FINAL
Work Plan for Rillito River Ecosystem Restoration Project
Areas 2 and 3, Tucson, Arizona

Prepared for

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For submittal to

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2.0 Scope of Work

2.1 Development of a Work Plan for Phase II of the Rillito River Ecosystem Restoration Project

Project Location: Tucson, Arizona.

Task Order (Type 1): Development of Work Plan for the Rillito River Ecosystem Restoration and Environmental Project—Phase II (Areas 2 and 3).

Description of Work and Services: Prepare Work Plan in accordance with the scope of work as follows:

2.1.1 Initial Activities

A. Receive and review project materials including:

   i. To-scale, plan view drawing (hardcopy and electronic files) of project area delineating project boundaries, approved channel design, topography lines, recent aerial photography, existing 3" irrigation mainline, proposed hardscape elements (e.g., trailhead, parking, turn-around), and existing hardscape elements (e.g., curbs, paving, soil cement, railings, pedestrian bridge). Site plan information will be provided to RECON for both Areas 2 and 3. Preferred scale for hardcopy plan sheets is 1"=100'.

   ii. Ecosystem Restoration Report and Environmental Assessment.

   iii. Project description and objectives.

   iv. Standard specifications

B. Meet with client and agency representatives to discuss approach and general schedule.

C. Review As-Built Irrigation Plans and confirm if the existing 3" irrigation mainline is adequate for project irrigation needs (without depleting volumes needs for Area 1). If larger piping is required, review proposed needs with client and agency representatives. Field work verifying depth of cover, capacity of lines, and accuracy of As-Built Plans is not included in RECON'S Scope of Work; such information will be obtained and verified by Macro-Z Technology (MZT) or Pima County and provided to RECON.

2.1.2 Site Reconnaissance

A. Conduct a site visit to walk the field-staked location of the proposed channel edges (staking or otherwise marking the channel edges will be performed by MZT beforehand). Discuss concepts for any additional grading that may be desirable to achieve on-site stormwater harvesting.

B. Project biologists to confirm previously identified areas of potentially sensitive vegetation and native amphibian habitat and to locate, map, and catalogue specific vegetation proposed for preservation in place. Identify the various plant communities currently occurring on-site.

C. Perform plot (relevé) vegetation sampling surveys (at least two per vegetation community). This data shall be used to determine plant species composition, diversity, density, and cover for the plant communities to be restored.

D. Permanent Transects: Identify vegetation monitoring transect locations, permanently mark the endpoints using rebar and caps, and record the locations of the permanent markers using a global positioning system (GPS) unit. Photograph each sampling site. These transects will be located in a manner to capture existing site conditions and provide a comparison baseline for monitoring once the project has been installed.

E. Identify areas and species of invasive and/or exotic plants, which would be proposed for removal.

F. Hazardous Materials: No activities relating to hazardous materials, soil or groundwater contamination identification, investigation, or assessment are included in this Work Plan preparation effort.

G. Cultural Resources: No activities relating to cultural resources identification, investigation, or assessment are included in this Work Plan preparation effort.

2.1.3 Reporting

A. Prepare a written summary of estimated plant densities and plant cover within the various communities, comprehensive lists of native plant and invasive exotic species, and recommendations for plant community restoration.

B. Prepare a written plan indicating weed removal methods and criteria to indicate successful control. This information may be incorporated into the Planting Plan.

2.1.4 Monitoring Plan

Develop an ecosystem restoration monitoring plan identifying monitoring tasks required during and after project staging, clearing, construction, and installation. Describe required tasks such as designating resources not to be impacted by construction, directing seed collection and plant production, inspecting materials, directing planting, monitoring for invasive species, recommending weed control methods, monitoring for restoration success, developing remedial actions to address any problems encountered in the field, and coordinating with the U.S. Army Corps of Engineers (USACE), resource agencies, and Pima County.

2.1.5 Maintenance Schedule and Guidelines

Prepare a summary of basic maintenance practices that would be necessary to establish the plantings, avoid unwanted plant invasions, and ensure adequate operation of irrigation system during the establishment period. Include a seasonal maintenance schedule.

2.1.6 Drawings/Sketches

A. Planting Plan and Details: Prepare a Planting Plan that includes a site description, restoration approach, site preparation techniques, planting species/density list, seeding species/quantities list, map showing plant community planting locations, notes regarding plant establishment period maintenance and monitoring, five-year maintenance and monitoring, success criteria, and reporting schedule. Develop a template for each distinct plant community shown in the Planting Plan. Provide template drawings with sufficient detail to show the species and quantities of plantings for representative areas. Prepare necessary details to describe methods and materials for installation of plant materials. Enhance existing native vegetation by removal of non-natives followed by supplemental planting.

B. Irrigation Plan and Details: Prepare an Irrigation Plan to support the specified plant materials and communities through their establishment period. Identify, locate, and specify irrigation system components including irrigation mainline, meter if desired by Pima County, valves, piping, and all necessary components. Prepare a template in sufficient detail to show the layout of piping and components required by various representative areas. Prepare necessary details to describe methods and materials for irrigation system and components installation.

C. Grading Plan: Develop a conceptual grading plan that provides a naturalistic drainage pattern that will allow for passive water harvesting elements (e.g., basins and swales). This concept plan is not intended to alter the approved channel design, but rather to address other areas of the site that have previously altered topography

and are lacking native trees and shrubs. Any grading or contouring proposed by this concept plan shall result in slopes generally less steep than 3:1 and shall not impact areas of existing vegetation identified for preservation in-place. The conceptual grading plan will be described by diagrammatic plan view and cross-section sketches and by notes.

D. Drawings/sketches shall be prepared using ARCView and Microstation format. The dimensions of a full-size drawing will be approximately 24”x36” with USACE title blocks. The line weights will be sized to be clearly readable when reduced to 11"x17".

2.1.7 Specifications

Prepare specifications for demolition, earthwork, clearing and grubbing, planting, seeding, temporary protective fencing, soil amendment and site preparation, dust suppression, invasive plant removal, erosion control, and irrigation system.

2.1.8 Preliminary Work Plan Document

Compile items above into a bound Preliminary Work Plan document. Submit to MZT for review and comment. Prepare one set of revisions and resubmit to MZT for their submittal to the USACE.

2.1.9 Final Work Plan Document

Incorporate USACE comments from Draft Work Plan and submit a Final Work Plan.

2.1.10. Team Meetings

Prepare for and attend six team meetings to discuss project progress and review project materials.

2.1.11 Public Meetings

Attend one public meeting and provide plan view drawings of the proposed ecosystem restoration plan.

2.1.12 Additional Services

If meetings, reports, plans, maps, research, field work, hardscape design (walls, paving, etc.), additional revisions, or other services not specified above (including the collection or planting of seeds, cuttings, and other plant materials) are deemed necessary by the USACE Environmental Manager or local sponsor, these would require additional

authorization by USACE and are not to be considered a part of this “Basic Scope of Work.” Such tasks will be performed and billed as additional services in accordance with the rate schedule.

3.0 Site Investigation and Study Results

3.1 Vegetation Characterization

RECON biologists conducted site vegetation characterization during September 2006 for the development of this Work Plan and to establish the long-term monitoring program. Two different field methods were utilized (relevés and transects) as described below. Locations of the relevés and transects are shown in Figures 1 and 2.

3.1.1 Relevés

Biologists sampled vegetation using the relevé method (Mueller-Dombois and Ellenberg 1974) in all existing plant communities within the project area. This method involves the placement of temporary 7-meter radius circular plots (relevés) in all vegetation communities (or discrete entities). Within each relevé, all species present were identified and assigned a cover and abundance value from the Braun-Blanquet Scale of Cover and Abundance (Mueller–Dombois and Ellenberg 1974). Data collection forms are presented in Attachment A. A total of 12 relevés were established in Areas 2 and 3. These data (Attachment B) have been used to help determine appropriate seed mix species as well as to assist in the identification of invasive species management issues.

3.1.2 Transects

Cover, density, and diversity are parameters that will reflect the habitat value of the restored vegetation communities within the project area. Monitoring of these parameters will track how the restoration effort performs over time.

Eight permanent monitoring transects (50 meters in length) were established throughout the project area. Transect locations were chosen to capture the range of pre- and post-restoration vegetation communities. The start and end points of each transect are marked in the field with rebar stakes including labeled orange plastic safety caps as well as Universal Transverse Mercator (UTM) coordinates (Table 1). Once the project has been implemented, it may be appropriate to add additional monitoring transects at the discretion of the Habitat Restoration Specialist, especially within the riparian corridors.

Monitoring transects were evaluated according to the point intercept method. This method is easily repeatable (any two people should get similar results), easy to learn, and efficient. Measuring cover by this method is also considered to be the least biased of typical methods (Bonham 1989; Barbour *et al.* 1987). The method is based on a 50-

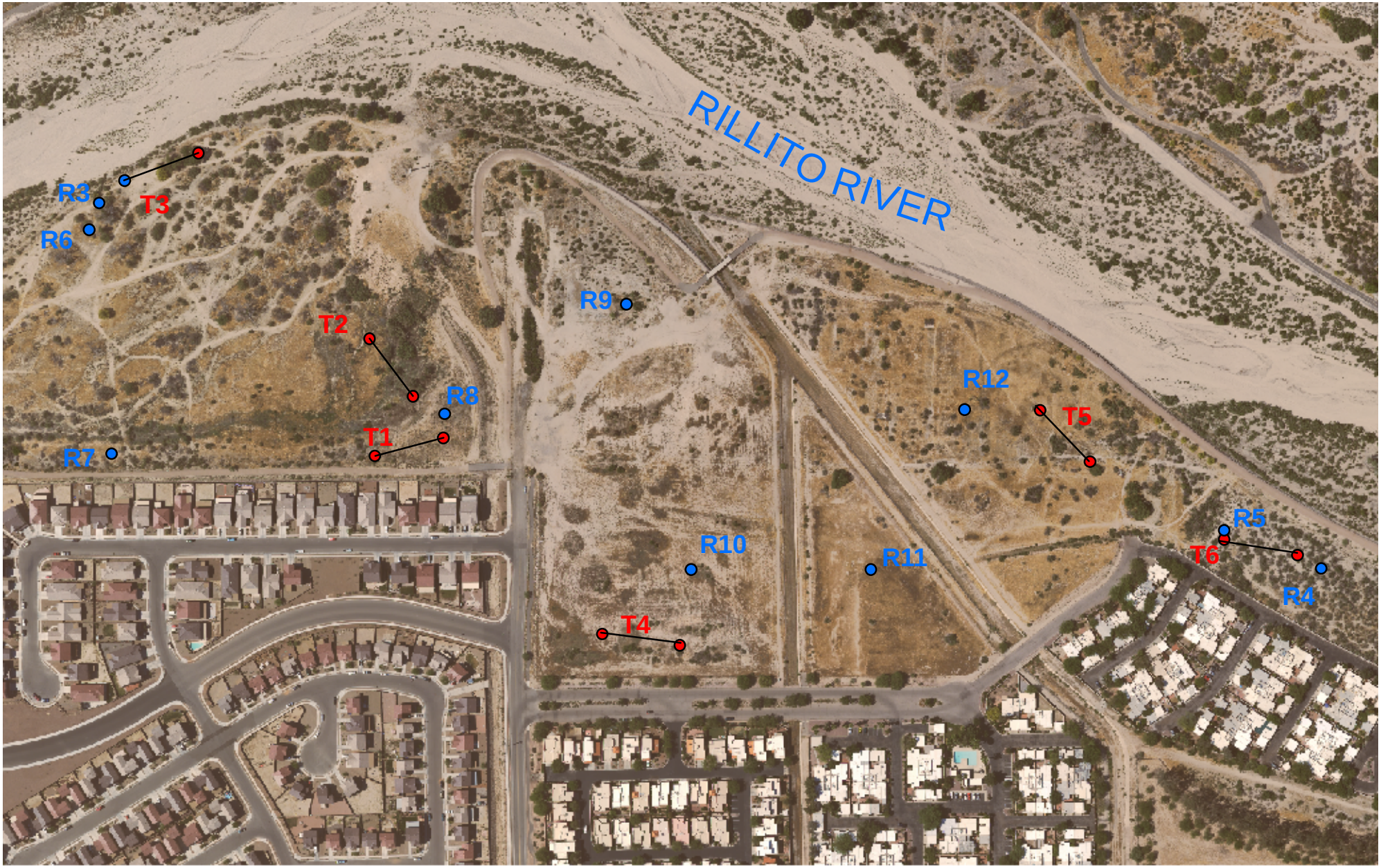


FIGURE 3-1: RILLITO RIVER ECOSYSTEM RESTORATION TRANSECT & RELEVE LOCATIONS* - AREA 3

LEGEND

- Transect End Points
- Releve Point

0 75 150 300 450 600 Feet

E

RECON

*Transects will be utilized in the long-term monitoring of the project. Releves are temporary and used to inform the selection of the seed mix (see Planting Plan for details).

FIGURE 3-2: RILLITO RIVER ECOSYSTEM RESTORATION TRANSECT & RELEVE LOCATIONS* - AREA 2

LEGEND

Transect End Points

Releve Point

0 75 150 300 450 600 Feet

RECON

*Transects will be utilized in the long-term monitoring of the project. Releves are temporary and used to inform the selection of the seed mix (see Planting Plan for details).

meter point transect centered on a 2×50-meter plot. Using this method, vegetation is sampled by points at 0.5-meter intervals along the 50-meter transect to determine cover. The surveyor will note the species encountered at each interval (see Attachment C, transect data form). In addition, individuals of each perennial species rooted within the 2×50-meter plot will be counted to determine shrub density and diversity. All annuals present in the 2×50-meter plot will also be noted.

Vegetation sampling will be repeated annually during the month of August or September, beginning in the second year of project implementation, to record maximum species diversity and maintain consistency between years. Baseline data were collected in September of 2006 and are presented in Attachment D.

TABLE 3-1
TRANSECT DESCRIPTIONS AND LOCATIONS

Transect	Pre-Restoration Vegetation Community	Transect Start UTM (NAD 1927)	Transect End UTM (NAD 1927)
1	Previously Graded and Seeded	0509266 E 3570651 N	0509220 E 3570639 N
2	Weedy Basin	0509246 E 3570679 N	0509217 E 3570718 N
3	Degraded Riparian	0509103 E 3570844 N	0509053 E 3570826 N
4	Disturbed	0509372 E 3570113 N	0511257 E 357012 N
5	Disturbed	0511023 E 3570518 N	0509424 E 3570510 N
6	Natural	0509791 E 3570578 N	0509840 E 3570567 N
7	Disturbed	0510613 E 3570132 N	0510662 E 3570123 N
8	Weedy Basin	0510656 E 3570150 N	0510704 E 3570147 N

3.1.2.1 Photo Monitoring

Each sampling site will be photographed during February–March, as well as during September–October transect monitoring period. This photographic monitoring schedule will capture seasonal changes in the flora. At each transect start point, photographs will be taken at due north and south directions; at the transect end points, photographs will be taken at due east and west directions (Table 2). This will result in 64 photos per year.

TABLE 3-2
PHOTOGRAPHIC MONITORING SCHEDULE

Years 1–5	Transect Start	Transect End
Feb–March	Photos Due North and South	Photos Due East and West
Sept–Oct	Photos Due North and South	Photos Due East and West

Baseline photos were taken in September 2006 and are archived on a CD (Attachment D).

3.1.2.2 Summary of Baseline Transect Data

A summary of the baseline transect data (collected in September 2006) is presented in Table 3. One trend is that the areas that have been left undisturbed or that were seeded previously (Transects 1, 3, 5, 6, and 7) have lower cover values and lower percentage of species for invasive exotics. The weedy basin areas (west of Columbus and in Area 2) have the highest values for invasive exotic species.

TABLE 3-3
BASELINE TRANSECT DATA SUMMARY (SEPTEMBER 2006)

	Area 3						Area 2	
	1: Seeded Area West of Columbus	2: Weedy Basin West of Columbus	3: Degraded Riparian	4: Disturbed Area East of Columbus	5: Natural Area, East Part of Area 3	6: Natural Area, East part of Area 3	7: Above Basin	8: Weedy Basin
% Total Cover (includes annuals and perennials)	59%	80%	62%	72%	84%	56%	65%	81%
% Perennial Cover	34%	44%	61%	23%	11%	56%	31%	62%
% Exotic Invasive Cover	4%	41%	2%	23%	0%	1%	6%	52%
Number of Species on transect	14	17	9	12	7	6	14	16
% of Species Exotic Invasives	7%	53%	11%	25%	0%	17%	14%	44%

Attachment A
Relevé Data Form

RILLITO RIVER ECOSYSTEM RESTORATION AND ENVIRONMENTAL PROJECT, AREAS 2 & 3

RELEVÉ DATA FORM

Date: Personnel:

UTM Coordinates (NAD 1983):

_____E _____N

Location:

Vegetation Entity: Relevé#:

Notes:

Woody Species Present (Cover and Abundance Rating)

Herbaceous Species Present (Cover and Abundance Rating)

Attachment B
Relevé Data

Relevé Data
(October 2006)

	Braun-Blanquet Cover and Abundance Rating											
Species	**#1**	**#2**	**#3**	**#4**	**#5**	**#6**	**#7**	**#8**	**#9**	**#10**	**#11**	**#12**
Allionia incarnata		1							0.75			
Amaranthus fimbriatus		1	1		0.75	0.75			2			
Amaranthus palmeri		1	0.75			1	2					1
Amaranthus sp. (prostrate)		0.75										
Ambrosia ambrosioides		0.75			0.5							
Ambrosia deltoidea								1				
Aristida purpurea	1	0.75			0.5			1	0.75	0.75		
Atriplex canescens								1				
Atriplex polycarpa								2				
Baccharis sarothroides	2	2	1	2	1		2		2	3	2	
Boerhaavia coccinea	2		0.75	0.75			0.5	2	0.75			
Boerhaavia coulteri			0.75						0.75	0.75	1	1
Bouteloua aristidoides	2		0.75			0.75	2		2	2	3	2
Bouteloua barbata									0.75	1		
**Brassica sp. ?*			1									
Brayulinea densa			0.5									
**Cenchrus sp.*		0.75										
Chloris virgata		0.75					0.5			1		
Cuscuta sp.	0.5											
**Cynodon dactylon*		2	1		0.75	0.5	0.5		1	4	3	
Datura spp.	2	2	1		2		0.5					
Digitaria californica							0.5					
**Echinochloa colonum*		1	0.75		0.75	0.75			0.5			
Encelia farinosa								2				
**Eragrostis lehmanniana*	0.5	3	1			2	2		0.75			
**Eragrostis cilianensis*		0.75	0.75			0.75	0.75		0.75			
Eriochloa acuminata		0.75				0.5			0.5	1		

Relevé Data
(October 2006)
(cont.)

