US Army Corps of Engineers
Los Angeles District

Santa Cruz River, Paseo de las Iglesias
Pima County, Arizona

Draft Feasibility Study

APPENDIX E

DESIGN APPENDIX

July 2004

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Figures

1.0 OBJECTIVE

The objective of the Paseo de las Iglesias project is to implement restore riparian habitat in the vicinity of eastern Pima County. The purpose of this appendix is to present feasibility study results of the civil design effort. Design data and calculations were developed sufficient 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.

2.0 STUDY AREA

The Paseo de las Iglesias project is located in eastern Pima County, Arizona. The study area extends along the Santa Cruz River between Congress Street downstream to Los Reales Road upstream for a total length of approximately 7.5 miles.

3.0 PROJECT DESIGN DEVELOPMENT

3.1 Typical Project Design Features

A. Tributary Water Harvesting Basins

Tributary water harvesting basins will be constructed along the main channel of the Santa Cruz in areas that are typically protected from high energy discharges. The best location for the construction of a basin is at the confluence of the main channel and a tributary wash where fluvial deposition has been prevalent. The basin should be located on a raised bar or terrace and should be rectilinear in shape with a length to width ratio greater than 1.5. The long axis of the basin will be roughly aligned with the wash channel centerline. With this type of layout configuration, surface water from the tributary wash can be diverted into the basin and captured.

The basins will consist of an excavated depressional area that is back-filled with high porous media (gravel and sand) to promote infiltration into the near subsurface. The basin will provide detention storage for channel flow through infiltration and will minimize surface evaporation while providing subsurface moisture for rooted vegetation. The porous media will be sorted and graded by size through the depth of the basin to provide a matrix for root mass development from the establishment of vegetation on the surface.

Construction techniques include excavation of existing grades to a depth of approximately 48-inches below grade. To protect against possible washout during storm events, the side slopes of the basin will be shallow and no steeper than a five percent grade. Excavated material will be inspected and useable material stockpiled on-site for backfill. It is anticipated that approximately 25 percent of the cut material will be suitable for backfill. The remaining 75 percent will be loaded and hauled to the southern project area disposal site.

Upon certification that the subgrade surface is free of debris and protuberances, the excavated surface will be compacted to 90 percent Proctor. Clean sand, part of which can be reclaimed from existing cut material, will be back-filled into the basin directly overtop the compacted earth floor. The sand layer will be approximately 12-inches in depth and tapered to 4-inches in depth around the basin perimeter. The second layer to be filled will consist of 12-inches of No. 57 bluestone, or approved equivalent, and will serve to allow quick infiltration and provide a matrix for root mass development. Over top of the bluestone, the third layer of back-fill will consist of 12-inches of No. 2 gravel, or approved equivalent, which will promote quick infiltration and provide a filter layer to trap organic material. The top most layer will consist of 12-inches of native topsoil and loam mix, part of which can be reclaimed from existing cut material, which will serve as the high-organic layer to promote vegetative success.

The proposed surface of the water harvesting basin will be fine graded to direct channel discharges toward the basin interior. A planting mix of cottonwood willow and mesquite will consist of the dominant woody vegetation. Figure 5 illustrating the Airport Wash Diversion Basin (discussed later in this appendix) also provides an illustration for the tributary water harvesting basins with the exception that the downstream excavated trench slope grade for the tributary basin would not to exceed 5%.

B. Grade Control Structure Water Harvesting Basins

In order to limit deep infiltration losses of flow in the main channel, certain areas will be designated for construction of water harvesting basins, similar in design to the Tributary Water Harvesting Basins described above. Grade Control Water Harvesting Basins will be constructed immediately upstream of five existing grade control structures along the main channel of the Santa Cruz River. Each basin will be approximately 1-acre in area and will be rectilinear in shape, with a length to width ratio greater than 1.5. The long axis of the basin will be roughly aligned with the main channel centerline.

The basins will consist of an excavated depressional area that is back-filled with high porous media (gravel and sand) to promote infiltration into the near subsurface. The basin will provide detention storage for channel flow through infiltration and will minimize surface evaporation while providing subsurface moisture for rooted vegetation. The porous media will be sorted and graded by size through the depth of the basin to provide a matrix for root mass development from the establishment of herbaceous vegetation on the surface.

Grade Control Water Harvesting Basins will be designed and constructed identical to Tributary Water Harvesting Basins and will only differ in the type of vegetation that will be permitted to grow. Whereas woody vegetation, like cottonwood willow and mesquite, will be planted on the Tributary Water Harvesting Basins, only herbaceous non-woody vegetation will be permitted to flourish on the Grade Control Water Harvesting Basins. Emergent type grasses and reeds that display low hydraulic friction coefficients will be planted. Operation and maintenance practices will be instituted to remove any undesirable woody vegetation that would potentially cause increased hydraulic friction across the invert of the main channel.

C. Bank Stabilization through Excavation

Stream banks along the Santa Cruz River are highly unstable and nearly vertical cliffs composed of weakly cemented sands which are greatly susceptible to instability from wind and water erosion. These cliffs, which are devoid of vegetation, are unprotected from erosion from shear stresses during flood events, high winds and desiccation. Some of these unstable over-steep banks can be cut back through excavation to gentler slopes and then re-vegetated for ecosystem improvements.

Two variations of bank excavation were investigated to stabilize the unstable slopes. Each variation is a function of the amount of land available in the historic floodplain that is adjacent to the river bank under consideration for excavation. Where available land is not a constraint, banks are graded to a five-on-one horizontal to vertical (5:1 H:V) slope and then stabilized through vegetation. In areas where insufficient space exists to accommodate 5:1 slopes, placement of soil cement will be necessary for bank protection.

Excavation of the unstable slopes will be completed only above the 2-year flood water surface elevation and will continue upslope at a uniform 5:1 grade. Channel features that exist below the 2-year flood water surface elevation will be protected during excavation and returned to their pre-construction conditions before the project is completed. Cut material from the excavation will be loaded and hauled to the disposal area located at the abandoned sand and gravel quarry site at the southern end of the project area. Excavated material will not be side cast on-site. The potential for increases in erosion will be minimized by limiting the area of exposed soils during construction, completing earth-disturbing activities during the dry season, rapid revegetation of exposed soil areas and implementation of an erosion and sedimentation control plan that identifies best management practices (BMPs) appropriate for the Study Area.

All excavated slopes will be stabilized with vegetation and irrigated to promote quick growth. Irrigation practices on the excavated slopes will be comprised of leach field piping and pressure flow directed to the site from irrigation main lines located along the historic floodplain. Detailed analysis of the resulting stability of the regraded slopes will be performed as part of the final design phase and the recommendations of that analysis will be incorporated into the project construction plans and specifications..

D. Bank Stabilization with Soil Cement

In areas where insufficient space exists in the Historic Floodplain to accommodate 5H:1V excavated slopes, the placement of soil cement will be necessary for bank protection. Soil cement has been used extensively along the Santa Cruz River and in many other areas within Pima County and southern Arizona. Proven construction techniques have been established and adopted by various permitting authorities at the local and state level. Notwithstanding the industry accepted construction methods, the following paragraph describes soil cement application assumption used for concept design development.

At five locations along the Santa Cruz River, there are areas that exhibit moderate to severe bank instability in close proximity to the project boundaries. In these areas, real estate within the historic floodplain is limited in width and prohibits large excavation measures required for bank stability projects. With the application of soil cement, a narrow project footprint is all that is needed for successful stabilization of the eroding river banks. The total length of soil cement required is approximately 4,700 linear feet with a length-weighted average above grade vertical height of 19 feet.

Soil cement application will be required in five locations and will be based on several assumptions. The finished slope of a soil cement project will be on a 1H:1V grade. At least 10 feet of subsurface soil cement will be constructed to support the entire structure and to provide toe protection in the event of erosion. Combining the subsurface vertical depth of 10 feet with the average above grade vertical height of 19 feet, the total vertical application of soil cement will average at an approximate height of 30 feet. The top elevation of each soil cement section will terminate at the approximate elevation of the adjacent historic floodplain. The thickness of the soil cement will be approximately 8 feet which will be comprised of individual 8-inch thick lifts.

E. Irrigation System Design for Furrow Irrigation

Furrow irrigation will be established in the designated planting areas of the Historic Floodplain and will consist of cut furrows to receive surface flow for flood irrigation. This system will include all necessary piping and will be considered as permanent irrigation for the life of the project.

The design and construction of a permanent irrigation system requires the presence of a pressure water main that is brought to the project area and can sustain the water demands set by the irrigation requirements. At the location of the water main, header group piping will be installed along the Santa Cruz River channel that will convey the water toward specific locations within the project that will require irrigation. With the establishment of header groups, piping schemes and water distribution regimes will be facilitated and controlled on a systematic basis.

Gated supply piping will be installed in cut trenches and will provide flood irrigation water to each furrow by way of small diameter flexible tubing. Pressure regulation will be needed along supply piping to prevent scour and soil erosion that may result by irrigation applied at high pressures. At each small diameter tubing, water will be introduced into the furrow and allowed to gravity flow down the furrow. The rate of irrigation, amount to be applied to each furrow, and the duration will be adjusted at each planting area based on trial and error as it is assumed that the areas to receive furrow irrigation are heterogeneous in soil composition and topography.

Proper design of furrow irrigation requires detailed knowledge of the near surface geology and soil conditions to allow for efficient irrigation and to minimize losses due to infiltration and evapotranspiration. Sub-desert region irrigation practices prevalent in central and southern Arizona, where soil conditions consist of sand and loam, are successful when the furrow lengths are limited to a maximum distance of approximately 600 linear feet. At this furrow length, when considering soil conditions, the soil moisture depletion in the effective root zone is minimized, which allows for greater plant uptake.

The biggest requirement for successful furrow irrigation is that the field must have a positive and continuous furrow grade, which requires precision land grading. Precision grading results in positive field drainage that greatly enhances vegetative production. The furrow grade should be a minimum of 0.1 percent and no more than 0.5 percent with furrow grades between 0.15 and 0.3 percent as the most desirable. Furrow spacing to support the proposed mesquite and shrub planting should be eight (8) feet center-to-center. Each furrow will be triangular in cross section with an average depth of eight (8) inches and 3H:1V slide slopes.

After each planting area is graded for flood irrigation drainage, furrows will be excavated with the cut material side cast in the area between adjacent furrows. Prior to planting, the invert of each furrow will be compacted with a wheeled vehicle for one pass to create a flow channel along the furrow that will promote longitudinal distribution of flood irrigation to the hydraulically most remote point of the furrow. Plants will be installed along the shoulder of each side of each furrow, so that each plant is positioned close to irrigation sources. At initial plant installation, weeds will be removed from the furrow invert to insure each furrow receives adequate irrigation along its entire length. Weed control will continue within the furrows until such time that installed plants have established mature roots and will be able to compete for water sources. A typical furrow irrigation cross section is shown in Figure 1.

F. Irrigation System Design for Leach Field Pipes

Leach field irrigation will be installed on all excavated and natural slopes and second bench areas designated for ecosystem planting. Leach field irrigation will consist of buried pipes that will provide water to the roots of installed plants, and will rely on header pipes providing flow from water main pipes. Water distribution will commence through pressure flow from header group pipes with water pressures dropping to provide just enough flow through leach field pipe at the base of installed plant root masses. The leach field pipes, by definition, will be fitted with orifice openings to allow water to seep into the surrounding soil formation. With this type of irrigation, water is provided directly to the roots of the installed plants without potential looses due to surface evaporation or deep infiltration.

All piping from the header pipes to the leach field pipes will be installed in the subsurface. Trenches will be excavated and backfilled with the same material; excess cut material will be hauled off-site to the disposal area located at the southern end of the project area. Header pipes will be installed on gravel beds and protected within reason from rotational, tensile, or compressive forces. Leach field pipes, used on excavated and natural slopes, will be installed in trenches and overtop medium permeability geosynthetic fabric. The geosynthetic fabric will be used to provide a semi-permeable layer directly underneath the leach pipes to minimize deep infiltration and will induce a downslope flow regime of the irrigation water. The fabric will have an allowable permeability not to exceed 10^{-4} cm/sec. Geosynthetic fabric will not be used when installing leach field pipe on the second bench areas, which have very shallow surface grades.

Leach field piping will be installed parallel to topographic contours and will be limited to a length not to exceed 2,000 linear feet. It has been assumed that this limit in length will help to minimize operation and maintenance requirements by limiting the number of fittings required for each pipe run and to minimize head losses. Leach field pipe will be installed in trenches with a 10-foot center-to-center separation. Each pipe run will be installed no greater than 12-inches below grade, with the crown of the pipe located approximately 4-inches below grade. Leach field pipes will be wrapped in filter fabric to limit clogging to the orifice openings.

Plants will be installed between the leach field pipes and will be offset from the center line of the pipes by a minimum distance of 18-inches on the upslope side and 24-inches on the down slope side. Minimum separation distances will be applied to irrigation practices on the excavated and natural slopes to prevent roots from clogging the leach field pipes. A typical irrigation leach field cross section is shown in Figure 2.

G. Sprinkler Irrigation System Design

The design and construction of a permanent sprinkler irrigation system requires the presence of a pressure water main that is brought to the project area and can sustain the water demands set by the irrigation requirements. At the location of the water main, distribution piping will be installed along the Santa Cruz River channel that will convey the water toward specific locations within the project that will require irrigation. With the establishment of distribution groups, piping schemes and water distribution regimes will be facilitated and controlled on a systematic basis. This system will include all necessary piping and sprinkler heads and will be considered as permanent irrigation for the life of the project.

Sprinkler irrigation will be applied to the first bench areas within the Santa Cruz River valley. First bench areas are distinguished by fluvial geomorphological features that include areas raised above the main channel invert that display sedimentation buildup through natural processes. The first bench is typically located above the 2-year water surface elevation and supports a variety of low lying vegetation that can withstand moderate hydrodynamic forces resulting from infrequent inundation.

Sprinkler irrigation in these areas is best suited due to the remote delivery of irrigation water and the less intrusive construction requirements. All associated piping that delivers water to the individual sprinkler heads will be installed in subsurface at the toe of the second bench. Excavation and placement of all piping will occur at an elevation above the 25-year water surface elevation. Trenches will be excavated and backfilled with the same material; excess cut material side cast and compacted on-site. Distribution pipes will be installed on gravel beds and protected within reason from rotational, tensile, or compressive forces. In narrower reaches of the Santa Cruz River where the banks have been stabilized with soil cement the sprinkler heads will be mounted on the soil cement banks

Sprinkler heads will be designed to provide for long reach distribution with an arc radius of approximately 150 feet. Distribution pipe sizing and pressure requirements will be adjusted with commercially available sprinkler heads to attain the 150-foot distribution pattern. Sprinkler heads will be installed at an interval distance to provide for 25 feet of distribution overlap from each adjacent head. Thrust blocks will be installed at each elbow or bend in the piping to maintain system integrity and prevent damage or erosion to surrounding areas.

3.2 Specific Project Design Features

A. Let Down Structures for Gully Stabilization

At five locations along the Santa Cruz River valley there are moderate to severely eroded gullies that have formed from stormwater runoff spilling over the valley cliffs in an uncontrolled manner. All five gullies are located between Irvington Road and Valencia Road, four of which are located on the right descending bank, one of which is located on the left descending bank. These gullies are formed through the discharge of small catchment areas that have been isolated from larger catchments due to constructed municipal features including roads and bridges. The catchment areas are located within the historic floodplain in areas typically characterized as devoid of vegetation. The formation of the gullies are currently unchecked by any stabilization efforts and will continue to erode if appropriate measures are not taken.

The construction of let down structures will allow for stormwater discharge from the historic floodplain to the Santa Cruz River in a non-erosive manner. Let down structures will comprise Pipe Slope Drains for the non-erosive conveyance of stormwater through the gully features. Each site will then be backfilled to bury the conveyance piping and return the river valley walls to natural looking conditions. Fill material will be obtained from other project areas where cut material is in surplus. The conveyance piping will consist of bituminous coated corrugated metal piping typically used for road culverts. All piping will be supported on a gravel base and protected from excessive overburden forces.

The initial construction of the Let Down Structures will consist of the removal of debris and woody vegetation within the limits of the gully. The gully invert will then be graded to receive conveyance piping. A gravel base will be installed along the piping alignment to support the piping. After the piping is installed and secured to the gully slopes, fill material will be dumped and compacted to bury the piping and return the river valley wall to its original condition. Pipe end fitting will be installed with protective wingwalls and trash racks to allow for non-erosive discharge and prevent clogging of the conveyance piping. At the discharge end of the piping, an energy dissipation structure will also be installed. Figure 3 illustrates the Let Down Structure

B. Water Diversion Channel

A water diversion channel will be constructed along the left descending bank of the Airport Wash to capture surface runoff for diversion to a small basin. At the upstream end of the existing drop structure along the wash channel, a level spreading device will be constructed to divert a portion of the surface flow into a trapezoidal diversion channel. The channel will extend approximately 1,000 linear feet and will deliver surface water to a newly planted area for ecosystem restoration. The cut material from the excavation of the diversion channel will be mounded to construct a horse-shoe shaped low-head embankment on the downstream side of the area. The embankment will prevent the surface water from flowing back into the tributary channel which will therefore provide irrigation for the ecosystem restoration planting. Design calculations are presented in Tables 1 and 2. Figure 4 illustrates the water diversion channel and Figure 5 illustrates the basin design.

Table 1
Airport Wash Basin Diversion Channel
Rating Table for Trapezoidal Channel

Project Description	
Project File	c:\docume~1\billbi~1\my documents\paseo\hydraulics\furrow d.fm2
Worksheet	Airport Wash Diversion Chnnl
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Discharge

Constant Data	
Mannings Coefficient	0.030
Channel Slope	0.005000 ft/ft
Left Side Slope	3.000000 H : V
Right Side Slope	3.000000 H : V
Bottom Width	4.00 ft

Input Data	Minimum	Maximum	Increment
Depth	0.10	2.00	0.10 ft

Rating Table

Depth (ft)	Discharge (cfs)	Velocity (ft/s)
0.10	0.31	0.72
0.20	1.01	1.09
0.30	2.04	1.39
0.40	3.40	1.63
0.50	5.09	1.85
0.60	7.12	2.05
0.70	9.50	2.23
0.80	12.26	2.39
0.90	15.39	2.55
1.00	18.92	2.70
1.10	22.86	2.85
1.20	27.23	2.99
1.30	32.03	3.12
1.40	37.29	3.25
1.50	43.01	3.37
1.60	49.22	3.50
1.70	55.93	3.62
1.80	63.14	3.73
1.90	70.88	3.85
2.00	79.16	3.96

Table 2
Airport Wash Basin Diversion Channel
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\docume~1\billbi~1\my documents\paseo\hydraulics\furrow d.fm2
Worksheet	Airport Wash Diversion Chnnl
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.005000	ft/ft
Depth	1.25	ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	4.00	ft

Results		
Discharge	29.57	cfs
Flow Area	9.69	ft^2
Wetted Perimeter	11.91	ft
Top Width	11.50	ft
Critical Depth	0.94	ft
Critical Slope	0.015669	ft/ft
Velocity	3.05	ft/s
Velocity Head	0.14	ft
Specific Energy	1.39	ft
Froude Number	0.59	
Flow is subcritical.		

3.3 Planting Activities

Prior to planting, site preparation would include rough grading and scarifying of subsoil to receive topsoil, mulching/crimping/tilling of topsoil, and placement of rocks and coarse woody debris. Hydro-seeding would be used to spread a mix of native seed, mulch and fertilizer over all areas.

Plantings of mesquite and riparian shrubs will be interspersed throughout the project area. In the terraces and on the vegetated banks riparian shrub will be the dominant cover type while mesquite will dominate in the historic floodplain. Areas of cottonwood-willow will be planted at the tributary basins and emergent marsh will be created at the grade control basins.

Plantings will include mesquite planted with a high density using larger specimens of mesquite, blue palo verde, netleaf hackberry, wolfberry, graythorn, catclaw acacia, fourwing saltbush, and sacaton. Fremont cottonwood, Gooding's Willow, and velvet ash will be added to the plantings at the tributary water harvesting basins. Native herbaceous grasses will be planted in the water harvesting basins upstream of existing grade-control structures.

