EcoPlan Associates, Inc.
Environmental Science & Resource Economics

Transmittal

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To:	Ramzi Georges, David Evans and Associates, Inc.
From:	Ron van Ommeren
Project Number:	AWPF Grant No. 07-142
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Regarding:	Summary Report–First Submittal

Comments: Enclosed is the first submittal of the Summary Report for this project. Please review and provide comments. If you have questions, please contact me at (480) 733-6666, ext. 126, or at rvanommeren@ecoplanaz.com.

Summary Report

Reduction of Erosion and Sedimentation Along the Lower San Pedro River Through Hydrologic Restoration of Modified Ephemeral Washes

AWPF Grant No. 07-142

September 2014

Summary Report

Reduction of Erosion and Sedimentation Along the Lower San Pedro River Through Hydrologic Restoration of Modified Ephemeral Washes

AWPF Grant No. 07-142

Submitted to:
Arizona Water Protection Fund
Arizona Department of Water Resources
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September 18, 2014

The Arizona Water Protection Fund Commission has funded all or a portion of this report or project. The views or findings presented are the grantee's and do not necessarily represent those of the commission, the state, or the Arizona Department of Water Resources.

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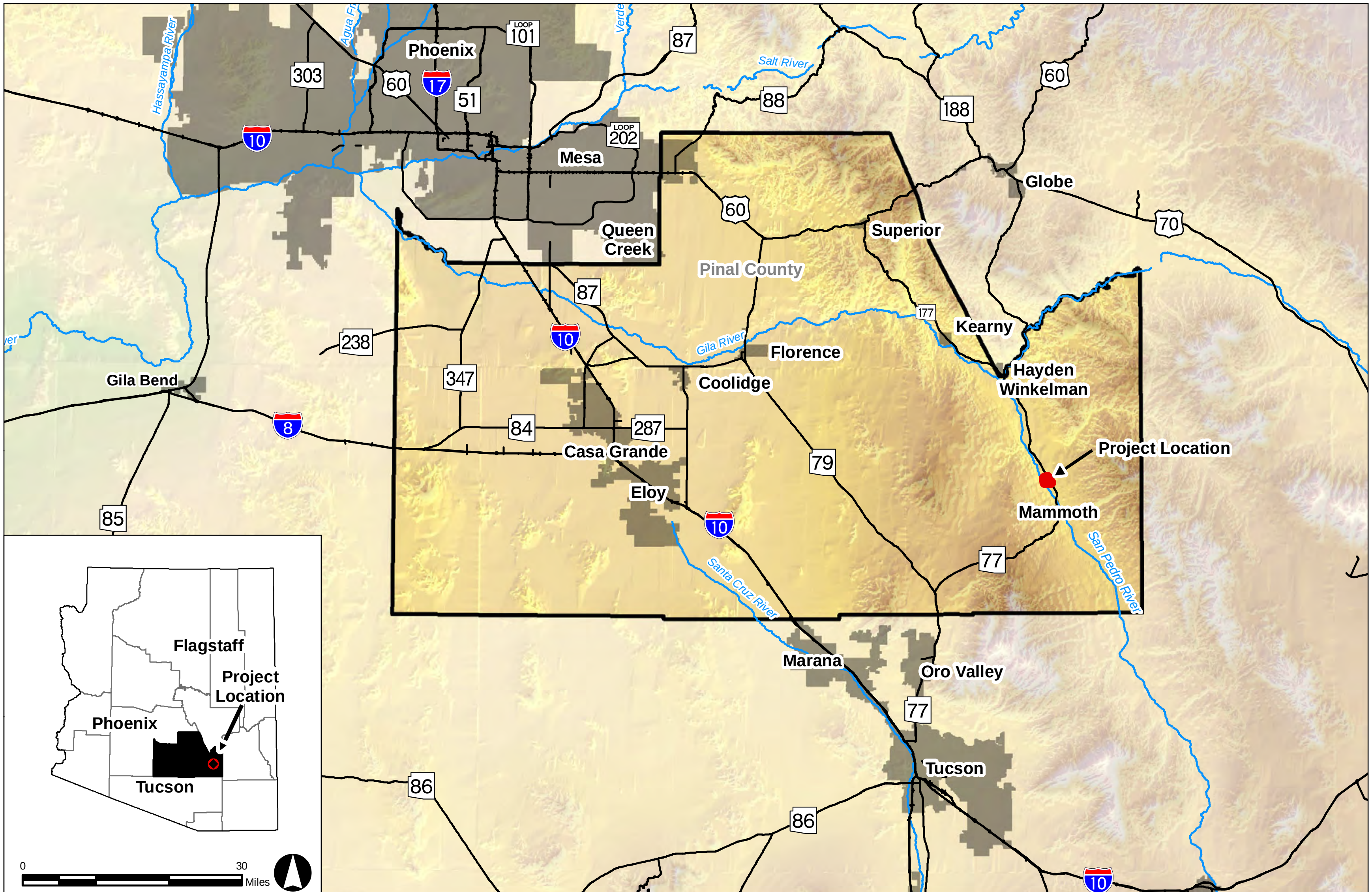
Introduction