	Braun-Blanquet Cover and Abundance Rating											
Species	**#1**	**#2**	**#3**	**#4**	**#5**	**#6**	**#7**	**#8**	**#9**	**#10**	**#11**	**#12**
**Eriodium cicutarium*		0.75	0.75							0.75		
Erioneuron pulchellum							0.5					
Euphorbia sp.	2	1	0.75		0.75		0.5		0.5	0.75		
Galium sp.			0.5									
Glandularia gooddingii		0.5				0.5						
Gossipium thurberi	1		0.5									
Guardiola platyphylla		0.5										
Gutierrezia sarothrae				0.75								
Hymenoclea monogyra	1	0.75	2	3	1		2					1
Hymenothrix wislizenii				0.75	0.5				0.75			
Ipomoea barbatisepala			0.5									
Isocoma tenuisecta	1	1										
**Lactuca serriola*		0.5										
Larrea tridentata								3				
Leptochloa dubia		0.75	0.75									
Leptochloa filiformis		0.75				0.5						
Machaeranthera tana			0.75									0.75
Mimosa acuelatacarpa	1											
Muhlenbergia porteri			0.75									
Sporobolis contractus		0.75	0.75									
Nama sp.		0.75	0.75			0.75						
Nicotiana obtusifolia		0.75	0.75			0.75						
**Enneapogon cenchroides*					0.75		0.5			1	3	1
**Parkinsonia aculeata*			1					1				
Parkinsonia florida	2		2			2						
Pectis papposa					0.5							
**Pennisetum ciliare*		2			0.75	0.5	0.5	1	1	1	1	
Phoradendendron sp.			0.5									

Relevé Data
(October 2006)
(cont.)

	Braun-Blanquet Cover and Abundance Rating											
Species	**#1**	**#2**	**#3**	**#4**	**#5**	**#6**	**#7**	**#8**	**#9**	**#10**	**#11**	**#12**
Physalis spp.			0.5							0.75		
Populus fremontii			3			3						
Portulaca sp.			1		1	1	2	2	1	1	1	2
Proboscidea parviflora	1											
**Prosopis sp.* (S. American)	1											
Prosopis velutina	1			1	1	2			2			
**Salsola sp.*					0.75		0.5	0.75	0.75	0.75		
Sarcostemma cynanchoides		0.75						0.75	1			
**Cyperus esculenta*		0.75	0.75		0.75	0.5						
Senna covesii	1								1			
Setaria macrostachya			1									
**Sisymbrium irio*		0.75	0.75			0.5	0.5					
Solanum eleagnifolium	0.75											
**Sorghum halapense*		1	1		1	1	1					
Sporobolis cryptandrus							0.5					
**Tamarix sp.*									3			
Tidestromia lanuginosa	2	1	0.5		0.75		0.5	2	1	0.75	1	3
Verbesina enceliodes		0.5	0.5		0.75		2					2
**Xanthium strumarium*		1			1	0.5						
Zizyphus obtusifolia			0.5									

Braun-Blanquet scale of cover and abundance	
5	**Any number, 75 - 100% cover**
4	**Any number, 50 - 75% cover**
3	**Any number, 25 - 50% cover**
2	**Any number, 5 - 25% cover**
1	**Scattered, 1-5% cover**
0.75	**seldom (more than 1) with insignificant cover**
0.5	**solitary, with insignificant cover**

* An invasive, non-native plant

Attachment C
Transect Data Form

RILLITO RIVER ECOSYSTEM RESTORATION AND ENVIRONMENTAL PROJECT, AREAS 2 & 3

TRANSECT DATA FORM

Date: Personnel:
UTM Coordinates (NAD 1983):
Start: E N
End: E N
Location:
Vegetation Entity: Transect #:
Photos taken?
Start (due north and south) **Y or N**
End (due east and west) **Y or N**
Notes:

I. POINT-INTERCEPT DATA

Point (m)	Species
0.5	
1.0	
1.5	
2.0	
2.5	
3.0	
3.5	
4.0	
4.5	
5.0	
5.5	
6.0	
6.5	
7.0	
7.5	
8.0	
8.5	
9.0	
9.5	
10.0	
10.5	
11.0	
11.5	

I. POINT-INTERCEPT DATA (cont.)

Point (m)	Species
12.0	
12.5	
13.0	
13.5	
14.0	
14.5	
15.0	
15.5	
16.0	
16.5	
17.0	
17.5	
18.0	
18.5	
19.0	
19.5	
20.0	
20.5	
21.0	
21.5	
22.0	
22.5	
23.0	
23.5	
24.0	
24.5	
25.0	
25.5	
26.0	
26.5	
27.0	
27.5	
28.0	
28.5	
29.0	
29.5	
30.0	
30.5	
31.0	
31.5	
32.0	
32.5	
33.0	
33.5	
34.0	
34.5	
35.0	
35.5	
36.0	
36.5	

I. POINT-INTERCEPT DATA (cont.)

Point (m)	Species
37.0	
37.5	
38.0	
38.5	
39.0	
39.5	
40.0	
40.5	
41.0	
41.5	
42.0	
42.5	
43.0	
43.5	
44.0	
44.5	
45.0	
45.5	
46.0	
46.5	
47.0	
47.5	
48.0	
48.5	
49.0	
49.5	
50.0	

II. BELT DATA

Perennials (list species and count individuals rooted within the 2 X 50-meter plot):

Annuals (list all species present):

4.0 Work Plan Description

4.1 Background

Section 1135 of the Water Resources Development Act of 1986 (Public Law 99-662) provides authority to the USACE to identify opportunities for improvement of the environment through the modification of flood control facilities and other water resource projects constructed by the USACE. In accordance with Section 1135, Pima County, Arizona, requested the Los Angeles District of the USACE to initiate a study of ecosystem restoration along a portion of the Rillito River.

Historically, the Rillito River flowed perennially, meandering and supporting dense vegetation of cottonwood, willows, mesquite bosques, numerous beaver dams, and wetlands. Urbanization, along with agriculture, increased and contributed to a loss in surface water flow, a decrease in the water table, and bank stabilization for flood control. Today much of the riparian habitat adjacent the Rillito River is degraded (USACE 2004).

An Ecosystem Restoration Report and Environmental Assessment, completed by the USACE (2003), investigated the feasibility of proposed modifications to the banks and overbank areas of the Rillito River and evaluated the environmental and socioeconomic effects of an ecosystem restoration project on the surrounding areas. The preferred alternative identified in that document emphasizes the creation of riparian woodland habitat along created linear wet areas with xeroriparian habitat in the remaining areas to act as a buffer from adjacent land uses. Under this alternative, the 60-acre study site is divided into distinct areas (Areas 1, 2, and 3) based on the restoration effort that will occur in each area. The Final Work Plan for Area 1 was completed in May 2006 and construction began in September 2006. This Work Plan is for Phase II and addresses restoration efforts in Areas 2 and 3.

4.2 Project Location

The Rillito River Ecosystem Restoration Project–Phase II project will restore habitat on two parcels of land on the southern bank of the Rillito River between Craycroft Road and Dodge Boulevard in Tucson, Arizona.

Area 2 is an approximately 4-acre parcel east of Swan Road in Section 26 of Township 13 South, Range 14, East Gila and Salt River Meridian, Arizona. The site is adjacent to the outlet of Alamo Wash and is highly disturbed.

Area 3 is an approximately 50-acre parcel located at the northern end of Columbus Boulevard in Section 27 of Township 13 South, Range 14, East Gila and Salt River Meridian, Arizona. The site presently contains one secondary and two primary concrete-lined channels that convey storm water flow into the Rillito River. Some areas of the site have been heavily disturbed while others retain the basic elements of the surrounding natural landscape.

4.3 Project Summary

This Work Plan focuses on the restoration of riparian and associated habitats and supplements previously approved plans to remove the existing drainage channels and construct three meandering riparian channels. The new channel design includes a terraced cross-section allowing for plantings on the terraces. This restoration plan includes a grading plan, details, and notes; a planting plan, details, and notes; an irrigation plan, details, and notes; an invasive species management plan; and a monitoring plan. A Habitat Restoration Specialist will monitor all aspects of this project to ensure that they are implemented in the most prudent and efficient way to protect the integrity of the restoration effort. This person will have a minimum of a Bachelor's degree in a natural resources-related field, and five years of experience in similar efforts.

The restoration plan has five main treatments: xeroriparian terrace, xeroriparian buffer, enhancement areas, seeded-only areas, and areas of intensive invasive species removal. In addition, there will be areas that will not receive any vegetation treatment (e.g., the channel bottoms). These different elements will work together to create a diverse mosaic of native vegetation that will be available as wildlife habitat and for the recreational enjoyment of adjoining residents and users of the Rillito River Park Multi-use Path.

The restoration plan has been developed to become a self-sustaining ecosystem (non-irrigated) upon completion of the five-year establishment period. Emphasis has been placed upon the use of site-appropriate native vegetation, removal of invasive species, leaving existing stands of native vegetation intact, and working with the existing site contours for minimal ground disturbance in order to protect the native amphibian populations onsite to the greatest extent possible. Existing protected native plants will be protected in place and marked with flagging. Non-native invasive species will be flagged for removal or treatment in a contrasting color. Water harvesting principles are incorporated into the grading design between channels to conserve water and increase the long-term sustainability of the site. An irrigation system will support the planting areas through their establishment period, which lasts 2 to 5 years depending on rain and other weather conditions. Locations and details for these elements are shown on the drawings (Section 6.0).

5.0 Method of Maintenance, Repair, and Rehabilitation

5.1 Invasive Species Management Plan

5.1.1 Introduction

Several invasive non-native plant species are present within the Rillito River Ecosystem Restoration Project Areas 2 and 3. These species can be expected to increase in number and distribution with ground-disturbing activities associated with restoration, without the implementation of appropriate control measures. The ultimate success of the restoration project will largely depend upon the control of invasive species, which can outcompete the native species that the project is designed to promote.

Invasive species often produce enormous quantities of viable seed and can be very difficult to control once established; therefore, early detection is key to management success. This Invasive Species Management Plan is designed to be implemented over five years in conjunction with the Maintenance and Monitoring Plan. If the program is successful in controlling problem species, a reduced level of effort (i.e., periodic spot control and identification–eradication of new populations) will be required after the initial five years for long-term control.

The management program will be based on the concepts of:

- **Eradication.** Eradication of existing problem species within the project area;
- **Prevention.** Preventative actions to keep the project area free of species that are not yet established, but that may be expected to colonize the area;
- **Management.** and,
- **Monitoring.** Ongoing monitoring to ensure success and identify adaptive management needs as new infestations arise.

The natural open space of the project area is not isolated, but exists within a matrix of neighboring open space areas, a recreational multi-use path, and residential development. For many plants, the mechanism for dispersal may include wind, water, or transport by animals (including humans). For this reason, any adjacent areas occupied by invasive plants may pose a threat to neighboring lands, as these modes of seed transport may carry unwanted species into the open spaces. Surveys for invasive plant species should include reconnaissance surveys on neighboring lands, with landowners'

approval, for invasive species and potential sources of seed production. If populations of invasive species are discovered in parcels immediately adjacent to the restoration site, the project proponent should work with the respective landowner to eradicate or manage the off-site problem.

5.1.2 Management Tools

The species, location, and extent of invasive species infestation will largely determine the management tools used to control populations. Consideration will also be given to the difficulty of controlling a particular invasive species.

All options of control will be considered before action is taken. These methods may include removal by hand or machine, passive management (allowing native species to become established and out-compete invasives), and/or application(s) of herbicides. Each of these management tools has advantages and disadvantages, and often the best approach is a combination of methods (Bossard *et al*. 2000). In addition, optimum timing of invasive species management strategies can vary by the type of plant in question. For example, for many perennial species, timing of control may not be as critical as for annual species. Annual invasive species are best controlled before they set seed in order to limit costly repeat efforts.

A number of operational considerations should be taken into account when considering any invasive species management tool. The first consideration that a land manager faces is the varying cost of available management tools. Hand removal operations consist of the expense of the removal equipment as well as significant labor costs. If ground in the removal site is disturbed, reseeding or container planting and costs associated with these tasks should be considered. Revegetation of disturbed areas will be an important preventative strategy for suppressing future invasive species infestations.

5.1.2.1 Prevention

The most effective and efficient invasive species control strategies prevent invasions from occurring and quickly detect invasions that do occur so that invasive species can be eradicated or contained before they spread (Bossard *et al*. 2000). Management tools to prevent the establishment of invasive species within a given area include regular monitoring for invasive species, eradicating species immediately upon detection, removing exotic seed sources from neighboring areas, and revegetating areas as soon as disturbances occur. If it is not feasible to remove a particular invasive species in its entirety, preventative measures may include cutting seed heads off plants and raking and removing seeds as they fall to the ground.

Many non-native invasives can be reduced with the successful establishment of native species through restoration.

5.1.2.2 Eradication

Eradication is the complete elimination of an invasive species from a given area. Invasive species eradication is possible, if the populations on-site are targeted for removal. However, the species are likely to reinvade from adjacent properties, if there are no barriers to prevent dispersal. Early detection and removal of a new invasive species infestation is critical, if eradication is the management goal of a particular species.

5.1.2.3 Physical Control

5.1.2.3.1 Material Removal

Physical control often involves hand dethatching, pulling, cutting, mowing, line trimming, or removal by mechanical means. These methods are labor intensive, but may often be the most appropriate methods for the relatively small project area size and limited infestation present within the project area. Physical methods of invasive species control may provide an advantage in these situations where desirable species may be left in place, while surrounding invasive species may be removed.

These methods will be especially useful and applicable to the weedy basin present in the western portion of Area 3. In this area of dense invasive species, the Habitat Restoration Specialist will work with the landscape contractor to identify appropriate material removal methods. The goal will be to reduce the stronghold of the invasives so that the native species present will be allowed to flourish. No planting or seeding will be performed in this area; the invasive species management will be the primary means for habitat improvement.

5.1.2.3.2 Mulching

Applying mulch, black paper, or black plastic excludes light from reaching invasive species and prevents them from photosynthesizing. Commonly used mulch includes grass clippings, hay, manure, straw, sawdust, wood chips, or rice hulls. Mulches can be a very effective form of invasive species control in small areas and can aid in soil stabilization, moisture retention, and soil insulation. If mulch is used as a form of invasive species control, it is imperative that invasive species-free material is used to prevent the introduction of other invasive species.

5.1.2.4 Chemical Control

The chemical means of controlling invasive species is the application of herbicides. Herbicides kill or inhibit plant growth and can be very effective in controlling many invasive species. Each invasive species may have different requirements regarding effective herbicides, application rates, and timing of application.

Using herbicides to control invasive species requires careful planning and a professional staff familiar with the application areas and herbicides they are using. The use of herbicides should be under the direction of a professional pesticide applicator with a Qualified Applicators License (QAL) and a Pesticide Applicators License (PAL). Before applying any herbicide, the applicators should be aware of all safety regulations, applicable environmental regulations, and be familiar with target versus native plants. The Habitat Restoration Specialist is responsible for meeting these requirements and approving any trained staff or certified pesticide applicators that will handle herbicides. The Habitat Restoration Specialist should be consulted before actions are taken.

The method of application varies from one species to the next and with the degree of infestation. The application method ultimately chosen should minimize risks of harming non-target plants. The environmental risks of some herbicides may include drift, volatization, persistence in the environment, groundwater contamination, and harmful effects on animals.

The presence of high levels of free lime in the soils of the project area may affect the soluability of herbicides in the soil. Therefore, herbicides should only be applied directly to individual plants as opposed to broadcasting them on areas of soil.

5.1.2.5 Competition and Restoration

Competition and restoration involves the planting and rearing of native species so they may out-compete invasive species. By increasing the density and distribution of native trees, shrubs, and forbs, there is less space available for invasive species to occupy. Planting will often involve a maintenance period where watering and weeding will be necessary until the plants have become established. This method of invasive species management must be implemented in conjunction with another form of invasive species control, such as dethatching, mulching, and/or herbicide use.

5.1.3 Tiered Management Approach

There are a variety of invasive non-native species present in the project area. In addition, other invasive non-natives are expected to either be currently present in the seed bank (i.e., not expressed above ground) or that may be expected to become established when the area is disturbed by construction. Invasive non-natives will be

managed according to a tiered approach that will allow for efficient site-specific assessment and flexibility in management decisions. The three tiers of the management approach are described below and in Table 5-1.

