APPENDIX D. RESOLUTION COPPER PROJECT CLEAN WATER ACT SECTION 404 CONCEPTUAL COMPENSATORY MITIGATION PLAN

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RESOLUTION COPPER PROJECT CLEAN WATER ACT SECTION 404 CONCEPTUAL COMPENSATORY MITIGATION PLAN

Prepared for: Resolution Copper

Prepared by: WestLand Resources, Inc.

Date: June 21, 2019

Project No.: 807.175 03 03

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1. INTRODUCTION

Resolution Copper Mining, LLC (Resolution, or the Applicant) proposes to develop and operate an underground copper and molybdenum mine near Superior, Arizona. As proposed, the tailings storage facility (TSF), pipelines, and associated facilities require the discharge of fill to surface water features that the U.S. Army Corps of Engineers (Corps) is anticipated to determine to be potentially jurisdictional waters of the United States (waters of the U.S.) pursuant to a preliminary jurisdictional determination (PJD). Based on the presumption that potentially jurisdictional waters of the U.S. will be impacted by discharges of dredged or fill material resulting from portions of Resolution's planned mine development, Resolution will need to make an application for a Clean Water Act (CWA) Section 404 permit for these discharges.

In order to secure a CWA Section 404 permit, the Applicant is bound by the requirements of the Corps's and the U.S. Environmental Protection Agency's (EPA) "Final Rule for Compensatory Mitigation for Losses of Aquatic Resources" (33 C.F.R. Parts 325 and 332 and 40 C.F.R. Part 320; published in 73 Fed. Reg. 19594-19705) (Corps & EPA 2008), hereinafter referred to as the 2008 Mitigation Rule. The fundamental objective of the 2008 Mitigation Rule is to establish standardized compensatory mitigation criteria for all mitigation types to offset unavoidable impacts to waters of the U.S. authorized through the issuance of a CWA Section 404 permit. Compensatory mitigation is required after efforts to avoid and minimize impacts have been exhausted and impacts to waters of the U.S. would still occur. This conceptual compensatory mitigation plan introduces the suite of potential mitigation elements that Resolution will use to comply with the 2008 Mitigation Rule. A final conceptual mitigation plan will be developed once the extent of waters of the U.S. is confirmed and the magnitude of impacts (direct and indirect) have been refined. These mitigation measures will be evaluated as part of the National Environmental Policy Act (NEPA) evaluation being led by the U.S. Forest Service (USFS) with the Corps as a cooperating agency.

2. PROJECT DESCRIPTION

Resolution's planned mine development is located near Superior in Pinal County, Arizona (**Figure 1**) in an area called the Copper Triangle and specifically within the Pioneer Mining District. Mine exploration and operations have been conducted in the area since the early 1860's, when the discovery of silver led to the development of the Silver King Mine. Magma Copper Company (Magma) took over the Silver King Mine and operated it as the Magma Mine from 1912 until the concentrator was finally shut down in 1996. After Magma's shutdown, the Resolution ore deposit was discovered 1.2 miles south of the existing Magma Mine and 7,000 feet below the ground surface.

Resolution was formed as a limited liability company in 2004 by Rio Tinto and BHP Billiton. Rio Tinto is the managing entity and possesses a 55-percent ownership stake in Resolution, while BHP Billiton maintains 45-percent ownership. Since 2004, Resolution has steadily worked to investigate and delineate the Resolution ore body, develop a mine design, prepare environmental and engineering studies to support the mine permitting and approvals effort, and conduct multiple community outreach efforts and public meetings to inform and involve the public as plans were developed. These efforts led to the submittal of a General Plan of Operations (GPO) to the USFS in November 2013, and the subsequent NEPA evaluation by the Corps and the USFS.

Resolution proposes the development of the Resolution ore body using panel caving, a type of block cave mining. The copper and molybdenum ore will be mined, undergo primary crushing underground, and then be sent to a newly constructed concentrator facility to be located at the existing WPS north of Superior. Concentrate produced here will be transported offsite for additional processing, while the resulting tailings will be transported via a tailings pipeline to the proposed TSF location. Under the current proposed operating conditions and Life of Mine (LOM) planning parameters, the Resolution ore body is sufficient to support the concentrator operations for approximately 41 years. As currently configured, operations are anticipated to result in the mining of approximately 1.4 billion tons of copper and molybdenum ore and the production of approximately 1.37 billion tons of tailings.

Through the alternatives analysis process under NEPA, the U.S. Forest Service (USFS) evaluated numerous geographic locations for tailings storage within an approximately 200-mile radius around the mine. The USFS evaluated both singular TSFs, where pyrite and scavenger tailings were stored together, and separate scavenger and pyrite TSFs, depending on the geophysical and hydrogeological setting. Additional factors included favorable topography and sufficient storage capacity. This information is detailed in Section 2 and Appendix B of the *Resolution Copper Project and Land Exchange Draft Environmental Impact Statement* (USFS 2019). The final alternatives selected for detailed analysis were those TSF designs that addressed the widest range of issues identified during public scoping and had the potential to be selected as the least environmentally damaging practicable alternative (LEDPA). This conceptual compensatory mitigation plan has been developed based on the assumption that the Corps could ultimately identify, from the range of alternatives evaluated in the DEIS, a TSF alternative that has impacts to jurisdictional waters of the U.S. as the LEDPA for the Resolution Project (WestLand 2019). The suite of potential mitigation elements described within this plan would then be used to comply with the 2008 Mitigation Rule. However, the mitigation elements described herein would be applicable to all the alternatives carried forward for consideration in the DEIS (USFS 2019) and the practicability analysis (WestLand 2019).

3. AVOIDANCE AND MINIMIZATION

The development of alternatives for Resolution's proposed underground copper and molybdenum mine design included a significant effort to avoid and minimize impacts to potential waters of the U.S. to the extent practicable. As described above, only certain alternative locations for the TSF, pipelines, and associated facilities analyzed in the practicability analysis have impacts to potential waters of the U.S. An exhaustive evaluation of TSF alternatives was completed by the USFS and cooperating agencies, including the Corps. This evaluation of alternatives included other existing mine, or brownfields, sites in Arizona (USFS 2019). While the use of one of these brownfields sites would likely have avoided impacts to waters of the U.S., the agencies determined that none of the brownfields alternatives were available, feasible, or reasonable alternatives for TSF locations and those sites were therefore dismissed from detailed analysis. After dismissal of the brownfield alternatives, 15 initial alternative TSF locations to that location proposed in the GPO were screened and assessed using criteria developed from the public and agency scoping processes conducted by the USFS, as well as input from cooperating agencies and Resolution Copper (USFS 2019).

Numerous aspects of TSF design and construction such as embankment type (e.g., upstream, centerline, modified centerline, and downstream embankments), foundation treatment and lining options, management of PAG tailings, and deposition methods (e.g., conventional thickened, high-density thickened, and filtered, or 'dry-stack') were assessed for use at these locations as described in the DEIS (USFS 2019). Five TSF alternatives were ultimately considered for detailed analysis in the DEIS (USFS 2019) and practicability analysis (WestLand 2019), and included a mix of locations, embankment types, and tailings deposition and placement technologies. A number of onsite mitigation measures (referred to as "applicant committed environmental protection measures") were incorporated into the TSF designs to address impacts to the aquatic environment, including waters of the U.S., and water quality and quantity functions. Although the area beneath the footprint of the TSF and its appurtenant features will no longer contribute runoff from precipitation to downstream drainage reaches, the TSF design minimizes impacts to downstream waters of the U.S. by diverting upstream stormwater flows around the facility. Similarly, the stormwater controls, run-on diversions, and engineering controls have been designed to maintain downstream stormwater flows while minimizing the risk of contaminant discharge to downstream surface water features to the maximum extent practicable.

Given that the footprints of the practicable TSF alternatives contain ephemeral drainage channels and will be operated as part of an active copper mine, little opportunity exists for the development of onsite mitigation for unavoidable impacts to waters of the U.S. Aquatic habitat functions that will be lost through development of the TSF are anticipated to be mitigated offsite.

4. PROJECT IMPACTS TO WOTUS

As proposed, only the development of the TSF and associated infrastructure (including pipelines) may require a discharge of dredged or fill material into waters of the U.S. Discharge of fill for the development of these features, particularly the TSF, consists mostly of the levelling of existing topography through cut and fill of the natural ground surface. Materials to be discharged would consist of native soil and rock taken from the footprint of the constructed features during the grading process.