This report summarizes activities associated with the hydrologic restoration of modified ephemeral washes along a reach of the Lower San Pedro River in Pinal County, Arizona (Figure 1). The project area is along State Route (SR) 77, approximately 4 miles north of Mammoth within a portion of Section 36 in Township 7 South, Range 16 East on the Lookout Mountain (1972), Arizona, United States (US) Geological Survey 7.5-minute quadrangle (Figures 2–3).

The purpose of the restoration project was to address massive erosion problems that resulted from the alteration of natural historical washes as land was cleared and leveled for agricultural purposes. Prior to restoration, the project site was vacant, undeveloped land previously used for farming. The two washes in the project area (North Wash and South Wash) that flow under SR 77 through concrete box culverts were conveyed via a constructed channel (ditch) to the Lower San Pedro River. The ditch was originally constructed to divert the flow from the two washes north and then west around the agricultural fields to prevent erosion and seasonal flooding of the fields. The agricultural fields and the ditch were subsequently abandoned and are no longer maintained. A breach in the ditch bank (berm) occurred at the beginning of the North Wash in the project area where flow broke out and tried to continue in its historic path (Figure 3).

Restoration was funded through Arizona Department of Water Resources Arizona Water Protection Fund (AWPF) Grant No. 07-142 and involved filling the ditch between the two washes, removing the associated berm, recontouring the transition between the uplands and the terrace of the agricultural fields, constructing two channels to restore the natural (historic) flow pattern, and re-establishing native plant communities to stabilize all construction areas. Flow to the North Wash was restored through a grade-separation diversion from the South Wash, with flows continuing down a portion of the irrigation ditch before entering the North Wash channel alignment. Project implementation consisted of design plan development, channel excavation and filling, agricultural field/upland/terrace recontouring, native vegetative seeding and irrigation, invasive/exotic species maintenance, and monitoring. Specific project tasks identified in the AWPF grant and their completion status and dates are listed in Table 1.



Reduction of Erosion and Sedimentation Along the Lower San Pedro River Through Hydrologic Restoration of Modified Ephemeral Washes

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Figure 1. Project area

Reduction of Erosion and Sedimentation Along the Lower San Pedro River Through Hydrologic Restoration of Modified Ephemeral Washes