The Arizona Wildlands Invasive Plant Working Group (AZ-WIPWG) has ranked 71 plant species known to be invasive into Arizona's natural ecosystems through the application of a regionally developed objective assessment protocol (AZ-WIPWG 2005a). Although this list is non-regulatory, it is endorsed by several state and federal agencies (including the USACE) as a guide for invasive species management. Several invasive species that are either present within the project area or that can reasonably be expected to become established are presented in Table 5-1 with their respective AZ-WIPWG ratings.

TABLE 5-1
TARGET SPECIES FOR MANAGEMENT WITHIN THE RILLITO RIVER ECOSYSTEM RESTORATION PROJECT AREAS 2 & 3

Tier	Common name	Scientific name	Form	AZ-WIPWG Rating
Tier 1 Plants: Goal = heavy control/ eradication	giant reed	*Arundo donax*	perennial giant bunchgrass	HIGH
	Mexican paloverde	*Parkinsonia aculeata*	tree	Not ranked
	buffel grass	*Pennisetum ciliare*	perennial bunchgrass	HIGH
	African sumac	*Rhus lancea*	tree	MEDIUM
	tamarisk	*Tamarix sp.*	shrub	HIGH
Tier 2 Plants: Goal = management	Bermuda grass	*Cynodon dactylon*	perennial grass	MEDIUM
	soft feather pappusgrass	*Enneapogon cenchroides*	annual bunchgrass	not ranked
	Lehmann's lovegrass	*Eragrostis lehmanniana*	perennial bunchgrass	HIGH
	Rose natal grass	*Melinis repens*	annual bunch grass	not ranked
	Russian thistle	*Salsola iberica*	annual herb	MEDIUM
	London rocket	*Sisymbrium irio*	annual herb	not ranked
	Johnson grass	*Sorghum halapense*	perennial bunchgrass	MEDIUM
	cocklebur	*Xanthium strumarium*	annual herb	not ranked
Tier 3 Plants: Goal = monitoring/ prevention	red brome	*Bromus rubens*	annual grass	HIGH
	starthistles	*Centaurea melitensis, C. solstialis*	annual herb	MEDIUM, HIGH
	fountain grass	*Pennisetum setaceum*	perennial bunchgrass	HIGH

HIGH: These species have severe ecological impacts on ecosystems, plant and animal communities, and vegetation structure; invasiveness attributes are conducive to moderate-to-high rates of dispersal and establishment; and species are usually widely distributed, both among and within ecosystems/communities.

MEDIUM: These species have substantial and apparent ecological impacts on ecosystems, plant and animal communities, and vegetation structure; invasiveness attributes are conducive to moderate-to-high rates of dispersal, often enhanced by disturbance; and ecological amplitude (diversity of ecosystems/communities) and distribution (within and ecosystem/community) range from limited to widespread.

The project area was surveyed for the presence of invasive species during September 2006. It is important to note that this survey occurred after an extremely wet summer; summer annuals were well represented, whereas winter annuals were not present due to the timing of the survey. This survey assisted in the identification of target species listed in Table 5-1, but was not all-inclusive of the species that may become problems within the project area. Changing site conditions may work in concert with unpredictable climatic patterns to encourage invasion of species that are not explicitly identified in this plan. A strategy of on-going monitoring and adaptive management will be necessary to identify additional target species as the project schedule progresses in coordination with the Habitat Restoration Specialist, who will identify the proper management tier for any new non-native invasive species that is found within the project area.

5.1.3.1 Tier 1: Heavy Control/Eradication

Tier 1 consists of species that will be aggressively targeted for eradication. The entire project area will be surveyed for these species, and they will be eliminated to the highest degree possible, according to the species-specific control methods described below.

5.1.3.1.1 Giant Reed (*Arundo donax*)


Carianne Funicelli

Giant reed is a robust perennial grass nine to thirty feet tall, growing in many-stemmed, cane-like clumps, spreading from horizontal rootstocks below the soil, and often forming large colonies many meters across. The light green leaves diverge from the stem in a distinctive herringbone pattern. Giant reed is indigenous to the Mediterranean Basin or to warmer regions of the Old World. It was brought to North America and grown for

roofing material, to construct musical instruments, and for erosion control. Invasive populations resulted from escapes and displacements of plants from managed habitats.

The species reproduces vegetatively, either from underground rhizome extension or from plant fragments carried downstream, primarily during floods, to become rooted and form new clones. Large colonies of this species typically occur in low-gradient riparian areas and floodplains of medium-sized to large streams. Scattered colonies occur in moist areas or springs and on steeper slopes of dry riverbanks.

Giant reed is suspected of altering hydrological regimes and reducing groundwater availability by transpiring large amounts of water from semi-arid aquifers. It alters stream flow and channel morphology by the retention of sediments and constricting stream flows. During storm flows, the shallow roots of giant reed are undercut. The roots then slump and break away from the stream banks, taking the soil with them. The material then floats downstream and clogs culverts, channels, and bridge crossings. This results in the giant reed spreading vegetatively downstream. These obstructions have been known to cause flooding and to wash out bridges, causing millions of dollars in damages.

Giant reed displaces native plants and associated wildlife species because of the massive stands it forms (Bell 1994). As giant reed replaces riparian vegetation, it reduces habitat and food supply, particularly insect populations, for avian species (Frandsen and Jackson 1994) and reduces shade cover to the in-stream habitat, leading to increased water temperatures and reduced habitat quality for aquatic wildlife (Franklin 1996). In addition, giant reed is highly flammable throughout most of the year and appears to be highly adapted to extreme fire events (Bell 1996; Scott 1994).

Giant reed is currently established in dense pockets within the project area, especially in the western portion of Area 3. In addition, it is common both upstream and downstream and can be expected to re-invade the area. Treatment should include sensitivity for the reptile habitat created by the dense clumps of giant reed through the control methods outlined below.

Prevention: Pima County should work with adjacent landowners to remove source populations in the area.

Mechanical control: In order to preserve reptile habitat until the restoration plantings become established, the large, well-established clumps of giant reed should be controlled using a sensitive combination of control methods. The biomass above 6 feet should be removed and hauled offsite. Then chemical control should be applied as outlined below, and the resulting litter should remain in place to continue to provide habitat value after the plants are dead.

For small clumps or individual plants that do not have a well-developed base that is providing reptile habitat, treatment should be immediate removal by the most appropriate of the following methods: hand pulling, chainsaw, machete, shovel, or backhoe. Early detection will enable removal of giant reed with the least amount of ground disturbance possible. Complete removal is necessary to prevent vegetative re-sprouting. Mechanical removal may need to be followed up with chemical control.

Chemical control: If giant reed becomes well-established before control is possible, it may be necessary to use herbicide.

The key to all giant reed removal is killing of the root mass. This requires treatment of the plant with a systematic herbicide at appropriate times of the year to ensure translocation to the roots. Currently, Rodeo® and Aquamaster® are the only herbicides that are approved for use in wetlands and have proven very effective against giant reed. The herbicide treatment should include a foliar application of a two-to-five-percent solution (or at the manufacturer's recommendation) applied post-flowering and pre-dormancy at a rate of 0.5 to 1 liter/hectare (0.2 to 0.6 liter/acre) (Bell 1997). During this time, usually mid-August to early November, the plants are actively translocating nutrients to the root mass in preparation for winter dormancy that results in effective movement of herbicide to the roots. Two to three weeks after foliar herbicide application, the leaves and stems should begin to brown and soften.

Treatment schedule: Giant reed should be removed as soon as it is detected; seasonality is not important for mechanical removal, but herbicide application should occur once flowering is complete (late summer) and before winter dormancy. Follow-up control should occur at least twice per year.

5.1.3.1.2 Mexican Paloverde (*Parkinsonia acuelata*)

Mexican paloverde is a tree that grows 15–30 feet tall. It is distinguished from the native blue paloverdes (*Parkinsonia florida* and *P. microphylla*) within the project area by its long leaf rachises and generally weeping appearance. This species is native to Mexico and tropical America. Mexican paloverde is common throughout the project area. Although this species is not addressed in the AZ-WIPWG assessment, the restoration project presents a unique opportunity to eradicate it from the site to preserve a completely native tree flora.

The Habitat Restoration Specialist will locate and flag all specimens within the project area. A two-pronged treatment approach will be followed for this species, based on location of the individual tree. Very small trees and those in close proximity to the river trail should be removed, whereas larger trees in areas of desirable vegetation should be killed with herbicide, but remain in place to provide snags for wildlife benefit and to avoid unnecessary soil disturbance. The Habitat Restoration Specialist will work with the grading crew to identify which individual trees should be removed.

Mechanical control: Small individuals of Mexican paloverde trees that are identified for removal by the Habitat Restoration Specialist should be removed by bulldozer or pulling with a tractor to effectively remove all roots. Larger trees that are to be removed due to proximity to the river path should be cut down, and the stumps immediately treated with herbicide as described below. Seedlings should be pulled by hand or machine, as appropriate. Follow-up removal will be necessary as ground disturbance will encourage additional seedling germination and establishment.

Chemical control:
For trees that are to be removed due to close proximity to the river path: Immediately (within 15 seconds) after Mexican paloverde trees are cut as close to the ground as possible, the stumps should be treated with herbicide (picloram or triclopyr, trade name Access, has been successfully used) to prevent resprouting.

For trees that are to remain in place: Holes are to be drilled near the base of the trunk, and picloram or triclopyr should be injected into the holes to kill the tree. Trees should be monitored to ensure the herbicide's effectiveness.

Treatment schedule: Mexican paloverde trees can be removed and/or treated with herbicide during any season. Treatment should occur in conjunction with site preparation and grading activities. Follow-up control should occur at least twice per year.

5.1.3.1.3 Buffelgrass (*Pennisetum ciliare*)

Buffelgrass is a bunchgrass native to Africa that has spread extensively through the wildlands of the Sonoran Desert. Buffelgrass was introduced for livestock forage and reclamation applications in the 1930s and has since become an extensive problem in many different kinds of areas, including roadsides, uplands, and within the urban core.


Carianne Funicelli

Buffelgrass is present in extensive stands throughout the project area and should be

considered among the most urgent of invasive issues within the project area.

Prevention: Pima County should work with adjacent landowners to remove potential source populations in the area.

Mechanical control: Individual plants should be removed by shovel or digging bar immediately. Inflorescences should be clipped and securely bagged prior to digging out the plant to reduce the number of seeds that escape.

Chemical control: Buffelgrass should be treated with glyphosate while it is actively growing.

Treatment Schedule: Follow-up control should occur at least twice per year.

5.1.3.1.4 African Sumac (*Rhus lancea*)

African sumac is native to South Africa and widely used as an ornamental tree in the Sonoran Desert. The shiny dark green leaves are palmately compound in groups of three. African sumac reseeds aggressively and has become a problematic species in washes throughout Tucson.

There are relatively few individuals of African sumac in the project area; the Habitat Restoration Specialist will mark all individuals for destruction.

Prevention: Pima County should work with adjacent landowners to remove potential source populations in the area.

Mechanical control: Individual plants should be removed by shovel or digging bar immediately. Larger plants should be removed by bulldozer. This species needs to be hauled off-site, even if there are no seeds, because it is allelopathic.

5.1.3.1.5 Salt Cedar (*Tamarix* spp.)

Salt cedar (*Tamarix* spp.) is a rhizomatous shrub that may occur as spotty to heavy infestations along drainages and shores of water bodies. The scale-like leaves have salt glands; flowers are small, white to deep pink, and densely packed on racemes. The bark is reddish-brown with smooth stems less than one inch in diameter. Salt cedar is native to Eurasia and Africa, and was used in the 1800s as erosion control, windbreaks, shade, and as an ornamental. It spreads by seed and vegetative growth. An individual plant can produce 500,000 seeds per year.

Presence of salt cedar can have devastating effects on native habitats, and it has been a pervasive problem across the American southwest for several decades. Some of the more profound effects include dramatic narrowing of stream channels and sediment trapping, lowering water tables, and increasing in soil salinity, fire frequency, plant community composition, and native wildlife diversity.

Like many other invasive species, salt cedar is easily spread and difficult to eradicate. Therefore, early detection and control are critical to the successful control of this species. Post treatment monitoring is also essential, since salt cedar is capable of resprouting following treatment.

There are several large Athel trees (Tamarix aphylla) present in the central portion of Area 3; these trees, although non-native, are to remain in place in order to continue to provide dense shade and canopy, unless otherwise directed by Pima County Regional Flood Control District personnel.

Mechanical control: Removal by mechanical methods is not an effective means of controlling salt cedar, since it tends to resprout vigorously following cutting. Seedlings and small plants may be successfully uprooted by hand, if the entire root system can be removed.

Chemical control: The most frequently used and effective method is to cut the salt cedar shrub near to the ground and immediately (in less than 30 seconds) apply a triclopyr or glyphosate herbicide to the cut stump. This technique usually results in a 90-percent kill rate.

Treatment schedule: Salt cedar should be immediately eradicated upon detection. All cut vegetative material should be bagged and carried off-site. Follow-up control should occur at least twice per year.

5.1.3.2 Tier Two: Control

5.1.3.2.1 Bermuda Grass (*Cynodon dactylon*)

Bermuda grass is a turf-forming grass that spreads by seeds, stolons, and rhizomes. It is an early successional species that can become established more quickly than other species, and it forms a dense turf that can preclude the growth of other species (AZ-WIPWG 2005b).

Bermuda grass is currently established in certain parts of the project area, especially the weedy basins. The following information on control of Bermuda grass is summarized from the University of California's Integrated Pest Management Pest Management Guidelines (Elmore and Cudney 2006).

Prevention: New infestations of Bermuda grass can be greatly reduced or prevented by minimizing soil disturbance and maintaining plant cover that shades soil surfaces (Chambers and Hawkins, n.d.). Bermuda grass can be shaded out with dense or complete canopy cover, although this will probably not be possible in the first stages of this project. Shaded growth will be fine and spindly; plants are easier to remove than those growing in full sun. Shade from short shrubs or ground covers will not be effective; Bermuda grass will simply grow up through these plants.

Mechanical control: Bermuda grass may be controlled with mulches of black polyethylene plastic or geotextile landscape fabric that block out all light if occurring in monotypic stands. The grass should be mowed and irrigated; plastic placed over the plants; and plastic left intact (without any holes) for at least 6 to 8 weeks in summer. Placing plastic over Bermuda grass in winter will not control it. It is important to make sure that the plastic remains intact without holes or Bermuda grass will grow through the holes and survive.

Clear plastic mulching (solarization) is effective for eradication of Bermuda grass plants and seed, if it is applied during periods of high solar radiation. Before applying the plastic, closely mow the Bermuda grass, remove the clippings, and water the area well. It is not necessary to cultivate before solarization, but a shallow cultivation may improve control. Place clear, ultraviolet (UV) protected polyethylene over the area. The plastic

should extend roughly two feet beyond the Bermuda grass stolons to make sure that the infested area is covered; it must be maintained intact for four to six weeks. Shade will reduce the effectiveness of solarization, because it limits the amount of radiation. After solarization, do not cultivate the area deeper than three inches to avoid bringing invasive species seed into the upper soil layer. Solarization is the only effective way to kill seeds in the soil.

Chemical control: Post-emergent herbicides can be used when Bermuda grass is actively growing (late spring–summer). Selective herbicides should be applied in early spring when new Bermuda grass growth is less than 6 inches in height, then reapplied before the regrowth reaches 6 inches in height. Additional applications may be needed as new growth occurs. Follow label directions to ensure that any annual limits of application are not exceeded. Control will be increased if the plant is growing well with plenty of leaf area. Plants that are drought stressed, insect damaged, or with dust on the leaves will not be controlled.

Glyphosate (Rodeo/Aquamaster and other formulations) is a non-selective herbicide that kills both the tops of the plant and the roots. For it to be most effective, it must be applied to vigorously growing Bermuda grass that is not water stressed. Do not mow the Bermuda grass for 2 to 3 weeks before applying it and withhold water for 2 to 3 days after an application. For even more effective control, spray the area with glyphosate, leave it for up to seven days, then cultivate the area to cut surface stolons, and bring rhizomes to the surface to dry out. If the area isn't cultivated, another application of glyphosate may be necessary when the invasive species begins to grow again.

Treatment schedule: If using mulching methods to control Bermuda grass, application must occur during the hot summer months. Herbicide application should occur during vigorous, active growth (late spring–summer). Follow-up control should occur at least twice per year.

5.1.3.2.2 Soft Feather Pappusgrass (*Enneapogon cenchroides*)


http://www.krugerpark.co.za/afric
nine-awned_grass.html

Soft feather pappusgrass is an annual bunchgrass from Africa and Asia that is a relatively new and unknown invasive challenge in the Tucson area. It is present in large pockets throughout the project area, especially in the east-central portion of Area 3. There is no literature available on effective treatment of this plant; however the following protocols should be followed.

Mechanical control: During the initial construction phase, all individuals should be removed in a careful

manner to limit the amount of seedfall. Plants should be bagged and disposed of off-site.

Chemical control: Glyphosate or other herbicide approved by the Habitat Restoration Specialist should be applied while the plants are green and vigorously growing.

Treatment schedule: This species germinates with summer rains and should be treated immediately, because it is an annual that sets seed quickly.

5.1.3.2.3 Lehmann's Lovegrass (*Eragrostis lehmanniana*)

The following species information is taken from Moser and Crisp (n.d.). Lehmann's lovegrass is a warm season perennial bunchgrass that grows to a height 1 1/2 to 2 feet. The plant forms a compact crown with numerous stem bases. Most stems remain upright, but some become procumbent and can root at the nodes. This makes it difficult to distinguish individual plants in dense stands. Reproduction is by seeds and by stolons. The plants produce many seeds, which are dormant after they fall from the plant. Seeds sprout after the dormancy period of 6 to 9 months or can sprout in less time if scarified by heat. Heat scarification can occur after a fire or from hot desert heat. Fire intensity in stands of Lehmann's lovegrass can be very high.