The aquatic resources at all of the TSF alternatives carried forward for evaluation in the DEIS (USFS 2019) and the practicability analysis (WestLand 2019) are comprised almost entirely of ephemeral washes. The ephemeral wash systems flow only in direct response to precipitation events and typically support some level of xeroriparian habitat. Two alternatives also include groundwater dependent ecosystems (e.g., seeps, springs) that support habitat more indicative of the hydric conditions. In general, these features exist in a largely unaltered state with primary land use within these footprints consisting of ranching or light recreational use.

The South Pacific Division of the Corps has developed the *Standard Operating Procedure for the Determination of Mitigation Ratios* (Corps 2015) for determining compensatory mitigation requirements for the processing of CWA Section 404 permits. The substantive component of this procedure is completion of the Mitigation Ratio-Setting Checklist (MRSC). The completed MRSC is intended to provide a ratio determining the amount of acreage necessary as compensatory mitigation to offset the acreage of authorized impacts, in compliance with the 2008 Mitigation Rule. Completion of the MRSC comprises a 10-step process that includes a functional analysis of impacted waters of the U.S. and proposed mitigation parcels, establishes baseline mitigation ratios, and authorizes adjustment of those ratios based on specified criteria.

Step 1 within the MRSC is the identification and classification of the aquatic resources present at and functions provided by the impact site and the proposed mitigation site. If a TSF alternative that has impacts to jurisdictional waters of the U.S. is identified by the Corps as the LEDPA, the aquatic resources at the impact site and mitigation site will be classified by their hydrologic, chemical, and biotic function. Step 2 of the MRSC is a qualitative assessment of the functions of the aquatic resources impacted and an assessment of the functional gain from the proposed mitigation actions. The assessed functions will be consistent with those hydrologic, chemical, and biotic functions identified in the South Pacific Division's *Standard Operating Procedure for the Determination of Mitigation Ratios* (Corps 2015). An example of 11 functions typically utilized for this purpose are listed in **Table 1**.

Table 1. Functions Evaluated for TSF Impacted Drainages

Evaluated Functions
HYDROLOGIC FUNCTIONS
Hydrologic Connectivity
Subsurface Flow and Groundwater Recharge
Energy Dissipation
Sediment Transport/Regulation
CHEMICAL FUNCTIONS
Elements, Compounds, and Particulate Cycling
Organic Carbon Export/Sequestration
BIOTIC FUNCTIONS
Aquatic Invertebrate Fauna
Presence of Fish and Fish Habitat Structure
Riparian/Wetland Vegetation Structure
Age Class Distribution of Wooded Riparian or Wetland Vegetation
Native/Non-native Plant Species

Evaluation of these eleven functions will be based on available data, published literature, aerial photography, general field observations, and field data collected from both the impact and proposed mitigation sites. It is anticipated that this effort will also include use of the *California Rapid Assessment*

Method (CRAM) *Episodic Riverine Field Book, version 2.0* (CWMW 2018), which was specifically developed to assess the functionality of ephemeral drainages based on relationships between condition and function. The functions of each identified drainage class will be scored qualitatively. The assessment of ephemeral drainages impacted will compare on-site aquatic features to normally functioning reference washes of the same class and similar flow regime. These functions will then be compared to those aquatic functions provided by the proposed mitigation activities to assess aquatic functions and values lost if the Project is permitted compared to aquatic functions and values gained through mitigation. Given the nature of the proposed mitigation sites, it is likely that this will require a functional comparison of services provided by ephemeral systems to services provided by perennial and intermittent systems (e.g., the Gila River). The assessment is not intended to make a value judgement between ephemeral and perennial systems; rather, the assessment fulfills the purposes of the MRSC to provide a comparative assessment of the functionality of the systems at the impact and mitigation sites and to develop a mitigation ratio that will ensure there is no net loss of aquatic functions and values. It is likely that this comparison will remove from the list of assessed functions factors such as 'Presence of Fish Habitat and Structure' not provided by ephemeral systems that would more heavily weight perennial or intermittent regimes.

To compensate for these unavoidable impacts and functional losses, five offsite mitigation opportunities have been identified that provide the potential for functional gains through implementation of active management, enhancement, restoration, and preservation activities.

5. MITIGATION OPPORTUNITIES

The 2008 Mitigation Rule identifies general classes of compensatory mitigation and identifies clear preferences among these classes, specifically noting that mitigation banks[1] and then in-lieu fee (ILF) mitigation are preferred over permittee-responsible onsite or offsite mitigation. As a general matter, in-kind mitigation is preferred over out-of-kind mitigation.

In accordance with the Corps's *Final 2015 Regional Compensatory Mitigation and Monitoring Guidelines* (2015), Resolution evaluated mitigation opportunities, based on the above hierarchy, within the Project watershed (Middle Gila Watershed [USGS HUC 15050100]) and adjacent watersheds. WestLand is not aware of any watershed planning efforts for the HUC-6 or HUC-8 watersheds within which the Project is located that identify specific restoration goals for aquatic resources. No onsite mitigation opportunities were identified.

Five offsite mitigation opportunities (**Figure 2**) have been identified as Potential Mitigation Opportunities (**Section 5.1**). The relative benefits of each mitigation opportunity are discussed based on WestLand's recent experience working within the framework of the 2008 Mitigation Rule on similar mining projects (WestLand 2017, 2018) and following Corps guidelines (Corps 2015). The mitigation opportunities include both permittee-responsible and ILF mitigation. Fulfillment of mitigation under

1 There are currently no mitigation banks established in Arizona.

each opportunity would provide regional conservation benefits, though not all of the proposed mitigation measures will create xeroriparian habitat similar to the habitat that will be lost or impacted by the Project. Some of the opportunities entail preservation, enhancement, and restoration of high-value mesoriparian and hydroriparian habitats, which are rarer within the regional landscape and have higher productivity and wildlife values (Lowery, Stingelin, and Hofer 2016).

5.1. Potential Mitigation Opportunities

5.1.1. GRIC MAR-5 Recharge Project

The Gila River Indian Community (GRIC, the Community) MAR-5 Recharge Project is, to-date, a 3-year pilot study to evaluate the effectiveness of recharging a portion of the GRIC allotment of CAP water into the Gila River, on the Community's lands (**Appendix A**). Over the 3-year pilot study, CAP water was discharged at a single turnout near the Olberg Road Bridge in GRIC District 3. Water discharge at the site initiated in August 2015, and vegetation monitoring was conducted at the site each year from 2015 through 2017, including baseline data collection in June 2015. The pre-discharge vegetation of the area was described as a sparse collection of upland woody shrubs with desert forbs and Bermudagrass (*Cynodon dactylon*), along with the nonnative, invasive tamarisk (*Tamarix* spp.). The 2017 data show a five-fold increase in total vegetation volume and a six-fold increase in total herbaceous cover, and at the end of the pilot study the site was populated with desirable riparian species including cattails (*Typha* spp.) and Goodding's willow (*Salix gooddingii*). Tamarisk density at the site also increased substantially, from 11 plants per hectare in June 2015 to 352 plants per hectare in 2017 (**Appendix A**).

The instream discharge created an approximately 123-acre wetted area at the GRIC MAR-5 site (**Figure 3**), and it is anticipated that continued discharges would allow for significant ecological lift as riparian habitat in this area continues to develop, though Corps guidance (2015) indicates that mitigation credited towards this lift may be negatively-impacted by the presence and density of tamarisk. The GRIC Department of Environmental Quality has recently conducted limited tamarisk removal and native plant reseeding at the GRIC MAR-5 site and has identified a large tamarisk thicket directly upstream that is likely a major seed source contributing to the tamarisk colonization and proliferation at the GRIC MAR-5 site. Tamarisk removal and native reseeding efforts at the upstream tamarisk seed source are described in the Olberg Road Restoration Site Project mitigation option (**Section 5.1.3**).

The Corps places a high value on restoration projects (33 CFR 332.3(a)(2)), and the GRIC MAR-5 recharge project represents a significant restoration effort on one of Arizona's largest river systems. The Corps prefers that mitigation take place within the same watershed as the impacted site (33 CFR 332.3(b)), and the GRIC MAR-5 site occurs within the same HUC 8 watershed, the Middle Gila, as the Project (**Figure 2**). Additionally, the Community has indicated that the GRIC MAR-5 recharge project would restore a cultural resource (surface flows in the Gila River), which has significant traditional value to the Community.

