US Army Corps
of Engineers
Los Angeles District

Little Colorado River at Winslow, Navajo County, Arizona

Flood Risk Management Feasibility Study

APPENDIX D

Engineering Design

October 2018

U.S. ARMY CORPS OF ENGINEERS

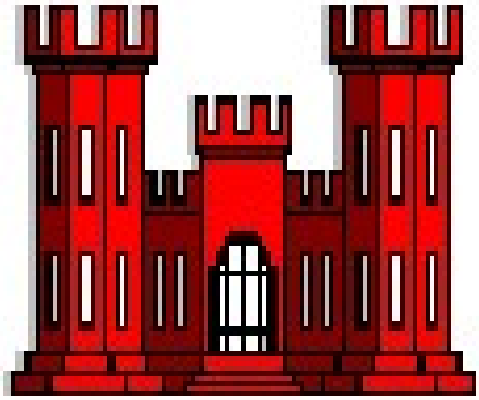
LOS ANGELES DISTRICT

ENGINEERING DESIGN APPENDIX

Little Colorado River at Winslow

Winslow, Arizona

FEASIBILITY STUDY



October 2018

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LIST OF ACRONYMS/ABBREVIATIONS

ACORNYM/ABBREVIATION	MEANING
ABC	aggregate base course
ACE	annual chance exceedance
ADOT	Arizona Department of Transportation
APS	Arizona Public Services
BMPs	best management practices
BNSF	Burlington Northern Santa Fe
CY	cubic yards
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
I-40	Interstate 40
LCR	Little Colorado River
lf	linear feet
NCFCD	Navajo County Flood Control District
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and Maintenance
PDT	Project Delivery Team
PED	Preconstruction, Engineering and Design
PVC	polyvinyl chloride
RCB	reinforced concrete box
RCP	reinforced concrete pipe
RIP	Rehabilitation Program
RWDL	Ruby Wash Diversion Levee
RWL	Ruby Wash Levee
SR	State Route
TCE	Temporary Construction Easement
USACE	United States Army Corps of Engineers
WL	Winslow Levee

1.0 OBJECTIVE

The purpose of this appendix is to provide results from the Engineering Design analysis for the multiple design alternatives considered for the Little Colorado River (LCR) at Winslow feasibility study. Design data and calculations were sufficiently developed to determine the technical and economic feasibility of each alternative and in the event the project is authorized, to provide a base design leading to the development of the construction plans and specifications. The objective of the LCR Feasibility Study is to investigate alternatives for flood risk reduction to the Winslow Community.

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2.0 STUDY AREA

The study is located in the city of Winslow, county of Navajo, Arizona, approximately 55 miles east of the intersection of Highway 17 and Interstate Highway 40 (I-40) in the northeastern portion of Arizona, at the confluence of the LCR and Ruby Wash. The LCR generally runs from south to north near Winslow. Ruby Wash joins the LCR just south of State Route (SR) 87. The existing Ruby Wash Diversion Levee (RWDL) generally runs in an east-west direction (see Plate 1)

The City of Winslow is located on the Colorado Plateau in Navajo County, Arizona, at an elevation of 4,880 feet above sea level, North American vertical Datum of 1988 (NAVD 88). Winslow is the largest city in Navajo County, approximately twice the size of the county seat of Holbrook. Winslow is located on I-40 along the western border of Navajo County. Flagstaff is located 55 miles to the west, and Albuquerque lies 265 miles to the east. The state capital of Phoenix is located 133 miles to the southwest of Winslow.

The study area includes the floodplain of the LCR from the Clear Creek confluence downstream (northwest) to the northern end of the existing Winslow Levee (WL). The 49-square-mile study area encompasses the majority of the City of Winslow, including the Ruby Wash Diversion Levee and the Ruby Wash Levee (RWL). The tributaries of Ruby Wash, Clear Creek, Cottonwood Wash and Salt Creek join the LCR mainstem within the study area.

The City of Winslow has a long history of flooding along the LCR and its tributaries. There is an immediate need to reduce the risk of property damage caused by flooding in the City of Winslow and the surrounding communities. More importantly, there is a need to reduce the risk of loss of life, and to improve public safety caused by flooding.

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3.0 EXISTING LEVEES

3.1 Winslow Levee (WL)

The approximately 7.3-mile long WL was constructed along the west side of the LCR by the Navajo County Flood Control District (NCFCD) and the Arizona Department of Water Resources between 1986 and 1989. The levee design included bank protection and cutoff walls. The WL was designed to contain the 100-year flood flow of 65,000 cfs (cubic feet per second). Recent studies indicate the levee no longer provides 100-year flood protection. The levee was de-accredited by the Federal Emergency Management Agency (FEMA) in 2008, placing 2,700 parcels and 1,500 structures within the 100-year floodplain.

On January 8, 1993, the levee was overtopped by a flood event having an estimated peak discharge between 57,000 cfs and 75,000 cfs. As a result, a 400-foot section of levee was washed out, while a 3,000-foot section of levee was damaged. Properties (both private and public) were flooded in Ames Acres, Bushman Acres, and other areas behind the levee. In total, 204 parcels were inundated and 140 structures (both private and public) were damaged. A lawsuit resulted, which required $1,400,000 in Navajo County funds to settle. Temporary repairs to the levee were completed immediately following the flooding. Permanent repairs were completed in 1994 using FEMA, State, and County funds.

On December 31, 2003, the levee experienced a piping failure at well below a 100-year flood event (16-foot flood water elevation vs. a 25-foot elevation for a 100-year event). Fortunately, an alert citizen reported the impending levee failure and Navajo County responded immediately. Catastrophic failure was avoided by depositing material on the riverside of the levee. Permanent repairs matching the original design were completed in 2005. A later investigation for the cause of the failure found the bentonite core was intact, and the piping was induced by sandy subsoil beneath the levee core.

Hydraulic models recently completed by Delph Engineering (under contract with the U.S. Army Corps of Engineers [USACE], Los Angeles District [SPL]) indicate the levee, in its current condition, will overtop in approximately the same location as it did in January of 1993 at a discharge of 55,000 cfs. This is approximately the 2% annual chance of exceedance (50-year) flood. The floodplain study concludes the WL does not have the capacity to contain the 1% annual chance of exceedance (ACE) (100-year) flood and does not meet FEMA standards for 100-year flood protection due to sediment deposition and a deficiency in levee height.

FEMA's standards for certifying levees for 100-year flood protection require levees to have a minimum of 3 feet of freeboard. In addition to this, when the WL was designed, it was determined another 2 to 3 feet of freeboard would be needed to provide storage for sediment that would build up within the channel over the life of the levee. So for most of the levee, the design freeboard was 5 to 6 feet. A comparison of the consultant's surveyed elevations at top of the existing levee with

the calculated 100-year floodwater surface elevations indicates the levee is substantially deficient in height along much of its length.

Levee reconstruction is needed to reduce potential property damage caused by flooding in the City of Winslow and the surrounding communities. This action would also reduce the potential risk of loss of life, and to improve public safety caused by flooding. The existing levee cannot be strengthened or raised via partial reconstruction, or by adding material to the top and side slopes of the levee (refer to the existing levee condition described in the geotechnical appendix). Instead, it is necessary to rebuild the entire levee because of the improper engineering design and construction of the foundation for the existing levee. Additional real estate is required to accommodate the new levee footprint. Rebuilding the levee requires existing utility crossings to be redesigned and reconstructed accordingly. Further design studies and construction plans will be needed before the work can begin.

3.2 Ruby Wash Diversion Levee (RWDL)

In addition to the WL, several other structures contribute to the current level of flood risk reduction for the City of Winslow. These consist of the RWDL and the RWL. The USACE designed and constructed the RWDL. This levee is a rock and soil embankment extending 5.3 miles from the high ground near the southwest corner of the Winslow Airport to the LCR south of the Burlington Northern Santa Fe (BNSF) Railroad Bridge east of Winslow. The construction of this levee was completed in 1970. Flows in Ruby Wash and in other streams crossing the alignment of the levee are diverted east to the LCR, eliminating flood hazards along Ruby Wash. The RWDL reduces the flood risk to the Winslow Airport and approximately 500 residents.

3.3 Ruby Wash Levee (RWL)

The Ruby Wash Levee was constructed by the Arizona Department of Transportation (ADOT) in 1980 as part of the I-40 at Winslow Project (Project I-40-4(81). The Ruby Wash Channel extends from Third Street to I-40. Due to the flat terrain along the channel alignment, the channel was constructed using a small amount of excavation below the existing ground surface. The majority of the channel construction was accomplished by creating embankments of compacted earth fill above the natural ground elevation to form the channel banks, which are referred to as compacted earth fill levees.

Navajo County made substantial engineered improvements to the RWL in the late 1990s. The levee provides flood protection for a portion of downtown Winslow. The levee met 44CFR 65.10 requirements prior to the FEMA Map Modernization program. The RWL is not included in the USACE Rehabilitation Program (RIP).

4.0 ALTERNATIVES

All alternatives described below include the nonstructural measures of improving the flood warning system.

4.1 Alternative 1.1 – Rebuild Levee System along Current Alignment

Rebuild the WL and the eastern end of the RWDL along their current alignments, construct a new levee parallel to I-40, and improve conveyance under the BNSF Railroad Bridge with channelization and salt cedar tree removal. New levee construction would be designed to provide approximately 90% assurance of containing the 1% ACE event. Three feet of elevation above the stage corresponding with the 1% median discharge was included in the design to achieve this level of assurance. The intent of this levee scale is that it would meet FEMA levee accreditation criteria, as this is a plan of interest to the non-Federal sponsor.

4.1.1 Levee Construction

From upstream to downstream, the levee improvements would consist of the following:

A. Rebuild the easternmost 2,000 feet of the RWDL to its abutment with the WL.
B. Rebuild 3,500 feet of WL from the RWDL's abutment to I-40.
C. Construct 3,700 feet of new levee along the north side of and parallel to I-40.
D. Rebuild 26,490 feet of WL from I-40 to the north end of the proposed project near McHood Road.

The total length of new and reconstructed levees would be 35,690 feet.

Rebuild/Reconstruction of the WL and RWDL and construction of the new levee consist of compacted earth fill and revetment improvements. Revetment improvements include soil cement and grouted/ungrouted stone on the levee riverside slope. Soil cement is considered to provide better protection for the levee against impinging flows. Whereas, grouted/ungrouted riprap would be more feasible for areas not subject to impinging flows and located away from the flow path (See Plate 2).

Cross sections of the soil cement levee and grouted/ungrouted stone shown on Plate 9 provide the flowing design dimensions:

- 16-feet drivable top width
- 16.3-feet maximum height
- 1H:1V soil cement riverside slope
- 2H:1V grouted/ungrouted stone riverside slope
- 3H:1V gravel mulch also known as ABC landside slope
- 15-feet maximum soil cement toe-down depth.
- 5-feet-deep, 3-feet bottom wide trapezoidal key trench
- 6-feet-deep, 10-feet-wide trapezoidal trench drain
- 210-feet-wide levee footprint including the maintenance road and trench rain

4.1.2 Levee Construction Features

A. 3-feet-deep concrete V-notch ditch
B. 15-feet-wide ABC (aggregate base course), 4-inch-thick Operation and Maintenance (O&M) road.
C. 35-feet temporary construction easement (TCE) on the levee landside
D. 25-feet TCE on the riverside

The total construction corridor would be 270-feet-wide (210 feet levee footprint+25 feet riverside TCE+35 feet landside TCE). The total area of the project would be approximately 222 acres.

4.1.3 Channel Construction Features

In addition to levee construction and levee associated construction features, Alternative 1.1 includes saltcedar removal and river channelization to increase conveyance of floodwater under the BNSF Railroad Bridge. Saltcedar would be removed from a ±96-acre area in the vicinity of the BNSF Railroad and SR 87 bridges using land clearing equipment. Removed saltcedar would be disposed of on an upland location outside of the floodplain.

Following saltcedar removal, the river would be channelized for a length of ±2,500 feet in vicinity of the BNSF R/R Bridge by excavating a ±26-acre area to the current thalweg depth. Excavation depth would vary from six to eight feet. The bottom of the newly excavated channel would remain earth-lined. Excavated material would either be recycled for levee construction, or disposed of on an upland area outside of Section 404 jurisdiction. The newly excavated channel would include a ±390 feet wide low flow channel with soil cement banks, and overflow terraces with riprap embankment armoring. The total width of the channel, terraces and armored embankments would be ±650 feet.

Dewatering and/or water diversion would be required for the work proposed in the LCR channel and on the riverside of the levee. Existing floodplain soils would not support the weight of construction equipment or, in some areas, even a standard passenger vehicle. Wheeled or tracked transport across the LCR channel or adjacent floodplain would require soil enhancements in addition to dewatering to avoid equipment bog down. Any soil enhancements placed can be removed after the construction ends and the construction/access road alignment is restored.

4.1.4 Nonstructural Measures

Alternative 1.1 would include a flood warning system consisting of a flood detection network (including a communication system) and an emergency response/evacuation plan.

4.1.5 Material Required for Construction

Approximately 300,000 CY (cubic yards) of material would be excavated from the LCR floodplain at the BNSF Railroad Bridge. The USACE is assuming 50% of the material excavated from the river for conveyance at the BNSF Railroad Bridge can be re-used for construction. As part of the channelization work, approximately 37,000 CY of soil cement and 26,000 CY of 36-inch riprap would be installed to create a low flow channel, terrace and armored side slopes.

Approximately 623,000 CY of material would be obtained by demolishing existing levee embankments. No testing of the material in the existing levees could be found, and no investigation sampling and testing was done as part of this feasibility study. Based on field observations of the levee surface, the USACE anticipates that 70% of the material from demolition of the existing levee system could be re-used for new levee construction.

Excavation of a new trench drain along the landside toe of the levee would yield approximately 174,000 CY of additional material. Based on the information available, the USACE is assuming the soils excavated from the trench drain could be re-used for new levee construction.

Reconstruction of the levees would require an estimated 624,000 CY of material. This material would be obtained from the LCR channelization, levee demolition, and trench drain excavation to the extent practicable. Unusable materials would be disposed of at nearby disposal areas as waste.

The trench drain filter material would require approximately 63,000 CY of sand and 63,000 CY of gravel. The sand and gravel would either be obtained on site if appropriate materials are available, or trucked from off-site sources as necessary. The remaining trench volume would be backfilled using approximately 48,000 CY of material originally excavated from the trench.

The existing levees to be reconstructed are armored by approximately 25,000 CY of large-sized, high-quality, durable basalt riprap with a median rock size (D_{50}) of approximately 10 inches. This riprap would be removed from the existing levee embankment and stockpiled for reuse on the reconstructed levees. An additional 8,000 CY of poor quality sandstone and broken concrete riprap would either be stockpiled for flood fighting, or disposed of off-site.

The riverside levee embankment armoring consists of soil cement south of I-40 and in the vicinity of two impingement points further downstream, for a total of 12,217 linear feet (lf) of soil cement. The remaining 23,477 lf of riverside levee embankment would be armored using a combination of riprap and grouted stone, as appropriate. Installation of the armoring would require approximately 137,000 CY of soil cement and 58,000 CY of 24-inch-thick riprap. The estimated 25,000 CY of riprap salvaged from the existing levees would be reused where appropriate for this work. Although the gradation is much smaller than either the 24- or 36-inch thick stone specified, this smaller on-site stone could be used for some of the smaller gradation fractions in a 24- or 36-inch protection stone layer. Additional basaltic riprap would be obtained from the Brimball Hardluck Quarry in Indian Wells, AZ. This quarry is located 43 miles northeast of Winslow Levee (a 60 mile one-way haul distance along existing, but indirect roads).

For landside levee slope protection, a 4-inch-thick layer of ABC would be installed on the landside of the levee for slope protection. Approximately 10,000 CY of ABC would be needed for this work. Construction of the 15-feet-wide operation and maintenance road along the length of the project would require an additional 5,200 CY of aggregate binder course gravel mulch also known as ABC.

Construction fines (clay and silt) for levee embankment construction would be obtained, to the extent practicable, from the materials available on-site. Possible sources for this material consist

of the old river channel on City of Winslow property adjacent to the Winslow Levee, or a dust dune located between the Winslow Levee and the LCR. Any needed fines not available locally would need to be trucked in from off-site sources.

4.1.6 Borrow

Alternative 1.1 would entail borrow of construction materials from multiple sites, consisting of the existing levee embankments, trench drain excavation, and the ±26-acre LCR channelization area. Volume of borrow materials would be very minimal. It is estimated volume of borrow materials would be 671 CY. Additional sources of material may include, as necessary, the commercial Dyna Sand and Rock/Winslow Ready Mix site east of the LCR, the "O'Haco Northwest" pit located 2.5 road miles northwest of the north end of the Winslow Levee, the ±18-acre old river bend on the City of Winslow property at French Road, and the dust dune located in the floodplain between the Winslow Levee and LCR. Access to the dust dune in the LCR floodplain would require construction of a temporary access road ±30-feet-wide and ±800 feet in length within the floodplain. This road would not need to cross areas within Section 404 jurisdiction given the current configuration of the floodplain. Plate 13 provides borrow sites.

4.1.7 Disposal

Alternative 1.1 would require disposal of an estimated 426,000 CY of material. All excess material originating from the LCR channelization area and levee demolition south of I-40 is assumed to be disposed of on the McCauley properties east of the LCR (Dyna Sand and Rock/Winslow Ready Mix is located on the same properties). Excess material originating from the rest of the project would be hauled to four upland locations on the land side of the levee. Material would be distributed to these disposal areas in a manner that minimizes haul distances, as shown in the following table. The material is anticipated to be spread at a thickness of one foot to 2.5 feet. Due to the topography of the McCauley site, material deposition may be deeper than 2.5 feet in some areas (Table 1). Disposal sites are shown on Plate 13.

Table 1: Alternative 1.1 Disposal Volume and Spreading Area Calculations

	O'Haco North	O'Haco Middle	O'Haco South	City of Winslow	McCauley Tracts	Total
Area Available (Acres)	50	37	141	45	503	
Material (CY)	10,200	15,300	37,000	57,200	306,000	426,000
Area Needed (Acres)						
1 foot fill depth	6.3	9.5	22.9	35.4	189.7	263.8
2.5 feet fill depth	2.5	3.8	9.2	14.2	75.9	105.6

4.1.8 Staging/Stockpiling Areas

Construction equipment is proposed to be staged at eight locations along the project construction corridor. Four of these sites are located on the same properties used as disposal areas (O'Haco

North, O'Haco Middle, O'Haco South, City of Winslow). Current land use and area needed at each staging area is provided in Table 2.

Table 2: Proposed Alternative 1.1 Staging Areas

	O'Haco North	O'Haco Middle	O'Haco South	City of Winslow	Pugh/Gale	Transcon LLC	Klaus Bolle	Navajo Tribe
Area (Acres)	2	2	2	5	2	2	2	2
Current Land Use	Rangeland	Rangeland	Rangeland	Pasture	Rangeland	Vacant Floodplain	Vacant	Vacant

A batch plant would be located on the five acre City of Winslow staging area. This plant would provide the concrete and grout needed for installation of soil cement and grouted stone, respectively.

The Pugh/Gale staging area is located behind the existing Winslow Levee at the North Road alignment. The Transcon LLC staging area is located on the riverside of the levee, adjacent to the north side of I-40. Heavy construction equipment would need to pass under the BNSF Railroad Bridge for access to the proposed staging area owned by the Navajo Tribe. Measures required to ensure equipment access without bog down have been addressed in the discussion of Channel Construction Features above. Limited equipment staging and stockpiling would also take place along the 50-feet-wide construction corridor, as cost effective and appropriate.

4.1.9 Ingress-Egress

Seven ingress-egress routes for access to the construction corridor have been identified and shown on Plate 12. From upstream to downstream, they are shown in Table 3.

Table 3: Alternative 1.1 Ingress-Egress

Location	Required Improvements	Permanence
South side of SR87 west of the Winslow Levee	Present and in use – road safety, load and widening improvements needed	Permanent project feature
North side of SR87 west of the Winslow Levee	Present and in use – road safety, load and widening improvements needed	Permanent project feature
Westbound I-40 frontage road east from Transcon Lane	Present and in use – load and widening improvements needed	Permanent project feature
North end of Transcon Lane via unpaved road along south	Widening of existing unpaved roads and new unpaved road	Temporary access; restored to original condition upon project completion

Location	Required Improvements	Permanence
side of ADOT drainage easement	construction needed for 2,800 feet	
East from intersection between French Road and Oak Road, then north across the French Farm	1,500 feet of new unpaved road construction needed	Temporary access; restored to original condition upon project completion
East from the east end of North Road	1,500 feet of new unpaved road construction needed	Temporary access; restored to original condition upon project completion
McHood Road	Existing paved road	Permanent project feature

Ingress-egress routes are anticipated to be ±30 feet in width to allow safe passage of heavy construction equipment.

4.1.10 Utilities

There are eleven separate utilities and/or utility crossings within the Alternative 1.1 construction corridor. These utilities consist of irrigation infrastructure, local and regional electrical service, a fiber optic line, a high pressure gas line, drainage infrastructure operated by ADOT, private arena lights, a potable water line, and a wastewater treatment outfall. Utilities would be relocated/reconstructed in place, protected in place, or avoided via minor changes to project alignment during Preconstruction, Engineering and Design (PED). Refer to Table 4 for a description of the utilities and impacts associated with Alternative 1.1. These existing utilities are also shown on Plate 11.

Table 4: Alternative 1.1 Utilities (Listed in order from upstream to downstream)

Utility	Owner/Operator	Specifications	Action During Construction
Inverted Siphons	Winslow Irrigation District	Two siphons constructed with 30-inch-diameter reinforced concrete pipe	Relocate (reconstruct in place)
Utility line on wooden poles	Unknown	Single overhead line and two wooden poles	Relocate or remove
Fiber Optic Line	CenturyLink	Major trunk line and local service line in 4-inch conduit	Protect in place

Utility	Owner/Operator	Specifications	Action During Construction
High Pressure Gas Line Crossing No. 1	Kinder-Morgan	4.5-inch outside diameter pipe	Relocate
High Tension Electric Lines	Arizona Public Services (APS)	Unknown; possibly 130kV	Within construction access easement; protect in place
High Pressure Gas Line Crossing No. 2	Kinder-Morgan	4.5-inch outside diameter pipe	Relocate
K3 Channel, Under I-40	ADOT	8 - barrel concrete box culvert with lift gates	Not in construction area; levee design to be refined during PED to avoid impacts, as needed
High Pressure Gas Line Crossing No. 3	Kinder-Morgan	4.5-inch outside diameter pipe	Relocate
I-4 Hydraulic Gate	ADOT	4-barrel 4-feet X 10-feet concrete box culvert with lift gates	Relocate (rebuild in place)
Arena lights	Hatch, Ben Trustee B & M Hatch Family Trust	Four livestock arena light poles	Design to be refined during PED to avoid impacts
Homolovi Water Line	City of Winslow	6-inch PVC line for potable water supply	Relocate
Winslow Wastewater Outfall	City of Winslow	12-inch diameter ductile iron pipe	Relocate
Line of wooden and metal power poles	Arizona Public Services (APS)	Local electrical service, overhead line	Relocate poles as necessary; remove abandoned part of system; avoid part of system

To protect the CenturyLink fiber optic conduit in place, it would be encased in concrete with concrete slope anchors beneath the riverside levee slope (10 feet on center). The concrete encasement would extend 30 feet out from the landside levee toe and 10 feet out from the riverside toe-down. The landside encasement extension would be to protect the line from construction traffic.