Lehmann's lovegrass was first introduced to the southwest for cattle forage improvement. Lehmann's lovegrass quickly reseeds itself after disturbance. It is very competitive and can replace native species through plant competition over a few growing seasons. Desert and grassland birds are less abundant in Lehmann's lovegrass areas than in the native plant communities they often replace.

Mechanical control: Chopping or mowing would not be effective as these actions would probably do nothing more than mimic a grazing animal. Individual plants should be removed by shovel or digging bar.

Chemical control: Spot applications of herbicides may be used as deemed necessary by the Habitat Restoration Specialist.

5.1.3.2.4 Rose Natal Grass (*Rhynchelytrum repens, Melinis repens*)

Rose natal grass is another invasive bunchgrass from South Africa. It is a short-lived summer perennial with distinctive fluffy inflorescences that range in color from red to purple, maturing to a silvery pink.

Mechanical Control: Chopping or mowing would not be effective, as these actions would probably do nothing more than mimic a grazing animal. Individual plants should be removed by shovel or digging bar.

Chemical Control: Spot applications of herbicides may be used as deemed necessary by the Habitat Restoration Specialist.

5.1.3.2.5 Russian Thistle (*Salsola* sp.)

Russian thistle, also known as tumbleweed, is an annual that grows one to four feet tall. This common inhabitant of disturbed areas blooms from July to October. In the fall, the plant often breaks off at the ground and tumbles around dropping its seeds along the way. Russian thistle is a native to Eurasia. Russian thistle is prevalent throughout the disturbed portions of the project area, especially near the multi-use path.

The Habitat Restoration Specialist shall locate and mark all specimens within the project area. All Russian thistle individuals shall be removed by mechanical (preferred) or chemical control as described below prior to planting and seeding of the project area. Monitoring of the project area during the establishment period will be important to identify any infestations that may arise with initial soil disturbance. Russian thistle is shade intolerant (DeLoach et al. 1986) and will likely be shaded out as native vegetation becomes established and matures. Russian thistle has high reproductive potential, with each plant capable of producing up to 250,000 seeds (Young 1991). However, seed germination from soil seed bank drops off sharply after the first year and was not found to occur after year three in a four-year study in Canada (Crompton and Bassett 1985).

Mechanical control: Russian thistle should be pulled by hand to remove the plant before the seed heads have formed. This species may need to be removed more than once in a growing season.

Chemical control: Russian thistle should be sprayed with the herbicide glyphosate when the plant is actively growing but prior to flowering. Herbicide application rates should wet the plant thoroughly. Chemical control may be preferred in some situations to limit ground disturbance.

Treatment schedule: Control methods should be applied before the plants set seed and while the plants are actively growing. Seeds are produced during the summer; by fall the plant dries out, breaks off, and rolls away. Therefore, the optimal time to control Russian thistle is in the spring during active growth. Follow-up control should occur at least twice per year.

5.1.3.2.6 London Rocket (*Sisymbrium irio*) and Other Winter Mustards

London rocket is a highly competitive winter annual. The edges of the first true leaves of seedlings are often somewhat indented, and most or all of the early leaves are deeply indented. The stems of mature plants bear long, tubular seedpods and have a small cluster of yellow flowers at the tip. The plants usually grow to about two feet tall. London rocket is found in irrigated fields, moist fallow fields, roadsides, and tends to carpet the ground under mesquites along the rivers in the spring.

Chemical control: London rocket is resistant to Group B/2 herbicides, known as acetolactate synthase (ALS) inhibitors.

Treatment schedule: Seedlings that emerge in autumn can be controlled by autumn or early spring cultivations.

5.1.3.2.7 Johnson Grass (*Sorghum halapense*)

Johnson grass is an aggressive coarse perennial grass with bright green leaves and it can reach heights of over 6 feet. It spreads both by seeds and by rhizomes, and can be dispersed by wind, water, and wildlife. It is native to the Mediterranean.

Prevention: Johnson grass is very difficult to control. The best strategy is to keep it from invading and remove any individuals that begin to establish (Chambers and Hawkins, n.d.).

Mechanical control: For small infestations, the entire plant should be removed manually. It is critical to remove the deep rhizomes. This species should be bagged and hauled off site.

Chemical control: Spot applications of systemic herbicides may be used as deemed necessary by the Habitat Restoration Specialist.

Treatment Schedule: Plants may be removed at any time of the year, but is preferable before flowering.

5.1.3.2.8 Cocklebur (*Xanthium strumarium*)

Cocklebur is a perennial herb that was introduced from Europe. Its stems are thick and fleshy with red or black spotting. The leaves are coarsely toothed and triangular; the fruits are barrel-shaped with spines. Cocklebur is a maximum of five feet tall. They are found in disturbed areas below 500 m in altitude throughout the United States. All parts of the plant have a very high toxicity. These plants rapidly out-compete native annuals and drastically reduce the land value of irrigated pasture.

Mechanical Control: Physical removal of the plants by hand pulling, mowing, and tillage are all effective, if done prior to flowering.

Chemical control: Spot applications of herbicides may be used as deemed necessary by the Habitat Restoration Specialist.

Treatment schedule: Plants may be removed at any time of the year, but greater success is achieved if removal is conducted in early spring.

5.1.3.3 Tier 3: Monitoring / Prevention

The plants that are identified as Tier Three species are not yet present in the project area, but that have the potential to become established and pose serious problems. The Habitat Restoration Specialist shall inspect the project area for these species (as well as others that may become established) over the course of the five-year monitoring period. If they are detected, they would be treated with the same urgency as Tier One species, with control action initiated immediately.

5.1.3.3.1 Fountain Grass (*Pennisetum setaceum*)

See buffelgrass discussion above. These African bunchgrasses are closely related and would be managed in the same manner.

Fountain grass is a coarse perennial grass with a densely clumped growth form and erect stems up to five feet tall. The flower heads are prominent, nodding, and feathery. They resemble bottlebrushes six to fifteen inches long with many, small, pink to purple flowers. Fountain grass is a native of Africa and the Middle East, but has become a widely popular ornamental plant. It easily reproduces from seed that is transported by humans, animals, and short distances by wind. Fountain grass has the ability to adapt physiologically and morphologically to different environments. Thick infestations of fountain grass can interfere with regeneration of native plant species. Fountain grass can be expected to invade to project area from the adjacent residential areas, where it is used widely as an ornamental landscaping plant.

Prevention: Pima County should work with adjacent landowners to remove potential source populations in the area.

5.1.3.3.2 Red brome (*Bromus rubens*)

Red brome is an annual grass that germinates with winter precipitation. It competes with native species for moisture, nutrients, and space, in some places replacing stands of native perennial grasses. It is widely implicated in promoting wildfires (Chambers and Hawkins, n.d.). In addition, the seed-bearing spikelets are very sharp and stiff and can become lodged in the fur, feet, ears, and eyes of native and domestic animals.

Mechanical control: Manual removal of plants through pulling and hoeing can be effective if done before seeds mature, but is usually feasible only with small infestations. In small infestations, covering the ground with mulch or black plastic (solarization) will reduce plant growth (Chambers and Hawkins, n.d.).

Treatment schedule: Plants should be treated immediately upon identification and before the seeds mature.

5.1.3.3.3 Starthistle (*Centaurea melitensis* and *C. solstitialis*)

Starthistle is a winter annual that can grow in thick, impenetrable stands. It blooms in May and June.

Mechanical Control: Small infestations can be hand-dug. This is especially effective on new introductions. Care should be taken not to spread seeds when hand-pulling. Placing the pulled plants in a garbage bag is a good measure to prevent seed spread. On large-scale infestations, tilling so that the roots are separated below the soil surface should provide complete control of these plants.

Chemical control: Mature plants are harder to control than immature plants in the rosette stage. Effective herbicides include: 2,4-D, clopyralid, and glyphosate. Chemical control is an appropriate tool to use: 1) on large infestations, especially when desirable plants are abundant in the under story; 2) in highly productive soils; and 3) around the perimeter of infestations to contain their spread. Picloram may be applied to seedlings or rosettes with some effect.

Treatment Schedule: Early detection and treatment is critical because once the plants flower, they can produce viable seeds within eight days (Chambers and Hawkins, n.d.).

5.1.4 Invasive Species Monitoring

The restoration site will be monitored both qualitatively and quantitatively for five years following the construction year, according to Section 3.12.3, Maintenance and Monitoring of the Combined Ecosystem Restoration Report and Environmental Assessment, and the directives outlined in the Maintenance and Monitoring Plan. Areas that have been treated for invasive species should be closely monitored for resprouting and/or seedling germination; appropriate control methods should be promptly applied. The restoration area's cover of invasive plant species will not exceed an absolute value of 10 percent, and its cover of perennial invasive species should not exceed an absolute value of 0 percent.

5.2 Monitoring Plan

5.2.1 Performance Standards for the Target Dates and Success Criteria

The restoration site will be monitored by the Habitat Restoration Specialist both qualitatively and quantitatively for five years following the construction year. This person will have a minimum of a Bachelor's degree in a natural resources-related field, and five years of experience in similar efforts.

The performance goals will evaluate plant species diversity and density relative to the design parameters (Table 5-1). The habitat restoration will be considered successful, if the restoration site achieves values of at least 75 percent of the design parameters and at least 60 percent total cover by Year 5. In addition, the restoration area's cover of exotic invasive plant species will not exceed an absolute value of 10 percent, and its cover of perennial invasive species should not exceed an absolute value of 0 percent. Tables 5-2 and 5-3 present the specific performance criteria.

5.2.2 Target Functions and Values

By satisfying the performance standards, the restoration site indicates that it is establishing itself as self-sustaining habitat that is equivalent in form, function, and value to a natural, undisturbed site. Moreover, the restoration site must sustain itself for a minimum of one year (meeting Year 5 performance standards of 75 percent of performance design parameters) in the absence of significant maintenance measures.

The performance standards described in Tables 5-3 and 5-4 for achieving species diversity and density will be based on a relative percentage of design parameters outlined in the Planting Plan (see Sheet 6 of the Work Plan Drawings and Table 5-1). For example, if the design parameters included 50 trees per acre, after five years of monitoring the mitigation site must reach 75 percent of that value (i.e., 37.5 trees per acre). Each restored vegetation community will be considered to meet the diversity criteria, if it contains at least 75 percent of the species included in the design parameters after five years. The values presented for Years 2 through 4 are recommended goals to be used in obtaining the performance standard given for Year 5. Within each habitat, cover of exotic invasive plant species will not exceed an absolute value of 10 percent of annual invasive species and 0 percent cover of perennial invasive species.

TABLE 5-2
PERFORMANCE GOALS AND STANDARDS FOR THE XERORIPARIAN PLANTINGS

	Relative Percentage of Design Parameters		Absolute Value	
Year	Density	Diversity	Total Cover	Cover of Exotic Invasives
1	40%	50%	25%	
2	50%	60%	30%	
3	60%	70%	40%	<10%
4	70%	75%	50%	
5	75%	75%	60%	

TABLE 5-3
PERFORMANCE GOALS AND STANDARDS FOR THE ENHANCEMENT PLANTINGS

	Relative Percentage of Design Parameters		Absolute Value	
Year	Density	Diversity	Total Cover	Cover of Exotic Invasives
1	40%	50%	25%	
2	50%	60%	30%	
3	60%	70%	35%	<10%
4	70%	75%	40%	
5	75%	75%	45%	

TABLE 5-4
DESIGN PARAMETERS PER PLANTING PLAN

Post-Restoration Vegetation Community	Density			Diversity	
	Trees per Acre (15-gal)	Shrubs per Acre (5-gal)	Small Perennials per Acre (1-gal)	Seed Species	Container Species
Xeroriparian Terrace	85	255	383	22	21
Xeroriparian Buffer	55	165	248	22	21
Enhancement	35	105	158	22	22
Seed-only Area	0	0	0	22	0

5.2.3 Monitoring Methods

Specific management and monitoring activities will track changes over time and measure conditions against the success standards. Parameters for monitoring activities are grouped into two levels, qualitative and quantitative, based on the level of effort and type/intensity of data collection.

5.2.3.1 Qualitative Monitoring

Qualitative monitoring is subjective and/or general, and provides information such as presence or absence of specific plant species, hydrology indicators, or a general assessment of site conditions. Qualitative monitoring will initially be performed to evaluate transplant health and non-native species presence, and to identify (and correct) problems as they arise to ensure successful habitat restoration. Qualitative monitoring tracks the quality of the newly established resources as well as identifies maintenance needs. The most important benefit of qualitative monitoring is that it allows the project to be implemented in a manner consistent with the intent of the Work Plan, by allowing ample interfacing of the Landscape Architect and Habitat Restoration Specialist with contractors and personnel conducting the implementation.

Qualitative monitoring will be used to inform site maintenance needs for items including, but not limited to:

- Proper irrigation system function;
- Stormwater harvesting basin function and removal of sediment if necessary;
- Removal of litter and debris;
- Invasive species management needs; and
- Replacement of container plants and reseeding to compensate for mortality, areas damaged by large storm flows, and/or vandalism.

Following the completion of the implementation period, qualitative monitoring will continue as part of the adaptive management for the restoration site. Monitoring will include photographing the site from precisely documented locations at specific (regular) times of the year in conjunction with the quantitative vegetation monitoring that is described below. The purpose of this form of monitoring is to visually document the changes in a landscape over a period of time. The Habitat Restoration Specialist will keep a site journal to document changes and adaptive measures taken to address problems. Any negative changes, such as large-scale non-native plant invasions or high native plant mortality, will be immediately addressed through consultation with field staff and the Habitat Restoration Specialist followed by actions to repair the system. Negative

changes that may directly affect state or federally listed species (such as the identification of non-native wildlife) will immediately be reported to the appropriate agency (U.S. Fish and Wildlife Service and/or Arizona Game and Fish Department).

Human impacts, which include trampling, trash dumping, frightening wildlife, and introducing unwanted pets, should also be monitored. If humans are having a negative impact, solutions such as planting of defensive vegetation such as cacti or mesquite, changing fence type, and increasing the active presence of law enforcement may be necessary. It may also be useful to monitor positive aspects of human use for purposes of adaptive management and publicity (University of Washington Restoration Ecology Network 2002).

Qualitative monitoring will occur daily during the implementation period, bi-weekly for the first six months following implementation, monthly for the next two years, and quarterly (every three months) thereafter.

5.2.3.2 Quantitative Monitoring

Unlike qualitative monitoring, which provides rapid assessments that can be repeated regularly, quantitative monitoring is a more intensive approach that measures specific attributes via sampling methodologies to produce quantifiable data. Quantitative monitoring will occur regularly to provide an unbiased assessment of vegetation conditions.

5.2.3.3 Transects

Cover, density, and diversity are parameters that will reflect the habitat value of the restored vegetation communities within the project area. Monitoring of these parameters will track how the restoration effort performs over time.

Eight permanent monitoring transects (50 meters) have been established in the project area. Transect locations were chosen to capture the range of pre- and post-restoration vegetation communities. The start and end points of each transect are marked in the field with rebar stakes including labeled orange plastic safety caps as well as UTM coordinates (see Section 3.0 for details). Once the project has been implemented, it may make sense to add additional monitoring transects, especially within the riparian corridors.

Monitoring transects will be evaluated according to the point intercept method. This method is easily repeatable (any two people should get similar results), easy to learn, and efficient. Measuring cover by this method is also considered to be the least biased of typical methods (Bonham 1989; Barbour *et al*. 1987). The method is based on a 50-meter point transect centered on a 2×50-meter plot. Using this method, vegetation is sampled by points at 0.5-meter intervals along the 50-meter transect to determine cover.

The surveyor will note the species encountered at each interval. In addition, individuals of each perennial species rooted within the 2×50-meter plot will be counted to determine shrub density and diversity. All annuals present in the 2×50-meter plot will also be noted.

Vegetation sampling will be repeated annually during the months of August or September, beginning in the year of project implementation, to record maximum species diversity and maintain consistency between years. Baseline data were collected in September of 2006 and are presented in Attachment 2.

5.2.3.4 Photo Monitoring

Each sampling site will be photographed during February–March, as well as during September–October transect monitoring period. This photographic monitoring schedule will capture seasonal changes in the flora. At each transect start point, photos will be taken at due north and south directions; at the end points, photos will be taken due east and west (Table 5). This will result in 64 photos per year.

TABLE 5-5
PHOTOGRAPHIC MONITORING SCHEDULE

Years 1–5	Transect Start	Transect End
Feb–March	Photos Due North and South	Photos Due East and West
Sept–Oct	Photos Due North and South	Photos Due East and West

Baseline photos were taken in September of 2006 and are archived on a CD (See Site Investigation section).

5.3 Monitoring Schedule

The monitoring period will begin with implementation of the restoration work and will continue for five years or until the restored vegetation has met performance standards. The monitoring program will be conducted by the Habitat Restoration Specialist as outlined in Table 5-6.