5.1.2. Lower San Pedro River Wildlife Area In-lieu Fee Project

The ILF mitigation programs allow impacts to surface water features to be mitigated through funds paid to a governmental or non-profit natural resources management entity as a means to satisfy compensatory mitigation requirements (Corps & EPA 2008). These programs are a form of compensatory mitigation that can aid in larger restoration efforts, making ILF projects (along with mitigation banks) the Corps's preferred method of compensatory mitigation (Corps 2015).

The Arizona Game and Fish Department (AGFD) has developed an ILF mitigation project, the Lower San Pedro River Wildlife Area (LSPRWA) along the San Pedro River near Winkelman, Arizona. Although the LSPRWA ILF project is located within the Lower San Pedro (HUC 8) watershed adjacent to the Project area's watershed (**Figure 2**), the ILF project itself is located near the watershed boundary and has been used as mitigation for other projects located in the Middle Gila River HUC 8 watershed (WestLand 2018). The LSPRWA ILF project consists of converting over 100-acres of agricultural fields to native pasture grasses to reduce groundwater consumption and help restore base flows and riparian habitat (BFWS 2019). Additionally, the restoration project will involve substantial exotic species removal and subsequent plantings to establish native woody vegetation within the 2,116 acre site (Lowery, Stingelin, and Hofer 2016).

The AGFD has indicated in a letter to Resolution Copper (**Appendix B**) that all advanced credits available for purchase through the LSPRWA ILF project have been sold or obligated for sale. However, AGFD will expand the LSPRWA ILF project to make an additional 650 credits available for purchase through five future phases of development. Resolution may purchase as many LSPRWA ILF credits as necessary to meet the mitigation requirements needed to offset impacts resulting from the project. Given the lengthy mine construction period, tailings would not need to be placed for at least a decade. As such, additional credits are anticipated to be available well before impacts from TSF deposition.

The LSPRWA ILF project has previously been used as mitigation by Asarco in support of the proposed Ripsey Wash TSF project (Ripsey) (WestLand 2018). Ripsey is similar to the Project in that for both projects, all proposed impacted drainages are ephemeral. Mitigation ratios established using the LSPRWA ILF to offset impacts from Ripsey were set at 1:1 for both newly-established wetland habitat and restored riparian habitat (WestLand 2018). Due to the similar nature and functional value of the proposed impacted drainages between Ripsey and the Project, WestLand assumes that a mitigation ratio of 1:1 or similar would be used for the Project.

5.1.3. Olberg Road Restoration Site Project

The proposed 23-acre Olberg Road Restoration Site (ORRS) is located along the south bank of the Gila River just east of the Olberg Bridge in GRIC District 3, immediately upstream of the GRIC MAR-5 site (**Figure 3**). The conceptual mitigation strategy for the ORRS project consists of exotic tree species (principally tamarisk) removal and control, combined with native plant species reseeding. Nonnative, invasive tamarisk has shown substantial increase in cover at the GRIC MAR-5 site during the 3-year pilot study (**Appendix A**), prompting identification of the 23-acre ORRS as a major tamarisk seed source for the GRIC MAR-5 site. Exotic tree species removal and control combined with seeding of native plant species at the ORRS site would allow for the establishment and maintenance of a riparian habitat dominated by native tree species, and eliminate a large, local source of exotic tree species seed from that section of the Gila River.

The ORRS project is not expected to generate the same ecological lift and mitigation credit value as the GRIC MAR-5 site, as it provides fewer ecological benefits relative to restoring surface flows and high-value riparian vegetation. The mitigation actions associated with tamarisk removal and reseeding would be considered as restoration.

5.1.4. Queen Creek Project

Conceptual mitigation elements for the Queen Creek project consists of actions to improve the ecological condition of a stretch of Queen Creek near Superior, Arizona (**Figure 2**). The actions include the removal of tamarisk to allow riparian vegetation to return to its historic composition and structure and promote more natural stream functions. Additionally, a conservation easement would be established, covering approximately 150 acres along 1.8 miles of Queen Creek to restrict future development of the site and provide protected riparian and wildlife habitat. The 150-acre Queen Creek project area includes lands owned by Resolution and BHP Mineral Resources, Inc. (BHP).The Corps would likely categorize the Queen Creek project as an enhancement (lift of one or a few selected functions) project. However, important to note is that the Queen Creek project would be accessible and highly-visible from Superior (**Figure 2**), allowing a local community affected by the Project to be a major beneficiary of the mitigation.

5.1.5. Arlington Wildlife Area In-lieu Fee Project

The Arlington Wildlife Area (AWA), another AGFD ILF mitigation project, is a 1,500-acre wetland and riparian habitat restoration project along the west bank of the Gila River in Maricopa County, Arizona. The AWA is located within the Lower Gila (HUC 8) watershed, adjacent to the Project area's Middle Gila watershed (**Figure 2**). The AWA consists of agricultural lands, constructed wetlands, and riparian areas dominated by tamarisk and mixed native and non-native vegetation (AGFD 2019). Restoration actions at the AWA consist of streambank shaping, erosion control, and native revegetation. As an ILF project, the Corps places high value on this opportunity due to its potential to have a substantial impact on broader restoration efforts.

6. LONG-TERM SITE PROTECTION INSTRUMENTS

All of the permittee-sponsored mitigation opportunities (GRIC MAR-5 Recharge Project, ORRS Project, and the Queen Creek project) to the extent necessary will have a suitable site-protection instrument recorded in their respective counties or tribal government to provide long-term protection of the conservation objectives outlined here and to comply with the 2008 Mitigation Rule. The details of the site-protection instruments to be recorded at these mitigation sites have not been finalized at this time, though incompatible uses will be prohibited. Some low-impact public uses such as hiking and bird watching may be allowed in certain areas. The permittee would provide funds for the long-term management of the sites pursuant to the respective site-protection instrument.

7. REFERENCES

Arizona Game and Fish Department. 2019. "Arlington Wildlife Area." Arizona Game and Fish Department. https://www.azgfd.com/wildlife/viewing/wheretogo/arlington/.

Business for Water Stewardship. 2019. "Lower San Pedro River Habitat Restoration." Business for Water Stewardship. https://businessforwater.org/projects/lower-san-pedro-river-wildlife-area.

California Wetlands Monitoring Workgroup (CWMW). 2018. California Rapid Assessment Method (CRAM), Episodic Riverine Field Book, Version 2.0. August 2018.

Lowery, Shawn F., Angela Stingelin, and Charles Hofer. 2016. Conceptual Plan, January 2016, In-Lieu Fee Restoration Project Site Wetland Restoration and Monitoring at the Lower San Pedro River Wildlife Area, Pinal County, Arizona. Phoenix: Arizona Game and Fish Department.

U.S. Army Corps of Engineers. 2015. Final 2015 Regional Compensatory Mitigation and Monitoring Guidelines. U.S. Army Corps of Engineers - South Pacific Division. January 12, 2015. 70.

U.S. Army Corps of Engineers, and U.S. Environmental Protection Agency. 2008. Compensatory Mitigation for Losses of Aquatic Resources; Final Rule. *Federal Register*. April 10, 2008. 19594-19705.

U.S. Forest Service. 2019. Resolution Copper Project DRAFT Environmental Impact Statement. U.S. Deparment of Agriculture.

WestLand Resources, Inc. 2017. Clean Water Act Section 404 Conceptual Mitigation Plan Lone Star Ore Body Development Project. *Prepared for U.S. Army Corps of Engineers on Behalf of Freeport-McMoRan Safford Inc.* Tucson, Arizona: WestLand Resources, Inc. February 3, 2017.

______. 2018. Ripsey Wash Tailings Storage Facility Revised Clean Water Act Section 404 Conceptual Mitigation Plan. *Prepared for ASARCO LLC - Ray Operations*. Tucson, Arizona: WestLand Resources, Inc. February 1, 2018.

______. 2019. DRAFT Practicability Analysis in Support of Clean Water Act 404(b)(1) Alternatives Analysis. *Prepared for U.S. Army Corps of Engineers on behalf of Resolution Copper*. Tucson, Arizona: WestLand Resources, Inc. June 2019.