The Kinder-Morgan gas line crosses the construction corridor three times. A total of 1,200 feet of gas line would need to be relocated to a sufficient depth to pass beneath the new construction

to avoid levee penetrations. This work would involve excavation and removal of the existing line, trenching and side cast of excavated material, placement of new line, backfill, and connection of the new line. Use of directional boring for part of the relocation work may be feasible.

The potable water line runs parallel to the landside of the Winslow Levee for a distance of ±1,000 feet from the east end of Prosperity Avenue to an access vault at the landside toe of the levee. An estimated 1,600 feet of this line would need to be relocated during project construction.

The Winslow Wastewater Outfall is the National Pollutant Discharge Elimination System (NPDES)-permitted wastewater discharge point for the City of Winslow. Discharge is through a 12-inch-diameter ductile iron pipe with the outlet located approximately 100 feet off of the riverside toe of the levee. The outlet of this pipe is covered by a 12-inch diameter flap valve and reinforced by a concrete headwall. Approximately 400 feet of the outfall pipe would need to be relocated during construction.

The ADOT K3 channel is aligned with a normally dry manmade channel that extends under I-40. This gate is normally closed, but can be opened by means of lift gates. This canal has no discernable channel north of I-40. The current project design does not accommodate K3 channel flows through the newly constructed levee. Flows could be diverted along the north toe of the I-40 embankment back into the LCR. If this is not possible, the new levee may need a box culvert with lift gates.

If possible, utility line relocations would be accomplished in a manner that does not require service interruptions. However, during relocation of these utilities and final connection of the new lines to the existing lines, temporary disruptions to potable water and natural gas service may be necessary. Potable water service disruptions would be limited to Homolovi State Park. Discharge of treated wastewater to the LCR would be maintained without interruption. Service outages, if necessary, are anticipated to be short term. Multiple service outages for one or more utilities are also possible. Since the CenturyLink fiber optic line would be protected in place, no service interruptions are expected.

4.1.11 Construction Equipment

Typical equipment to be used during the construction period include loaders, scrapers, dozers, trucks, blades, roller compactors, a concrete batch plant, concrete mixers, water trucks, and backhoes.

4.1.12 Duration of Construction

The construction duration for Alternative 1.1 is estimated at approximately eight years. Construction would begin at the upstream end of the project and progress downstream. Conveyance improvements would be completed ahead of levee reconstruction. This is to both provide conveyance of the design flood under the BNSF Railroad Bridge, and to provide materials needed for levee construction.

Construction activities would likely not be continuous. In order to provide a functioning flood risk management project, construction would occur during the typical six month May through October low water season. Demolished levee segments would need to be rebuilt in order to provide a functioning levee during the November through April period when flood risk is increased by winter storms and spring snowmelt. Concurrent work at different locations may be required to ensure that levee reconstruction is complete before the next winter rainy season.

Construction equipment would generally be operated ten hours a day. If acceleration of work is required to ensure reconstruction of demolished levee segments before the winter rainy season (November through April), the daily work schedule may be extended.

4.1.13 Property Ownership

Navajo County currently holds a ±100-340-feet-wide, ±113-acre permanent flood control easement along the current alignment of the Winslow Levee. The project width is expected to be as wide as 210 feet where the levee height is greatest. The existing easement is not wide enough to accommodate the proposed new project along most of the project length. Therefore, Navajo County would need to obtain additional easements from property owners to construct and operate the new project.

Temporary construction easements would be required on either side of the 210-feet-wide project area to accommodate the needed 270-feet-wide construction corridor. Temporary construction access is described under Levee Construction Features above.

Approximately 20 properties would be affected for construction of Alternative 1.1. The affected properties include the BNSF Railroad corridor, two ADOT properties (I-40/SR 87 right-of-way and a drainage easement), 12 mostly large ranch/vacant properties, three large ranch properties having residences and/or outbuildings well outside of the construction zone, and two additional properties where residences and/or outbuildings are located within or close to the construction access corridor.

Approximately four occupied residences are located within 200 feet of the existing levee, and one of these is within 100 feet. Relocations may be avoided with minor changes to the levee alignment during PED. Relocation of occupied structures is not anticipated for Alternative 1.1.

Permanent or temporary permits issued by ADOT and BNSF would be required to construct the LCR channelization measures. Such authorizations would also be needed for portions of the levee reconstruction located within ADOT and BNSF rights-of-way.

4.2 Alternative 3.1 – Rebuild Levee System with Extensive Winslow Levee Setback

Alternative 3.1 proposes to rebuild part of the WL along its current alignment, set back part of the WL, remove the original WL in the setback areas, rebuild the eastern end of the RWDL along its current alignment, construct a new levee parallel to I-40, and improve conveyance under the BNSF Railroad Bridge as shown on Plate 3. New levee construction would be designed to provide approximately 90% assurance of containing the 1% ACE event. Three feet of elevation above the stage corresponding with the 1% median discharge was included in the

design to achieve this level of assurance. The intent of this levee scale is to meet FEMA levee accreditation criteria, as this is a plan of interest to the non-Federal sponsor.

4.2.1 Levee Construction

From upstream to downstream, the levee improvements would consist of the following:

A. Rebuild the easternmost 2,000 feet of the RWDL to its abutment with the WL.
B. Rebuild 3,500 feet of WL from the RWDL's abutment to I-40.
C. Construct 3,700 feet of new levee along the north side of and parallel to I-40.
D. Set back 12,795 feet of the WL to reduce probability of impingement by the LCR.
E. Rebuild 12,860 feet of WL from I-40 to the north end of the proposed project near McHood Road.

The total length of new and reconstructed levees would be 34,855 feet.

The typical levee section and construction corridor would be as described for Alternative 1.1, except that the maximum levee height would be 15.2 feet. The total area of the project and temporary construction corridor would be approximately 216 acres.

4.2.2 Channel Construction Features

Alternative 3.1 includes the same channelization features as described for Alternative 1.1.

4.2.3 Nonstructural Measures

Alternative 3.1 would include a flood warning system.

4.2.4 Material Required for Construction

Alternative 3.1 includes the same channelization features as described for Alternative 1.1. Thus, the material volumes and re-use assumptions for these features are identical.

Approximately 568,000 CY of material would be obtained by demolishing existing levee embankments. Excavation of the trench drain along the landside toe of the levee would yield an estimated 168,000 CY of additional material. Re-use assumptions for this material are as described for Alternative 1.1.

Reconstruction of the levees would require an estimated 625,000 CY of material. This material would be obtained from the LCR channelization, levee demolition, and trench drain excavation to the extent practicable. Unusable materials would be disposed of at nearby disposal areas as waste.

The trench drain filter material would require approximately 61,000 CY of sand and 61,000 CY of gravel. The sand and gravel would either be obtained on-site if appropriate materials are available, or trucked from off-site sources as necessary. The remaining trench volume would be backfilled using approximately 46,000 CY of material originally excavated from the trench.

The existing levees to be reconstructed are armored by approximately 25,000 CY of large-sized, high-quality, durable basalt riprap with a median rock size (D_{50}) of approximately 10 inches.

This riprap would be removed from the existing levee embankment and stockpiled for reuse on the reconstructed levees. An additional 8,000 CY of poor quality sandstone and broken concrete riprap would either be stockpiled for flood fighting, or disposed of offsite.

The riverside levee embankment armoring consists of soil cement south of I-40 and in the vicinity of the impingement points further downstream, for a total of 12,217 lf of soil cement. The remaining 23,477 lf of riverside levee embankment would be armored using a combination of riprap and grouted stone, as appropriate. Installation of the armoring would require approximately 79,000 CY of soil cement and 57,000 CY of 24-inch riprap. The estimated 25,000 CY of riprap salvaged from the existing levees would be reused as described for Alternative 1.1. Additional basaltic riprap would be obtained as described for Alternative 1.1.

For landside levee slope protection, a 4 inch layer of gravel mulch also known as ABC would be installed on the landside of the levee for slope protection. Approximately 9,800 CY of gravel mulch would be needed for this work. Construction of the 15-feet-wide maintenance road along the length of the project would require an estimated 4,800 CY of aggregate binder course gravel mulch.

Construction fines (clay and silt) for levee embankment construction would be obtained as described for Alternative 1.1.

4.2.5 Borrow

Alternative 3.1 would utilize the same borrow sources as Alternative 1.1.

4.2.6 Disposal

Alternative 3.1 would require disposal of an estimated 365,000 CY of material. The 45-acre City of Winslow disposal site would not be used for Alternative 3.1. This is because the majority of the site would be within the setback levee alignment, or on the riverside of the levee. Remaining disposal sites would be as described for Alternative 1.1. Material that would have been hauled to the City of Winslow site would be distributed to the McCauley and O'Haco South sites in a manner that minimizes haul distances. The material would be spread as described for Alternative 1.1. Disposal plan site utilization is provided in table 5

Table 5: Alternative 3.1 Disposal Volume and Spreading Area Calculations

	O'Haco North	O'Haco Middle	O'Haco South	City of Winslow	McCauley Tracts	Total
Area Available (Acres)	50	37	141	45	503	
Material (CY)	9,400	14,100	53,000	0	289,000	365,000
Area Needed (Acres)						
1 foot fill depth	5.8	8.7	32.8	0	178.8	226.2
2.5 feet fill depth	2.3	3.5	13.1	0	71.5	90.4

4.2.7 Staging/Stockpiling Areas

Staging and stockpiling would be as described for Alternative 1.1, except that the City of Winslow staging area would not be used. The batch plant proposed for the City of Winslow site would be relocated to property adjacent to the ADOT I-4 hydraulic gate right-of-way, on property owned by either the Navajo Tribe or Transcon, L.L.C (Table 6).

Table 6: Proposed Alternative 3.1 Staging Areas

	O'Haco North	O'Haco Middle	O'Haco South	Navajo Tribe or Transcon, LLC	Pugh/Gale Levee Setback	Transcon LLC	Klaus Bolle	Navajo Tribe
Area (Acres)	2	2	2	5	2	2	2	2
Current Land Use	Rangeland	Rangeland	Rangeland	Pasture	Rangeland	Vacant Floodplain	Vacant	Vacant

4.2.8 Ingress-Egress

Since the City of Winslow property would not be used for staging, stockpiling, or the batch plant, the ingress-egress road across the French Farm would not be needed. Instead, access to either the Navajo Tribe or Transcon, LLC would be required. The Navajo Tribe site can be accessed from the Alternative 3.1 levee construction corridor, or from Oak Road. Access to the potential Transcon, LLC staging area would be possible directly from the levee construction corridor.

4.2.9 Utilities

Utility impacts would be identical to those for Alternative 1.1, with the exception of the Homolovi Water Line. An additional 400 feet of this line (total of 2,000 feet) would need to be relocated to accommodate the Winslow Levee setback. The likelihood of service disruptions would also be as described for Alternative 1.1. In addition, utilities serving eight residences to be relocated would be removed from areas within the setback levee alignment and in areas

restored to the active LCR floodplain. These utilities consist of potable water and sewer service, as well as electrical, telephone, and cable internet/television service.

4.2.10 Construction Equipment

Equipment used during construction would be as described for Alternative 1.1.

4.2.11 Duration of Construction

Construction duration for Alternative 3.1 is estimated at approximately eight years. Construction activities, scheduling and work hours would be as described for Alternative 1.1.

4.2.12 Property Ownership

As described for Alternative 1.1, Navajo County would need to obtain additional permanent flood control easements from property owners to construct and operate the new project. Approximately 29 properties would be affected for construction of Alternative 3.1. The affected properties include the BNSF Railroad corridor, two ADOT properties (I-40/SR 87 right-of-way, and a drainage easement), 13 mostly large ranch/vacant properties, three large ranch properties having residences and/or outbuildings well outside of the construction zone, and 12 additional properties where residences and/or outbuildings are located within or close to the construction access corridor.

The significant setback of the Winslow Levee north of I-40 would restore approximately 261 acres to the active LCR floodplain. Construction of this setback levee would require relocation of up to ten residences and associated outbuildings. Implementation of Alternative 3.1 would place these residences either within the setback levee alignment, or on the river side of the levee. Relocations required for this or any other alternative would be accomplished in compliance with the Relocation Act.

4.3 Alternative 7 -Nonstructural Measures

Alternative 7 proposes non-structural measures include flood proofing the residences located north of I-40 and east of North Park Drive. This area includes the Bushman Acres and Ames Acres subdivisions. A total of 117 homes in Reach 1 and 28 homes in Reach 2 would be elevated above the 1% ACE water surface elevation. The range of elevations required to elevate these homes above the 1% ACE water surface elevation is between 0 and 4.74 feet. Alternative 7 would also include establishment of a flood warning system.
The area where nonstructural measures would be implemented is shown as the square grid area in Plate 4.

4.4 Alternative 8: Rebuild Levee System with Homolovi I Levee Setback

Rebuild most of the WL along its current alignment, set back a short segment of the WL across the LCR from the Homolovi I Pueblo, remove the original WL in the setback area, rebuild the eastern end of the RWDL, construct a new levee parallel to I-40, and improve conveyance under the BNSF Railroad Bridge as shown on Plate 5. New levee construction would be designed to provide approximately 90% assurance of containing the 1% ACE event. Three feet of elevation above the stage corresponding with the 1% median discharge was included in the design to

achieve this level of assurance. The intent of this levee scale is to meet FEMA levee accreditation criteria, as this is a plan of interest to the non-Federal sponsor.

4.4.1 Levee Construction

From upstream to downstream, the levee improvements would consist of the following:

A. Rebuild the easternmost 2,000 feet of the RWDL to its abutment with the WL.
B. Rebuild 3,500 feet of WL from the RWDL's abutment to I-40.
C. Construct 3,700 feet of new levee along the north side of and parallel to I-40.
D. Rebuild 26,909 feet of WL from I-40 to the north end of the proposed project near McHood Road including a 1,600 feet long levee setback across from Homolovi I and removal of a 2,000 feet section of the original WL.

The total length of new and reconstructed levee would be 36,109 feet.

The typical levee section and construction corridor would be as described for Alternative 1.1. The total area of the project and temporary construction corridor would be approximately 220 acres.

4.4.2 Channel Construction Features

Alternative 8 includes the same channelization features as described for Alternative 1.1.

4.4.3 Nonstructural Measures

Alternative 8 would include a flood warning system.

4.4.4 Material Required for Construction

Alternative 8 includes the same channelization features as described for Alternative 1.1. Thus, the material volumes and re-use assumptions are identical.

Approximately 618,000 CY of material would be obtained by demolishing existing levee embankments. Excavation of the trench drain along the landside toe of the levee would yield approximately 169,000 CY of additional material. Re-use assumptions for this material are as described for Alternative 1.1.

Reconstruction of the levees would require an estimated 621,000 CY of material. This material would be obtained from the LCR channelization, levee demolition, and trench drain excavation to the extent practicable. Unusable materials would be disposed of at nearby disposal areas as waste.

The trench drain filter material would require approximately 62,000 CY of sand and 62,000 CY of gravel. The sand and gravel would either be obtained on-site if appropriate materials are available, or trucked from off-site sources as necessary. The remaining trench volume would be backfilled using approximately 46,000 CY of material originally excavated from the trench.

The existing levees to be reconstructed are armored by approximately 25,000 CY of large-sized, high-quality, durable basalt riprap with a median rock size (D_{50}) of approximately 10 inches.

This riprap would be removed from the existing levee embankment and stockpiled for reuse on the reconstructed levees. An additional 8,000 CY of poor quality sandstone and broken concrete riprap would either be stockpiled for flood fighting, or disposed of off-site.

The riverside levee embankment armoring consists of soil cement south of I-40 and in the vicinity of two impingement points further downstream, for a total of 9,165 lf of soil cement. The remaining 17,744 lf of riverside levee embankment would be armored using a combination of riprap and grouted stone, as appropriate. Installation of the armoring would require approximately 125,000 CY of soil cement and 58,000 CY of 24-inch riprap. The estimated 25,000 CY of riprap salvaged from the existing levees would be reused as described for Alternative 1.1. Additional basaltic riprap would be obtained as described for Alternative 1.1.

For landside levee slope protection, a 4-inch layer of gravel mulch also known as ABC would be installed on the landside of the levee for slope protection. Approximately 10,000 CY of gravel mulch would be needed for this work. Construction of the 15-feet-wide maintenance road along the length of the project would require an estimated 5,000 CY of aggregate binder course gravel mulch.

Construction fines (clay and silt) for levee embankment construction would be obtained as described for Alternative 1.1.

4.4.5 Borrow

Alternative 8 would utilize the same borrow sources as Alternative 1.1.

4.4.6 Disposal

Alternative 8 would require disposal of an estimated 419,000 CY of material. The disposal plan would utilize the same properties as outlined for Alternative 1.1. The material would be spread as described for Alternative 1.1. Disposal plan site utilization is provided in Table 7.

Table 7: Alternative 8 Disposal Volume and Spreading Area Calculations

	O'Haco North	O'Haco Middle	O'Haco South	City of Winslow	McCauley Tracts	Total
Area Available (Acres)	50	37	141	45	503	
Material (CY)	10,200	15,300	36,900	57,100	300,000	419,000
Area Needed (Acres)						
1 foot fill depth	6.3	9.5	22.9	35.4	185.8	259.9
2.5' fill depth	2.5	3.8	9.1	14.2	74.3	103.9

4.4.7 Staging/Stockpiling Areas

Areas used for staging, stockpiling and the batch plant would be as described for Alternative 1.1. The Pugh/Gale staging area is located behind the existing WL at the North Road alignment. During construction of the proposed project, this staging area would end up on the riverside of the new levee alignment. However, this site would remain behind the existing WL until the levee embankment is demolished.

4.4.8 Ingress-Egress

Ingress-egress routes for Alternative 8 would be as described for Alternative 1.1.

4.4.9 Utilities

There are eleven separate utilities and/or utility crossings within the Alternative 8 construction corridor. Utilities would be relocated/reconstructed in-place, protected in-place, or avoided via minor changes to project alignment during PED. Utility impacts, including possibility of service disruptions, would be identical to those for Alternative 1.1.

4.4.10 Construction Equipment

Equipment used during construction would be as described for Alternative 1.1.

4.4.11 Duration of Construction

Construction duration for Alternative 8 is estimated at approximately eight years. Construction activities, scheduling and work hours would be as described for Alternative 1.1.

4.4.12 Property Ownership

Alternative 8 would affect the same 20 properties described for Alternative 1.1. The only difference is that setback of the levee across from Homolovi I would restore approximately 12 acres of vacant area to the active LCR floodplain. The area that would be restored to the floodplain is located on two properties. Relocations can be avoided with minor changes to the levee alignment during PED. Relocation of occupied structures is not anticipated for Alternative 8.

4.5 Alternative 9 – Reconstruct Ruby Wash Diversion Levee (RWDL)

Alternative 9 proposes to rebuild the eastern end of the RWDL at its existing height. This alternative includes no improvements to the Winslow Levee, no conveyance improvements, and use of nonstructural measures for residences north of I-40. Plate 6 provides the project features proposed for Alternative 9. This alternative would reduce the risk of flooding for events up to the 2.8% ACE (36-year) flood (LCR flows up to 44,780 cfs).

4.5.1 Levee Construction Features

Rebuild the easternmost 2000 feet of the RWDL to its abutment with the WL.

The typical levee section and construction corridor width would be as described for Alternative 1.1, except the maximum levee height would be 6.1 feet, and the trench drain would not be included. Due to the small size of the project, the area of the project and temporary construction corridor would be approximately 12 acres in size.

4.5.2 Channel Construction Features

Conveyance under the BNSF Railroad Bridge is already sufficient to convey the 2.8% ACE flood. For this reason, Alternative 9 does not include channelization measures.

4.5.3 Nonstructural Measures

Nonstructural measures (flood proofing and a flood warning system) would be implemented as part of Alternative 9. Flood proofing of residential structures would be implemented in the area north of I-40 on a voluntary basis.

4.5.4 Material Required for Construction

Approximately 2,600 CY of material would be obtained by demolishing the easternmost 2,000 feet of the RWDL. An estimated 3,300 CY of sandstone riprap and concrete rubble would be removed from the levee and stockpiled for flood fighting, or disposed of off-site. The RWDL reconstruction does not include a trench drain.

Reconstruction of the levees would require approximately 4,200 CY of material. This material would be obtained from the levee demolition to the extent practicable. Unusable materials would be disposed of at nearby disposal areas as waste.

The riverside levee embankment armoring would be armored using a combination of riprap and grouted stone, as appropriate. Installation of the armoring would require approximately 200 CY of 24-inch riprap/grouted stone. Since there is no salvage of basaltic riprap from the WL, all of the stone needed for Alternative 9 would need to be trucked in from off-site.

For landside levee slope protection, a 4-inch layer of gravel mulch also known as ABC would be installed on the landside of the levee for slope protection. Approximately 300 CY of gravel mulch would be needed for this work. Construction of the 15-feet-wide maintenance road along the length of the project would require an additional 350 CY of aggregate binder course gravel mulch.

Construction fines (clay and silt) for levee embankment construction would be obtained as described for Alternative 1.1.

4.5.5 Borrow

Alternative 9 would utilize only the McCauley site, since the remaining four disposal sites are too distant.

4.5.6 Disposal

Since Alternative 9 does not include LCR or trench drain excavation, it results in a net shortage of approximately 2,500 CY of material (Table 8). A small volume (less than 500 CY) of unsalvageable sandstone riprap and unusable levee fill may require disposal. This waste material would be disposed of on the McCauley site, or at a local inert landfill if it is more economical. If the McCauley site is used, spreading of the material would require a minimal area ranging from 0.1 to 0.3 of an acre, depending on disposal depth.

Table 8: Alternative 9 Disposal Volume and Spreading Area Calculations

	O'Haco North	O'Haco Middle	O'Haco South	City of Winslow	McCauley Tracts	Total
Area Available (Acres)	50	37	141	45	503	
Material (CY)	0	0	0	0	500	500
Area Needed (Acres)						
1 foot fill depth	0	0	0	0	0.3	0.3
2.5' fill depth	0	0	0	0	0.12	0.12

4.5.7 Staging/Stockpiling Areas

Due to the limited levee reconstruction, Alternative 9 would require only two staging areas. These consist of the sites on the Klaus Bolle site and the nearby property owned by the Navajo Tribe.

4.5.8 Ingress-Egress

Two ingress routes off of the north and south side of SR 87 west of the WL would be required. These would be as described for Alternative 10.

4.5.9 Utilities

There are only two utility crossings within the Alternative 9 construction corridor. These consist of the pair of inverted siphons operated by the Winslow Irrigation District, and an unknown local utility that runs overhead on a line of wooden utility poles. The inverted siphons would be reconstructed in place during construction. Two wooden poles within or close to the construction corridor would require relocation.

4.5.10 Construction Equipment

Equipment used during construction would be as described for Alternative 1.1.

4.5.11 Duration of Construction

Construction duration for Alternative 9 is estimated at approximately four years. Actual construction activities may be completed in much less time. The four year duration is allowed for the more gradual implementation of flood proofing measures. Construction activities, scheduling and work hours would be as described for Alternative 1.1.

4.5.12 Property Ownership

Construction work for Alternative 9 would be located entirely on a large, vacant parcel owned by the Navajo Tribe. Associated ingress-egress and staging activities would affect the BNSF Railroad and ADOT properties, and a vacant private parcel proposed as a staging area.

4.6 Alternative 10/10.1 – Rebuild RWDL and Winslow Levee to North road to Contain the 1% ACE Flood

Alternative 10.1 (Recommended Plan) would include the following components, from upstream to downstream include:

A. Removal and reconstruction of the easternmost 2,000 feet of the RWDL to its abutment with the WL.
B. Removal and reconstruction of approximately 3,297 feet of WL from its abutment with the RWDL to I-40.
C. Removal and reconstruction of the WL from I-40 to a point 0.8 of a mile north of North Road, including setback of 1,600 feet.
D. Improvement of conveyance under the BNSF Railroad Bridge through channelization and salt cedar removal.