3.4 Recreational Features

The County has indicated they would like to include recreation features within the proposed project. Within the proposed recreation areas, improvements to the project may consist of a multipurpose trail system that incorporates the potential for educational benefits associated with habitat restoration, and the inclusion of benches and ramadas, and native plant material. Incidental to the primary project objective of the proposed project (environmental restoration) is the creation of passive recreational opportunities associated with the restored habitat areas, including the use of maintenance roads as trails for walking and biking, and areas for observing wildlife and learning about the natural history of the river. Also, interpretive signage should also be included as part of the project for public use and involvement to better understand the habitats and natural history associated with the river channel. Recreational features considered are as follows:

a. Install three new Comfort Stations on the west bank. The restroom building is erected on a concrete slab and constructed of interlocking 8”Wx16”Lx8”H split concrete blocks. The building has 3 doors, 4 Lexan windows, and 4 steel roof panels. A typical comfort station is shown in Figure 6.
b. Multipurpose trails with paved trail, unpaved trail, and decomposed granite (DG) trail are used in both north and south banks. A typical cross section of each trail is shown in Figure 7.
c. Install 16 new parking spaces at each of five locations. On the east bank near Valencia Road and midway between Silverlake Road and Ajo Way. On the west bank south of Valencia Road, approximately midway between Valencia road and Drexel Road, and approximately midway between Ajo Way and Irvington Road.

3.4 Project Maps

Figures 8 through 31 provide mapping of the project area with the locations of all project features identified.

Figures

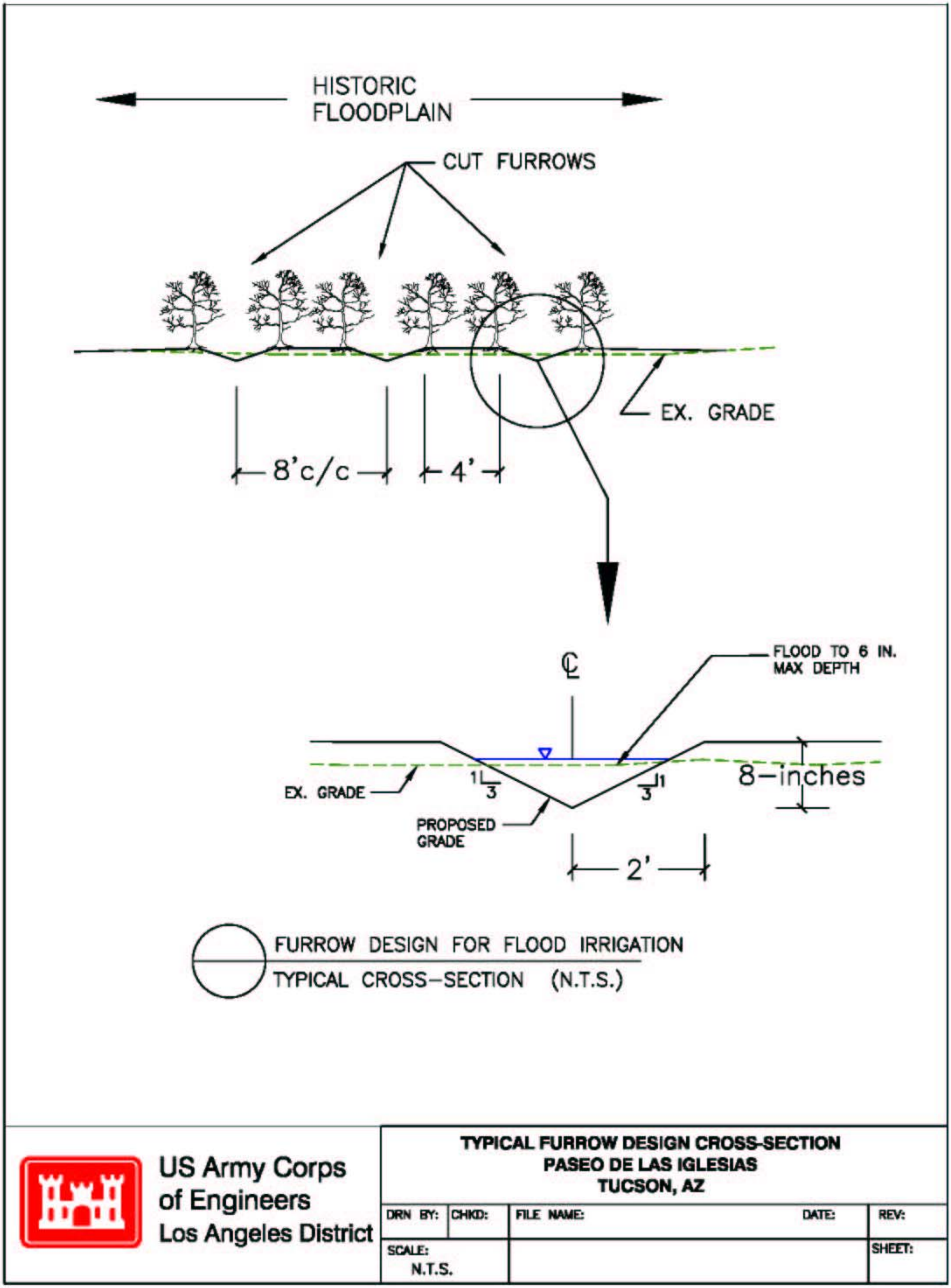
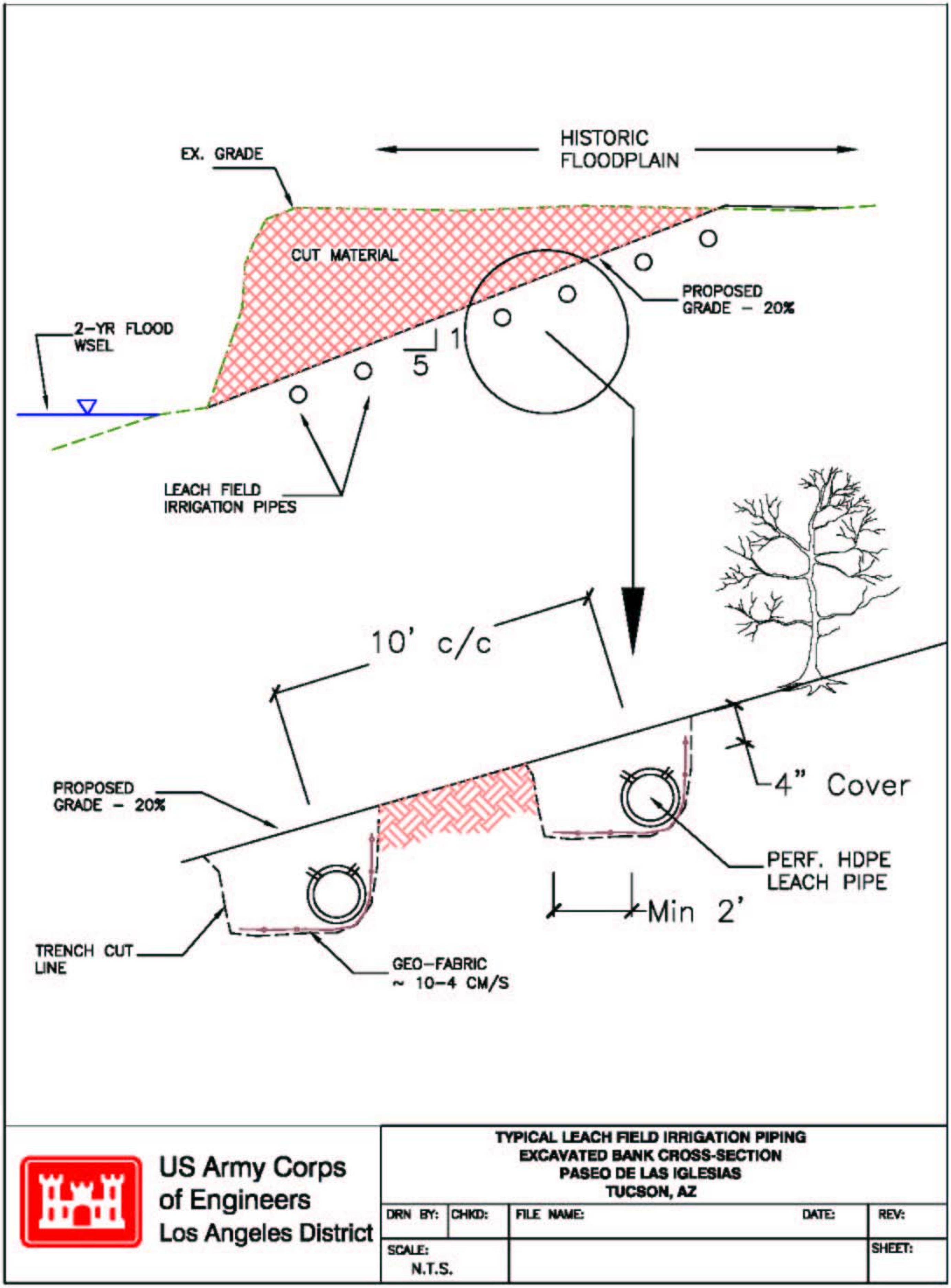
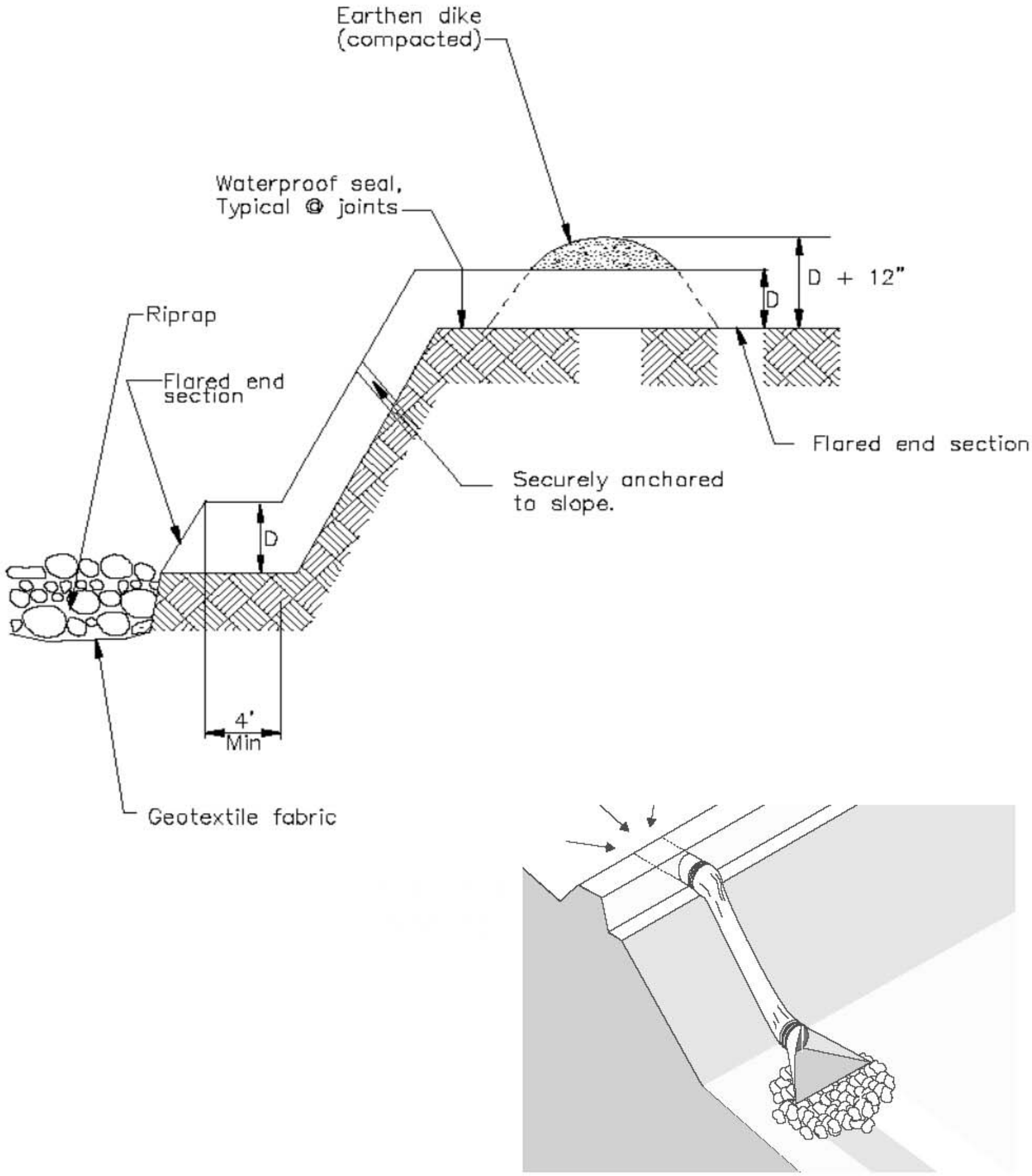

HISTORIC FLOODPLAIN
CUT FURROWS
EX. GRADE
8'c/c
4'
℄
FLOOD TO 6 IN. MAX DEPTH
EX. GRADE
1
3
3
1
8-inches
PROPOSED GRADE
2'
FURROW DESIGN FOR FLOOD IRRIGATION
TYPICAL CROSS-SECTION (N.T.S.)
US Army Corps of Engineers Los Angeles District
TYPICAL FURROW DESIGN CROSS-SECTION
PASEO DE LAS IGLESIAS
TUCSON, AZ
DRN BY:
CHKD:
FILE NAME:
DATE:
REV:
SCALE:
N.T.S.
SHEET:

Figure 1



HISTORIC
FLOODPLAIN
EX. GRADE
CUT MATERIAL
PROPOSED
GRADE - 20%
2-YR FLOOD
WSEL
1
5
LEACH FIELD
IRRIGATION PIPES
10' c/c
4" Cover
PROPOSED
GRADE - 20%
PERF. HDPE
LEACH PIPE
Min 2'
TRENCH CUT
LINE
GEO-FABRIC
~ 10-4 CM/S
US Army Corps
of Engineers
Los Angeles District
TYPICAL LEACH FIELD IRRIGATION PIPING
EXCAVATED BANK CROSS-SECTION
PASEO DE LAS IGLESIAS
TUCSON, AZ
DRN BY:
CHKD:
FILE NAME:
DATE:
REV:
SCALE:
N.T.S.
SHEET:

Figure 2



US Army Corps
of Engineers
Los Angeles District

PIPE SLOPE DRAIN DETAIL
AS PART OF LET DOWN STRUTURE
PASEO DE LAS IGLESIAS
TUCSON, AZ

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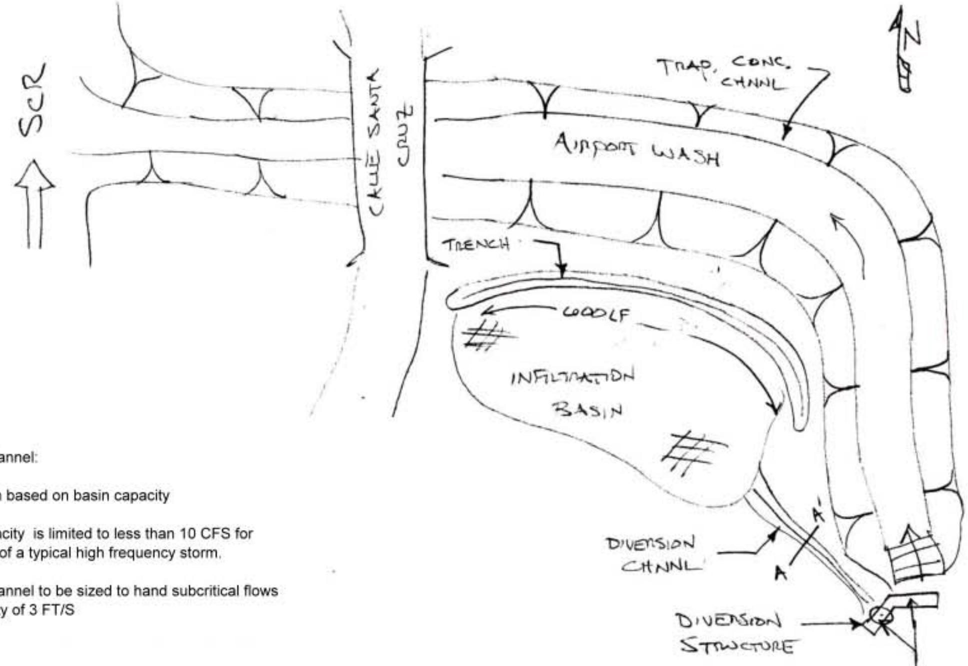
Figure 3

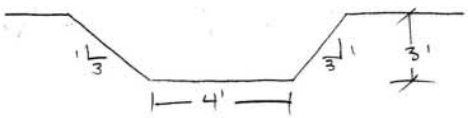


Diversion Channel:

Cross section based on basin capacity

Assume capacity is limited to less than 10 CFS for the duration of a typical high frequency storm.