TABLE 5-6
MONITORING SCHEDULE

Type/Task	Pre-implementation	Implementation	Year 1 (2007)	Year 2 (2008)	Year 3 (2009)	Year 4 (2010)	Year 5 (2011)
Qualitative Monitoring	–	Daily	Bi-weekly/ Monthly	Monthly	Quarterly	Quarterly	Quarterly
Vegetation Monitoring Transects	Sept 2006	–	Aug–Sept	Aug–Sept	Aug–Sept	Aug–Sept	Aug–Sept
Photo Monitoring	Sept 2006	–	Feb–Mar and Aug–Sept	Feb–Mar and Aug–Sept	Feb–Mar and Aug–Sept	Feb–Mar and Aug–Sept	Feb–Mar and Aug–Sept

5.4 Annual Monitoring Reports

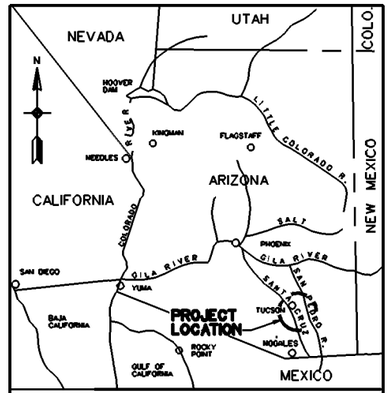
Annual reports summarizing monitoring results of the habitat restoration will be submitted to the USACE and the Pima County Regional Flood Control District within two months of the end of the monitoring year. The quantitative monitoring section will include survey methods, data summary analyses, comparison to performance standards, discussions, reporting remedial actions, recommendations, and photo documentation. Each annual report will compare findings of the current year with those in previous years.

6.0 Work Plan Drawings

Work Plan drawings provided in a separate CD.

7.0 USACE Engineering Drawings

INDEX TO DRAWINGS



VICINITY MAP

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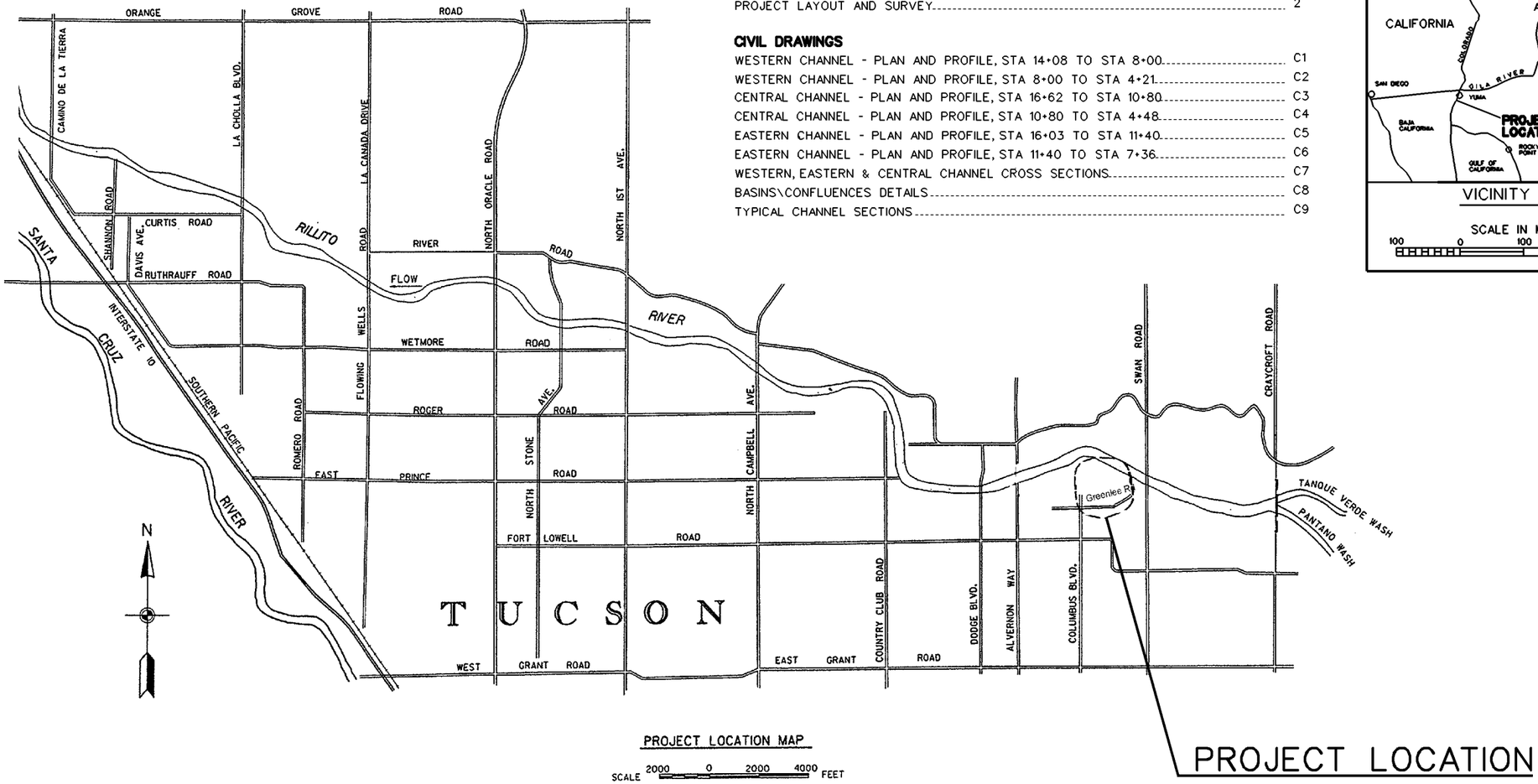

PROJECT LOCATION MAP

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RILLITO RIVER, TUCSON, ARIZONA
RILLITO RIVER
ECOSYSTEM RESTORATION PROJECT
PROJECT LOCATION; VICINITY MAP AND INDEX

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
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CORPS OF ENGINEERS

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1	463,904.33	1,014,495.71	34° 51' 29"	125.00	39.24	76.05	12+91.30	13+67.35
2	464,165.53	1,014,676.09	79°45' 20"	275.00	229.75	382.80	8+60.07	12+42.87
3	464,411.95	1,014,428.58	45°07' 38"	250.00	103.88	196.90	6+47.54	8+44.44
4	464,630.85	1,014,428.58	40° 31' 07"	250.00	92.28	176.80	4+47.99	6+24.79

CENTRAL CHANNEL								
P.I. NO.	NORTHING	EASTING	Δ	R=	T=	L=	B.C. STA.	E.C. STA.
5	464,122.30	1,014,825.54	82° 18' 13"	125.00	109.24	179.56	13+26.40	15+05.96
6	464,321.19	1,015,015.70	96°53' 51"	125.00	141.03	211.40	10+90.07	13+01.47
7	464,490.53	1,014,789.62	22°37' 46"	150.00	30.01	59.24	9+19.35	9+78.59
8	464,613.42	1,014,717.11	59°27' 55"	150.00	85.66	155.66	7+36.67	8+92.30
9	464,613.42	1,014,443.47	49°28' 53"	250.00	115.20	215.90	4+47.99	6+63.89

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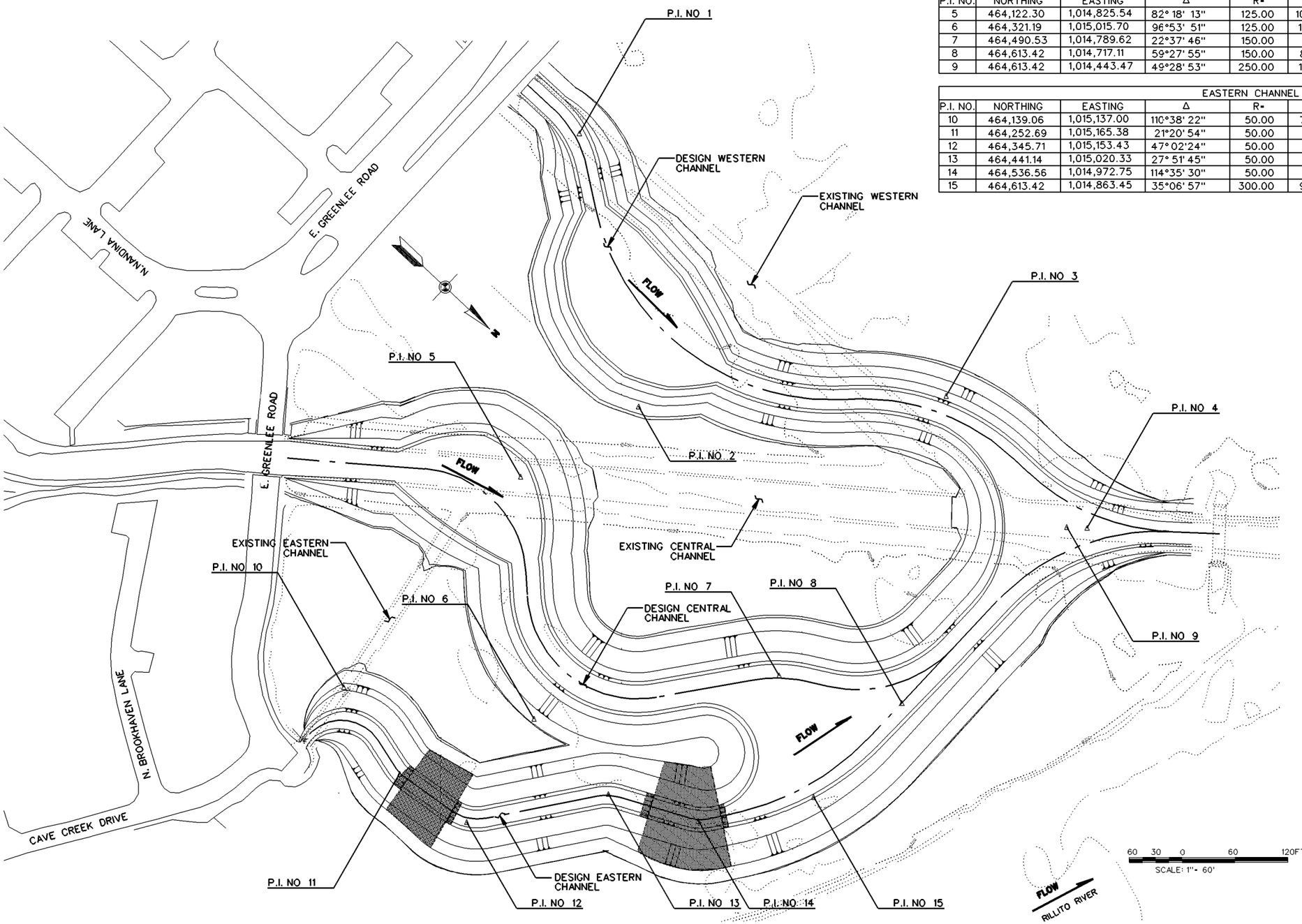
11	464,252.69	1,015,165.38	21°20' 54"	50.00	9.42	18.63	14+47.59	14+66.22
12	464,345.71	1,015,153.43	47°02'24"	50.00	21.76	41.05	13+43.94	13+84.99
13	464,441.14	1,015,020.33	27° 51' 45"	50.00	12.40	24.31	11+90.01	12+14.33
14	464,536.56	1,014,972.75	114°35' 30"	50.00	12.64	24.77	10+83.66	11+08.43
15	464,613.42	1,014,863.45	35°06' 57"	300.00	94.92	183.87	8+73.75	10+57.61



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RILLITO RIVER
ECOSYSTEM RESTORATION PROJECT
PROJECT LAYOUT AND SURVEY

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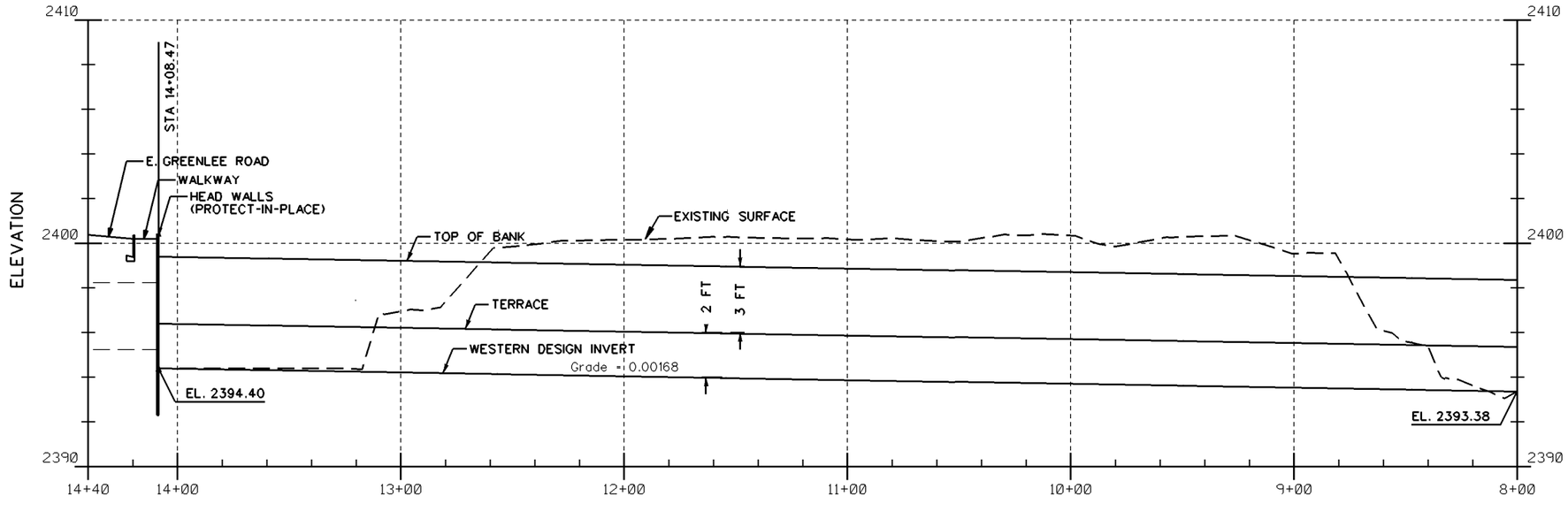

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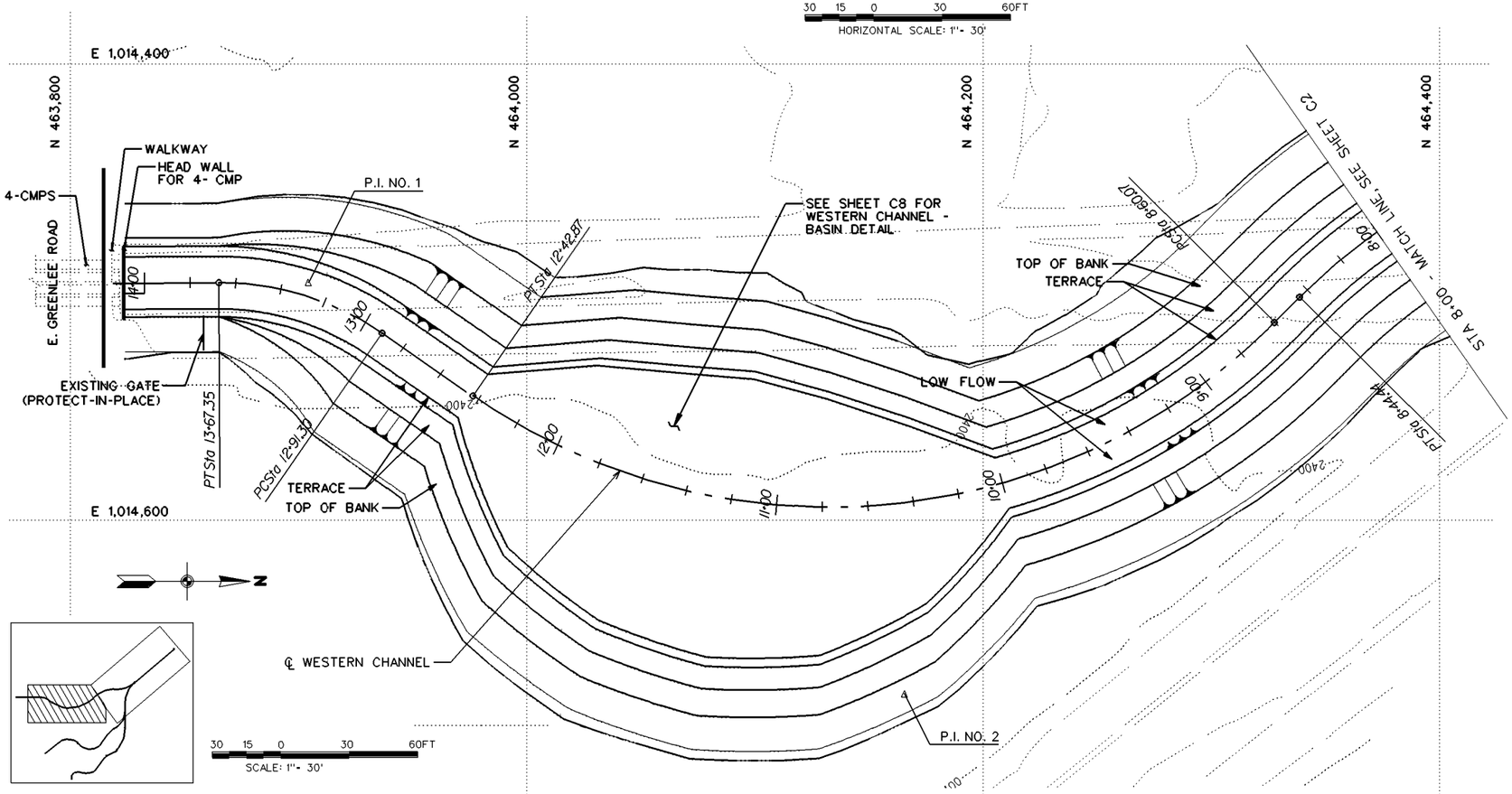

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RILLITO RIVER
ECOSYSTEM RESTORATION PROJECT
WESTERN CHANNEL - PLAN AND PROFILE,
STA 14+08 TO STA 8+00