The total length of new and reconstructed levees would be approximately 22,570 feet.

New levee construction would be designed to provide approximately 90% assurance of containing the 1% ACE event. Three feet of elevation above the stage corresponding with the 1% median discharge was included in the design to achieve this level of assurance. The intent of this levee scale is that it would meet FEMA levee accreditation criteria, as this is a plan of interest to the non-Federal sponsor.

Further analysis indicated a 0.3-foot levee height is necessary to achieve a 90% assurance level. The additional levee height would increase the assurance that the designated flood can be contained. (Plate 7).

No improvements would be made to the WL downstream of the federal project. In addition to the components listed above, nonstructural measures (flood proofing of residential structures and a flood warning system) would be implemented as part of Alternative 10. Flood proofing of residential structures would be implemented in the area north of North Road, and east of North Park Drive, on a voluntary basis. Alternative 10.1 (Recommended Plan) would not include flood proofing measures, which is the only difference from Alternative 10.

4.6.1 Levee Construction

From upstream to downstream, the levee improvements would consist of the following:

A. Rebuild the easternmost 2,000 feet of the RWDL to its abutment with the WL.
B. Rebuild 3,297 feet of WL from the RWDL north abutment to I-40.
C. Construct 3,700 feet of new levee along the north side of and parallel to I-40.
D. Rebuild 13,370 feet of WL from I-40 to the north end of the proposed project, 0.8 miles north of North Road, including 1,600 feet long levee setback across from Homolovi I and removal of a 2,000-foot section of the original WL where it is placed by the levee setback.

The typical levee section and construction corridor width would be as described for Alternative 1.1, except that the maximum levee height would be about 16.3 feet. Due to the shorter length of the project, the area of the project and temporary construction corridor would be reduced to approximately 139 acres.

4.6.2 Levee Construction Features

Levee Construction features for the Recommended Plan are identical with the ones described for Alternative 1.1.

4.6.3 Channel Construction Features

The Recommended Plan includes the same channelization features as described in Alternative 1.1.

4.6.4 Nonstructural Measures

Alternatives 10/10.1 include a flood warning system. The Recommended Plan includes flood proofing measures for residences north of North Road and East of North Park Drive.

4.6.5 Material Required for Construction

Alternatives 10/10.1 include the same channelization features as described for Alternative 1.1. Thus, the material volumes and re-use assumptions are identical.

Approximately 428,000 CY of material would be obtained by demolishing existing levee embankments. Excavation of the trench drain along the landside toe of the levee would yield approximately 110,000 CY of additional material. Re-use assumptions for this material would be approximately 78 percent.

Reconstruction of the levees would require approximately 460,000 CY of fill material. This material would be obtained from the LCR channelization, levee demolition, and trench drain excavation to the extent practicable. Unsuitable materials would be disposed of at nearby stockpile/disposal areas.

The trench drain filter material would require approximately 40,000 CY of sand and 40,000 CY of gravel. The sand and gravel would either be obtained on-site if appropriate materials are available, or trucked from off-site sources as necessary. The remaining trench volume would be backfilled using an estimated 30,000 CY of material originally excavated from the trench.

The existing levees to be reconstructed are armored by approximately 10,000 CY of large-sized, high-quality, durable basalt riprap with a median rock size (D_{50}) of approximately 10 inches. This riprap would be removed from the existing levee embankment and stockpiled for reuse on the reconstructed levees. An additional 8,000 CY of poor quality sandstone and broken concrete would either be stockpiled for flood fighting or disposed of off-site.

The riverside levee embankment armoring consists of soil cement south of I-40 and in the vicinity of the upstream impingement point, for a total of 6,947 linear feet of soil cement. The remaining 15,623 feet of riverside levee embankment would be armored using a combination of riprap and stone, as described for Alternative 1.1. Installation of the armoring would require approximately 99,000 CY of soil cement and 55,000 CY of 24 inch riprap.
Launch-stone consisting of -24 inch to -48 inch will be placed in the toe-down of the grouted stone or soil cement as shown on Plates 9 and 10. Launch-stone amounts to approximately 34,000 CY. Refer to Hydrologic and Hydraulics Appendix, Section 15 for further discussion of launch stone.

Quantities indicated above are approximate. It is anticipated quantities would increase to a full scale when final refinement for the scour depth and launch stone toe is completed during the PED phase.

4.6.6 Borrow

Alternatives 10/10.1 would utilize the same borrow sources as Alternative 1.1.

4.6.7 Disposal

Alternatives 10/10.1 would require disposal of an estimated 223,959 CY of material. All excess material originating from the LCR channelization area, levee demolition south of I-40, levee toe-down and associated features requiring excavation including the trench drain and collector channel is anticipated to be disposed of on the McCauley properties east of the LCR (Dyna Sand and Rock/Winslow Ready Mix is located on the same properties). Excess material originating from the rest of the project would be hauled to the City of Winslow or O'Haco South sites. Material would be distributed to these disposal areas in a manner that minimizes haul distances. The O'Haco Middle and O'Haco North sites would not be used due to their distance from the project area. Borrow/Disposal sites are shown on Plate 13. The material is anticipated to be spread at a thickness of one foot to 2.5 feet. Due to the topography of the McCauley site, material deposition may be deeper than 2.5 feet in some areas. Disposal plan site utilization is provided in Table 9.

Table 9: Alternative 10.1 Disposal Volume and Spreading Area Calculations

	O'Haco North	O'Haco Middle	O'Haco South	City of Winslow	McCauley Tracts	Total
Area Available (Acres)	50	37	141	45	503	
Material (CY)	0	0	5,527	33,028	185,404	223,959
Area Needed (Acres)						
1 foot fill depth	0	0	5.1	30.4	170.0	205.5
2.5' fill depth	0	0	2.0	12.2	68.0	82.2

4.6.8 Staging/Stockpiling Areas

Locations for staging, stockpiling and the batch plant would be as described for Alternative 1.1, except that the O'Haco North and O'Haco Middle sites would not be used. This is because these sites are located well north of the north end of the proposed construction. The Pugh/Gale staging area is located behind the existing WL at the North Road alignment. During construction of the proposed project, this staging area would end up on the river side of the new levee alignment. However, this site would remain behind the existing WL until the existing levee embankment is demolished.

4.6.9 Ingress-Egress

Ingress-egress would be as described for Alternative 1.1, except that the northernmost ingress-egress route (McHood Road) would likely not be needed. It is located well north of the proposed project.

4.6.10 Utilities

There are nine separate utilities and/or utility crossings within the Alternatives 10/10.1 construction corridor. These utilities consist of irrigation infrastructure, local and regional

electrical service, a fiber optic line, a high pressure gas line, drainage infrastructure operated by ADOT, private arena lights, and a potable water line. The City of Winslow wastewater outfall and line of wooden/metal power poles (both affected by Alternatives 1.1, 3.1 and 8) are north of the project construction corridor. Utilities would be relocated/reconstructed in place, protected in place, or avoided via minor changes to project alignment during PED. Refer to Table 10 for a description of the utilities and impacts associated with Alternatives 10/10.1.

Table 10: Alternative 10/10.1 Utilities (Listed in order from upstream to downstream)

Utility	Owner/Operator	Specifications	Action During Construction
Inverted Siphons	Winslow Irrigation District	Two siphons constructed with 30 inch reinforced concrete pipe	Relocate (reconstruct in place)
Utility line on wooden poles	Unknown	Single overhead line with unidentified local utility	Relocation or removal
Fiber Optic Line	CenturyLink	Major trunk line and local service line in 4-inch conduit	Protect in place
High Pressure Gas Line Crossing No. 1	Kinder-Morgan	4.5-inch outside diameter pipe	Relocate
High Tension Electric Lines	Arizona Public Services (APS)	Unknown; possibly 130kV	Within construction access easement; protect in place
High Pressure Gas Line Crossing No. 2	Kinder-Morgan	4.5-inch outside diameter pipe	Relocate
K3 Channel, Under I-40	ADOT	8 barrel concrete box culvert with lift gates	Not in construction area; levee design to be refined during PED to avoid impacts, as needed
High Pressure Gas Line Crossing No. 3	Kinder-Morgan	4.5-inch outside diameter pipe	Relocate
I-4 Hydraulic Gate	ADOT	4 barrel 4-feet X 10-feet concrete box culvert with lift gates	Relocate (rebuild in place)
Arena lights	Hatch, Ben Trustee B & M Hatch Family Trust	Four livestock arena light poles	Design to be refined during PED to avoid impacts
Homolovi Water Line	City of Winslow	6-inch PVC line for potable water supply	Relocate

Utility impacts, including possibility of service disruptions, would be identical to those for Alternative 1.1., with two exceptions: the Winslow wastewater outfall and the northernmost APS service poles are outside of the project area and would not be impacted.

4.6.11 Construction

Construction would begin at the upstream end of the project and progress downstream. Conveyance improvements would either be completed ahead of or concurrent with levee reconstruction. It is recommended conveyance improvements or channelization be completed concurrently with levee reconstruction/construction because suitable material excavated from the LCR would be used for levee reconstruction/construction. This is to both provide conveyance of the design flood under the BNSF Railroad Bridge and to provide materials needed for levee construction.

4.6.12 Construction Equipment

Equipment used during construction would be as described for Alternative 1.1

4.6.13 Duration of Construction

Construction duration for the Recommended Plan is estimated at 2.5 years, which is the most-likely schedule, irrespective of schedule contingency. Construction activities, scheduling and work hours would be as described for Alternative 1.1

The proposed construction plan would be implemented via one phase. Construction consists of demolition of the existing levee and construction of a new levee, extension of interior drainage and associated features including the trench drain and collector channel. The estimated construction time assumes year-around construction with allowance for adverse weather delays, the monsoon season and national holidays. Construction would generally stop on the months of July, August and September. Construction phasing would be accomplished in a manner that assures a functioning levee system during each winter-spring rain and snowmelt season. Since freezing winter temperatures and high summer temperatures occur at Winslow, placing of materials should be planned for periods of mild weather.

4.6.14 Property Ownership

Approximately 15 properties would be affected for construction of Alternatives 10/10.1. The affected properties include the BNSF Railroad corridor, two ADOT properties (I-40 and a drainage easement), nine mostly large ranch/vacant properties, a large ranch property having residences and/or outbuildings outside of the construction zone, and two additional properties where residences and/or outbuildings are located within or close to the construction access corridor. Approximately four occupied residences are located within 200 feet of the existing levee, and one of these is within 100 feet. Relocations are anticipated to be avoided with minor adjustments to the levee alignment and construction corridor during PED.

Setback of the Winslow Levee across from Homolovi I would restore approximately 12 acres to the active LCR floodplain. No structures are located within the proposed levee setback area. Relocation of occupied structures is not anticipated for Alternatives 10/10.1.

4.7 Alternative 10.2 – Rebuild the RWDL and WL to North Road to Contain the 4% ACE Flood

Alternative 10.2 proposes to rebuild the WL from the RWDL downstream to a point 0.8 miles north of North Road, no improvements to the Winslow Levee downstream of the federal project, set back a short segment of the WL across the LCR from the Homolovi I Pueblo, remove the original WL in the setback area, rebuild the eastern end of the RWDL, and construct a new levee parallel to I-40. New levee construction would be designed to provide approximately 90% assurance of containing the 4% ACE event. Three feet of elevation above the stage corresponding with the 4% median discharge was included in the design to achieve this level of assurance. Alternative 10.2 does not include nonstructural measures other than implementation of a flood warning system.

4.7.1 Levee Construction Features

Levee construction features for Alternative 10.2 are identical to those for Alternative 10.1, except that the levee would be constructed at a scale that provides a 90% assurance of containing the 4% ACE flood. The maximum levee height would be 13.3 feet.

4.7.2 Channel Construction Features

Conveyance under the BNSF Railroad Bridge is already sufficient to convey the 4% ACE flood. For this reason, Alternative 10.2 does not include channelization measures.

4.7.3 Nonstructural Measures

Alternative 10.2 would include a flood warning system.

4.7.4 Material Required for Construction

Approximately 346,000 CY of material would be obtained by demolishing existing levee embankments. Excavation of the trench drain along the landside toe of the levee would yield an estimated 117,000 CY of additional material. Re-use assumptions for this material is as described for Alternative 1.1.

Reconstruction of the levees would require approximately 282,000 CY of material. This material would be obtained from the levee demolition, and trench drain excavation to the extent practicable. Since Alternative 10.2 does not include the LCR channelization, excess material from this source would not be available for construction. Unusable materials would be disposed of at nearby disposal areas as waste.

The trench drain filter material would require approximately 40,000 CY of sand and 40,000 CY of gravel. The sand and gravel would either be obtained on-site if appropriate materials are available, or trucked from offsite sources as necessary. The remaining trench volume would be backfilled using an estimated 30,000 CY of material originally excavated from the trench.

The existing levees to be reconstructed are armored by approximately 10,000 CY of large-sized, high-quality, durable basalt riprap with a median rock size (D_{50}) of approximately 10 inches. This riprap would be removed from the existing levee embankment and stockpiled for reuse on the reconstructed levees. An additional 8,000 CY of poor quality sandstone and broken concrete would either be stockpiled for flood fighting, or disposed of off-site.

The riverside levee embankment armoring consists of soil cement south of I-40 and in the vicinity of the upstream impingement point, for a total of 10,006 lf of soil cement. The remaining 12,546 lf of riverside levee embankment would be armored using a combination of riprap and grouted stone, as appropriate. Installation of the armoring would require approximately 83,000 CY of soil cement and 31,000 CY of 24-inch riprap. The estimated 10,000 CY of riprap salvaged from the existing levees would be reused as described for Alternative 1.1. Additional basaltic riprap would be obtained as described for Alternative 1.1.

For landside levee slope protection, a 4-inch-thick layer of gravel mulch also known as ABC would be installed on the landside of the levee for slope protection. Approximately 5,400 CY of gravel mulch would be needed for this work. Construction of the 15-feet-wide maintenance road along the length of the project would require an additional 2,800 CY of aggregate binder course gravel mulch.

Construction fines (clay and silt) for levee embankment construction would be obtained as described for Alternative 1.1.

4.7.5 Borrow

Alternative 10.2 would utilize the same borrow sources as described for Alternatives 10/10.1.

4.7.6 Disposal

Alternative 10.2 would require disposal of an estimated 151,000 CY of material. The disposal plan would utilize the same sites and spreading depths described for Alternative 10.1.

Table 11: Alternative 10.2 Disposal Volume and Spreading Area Calculations

	O'Haco North	O'Haco Middle	O'Haco South	City of Winslow	McCauley Tracts	Total
Area Available (Acres)	50	37	141	45	503	
Material (CY)	0	0	16,700	100,000	33,800	151,000
Area Needed (Acres)						
1 foot fill depth	0	0	10.4	See Note[1]	20.9	93.4
2.5 feet fill depth	0	0	4.1	24.8	8.4	37.3

[1] To maintain efficient haul distances, a minimum spreading depth of approximately 1.5 feet would be needed for the City of Winslow staging area.

4.7.7 Staging/Stockpiling Areas

Locations for staging, stockpiling and the batch plant would be as described for Alternative 1.1, except that the O'Haco North and O'Haco Middle sites would not be used.

4.7.8 Ingress-Egress

Ingress-egress would be as described for Alternative 1.1, except the northernmost ingress-egress route (McHood Road) would likely not be needed.

4.7.9 Utilities

There are eleven separate utilities and/or utility crossings within the Alternative 10.2 construction corridor. Utilities would be relocated/reconstructed in place, protected in place, or avoided via minor changes to project alignment during PED. Utility impacts, including possibility of service disruptions, would be identical to those for Alternatives 10/10.1.

4.7.10 Construction Equipment

Equipment used during construction would be as described for Alternative 1.1.

4.7.11 Duration of Construction

Construction duration for Alternative 10.2 is estimated at approximately six years. Construction activities, scheduling and work hours would be as described for Alternative 1.1.

4.7.12 Property Ownership

Property requirements would be as described for Alternatives 10/10.1, with one exception. Temporary access easements and access permits would not be required for the conveyance improvement measures, since they are not included in Alternative 10.2. Relocation of occupied structures is not anticipated for Alternative 10.2. Plate 7.1 presents the overall plan of the Alternative 10.2

4.8 Alternative 10.3 – Rebuild the RWDL and Winslow Levee to North Road to Contain the 2% ACE Flood

Rebuild the WL from the RWDL downstream to a point 0.8 miles north of North Road, no improvements to the WL downstream of the federal project, set back a short segment of the Winslow Levee across the LCR from the Homolovi I Pueblo, remove the original WL in the setback area, rebuild the eastern end of the RWDL, construct a new levee parallel to I-40, improve conveyance under the BNSF Railroad Bridge. New levee construction would be designed to provide approximately 90% assurance of containing the 2% ACE event. Three feet of elevation above the stage corresponding with the 2% median discharge was included in the design to achieve this level of assurance. Alternative 10.3 does not include nonstructural measures other than implementation of a flood warning system. Plate 7.2 provides levee layout and its associated features for Alternative 10.3.

4.8.1 Levee Construction Features

Levee construction features for Alternative 10.3 are identical to those for Alternative 10.1, except that the levee would be constructed at a scale that provides a 90% assurance of containing the 2% ACE flood. The maximum levee height would be 14.5 feet.

4.8.2 Channel Construction Features

Alternative 10.3 includes the same channelization features as described for Alternative 1.1.

4.8.3 Nonstructural Measures

Alternative 10.3 would include a flood warning system.

4.8.4 Material Required for Construction

Alternative 10.3 includes the same channelization features as described for Alternative 1.1. Thus, the material volumes and re-use assumptions are identical.

Approximately 346,000 CY of material would be obtained by demolishing existing levee embankments. Excavation of the trench drain along the landside toe of the levee would yield an estimated 117,000 CY of additional material. Re-use assumptions for this material is as described for Alternative 1.1.
Reconstruction of the levees would require approximately 331,000 CY of material. This material would be obtained from the LCR channelization, levee demolition, and trench drain excavation to the extent practicable. Unusable materials would be disposed of at nearby disposal areas as waste. The trench drain filter material would require approximately 40,000 CY of sand and 40,000 CY of gravel. The sand and gravel would either be obtained on-site if appropriate materials are available, or trucked from offsite sources as necessary. The remaining trench volume would be backfilled using 30,000 CY of material originally excavated from the trench.

The existing levees to be reconstructed are armored by approximately 10,000 CY of large-sized, high-quality, durable basalt riprap with a median rock size (D_{50}) of approximately 10 inches. This riprap would be removed from the existing levee embankment and stockpiled for reuse on the reconstructed levees. An additional 8,000 CY of poor quality sandstone and broken concrete riprap would either be stockpiled for flood fighting, or disposed of off-site.

The riverside levee embankment armoring consists of soil cement south of I-40 and in the vicinity of the upstream impingement point, for a total of 10,006 linear feet of soil cement. The remaining 12,546 feet of riverside levee embankment would be armored using a combination of riprap and grouted stone, as appropriate. Installation of the armoring would require approximately 83,000 CY of soil cement and 31,000 CY of 24-inch thick riprap. The estimated 10,000 CY of riprap salvaged from the existing levees would be reused as described for Alternative 1.1. Additional basaltic riprap would be obtained as described for Alternative 1.1.

For landside levee slope protection, a 4-inch-thick layer of gravel mulch also known as ABC would be installed on the landside of the levee for slope protection. A total of approximately 6,000 CY of gravel mulch would be needed for this work. Construction of the 15-foot-wide maintenance road along the length of the project would require an estimated 2,800 CY of aggregate binder course gravel mulch.

Construction fines (clay and silt) for levee embankment construction would be obtained as described for Alternative 1.1.

4.8.5 Borrow

Alternative 10.3 would utilize the same borrow sources as described for Alternatives 10/10.1.

4.8.6 Disposal

Alternative 10.3 would require disposal of an estimated 402,000 CY of material (

Table 12). The disposal plan would utilize the same sites and spreading depths described for Alternative 10.1.

Table 12: Alternative 10.3 Disposal Volume and Spreading Area Calculations

	O'Haco North	O'Haco Middle	O'Haco South	City of Winslow	McCauley Tracts	Total
Area Available (Acres)	50	37	141	45	503	
Material (CY)	0	0	11,300	67,600	323,000	402,000
Area Needed (Acres)						
1 foot fill depth	0	0	7.0	41.9	200.0	248.9
2.5 feet fill depth	0	0	2.8	16.8	80.0	99.6

4.8.7 Staging/Stockpiling Areas

Locations for staging, stockpiling and the batch plant would be as described for Alternative 1.1, except that the O'Haco North and O'Haco Middle sites would not be used.

4.8.8 Ingress-Egress

Ingress-egress would be as described for Alternative 1.1, except the northernmost ingress-egress route (McHood Road) would likely not be needed.

4.8.9 Utilities

There are nine separate utilities and/or utility crossings within the Alternative 10.3 construction corridor. Utilities would be relocated/reconstructed in place, protected in place, or avoided via minor changes to project alignment during PED. Utility impacts, including possibility of service disruptions, would be identical to those for Alternatives 10/10.1.

4.8.10 Construction Equipment

Equipment used during construction would be as described for Alternative 1.1

4.8.11 Duration of Construction

Construction duration for Alternative 10.3 is estimated at approximately six years. Construction activities, scheduling and work hours would be as described for Alternative 1.1.

4.8.12 Property Ownership

Property requirements would be as described for Alternatives 10/10.1. Relocation of occupied structures is not anticipated for Alternative 10.3.

The 2% ACE flood will require conveyance improvements at the BNSF Railroad Bridge. These improvements consist of widening and deepening the LCR channel for a distance of approximately 2,500 feet in the vicinity of the railroad bridge as described for Alternatives 1.1, 3.1, 8, 10 and 10.1 above. Saltcedar removal would also be required as described for these alternatives. See Plate 7.2.

4.9 Alternative 10.4 – Rebuild the RWDL and Winslow Levee to North Road to Contain 0.5% ACE Flood

Alternative 10.4 proposes to rebuild the WL from the RWDL downstream to a point 0.8 miles north of North Road, no improvements to the WL downstream of the federal project, set back a short segment of the WL across the LCR from the Homolovi I Pueblo, remove the original WL in the setback area, rebuild an approximate 2,000 feet eastern end of the RWDL, construct a new levee parallel to I-40, improve conveyance under the BNSF Railroad Bridge shown on Plate 7.3. New levee construction would be designed to provide approximately 90% assurance of containing the 0.5% ACE event. Three feet of elevation above the stage corresponding with the 0.5% median discharge was included in the design to achieve this level of assurance. Alternative 10.4 does not include nonstructural measures other than implementation of a flood warning system.

4.9.1 Levee Construction Features

Levee construction features for Alternative 10.4 are identical to those for Alternative 10.1, except that the levee would be constructed at a height sufficient to contain the 0.5% ACE flood. The maximum levee height would be 17.1 feet.

4.9.2 Channel Construction Features

In addition to levee construction, Alternative 10.4 includes saltcedar removal and river channelization needed for conveyance of the 0.5% ACE flood under the BNSF Railroad Bridge. Saltcedar would be removed from a ±74-acre area in the vicinity of the BNSF Railroad and SR 87 bridges using land clearing equipment. Removed saltcedar would be disposed of on an upland location outside of the floodplain.