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Figure 2. Project vicinity

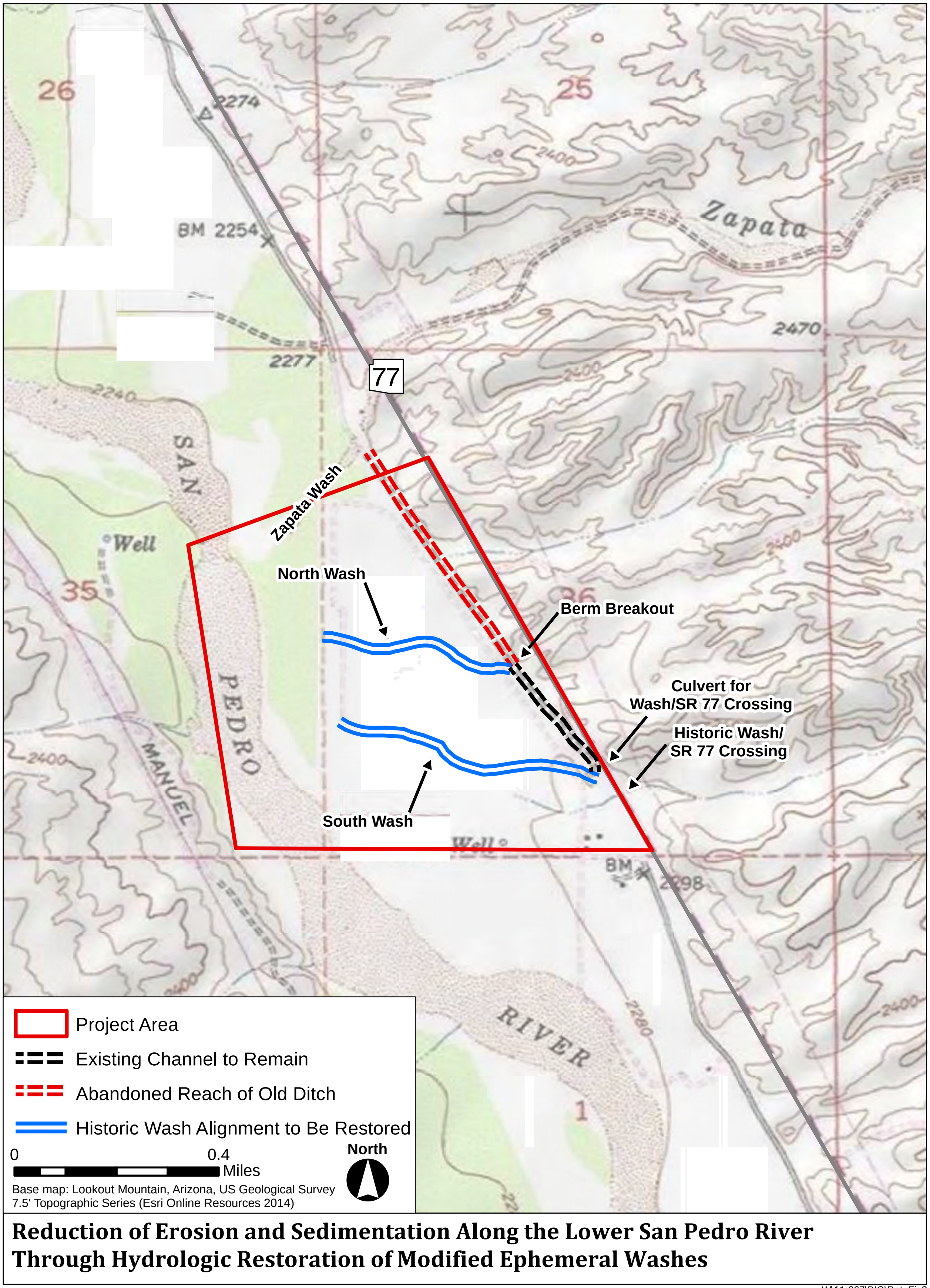


Figure 3. Preconstruction conditions and ephemeral drainages proposed for hydrologic restoration

Table 1. Project tasks, completion status and appendix reference, and completion date

Task	Description	Completion Status and Appendix Reference	Completion (Report) Date
1	Permits, clearances, authorizations and agreements	Complete (see Appendix A–Permits)	April 2011
2	Development of project work plans	Complete (see Appendix B–Project Work Plans)	April 2011
3	Deconstruction of the existing ditch system and restoration of historic washes	Complete (see Appendix C–Field Reports, Appendix D–Restoration Completion Report)	August 2011
4	Fence and supplemental irrigation construction	Complete (see Appendix E–Fence Construction, Deconstruction, and Supplemental Irrigation Completion Report)	December 2011
5	Implement the project revegetation plan	Complete (see Appendix F–Revegetation Completion Report)	December 2011
6	Implement monitoring	Complete (see Appendix G–Aerial and Topographic Monitoring, Appendix H–Baseline Monitoring Report, Appendix I–Post-construction Monitoring Report, Appendix J–Quarterly Reports, Appendix K–Field Notes	April 2014
7	Final report	This report	August 8, 2014

Objectives identified for monitoring were to (1) document the entire project in a manner that demonstrates successful completion of the project tasks, which will also provide information useful to future design of similar types of projects, (2) document the progress of the revegetation effort in a manner that records the status of the planting and provides information that will inform adaptive management of the site, and (3) document the geomorphic status of the excavated washes. Specific research questions were:

- ***Vegetation Establishment***—Did planted and irrigated vegetation become established and resilient enough to stop supplemental irrigation after the monitoring period?
- ***Channel Stability***—Did the grasses establish as planned within incised floodplain? Did channel design and revegetation plan create for stabilizing channel conditions at the site?
- ***Reduction in Erosion and Sedimentation***—Did implementation of the project, including revegetation efforts, successfully reduce erosion across the site?
- ***Weed Control***—Did Indian wheat outcompete Russian thistle?
- ***Project Success***—Is this a restoration model to restore conditions in similar sites and natural habitat on tributary ephemeral washes?

This report describes restoration methodologies used and the outcome of identified project tasks, analyzes field and other monitoring data collected, makes recommendations for any changes or future actions, and evaluates project success in meeting the stated objectives and research questions.

Methods

Deconstruction of the Existing Ditch System and Restoration of Historic Washes

Project activities related to deconstruction of the existing ditch system and restoration of historic washes occurred between June and August 2011. Survey and staking of the project area and mobilization of construction equipment occurred on June 22 and 23, 2011. Construction equipment included a fuel truck, water tender, bulldozer, tractor with a double skidder, and an excavator. The tractor was used for rough grading and moving dirt. A Global Positioning System (GPS)–guided grader and a manual guided grader were used for finer grading work.