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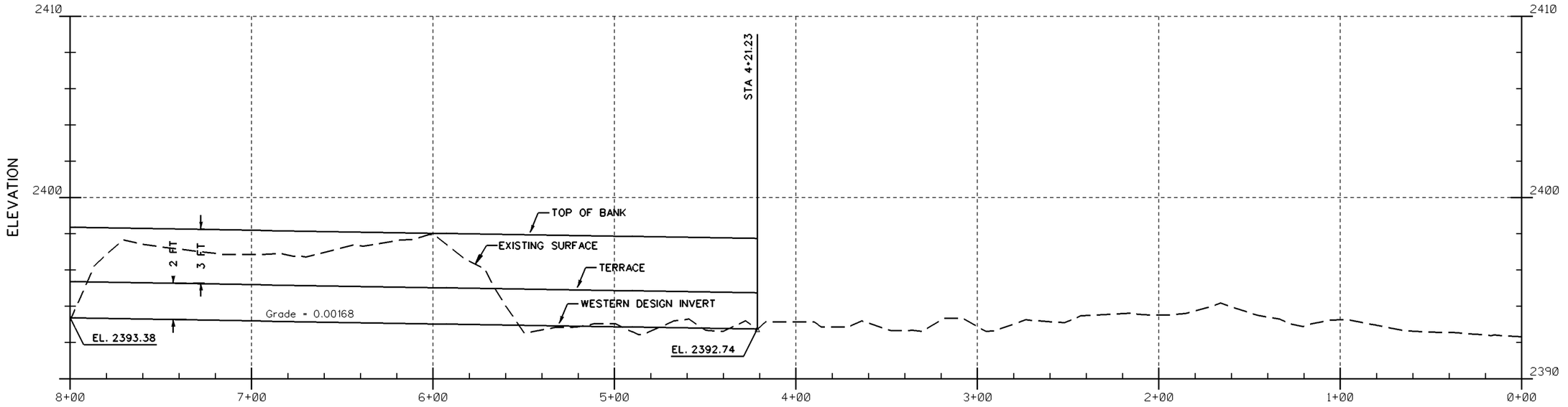

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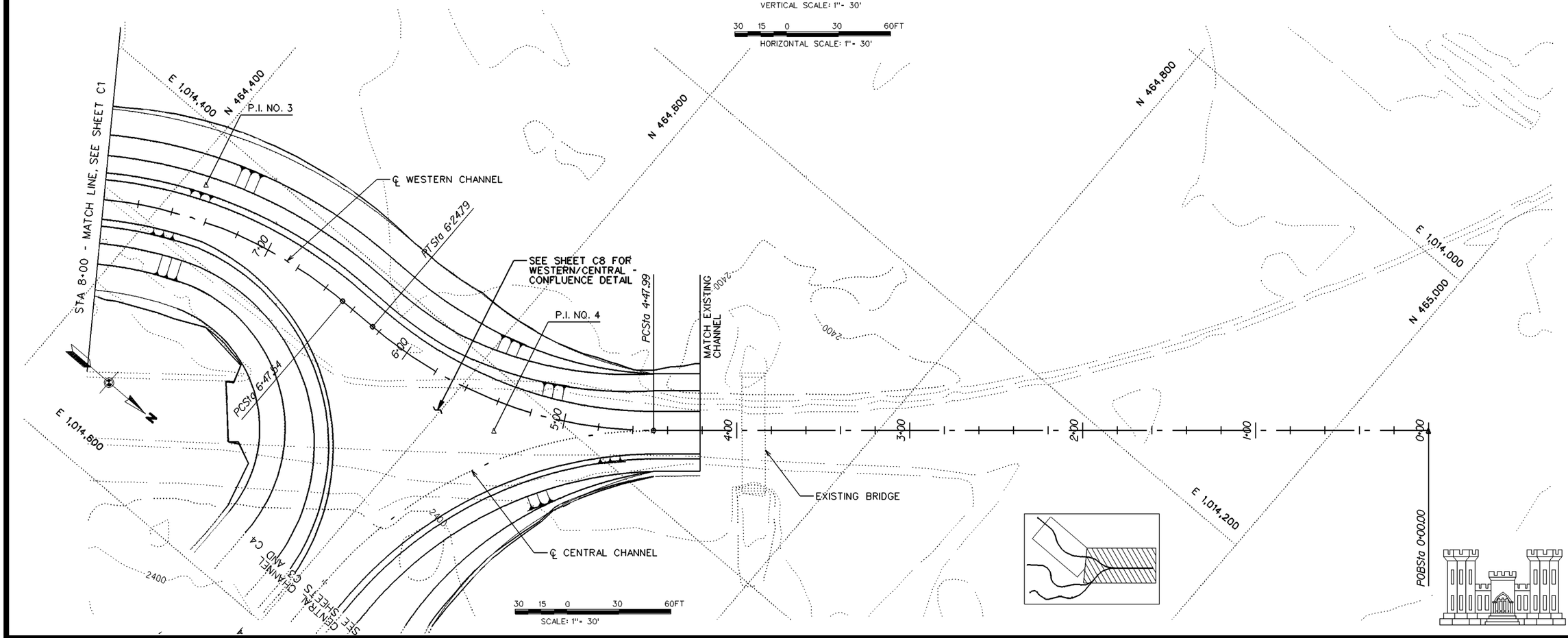

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RILLITO RIVER
ECOSYSTEM RESTORATION PROJECT
WESTERN CHANNEL - PLAN AND PROFILE,
STA 8+00 TO STA 4+21

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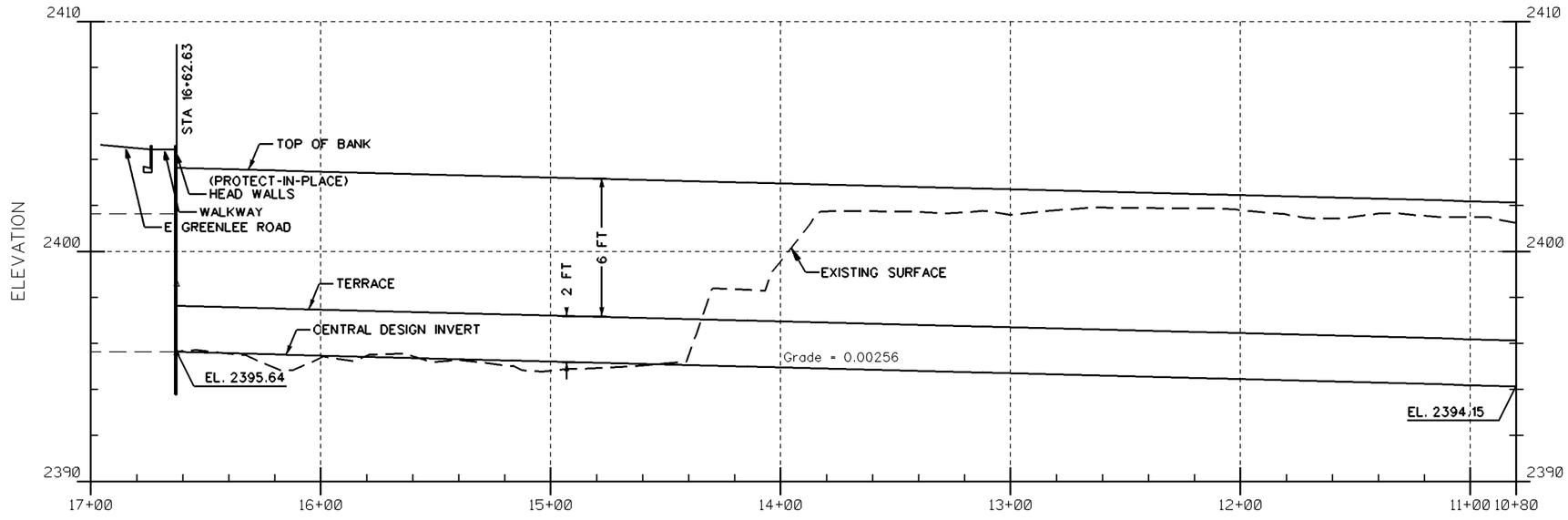

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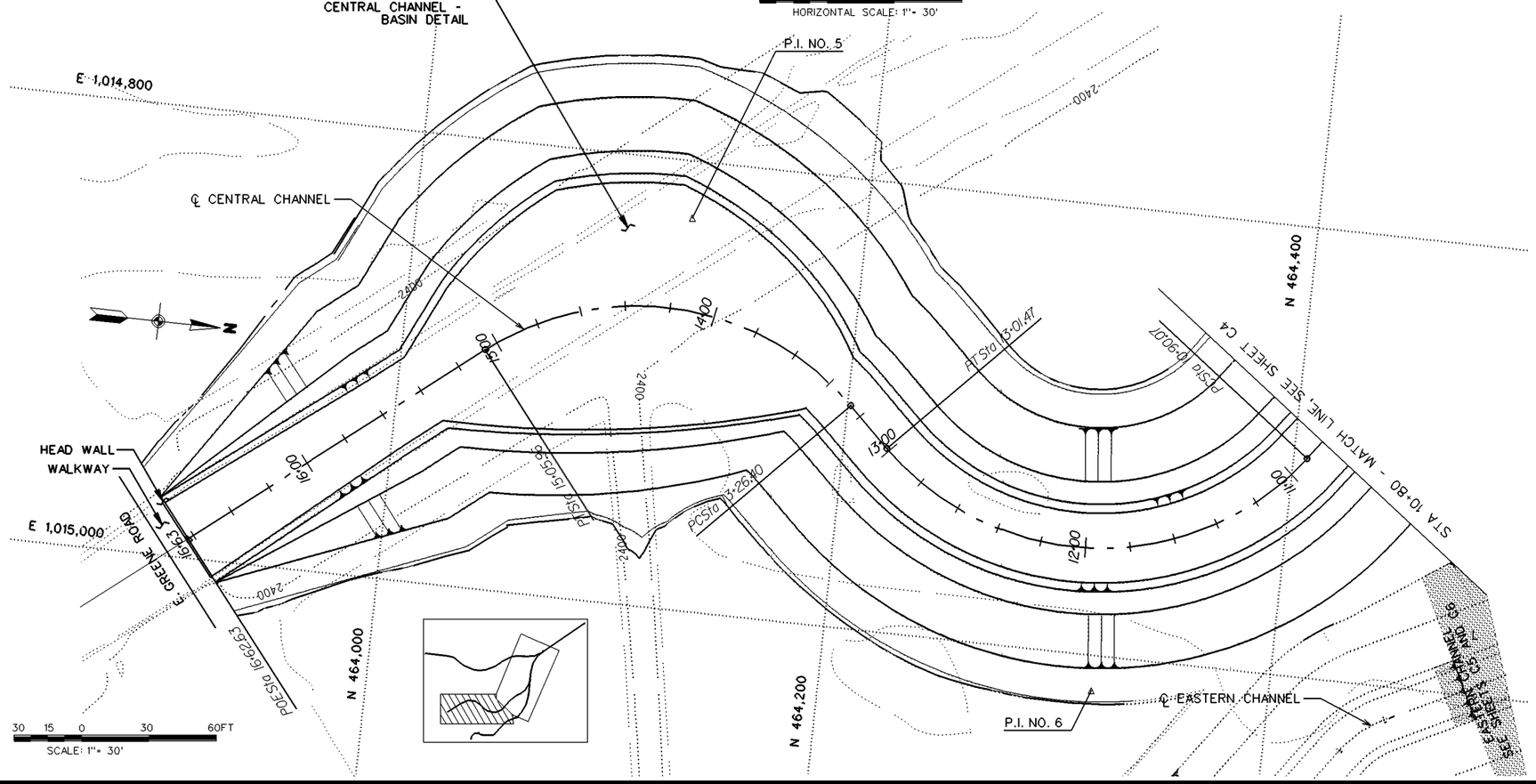

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RILLITO RIVER
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CENTRAL CHANNEL - PLAN AND PROFILE,
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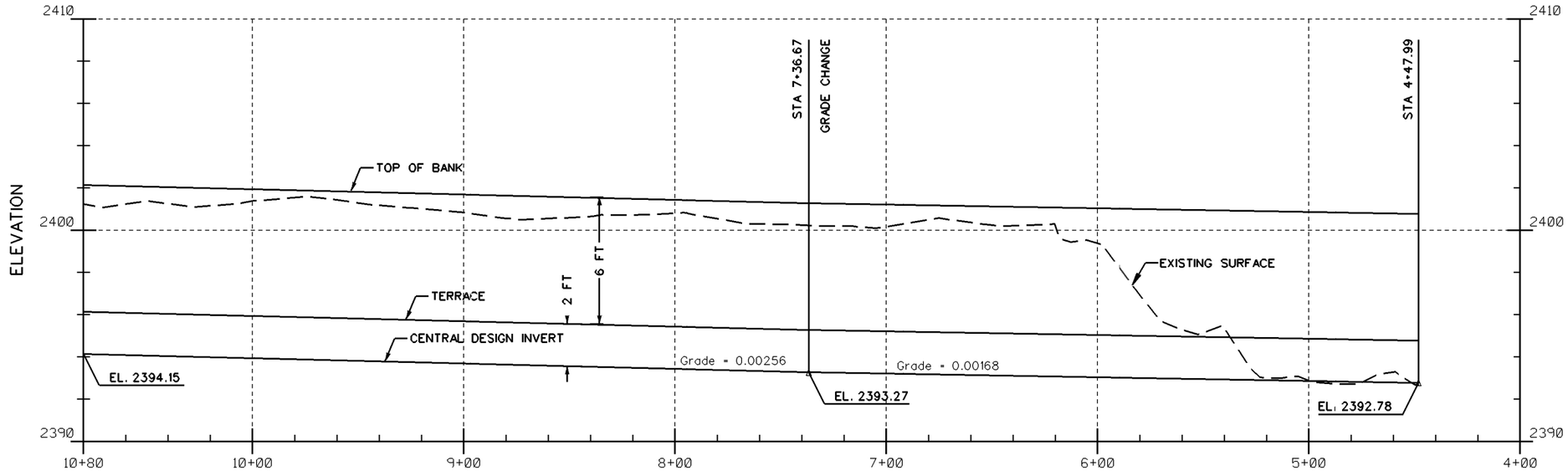

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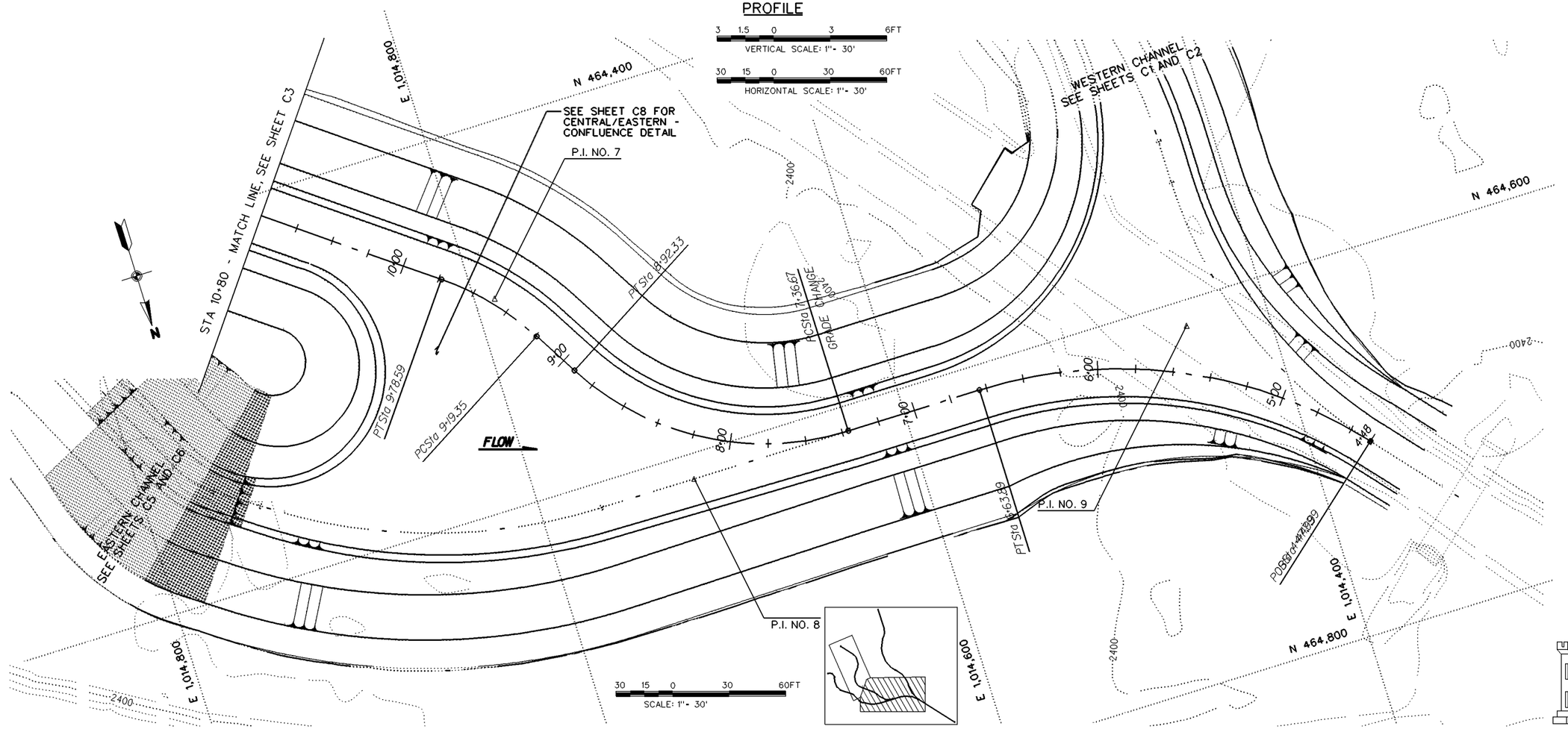