Following saltcedar removal, the river would be channelized for a length of ±6,000 feet at the BNSF Railroad Bridge by excavating a ±81-acre area to the current thalweg depth. Excavation depth would range from six to eight feet. The bottom of the newly excavated channel would remain earth-lined. Excavated material would either be recycled for levee construction, or disposed of on an upland area. The newly excavated channel would include a ±390 feet wide low flow channel with soil cement banks, and overflow terraces with riprap embankment armoring. The total width of the channel, terraces and armored embankments would be ±650 feet.

Dewatering and/or water diversion would be required for the work proposed in the LCR channel and on the riverside of the levee. Existing floodplain soils would not support the weight of construction equipment or, in some areas, even a standard passenger vehicle. Wheeled or tracked transport across the LCR channel or adjacent floodplain would require soil enhancements in addition to dewatering to avoid equipment bog down. Any soil enhancements placed can be removed after the construction ends and the construction/access road alignment is restored.

4.9.3 Nonstructural Measures

Alternative 10.4 would include a flood warning system.

4.9.4 Material Required for Construction

Approximately 345,000 CY of material would be excavated from the LCR floodplain at the BNSF Railroad Bridge. The USACE is also assuming that 50% of the material excavated from the river for conveyance at the BNSF Railroad Bridge can be re-used for construction. As part of the channelization work, 42,000 CY of soil cement and 30,000 CY of 36-inch riprap would be installed to create a low flow channel, terrace and armored side slopes.

Approximately 346,000 CY of material would be obtained by demolishing existing levee embankments. Excavation of the trench drain along the landside toe of the levee would yield an estimated 117,000 CY of additional material. Re-use assumptions for this material are as described for Alternative 1.1.

Reconstruction of the levees would require approximately 469,000 CY of material. This material would be obtained from the LCR channelization, levee demolition, and trench drain excavation to the extent practicable. Unusable materials would be disposed of at nearby disposal areas as waste.

The trench drain filter material would require 40,092 CY of sand and 40,092 CY of gravel. The sand and gravel would either be obtained on-site if appropriate materials are available, or trucked from off-site sources as necessary. The remaining trench volume would be backfilled using an estimated 30,000 CY of material originally excavated from the trench.

The existing levees to be reconstructed are armored by approximately 10,000 CY of large-sized, high-quality, durable basalt riprap with a median rock size (D_{50}) of approximately 10 inches. This riprap would be removed from the existing levee embankment and stockpiled for reuse on the reconstructed levees. An additional 8,000 CY of poor quality sandstone and broken concrete riprap would either be stockpiled for flood fighting, or disposed of off-site.
The riverside levee embankment armoring consists of soil cement south of I-40 and in the vicinity of the upstream impingement point, for a total of 10,006 lf of soil cement. The remaining 12,546 lf of riverside levee embankment would be armored using a combination of riprap and grouted stone, as appropriate. Installation of the armoring would require approximately 83,000 CY of soil cement and 31,000 CY of 24-inch-thick riprap. The estimated 10,000 CY of riprap salvaged from the existing levees would be reused as described for Alternative 1.1. Additional basaltic riprap would be obtained as described for Alternative 1.1.

For landside levee slope protection, a 4-inch layer of gravel mulch would be installed on the landside of the levee for slope protection. A total of approximately 7,100 CY of gravel mulch would be needed for this work. Construction of the 15-feet-wide maintenance road along the length of the project would require an estimated 2,800 CY of aggregate binder course gravel mulch.

Construction fines (clay and silt) for levee embankment construction would be obtained as described for Alternative 1.1.

4.9.5 Borrow

Alternative 10.4 would utilize the same borrow sources as described for Alternatives 10/10.1.

4.9.6 Disposal

Alternative 10.4 would require disposal of an estimated 309,000 CY of material (Table 13). The disposal plan would utilize the same sites and spreading depths described for Alternative 10.1.

Table 13: Alternative 10.4 Disposal Volume and Spreading Area Calculations

	O'Haco North	O'Haco Middle	O'Haco South	City of Winslow	McCauley Tracts	Total
Area Available (Acres)	50	37	141	45	503	
Material (CY)	0	0	8,200	49,100	252,000	309,000
Area Needed (Acres)						
1 foot fill depth	0	0	5.1	30.4	155.9	191.4
2.5 feet fill depth	0	0	2.0	12.2	62.4	76.6

4.9.7 Ingress

Locations for staging, stockpiling and the batch plant would be as described for Alternative 1.1, except the northernmost ingress-egress route (McHood Road) would likely not be needed.

4.9.8 Utilities

There are nine separate utilities and/or utility crossings within the Alternative 10.4 construction corridor. Utilities would be relocated/reconstructed in-place, protected-in-place, or avoided via minor changes to project alignment during PED. Utility impacts, including possibility of service disruptions, would be identical to those for Alternatives 10/10.1.

4.9.9 Construction Equipment

Equipment used during construction would be as described for Alternative 1.1.

4.9.10 Duration of Construction

Construction duration for Alternative 10.4 is estimated at approximately six years. Construction activities, scheduling and work hours would be as described for Alternative 1.1.

4.9.11 Property Ownership

Property requirements would be as described for Alternatives 10/10.1, except more real estate would be required for the larger conveyance improvement measures associated with Alternative 10.4. Relocation of occupied structures is not anticipated for Alternative 10.4

4.10 Alternative 11 – No Action Alternative

The No Action Alternative (Alternative 11) assumes that no Federal action would be undertaken to address the flood risk to the Winslow community. The Navajo County Flood Control District and the City of Winslow will continue O&M activities for the existing WL and RWDL, respectively. Levee repairs and improvements will typically be completed on a reactionary, as-needed post-flood basis. Under the No Action Alternative, the flood risk in the Winslow area is expected to remain essentially unchanged over the period of analysis which is 50 years. The No

Action Alternative is synonymous with the future without project condition. Plate 8 presents No Action Alternative.

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5.0 UTILITIES INFORMATION

There are multiple existing utilities located within the project construction corridor for each alternative, except Alternative 7 - Non-structural Measures Only and Alternative 11-No Action Alternative that don't require improvements. These utilities would require relocation, reconstruction, and/or protection-in-place, see Plate 11, or Table 4 on Page 12 for utility information. The following existing utilities are considered to impact or likely impact the project.

5.1 Winslow Irrigation District Inverted Siphons

There are two inverted siphons consisting of 30-inch reinforced concrete pipe (RCPs) crossing underneath the east end of the RWDL. These two siphons were buried approximately 5 feet measured vertically from the existing ground surface to the top of pipe, and conflict with the proposed improvement for east end of the RWDL. Relocation and reconstruction of the two siphons would be necessary to accommodate RWDL toe-down design requirements. Relocation and reconstruction work would involve excavation, removal of the existing siphons, and reconstruction of new siphons to avoid impacting the proposed RWDL toe-down. This work would also include trenching, placement of new lines connecting the new siphons, and backfill.

5.2 Wooden Utility Poles and Overhead Power Line

Located approximately 200 feet east of the two inverted siphons mentioned above are two wooden utility poles with an overhead power line. The poles are located on either side of the RWDL, within the project limits. These utility poles conflict the RWDL improvement project and need to be relocated prior to construction.

5.3 Buried Telephone Cable

There is an abandoned buried telephone cable located at approximately STA 6+10 along the WL. This buried telephone cable is no longer in service, and therefore, there is no need to replace, relocate, or protect-in-place. It shall be removed off-site during construction.

5.4 CenturyLink Fiber Optic Line

There is an existing a fiber optic line inside a 4-inch diameter polyvinyl chloride (PVC) conduit that was buried approximately 8.65 feet below the existing ground surface at the closet manhole in vicinity of the WL. This fiber optic line is located underneath the WL, between WL STAs 6+00 and 7+00. Protection of the fiber optic line is required during construction for all alternatives, except for Alternatives 7 and 9 where nonstructural measures were considered. To protect the CenturyLink fiber optic conduit in place, it would be necessary to encase the fiber optic conduit in concrete encasement with slurry concrete anchors beneath the WL and WL riverside slope extending 20 feet from the levee toe-down at the determined intervals (10-feet center-to-center). In addition to encasing the fiber optic conduit beneath the levee and levee riverside slope, it will be necessary to encase the fiber optic conduit with concrete for an additional 30 feet out from the visible landside levee toe and 10 feet out from the last slurry concrete anchor on riverside levee.

5.5 Kinder-Morgan High Pressure Gas Line Crossing Nos 1, 2 & 3

The Kinder-Morgan high pressure gas line crosses the WL project limits at three locations; at approximately WL STA 6+45, STA 52+00, and STA 81+11.10. The pressure gas line is a 4.5-inch outside diameter pipe buried at a depth shallower than the design depth of the proposed WL toe-down. Relocation of the pressure gas line to a sufficient depth to avoid levee toe-down penetrations would be needed for each of the crossings. It was estimated a total length of 1,200 feet of the gas line would need to be relocated. Relocation work would involve excavation, trenching, and shoring underneath the WL, WL landside, and riverside slopes to construct a new line. This relocation work would require temporary disruption of service of an existing line for a short period of time, but not to exceed 3 hours for connecting to a new line for each crossing.

5.6 APS High Tension Overhead Electric Line

Arizona Public Services (APS) high tension electric overhead lines are located at approximately WL STA 9+00, within the project construction access easement, but not within the construction limits. These electric lines would need to be protected-in-place during construction. In order to ensure that the single powerline pylon within the construction corridor can remain in place, the Corps implementation Project Delivery Team (PDT) in coordination with the project sponsor (Navajo County) should obtain written and signed clearance requirements from APS before beginning detailed design. The PDT is also advised to obtain low wire survey shots of the wire crossings to confirm that the proposed levee construction meets vertical clearance requirements if the pylon remains in place.

5.7 ADOT K-3 Channel - Under I-40

The ADOT K-3 Channel is located under and along the I-40, at approximately WL STA 59+68. This channel is not located in the construction area. Therefore, the current project design does not include K-3 channel flows. The K-3 channel flows would be diverted along the north toe of the I-40 embankment. The final levee design would be refined during PED to avoid impacts to the K-3 channel.

5.8 ADOT 4-Cell 4-ft X 10-ft RCB Culvert with I-4 Hydraulic Lift Gate

The ADOT 4-cell 4-feet by 10-feet reinforced concrete box (RCB) culvert including hydraulic lift gate is located at approximately WL STA 92+13.41. This ADOT structure would need to be rebuilt/reconstructed in place due to impacting the proposed project construction area. Reconstruction of the RCB culvert including lift gate would consist of demolishing of the existing structures and reconstructing in-kind.

5.9 Arena Light Poles – Overhead Lighting

There are four arena light poles located between WL STA 132+00 and STA 134+00, which may not need to be relocated due to minor adjustment of the levee control line (realignment). Realignment of the levee can be accomplished during the PED phase.

5.10 Winslow Homolovi Water Line

An existing 6-inch diameter PVC potable water supply line for Homolovi State Park is located at WL STA 158+00. This 6-inch PVC water line that runs parallel to the WL landside slope for an

approximate distance of 1,000 feet would need to be relocated and replaced with the new 6-inch PVC line or equivalent. Relocation work would be accomplished in a manner that does not require service interruptions. However, during final connection of the new line to the existing line, temporary interruption to potable water service may be needed. It is anticipated that interruption to this 6-inch PVC service would not last more than 2 hours.

5.11 Winslow Wastewater Outfall

The Winslow Wastewater Outfall is the NPDES - permitted wastewater treatment discharge point for the City of Winslow. It is located at WL STA 223+00 and impacts the proposed WL improvement project for Alternatives 1.1, 3.1 and 8. The discharge pipe consists of a 12-inch diameter ductile iron with outlet structure located approximately 100 feet off of the visible riverside toe of the levee. The outlet structure includes a 12-inch flap valve and a reinforced concrete headwall. Relocation of the Winslow Wastewater Outfall including the outlet structure would involve construction of the new outfall and outlet structure and demolition of the existing outfall. Relocation work would be accomplished in a manner that does not require service interruptions. However, during final connection of the new wastewater line to the existing wastewater line, temporary interruption to wastewater service may be necessary. It is anticipated that interruption to the wastewater line service would not last more than 2 hours.

5.12 APS Overhead Electric Lines, Wooden and Metal Power Poles

There are 9 utility poles within the vicinity of the project corridor for Alternatives 1.1, 3.1 and 8. Six of 9 poles are wooden poles, and the remaining 3 poles are metal poles. These utility poles are located approximately between STA 223+00 and STA 242+00. These utility poles provide electrical service to the locals via overhead power lines. Two metal poles located within a few feet of the edge of the construction access corridor would not require relocation since there is enough space to provide a workable condition around the poles. One of the wooden poles has been broken and abandoned and would not need to be replaced, because this pole is no longer in service. Relocation of 6 utility poles would be necessary to accommodate project improvements. Relocation work for the wooden poles would involve installation of new poles including power lines and removal of the existing poles. Work required for relocation of the metal pole would involve installation of the new pole and power lines including construction of footing and demolition and removal of the pole and the concrete footing/base. Relocation work would be accomplished in a manner that minimizes service interruptions during relocation of the existing the poles. However, temporary interruption would be necessary to connect/reconnect the existing lines with the new poles during the final connection phase.

5.13 Homolovi Buried Electrical Line

There is an abandoned buried electrical line located downstream from STA 242+00 within the project footprint. This buried electrical line has been abandoned and shall be removed off-site during construction.

5.14 O'Haco Private Well and Portable Pump

The very downstream end of the project shown on Plate 11 calls for removal of the O'Haco Well and Portable Pump. The well and portable pump shall be removed and disposed of during construction.

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6.0 BORROW SITES

Two type of locations are considered as borrow sources located in the vicinity of the project, the Riverine and Upland. See Plate 13.

6.1 Riverine Borrow

There are two potential riverine borrow sites situated in the LCR. The first site consists of material from existing levee embankments and trench excavations, as well as LCR floodplain sediment deposited in the vicinity of the BNSF Railroad Bridge. This borrow site would be excavated to increase conveyance under the railroad bridge and to obtain the design flow capacity for all alternatives except Alternatives 7 and 9 which called for nonstructural measures, and Alternative 10.2. The required excavation area to increase conveyance for Alternatives 1.1, 3.1, 8, 10, 10.1 and 10.3 would be approximately 26 acres. The required excavation area to increase conveyance for Alternative 10.4 would be approximately 81 acres. Sediment deposits are found to be suitable for levee construction.

The second borrow site is located near the upstream end of the project, north-east of the French Farm. This borrow site was established by oriented dust storms that formed a dust dune of an approximately 4.3-acres consisting of silt and fine-grained sandy silt. This dust dune material represents a potential source of fines.

6.2 Upland Borrow

Three sites located in the upland area have been identified as potential borrow areas for levee construction material. The first site is located directly east of French Road and north of Oaks Road, right next to the WL project. This site is owned by the City of Winslow consisting of two contiguous 80-acre parcels that extend into the LCR floodplain. Of the total 160 acres, approximately 45-acres is available for use. Geotechnical exploration has not been conducted for this site. However, the USACE study team examined available geologic maps, studied aerial photographs, and made conclusions concerning the site geology. The fine grained-sediments deposited over the years in the river could be used as fines for levee construction.

The second site, located at the northern end of the WL project, owned by Mr. Jim O'Haco, identified as "O'Haco Northwest" pit, provides an upland borrow source of material. This 39.2-acre site was used to mine for levee construction materials consisting of silty sandy clay. The material was also used for repair of the WL. Although this site is considered a good borrow area, it is located about 2.5 miles from the project's downstream end, which is further away from the project as compared to the first and third borrow sites.

The third site is an existing operating gravel and sand quarry, the Dyna Sand and Rock/Winslow Ready Mix site, owned by Mr. John McCauley. It is located near the southern end, on the east side of WL, about 0.7 miles east of the extent of the levee.

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7.0 DISPOSAL SITES

Five sites have been identified available for disposal of excess and waste material resulting from project construction. Refer to Plate 13. These sites are described as follows:

7.1 McCauley Site

John McCauley has offered the Dyna Sand and Rock/Winslow Ready Mix property for disposal. The property consists of three contiguous parcels totaling 503 acres, located near the upstream end, on the east side of WL (north side of I-40, between SR 87 and the LCR). This property is currently used for concrete and aggregate processing operation/facilities, and a borrow pit.

7.2 City of Winslow Site

This site consists of two contiguous 80-acre parcels. Approximately 45 acres are available for disposal. An agricultural area is located on the south end of the property, therefore, disposal is limited to north end only.

7.3 O'Haco North Site

The O'Haco North Site consists of approximately 50-acres of a 242- acre parcel located at the far northern end of the WL. Maximum disposal area allowed at this site is 5.8 acres.

7.4 O'Haco Middle Site

The O'Haco Middle Site consists of a 37-acre portion of the same 242-acre parcel on which the O'Haco North Site is located. LCR meanders creating a C-shape to separate the O'Haco North and O'Haco Middle sites. Maximum disposal area allowed for this site is 8.8 acres.

7.5 O'Haco South Site

The O'Haco South Site consists of a 400-acre parcel that extends into the LCR floodplain. Approximately 57 percent of the 400-acre parcel is located on the landside of the WL. The remaining 43 percent is situated in the levee floodplain (riverside). A maximum area appropriate for disposal is 32.8 acres.

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8.0 CONTRACTOR'S STAGING/STOCKPILE AREAS

The staging/stockpile areas have been identified and indicated on Plate 12 for all the alternatives, except Alternative 7-Nonstructural Measures Only that doesn't require staging/stockpile areas. Multiple staging/stockpile areas ranging from two to five acres per site have been identified and indicated for Alternatives 1.1, 3.1 and 8. Alternative 9 would require two-2-acre staging/stockpile areas due to limited levee improvements. Up to eight staging/stockpile areas would be needed for each of the remaining alternatives. In addition to staging/stockpile areas, a batch plant site would be needed for concrete and grouting operations for installation of soil cement and grouted stone slope. This batch plant site would be located on a 5-acre lot owned by the City of Winslow, except for Alternative 3.1, for which the batch plant would be located on property owned by the Navajo Tribe or Transcon, LLC.

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9.0 INGRESS – EGRESS ROUTES

Seven ingress/egress routes required for access to the project upstream to downstream have been identified and indicated on Plates 2, 3 and 5 for Alternative 1.1, 3.1 and 8, respectively. Two ingress/egress routes would be needed for alternative 9 because of limitation of levee improvements. Six ingress/egress routes would be needed for access to the project upstream and downstream for Alternative 10/10.1 and subsequent alternatives (see Plates 7, 7.1 through 7.4). It is proposed to have 30-feet-width two-way ingress/egress routes to allow safe passage of heavy construction equipment.

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10.0 CONSTRUCTION CONSIDERATIONS

10.1 Construction Period and Seasonal Compatibility

The proposed construction plan would be implemented via one phase. Construction consists of demolition of the existing levee and construction of a new levee, extension of interior drainage and associated features including the trench drain and collector channel. The construction time required is estimated to be 2.5 years for the Recommended Alternative. The estimated construction time assumes year-round construction with allowance for adverse weather delays, the monsoon season and national holidays. Construction would generally stop in the months of July, August and September.

As a result of the proximity of the river to the construction site, the construction period should be scheduled to coincide with a time of year when the flooding risk would be minimized. The risk factor could have significant impact on the construction cost of the project. The embankment work would be most susceptible to damage and construction delays during the wet season of the year. Winslow experiences both summer and winter rains; however, the primary rainy season occurs in July, August and September. The winter months of December through March also have the possibility of high flows in the channel due to winter storms and possible snow melt at higher elevations. Avoidance of these months to the extent possible in scheduling construction would be advantageous.

The estimated first cost of the levee includes estimates for construction, rights-of-way, and relocation of people (Alternative 3.1 only) and utilities. Allowances for contingencies, engineering and design, and supervision and administration of construction are also included in estimated first costs.

10.2 Material Sources

Due to relatively fair to good soil characteristics and the proximity of residential and agricultural developments to the levee, it was determined that the area within the river and adjacent to the levee would provide a suitable source for the materials required for compacted earth fill and soil cement construction. The material in this area consisted primarily of relatively clean sands that may need to be blended with silt from local dunes or other sources of fines. Refer to the Geotechnical Appendix, Section 5.3 for more information on the material sources.

The closest source for large basalt is the existing, operating Brimball Hardluck Quarry, in Indian Wells, AZ, 40 miles north of Holbrook on SR 77. This location is 43 straight-line miles northeast of the Winslow Levee. The quantity of stone available should not be an issue. The material was tested prior to placement on the Winslow Levee by Navajo County contractors. Although there are some slight variations from the standard USACE test suite, all indications are that the stone would pass the USACE stone acceptance criteria. An existing quarry located approximately 60 miles from the southern end of the Winslow Levee was used to supply the riprap for the existing levee. This quarry was located in Bidahochi, AZ, and operated under the name ‘Bidahochi Quarry’.

10.3 Estimated Installation Cost

The total estimated project installation costs are the expected expenditures for construction, contingencies, land rights, engineering, and contract administration. The average annual cost used in computing the benefit cost ratio reflects installation costs plus annual operation and maintenance expenditures (
Table **14**).

An explanation of each of the components comprising the installation cost is presented below.

10.3.1 Construction

This item provides money to be paid to a contractor for actual construction of the project and protection of the existing structures and utilities. The construction cost is estimated by applying a unit cost to required quantities of construction materials and then totaling the costs computed for each construction item.

10.3.2 Contingencies

Contingency costs are included to provide an allowance for cost overruns resulting from unforeseen circumstances or unit price fluctuations that may occur during project installation.

10.3.3 Land Rights

Land rights costs include obtaining the additional right-of-way needed for levee construction. These costs also include the anticipated relocation of water, power, wastewater, fiber optic and gas line utilities. Right-of-way costs give consideration to acquisition of land or easements, as well as associated land acquisition costs such as title report, appraisals, right-of-way, survey, and agent fees.

10.3.4 Engineering and Administration

This category of expenditures includes the cost of final project design, contract administration, and construction inspection. These costs are normally estimated as a percentage of the construction cost.

Table 14: Costs for Alternatives

(FY 2014 Price Levels)

	Alternatives[1]	First Cost ($)	Operation and Maintenance (Annual)
1.1	Rebuild Levee System; 1% ACE Flood	$87,305,013	$102,000
3.1	Winslow Levee Setback; 1% ACE Flood	$91,703,551	$95,200
7	Nonstructural Measures (NS) Only	$19,172,028	$0
8	Homolovi I Levee Setback; 1% ACE Flood	$81,732,058	$99,000
9	Rebuild RWDL with Nonstructural Measures	$21,221,331	$5,850
10	Winslow Levee to North Road with Nonstructural Measures; 1% ACE Flood	$64,155,183	$67,800
10.1	Winslow Levee to North Road without Nonstructural Measures; 1% ACE Flood	$59,905,378	$67,800
10.2	Winslow Levee to North Road without Nonstructural Measures; 4% ACE Flood	$39,259,563	$24,800
10.3	Winslow Levee to North Road without Nonstructural Measures; 2% ACE Flood	$59,356,189	$67,000
10.4	Winslow Levee to North Road without Nonstructural Measures; 0.5% ACE Flood	$68,575,887	$91,300
11	No Action Alternative	$0.00	$0.00

[1] All Alternatives include Flood Warning System except Alternative 11

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11.0 OPERATION & MAINTENANCE

11.1 Operation

Operation of the proposed project will be the responsibility of NCFCD and will include, but not limited to: periodic inspection.