The berm/ditch deconstruction and wash construction occurred simultaneously during cut and fill activities. However, channel grading was completed prior to restoration of the historic flow pattern to avoid potential damage to the channels during construction. Soils were wetted with irrigation equipment to control fugitive dust during grading/cut and fill work. The topography of uplands and wash terrace area was recontoured and the two historic washes (North Wash and South Wash) were excavated and graded. About 3.5 acres of saltcedar (*Tamarix* sp.) was removed from the North Wash. Other weedy vegetation was removed from both washes. Fine grading of North Wash and South Wash and overbank construction was completed on August 9, 2011, in preparation for seeding.

Fence and Supplemental Irrigation Construction

Activities associated with this project task were completed between March 2010 and May 2011 and included fence deconstruction, construction, and maintenance; well rehabilitation; and installation of signage. In March 2010, approximately 3,000 linear feet of new Arizona Game and Fish Department standard fence was constructed along the south boundary of the project area to exclude wildlife and reduce impacts to the restoration area. Two gates were constructed to maintain access across the property. Between August and October 2010, approximately 2,000 linear feet of five-strand wire fence was removed from the location of berm removal, and recontouring and fencing materials were salvaged for later fence construction and repairs. On an ongoing (monthly) basis, the perimeter fence encircling the project area was patrolled and maintained, as needed. Well rehabilitation work was completed between June 2009 and September 2010 and included troubleshooting problems with the pump, connecting power service and installing a meter box, installing a new pump motor, and installing a flow meter to track water use. In March 2010, a sign was erected at the project site displaying information about the project.

Implement the Project Revegetation Plan

Site preparation and revegetation took place between August and September 2011 and included site preparation and seeding, with irrigation system setup, irrigation of seeded areas, and control of exotic plants occurring subsequently. Preparation for seeding involved mechanical cropping of existing vegetation, which consisted primarily of nonnative and/or invasive Russian thistle *(Salsola iberica),* amaranth (*Amaranthus* sp.), and silverleaf nightshade *(Solanum elaeagnifolium).* The 95-acre revegetation area was hydroseeded at a rate of 15 pounds of pure live seed per acre, with a mix of perennial trees and shrubs (velvet mesquite [*Prosopis velutina*], blue paloverde [*Parkinsonia florida*], creosote bush [*Larrea tridentata*], desert saltbush [*Atriplex polycarpa*], fourwing saltbush [*A. canescens*], and desert globemallow [*Sphaeralcea ambigua*]), perennial grasses (sand dropseed [*Sporobolus cryptandrus*], Rothrock's grama [*Bouteloua rothrockii*], plains bristlegrass [*Setaria macrostachya*], and purple three-awn [*Aristida purpurea*]), and Indian wheat *(Plantago ovata).*