FIGURES

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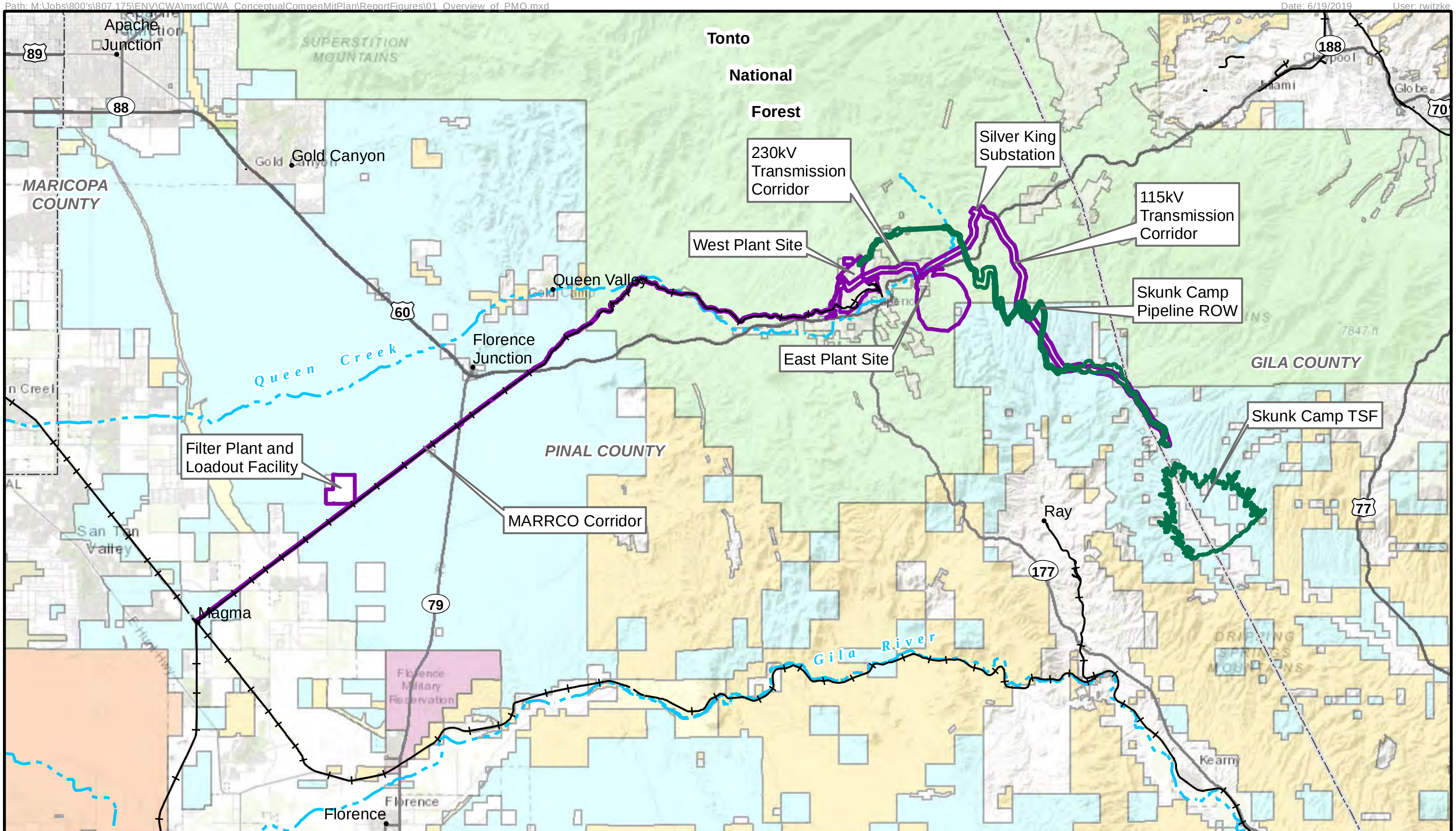


Pinal and Gila Counties, Arizona,
Data Source: BLM 2018, WRI Modified 2019,
ALRIS, SWCA, and USFS
Image Source: ArcGIS Online, World Topo Map

WestLand Resources

N

0 2.5 5 Miles

0 4 8 Kilometers

Legend

- Proposed Action
- GPO Mine Elements

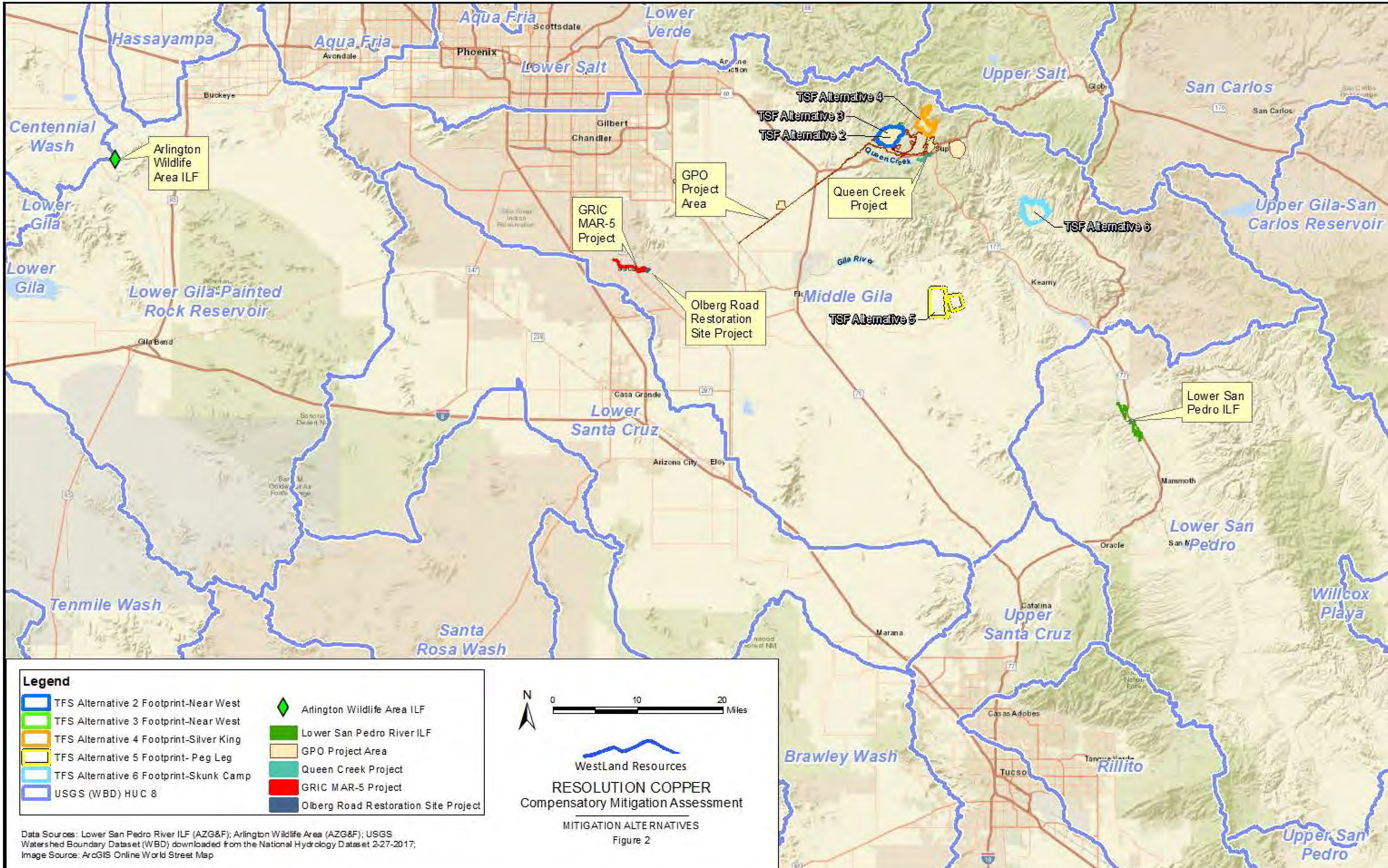
Surface Management (BLM)

- County
- Indian Lands
- Local or State Parks
- Other
- State Trust Land
- Bureau of Land Management (BLM)
- Military
- Bureau of Reclamation
- Private Land
- US Forest Service (USFS)