11.2 Maintenance

The NCFCD is responsible for maintenance of the proposed project. In order to determine the need for specific maintenance items, routine inspections should be conducted every six months or twice per year and after any significant flooding. The inspection crew would consist of two laborers with a pickup truck. It is estimated that these inspections would require a maximum of four working days per year. Each inspection would include a written report summarizing findings and recommending repairs that would correct any problems. Maintenance would include the following:

11.2.1 Vegetation Control

Active or passive establishment of vegetation on the earthen portions of the levee would attenuate erosion. However, vegetation maintenance may be required to ensure levee integrity. Levee structures to be maintained include the landside face of the levee (landside slope), top of the levee, access roads leading to top of the levee, operation and maintenance roads on both sides (river and landward) of the levee. The plant can grow to several feet within the span of one year. Hand removal using hand tools or chainsaws and herbicide application would be sufficient in most cases. However, mechanized mowing/cutting or mechanized removal could be required on a periodic basis. It is recommended that mechanized mowing/cutting with herbicide application to the cut stump be used. Mechanized equipment could consist of a mower, dump truck, and a loader as well as crew vehicles.

Annual vegetation management could require up to five laborers for a period of 10 working days.

11.2.2 Rodent Control

Burrowing animals are capable of perforating a levee with holes to the extent that the structural integrity of the levee may be jeopardized. To alleviate this problem, the rodent population should be kept under control by placing poison or traps in the burrows. Rodent problems should be identified during the quarterly inspections. Controlling this problem would require two laborers with a pickup truck and a supply of rodent poison or traps. It is estimated this program would require 48 hours per year per person.

11.2.3 Levee and Interior Drainage Structures Repairs

In order to maintain integrity of the levee, it is anticipated some repairs would be required after periods of significant flooding. This would include replacement of compacted earth fill along eroded sections of the levee and interior drainage structures, repairs to gated outlets and replacement of damaged sections of soil cement, grouted/ungrouted stone and gravel. It is estimated the majority of these repairs could be accomplished by a basic maintenance crew consisting of six workers utilizing one dump truck, one bulldozer, a pickup truck and one earth compactor. Over the life of the project, it is anticipated this crew would engage in levee and interior drainage structure repair work two weeks per year.

11.2.4 Sediment Removal in Vicinity of the BNSF Railroad and SR-87 Bridges

Removal of accumulated sediments in vicinity of the BNSF Railroad and SR-87 Bridges is required when it is determined that loss of channel capacity due to sediment build-up has been confirmed based on surveying the river cross sections as described below. The estimated channel length that requires sediment removal extends approximately 1,000 feet and 1,500 feet upstream and downstream of the BNSF Railroad Bridge respectively, covering the SR-87 Bridge at downstream of the BNSF Railroad Bridge. The average annual sediment deposition in the channelization area is approximately 1,900 CY which is equivalent to 95,000 CY for a 50-year span. It is estimated majority of work could be accomplished by a sediment removal crew of six members utilizing two track loaders, one excavator and two dump trucks. It is anticipated annual sediment removal could require a period of 15 working days to complete.

11.2.5 Survey River Cross Section

Survey River Cross Section provides a means for determining the reaches of the river where significant sedimentation is occurring. Survey monuments would be established at several selected levee stations with respect to the levee control line as part of levee construction. Thereafter, the cross sections of the river taken perpendicular to the levee control line would be surveyed on a periodic basis and after each significant flood. The results of the survey would be compared to the original designed and constructed cross sections and a determination made regarding the loss of channel capacity due to sediment build-up. These periodic and after each significant flood surveys would provide an indicator of the rate of freeboard loss or gain resulting from the sediment transport processes occurring in the river. It is estimated the necessary survey work could be completed by a 5-man survey crew working an average of two weeks per year.

11.2.6 Floodplain Management

Regardless of the implementation of the plan evaluated in this report, it is recommended that a floodplain management program be established to control development in the floodplain. If a flood control plan is adopted and implemented, floodplain management will ensure that the operation of the plan will not be compromised. It is extremely important that no development be allowed in the floodplain that would reduce the capacity of the system to pass the design flood. No annual costs are shown in Table 15 for this item since it will be required before Navajo County participates in the National Flood Insurance Program for the unincorporated area around Winslow

11.3 Environmental Commitment Measures

11.3.1 Removal of Woody Vegetation

To avoid impacts to migratory birds, work that would disturb or remove woody vegetation would not occur between April 15 and August 30 unless the affected area is first surveyed by a biologist and determined not to have nesting birds.

11.3.2 Conducting Surveys of the Yellow-Billed Cuckoo and Southwestern Willow Flycatcher

Prior to the start of any O&M activities, surveys for the yellow-billed cuckoo and southwestern willow flycatcher will be conducted within suitable habitat, if present. If the yellow-billed cuckoo or flycatcher is detected within the project area, best management practices (BMPs) would be applied to avoid effects to this species.

A. Follow-up treatments (e.g. mechanical and /or herbicide) of saltcedar would occur within saltcedar removal areas. This area would be reseeded and/or revegetated with native plantings.
B. During any O&M activities during minimal flow periods (near impingement points, channel excavation/widening, etc.), BMPs would be incorporated to minimize negative impacts to the sensitive flannelmouth as well as other fish species. BMPs may include, but are not limited to the following: silt curtains, wattles, coffer dams, and erosion protection screens. These BMPs would help to prevent fish access to the work site and ensure protection of water quality. BMPs would be inspected daily to maintain the connection to the substrate and would be removed following O&M activities.
C. In addition, any vegetated areas that are disturbed from disposal, borrow, staging, stockpiling, or access, or other O&M related activities would be returned to pre-O&M conditions.

Table 15: Annual Operation and Maintenance Costs

(FY 2014 Price Levels)

Alts	Periodic Inspections ($)	Vegetation Control ($)	Rodent Control ($)	Sediment Removal Under BNSF RR Bridge ($)	Survey Cross Sections ($)	Levee and Interior Drainage Repair ($)	Total Annual Costs ($)
1.1	8,000	15,000	2,400	32,400	24,000	20,200	102,000
3.1	8,000	13,000	2,400	32,400	24,000	15,400	95,200
7	0	0	0	0	0	0	0
8	8,000	14,000	2,400	32,400	24,000	18,200	99,000
9	500	1,000	350	0	5,850	1,500	9,200
10	4,000	7,500	1,400	32,400	12,000	10,500	67,800
10.1	4,000	7,500	1,400	32,400	12,000	10,500	67,800
10.2	2,000	3,500	800	0	10,000	8,500	24,800
10.3	4,000	7,500	1,400	32,400	12,000	10,500	67,800
10.4	5,500	7,500	1,400	50,400	14,000	12,500	91,300
11	0	0	0	0	0	0	0

11.4 Operation for the Recommended Plan (Alternative 10.1)

11.4.1 General

Guidance on the responsibilities for the operation of local protection projects constructed by the United States is found in 33 C.F.R. Section 208.10. This regulation describes local sponsor's responsibilities for operating the structural soundness and functionality of the project in order to assure the project meets its authorized purposes. Operations involve all activities required to keep the flood risk management systems or any of its components continuously operable for its authorized use. NCFCD, as the local sponsor, is responsible for the operation of the project and will include, but not be limited to periodic inspection. Project features including interior drainage structures (RCB and RCP culverts), access roads, ramps, gates, fences and signs must be continuously operated to obtain maximum benefits.

11.4.2 Levee

Particular attention would be given to monitoring the performance of the levee during high water events to ensure the levee is fully functional. This monitoring is particularly important as the levee construction/reconstruction consists of compacted earth/ soil cement fill and grouted stone revetment. Particular attention should be paid to any cracking of the riverward slope.

11.5 Maintenance of the Recommended Plan (Alternative 10.1)

Maintenance description and features required for the Recommended Plan (Alternative 10.1) would be similar to Maintenance described under paragraph 11.2 and included the following:

11.5.1 Salt Cedar Control

Saltcedar regrowth in the cross-hatched areas indicated on Plate 7 through natural recruitment is very likely. The plant can grow to several feet within the span of one year. It is recommended that mechanized mowing/cutting with herbicide application to the cut stump be used. This method includes the mechanized removal of above ground biomass accompanied by herbicide treatment of the cut stump. This approach is accomplished with either equipment that cuts and mulches the trees or grabs and cuts the trees for removal. Specialized mulching/chipping equipment has been shown to be effective. The trees are typically mulched in a six-foot wide path at a rate of 0.25 to 1.5 acres per hour depending on density, terrain, and equipment. It is highly suggested that if mulching/chipping on-site, depth should not exceed 2 inches. Herbicide application would be used after mechanical treatment of saltcedar. The preferred herbicides to use are Garlon®3A (for treatment of resprouts) and Garlon® 4 (for initial treatment). These are both selective herbicides which means that they can kill certain groups of plants and have little or no effect on other plants. These herbicides should not be used near surface water or saturated soils, unless certified by the Environmental Protection Agency (EPA) for aquatic use. Mechanized equipment could consist of a mower, dump truck, back hoe, and a loader as well as crew vehicles. Annual vegetation management could require up to five laborers for a period of 20 working days.

11.5.2 Access Ramps, Operation and Maintenance O&M) Roads

Access ramps and O&M roads should be maintained so that slope to drain remains at 2% and water will not collect and spill down the back slopes to cause erosion. Ramps and O&M roads should be properly maintained and kept serviceable. This work involves periodically grading and gravelling road surfaces. Grading consists of backfilling the depression areas with fill material and

compacting to obtain design grade and slope to drain without any ponded water. Appropriate measures should be taken to ensure the availability of adequate labor and materials to meet contingencies.

11.5.3 Access Gates, Fences and Signs

Maintenance required keeping these features in serviceable conditions shall include: sufficient cover for concrete footings, tightening bolt, nuts and anchors, and lubricated and lock-in-place hinges.

Table 16: Annual Operation and Maintenance Costs for the Recommended Plan

(FY 2018 Price Levels)

Periodic Inspections ($)	Vegetation Control ($)	Salt Cedar Control ($)	Rodent Control ($)	Sediment Removal Under BNSF RR Bridge ($)	Survey Cross Sections ($)	Levee and Interior Drainage Repair ($)	Access Ramp, O&M Roads, Access gates, Fences & Signs ($)	Total Annual Costs ($)
4,000	7,500	160,000	1,400	66.500	12,000	10,500	12,890	274,790

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12.0 EXISTING BRIDGE CROSSINGS

12.1 Burlington Northern Santa Fe (BNSF) Railroad and State Route (SR)-87 Bridges

Improvement of channel conveyance by removing river sediment under the BNSF Railroad and SR-87 Bridges requires bridge stability analysis to ensure the BNSF Railroad and SR-87 Bridges continue providing same levels of service and supports as with without project condition. Analysis of BNSF Railroad and SR-87 bridge stability has not been undertaken because it is not appropriate to perform such analysis in the feasibility study level due to time constraint. However, bridge stability analysis will be conducted during the PED phase.

Pertinent bridge construction data required for stability analysis include pier length, pier diameter, depth of each pier, and pier installation method (sunk by dredging/pneumatic hammering or/and others).

Record shows that one specific pier of the BNSF Railroad bridge experienced cracks during the pneumatic hammering installation and was repaired with steel band trusses.

12.2 River Sediment Excavation Under the BNSF Railroad and SR-87 Bridges

Excavation to remove river sediment under the BNSF Railroad and SR-97 Bridges would need to be examined/studied in detail so that bridge pier stability is maintained during and after river sediment excavation.

The basic and conservative approach that has been used widely for river sediment excavation under the bridge is as follows:

A. A 10-foot offset measured horizontally from each pier toward river centerline and longitudinal flow line is set as the excavation line/limits.
B. Excavation slope ratio of no steeper than 1H:1V for a three-foot depth or more, measured vertically from the excavation line/limits to the bottom of excavation.
C. No excavation required for the inside face of the piers facing directly with the bridge abutments and the channel banks.

Detailed bridge analysis for bridge pier stability will be performed during the PED Phase.

12.3 Interstate 40 (I-40) Bridge

Improvement of channel conveyance by removing river sediment under the I-40 Bridge does not require bridge stability analysis because minimal amount of river sediment removal would be needed to support the designed channel capacity for the 1% ACE under the bridge.

Detailed bridge analysis to assure bridge pier stability will be conducted in the PED Phase.

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13.0 REMOVAL OF EXISTING SANDSTONE BRIDGE PIERS AND PILES

13.1 Abandoned Sandstone Bridge Piers and Wooden Piles in Vicinity of the BNSF Railroad Bridge

It was noticed that abandoned sandstone bridge piers and wooden piles exist in the LCR. These existing abandoned features are located immediately north of the BNSF Railroad Bridge. Some of the abandoned bridge wooden piles are also located beneath the BNSF Railroad Bridge. To improve channel conveyance and achieve channel capacity, these existing abandoned features would need to be removed in conjunction with removal of river sediment. Depth of removal for the abandoned bridge piers and piles would be the same depth of removal for river sediment.

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14.0 REFERENCES

Federal Emergency Management Agency, National Flood Insurance Program 44 CFR 65.10, dated October 1, 2006.

Office of the Federal Register, Code of Federal Regulations, 33 CFR Section 208.10, Local Flood Protection Works; Maintenance and Operation of Structures and Facilities, dated July 1, 2011.

U.S Army Engineer District, Los Angeles (USACE), 1969, Design Memorandum No. 1, General Design, Winslow Flood Control Project, Winslow, AZ.

U.S Army Engineer District, Los Angeles (USACE), 1971, Little Colorado River Basin, Arizona and New Mexico, Winslow, Arizona and Vicinity, Winslow Flood Control Project, Plans.

Plans for the Construction of the Winslow Flood Control Project, Winslow, AZ on Little Colorado River.
Prepared for: Navajo County Flood Control District
Prepared by: PRC Engineering.
Date: September 1982

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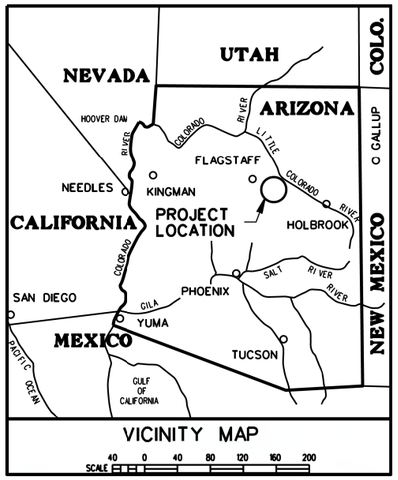
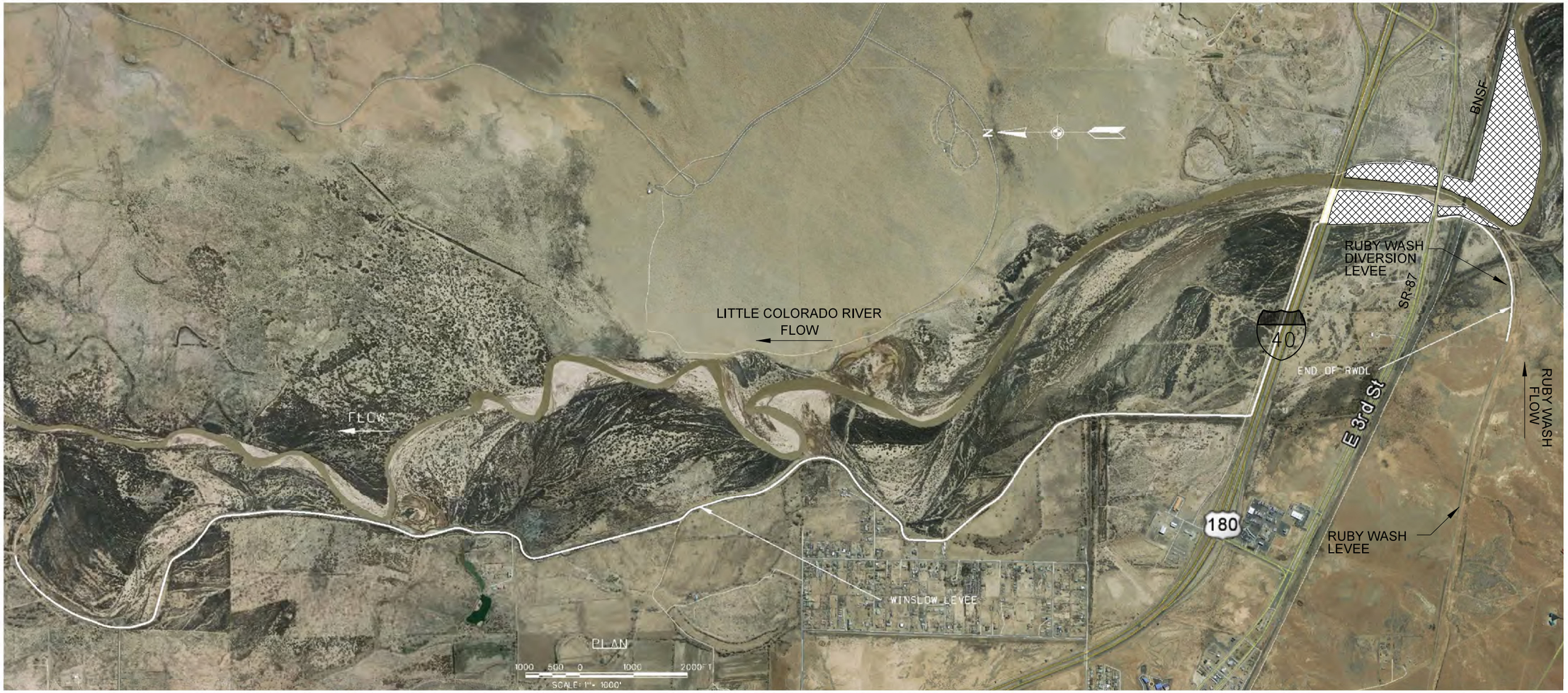


LEGEND

- 40 — INTERSTATE HIGHWAY
- 66 — STATE HIGHWAY
- U.S. 180 — U.S. HIGHWAY
- RAILWAY
- SALT CEDAR REMOVAL

LITTLE COLORADO RIVER AT WINSLOW
WINSLOW, ARIZONA



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LITTLE COLORADO RIVER AT WINSLOW FEASIBILITY STUDY
WINSLOW, ARIZONA

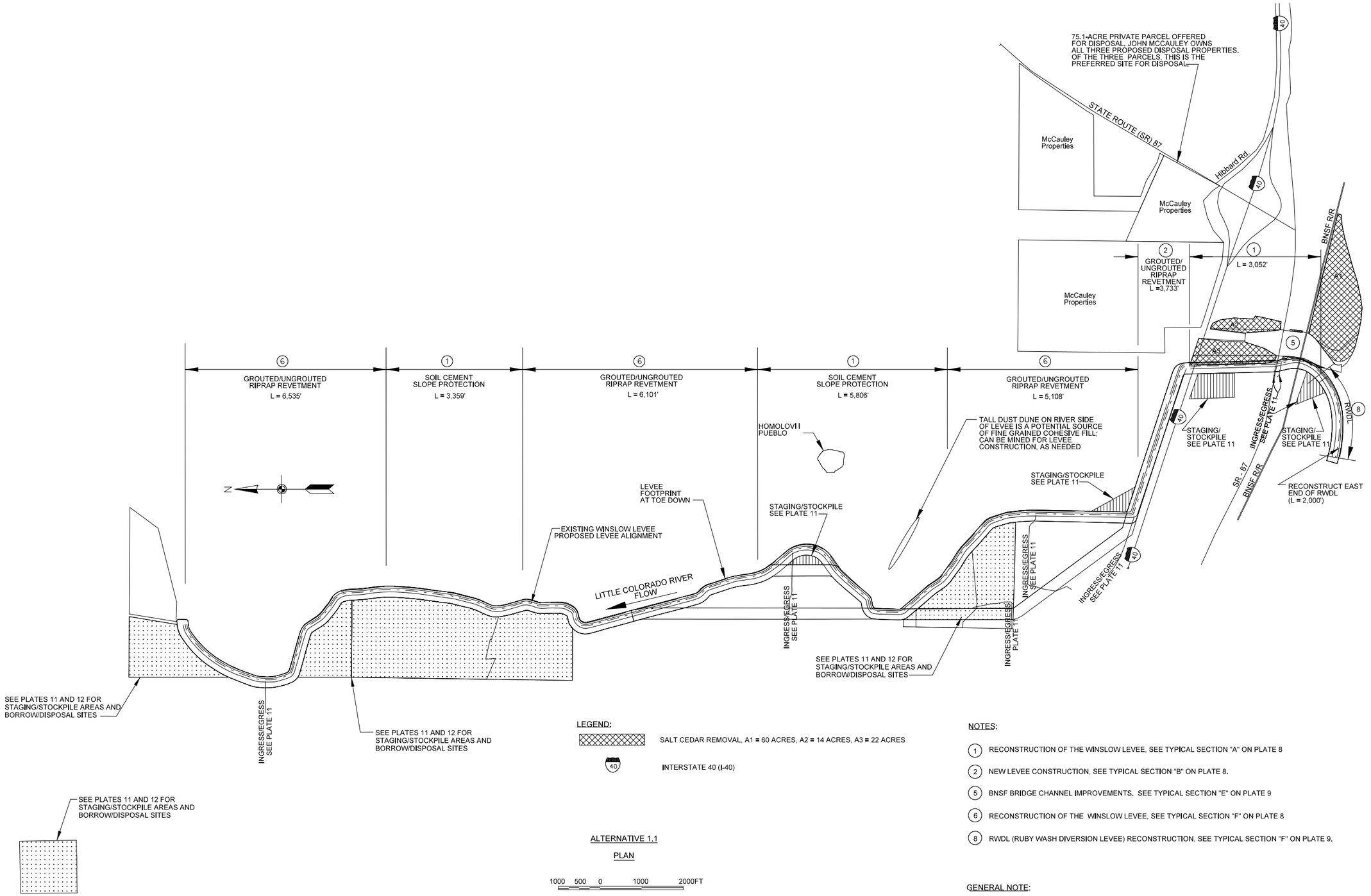
PROJECT LOCATION AND VICINITY MAP

US Army Corps of Engineers
Los Angeles District

Scale: AS SHOWN

PLATE
1

Plot Date: $date$



NOTES:

1. RECONSTRUCTION OF THE WINSLOW LEVEE, SEE TYPICAL SECTION "A" ON PLATE 8
2. NEW LEVEE CONSTRUCTION, SEE TYPICAL SECTION "B" ON PLATE 8.
5. BNSF BRIDGE CHANNEL IMPROVEMENTS. SEE TYPICAL SECTION "E" ON PLATE 9
6. RECONSTRUCTION OF THE WINSLOW LEVEE, SEE TYPICAL SECTION "F" ON PLATE 8
8. RWDL (RUBY WASH DIVERSION LEVEE) RECONSTRUCTION, SEE TYPICAL SECTION "F" ON PLATE 9.

GENERAL NOTE:

EXISTING UTILITIES ARE NOT SHOWN ON THE PLAN. SEE PLATE 10 FOR UTILITY INFORMATION.