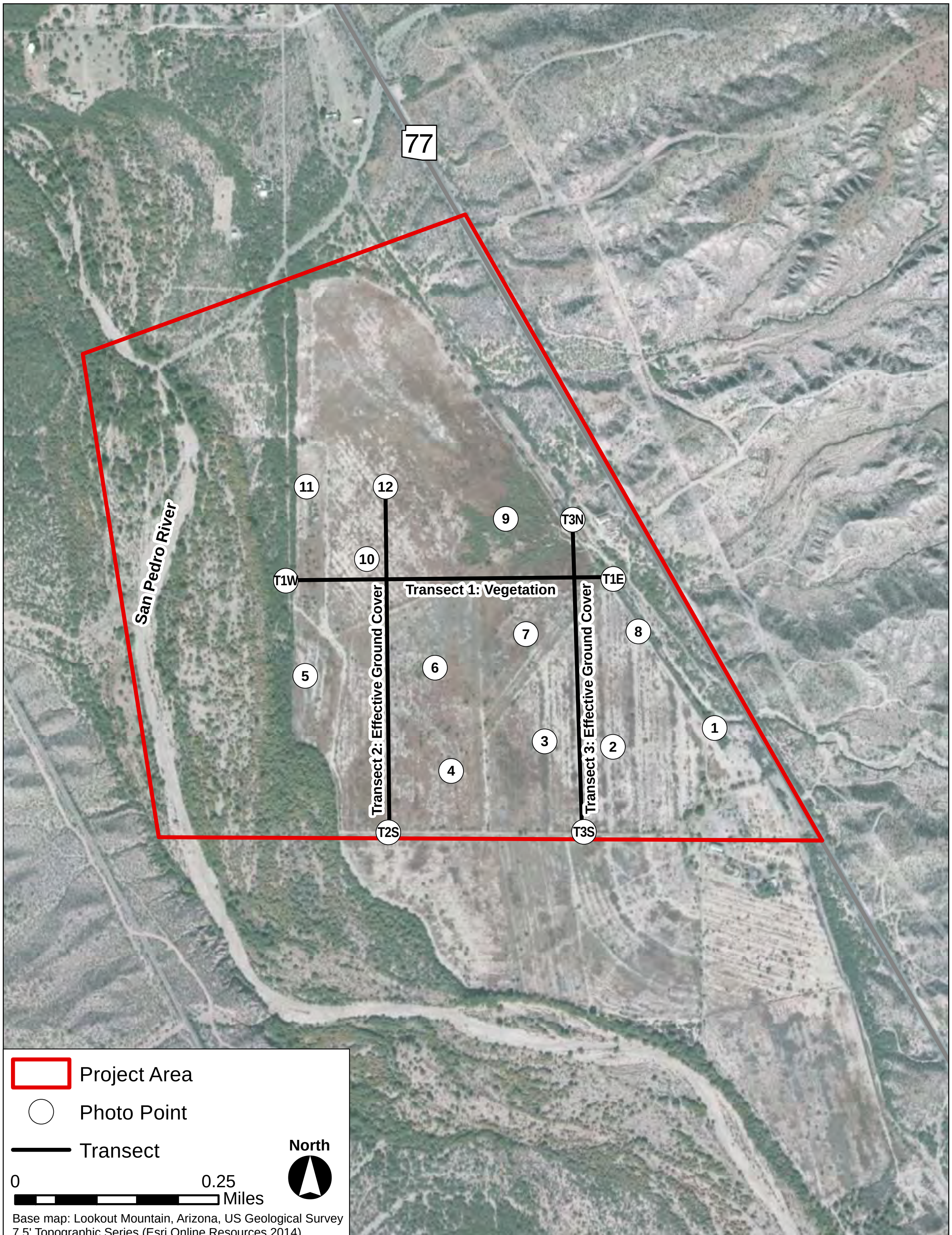
The irrigation system was set up by connecting the well source to a supply line and booster pumps that allowed a sprinkler to operate in a radial pattern over the revegetation area (i.e., a pivot system irrigating in a circular pattern). Supplemental irrigation was applied in October and November 2011, totaling 8.15 acre-feet. Thereafter, there were mechanical problems with the irrigation equipment and irrigation occurred sporadically until 2013, when a flooding event damaged the system. No supplemental irrigation was provided subsequently. Control of exotic plants (in addition to removal of saltcedar during construction and other species by mowing prior to seeding) consisted of mowing of vegetation (exotic as well as native plants) in January 2012.

Implement Monitoring

Standard transect surveys were used to quantify cover by plant species and effective ground cover within the revegetation area. Aerial photography and topographic analysis along with visual inspection of the site and ground-level photography were used to monitor geomorphic changes (patterns of erosion and sedimentation) over time. Stationary photo points were used to document all aspects of the project, including preconstruction conditions, construction activities and progress, status of the vegetation, and condition of the washes over time. Detailed methodology is described in the approved monitoring plan for the project (see Appendix B) and is summarized below.

Vegetation Monitoring

Vegetation monitoring was conducted along three permanent transects established in the restoration area. Baseline monitoring data were collected prior to construction/restoration of the site, and post-construction data were collected as part of quarterly monitoring.



Reduction of Erosion and Sedimentation Along the Lower San Pedro River Through Hydrologic Restoration of Modified Ephemeral Washes

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Figure 4. Photo point and monitoring transect locations

Belt Transect Monitoring

Vegetative cover by species was monitored along Transect 1, oriented perpendicular to the San Pedro River (Figure 4). This represented a belt transect 2,089.9 feet (637 meters) in length and 26.3 feet (8 meters) in width, comprising 54,852.9 square feet (5,096 square meters) in area. Percent cover by species was calculated as the estimated cover (area) occupied by a species within the belt transect divided by the total belt transect area.

Effective Ground Cover Monitoring

Effective ground cover was measured along Transects 2 and 3, oriented parallel to the San Pedro River (Figure 4). Transect 2 was approximately, 2,220 feet in length, and Transect 3 was approximately 1,954 feet in length. Ground cover by type (bare soil, rock, litter, or vegetation) was measured along each transect using the Variable Length Step Transect Method (a variation of the Line Intercept Method) and recorded on data forms. Percent cover by type was then calculated as the proportion of each type over the total number of intercepts recorded along each transect.

Photo Monitoring

The objective of photo monitoring was to provide a visual documentation of the construction phase of the project, changes in vegetation associated with construction and revegetation, and the effect of flow on geomorphologic properties of the excavated washes. This was accomplished through aerial photo monitoring and survey and through repeat ground-level photo monitoring.

Aerial Photo Monitoring and Survey

Low-level aerial photography, including topographic surveys, was completed on August 11, 2011, prior to construction activities, to document existing (baseline) site conditions. This was repeated on October 19, 2011, after completion of earthwork. The final aerial photography and topographic survey was completed on April 29, 2014, to document geomorphic changes (patterns of erosion and sedimentation) over time.