RESOLUTION COPPER
CWA Conceptual Compensatory Mitigation Plan

OVERVIEW OF PROPOSED MINING OPERATION

Figure 1



Hassayampa
Aqua Fria
Aqua Fria
Lower Verde
Lower Salt
Upper Salt
San Carlos
Centennial Wash
Lower Gila
Lower Gila
Lower Gila-Painted Rock Reservoir
Upper Gila-San Carlos Reservoir
Middle Gila
Lower Santa Cruz
Lower San Pedro
Tenmile Wash
Santa Rosa Wash
Upper Santa Cruz
Willcox Playa
Brawley Wash
Rillito
Upper San Pedro
Scottsdale
Phoenix
Avondale
Buckeye
Gilbert
Chandler
Globe
San Carlos
Gila Bend
Casa Grande
Arizona City
Eloy
Kearny
Mammoth
Oracle
Catalina
Marana
Casas Adobes
Tucson
Gila River
Queen Creek
Arlington Wildlife Area ILF
GPO Project Area
GRIC MAR-5 Project
Olberg Road Restoration Site Project
Queen Creek Project
Lower San Pedro ILF
TSF Alternative 2
TSF Alternative 3
TSF Alternative 4
TSF Alternative 5
TSF Alternative 6
Legend
TFS Alternative 2 Footprint-Near West
TFS Alternative 3 Footprint-Near West
TFS Alternative 4 Footprint-Silver King
TFS Alternative 5 Footprint- Peg Leg
TFS Alternative 6 Footprint-Skunk Camp
USGS (WBD) HUC 8
Arlington Wildlife Area ILF
Lower San Pedro River ILF
GPO Project Area
Queen Creek Project
GRIC MAR-5 Project
Olberg Road Restoration Site Project
N
0 10 20 Miles
WestLand Resources
RESOLUTION COPPER
Compensatory Mitigation Assessment
MITIGATION ALTERNATIVES
Figure 2
Data Sources: Lower San Pedro River ILF (AZG&F); Arlington Wildlife Area (AZG&F); USGS Watershed Boundary Dataset (WBD) downloaded from the National Hydrology Dataset 2-27-2017;
Image Source: ArcGIS Online World Street Map

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T4S, R6E, Portions of Sections 8 - 14,
Pinal County, Arizona.
Image Source: Pleiades Satellite Imagery 10/28/2017

0 800 1,600 Feet
0 250 500 Meters

N

Legend

- Olberg Road Restoration Site Project
- MAR-5 Wetted Area

RESOLUTION COPPER
CWA Conceptual Compensatory Mitigation Plan

GRIC MAR-5 PROJECT
Figure 3

WestLand Resources

APPENDIX A

Gila River Indian Community MAR-5 2017 Vegetation Monitoring Report

GILA RIVER INDIAN COMMUNITY MAR-5
2017 VEGETATION MONITORING REPORT
Resolution Copper

Prepared for:

RESOLUTION COPPER

102 Magma Heights – Superior, Arizona 85173
Project Number: 807.131 03 02
May 2019

WestLand Resources

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(follow text)

APPENDICES

1. INTRODUCTION AND BACKGROUND

WestLand Resources, Inc. (WestLand), was retained by Resolution to conduct vegetation monitoring of restoration efforts in partnership with the Gila River Indian Community (GRIC) through the discharge of Central Arizona Project (CAP) water to the Gila River as part of a Managed Aquifer Recharge (MAR) and riparian restoration pilot program.. Instream discharge of the GRIC CAP water allocation into the Gila River is currently conducted at a single turnout near the Olberg Road Bridge, referred to as MAR-5. The GRIC MAR-5 recharge study site is situated along the southern side of the Gila River, approximately 1 mile north of the town of Sacaton in Township 4 South, Range 30 East, Sections 9 through 11, 13, and 14 (the Project Area; **Figure 1**).

A 3-year pilot study to evaluate the effectiveness of the discharge at MAR-5 was initiated in 2015. Baseline vegetation data was collected in June 2015 before the initial discharge of water in July 2015. Additional vegetation data was collected in November and December 2015, November and December 2016, and November 2017.

This report presents the baseline vegetation data collected in June 2015 and provides a comparative analysis to the vegetation data collected in November-December 2015, November-December 2016, and November 2017 after instream discharge commenced at MAR-5. The report is presented in five sections: **Section 1**: Introduction, **Section 2**: Methods, **Section 3**: Results, **Section 4**: Discussion, and **Section 5**: References.

2. METHODS

Although the Corps has no approved wetlands functional assessment model for determining ecological restoration benefits in Arizona, WestLand used the Planning-based Wetland Functional Assessment Model developed by the Corps (Webb and Burks-Copes 2009) to establish an index of hydrological function of the MAR-5 recharge pilot study site, called its Functional Capacity Index (FCI). The FCI is a value ranging from 0 to 1 which reflects the quality of the evaluated wetland area relative to a hypothetical properly-functioning wetland. An index of “1” indicates that the wetland functions at a level equivalent to a wetland under reference standard conditions (Webb and Burks-Copes 2009), and an index at or above 0.50 indicates that the wetland has a moderate to high functional capacity (Burks-Copes and Webb 2003). The FCI is calculated by evaluating ten functions (e.g., channel dynamics, nutrient cycling, habitat structure), which in turn are calculated by formulas involving a total of 27 variables. Most of the variables are measured at the field sites; a few are evaluated using GIS. The Model converts measured variable values into a Variable Subindex (VSI) score for each variable, which ranges from 0 to 1. The VSI values comprise the variables within the formulas that calculate an FCI for each of the ten wetland functions. The FCI values of the 10 functions are averaged to produce an overall FCI for each sampled site. An overall average among all sites provides a single FCI for the entire study area. The FCI of the site is multiplied by the acreage of the represented area to calculate Functional Capacity Units (FCU). The value of the FCU reflects the quality and quantity of the wetland area, and can be compared among sites and over time for purposes of monitoring and mitigation.

2.1. Field Methods

The Model recognizes five types of wetlands (termed Partial Wetland Assessment Areas [PWAA]) in southern Arizona. All the study transects were in the Scrub-Shrubland PWAA, characterized by the presence of shrubs (defined as woody vegetation less than 3 inches in diameter at breast height), but lacking trees (>3 inches diameter at breast height). Also in the floodplain of the Gila River but outside of the channel wetted by discharge from MAR-5 are extensive areas of the Dry Riverbottom PWAA, characterized by a lack of woody vegetation (Webb and Burks-Copes 2009).

Prior to fieldwork, 38 study transects were selected by inspection of aerial imagery within the area predicted to be wetted from the discharges. Study transects were located perpendicular to the channel at intervals of approximately 200 meters (m). The lengths of the proposed transects varied in accordance with the width of the predicted wetted area (**Figure 2**). Throughout the four data collection periods, some transects were shortened, others were omitted, to better represent the wetted discharge channel and to omit non-wetted areas. Data was collected from 27 transects in June 2015, from 24 transects in November-December 2015, from 18 transects in November-December 2016, and from 24 transects in November 2017 (**Figure 3**). For transects that were shortened in November-December 2015 to include only wetted areas, the June data reported in **Section 3** was adjusted to correspond to the shortened transects, by deleting data points that were recorded in omitted sections of the transects.

At each transect, the following data were collected:

- Total Vegetation Volume (TVV)
- Percent Cover
- Belt Density of Woody Species
- Hydrological Variables
- Photographs

2.1.1. Total Vegetation Volume

The total vegetation volume (TVV) index is used to characterize community structure and composition of the vegetation and to provide an indication of overall productivity. This technique samples a series of one-decimeter (dm)-high by one-dm-radius cylinders (3.14 dm^3) from the ground surface through the top of the vegetation canopy at regular intervals along established transects. At each of the sample points per transect, a straight rod was held vertically; any live woody vegetation that occurred within a 10-centimeter (cm) radius cylinder centered on the vertical rod was recorded by species as "hits". Data was separated into 1-m vertical increments (ground-1 m, 1-2 m, 2-3 m, 3-4 m, 4-5 m, 5-6 m, 6-7 m, 7-8 m, and >8 m). Each vertical meter increment could have a maximum of 10 hits, corresponding to the number of 10-dm high x 10-cm radius cylinders occupied by live vegetation, within each vertical 1-m increment. For vegetation that occurred higher than 8 m, one hit was scored per species in the >8-m category.