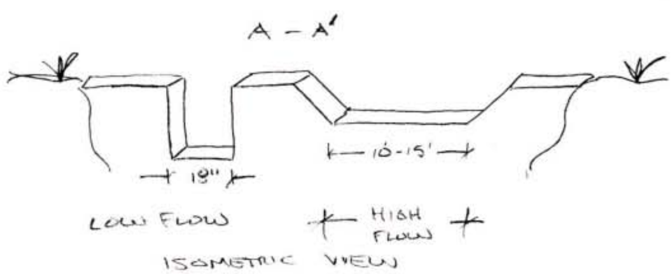
Diversion Channel to be sized to hand subcritical flows NTE a velocity of 3 FT/S

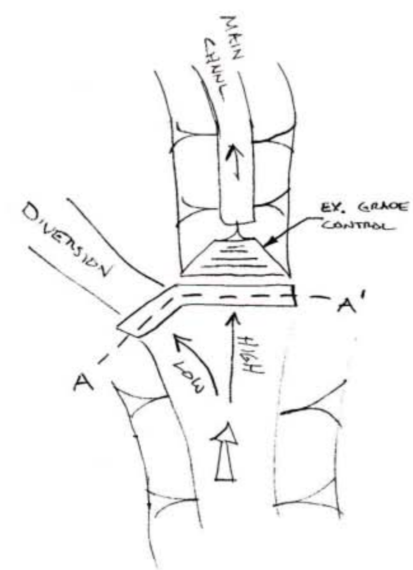


Diversion Structure:

Assume a Low Flow Restricting Weir

CIP Reinforced Concrete Structure





US Army Corps of Engineers
Los Angeles District

AIRPORT WASH BASIN PASEO DE LAS IGLESIAS TUCSON, ARIZONA				
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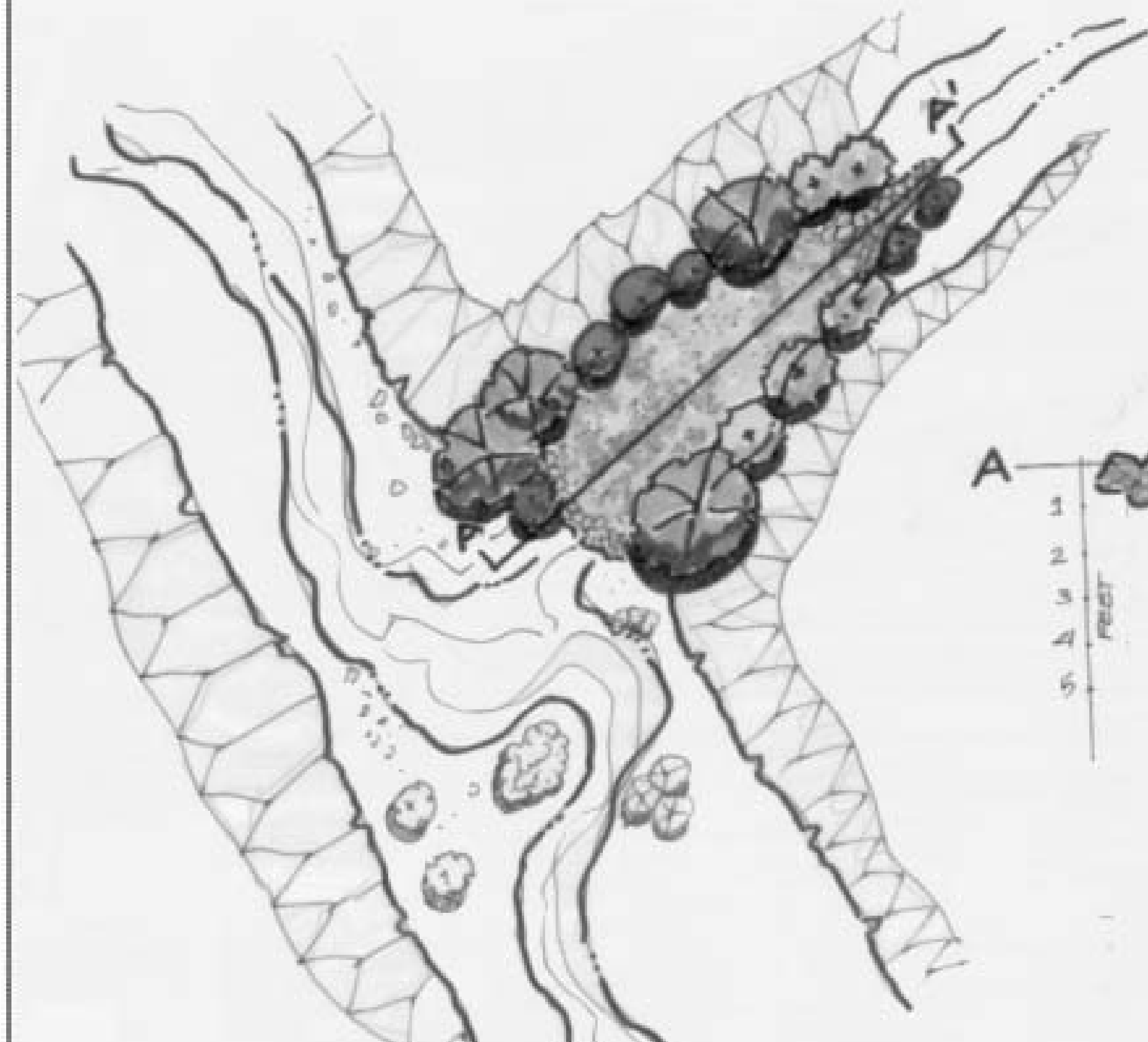
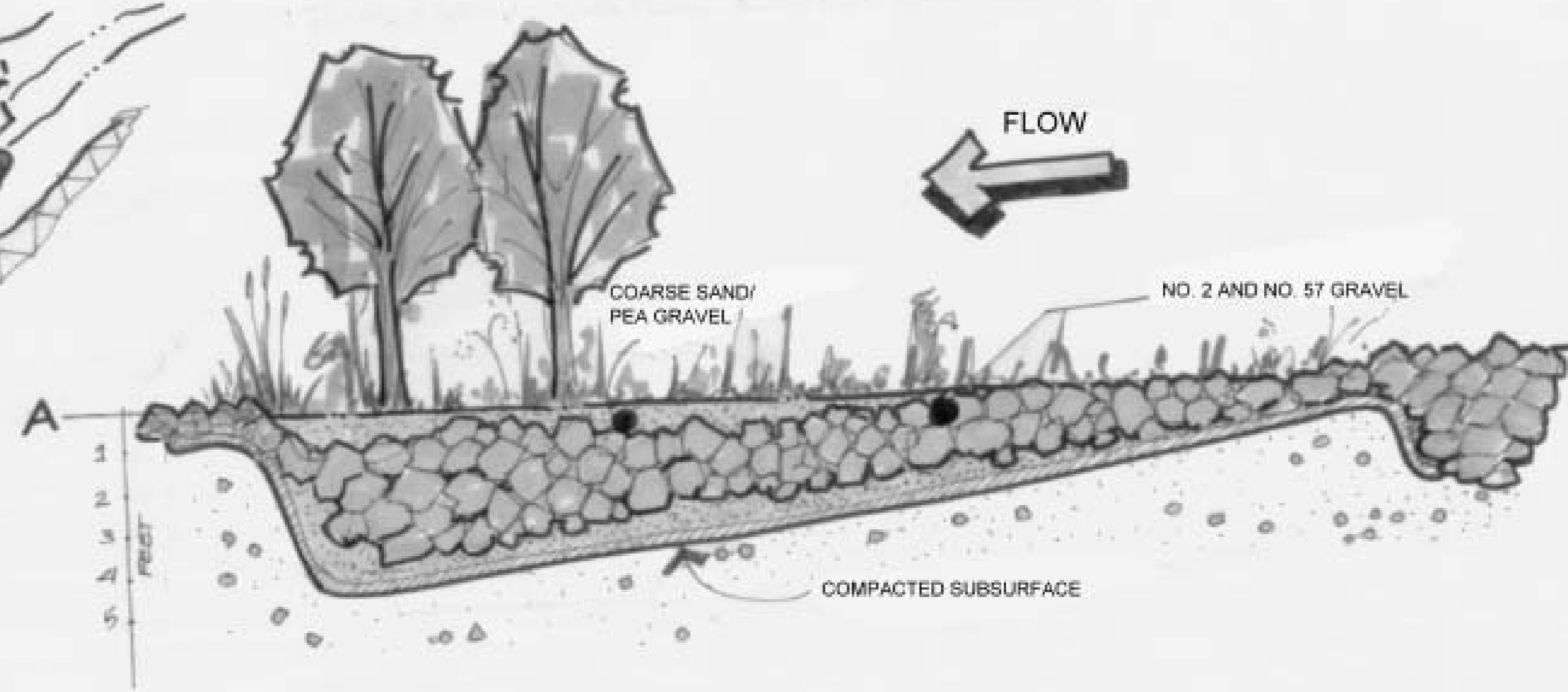
SCALE: N.T.S.				SHEET:

Figure 4

VALUE ENGINEERING PAYS





TRIBUTARY INFILTRATION BASIN CONCEPT

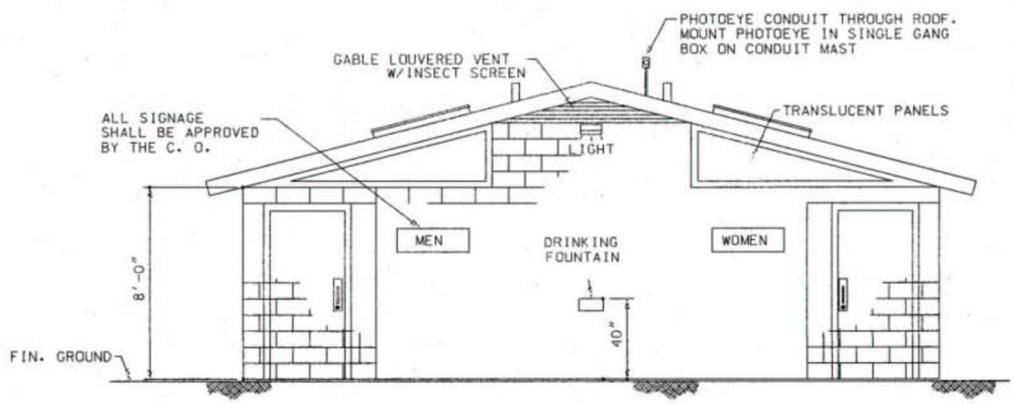
SAFETY PAYS

REVISIONS

FEASIBILITY REPORT
PASEO DE LAS IGLESIAS, PIMA COUNTY, ARIZONA

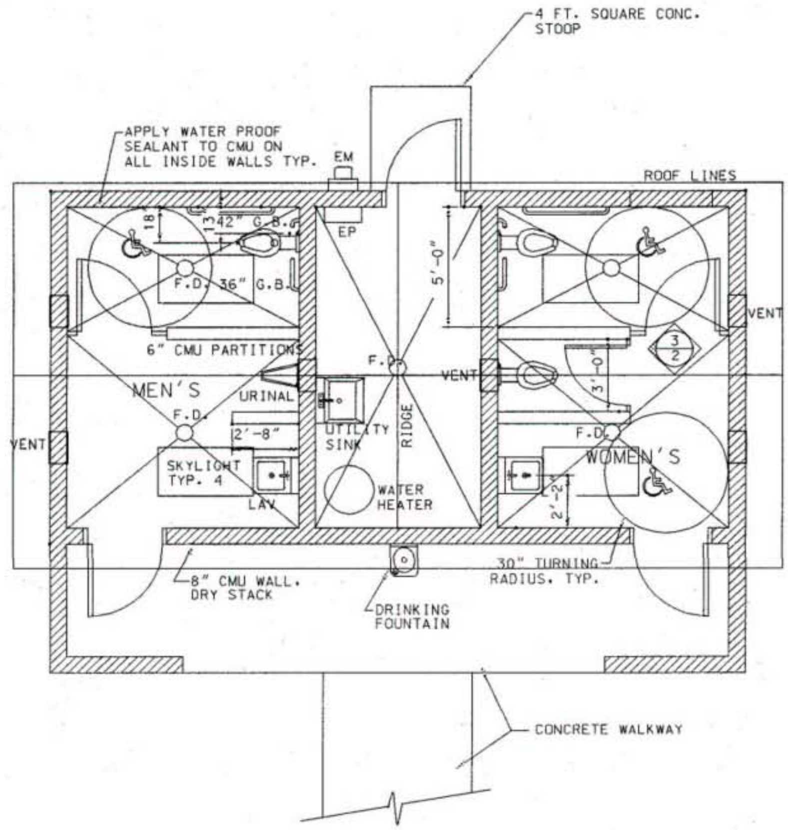
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

Figure 5



FRONT ELEV.

NOT TO SCALE



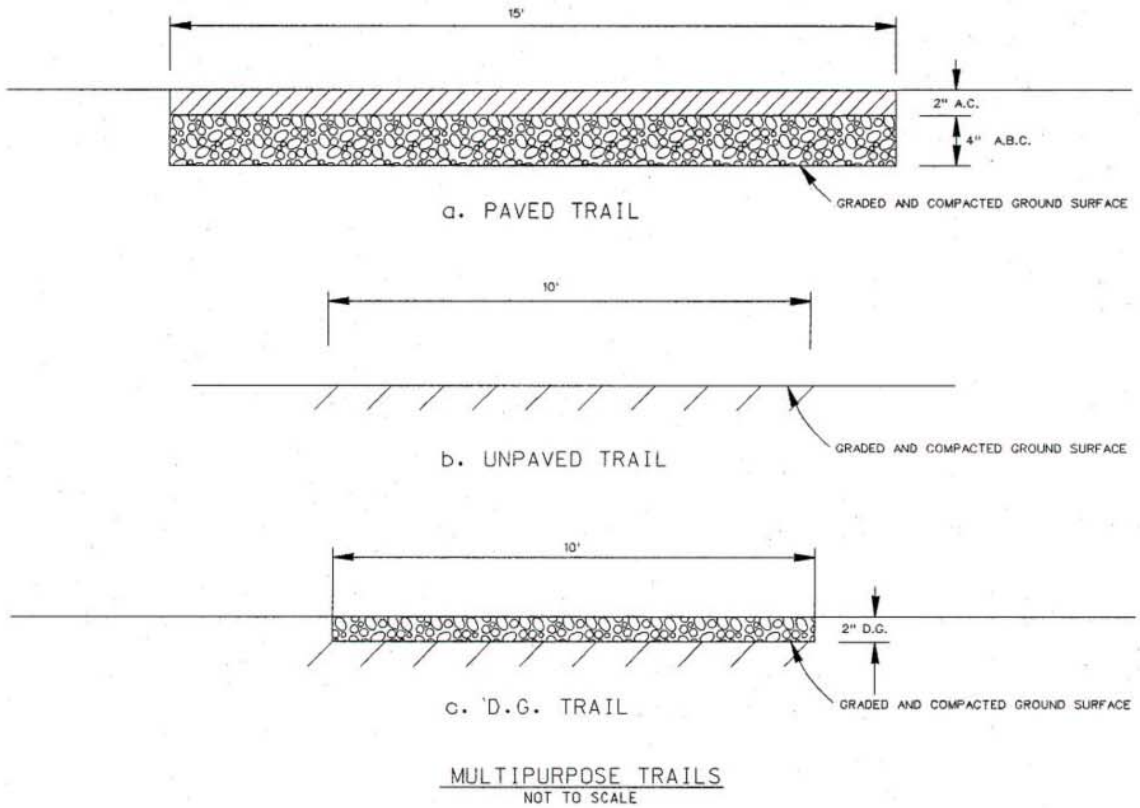
FLOOR PLAN

NOT TO SCALE

US Army Corps of Engineers Los Angeles District

COMFORT STATION PASEO DE LAS IGLESIAS TUCSON, AZ				
DRN BY:	CHKD:	FILE NAME:	DATE:	REV:
SCALE: N.T.S.				SHEET:

Figure 6

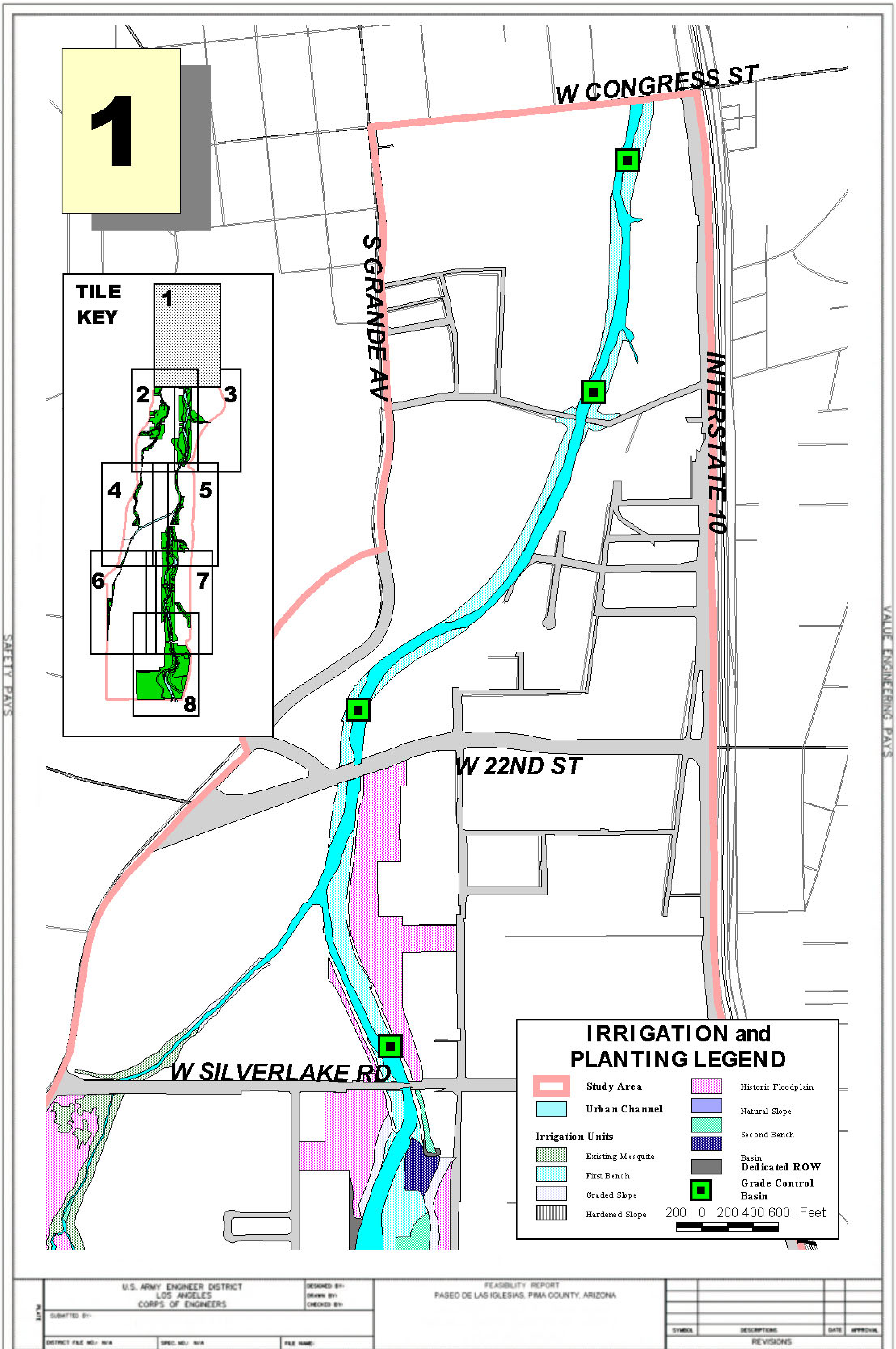


US Army Corps of Engineers Los Angeles District

MULTI-PURPOSE TRAILS
PASEO DE LAS IGLESIAS
TUCSON, AZ

DRN BY:	CHKD:	FILE NAME:	DATE:	REV:
SCALE: N.T.S.				SHEET:

Figure 7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TILE KEY
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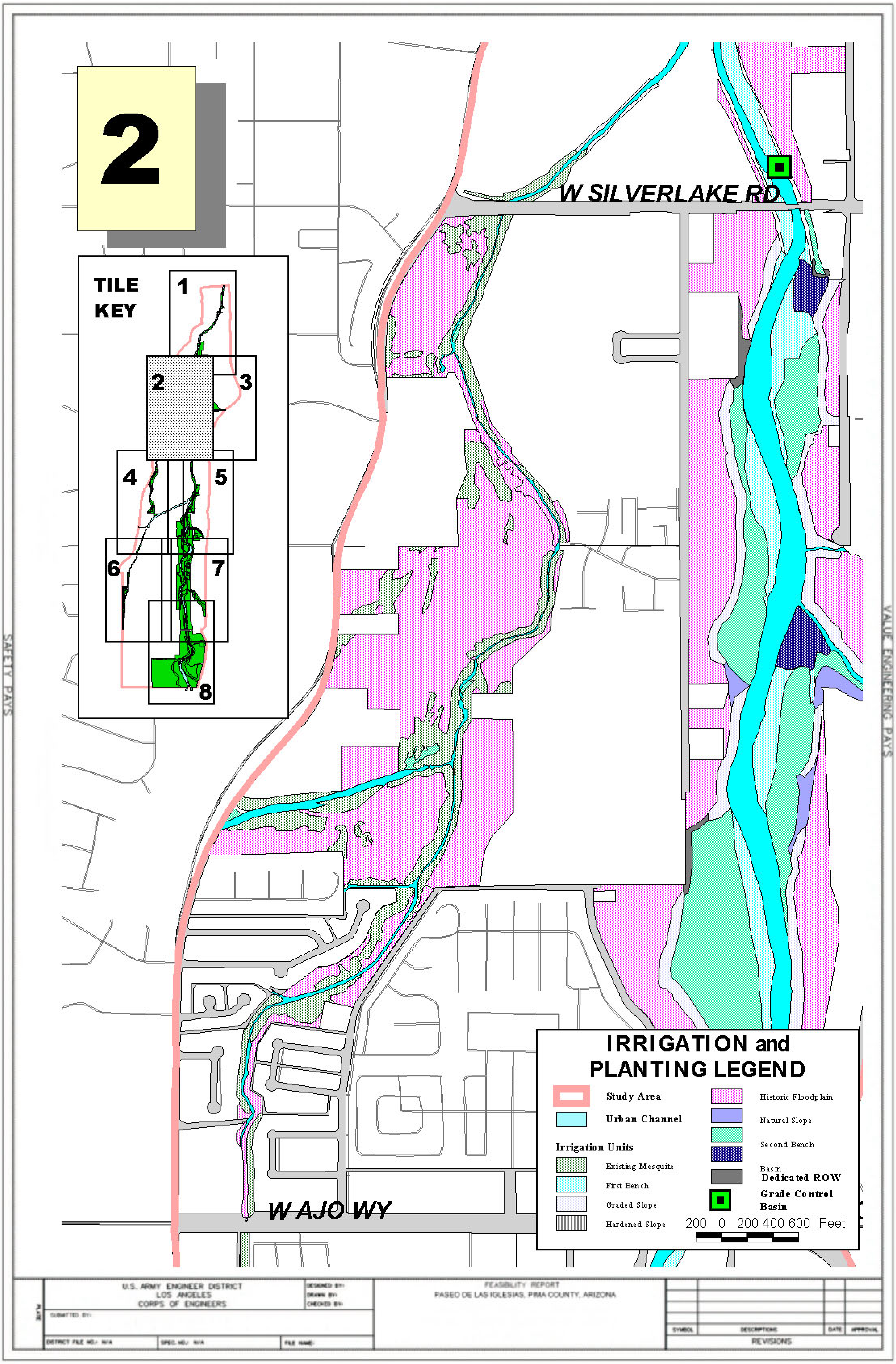
8
W CONGRESS ST
S GRANDE AV
INTERSTATE 10
W 22ND ST
W SILVERLAKE RD
IRRIGATION and PLANTING LEGEND
Study Area
Urban Channel
Irrigation Units
Existing Mesquite
First Bench
Graded Slope
Hardened Slope
Historic Floodplain
Natural Slope
Second Bench
Basin
Dedicated ROW
Grade Control Basin
200 0 200 400 600 Feet
SAFETY PAYS
VALUE ENGINEERING PAYS
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS
DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY:
DISTRICT FILE NO.: N/A
SPEC. NO.: N/A
FILE NAME:
FEASIBILITY REPORT
PASEO DE LAS IGLESIAS, PIMA COUNTY, ARIZONA
SYMBOL
DESCRIPTIONS
DATE
APPROVAL
REVISIONS
PLATE