Ground-level Photo Monitoring

Repeat ground-level photo monitoring was completed at 12 photo points dispersed through the project site and along the three vegetation sampling transects (Figure 4). The locations of photo points were based on those identified in the monitoring plan and were located in the field using a Garmin GPS unit (GPSmap 60CSx). The locations of some photo points were adjusted to provide better landscape views by avoiding vegetative or topographic constraints or interference. The locations of all photo points were marked with a 6-foot-long steel T-stake pounded into the ground to a depth of 2 feet. The marker posts were identified with metal tags attached to the T-stake, which recorded the photo point number. Photographs were taken using a tripod set at a standard height of 4 feet with the camera leveled and the top of the view screen set just above the horizon. Shots were taken facing each of the cardinal directions (north, east, south, and west) for a total of four photographs at each photo point. Photo points were initially established and temporarily monumented (staked) on May 31, 2011, prior to construction activities. Table 2 lists the coordinates of the photo points established in the field.

Table 2. Locations of photo points associated with ground-level photo monitoring (Universal Transverse Mercator coordinates in North American Datum 83, Zone 12)

Photo Point No.	Easting	Northing
1	531560	3626470
2	531343	3626414
3	531207	3626428
4	531019	3626370
5	530730	3626554
6	530991	3626573
7	531162	3626642
8	531391	3626640
9	531113	3626867
10	530851	3626790
11	530731	3626929
12/T2N	530890	3626926
T2S	530896	3626245
T3S	531283	3626246
T3N	531283	3626840
T1E	531338	3626707
T1W	530703	3626707

Repeat ground-level photography was taken on a monthly basis after construction, from June 2011 to June 2012. Subsequent photo monitoring occurred on a quarterly basis and is documented in quarterly monitoring reports up to and including the first quarter of 2014. Table 3 lists dates and descriptions of completed photo monitoring.

Table 3. Summary timeline of ground-level photo monitoring

Date Completed	Description
May 31, 2011	Baseline (preconstruction) conditions
June 22, 2011	Start construction
June 23, 2011	Start construction
June 29, 2011	Construction–grading and channel excavation
July 29, 2011	Construction–grading and channel excavation
August 16, 2011	Construction–revegetation
September 14, 2011	Construction–revegetation
September 26, 2011	Post-construction conditions
October 11, 2011	Post-construction conditions
October 28, 2011	Post-construction conditions
November 28, 2011	Post-construction conditions
December 27, 2011	Post-construction conditions
January 31, 2012	Post-construction conditions
February 17, 2012	Post-construction conditions
March 16, 2012	Post-construction conditions
April 17, 2012	Post-construction conditions
May 15, 2012	Post-construction conditions

Table 3. Summary timeline of ground-level photo monitoring

Date Completed	Description
June 12, 2012	Post-construction conditions
September 20, 2012	Post-construction conditions
December 19, 2012	Post-construction conditions
March 25, 2013	Post-construction conditions
June 27, 2013	Post-construction conditions
September 25, 2013	Post-construction conditions
December 4, 2013	Post-construction conditions
March 26, 2014	Post-construction conditions

Results

Vegetation Monitoring

Belt Transect Monitoring

Vegetation cover along Transect 1 changed significantly over the course of the monitoring period (Table 4). Cover of several seeded native species increased substantially, a nearly fivefold increase for mesquite, a more than fourfold increase for globemallow, a twofold increase for sand dropseed, and a more than twofold increase for saltbush. Removal of some nonnative/invasive species (tamarisk and amaranth) appears to have been effective because these species were not reported along the transect at the end of the monitoring period.

Conversely, cover of other nonnative/invasive species increased substantially (e.g., more than a 1,200-fold increase in convolvulus and about a 30-fold increase in Russian thistle). Some invasive species not reported initially along the transect were documented at the end of the monitoring period, most notably goosefoot, as well as some native species such as silverleaf nightshade and bladderpod. The following species included in the seed mix were not reported along this transect at the end of the monitoring period (though some have become established in parts of the restoration area outside Transect 1 and some are not readily observable in winter or early spring): blue paloverde, creosote bush, Rothrock's grama, purple three-awn, and Indian wheat.