The calculation procedure for computing vegetation volume data is provided below:

h_i = total number of hits (dm layers containing vegetation) at the i^{th} sample point

n = the total number of sample points within the transect

$\sum_{i=1}^{n} h_i$ = the sum of all hits within the transect

The sum of the hits can be used to calculate the volume of vegetation per dm^2 area for the transect:

$$\text{Vegetation volume per area (in decimeters)} = \frac{\sum_{i=1}^{n} h_i * 3.14dm^3}{n * 3.14dm^2}$$

The vegetation volume as cubic meters of vegetation per square meter, then, is calculated as:

$$\text{Vegetation volume per area (in meters)} = \frac{\sum_{i=1}^{n} h_i * 3.14dm^3}{n * 3.14dm^2} * \frac{1m^3}{1{,}000dm^3} * \frac{100dm^2}{1m^2}$$

This total vegetation volume per area can then be simplified and stated as an index value, TVV:

$$\text{TVV} = \frac{\sum_{i=1}^{n} h_i}{10n}$$

2.1.2. Percent Cover

Percent cover is defined as the proportion of the ground area that is covered by plant canopy, algae, water, or dead plant matter; the balance is bare ground. Plant canopy cover can be visualized as the outline projected to the ground resulting from draping a form-fitting sheet over the individual plant, i.e. ignoring small gaps in the canopy.

Percent cover was evaluated in June 2015, November-December 2016, and November 2017 with the line-intercept method, using the same transect lines established for TVV. Line-intercept essentially maps the transect in terms of the plants, litter, or bare ground that lie in a vertical plane defined by the transect. The observer begins at the 0-m mark on the transect tape and records the start and stop measures for each feature encountered along the line. For example, bare ground from 0 m to 13.75 m, mesquite canopy from 13.75 m to 20.30 m, etc., until the end of the transect is reached. Percent cover is calculated for each plant species and for litter and bare ground by summing the lengths for each feature and dividing by the total transect length. Adjustment of June data to the shortened November-December 2015 transects was accomplished by deleting any data points that occurred in portions of the transect that were later omitted. For example, Transect 3 was shortened from 250 m to 200 m; therefore, the June cover data that occurred in the last 50 m of the transect was deleted for comparison to later data.

In November-December 2015, plant cover was evaluated with the line-point method. Percent cover of a plant species or ground cover type is calculated as the percent of sample points in which the species occurred. The transect was sampled by identifying the plant species and ground cover that occurred at a series of points located at regular intervals. At each sample point, a vertical line was projected. The plant species and any dead plant matter that the vertical line intercepted was recorded. If more than one live plant species was intercepted, both species were recorded, as well as any dead plant matter. The cover of algae, algal remnants, or standing water was recorded. If there was neither live plant nor dead plant matter at the point, bare ground was recorded. Dead plant matter was recorded in one of these categories:

- LITTER (non-woody)
- FWD (Fine woody debris) ≤ 2.5 inches diameter
- CWD (Coarse woody debris) ≥ 2.5 inches diameter

2.1.3. Belt Density

Density is defined as the number of individual plants or plants of a given species per unit of area. Plant density monitoring occurred in June 2015 before the initiation of instream discharges to establish the baseline, and in November-December 2015, November-December 2016, and November 2017.

Plant density data was collected in 5-m-wide belt transects, which varied in length depending on the width of the channel (**Figure 3**). The belt transects were divided into 10-m by 5-m segments, and the number of individual perennial plants of each woody species that were more than 0.5 m in height was recorded within each segment. The ground rule for distinguishing conspecific individuals was a separation of at least 1 m between rooted stems. The division of the belt transects into segments enabled inter-year comparisons for transects that were shortened, by omitting the June 2015 data for any 10 m segments not later sampled. To document recruitment and establishment of seedlings, in November-December 2016 and November 2017, the woody plants were counted in these height classes: <20 cm, 21-50 cm, 51-100 cm, 101-200 cm and > 200 cm.

2.1.4. Photopoints

Photographs were taken from the endpoints of each of the transects, with views along the transects towards the other endpoint (**Appendix A**). Prints of the earlier photographs were taken into the field to ensure that the photos were matched (**Appendix A**).

2.1.5. Hydrological Variables

The following variables were evaluated in the field in November-December 2015, November-December 2017, and November 2017, using scores presented in the Model document (Webb and Burks-Copes 2009). Use of the Model was not implemented in time to collect data prior to discharge, thus there are no pre-discharge scores for these variables.

- DECAY: Presence of coarse woody debris in various stages of decomposition.
- FREQ: Frequency of inundation. This variable is intended to reflect the frequency of flood events necessary to inundate the site with perennial flow scored highest and 100-year flood return interval scored lowest.
- PORE: Soil pore space available for storing sub-surface water; depends on soil permeability. This variable was scored from 1 to 5, with a score of 1 indicating no restrictive layer and a score of 5 indicating a non-porous substrate.
- Q: This variable scores alterations of hydroregime by human activities, with no alterations scored highest and alterations with substantial changes to channel morphology scored lowest.
- SED: This variable scores the extent of sediment delivery to the wetland from human activity, with no human activity affecting sediment delivery scored highest, and site entirely filled with sediment from human sources scored lowest.
- SPECRICH: Species richness. A complete species list was made at each site on the same stream terrace and within 50 m upstream and downstream of each transect.
- SUBIN: Subsurface flow. This variable scores subsurface flow into the wetland either from adjacent lands or upstream sources, with subsurface flow evident scored highest and subsurface flow not evident scored lowest. Evidence of subsurface flow, in the absence of surface water, was marsh vegetation (cattails, bulrushes, reeds).
- SURFIN: Surface inflow from sheetflow. This variable was evaluated relative to an imaginary well-functioning reference area of the same PWAA in a similar hydrogeomorphic position. The variable scores surface inflow present and similar to pristine area highest, and no surface inflow with channelization scored lowest.
- TOPO: Macro- and microtopographic relief. Roughness and relief increase wetland function, by slowing and retaining water flow across the surface. Macrotopography refers to large-scale features such as bars and swales. Microtopography refers to small-scale features such as

pit-and-mound and hummock-and-hollow. This variable was scored from 1 to 5, with a score of 1 indicating complex macro and micro topographic relief and a score of 5 indicating steep banks and channelization, variable not recoverable.

- VEGSTRATA: Number of vegetation layers present. This variable has 14 categories from broad leaved tree to biotic soil crust. The more categories present, the higher the score.
- WIS: Wetland indicator score. This variable was evaluated after data entry, and was based on the plant species present. The Corps publishes an online list of species for the state of Arizona (Lichvar et al. 2016), with scores reflecting the degree to which a moist wetland habitat is necessary for the species. The lowest score (i.e. most indicative of wetland conditions) among the species present at each transect was used for the variable WIS.

  Scores are:

  1. Obligate
  2. Facultative wetland
  3. Facultative upland
  4. Upland

2.2. GIS Methods

The following variables were evaluated by inspection of Google Earth imagery:

- BUFFWIDTH (distance in meters to nearest human disturbance)
- CONTIG (cover of contiguous vegetation between wetlands and uplands)
- FPA (flood prone area)
- LANDBUFF (calculated from LANDUSE and BUFFWIDTH)
- LANDUSE (type of adjacent land use)
- TRIB (presence of connected tributaries)

2.3. Data Entry and Analysis

The field data was entered into an Excel™ workbook, and the Variable Subindex Score (VSI, a number between 0 and 1) for each variable was calculated. The VSI values populated the formulas that calculated the FCI values for the ten wetland functions:

- CHANNELDYN: maintenance of characteristic channel dynamics
- WATSTORENR: dynamic surface water storage/energy dissipation
- WATSTORLNG: long-term surface water storage
- WATSTORSUB: dynamic subsurface water storage
- NUTRIENT: nutrient cycling

- ELEMENTS: detention of imported elements and compounds
- DETPARTICL: detention of particles
- PLANTS: maintain characteristic plant communities
- HABSTRUCT: maintain spatial structure of habitat
- INTERSPERS: maintain interspersion and connectivity

More detailed descriptions of these functions are included in the Corps report (Webb and Burks-Copes 2009) and provided in **Appendix B**.

The Model requires a breakdown of plant canopy cover into herbaceous, shrub, and tree species, but only defines trees as greater than 3 inches in diameter at breast height (Webb and Burks-Copes 2009). Shrubs were classified as perennial woody plants with persistent single or multiple stems less than 3 inches in diameter at breast height, and herbaceous species as perennial or annual non-woody plants with single or multiple stems that do not persist.

A spreadsheet was created that lists every species found in all sites, with an indication for each species whether it is an herb, shrub, tree, invasive, and its WIS, if available. Species were counted as invasive and included in the variable INVAS if they appeared on the lists of:

1. Plant species listed as noxious weeds by the state of Arizona (Arizona Department of Agriculture 2005), and
2. Other non-native plant species considered invasive in Arizona (Northam et al. 2016).