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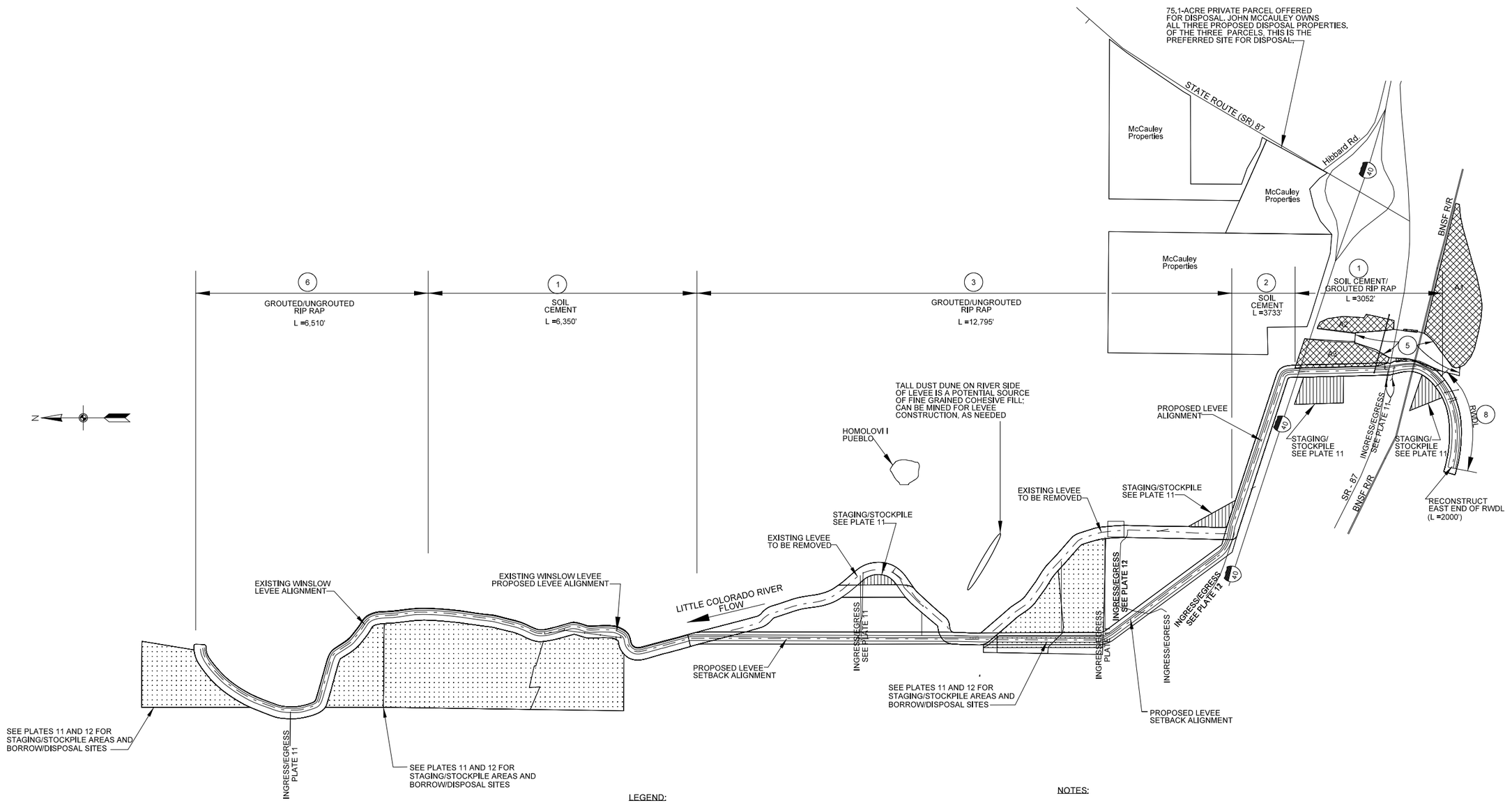
LITTLE COLORADO RIVER AT WINSLOW FEASIBILITY STUDY
WINSLOW, ARIZONA

ALTERNATIVE 1.1
REBUILD LEVEE SYSTEM

US Army Corps of Engineers
Los Angeles District

Scale: AS SHOWN
PLATE
2

Plot Date: $date$



LEGEND:

40 INTERSTATE 40 (I-40)

SALT CEDAR REMOVAL, A1 = 60 ACRES, A2 = 14 ACRES AND A3 = 22 ACRES.

ALTERNATIVE 3.1

PLAN

1000 500 0 1000 2000FT

NOTES:

1. RECONSTRUCT WINSLOW LEVEE, SEE TYPICAL SECTION "A" ON PLATE 8
2. NEW LEVEE, SEE TYPICAL SECTION "B" ON PLATE 8
3. REALIGN/SETBACK LEVEE (NEW), SEE TYPICAL SECTION "C" OR "D" ON PLATES 8 AND 9
5. BNSF BRIDGE CHANNEL IMPROVEMENTS, SEE TYPICAL SECTION "E" ON PLATE 9
6. RECONSTRUCT WINSLOW LEVEE, SEE TYPICAL SECTION "F" ON PLATE 8
8. RWDL (RUBY WASH DIVERSION LEVEE) RECONSTRUCTION, SEE TYPICAL SECTION "F" ON PLATE 9.

GENERAL NOTE:

EXISTING UTILITIES ARE NOT SHOWN ON THE PLAN. SEE PLATE 10 FOR UTILITY INFORMATION.

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LITTLE COLORADO RIVER AT WINSLOW FEASIBILITY STUDY
WINSLOW, ARIZONA

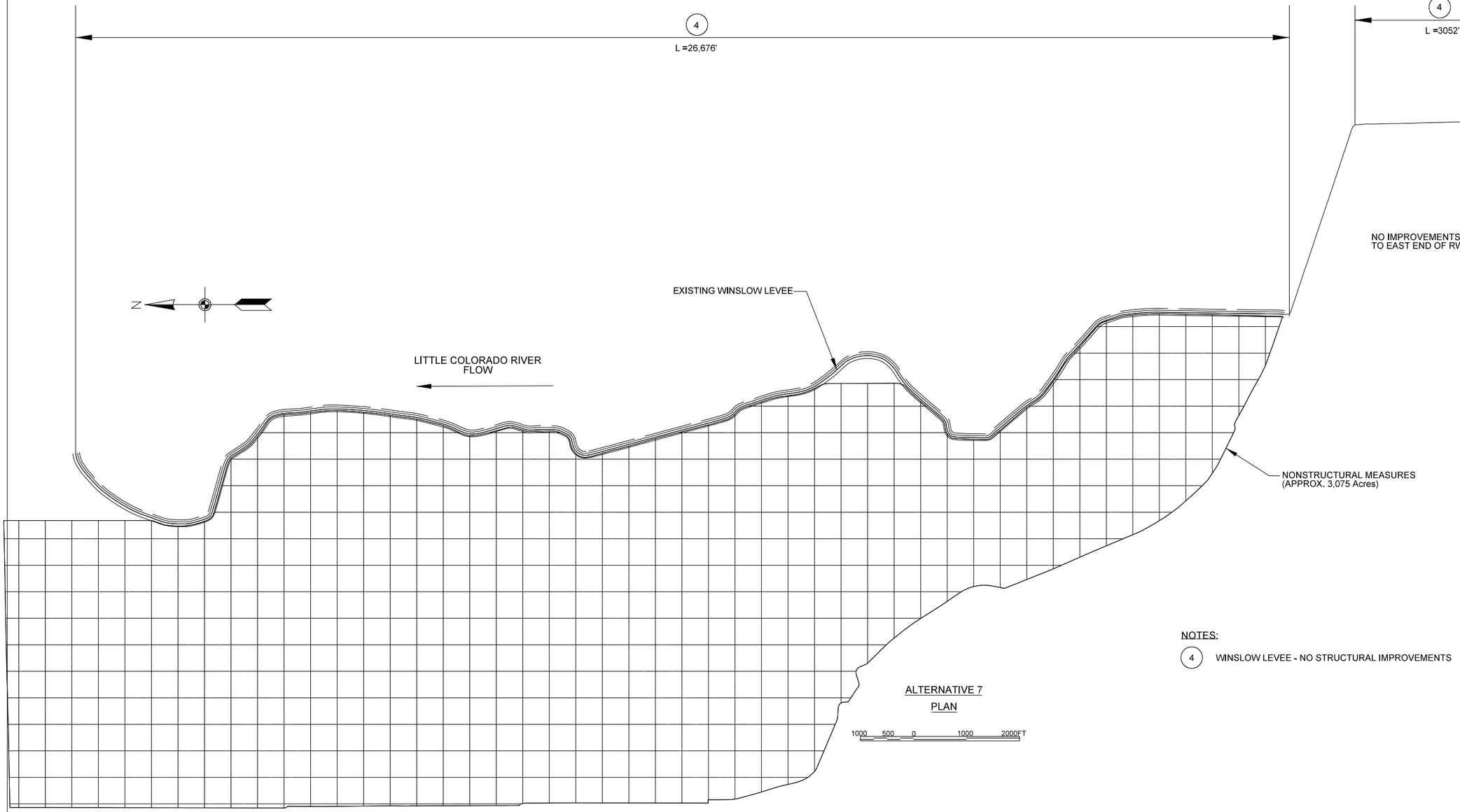
ALTERNATIVE 3.1
WINSLOW LEVEE SETBACK
PLAN

US Army Corps of Engineers
Los Angeles District

Scale: AS SHOWN

PLATE
3

Plot Date: $date$



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LITTLE COLORADO RIVER AT WINSLOW FEASIBILITY STUDY
WINSLOW, ARIZONA

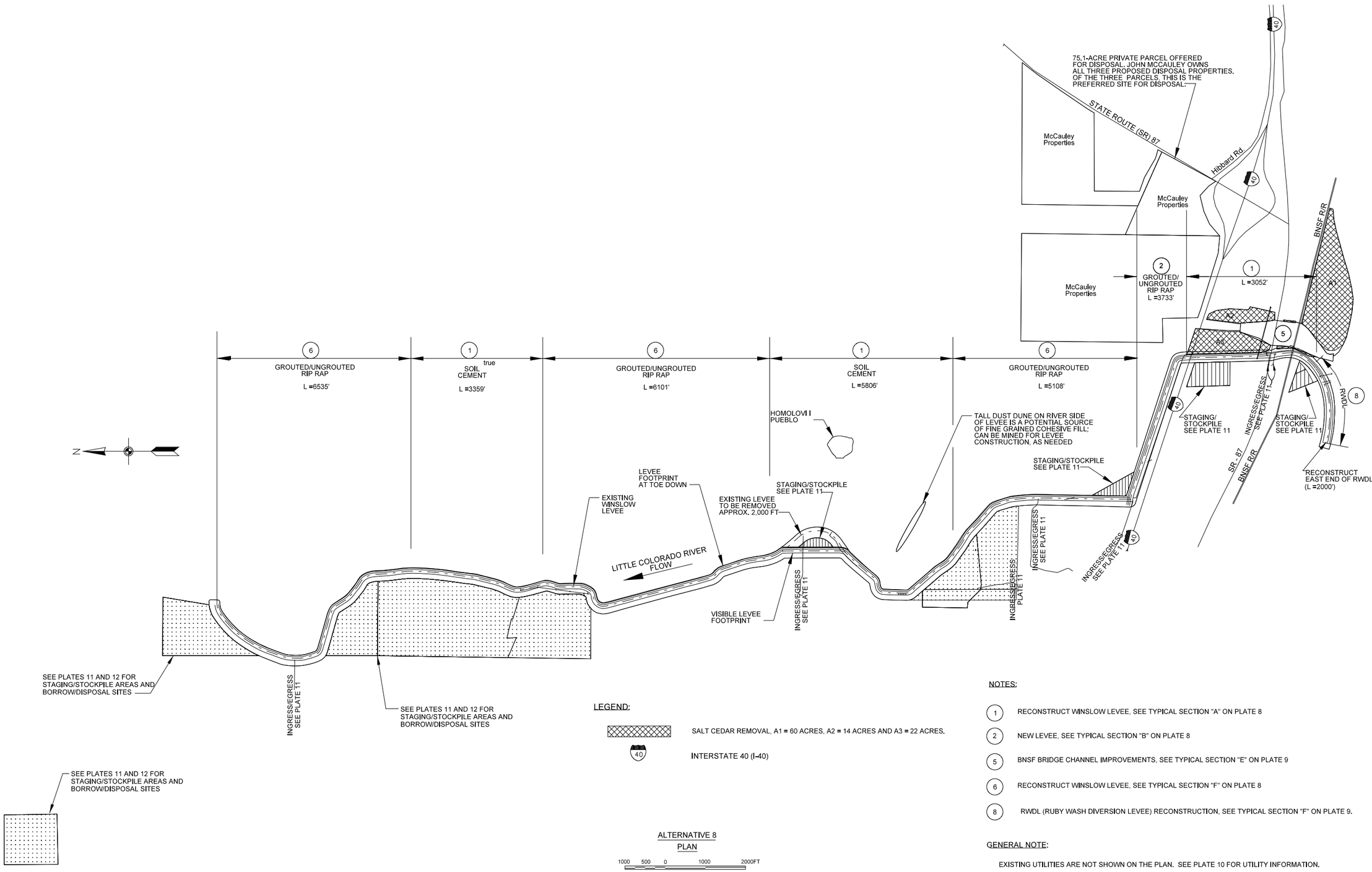
ALTERNATIVE 7
NONSTRUCTURAL MEASURES ONLY
PLAN

US Army Corps of Engineers
Los Angeles District

Scale: AS SHOWN

PLATE
4

Plot Date: $date$



NOTES:

1. RECONSTRUCT WINSLOW LEVEE, SEE TYPICAL SECTION "A" ON PLATE 8
2. NEW LEVEE, SEE TYPICAL SECTION "B" ON PLATE 8
5. BNSF BRIDGE CHANNEL IMPROVEMENTS, SEE TYPICAL SECTION "E" ON PLATE 9
6. RECONSTRUCT WINSLOW LEVEE, SEE TYPICAL SECTION "F" ON PLATE 8
8. RWDL (RUBY WASH DIVERSION LEVEE) RECONSTRUCTION, SEE TYPICAL SECTION "F" ON PLATE 9.

GENERAL NOTE:

EXISTING UTILITIES ARE NOT SHOWN ON THE PLAN. SEE PLATE 10 FOR UTILITY INFORMATION.

DESIGNED BY:
DRAWN BY:
CHECKED BY:
FILE NAME: ALT_8.DGN

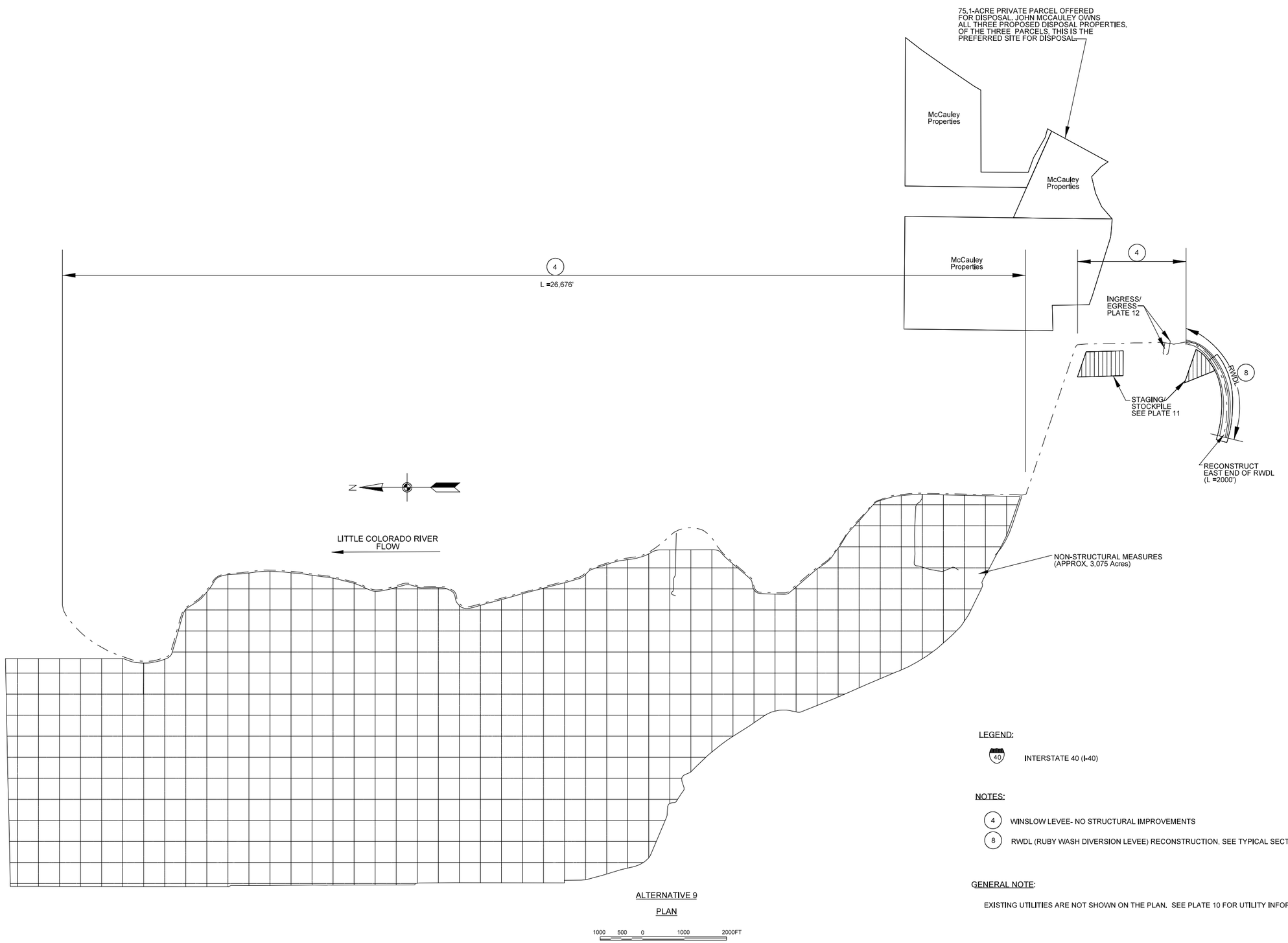
LITTLE COLORADO RIVER AT WINSLOW FEASIBILITY STUDY
WINSLOW, ARIZONA

ALTERNATIVE 8
HOMOLOVI I LEVEE SETBACK
PLAN

US Army Corps of Engineers
Los Angeles District

Scale: AS SHOWN
PLATE 5

Plot Date: $date$



ALTERNATIVE 9

PLAN

1000 500 0 1000 2000FT

LEGEND:

40 INTERSTATE 40 (I-40)

NOTES:

4 WINSLOW LEVEE- NO STRUCTURAL IMPROVEMENTS

8 RWDL (RUBY WASH DIVERSION LEVEE) RECONSTRUCTION. SEE TYPICAL SECTION "F" ON PLATE 9.

GENERAL NOTE:

EXISTING UTILITIES ARE NOT SHOWN ON THE PLAN. SEE PLATE 10 FOR UTILITY INFORMATION.

DESIGNED BY:

DRAWN BY:

CHECKED BY:

FILE NAME: ALT_9.DGN

LITTLE COLORADO RIVER AT WINSLOW FEASIBILITY STUDY
WINSLOW, ARIZONA

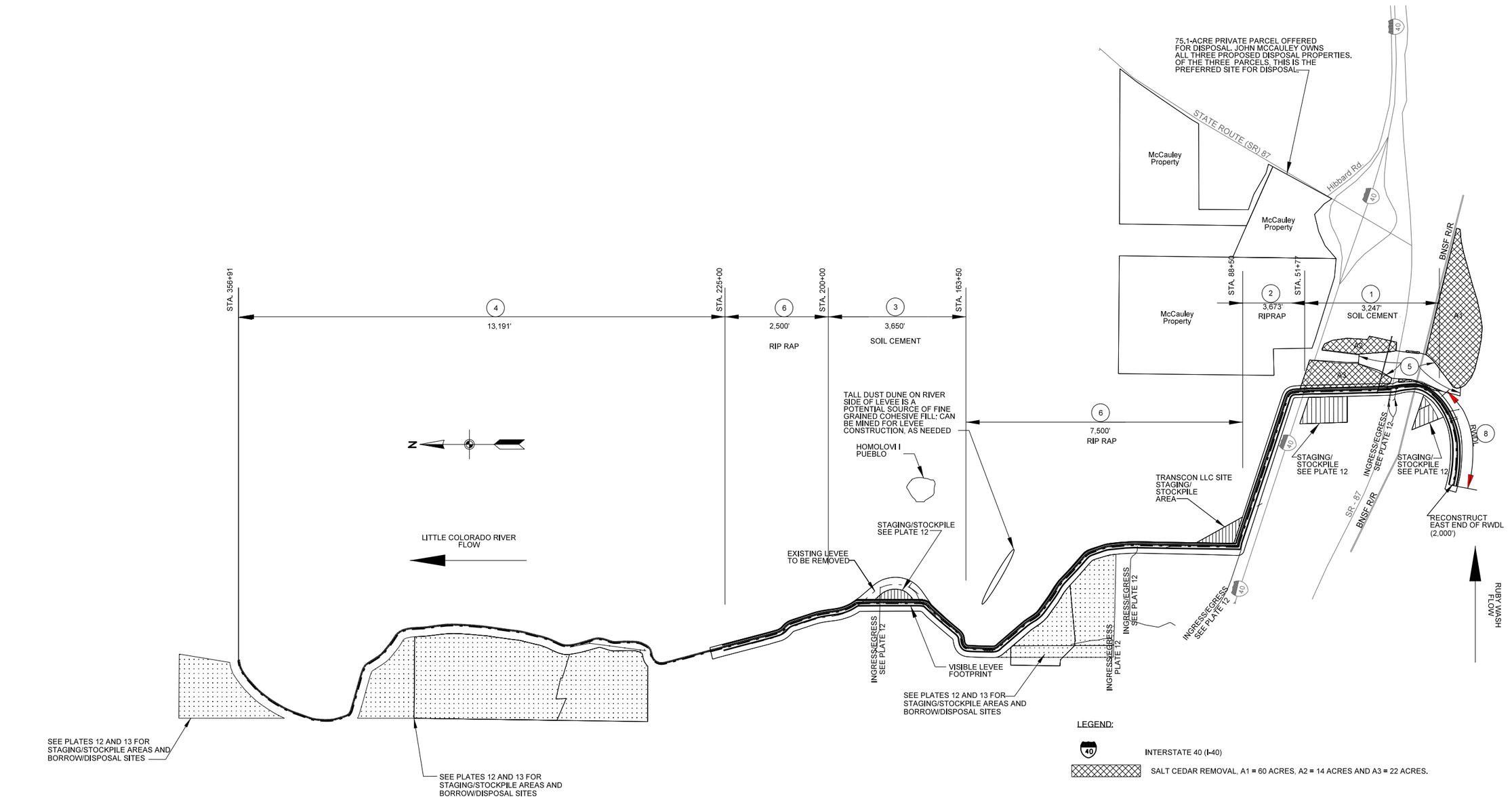
ALTERNATIVE 9
LEVEE INCREMENT 1

US Army Corps of Engineers
Los Angeles District

Scale: AS SHOWN

PLATE
6

Plot Date: $date$



GENERAL NOTE:

EXISTING UTILITIES ARE NOT SHOWN ON THE PLAN. SEE PLATE 11 FOR UTILITY INFORMATION.

NOTES:

1. RECONSTRUCT WINSLOW LEVEE, SEE TYPICAL SECTION "A" ON PLATE 9
2. CONSTRUCT NEW LEVEE, SEE TYPICAL SECTION "B" ON PLATE 9
3. RECONSTRUCT WINSLOW LEVEE, SEE TYPICAL SECTION "D" ON PLATE 10
4. WINSLOW LEVEE- NO STRUCTURAL IMPROVEMENTS
5. BNSF RAILROAD BRIDGE CHANNEL IMPROVEMENTS, SEE TYPICAL SECTION "E" ON PLATE 10
6. RECONSTRUCT WINSLOW LEVEE, SEE TYPICAL SECTION "F" ON PLATE 9
8. RECONSTRUCT RWDL (RUBY WASH DIVERSION LEVEE) RECONSTRUCTION, SEE TYPICAL SECTION "F" ON PLATE 9.