Table 4. Comparison of effective ground cover along Transect 1 before and after construction (restoration)

Plant Species	Baseline (pre-restoration, 2011) (percent of transect)	End of Monitoring Period (2014) (percent of transect)
Mesquite	3.3768	16.0635
Acacia	0.0204	Not reported
Kochia	0.2159	Not reported[1]
Tamarisk	0.0200	Not reported
Amaranth	0.3137	Not reported
Silverleaf nightshade	0.0352	2.6177
Russian thistle	0.1059	3.1711
Convolvulus	0.0021	2.6688

Table 4. Comparison of effective ground cover along Transect 1 before and after construction (restoration)

Plant Species	Baseline (pre-restoration, 2011) (percent of transect)	End of Monitoring Period (2014) (percent of transect)
Globemallow	0.0001	4.0640
Sacaton	0.000008	Not reported[2]
Sporobolus sp.	Not reported	1.9898[2]
Goosefoot	Not reported	4.2386
Nightshade sp.	Not reported	1.4768
Unknown Grass 1	Not reported	2.1468
Bermuda grass	Not reported	0.7339
Barley sp.	Not reported	2.4117
Saltbush sp.	Not reported	2.5942
Bladderpod	Not reported	1.8328
Unknown Grass 2 (annual)	Not reported	0.1570
Spiderling	Not reported	0.4710
Filaree	Not reported	0.0059

[1] 2014 quarterly monitoring reports list "goosefoot," which may represent kochia (*Bassia scoparia*), but it is listed separately in this table.

[2] 2014 quarterly monitoring reports list "Sporobolus sp.," which is likely sand dropseed (*Sporobolus cryptandrus*) that was included in the seed mix. The common name "sacaton" typically refers to either alkali or big sacaton (*S. airoides* or *wrightii*).

Effective Ground Cover

Effective ground cover along Transects 2 and 3 changed substantially over the course of the monitoring period. Along Transect 2, bare soil cover was reduced by more than half by the end of the monitoring period, while vegetation cover increased more than 13-fold and litter cover increased nearly sixfold (Table 5). Vegetation cover was composed primarily of Indian wheat, mesquite, Russian thistle, and convolvulus.

Table 5. Comparison of effective ground cover along Transect 2 before and after construction (restoration)

Cover type	Baseline (pre-restoration, 2011) (percent cover)	End of Monitoring Period (2014) (percent cover)
Bare soil	92.5	42.1
Vegetation	1.9	25.3
Litter	5.6	32.6
Rock	0	0

Similarly, along Transect 3 bare soil cover was reduced by more than half, vegetation cover increased more than 37-fold, and litter cover increased more than eightfold (Table 6). Vegetation cover was composed primarily of saltbush, Indian wheat, mesquite, and globemallow.

Table 6. Comparison of effective ground cover along Transect 3 before and after construction (restoration)

Cover type	Baseline (pre-restoration, 2011) (percent cover)	End of Monitoring Period (2014) (percent cover)
Bare soil	80.7	30.5
Vegetation	0.7	26.1
Litter	5.1	42.2
Rock	13.5	1.2

Photo Monitoring of Geomorphic Conditions

Aerial Photo Monitoring and Survey

Aerial photography and associated topographic surveys documented geomorphic conditions prior to construction/restoration, after completion of earthwork, and at the end of the monitoring period. Results of aerial photo monitoring and survey are included as exhibits in Appendix G. This appendix includes two exhibits that graphically depict geomorphic changes after construction and at the end of the monitoring period, respectively. The following is a narrative summary of what these two exhibits illustrate. In the exhibits, the light blue color can be ignored because it ranges from 0 feet to 0.5 feet in depth. The same applies to the light yellow color. The darker blue and darker yellow, in addition to other colors, are the ones of significance for comparison, taking into account the minor potential of inaccuracy in the survey.

Along the North Wash heading downstream from the culvert under SR 77, some scour appears to be occurring in the unimproved areas upstream of the improvements around an island of existing trees. Beyond that, there are some minor (±1 foot) sediment deposits/vegetation growth between Stations 29+50 and 24+00 as the grade of the channel flattens out (from 1.54 percent to 0.89 percent). The channel has remained relatively unchanged between Stations 23+00 and 18+00. Between Stations 18+00 and 13+50, deposition is occurring again as the channel flattens out again (from 0.89 percent to 0.44 percent) and makes its way through a curve. The remainder of the channel has very mild deposition.

Along the South Wash, deposition is occurring on the north side of the wash as the water exits the existing culvert. Some mild scour is visible on the south edge of the channel as the wash alignment curves to the north through Station 37+00. Between Stations 37+00 and 30+00, the flows exiting the previously mentioned curve are scouring the north edge of the channel bottom. Conversely, sediment is being deposited along the south edge through Station 33+00. The channel slope gradually begins to flatten around Station 27+50 and flattens further at Station 24+00. Sediment has deposited along the entire channel bottom through to Station 19+00. Sedimentation and vegetation growth continue to occur on the outside edges as the channel alignment meanders through to Station 12+00. Significant deposits appear to be settling south of the channel near Station 10+00.

Ground-level Photo Monitoring

Repeat ground-level photo monitoring at established photo points documented site conditions prior to construction, shortly after construction, and through the duration of the monitoring period. Ground-level photographs are included in the field reports and quarterly monitoring reports (Appendix C and Appendix J, respectively).