Figure 8



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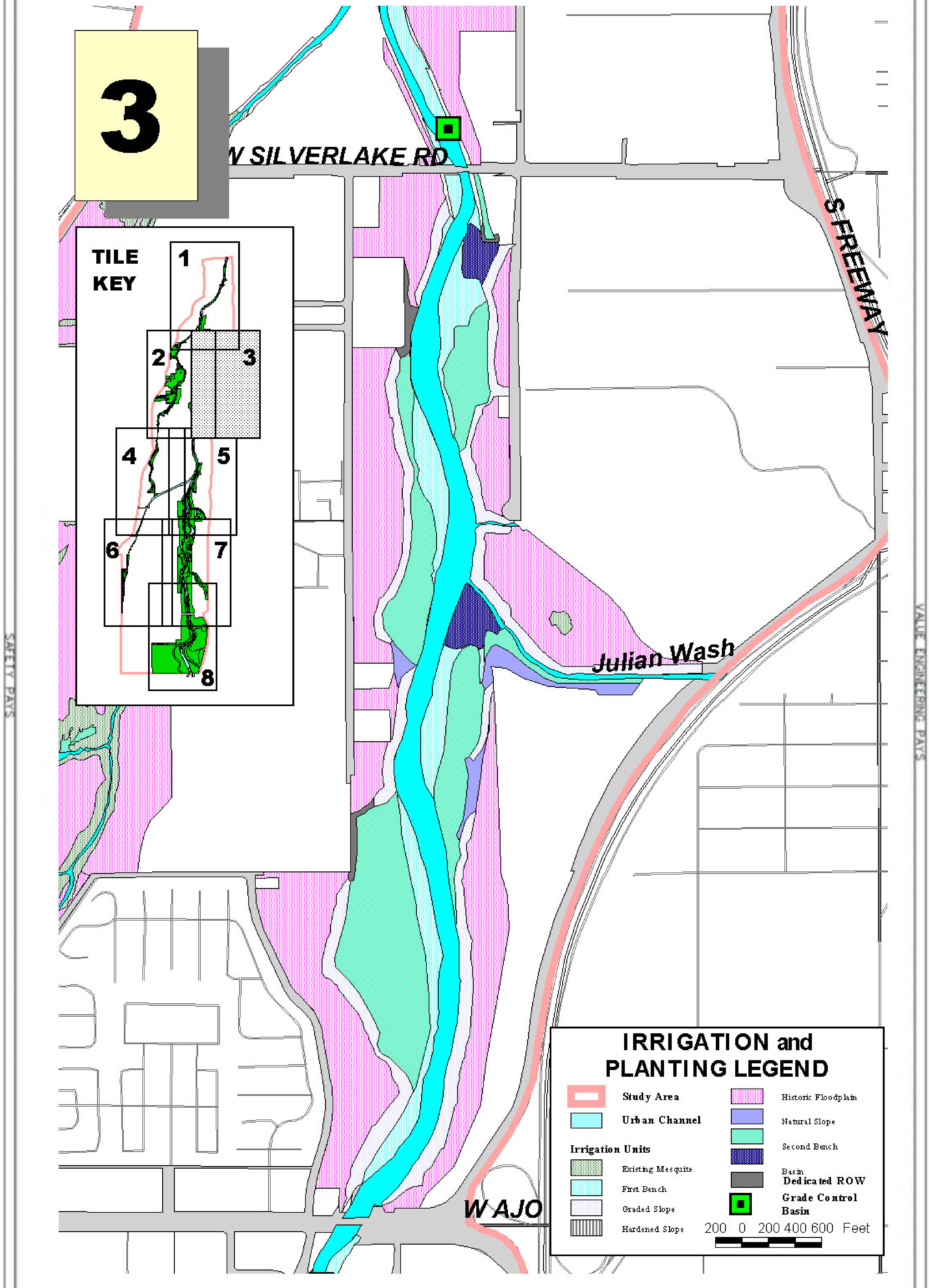
IRRIGATION and PLANTING LEGEND
Study Area
Urban Channel
Irrigation Units
Existing Mesquite
First Bench
Graded Slope
Hardened Slope
Historic Floodplain
Natural Slope
Second Bench
Basin
Dedicated ROW
Grade Control Basin
200 0 200 400 600 Feet
SAFETY PAYS
VALUE ENGINEERING PAYS
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS
DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY:
DISTRICT FILE NO.: N/A
SPEC. NO.: N/A
FILE NAME:
FEASIBILITY REPORT
PASEO DE LAS IGLESIAS, PIMA COUNTY, ARIZONA
SYMBOL
DESCRIPTIONS
DATE
APPROVAL
REVISIONS
PLATE

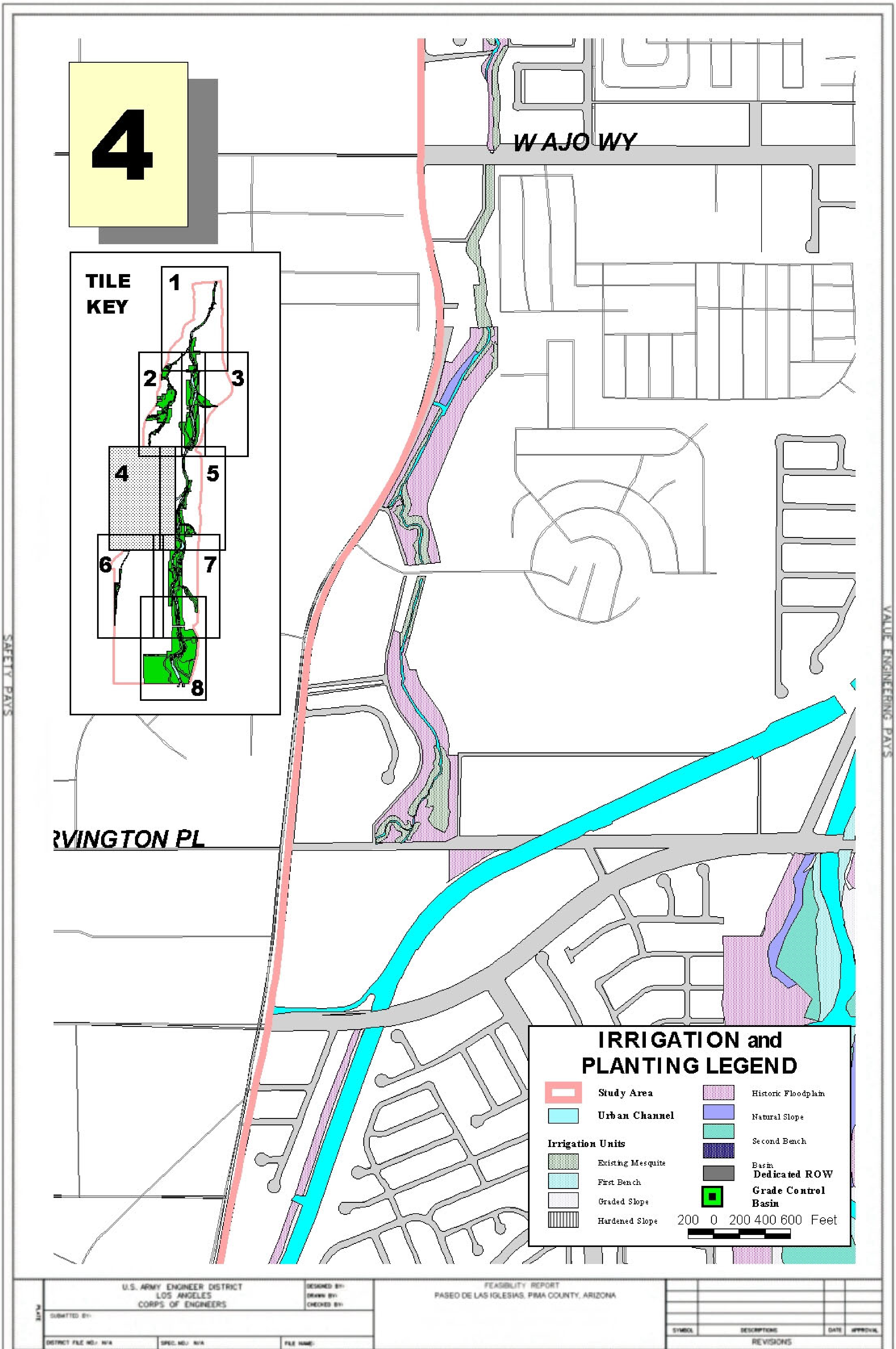
Figure 9



U.S. ARMY ENGINEER DISTRICT LOS ANGELES CORPS OF ENGINEERS	DESIGNED BY: DRAWN BY: CHECKED BY:	FEASIBILITY REPORT PASEO DE LAS IGLESIAS, PIMA COUNTY, ARIZONA	SYMBOL / DESCRIPTIONS / DATE / APPROVAL REVISIONS
SUBMITTED BY:			
DISTRICT FILE NO.: N/A	SPEC. NO.: N/A	FILE NAME:	

PLATE

Figure 10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Urban Channel
Irrigation Units
Existing Mesquite
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Graded Slope
Hardened Slope
Historic Floodplain
Natural Slope
Second Bench
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Grade Control Basin
200 0 200 400 600 Feet
SAFETY PAYS
VALUE ENGINEERING PAYS
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS
DESIGNED BY:
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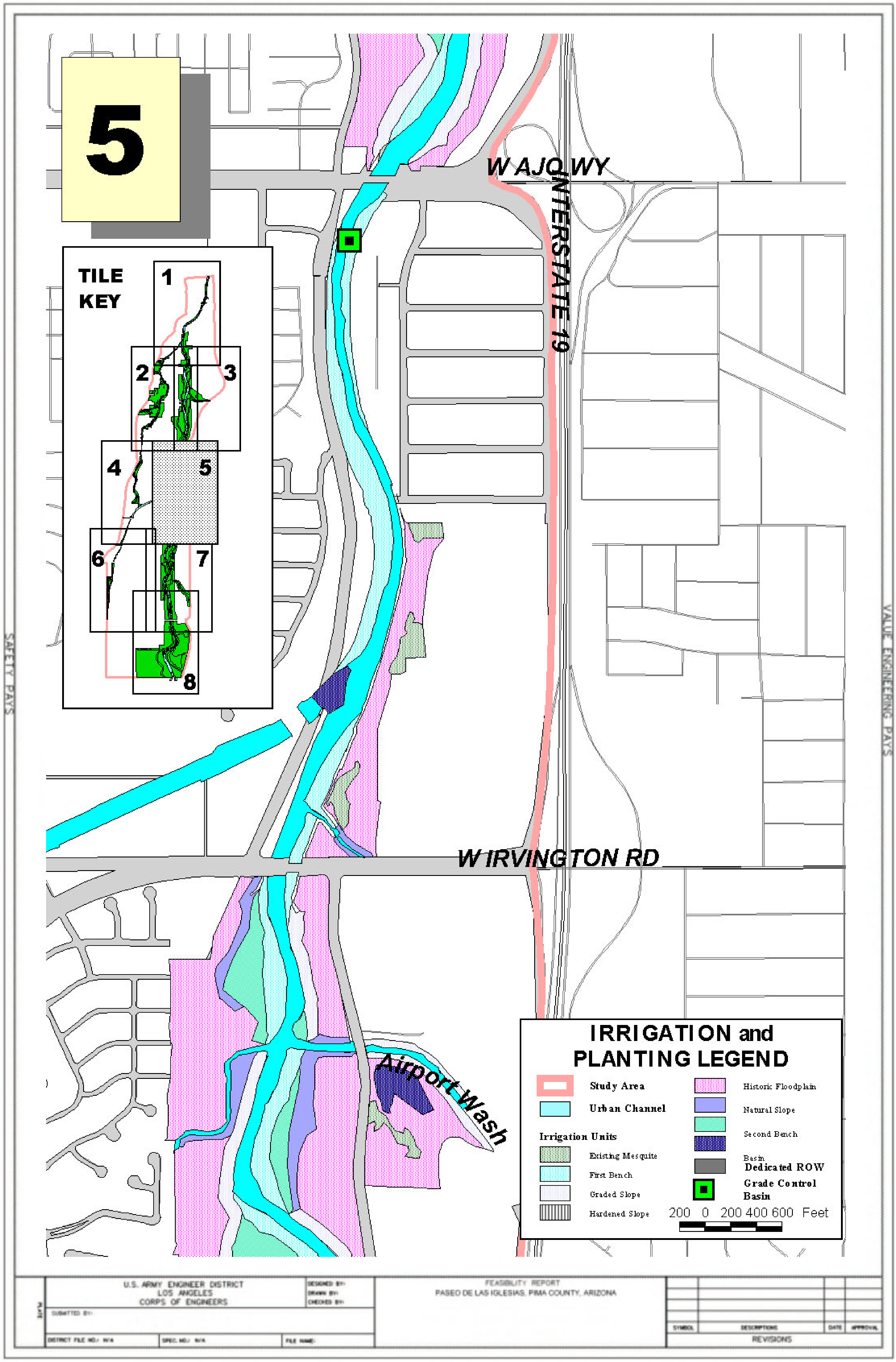
PLATE
DISTRICT FILE NO.: N/A
SPEC. NO.: N/A
FILE NAME:
FEASIBILITY REPORT
PASEO DE LAS IGLESIAS, PIMA COUNTY, ARIZONA
SYMBOL
DESCRIPTIONS
DATE
APPROVAL
REVISIONS

Figure 11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TILE KEY
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W AJO WY
INTERSTATE 19
W IRVINGTON RD
Airport Wash
IRRIGATION and PLANTING LEGEND
Study Area
Urban Channel
Irrigation Units
Existing Mesquite
First Bench
Graded Slope
Hardened Slope
Historic Floodplain
Natural Slope
Second Bench
Basin
Dedicated ROW
Grade Control Basin
200 0 200 400 600 Feet
SAFETY PAYS
VALUE ENGINEERING PAYS
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS
DESIGNED BY:
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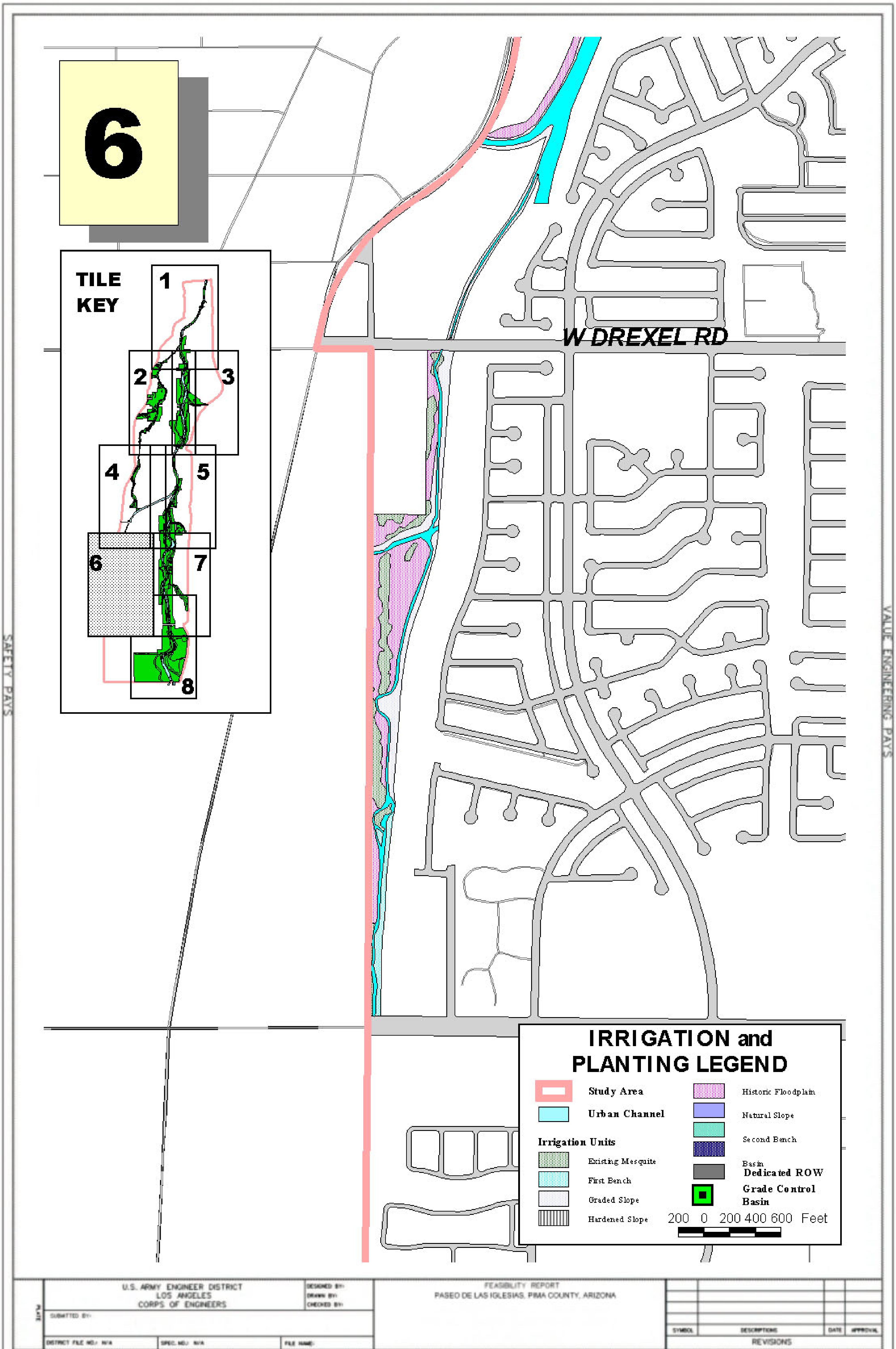
FILE NAME:
PLATE
FEASIBILITY REPORT
PASEO DE LAS IGLESIAS, PIMA COUNTY, ARIZONA
SYMBOL
DESCRIPTIONS
DATE
APPROVAL
REVISIONS