While TVV data was collected in the field by recording each species' contribution separately in 1-m by 20-dm cylinders; the data required by the Model is a single number, so all hits on all species were summed for entry into the data spreadsheets.

3. RESULTS AND DISCUSSION

3.1. Total Vegetation Volume

Comparisons of TVV index values by transect for the four sample periods are presented in **Table 1**, showing baseline data from June 2015 and post-discharge data from November-December 2015, November-December 2016, and November 2017.

Table 1. Total Vegetation Volume Index Summarized by Transect

Transect Number	Total Vegetation Volume Index, m^3/m^2			
	June 2015	November - December 2015	November - December 2016	November 2017
1	0	*	*	0.27
2	0.025	0.071	0.23	0.035
3	0.016	0	0.18	0.01
4	0.025	0.100	0.65	0.09
5	0.005	0.020	*	0.215
6	0.02	0.013	*	0.01
7	0.05	0.165	*	0.15
8	0.01	0.035	*	0.005
9	0.012	0.150	*	0.225
12	0.012	0	*	0.015
13	0.014	0.004	0.04	0.01
14	0.040	0.004	0.11	0
15	0.024	0	0.23	0.035
17	0.020	0	0.03	0.025
19	0.004	0	0.08	0.12
22	0.020	0	0.07	0.03
24	0.032	0	0.05	0.085
25	0.008	0.010	0.01	*
27	0.024	*	0.26	0.29
28	0.016	0	0.15	0.16
31	0.004	0	0.24	0.19
33	0.020	0.020	0.17	0.13
35	0	0	0	0.01
36	0.020	0	0.05	0
37	0.010	0.015	0.22	0.025
Average	0.017	0.0264	0.154	0.089

* Denotes transects that were not sampled during data collection.

The TVV values by transect of the most common woody species for each sampling period are presented in **Table 2**. All the woody species increased in volume over the study period; the greatest increase was in saltcedar (*Tamarix chinensis*).

Table 2. Total Vegetation Volume by Transect of Most Common Woody Species, June 2015, November-December 2015, November-December 2016, and November 2017

Transect	1	2	3	4	5	6	7	8	9	12	13	14	15	17	19	22	24	25	27	28	31	33	35	36	37
June 2015																									
Atriplex canescens	0	0.015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baccharis sarothroides	0	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isocoma pluriflora	0	0	0.008	0.005	0	0	0	0	0	0	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prosopis velutina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0
Tamarix chinensis	0	0	0.008	0.005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.005	0
November-December 2015																									
Atriplex canescens	0	0.009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baccharis sarothroides	0	0.011	0	0.070	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isocoma pluriflora	0	0.011	0	0	0	0	0	0	0	0	0	0.004	0	0	0	0	0	0	0	0	0	0	0	0	0
Prosopis velutina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.020	0	0	0.015
Tamarix chinensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
November-December 2016																									
Atriplex canescens	0	0.035	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baccharis sarothroides	0	0.005	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isocoma pluriflora	0	0.065	0.065	0.125	0	0	0	0	0	0	0.015	0	0	0	0	0	0.015	0	0	0.065	0	0	0	0	0
Prosopis velutina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.065	0	0	0.1
Tamarix chinensis	0	0.01	0.025	0.17	0	0	0	0	0	0	0	0	0.115	0.015	0.04	0.035	0.01	0.005	0.13	0.01	0.12	0.02	0	0.025	0.01
November 2017																									
Atriplex canescens	0.155	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baccharis sarothroides	0.01	0	0	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.03	0	0	0	0
Isocoma pluriflora	0	0.025	0.01	0	0.145	0.01	0.015	0.005	0	0	0	0	0.005	0	0	0	0.04	0	0	0.085	0	0	0	0	0
Prosopis velutina	0.04	0	0	0	0	0	0	0	0.21	0	0	0	0	0	0	0	0	0	0	0	0.03	0.095	0	0	0.005
Tamarix chinensis	0.065	0.01	0	0.02	0.07	0	0.105	0	0.015	0.015	0	0	0.03	0.025	0.12	0.03	0.045	0	0.27	0.075	0.13	0.035	0.01	0	0.02

3.2. PERCENT COVER

Comparisons of percent cover values of ground and plant cover categories averaged among transects during the four sample periods are presented in **Table 3**. There has been a decrease in bare ground, from 81.2 percent in June 2015 to 33.7 percent in November 2017. Herbaceous canopy cover has increased from 8.3 percent in June 2015 to 59.0 percent in November 2017, and shrub cover has increased from 3.3 percent to 10.5 percent.

Table 3. Percent Cover of All Categories of Ground Cover Averaged Across All Sampled Transects; June 2015, November-December 2015, November-December 2016, and November 2017

Ground Cover Categories	Average Percent Cover			
	June 2015	November - December 2015	November - December 2016	November 2017
Bare soil or rock	81.2	84.7	50.3	33.7
Litter	5.7	14.9	8.7	2.0
Herbaceous canopy	8.3	17.4	48.0	59.0
Shrub canopy	3.3	4.0	8.2	10.5

Comparisons of percent cover values of all plant species are presented in **Table 4**. The most notable changes, between June and November 2017 following the discharge of water in August 2015, were increases in herbaceous vegetation, mostly due to Bermudagrass (*Cynodon dactylon*), barnyard grass (*Echinochloa crus-galli),* and cattail (*Typha latifolia*). Cover of Bermudagrass averaged across all transects increased almost ten-fold, from 2.1 percent to 19.5 percent, and cover of barnyard grass increased from 0 to 17 percent (**Table 4**). The increase in cover of Bermudagrass and barnyard grass followed the discharge of water from MAR-5 and the summer rains. The increase in cattail cover, from 0 to 10 percent, can be directly attributed to the discharge from MAR-5, as it is an obligate wetland species (Lichvar et al. 2016) and is absent from the Gila River floodplain outside the discharge channel.

Table 4. Percent Cover of Live Vegetation; June 2015, November-December 2015, November-December 2016, and November 2017; Summarized by Species and Averaged Across All Sampled Transects

Species	Average Percent Cover			
	June 2015	November - December 2015	November - December 2016	November 2017
Ambrosia salsola	0	0.3	0.2	0.2
Amsinckia sp.	0	0.1	0	0
Atriplex canescens	0.3	0.2	0.2	0.4
Atriplex polycarpa	0.1	0.0	0.1	0
Atriplex rosea	4.3	0.0	11.0	0.9
Baccharis sarothroides	0.2	0.9	0.4	0.3
Bouteloua barbata	0	0.1	0.2	0
Brassica tournefortii	0	0.2	0	0
Camissonia sp.	0	0.3	0	0
Cynodon dactylon	2.1	11.4	13.4	19.5
Echinochloa crus-galli	0	0.3	5.2	16.9
Eclipta prostrata	0	0	0	4.2
Erodium cicutarium	0	0.3	0	0
Eriogonum sp.	0.1	0.0	2.5	0
Helianthus annuum	0	0	0	0.1
Heliotropium curassavicum	0	0	0.2	0
Isocoma pluriflora	1.1	1.2	2.8	2.3
Lactuca seriola	0	0	0	0.1
Leptochloa fulca	0	0	2.2	4.5
Pennisetum ciliaris	0	0.6	0.5	0.2
Prosopis velutina	0.6	1.0	0.3	1.6
Rumex sp.	0	0.0	1.7	0
Salsola tragus	1.6	1.3	7.0	1.5
Sonchus sp.	0	0.1	0	0
Sporobolus cryptandrus	0	0.1	0.3	0.1
Sphaeralcea sp.	0.1	0.1	0	0.1
Tamarix aphylla	0	0	0	0.1
Tamarix chinensis	1	0.3	4.2	5.6
Tidestromia lanuginosa	0	0.1	0	0.5
Tiquilia plicata	0.1	0.4	0.4	0.1
Typha latifolia	0	0	3.2	10.3
Unknown annual forb	0	0.2	0.1	0
Unknown annual grass	0	1.8	0	0

3.3. BELT DENSITY

Comparisons of belt density of woody species by transect are presented in **Table 5**. To enable comparison across sampling periods, **Table 5** does not include shrubs less than 0.5 m high, as this data was only collected in November 2016 and 2017. Comparisons of belt density of woody species by species are presented in **Table 6**. Height class data for the seven most common woody species, averaged across all transects sampled in November 2017, is presented in **Table 7**.

