Most are less than a few feet thick and locally include a few thin veins of quartz. The parent rock of the schist was derived from marine sediments, and the deformations and physical and chemical alteration, which produced the schist, principally occurred during emplacement of the Sierra Nevada Batholith. The granite dikes at the site are probably associated with the intrusion. The rock immediately upstream of the dam is granodiorite of the batholith.

Schist exposed in the river channel immediately downstream of the dam is fresh while weathering is progressively more intense on the valley slopes, ultimately forming an intensely weathered zone 40 to 50 feet thick at the elevation of the crest of the dam. From descriptions provided on logs of borings during foundation excavation, rock at or below the final foundation surface is moderately to slightly weathered. Due to the weathering profile of the near-surface bedrock, the dam design incorporated a floating target for the final foundation surface. An average thickness of 32 feet of material was removed to achieve a satisfactory foundation. However, the depth of excavation in the area of a fault zone on the left abutment locally approached 70 feet.

Foliation (schistosity) is pervasive at the site and is the primary structural feature of the schist. The attitude of this foliation varies locally, but is fairly uniform within the area of the dam foundation, striking N65 - 75°W (sub parallel to the dam axis) and dipping 55 - 85°SW (downstream). The schist readily cleaves along foliation in more weathered intervals of rock. However, this tendency is proportional to the degree of weathering and is absent in fresh rock. Although minor shearing is widespread at the site, only a few faults are specifically documented in the record of construction. Construction drawings and written records of the work indicate discrete sets of joints, "flat seams", steeply dipping faults, and other discontinuities occur within the area of the dam foundation.

A number of trenches and shafts were excavated during dam construction along "flat seams" and along portions of faults. These excavations were then backfilled with concrete.

An extensive and effective foundation grouting program was performed at Friant Dam.

The potential for reactive aggregate was a concern to engineers during the construction of Friant Dam. Chemical activity between high alkali cement and certain components of some concrete aggregate such as chert resulted in expansion within the concrete and subsequent cracking. Low alkali Portland-type cement with a pumicite pozzolan additive was used for most of the dam concrete, but in the early stages of construction, some cement was used that was high in alkalis. Deterioration of concrete due to alkali aggregate reaction is the most serious problem identified for the dam and spillway.

7. Location/Description of Nearest Borrow Areas (See **Attachment 2, Figure 1**):

Based on observations during the field review, and the results of previous studies, the following are potential sources for construction materials. Additional evaluation of materials is necessary to determine the adequacy, availability, and quantities of materials in these and other sources.

Earthfill – Limited quantities of low-plasticity, fine-grained soils are located within the reservoir area at Temperance Flat. Additional quantities of fine-grained soils may be available in the Auberry Valley area, and in an area south of Millerton Road near the Millerton Lake Recreation Area entrance.

Processed sands and gravels – Commercial sources and/or crushing and processing of quarried rock in the reservoir area.

Concrete aggregate - Commercial sources and/or crushing and processing of quarried rock in the reservoir area.

8. Location/Description of Equipment/Material Staging and Lay Down Areas (See **Attachment 2, Figure 1**):

Sufficient area exists in the immediate area downstream of the existing dam and/or adjacent to either dam abutment for construction use/staging/lay down areas.

9. Identification of Environmental Sensitive Areas (wetlands, springs, rivers, streams, endangered/threatened species habitats, etc.):

A detailed discussion of environmentally sensitive areas and environmental considerations for the Friant Dam raise options are presented in a separate report.

10. Description of Mining or Other Anthropologic Activities:

Historically, mining activities occurred in the proposed reservoir area at Temperance Flat (Sullivan Mine) and possibly other locations. Mining activities in any of the areas are no longer active.

11. Action Items/Data Needs (list who has responsibility and schedule for completion):

The following action items/data needs list shows the data requirements for appraisal level designs and cost estimates for the various dam raise options for Friant Dam.