Figure 12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Study Area
Urban Channel
Irrigation Units
Existing Mesquite
First Bench
Graded Slope
Hardened Slope
Historic Floodplain
Natural Slope
Second Bench
Basin
Dedicated ROW
Grade Control Basin
200 0 200 400 600 Feet
SAFETY PAYS
VALUE ENGINEERING PAYS
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS
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SUBMITTED BY:
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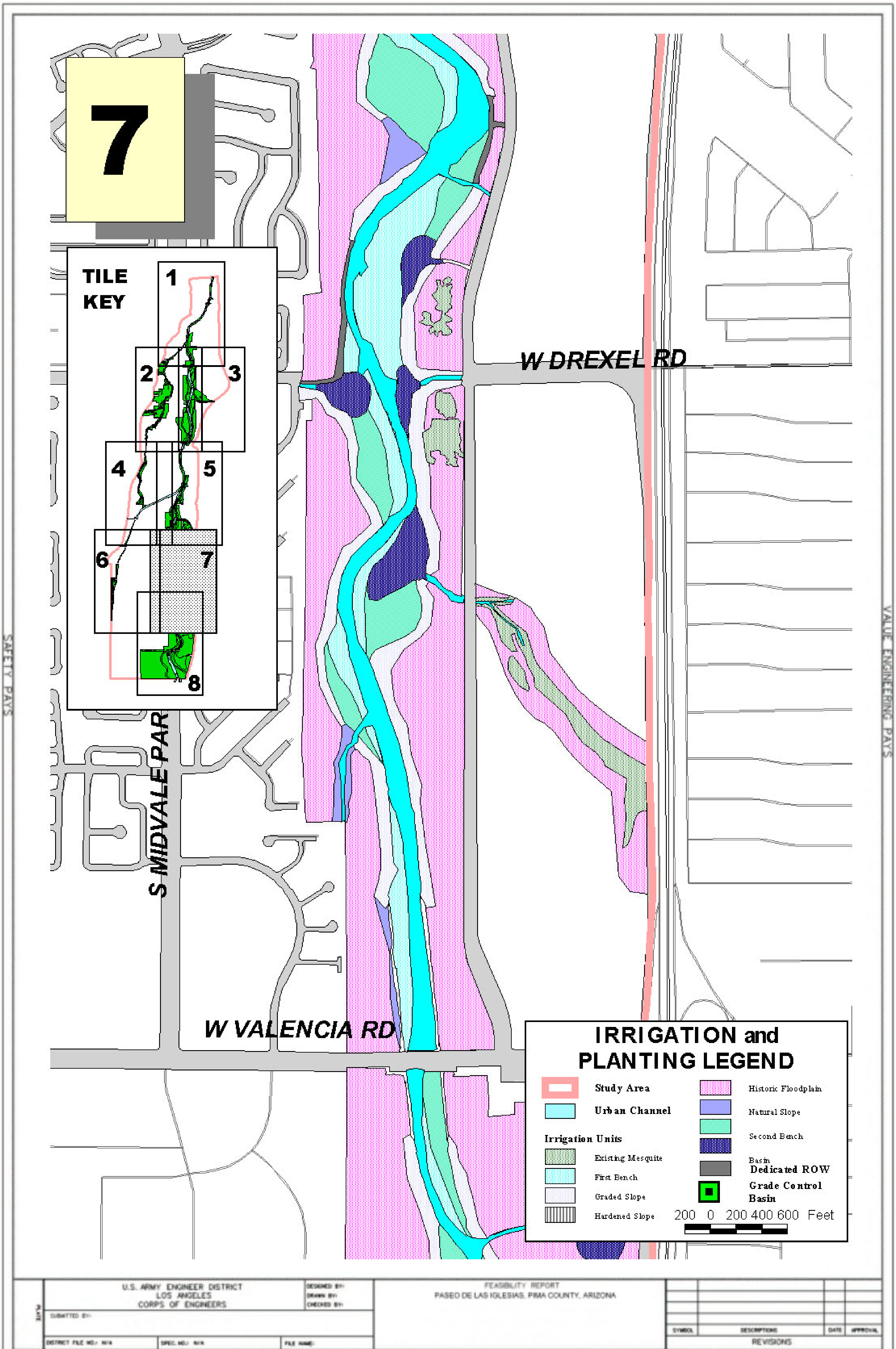
SPEC. NO.: N/A
FILE NAME:
FEASIBILITY REPORT
PASEO DE LAS IGLESIAS, PIMA COUNTY, ARIZONA
SYMBOL
DESCRIPTIONS
DATE
APPROVAL
REVISIONS
PLATE

Figure 13


7
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W VALENCIA RD
IRRIGATION and PLANTING LEGEND
Study Area
Urban Channel
Irrigation Units
Existing Mesquite
First Bench
Graded Slope
Hardened Slope
Historic Floodplain
Natural Slope
Second Bench
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Grade Control Basin
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SAFETY PAYS
VALUE ENGINEERING PAYS
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS
DESIGNED BY:
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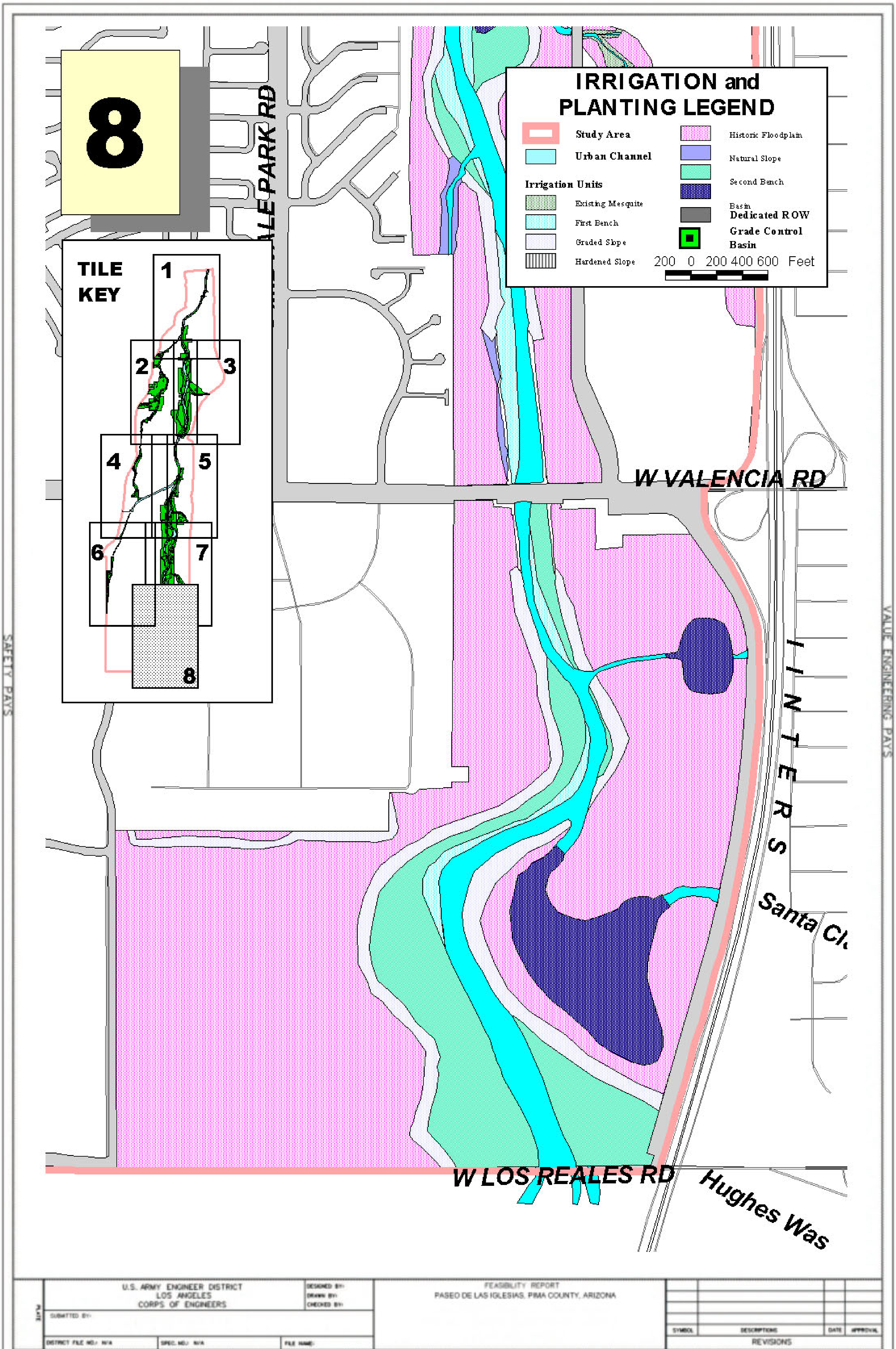
DISTRICT FILE NO.: N/A
SPEC. NO.: N/A
FILE NAME:
FEASIBILITY REPORT
PASEO DE LAS IGLESIAS, PIMA COUNTY, ARIZONA
SYMBOL
DESCRIPTIONS
DATE
APPROVAL
REVISIONS

Figure 14



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Urban Channel
Irrigation Units
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First Bench
Graded Slope
Hardened Slope
Historic Floodplain
Natural Slope
Second Bench
Basin
Dedicated ROW
Grade Control Basin
200 0 200 400 600 Feet
W VALENCIA RD
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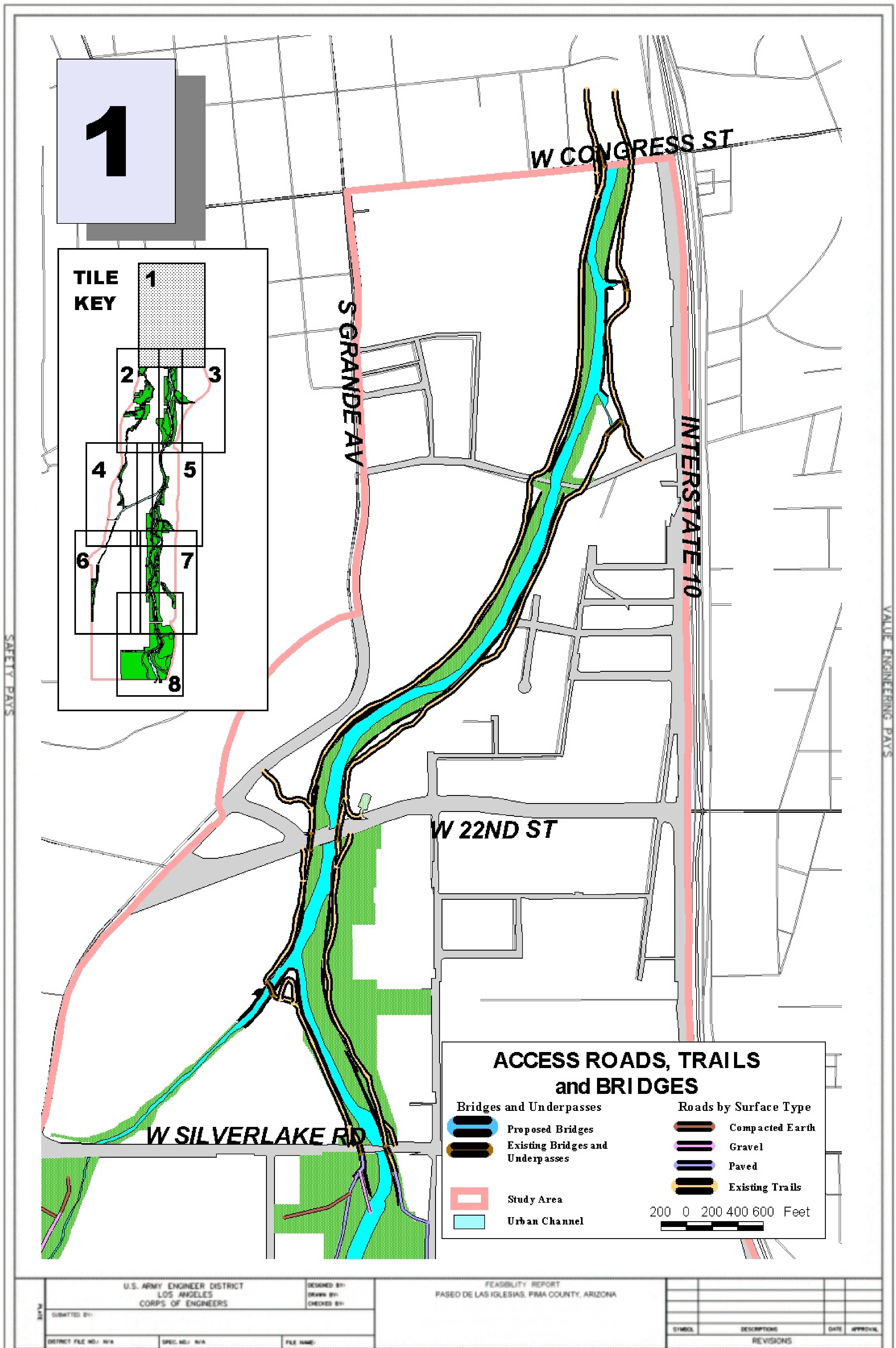
INTERSTATE
Santa Cl
Hughes Was
SAFETY PAYS
VALUE ENGINEERING PAYS
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS
DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY:
PLATE
DISTRICT FILE NO.: N/A
SPEC. NO.: N/A
FILE NAME:
FEASIBILITY REPORT
PASEO DE LAS IGLESIAS, PIMA COUNTY, ARIZONA
SYMBOL
DESCRIPTIONS
DATE
APPROVAL
REVISIONS

Figure 15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TILE KEY
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W CONGRESS ST
S GRANDE AV
INTERSTATE 10
W 22ND ST
W SILVERLAKE RD
ACCESS ROADS, TRAILS and BRIDGES
Bridges and Underpasses
Proposed Bridges
Existing Bridges and Underpasses
Study Area
Urban Channel
Roads by Surface Type
Compacted Earth
Gravel
Paved
Existing Trails
200 0 200 400 600 Feet
SAFETY PAYS
VALUE ENGINEERING PAYS
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS
DESIGNED BY:
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SUBMITTED BY:
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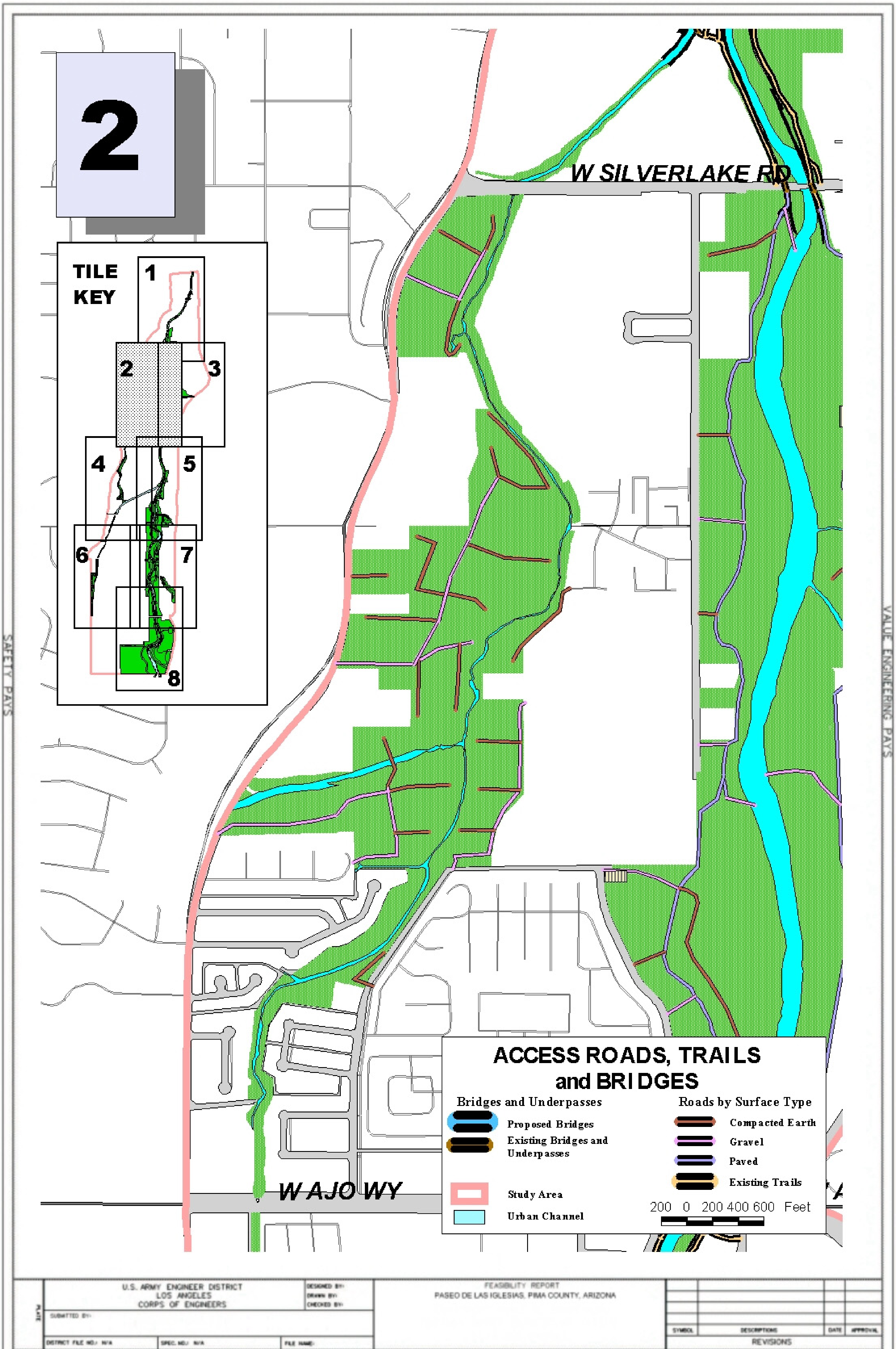
DISTRICT FILE NO.: N/A
SPEC. NO.: N/A
FILE NAME:
FEASIBILITY REPORT
PASEO DE LAS IGLESIAS, PIMA COUNTY, ARIZONA
SYMBOL
DESCRIPTIONS
DATE
APPROVAL
REVISIONS

Figure 16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SAFETY PAYS
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ACCESS ROADS, TRAILS and BRIDGES
Bridges and Underpasses
Proposed Bridges
Existing Bridges and Underpasses
Study Area
Urban Channel
Roads by Surface Type
Compacted Earth
Gravel
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Existing Trails
200 0 200 400 600 Feet
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS
DESIGNED BY:
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DISTRICT FILE NO.: N/A
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FILE NAME:
FEASIBILITY REPORT
PASEO DE LAS IGLESIAS, PIMA COUNTY, ARIZONA
SYMBOL
DESCRIPTIONS
DATE
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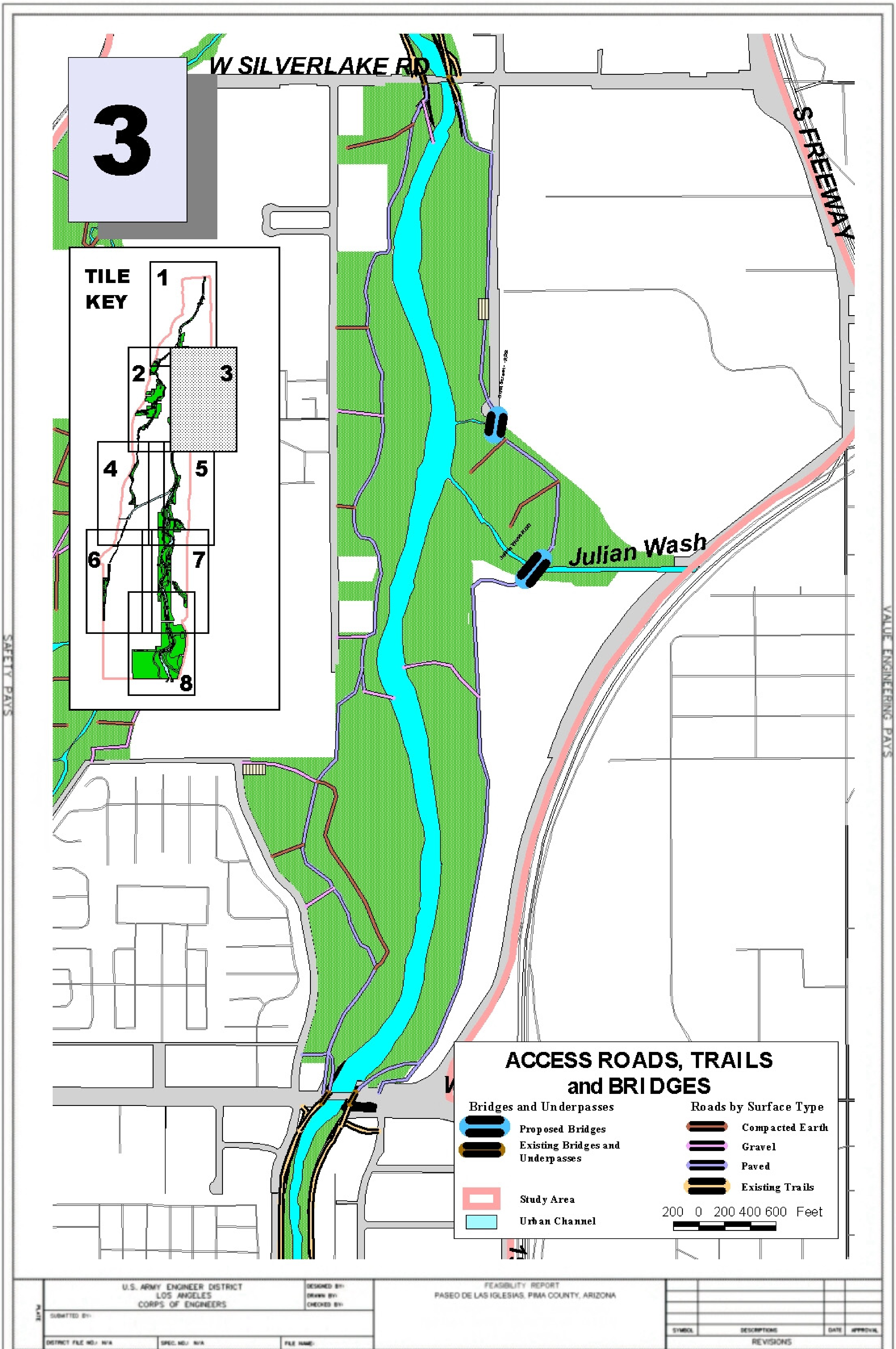
REVISIONS