ALTERNATIVE 10/10.1

PLAN

1000 500 0 1000 2000FT

DESIGNED BY:
DRAWN BY:
CHECKED BY:
FILE NAME: ALT_10.1.DGN

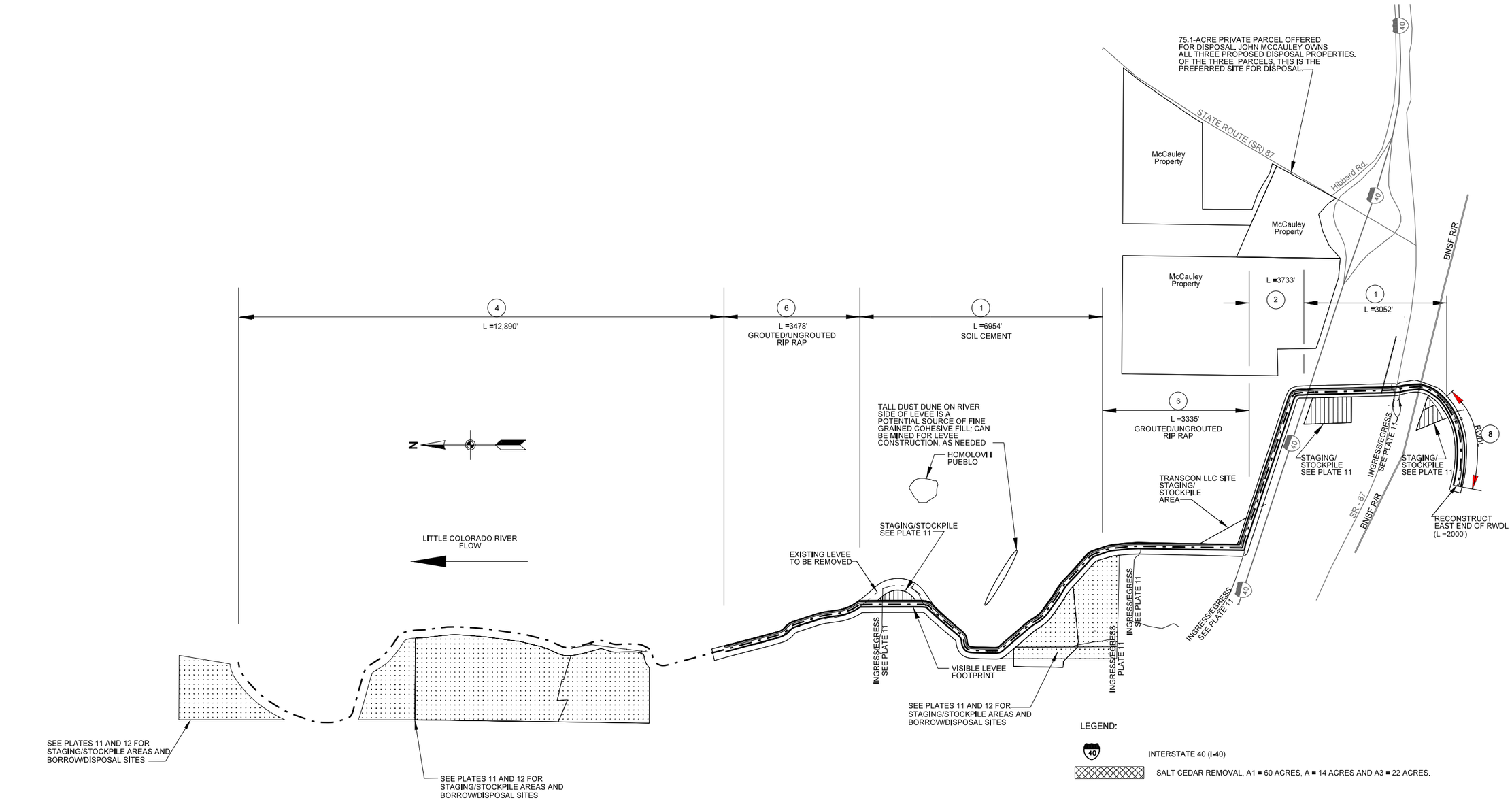
LITTLE COLORADO RIVER AT WINSLOW FEASIBILITY STUDY
WINSLOW, ARIZONA

ALTERNATIVE 10/10.1
REBUILD THE RWDL AND WINSLOW LEVEE TO NORTH ROAD TO CONTAIN THE 1% ACE FLOOD

US Army Corps of Engineers
Los Angeles District

Scale: AS SHOWN
PLATE
7

Plot Date: $date$



LEGEND:

40 INTERSTATE 40 (I-40)

SALT CEDAR REMOVAL, A1 = 60 ACRES, A = 14 ACRES AND A3 = 22 ACRES.

GENERAL NOTE:

EXISTING UTILITIES ARE NOT SHOWN ON THE PLAN. SEE PLATE 10 FOR UTILITY INFORMATION.

NOTES:

1. RECONSTRUCT WINSLOW LEVEE, SEE TYPICAL SECTION "A" ON PLATE 8
2. NEW LEVEE, SEE TYPICAL SECTION "B" ON PLATE 8
4. WINSLOW LEVEE- NO STRUCTURAL IMPROVEMENTS
5. BNSF RAILROAD BRIDGE CHANNEL IMPROVEMENTS, SEE TYPICAL SECTION "E" ON PLATE 9
6. RECONSTRUCT WINSLOW LEVEE, SEE TYPICAL SECTION "F" ON PLATE 8
8. RWDL (RUBY WASH DIVERSION LEVEE) RECONSTRUCTION, SEE TYPICAL SECTION "F" ON PLATE 9.

ALTERNATIVE 10.2
PLAN

1000 500 0 1000 2000FT

DESIGNED BY:
DRAWN BY:
CHECKED BY:
FILE NAME: ALT_7.2.DGN

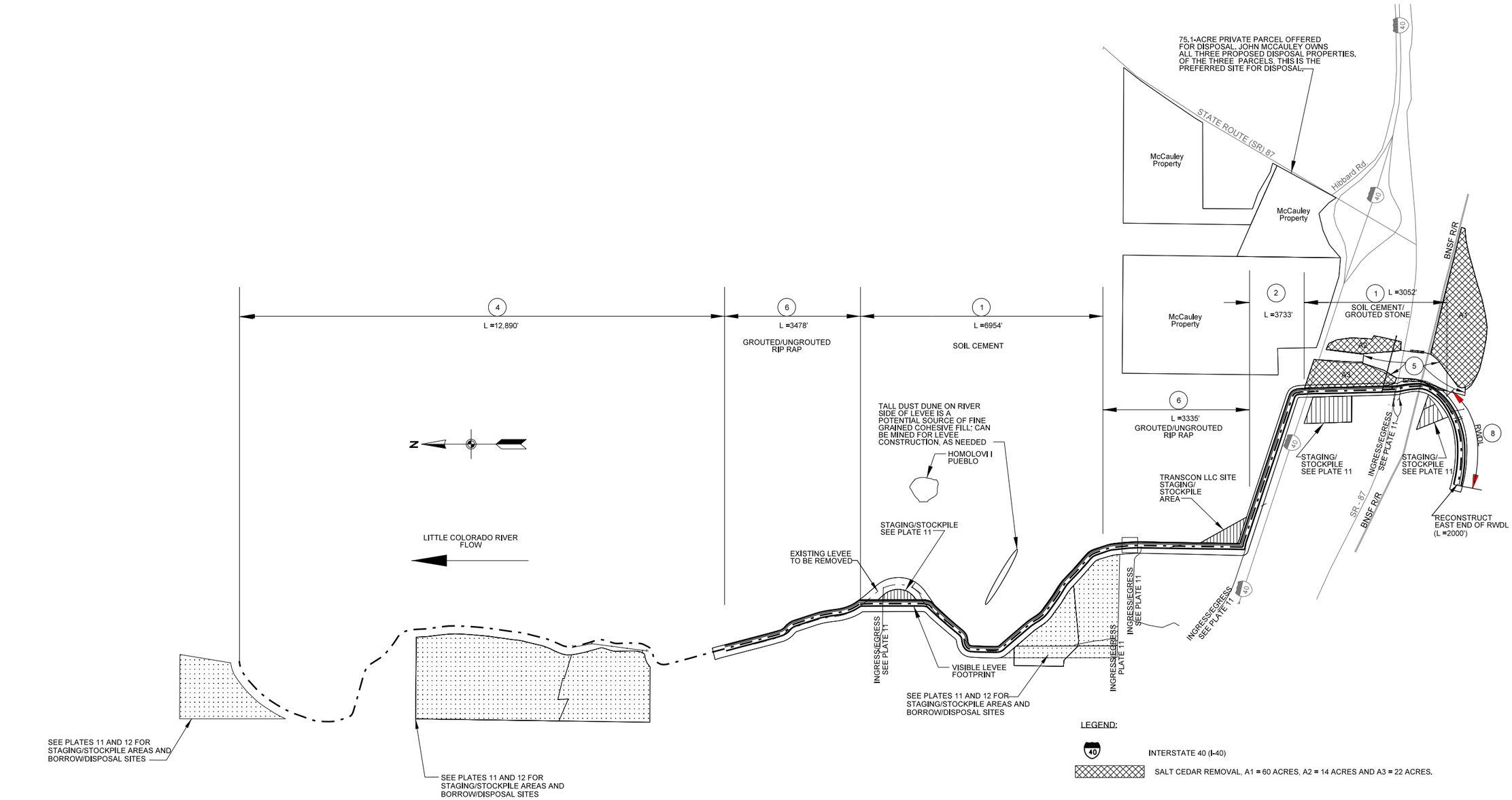
LITTLE COLORADO RIVER AT WINSLOW FEASIBILITY STUDY
WINSLOW, ARIZONA

ALTERNATIVE 10.2
REBUILD THE RWDL AND WINSLOW LEVEE TO NORTH ROAD TO CONTAIN THE 4% ACE FLOOD

US Army Corps of Engineers
Los Angeles District

Scale: AS SHOWN
PLATE
7.1

Plot Date: $date$



LEGEND:

40 INTERSTATE 40 (I-40)

SALT CEDAR REMOVAL, A1 = 60 ACRES, A2 = 14 ACRES AND A3 = 22 ACRES.

GENERAL NOTE:

EXISTING UTILITIES ARE NOT SHOWN ON THE PLAN. SEE PLATE 10 FOR UTILITY INFORMATION.

NOTES:

1. RECONSTRUCT WINSLOW LEVEE, SEE TYPICAL SECTION "A" ON PLATE 8
2. NEW LEVEE, SEE TYPICAL SECTION "B" ON PLATE 8
4. WINSLOW LEVEE- NO STRUCTURAL IMPROVEMENTS
5. BNSF RAILROAD BRIDGE CHANNEL IMPROVEMENTS, SEE TYPICAL SECTION "E" ON PLATE 9
6. RECONSTRUCT WINSLOW LEVEE, SEE TYPICAL SECTION "F" ON PLATE 8
8. RWDL (RUBY WASH DIVERSION LEVEE) RECONSTRUCTION, SEE TYPICAL SECTION "F" ON PLATE 9.

ALTERNATIVE 10.3
PLAN

1000 500 0 1000 2000FT

DESIGNED BY:
DRAWN BY:
CHECKED BY:
FILE NAME: ALT_10.3.DGN

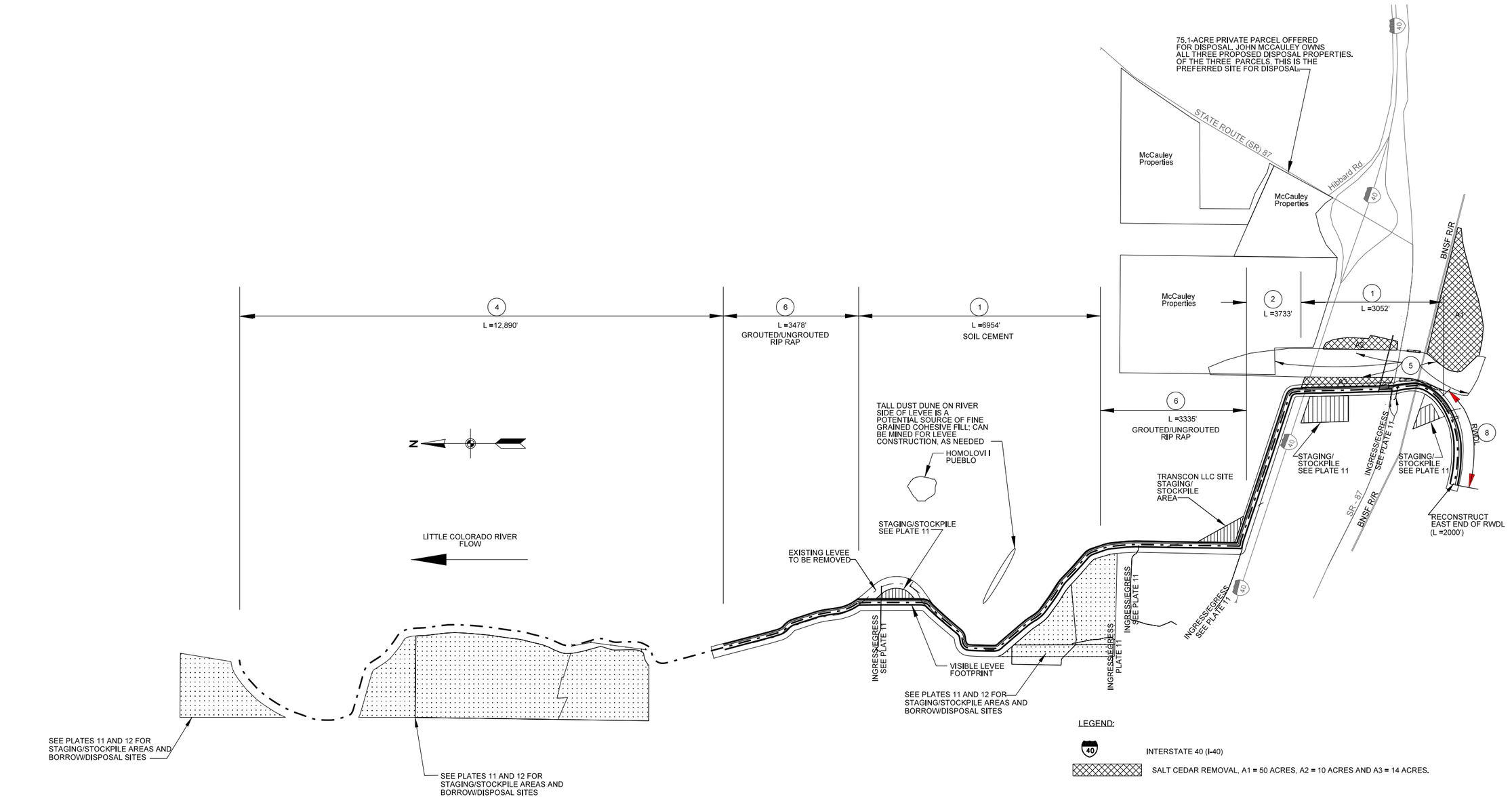
LITTLE COLORADO RIVER AT WINSLOW FEASIBILITY STUDY
WINSLOW, ARIZONA

ALTERNATIVE 10.3
REBUILD THE RWDL AND WINSLOW LEVEE TO NORTH ROAD TO CONTAIN THE 2% ACE FLOOD

US Army Corps of Engineers
Los Angeles District

Scale: AS SHOWN
PLATE
7.2

Plot Date: $date$



LEGEND:

INTERSTATE 40 (I-40)

SALT CEDAR REMOVAL, A1 = 50 ACRES, A2 = 10 ACRES AND A3 = 14 ACRES.

GENERAL NOTE:

EXISTING UTILITIES ARE NOT SHOWN ON THE PLAN. SEE PLATE 10 FOR UTILITY INFORMATION.

NOTES:

1. RECONSTRUCT WINSLOW LEVEE, SEE TYPICAL SECTION "A" ON PLATE 8
2. NEW LEVEE, SEE TYPICAL SECTION "B" ON PLATE 8
4. WINSLOW LEVEE- NO STRUCTURAL IMPROVEMENTS
5. BNSF RAILROAD BRIDGE CHANNEL IMPROVEMENTS, SEE TYPICAL SECTION "E" ON PLATE 9
6. RECONSTRUCT WINSLOW LEVEE, SEE TYPICAL SECTION "F" ON PLATE 8
8. RWDL (RUBY WASH DIVERSION LEVEE) RECONSTRUCTION, SEE TYPICAL SECTION "F" ON PLATE 9.

ALTERNATIVE 10.4
PLAN

1000 500 0 1000 2000FT

DESIGNED BY:
DRAWN BY:
CHECKED BY:
FILE NAME: ALT_10.4.DGN

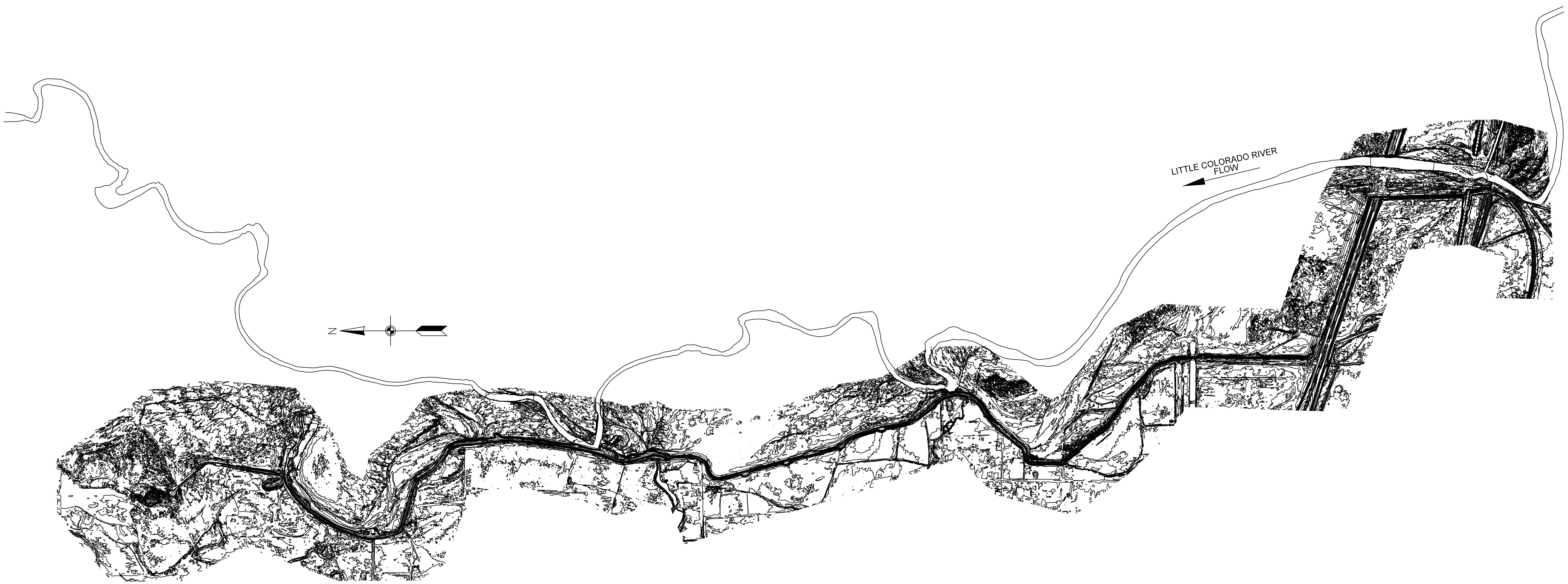
LITTLE COLORADO RIVER AT WINSLOW FEASIBILITY STUDY
WINSLOW, ARIZONA

ALTERNATIVE 10.4
REBUILD THE RWDL AND WINSLOW
LEVEE TO NORTH ROAD TO
CONTAIN THE 0.5% ACE FLOOD

US Army Corps of Engineers
Los Angeles District

Scale: AS SHOWN
PLATE
7.3

Plot Date: $date$



PLAN

1000 500 0 1000

SCALE: 1" = 1000'

LITTLE COLORADO RIVER AT WINSLOW FEASIBILITY STUDY
WINSLOW, ARIZONA

ALTERNATIVE 11
NO ACTION ALTERNATIVE

DESIGNED BY:

DRAWN BY:

CHECKED BY:

FILE NAME: StagingStockpileIngressEgress.dgn

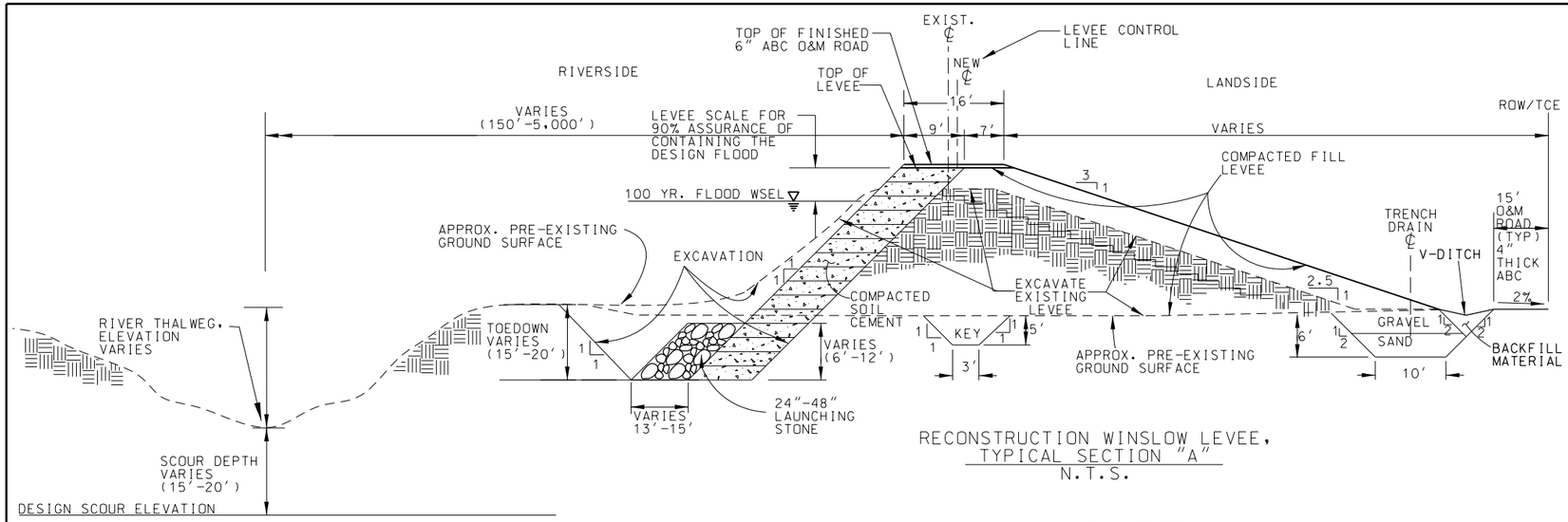
US Army Corps of Engineers
Los Angeles District

Scale: AS SHOWN

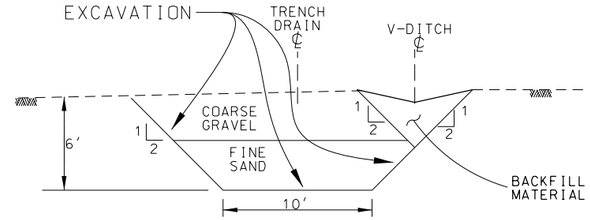
PLATE

8

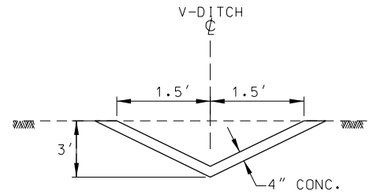
Plot Date: $date$



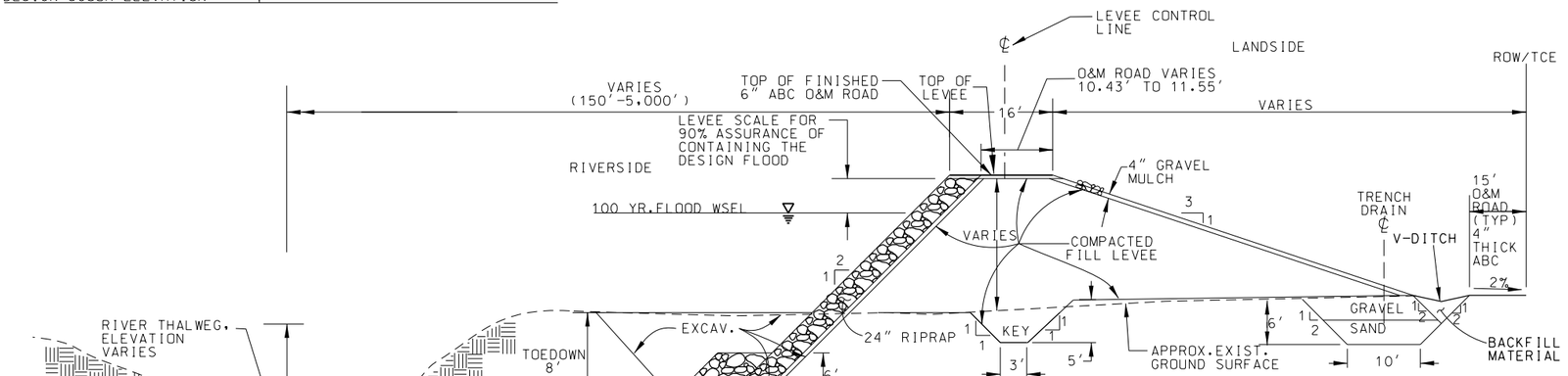
RECONSTRUCTION WINSLOW LEVEE, TYPICAL SECTION "A"
N.T.S.