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RILLITO RIVER
ECOSYSTEM RESTORATION PROJECT
CENTRAL CHANNEL - PLAN AND PROFILE,
STA 10+80 TO STA 4+48

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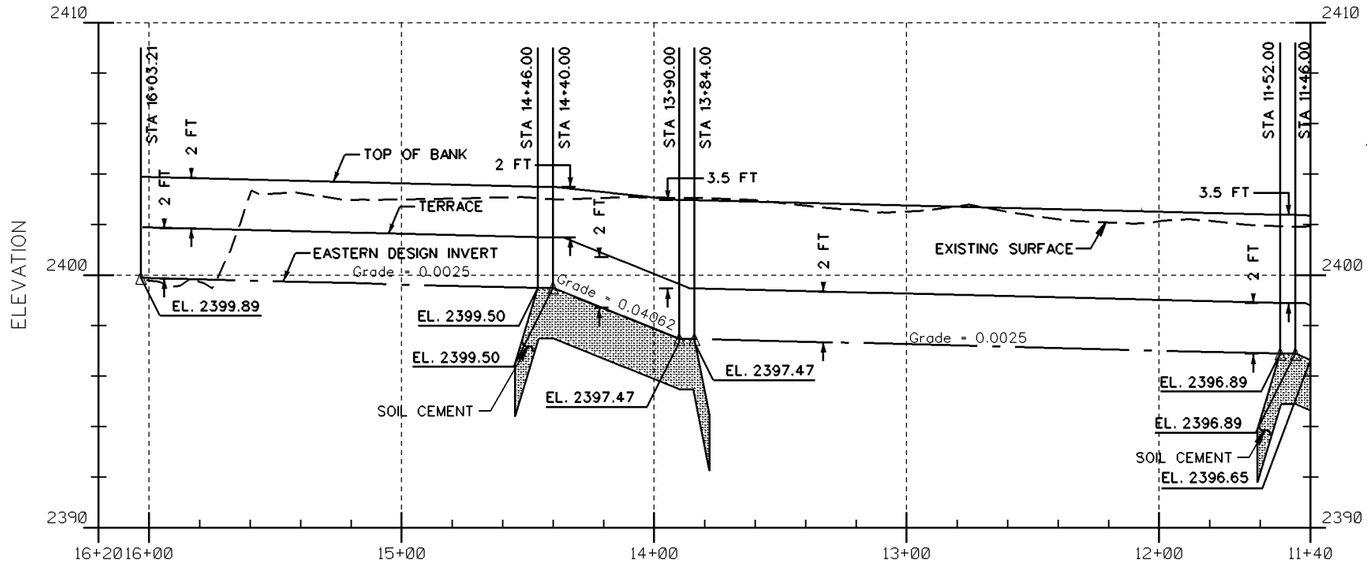

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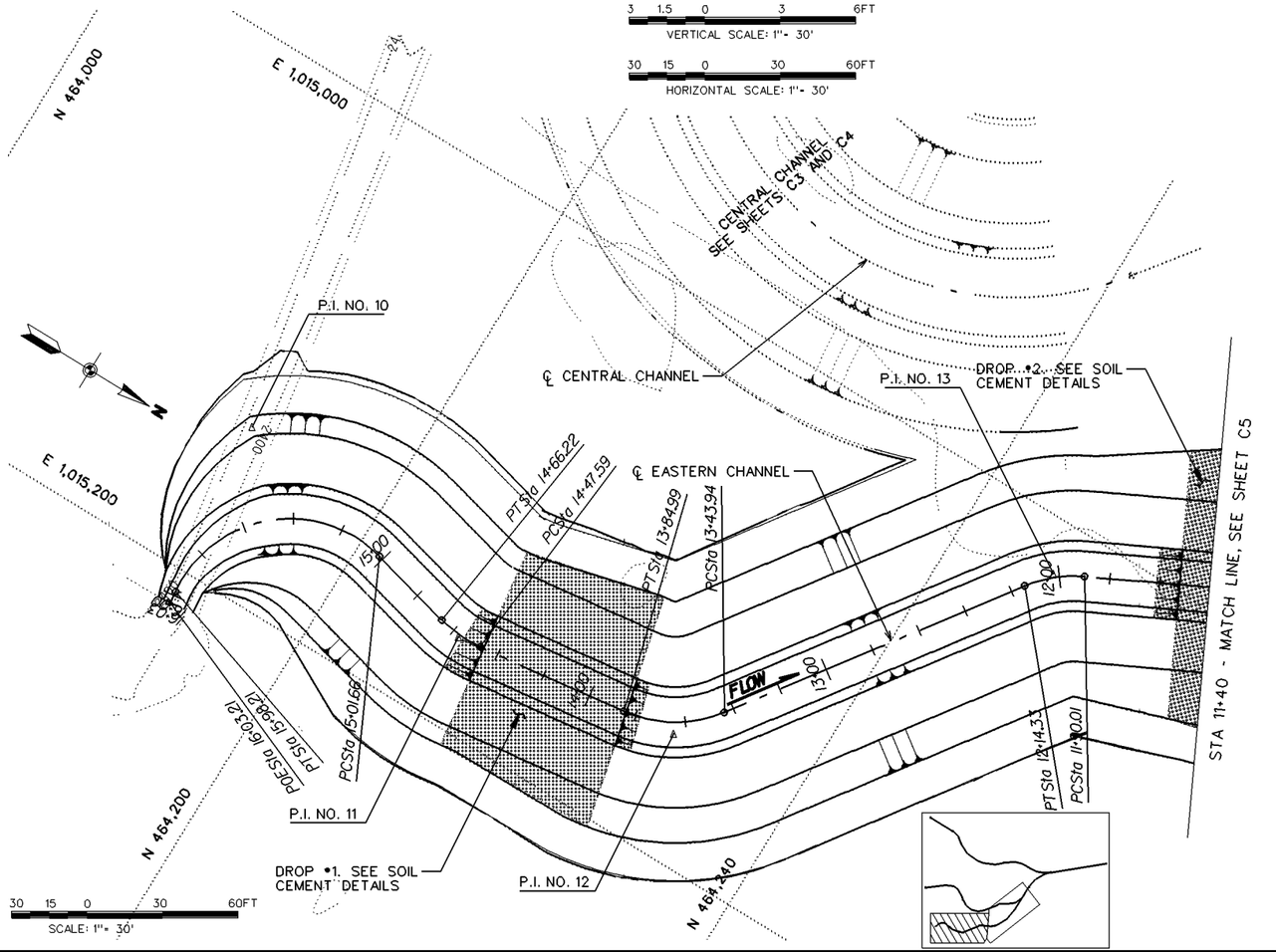

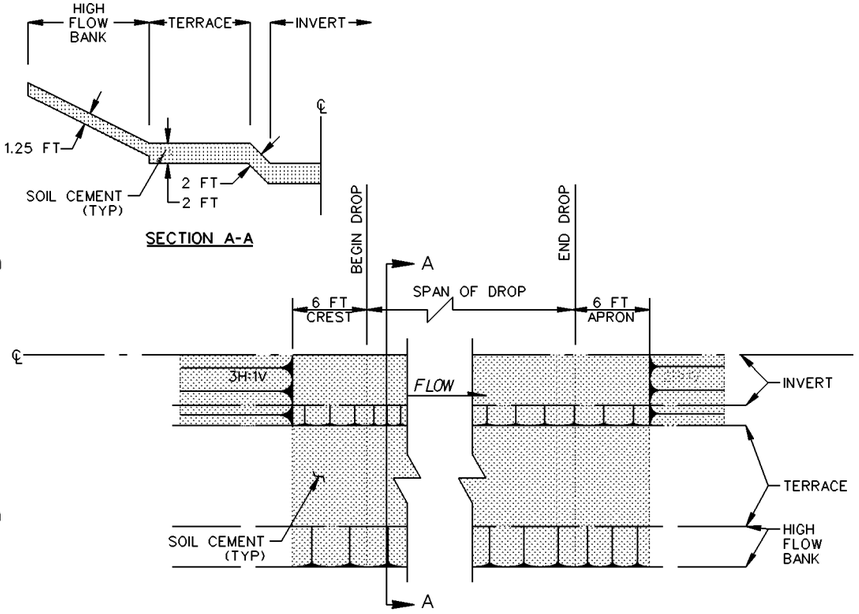

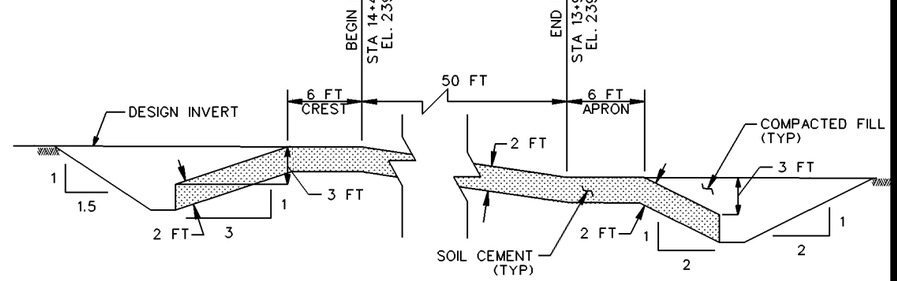

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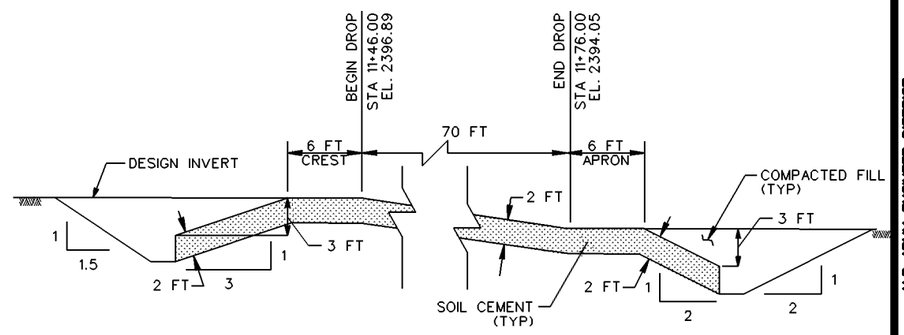

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RILLITO RIVER
ECOSYSTEM RESTORATION PROJECT
EASTERN CHANNEL - PLAN AND PROFILE,
STA 16+03 TO STA 11+40

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

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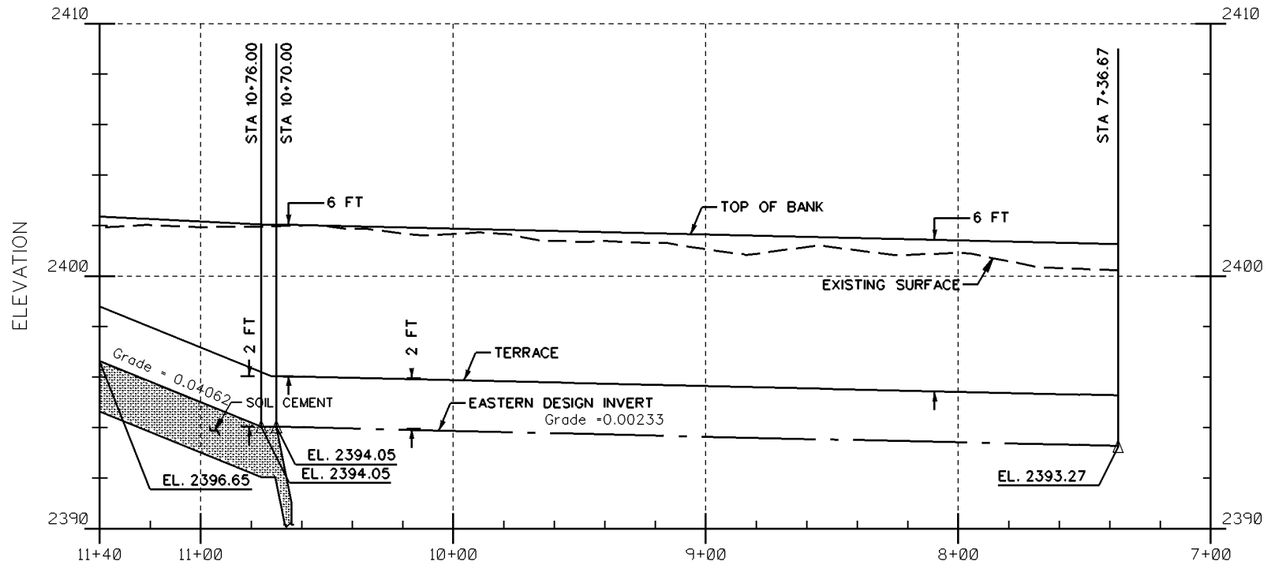

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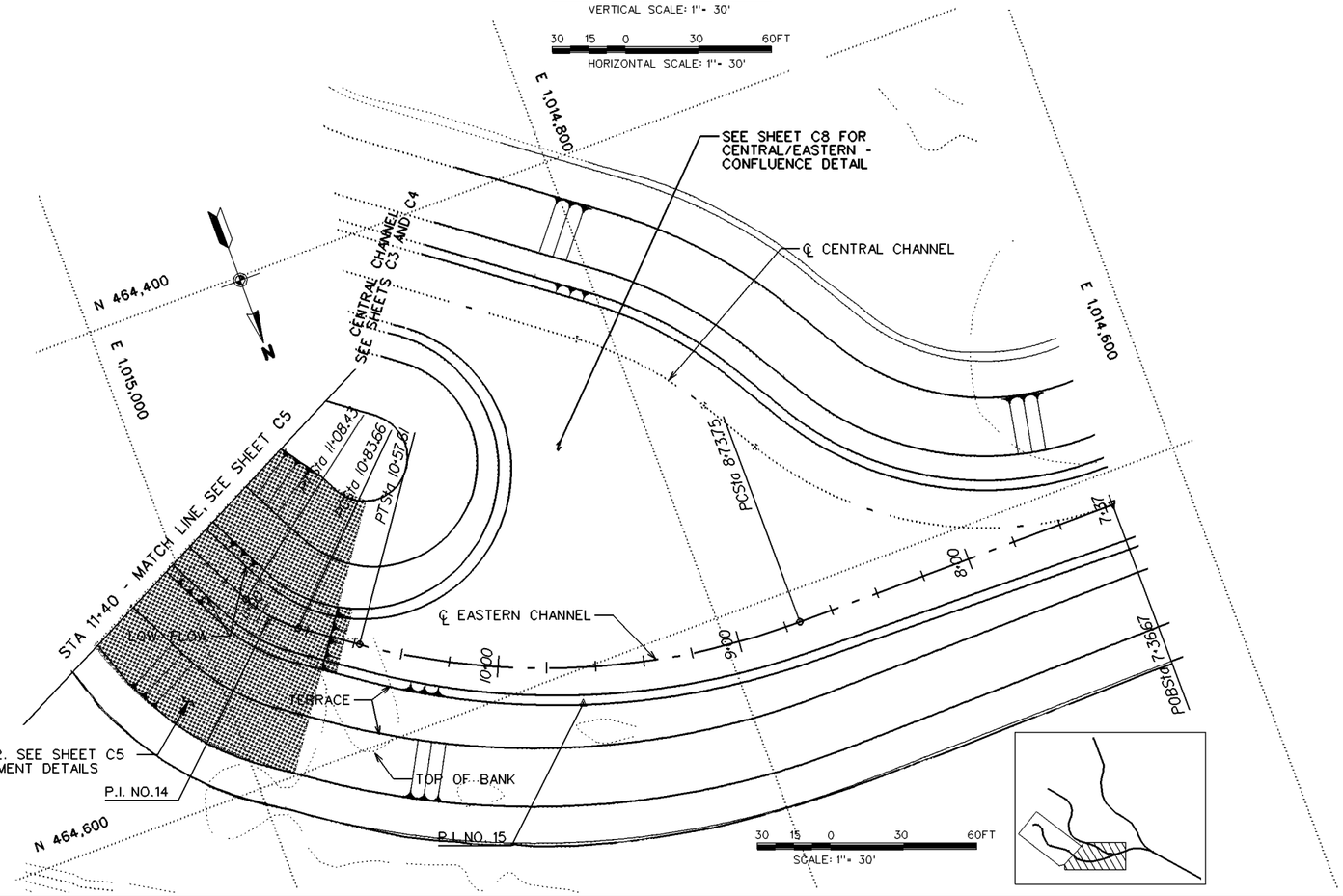

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

RILLITO RIVER, TUCSON, ARIZONA
RILLITO RIVER
ECOSYSTEM RESTORATION PROJECT
EASTERN CHANNEL - PLAN AND PROFILE,
STA 11+40 TO STA 7+36

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

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SUBMITTED BY:
DISTRICT FILE NO.