Discussion

This section discusses the research questions developed for the restoration project in light of the results of monitoring efforts implemented.

Vegetation Establishment—Did planted and irrigated vegetation become established and resilient enough to stop supplemental irrigation after the monitoring period?

Due to drought conditions that persisted throughout the monitoring period, vegetation did not become established and resilient enough to forgo the need for supplemental irrigation. Some seeded species did better than others, notably mesquite, globemallow, sand dropseed, and saltbush. Indian wheat and creosote bush became established in numerous patches throughout the restoration area. However, overall plant cover did not meet expectations. Due to mechanical issues, supplemental irrigation was sporadic through 2013, after which a flood event damaged the supply pipeline from the well and no supplemental irrigation occurred (Appendix I/J).

Channel Stability—Did the grasses establish as planned within incised floodplain? Did channel design and revegetation plan create for stabilizing channel conditions at the site?

Grasses did not become established in the floodplain to the extent planned, largely due to drought conditions exacerbated by mechanical issues with supplemental irrigation equipment/ infrastructure. However, vegetation became established in patches, and restoration has resulted in a greater diversity of plant species on the site. Based on monitoring results, the reconstructed channels appear to be stable and functioning as intended, with flows remaining confined to the reconstructed channels and natural hydrology restored. One location of primary concern, the culvert under SR 77, appears to be stable and functioning properly (Appendix G).

Reduction in Erosion and Sedimentation—Did implementation of the project, including revegetation efforts, successfully reduce erosion across the site?

Based on monitoring results, restoration appears to have successfully reduced erosion across the site. Aerial flight and field data show that some erosion and sedimentation have occurred, but erosion and sedimentation have been reduced overall, and no sheet flow events were observed during the monitoring period (Appendix G).

Weed Control—Did Indian wheat outcompete Russian thistle?

Indian wheat did not successfully outcompete Russian thistle over the restoration site as a whole, primarily due to lack of establishment of this seeded species related to drought conditions and problems with the supplemental irrigation system. However, Indian wheat became established in localized patches throughout the restoration site, and, in these patches, Russian thistle was absent or reduced in abundance. Due to lack of more widespread establishment of Indian wheat, the monitoring data are insufficient to assess whether this species can successfully outcompete Russian thistle on restoration sites. Additional monitoring may provide more conclusive data on long-term establishment of Indian wheat and its potential role in limiting the establishment or abundance of Russian thistle.

Project Success—Is this a restoration model to restore conditions in similar sites and natural habitat on tributary ephemeral washes?

There are elements of success associated with this restoration model and elements that warrant some changes in approach with regard to implementation. From an engineering standpoint, the project was successful because it restored natural hydrology to the site and reduced erosion and sedimentation. At the end of the monitoring period, there was no indication of any design failure in this regard.

From the standpoint of vegetation establishment, success was limited due to drought conditions and problems with the supplemental irrigation system. Furthermore, the irrigation design used was not extensive enough to adequately cover the site, and the equipment was not sufficiently reliable to provide supplemental irrigation when needed. Future restoration projects should implement irrigation systems with these limitations in mind.

The seed mix developed for the site appears to have been effective, with most seeded species becoming established to some extent. For future restoration projects, it is recommended that less mesquite be included in the seed mix because this species is pervasive throughout the area. It is further recommended that soil alkalinity be considered and that more alkaline-tolerant species (e.g., saltbush, creosote bush, alkali sacaton) be included in the seed mix (or be more prominent in the seed mix). This should improve vegetation establishment in restoration sites with alkaline, gypsiferous soils.

Overall, the project was successful in achieving the stated objectives. Restoration of the natural washes has prevented large-scale failure and further erosion of the berm and ditch system, has reduced erosion and sedimentation in the project area, and has restored the natural hydrology and geomorphology of the North and South Wash. Restoration of these two washes has resulted in the creation of approximately 10 acres of riparian habitat within the low flow channel and overbank areas of these drainages, where flows were previously cut off by the irrigation ditch and berm system. Though vegetation establishment was limited at the end of the monitoring period, restoration of natural hydrology is expected to result in re-establishment of riparian vegetation over time along these washes.

A final recommendation is to continue monitoring the restoration site, but on a less frequent (e.g., annual) basis. This would allow a better assessment of restoration success over the longer term, especially under more normal rainfall conditions.

Appendix A
Permits

Refer to separate PDF files for each appendix

Appendix B
Project Work Plans

Appendix C
Field Reports

Appendix D
Restoration Completion Report

Appendix E
Fence Construction, Deconstruction, and Supplemental Irrigation Completion Report

Appendix F
Revegetation Completion Report

Appendix G
Aerial and Topographic Monitoring

Appendix H
Baseline Monitoring Report

Appendix I
Post-construction Monitoring Report

Appendix J
Quarterly Reports

Appendix K
Field Notes