Figure 17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Julian Wash
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ACCESS ROADS, TRAILS and BRIDGES
Bridges and Underpasses
Proposed Bridges
Existing Bridges and Underpasses
Study Area
Urban Channel
Roads by Surface Type
Compacted Earth
Gravel
Paved
Existing Trails
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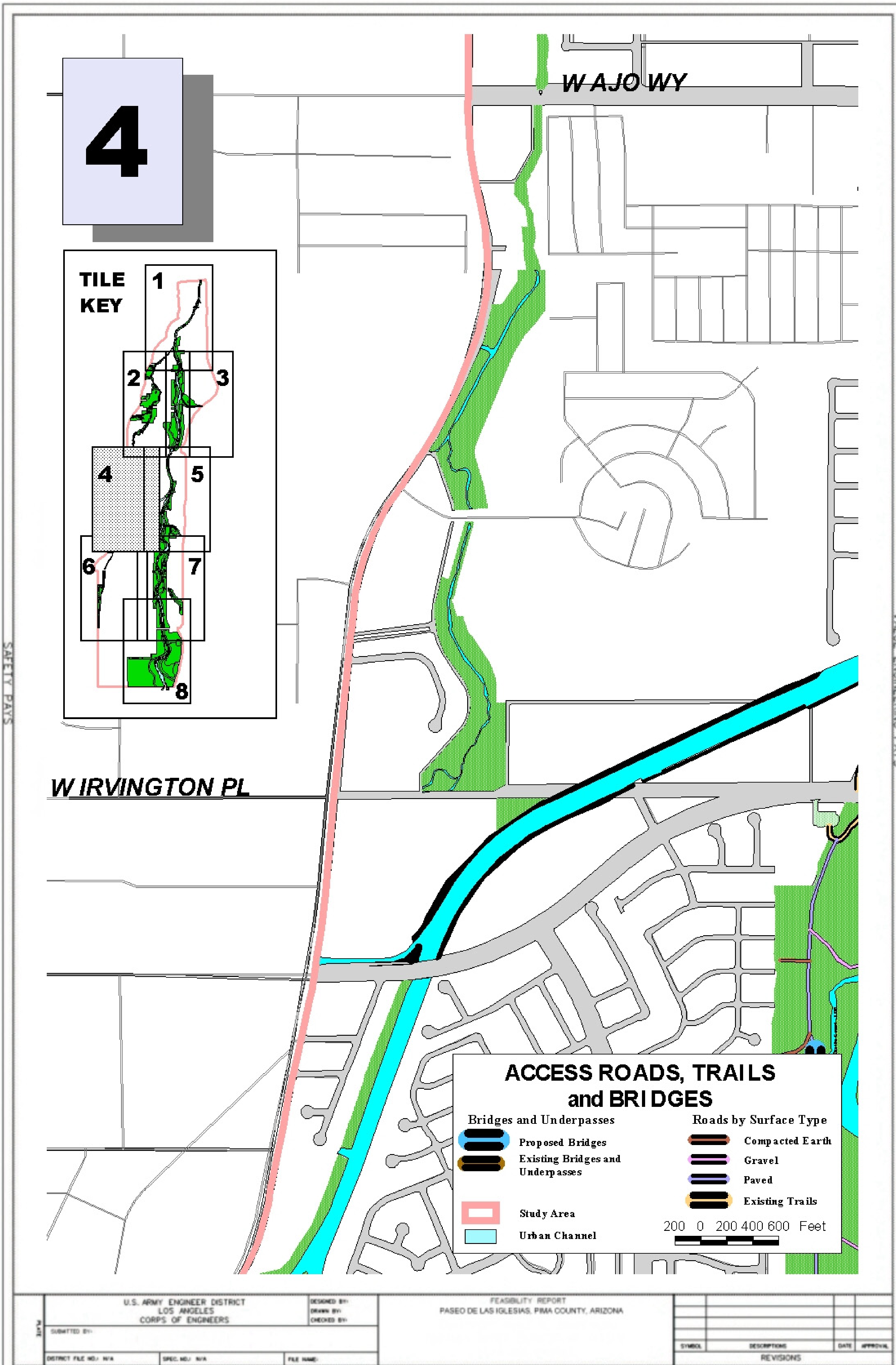
SAFETY PAYS
VALUE ENGINEERING PAYS
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS
FEASIBILITY REPORT
PASEO DE LAS IGLESIAS, PIMA COUNTY, ARIZONA
REVISIONS

Figure 18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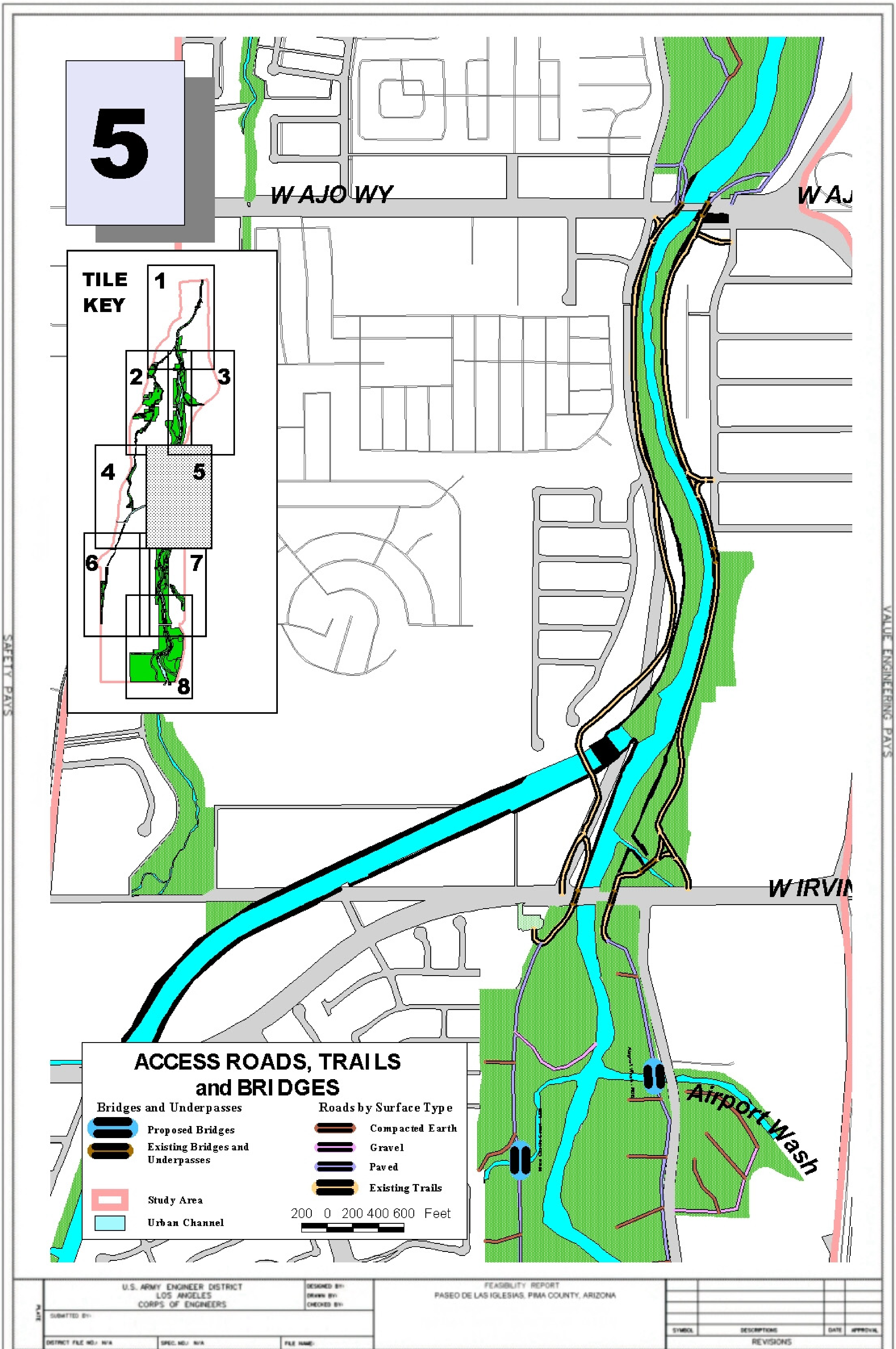
Bridges and Underpasses
Proposed Bridges
Existing Bridges and Underpasses
Study Area
Urban Channel
Roads by Surface Type
Compacted Earth
Gravel
Paved
Existing Trails
200 0 200 400 600 Feet
SAFETY PAYS
VALUE ENGINEERING PAYS
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS
FEASIBILITY REPORT
PASEO DE LAS IGLESIAS, PIMA COUNTY, ARIZONA
REVISIONS

Figure 19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Airport Wash
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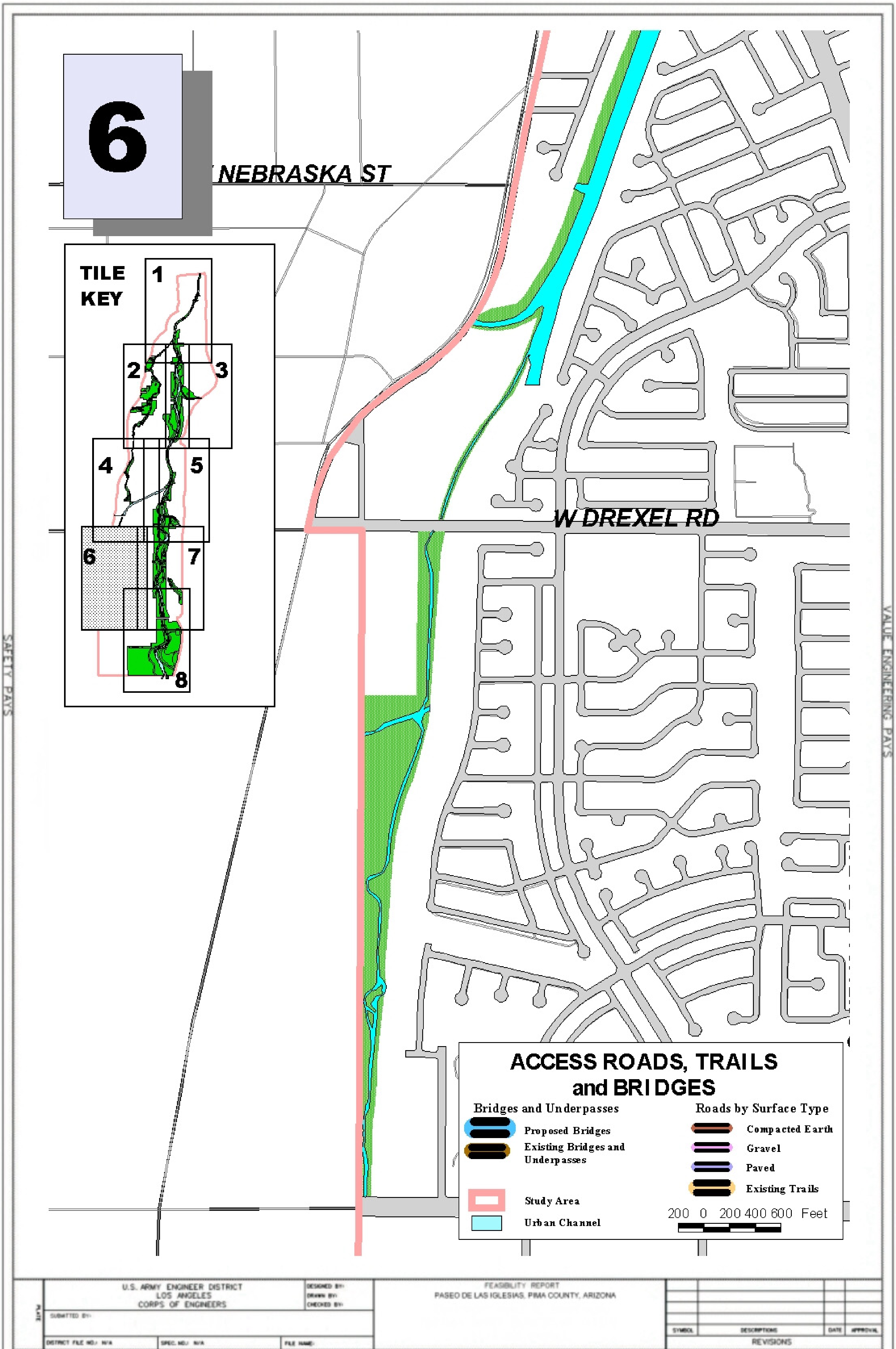
Bridges and Underpasses
Proposed Bridges
Existing Bridges and Underpasses
Study Area
Urban Channel
Roads by Surface Type
Compacted Earth
Gravel
Paved
Existing Trails
200 0 200 400 600 Feet
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS
FEASIBILITY REPORT
PASEO DE LAS IGLESIAS, PIMA COUNTY, ARIZONA
REVISIONS
SAFETY PAYS
VALUE ENGINEERING PAYS

Figure 20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SAFETY PAYS
VALUE ENGINEERING PAYS
ACCESS ROADS, TRAILS and BRIDGES
Bridges and Underpasses
Proposed Bridges
Existing Bridges and Underpasses
Roads by Surface Type
Compacted Earth
Gravel
Paved
Existing Trails
Study Area
Urban Channel
200 0 200 400 600 Feet
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS
DESIGNED BY:
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SUBMITTED BY:
PLATE
DISTRICT FILE NO.: N/A
SPEC. NO.: N/A
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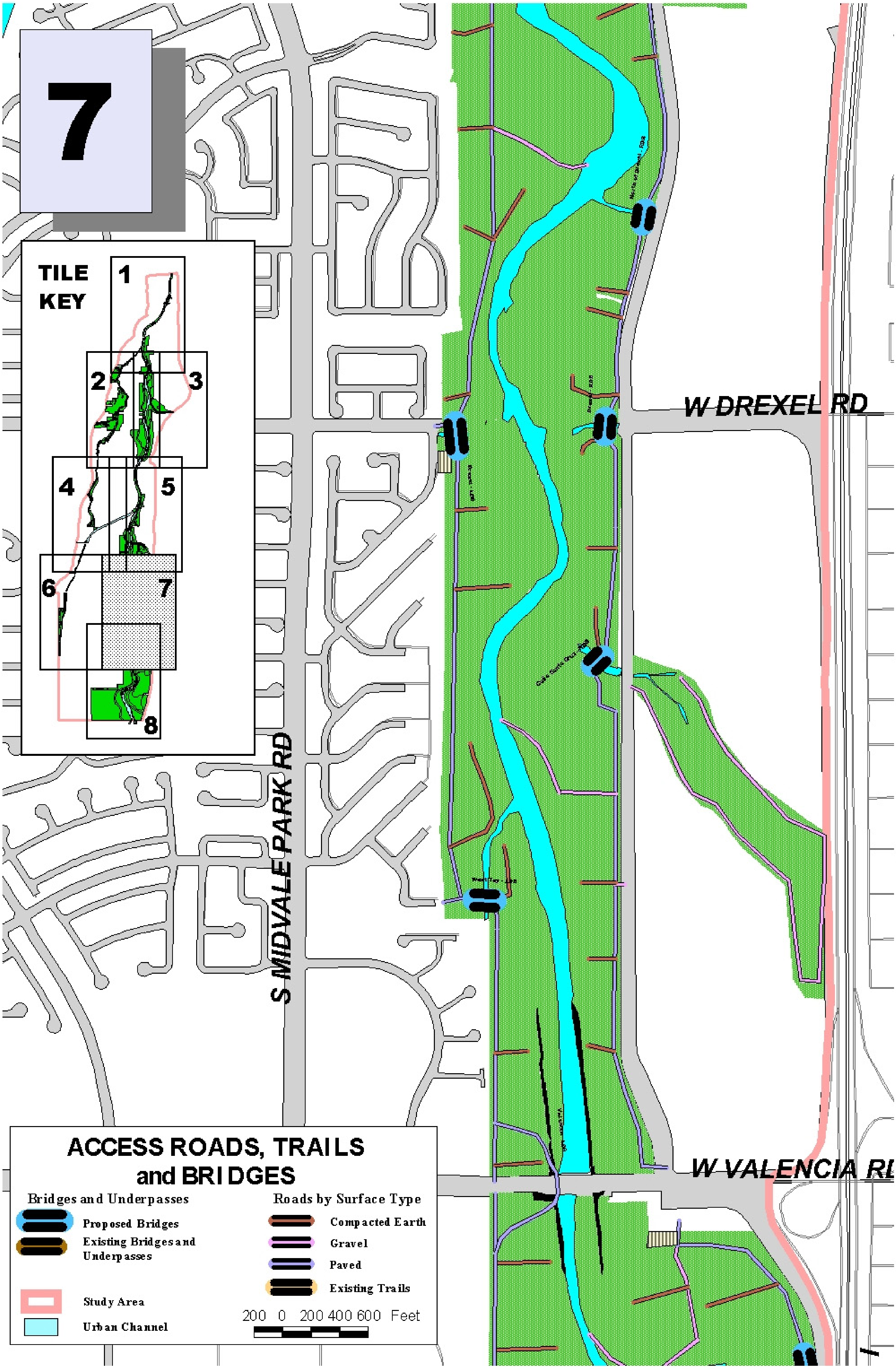
PASEO DE LAS IGLESIAS, PIMA COUNTY, ARIZONA
SYMBOL
DESCRIPTIONS
DATE
APPROVAL
REVISIONS

Figure 21



SAFETY PAYS

VALUE ENGINEERING PAYS

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY:
DRAWN BY:
CHECKED BY:

SUBMITTED BY:

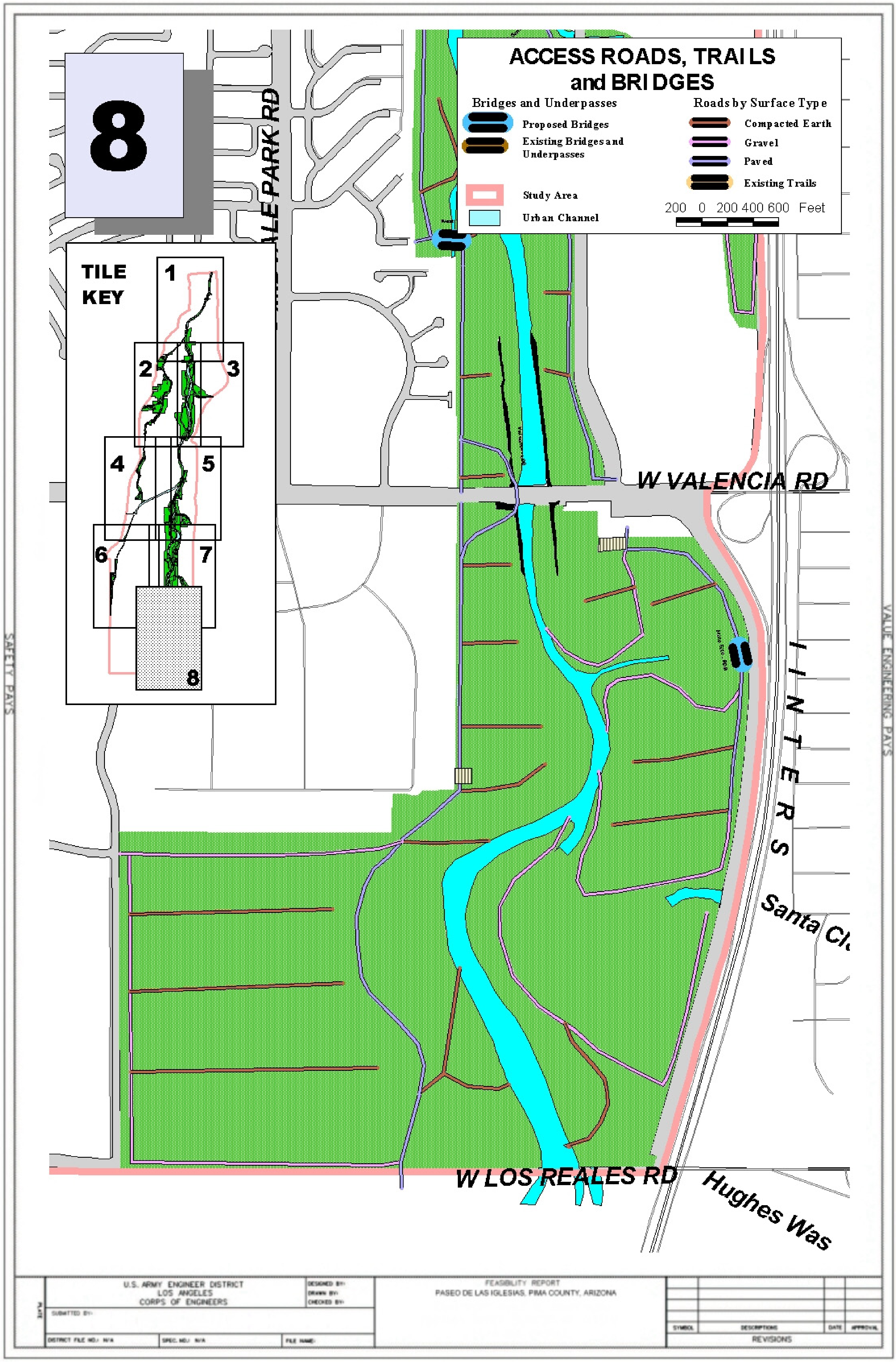
DISTRICT FILE NO.: N/A | SPEC. NO.: N/A | FILE NAME:

FEASIBILITY REPORT
PASEO DE LAS IGLESIAS, PIMA COUNTY, ARIZONA

SYMBOL	DESCRIPTIONS	DATE	APPROVAL

REVISIONS

Figure 22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ACCESS ROADS, TRAILS and BRIDGES
Bridges and Underpasses
Proposed Bridges
Existing Bridges and Underpasses
Study Area
Urban Channel
Roads by Surface Type
Compacted Earth
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Paved
Existing Trails
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W LOS REALES RD
Hughes Was
SAFETY PAYS
VALUE ENGINEERING PAYS
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS
DESIGNED BY:
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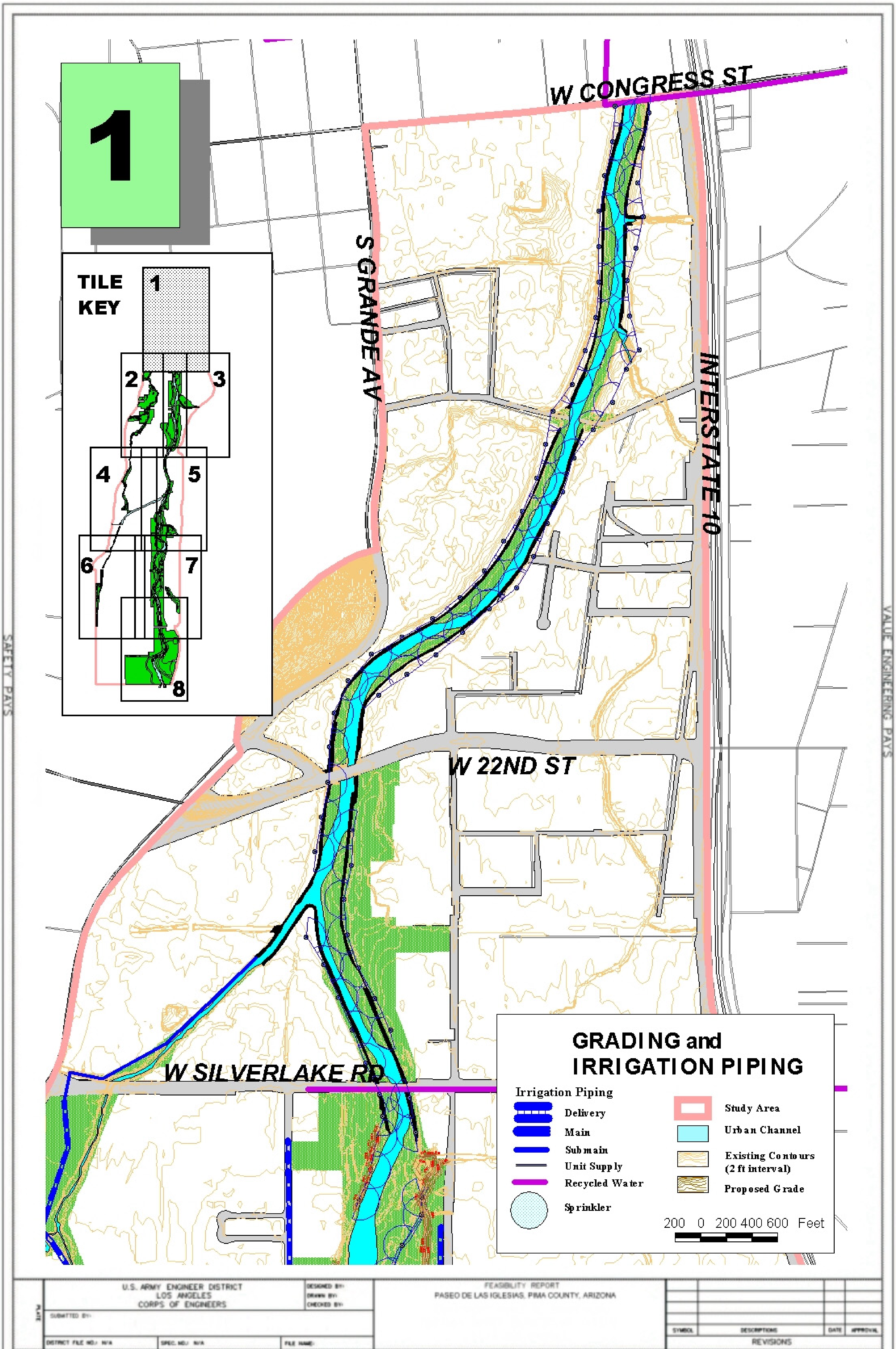
FILE NAME:
PLATE
FEASIBILITY REPORT
PASEO DE LAS IGLESIAS, PIMA COUNTY, ARIZONA
SYMBOL
DESCRIPTIONS
DATE
APPROVAL
REVISIONS

Figure 23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INTERSTATE 10
W 22ND ST
W SILVERLAKE RD
GRADING and IRRIGATION PIPING
Irrigation Piping
Delivery
Main
Submain
Unit Supply
Recycled Water
Sprinkler
Study Area
Urban Channel
Existing Contours (2 ft interval)
Proposed Grade
200 0 200 400 600 Feet
SAFETY PAYS
VALUE ENGINEERING PAYS
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS
DESIGNED BY:
DRAWN BY:
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SUBMITTED BY:
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FILE NAME:
FEASIBILITY REPORT
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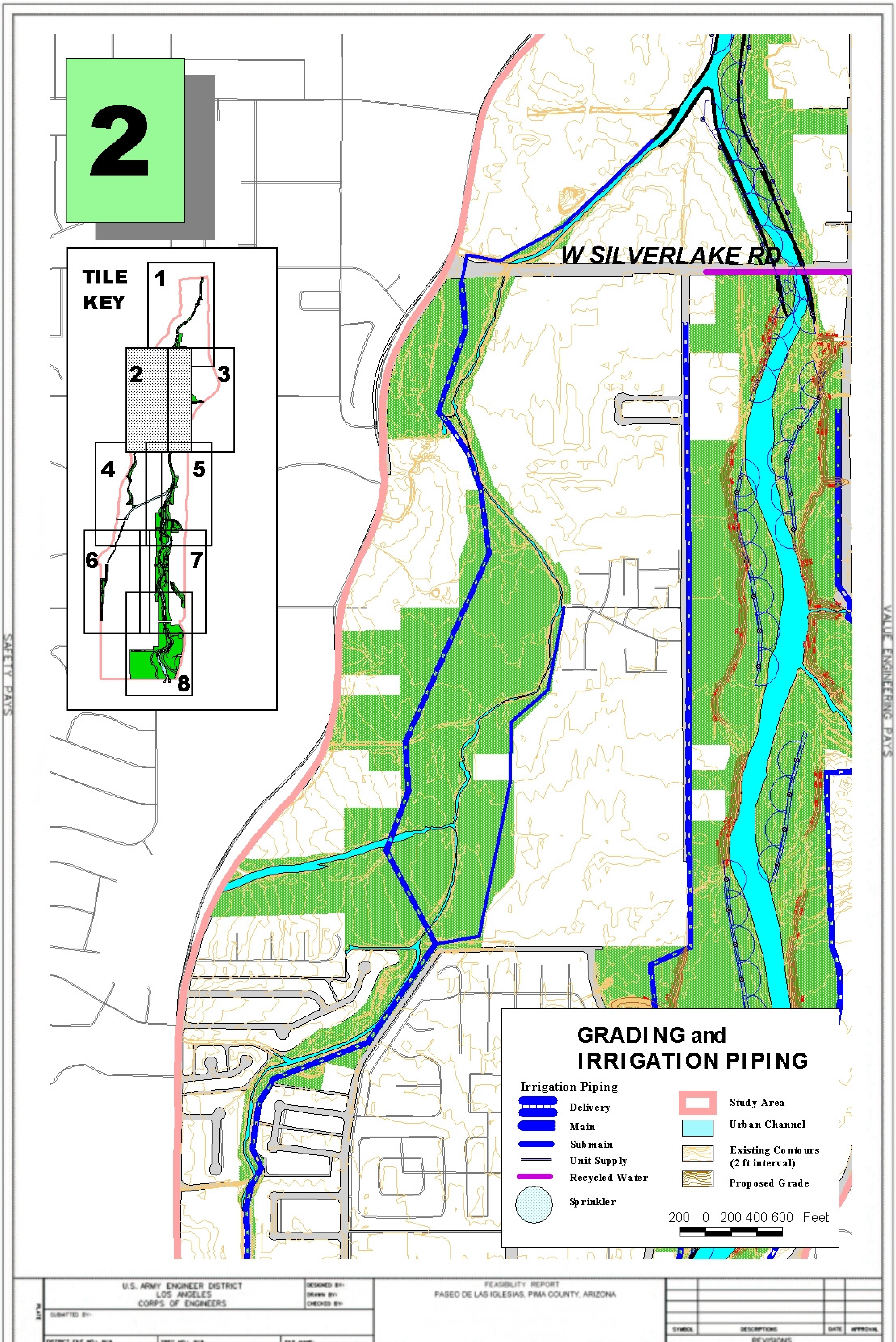
SYMBOL
DESCRIPTIONS
DATE
APPROVAL
REVISIONS
PLATE

Figure 24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GRADING and IRRIGATION PIPING
Irrigation Piping
Delivery
Main
Submain
Unit Supply
Recycled Water
Sprinkler
Study Area
Urban Channel
Existing Contours (2 ft interval)
Proposed Grade
200 0 200 400 600 Feet
SAFETY PAYS
VALUE ENGINEERING PAYS
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS
DESIGNED BY:
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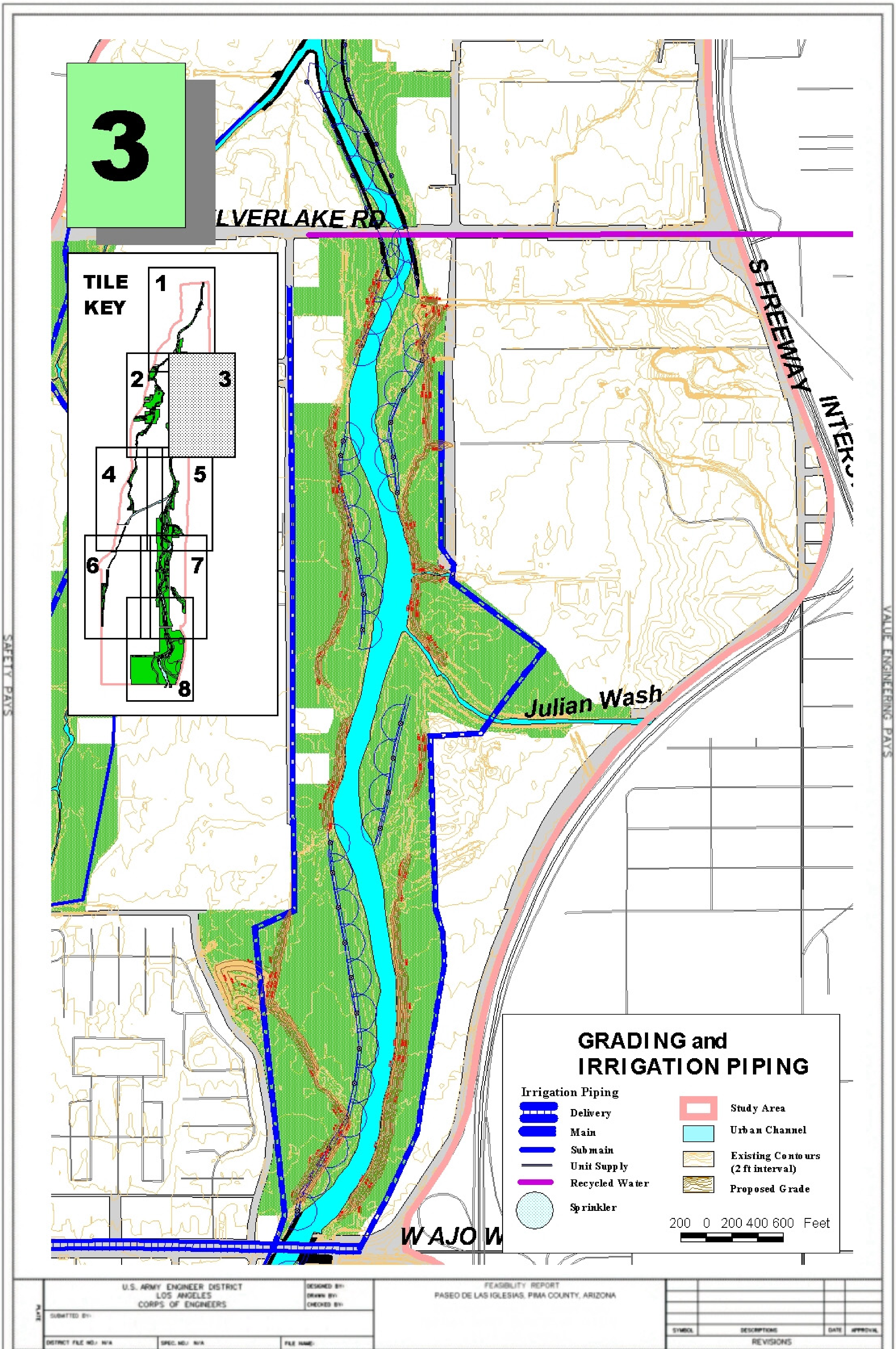
FILE NAME:
FEASIBILITY REPORT
PASEO DE LAS IGLESIAS, PIMA COUNTY, ARIZONA
PLATE
SYMBOL
DESCRIPTIONS
DATE
APPROVAL
REVISIONS

Figure 25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Irrigation Piping
Delivery
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Submain
Unit Supply
Recycled Water
Sprinkler
Study Area
Urban Channel
Existing Contours (2 ft interval)
Proposed Grade
200 0 200 400 600 Feet
SAFETY PAYS
VALUE ENGINEERING PAYS
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS
DESIGNED BY:
DRAWN BY:
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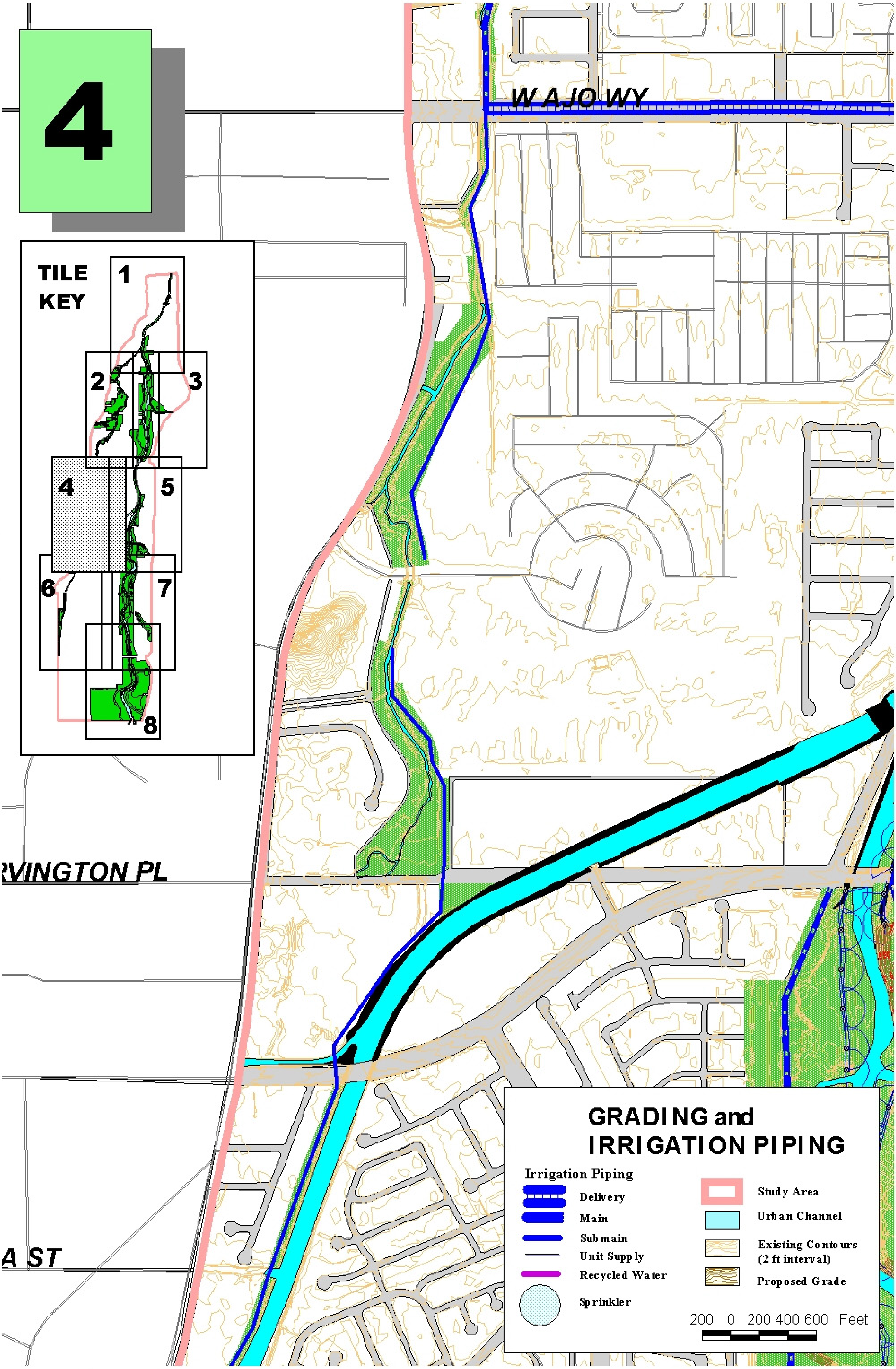
DISTRICT FILE NO.: N/A
SPEC. NO.: N/A
FILE NAME:
FEASIBILITY REPORT
PASEO DE LAS IGLESIAS, PIMA COUNTY, ARIZONA
SYMBOL
DESCRIPTIONS
DATE
APPROVAL
REVISIONS