Action Items/Data Needs

ITEM NO.	DESCRIPTION	RESPONSIBLE PARTY
1	Finalize detailed topography (1"=200', 5' contours)	MP-200/ July 19, 2002
2	Calculate additional reservoir area-capacity up to a maximum water surface at El. 700	MP-200/ July 19, 2002
3	Obtain results of past Millerton Lake sediment surveys (if available)	TSC/ July 19, 2002
4	Obtain historical records of Friant Reservoir operations.	TSC/ July 19, 2002
4	Develop Hydrologic Data (diversion floods) A current PMF for Friant Dam is available.	TSC/ August 9, 2002
5	Geologic conditions/mapping and materials investigations	MP-200, TSC/ August 9, 2002
6	Seismic/Seismotectonic Evaluation	TSC D-8330/ August 9, 2002
7	Perform a "house count" of existing residences located around Millerton Lake. House counts should be made for dam raises of 20, 40, 60 and 100 feet.	MP-200, TSC/ August 1, 2002

12. Routing:

MWH - 5
USBR - 5
DWR - 2

ATTACHMENT 2 – PHOTOGRAPHS

Site Review – Temperance Flat and Fine Gold Damsites, and Friant Dam Raise

Some photographs in this section of the Trip Report refer to the MP274 site, downstream of Temperance Flat, as the Pincushion Damsite in reference to nearby Pincushion Mountain, as identified on topographic maps of the area. The photograph labels and captions were written and scanned prior to the determination to refer to the sites by the respective nearest River Mile Post marker appearing on the topographic maps.

Photo 1 Upper San Joaquin River Basin Storage Project

FRIANT DIKE AREA

View to the south of the low terrain extending south-southeast from the high ground immediately left (southeast) of the left abutment of Friant Dam to approximately 1.5 miles southeast of the dam. One of the California State Parks boat ramps is visible at right center. Raising Friant Dam would require that a dike be constructed in this low area along the reservoir rim.

J. Sturm April 16, 2002

Photo 2 Upper San Joaquin River Basin Storage Project

SKY HARBOR

View to the east of the community of Sky Harbor, located 4 miles upstream (northeast) of Friant Dam, with Pincushion Mt. in the background. Sky Harbor includes approximately 30 homes and is one of two residential communities located on the shoreline of Millerton Lake.

J. Sturm June 12, 2002

Photo 3 Upper San Joaquin River Basin Storage Project

HIDDEN LAKE ESTATES

View to the north of the community of Hidden Lake Estates located 5 miles upstream (north) of Friant Dam. Hidden Lake Estates includes approximately 45 homes and is located immediately west of Fine Gold Damsite.

J. Sturm June 12, 2002

Photo 4 Upper San Joaquin River Basin Storage Project

HIDDEN LAKE ESTATES

Closeup view to the north of homes in the community of Hidden Lake Estates. The home shown at lower left is at the lowest elevation of any home located along the Millerton Lake shoreline.

J. Sturm June 12, 2002

Photo 5

Upper San Joaquin River Basin Storage Project

HIDDEN LAKE ESTATES

View to the south of the community of Hidden Lake Estates with Sky Harbor, Pincushion Mt. and Millerton Lake in the background.

J. Sturm

April16, 2001

Photo 6

Upper San Joaquin River Basin Storage Project

PINCUSHION DAMSITE

View upstream (southeast) of the damsite. Steep lower slopes expose hard, water-scoured moderately to slightly fractured granitic rock.

J. SturmApril, 16, 2001

Photo 27 Upper San Joaquin River Basin Storage Project

FINE GOLD RESERVOIR

Panoramic view to the southwest of the reservoir area. The highest peak in the background is Hulbert Mtn. (El.).

J. Sturm April 17, 2001

Photo 28 Upper San Joaquin River Basin Storage Project

KERCKHOFF POWERHOUSE NO. 2

Panoramic view to the northeast of the San Joaquin River canyon from the road just south of Temperance Flat. Kerckhoff Powerhouse No. 1and a waste berm are visible at photo center. The waste berm is composed of "tunnel muck" (mostly granitic rock fragments) that was produced by the excavations for the underground powerhouse and access tunnels.

J. Sturm June 12, 2002