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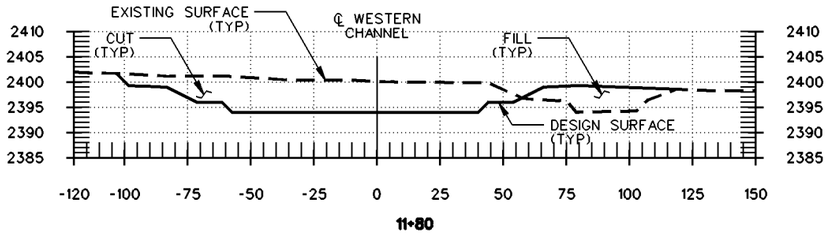
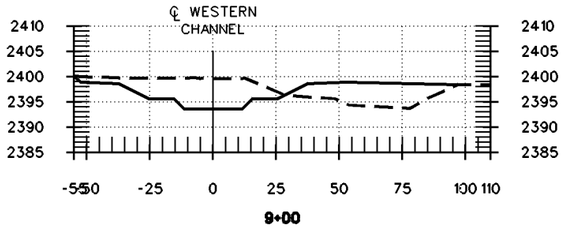
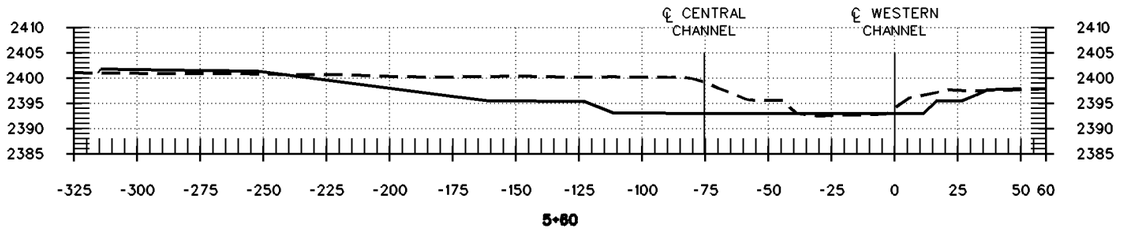
30:1

Plotted on _DATE_ ;at _TIME_ Filename: $FILE$

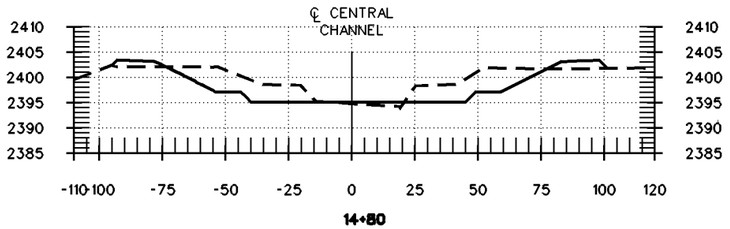
WESTERN ALIGNMENT

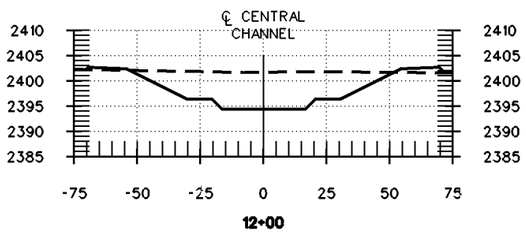


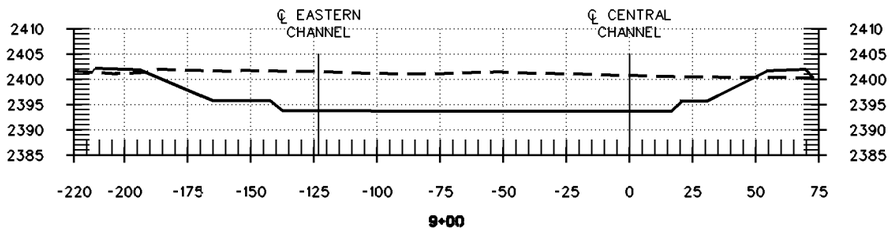




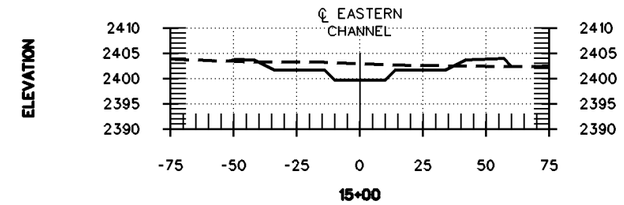
CENTRAL ALIGNMENT

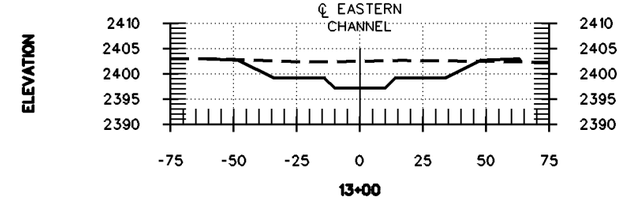


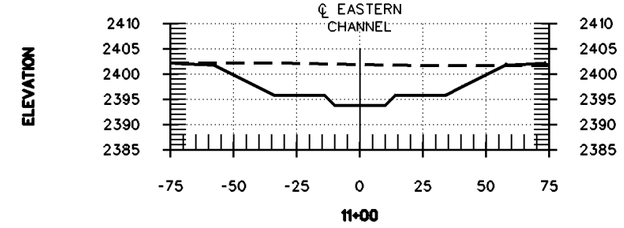




EASTERN ALIGNMENT







NOTES:
1. CROSS ARE TAKEN LOOKING UPSTREAM

REVISIONS

SYMBOL	DESCRIPTIONS	DATE	APPROVAL

RILLITO RIVER, TUCSON, ARIZONA
RILLITO RIVER
ECOSYSTEM RESTORATION PROJECT
WESTERN, CENTRAL & EASTERN CHANNEL CROSS SECTIONS

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

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SUBMITTED BY:
CADD FILE NAME:
DISTRICT FILE NO.

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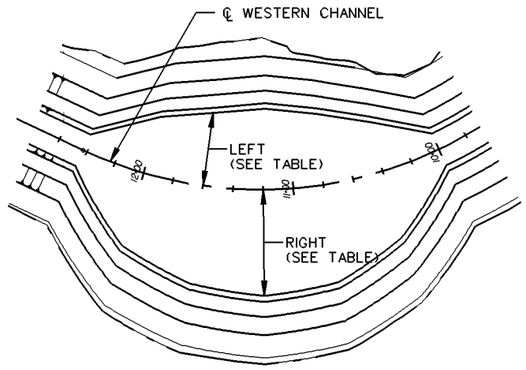
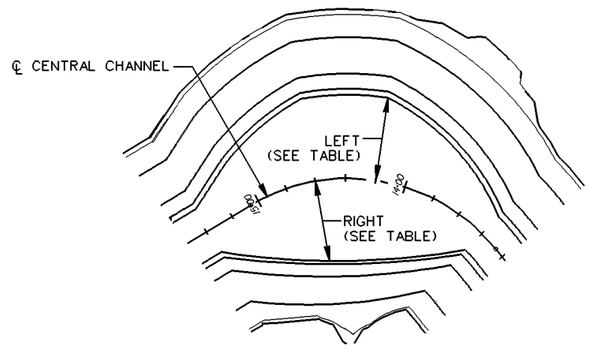


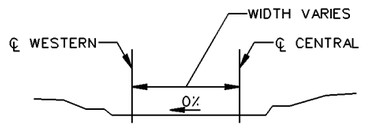
WESTERN ALIGNMENT		
STA	LEFT	RIGHT
10+00	11.5	11.5
10+40	34.3	45.0
10+80	47.8	65.0
11+20	53.5	70.0
11+60	48.5	65.0
12+00	38.6	50.0
12+43	11.5	11.5

WESTERN CHANNEL - BASIN DETAIL

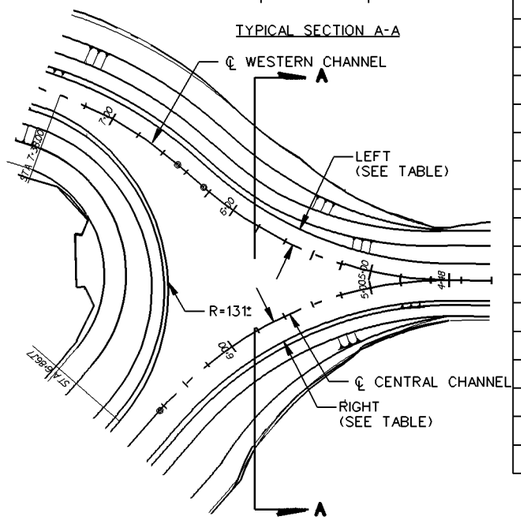


CENTRAL ALIGNMENT		
STA	LEFT	RIGHT
13+80	16.5	16.5
13+80	35.5	40.0
14+20	55.0	50.0
14+60	55.0	50.0
15+00	35.0	37.5
15+40	16.5	16.5

CENTRAL CHANNEL - BASIN DETAIL

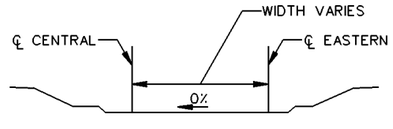


TYPICAL SECTION A-A

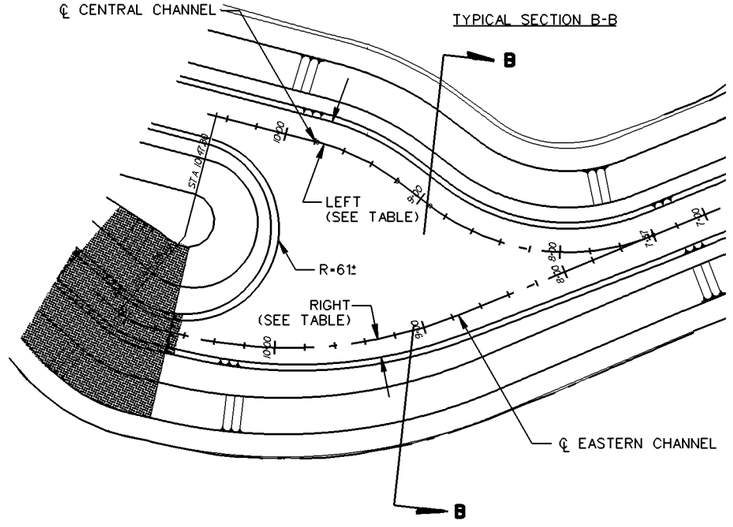


DIST TO BOTTOM OF LEFT/RIGHT LOW FLOW BANK		
	WESTERN ALIGNMENT	CENTRAL ALIGNMENT
STA	LEFT	RIGHT
4+60	11.0	14.7
4+80	11.1	14.9
5+00	11.2	15.0
5+20	11.3	15.2
5+40	11.4	15.4
5+60	11.4	15.6
5+80	11.5	15.7
6+00	11.5	15.9
6+20	11.5	16.1
6+40	11.5	16.3
6+60	11.5	16.4
6+80	11.5	16.5
7+00	11.5	
7+20	11.5	
7+40	11.5	

WESTERN/CENTRAL - CONFLUENCE DETAIL



TYPICAL SECTION B-B



DIST TO BOTTOM OF LEFT/RIGHT LOW FLOW BANK		
	CENTRAL ALIGNMENT	EASTERN ALIGNMENT
STA	LEFT	RIGHT
7+60	16.5	15.1
7+80	16.5	14.8
8+00	16.5	14.4
8+20	16.5	14.1
8+40	16.5	13.7
8+60	16.5	13.4
8+80	16.5	13.0
9+00	16.5	12.7
9+20	16.5	12.3
9+40	16.5	12.0
9+60	16.5	11.6
9+80	16.5	11.3
10+00	16.5	10.9
10+20	16.5	10.6
10+40	16.5	10.3
10+60	16.5	10.0
10+80		10.0

CENTRAL/EASTERN - CONFLUENCE DETAIL

NOTE:
LEFT / RIGHT TAKEN
LOOKING DOWNSTREAM

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
	REVISIONS		

RILLITO RIVER, TUCSON, ARIZONA
RILLITO RIVER
ECOSYSTEM RESTORATION PROJECT
BASINS/CONFLUENCES DETAILS

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

DESIGNED BY:
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SUBMITTED BY:
CADD FILE NAME:
DISTRICT FILE NO.

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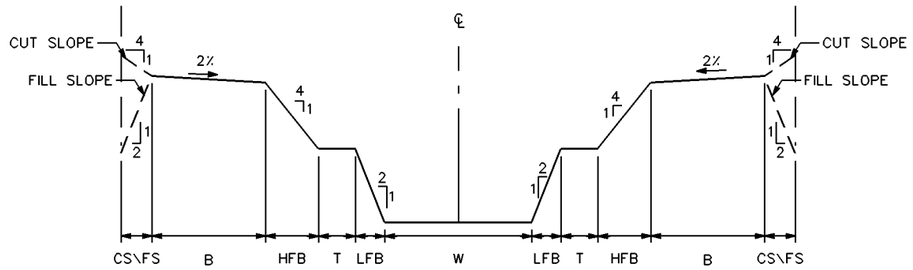
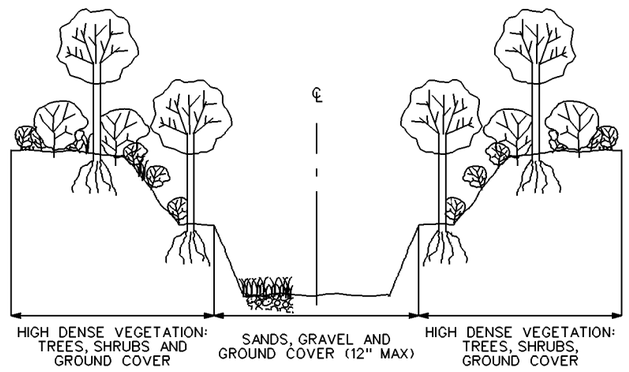
Plotted on _DATE_ ;at _TIME_ Filename: $FILE$



CHANNEL TEMPLATE

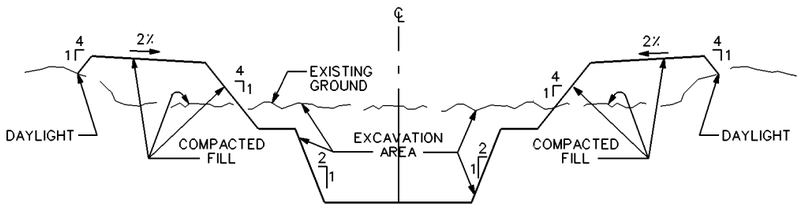
(SEE TABLE 1 FOR CHANNEL DIMENSIONS)
NOT TO SCALE



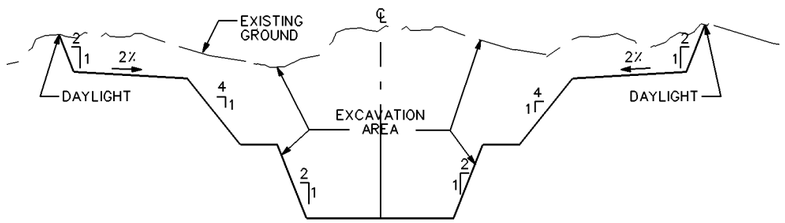
LANDSCAPE

NOT TO SCALE

NOTES:
1. FOR MORE INFORMATION ON THE TYPES OF TREES AND SHRUBS, SEE REPORT TITLED, "RILLITO RIVER, PIMA COUNTY, ARIZONA, ECOSYSTEM RESTORATION REPORT AND ENVIRONMENTAL ASSESSMENT."



FILL



CUT

EARTHWORK SECTIONS

NOT TO SCALE

TABLE 1 - CHANNEL DIMENSIONS

WESTERN CHANNEL						
STA	W	LFB	T	HFB	B	CS/FS
14+08	EXISTING					
13+67	EXISTING					
12+91	23	4	10	12	15	VARIES
12+43	23	4	10	12	15	VARIES
12+43 - 10+00	×W	4	10	12	15	VARIES
10+00	23	4	10	12	15	VARIES
7+38	23	4	10	12	15	VARIES
7+38 - 5+80^{L}	×W	4	10-30	12	15	VARIES
5+80 - 4+21^{L}	×W	4	30-EXISTING	12-0	15-0	VARIES
4+21^{L}	MATCH EXISTING					

CENTRAL CHANNEL						
STA	W	LFB	T	HFB	B	CS/FS
16+62	EXISTING					
15+40	33	4	10	24	15	VARIES
15+40 - 13+40	×W	4	10	24	15	VARIES
13+40	33	4	10	24	15	VARIES
10+53	33	4	10	24	15	VARIES
10+53 - 7+37^{L}	×W	4	10	24	15	VARIES
7+37	33	4	10	24	15	VARIES
6+72	33	4	10	24	15	VARIES
6+72 - 5+80^{R}	×W	4	10	24	15	VARIES
5+80 - 4+48^{R}	×W	4 - EXISTING	10 - EXISTING	24 - 0	15 - 0	VARIES
4+48^{R}	MATCH EXISTING					

EASTERN CHANNEL						
STA	W	LFB	T	HFB	B	CS/FS
16+03	EXISTING					
15+93	EXISTING					
14+40	20	4	20	8	15	VARIES
13+90	20	4	20	14	15	VARIES
11+90	20	4	20	14	15	VARIES
11+20	20	4	20	24	15	VARIES
10+54	20	4	20	24	15	VARIES
10+54 - 7+37^{R}	×W	4	20	24	15	VARIES

W --- WIDTH OF CHANNEL LOW FLOW
LFB --- WIDTH OF LOW FLOW BANK
T --- WIDTH OF TERRACE
HFB --- WIDTH OF HIGH FLOW BANK
B --- WIDTH OF BENCH
CS/FS --- WIDTH OF CUT OR FILL SLOPE

×W --- SEE SHEET C8 FOR DETAILS ON WIDTH
4+50$^{L/R}$ --- CHANNEL DIMENSIONS APPLY ONLY TO LEFT OR RIGHT BANK (LOOKING DOWNSTREAM)

SYMBOL	DESCRIPTIONS	DATE	APPROVAL

REVISIONS

RILLITO RIVER, TUCSON, ARIZONA
RILLITO RIVER
ECOSYSTEM RESTORATION PROJECT
TYPICAL SECTIONS

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

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DISTRICT FILE NO.

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100:1

8.0 Literature cited

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