Figure 26



SAFETY PAYS

VALUE ENGINEERING PAYS

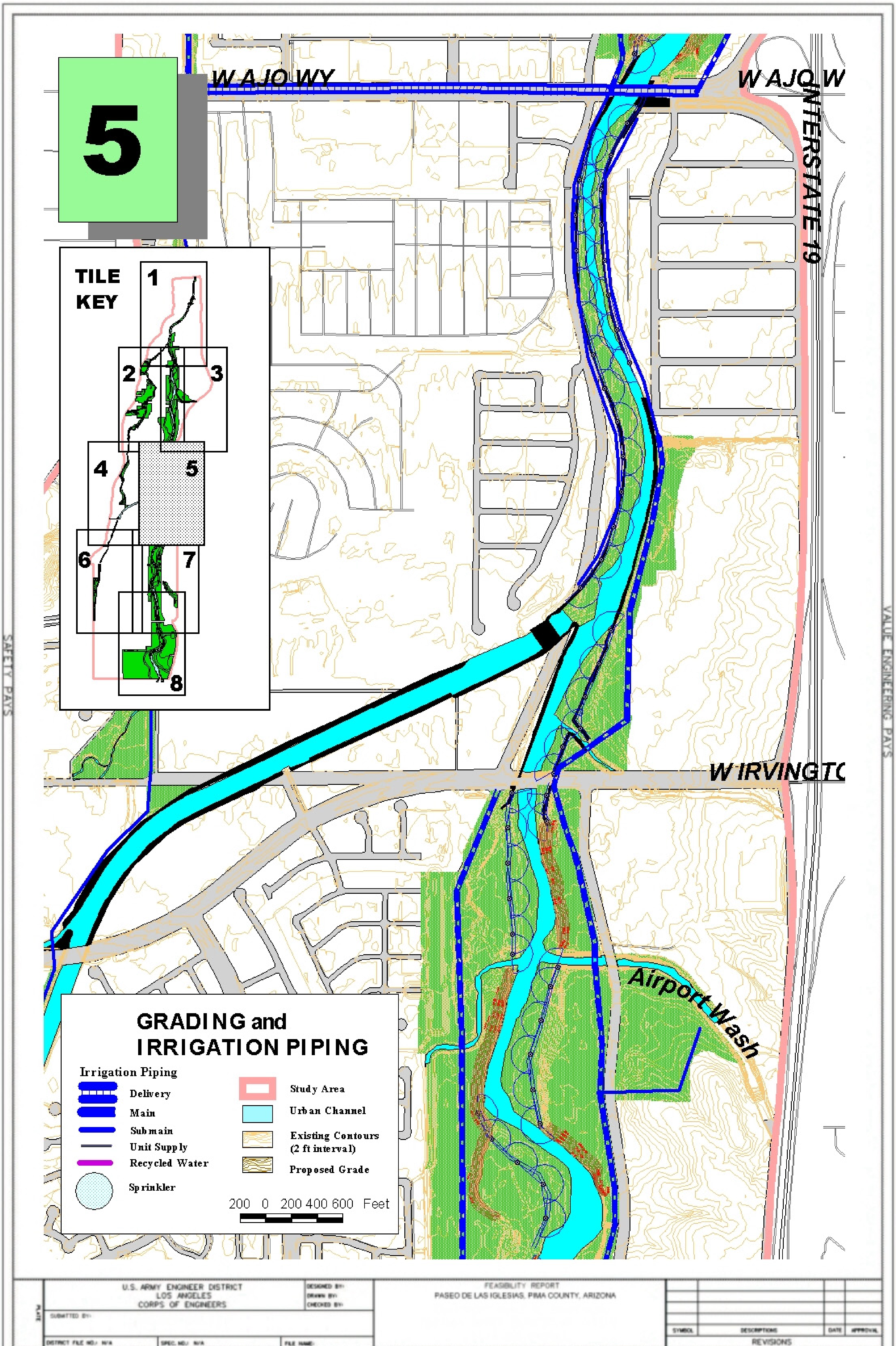
U.S. ARMY ENGINEER DISTRICT LOS ANGELES CORPS OF ENGINEERS	DESIGNED BY: DRAWN BY: CHECKED BY:	FEASIBILITY REPORT PASEO DE LAS IGLESIAS, PIMA COUNTY, ARIZONA
SUBMITTED BY:		
DISTRICT FILE NO.: N/A	SPEC. NO.: N/A	FILE NAME:

PLATE

SYMBOL	DESCRIPTIONS	DATE	APPROVAL

REVISIONS

Figure 27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Airport Wash
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Irrigation Piping
Delivery
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Submain
Unit Supply
Recycled Water
Sprinkler
Study Area
Urban Channel
Existing Contours (2 ft interval)
Proposed Grade
200 0 200 400 600 Feet
SAFETY PAYS
VALUE ENGINEERING PAYS
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS
DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY:
PLATE
DISTRICT FILE NO.: N/A
SPEC. NO.: N/A
FILE NAME:
FEASIBILITY REPORT
PASEO DE LAS IGLESIAS, PIMA COUNTY, ARIZONA
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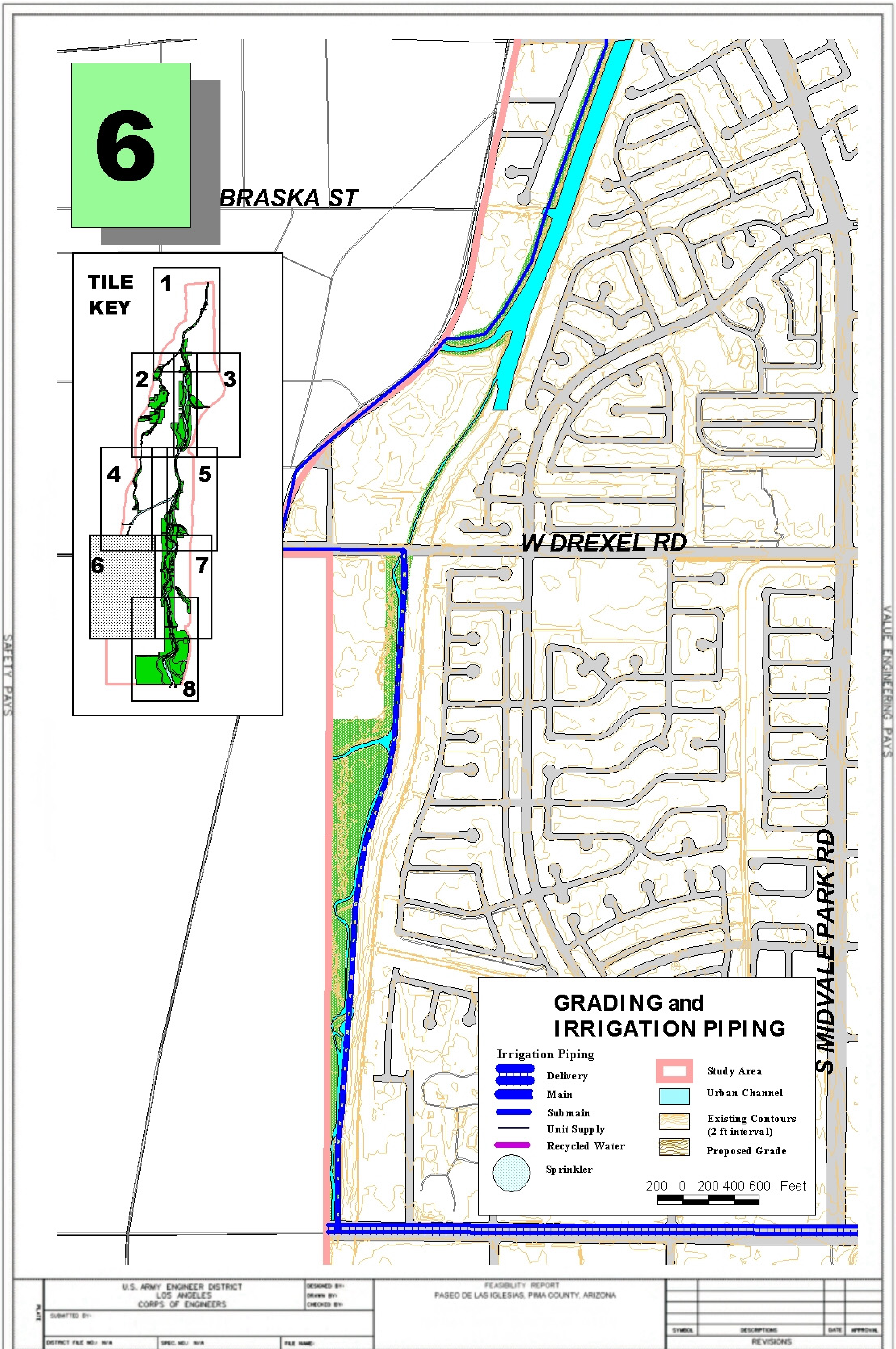
Figure 28


6
BRASKA ST
TILE KEY
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W DREXEL RD
S MIDVALE PARK RD
GRADING and IRRIGATION PIPING
Irrigation Piping
Delivery
Main
Submain
Unit Supply
Recycled Water
Sprinkler
Study Area
Urban Channel
Existing Contours (2 ft interval)
Proposed Grade
200 0 200 400 600 Feet
SAFETY PAYS
VALUE ENGINEERING PAYS
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS
DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY:
DISTRICT FILE NO.: N/A
SPEC. NO.: N/A
FILE NAME:
PLATE
FEASIBILITY REPORT
PASEO DE LAS IGLESIAS, PIMA COUNTY, ARIZONA
SYMBOL
DESCRIPTIONS
DATE
APPROVAL
REVISIONS

Figure 29

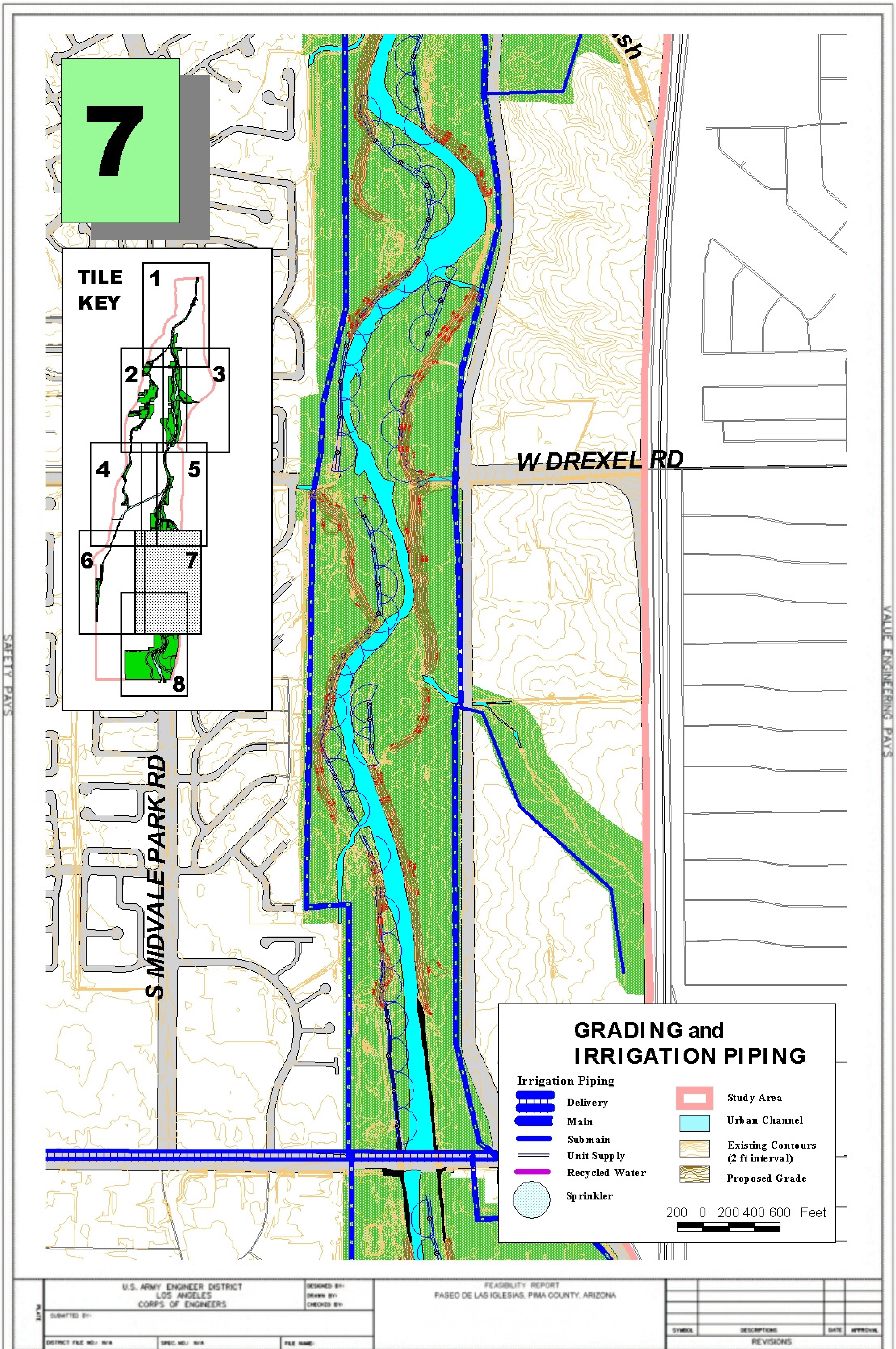
7
TILE KEY
1
2
3
4
5
6
7
8
W DREXEL RD
S MIDVALE PARK RD
GRADING and IRRIGATION PIPING
Irrigation Piping
Delivery
Main
Submain
Unit Supply
Recycled Water
Sprinkler
Study Area
Urban Channel
Existing Contours (2 ft interval)
Proposed Grade
200 0 200 400 600 Feet
SAFETY PAYS
VALUE ENGINEERING PAYS
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS
FEASIBILITY REPORT
PASEO DE LAS IGLESIAS, PIMA COUNTY, ARIZONA
REVISIONS

Figure 30

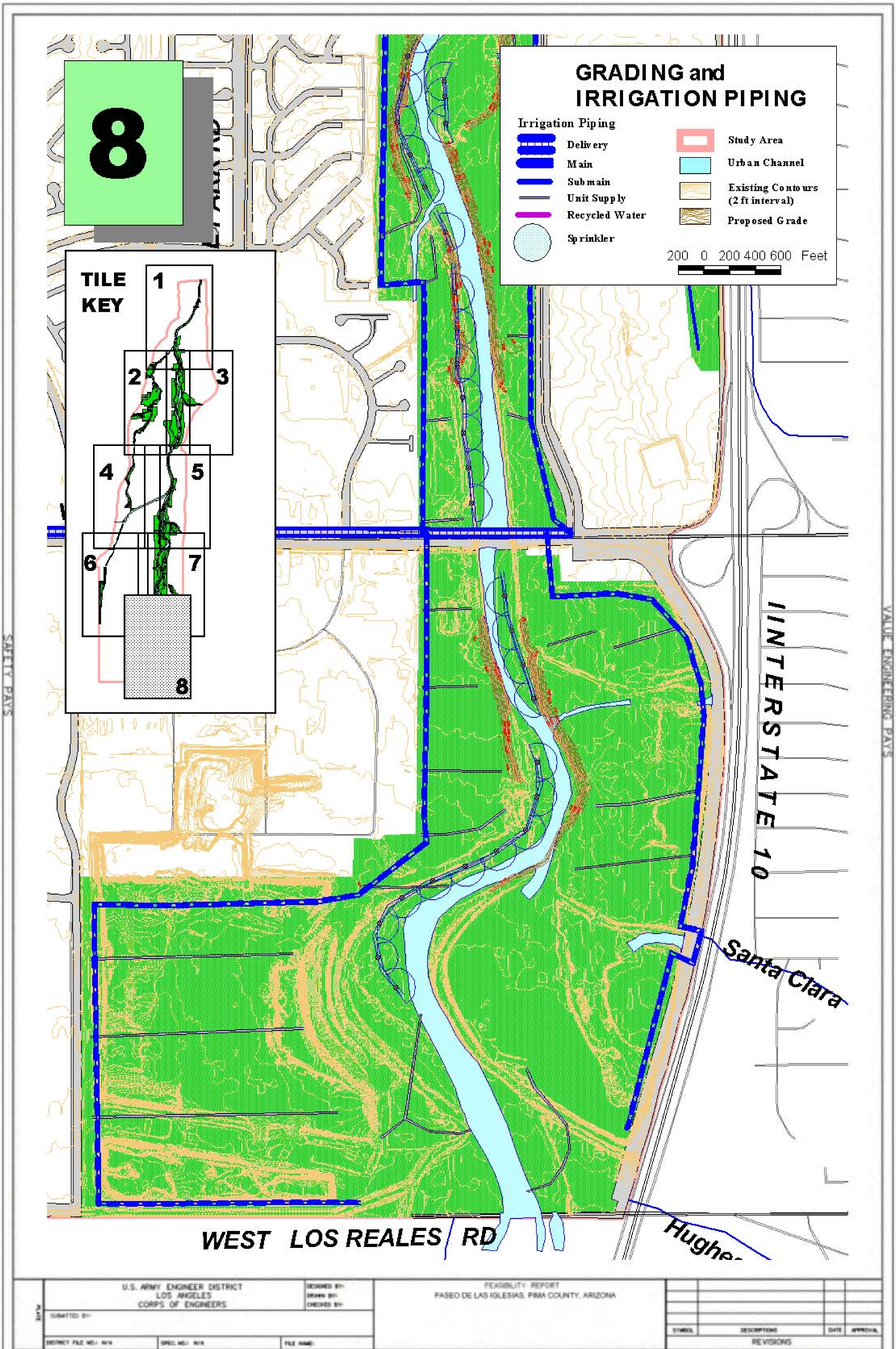
8
TILE KEY
1
2
3
4
5
6
7
8
GRADING and IRRIGATION PIPING
Irrigation Piping
Delivery
Main
Submain
Unit Supply
Recycled Water
Sprinkler
Study Area
Urban Channel
Existing Contours (2 ft interval)
Proposed Grade
200 0 200 400 600 Feet
INTERSTATE 10
Santa Clara
WEST LOS REALES RD
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS
DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY:
DISTRICT FILE NO.: N/A
SPEC. NO.: N/A
FILE NAME:
FEASIBILITY REPORT
PASEO DE LAS IGLESIAS, PIMA COUNTY, ARIZONA
SYMBOL
DESCRIPTIONS
DATE
APPROVAL
REVISIONS
SAFETY PAYS
VALUE ENGINEERING PAYS

Figure 31