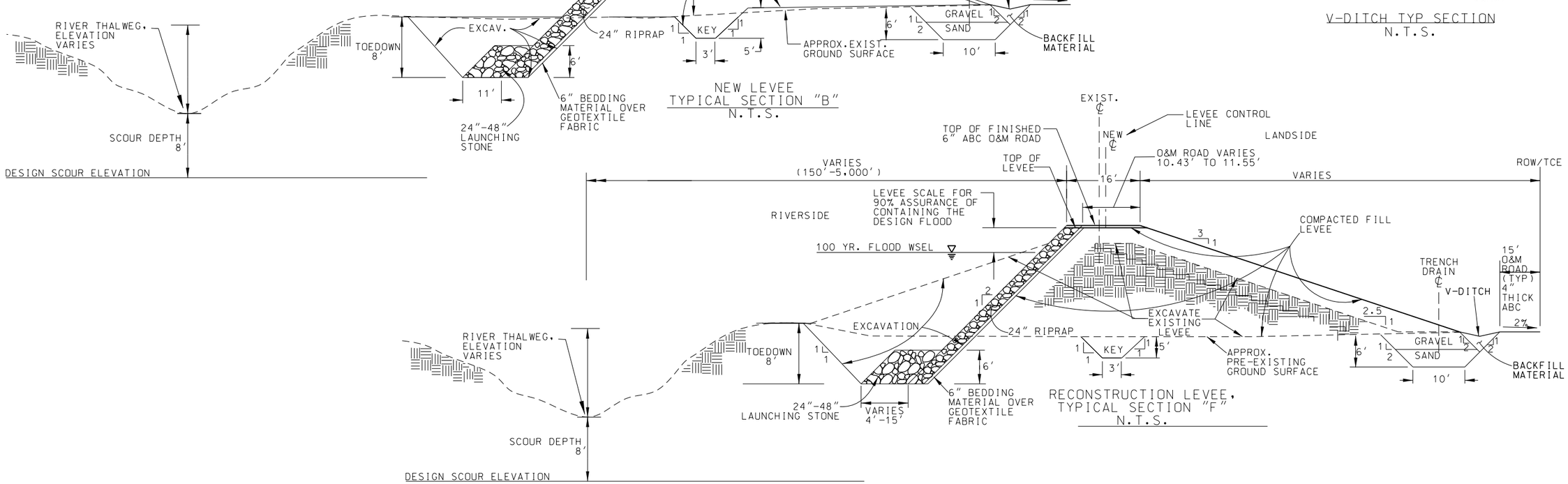
TRENCH DRAIN TYP SECTION
N.T.S.



V-DITCH TYP SECTION
N.T.S.



NEW LEVEE
TYPICAL SECTION "B"
N.T.S.



RECONSTRUCTION LEVEE, TYPICAL SECTION "F"
N.T.S.

DESIGNED BY:
DRAWN BY:
CHECKED BY:
FILE NAME:

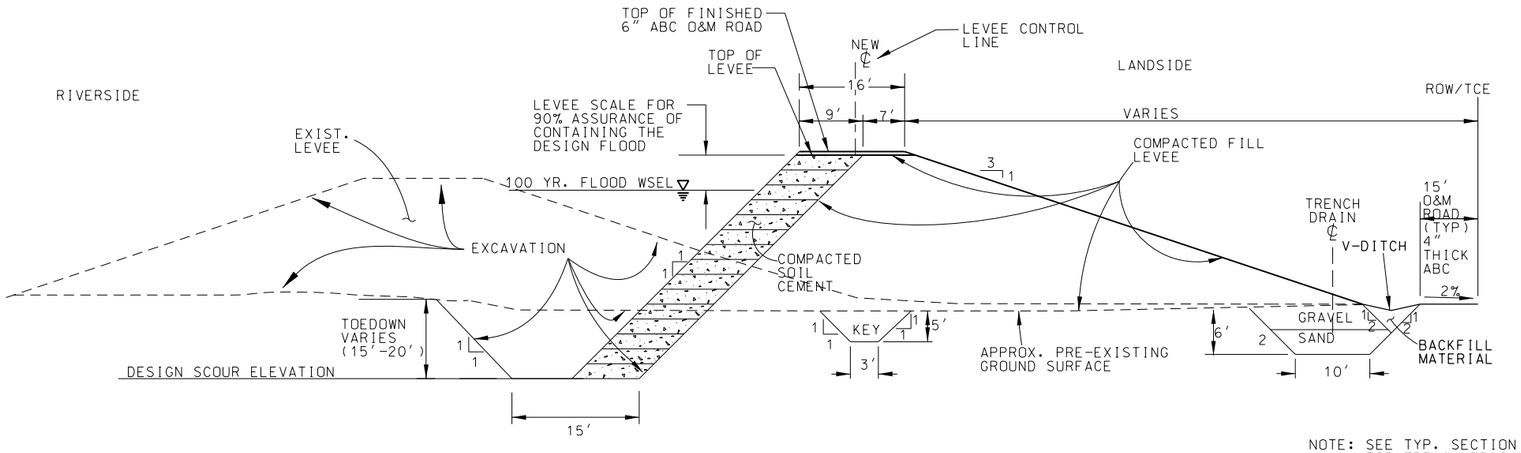
LITTLE COLORADO RIVER AT WINSLOW FEASIBILITY STUDY
WINSLOW, ARIZONA

TYPICAL LEVEE SECTIONS

US Army Corps of Engineers
Los Angeles District

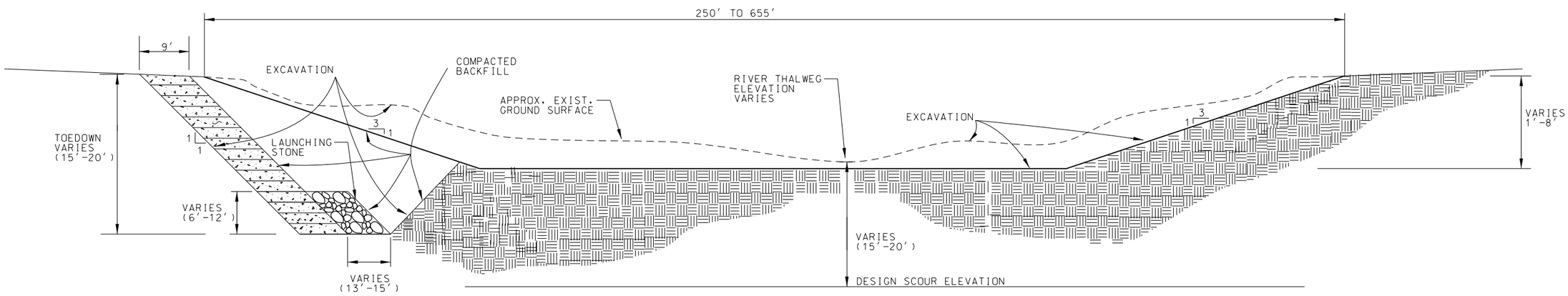
Scale AS SHOWN
PLATE 9

Plot Date: $date$



NOTE: SEE TYP. SECTION FOR TRENCH DRAIN ON PLATE 9.

RECONSTRUCTION WINSLOW LEVEE,
TYPICAL SECTION "D"
N.T.S.



NOTE: TYP. SECTION
LOOKING DOWNSTREAM

CHANNELIZATION
TYPICAL SECTION "E"
N.T.S.

DESIGNED BY:
DRAWN BY:
CHECKED BY:
FILE NAME:

LITTLE COLORADO RIVER AT WINSLOW FEASIBILITY STUDY
WINSLOW, ARIZONA

TYPICAL SETBACK LEVEE AND
CHANNELIZATION SECTIONS

US Army Corps of Engineers
Los Angeles District

Scale AS SHOWN
PLATE
10

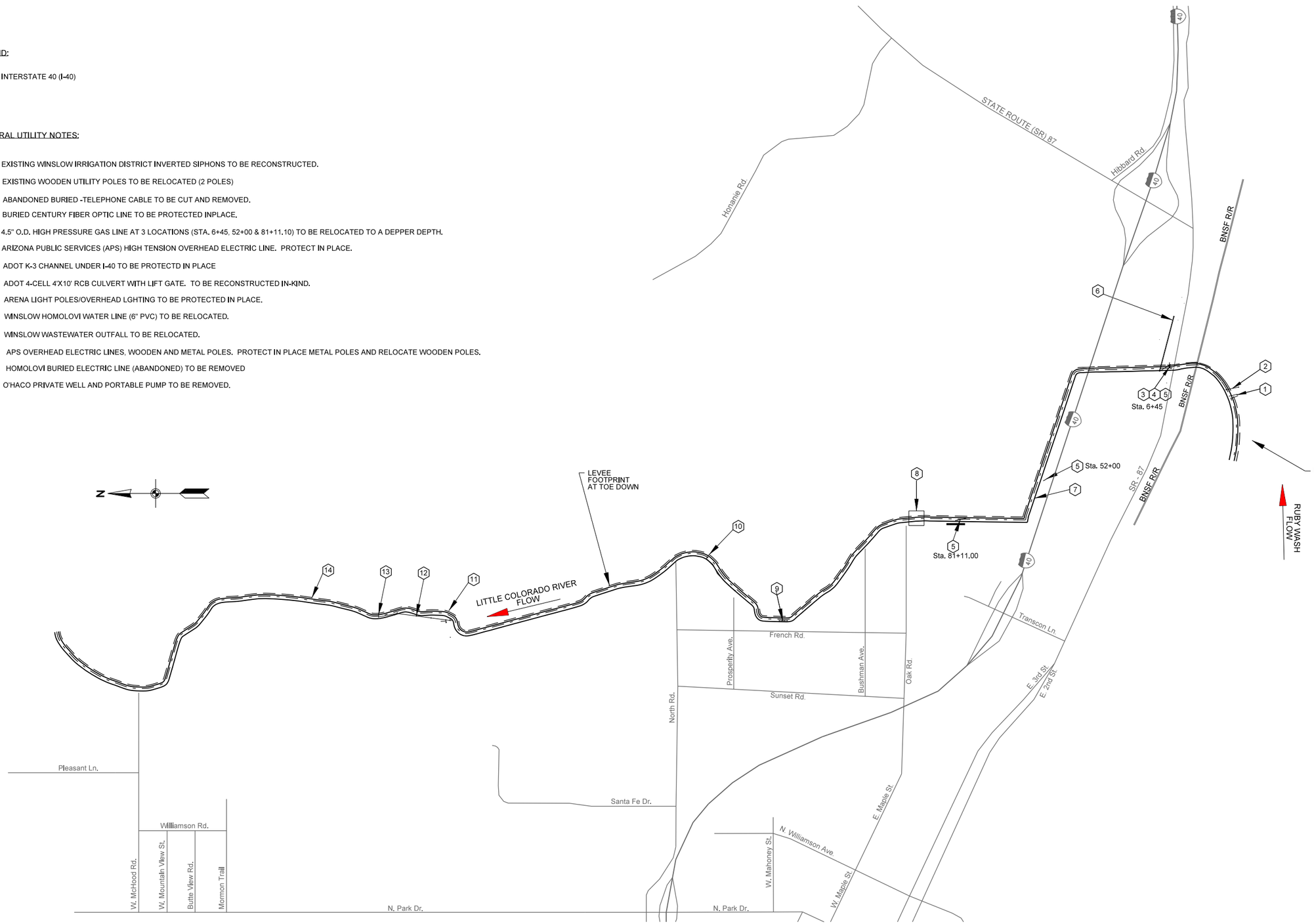
Plot Date: $date$

LEGEND:

40 INTERSTATE 40 (I-40)

GENERAL UTILITY NOTES:

1. EXISTING WINSLOW IRRIGATION DISTRICT INVERTED SIPHONS TO BE RECONSTRUCTED.
2. EXISTING WOODEN UTILITY POLES TO BE RELOCATED (2 POLES)
3. ABANDONED BURIED -TELEPHONE CABLE TO BE CUT AND REMOVED.
4. BURIED CENTURY FIBER OPTIC LINE TO BE PROTECTED INPLACE.
5. 4.5" O.D. HIGH PRESSURE GAS LINE AT 3 LOCATIONS (STA. 6+45, 52+00 & 81+11.10) TO BE RELOCATED TO A DEPPER DEPTH.
6. ARIZONA PUBLIC SERVICES (APS) HIGH TENSION OVERHEAD ELECTRIC LINE. PROTECT IN PLACE.
7. ADOT K-3 CHANNEL UNDER I-40 TO BE PROTECTD IN PLACE
8. ADOT 4-CELL 4'X10' RCB CULVERT WITH LIFT GATE. TO BE RECONSTRUCTED IN-KIND.
9. ARENA LIGHT POLES/OVERHEAD LGHTING TO BE PROTECTED IN PLACE.
10. WINSLOW HOMOLOVI WATER LINE (6" PVC) TO BE RELOCATED.
11. WINSLOW WASTEWATER OUTFALL TO BE RELOCATED.
12. APS OVERHEAD ELECTRIC LINES, WOODEN AND METAL POLES. PROTECT IN PLACE METAL POLES AND RELOCATE WOODEN POLES.
13. HOMOLOVI BURIED ELECTRIC LINE (ABANDONED) TO BE REMOVED
14. O'HACO PRIVATE WELL AND PORTABLE PUMP TO BE REMOVED.



EXISTING UTILITIES

DESIGNED BY:
DRAWN BY:
CHECKED BY:
FILE NAME: Existing Utilities.DGN

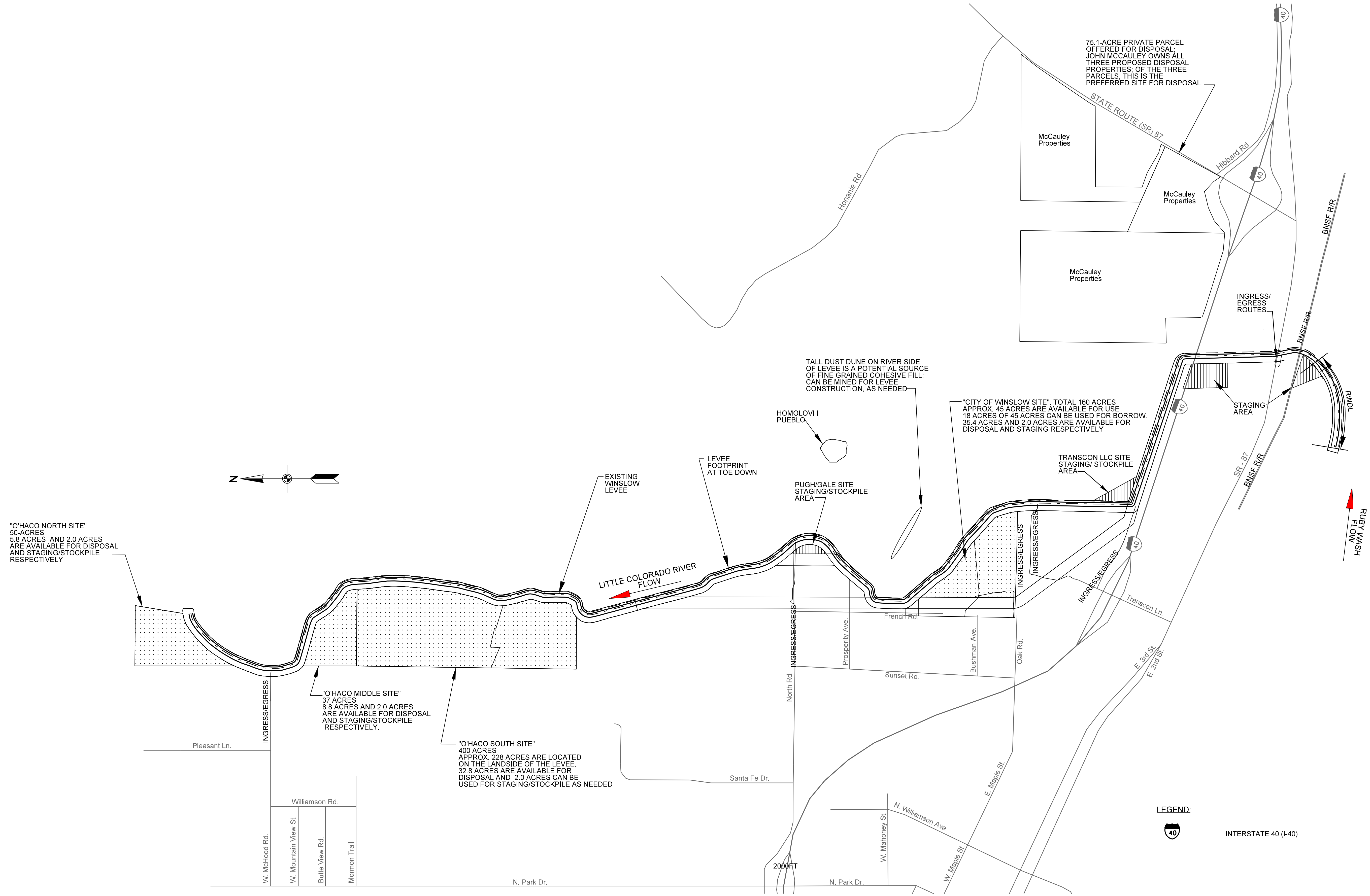
LITTLE COLORADO RIVER AT WINSLOW FEASIBILITY STUDY
WINSLOW, ARIZONA

EXISTING UTILITIES

US Army Corps of Engineers
Los Angeles District

Scale: AS SHOWN
PLATE
11

Plot Date: $date$



STAGING / STOCKPILE ARES
INGRESS / EGRESS ROUTES

PLAN

1000 500 0 1000
SCALE: 1" = 1000'

DESIGNED BY:
DRAWN BY:
CHECKED BY:
FILE NAME: StagingStockpileIngressEgress.dgn

LITTLE COLORADO RIVER AT WINSLOW FEASIBILITY STUDY
WINSLOW, ARIZONA

STAGING / STOCKPILE AREAS
AND INGRESS / EGRESS ROUTES

US Army Corps of Engineers®
Los Angeles District

Scale: AS SHOWN
PLATE
12

Plot Date: $date$

LEGEND:

40 INTERSTATE 40 (I-40)

N

"O'HACO NORTH SITE"
50-ACRES
5.8 ACRES AND 2.0 ACRES
ARE AVAILABLE FOR DISPOSAL
AND STAGING/STOCKPILE
RESPECTIVELY

"O'HACO NORTHWEST" SITE
A 39.2-ACRE PARCEL
FORMERLY MINED FOR LEVEE
CONSTRUCTION MATERIALS
WILL NOT USE MATERIAL FROM
THIS PARCEL UNLESS IT
CANNOT BE OBTAINED CLOSER
TO THE CONSTRCTION SITE

"O'HACO MIDDLE SITE"
37 ACRES
8.8 ACRES AND 2.0 ACRES
ARE AVAILABLE FOR DISPOSAL
AND STAGING/STOCKPILE
RESPECTIVELY.

"O'HACO SOUTH SITE"
400 ACRES
APPROX. 228 ACRES ARE LOCATED
ON THE LANDSIDE OF THE LEVEE.
32.8 ACRES ARE AVAILABLE FOR
DISPOSAL AND 2.0 ACRES CAN BE
USED FOR STAGING/STOCKPILE AS NEEDED

LEVEE CONTROL LINE

LITTLE COLORADO RIVER FLOW

TALL DUST DUNE ON RIVER SIDE
OF LEVEE IS A POTENTIAL SOURCE
OF FINE GRAINED COHESIVE FILL;
CAN BE MINED FOR LEVEE
CONSTRUCTION, AS NEEDED

"CITY OF WINSLOW SITE". TOTAL 160 ACRES
APPROX. 45 ACRES ARE AVAILABLE FOR USE
18 ACRES OF 45 ACRES CAN BE USED FOR BORROW.
35.4 ACRES AND 2.0 ACRES ARE AVAILABLE FOR
DISPOSAL AND STAGING RESPECTIVELY

75.1-ACRE PRIVATE PARCEL
OFFERED FOR DISPOSAL;
JOHN MCCAULEY OWNS ALL
THREE PROPOSED DISPOSAL
PROPERTIES; OF THE THREE
PARCELS, THIS IS THE
PREFERRED SITE FOR DISPOSAL

JOHN MCCAULEY PROPERTY

JOHN MCCAULEY PROPERTY

JOHN MCCAULEY PROPERTY

STATE ROUTE (SR) 87

Honanie Rd

Hibbard Rd

BNSF R/R

RWDL

SR - 87

BNSF R/R

RUBY WASH FLOW

Transcon Ln.

French Rd.

Prosperity Ave.

Bushman Ave.

Oak Rd.

Sunset Rd.

North Rd.

E. 3rd St.

E. 2nd St.

Santa Fe Dr.

E. Maple St.

N. Williamson Ave.

W. Mahoney St.

W. Maple St.

Pleasant Ln.

Williamson Rd.

W. McHood Rd.

W. Mountain View St.

Butte View Rd.

Mormon Trail

N. Park Dr.

N. Park Dr.

Fire Mtn. Rd.

Mikes Pike Blvd.

W. Fleming St.

W. 3rd St.

S. Highway 87

BORROW/DISPOSAL SITES

PLAN

1000 500 0 1000 2000FT

SCALE: 1" = 1000'

DESIGNED BY:	
DRAWN BY:	
CHECKED BY:	
FILE NAME:	BorrowDisposal.Dgn

LITTLE COLORADO RIVER AT WINSLOW FEASIBILITY STUDY
WINSLOW, ARIZONA

BORROW / DISPOSAL SITE

US Army Corps of Engineers
Los Angeles District

Scale: AS SHOWN

PLATE
13

Plot Date: $date$