Table 5. Total Woody Plant Density (Number of Plants >50 cm High Per Hectare) by Transect, June 2015, November-December 2015, November 2016, and November 2017

Transect	June 2015 *	Nov 2015	Nov 2016	Nov 2017
1	365	not sampled	not sampled	1050
2	1053	1093	3200	653
3	800	640	1490	750
4	914	900	1120	557
5	325	100	not sampled	1300
6	1286	1200	not sampled	457
7	320	1240	not sampled	1240
8	367	467	not sampled	267
9	100	250	not sampled	1200
10	100	0	not sampled	not sampled
11	0	0	not sampled	not sampled
12	171	114	not sampled	286
13	120	360	1160	40
14	0	280	not sampled	not sampled
15	0	0	6467	400
17	0	0	1333	267
19	0	0	1840	320
22	0	0	1750	700
24	0	100	7400	1000
25	0	200	1800	not sampled
27	0	0	6200	1600
28	100	0	1320	800
31	80	160	2560	640
33	0	0	800	700
35	400	0	400	533
36	100	100	1300	500
37	0	0	0	300

* June data was adjusted for any shortening of transects in November-December 2015 and November 2017.

Table 6. Woody Plant Density (Plants >50 cm Height Per Hectare) of Most Common Species Averaged Across All Sampled Transects, June 2015, November-December 2015, November-December 2016, and November 2017

Species	Belt Density (no. of plants per hectare)			
	June 2015 * (Baseline)	November - December 2015 (Post-discharge)	November - December 2016	November 2017
Ambrosia salsola	7	19	12	237
Atriplex canescens	18	20	20	95
Baccharis sarothroides	19	28	128	40
Isocoma pluriflora	158	207	524	149
Prosopis velutina	7	15	1	59
Salix gooddingii	0	0	87	12
Tamarix chinensis	11	6	1514	352
All woody species	244	300	2230	677

* June data was adjusted for any shortening of transects in November-December 2015 and November 2017.

From June 2015, before the initiation of MAR-5 discharge, to November-December 2015, all woody species increased in density, except for four-wing saltbush (*Atriplex canescens*) and saltcedar. In the period November 2015 to November 2016 desert broom (*Baccharis sarothroides*), jimmyweed (*Isocoma pluriflora*), Goodding's willow (*Salix gooddingii*), and saltcedar showed sharp increases in density, while mesquite showed a sharp decrease. The anomalously high-density data in 2016 may have been due to a mistaken sampling procedure: the rule of thumb for counting nearby plants as individuals was that each should be at least 1 m from a conspecific. This rule may not have been observed by the field crew in 2016, resulting in an overcount. The anomalous data for mesquite can be explained by the lack of data from transects that were not sampled in 2016 (transects 1, 5, 6, 7, 8, 9, and 12) in four of which mesquite had been present in 2015. Its large increase in 2017 was real, as it appeared for the first time in nine transects.

Table 7. Woody Plant Density (plants per hectare) by Height Class of Most Common Species Averaged across All Transects Sampled in November 2017

Species	Belt Density (no. of plants per hectare) by Height Class				
	< 20 cm	21-50 cm	51-100 cm	101-200 cm	>200 cm
Ambrosia salsola	0	2	18	13	1
Atriplex canescens	0	0	2	12	3
Baccharis sarothroides	0	3	14	19	3
Isocoma pluriflora	6	75	90	49	1
Prosopis velutina	9	24	10	5	11
Salix gooddingii	0	0	0	4	8
Tamarix chinensis	0	16	115	170	94

In the height class distribution shown in **Table 7**, a large proportion of plants of a given species in the smaller height classes (presumably younger individuals) indicates a growing population. Among these species, jimmyweed and mesquite show the most potential for population growth, with 37 percent and 57 percent respectively of their populations in the smaller two height classes. Goodding's willow, probably the most desirable tree species to become established in the wetted area (Webb and Burks-Copes 2009), has a low potential for increase given the small number of saplings present and the high cover of Bermuda grass in the wetter portions of the site as bare ground is required for willow recruitment (Stromberg 1993). Numerous willow saplings that had recently died were observed, probably a result of the fluctuations in ground water levels. Moist soils throughout the growing season are necessary for the establishment of willow recruits (Lite and Stromberg 2005, Stromberg 1993), and water stress effects are often most pronounced in the juveniles of a species (Lite and Stromberg 2005, Stromberg 1997).

3.4. INVASIVE SPECIES

Several species classified as non-native invasive plant to Arizona (Northam et al. 2016) occur in the GRIC MAR-5 study area, including buffelgrass (*Pennisetum ciliaris*), Sahara mustard (*Brassica tournefortii*), filaree (*Erodium cicutarium*), Bermudagrass, saltcedar, Athel tamarisk (*Tamarix aphylla*), Russian thistle, *Sonchus* sp., Mediterranean grass (*Schismus barbatus*), and barnyard grass. Bermudagrass, barnyard grass, and saltcedar have shown substantial increases in cover since the initiation of discharge in 2015 (**Table 5**).

3.5. HYDROLOGICAL VARIABLES

The field variables used in the Model were evaluated during fieldwork in November-December 2015, November-December 2016, and November 2017. The field and GIS variable values were converted to VSI scores and used to calculate the FCI scores for the three years. The overall averages of the FCI scores are presented in **Table 8**, as well as the FCU values (FCI multiplied by acreage). The slight increase in FCI score from 2015 to 2017 indicates that the site is approaching a moderate functional capacity (Burks-Copes and Webb 2003). Note that modifications to the MAR-5 discharge facility in 2017 resulted in an increased wetted area, which diverted water away from the established transects.

Table 8. Functional Capacity Index (FCI) Scores Averaged across All Sites and Functions, and FCU Values for the Entire Wetted Areas, Compared across All Sampling Periods

Category	November - December 2015	November - December 2016	November 2017
Overall Average FCI	0.44	0.61	0.47
Wetted acreage	53.9	53.9	123.4
FCU	23.7	32.9	58.0

The FCI scores for the hydrological functions evaluated at the transects in November-December 2015, November-December 2016, and November 2017 are provided in **Appendix C**. FCIs are scored from 0 to 1, with "1" considered a well-functioning wetland (riparian) site (Webb and Burks-Copes 2009). A comparison among years of FCI values for wetland functions averaged among all sample transects is provided in **Table 9**.

Table 9. Comparison Between Years of FCI Values Averaged across All Transects

Code	Name	2015	2016	2017
CHANNELDYN	Function 1: Maintenance of Characteristic Channel Dynamics	0.64	0.84	0.42
WATSTORENR	Function 2: Dynamic Surface Water Storage/Energy Dissipation	0.81	0.94	0.80
WATSTORLNG	Function 3: Long Term Surface Water Storage	0.51	0.92	0.66
WATSTORSUB	Function 4: Dynamic Subsurface Water Storage	0.50	0.50	0.50
NUTRIENT	Function 5: Nutrient Cycling	0.09	0.18	0.12
ELEMENTS	Function 6: Detention of Imported Elements and Compounds	0.32	0.51	0.41
DETPARTICL	Function 7: Detention of Particles	0.52	0.72	0.51
PLANTS	Function 8: Maintain Characteristic Plant Communities	0.17	0.50	0.47
HABSTRUCT	Function 9: Maintain Spatial Structure of Habitat	0.38	0.44	0.38
INTERSPERS	Function 10: Maintain Interspersion and Connectivity	0.40	0.51	0.40
	Average	**0.44**	**0.61**	**0.47**

The low FCI scores (less than 0.50) for most of the functions in **Table 9** indicate that, according to the Model, the GRIC MAR-5 site is presently not considered a well-functioning wetland (riparian) site. However, the site had just been recently tested with only 1 to 2 growing seasons, as such, it is expected that there would be significant potential for improvement. The water storage functions (Functions 2 - 4) will continue to improve with continued discharge from MAR-5. The CHANNELDYN, HABSTRUCT and INTERSPERS FCI scores will increase as more heterogenous habitats and contiguous areas of food and cover for wildlife develop with continued discharge of water into the channel. Likewise, the ELEMENT and NUTRIENT FCI scores will increase as plants colonize the wetted area and associated floodplain, and produce litter, fine and coarse woody debris, and increase the canopy and volume of vegetation.

The preponderance of invasive plants (see **Section 3.4**) will continue to depress FCI scores for the function PLANTS (maintenance of characteristic plant communities). However, with the implementation of an invasive species management plan the score would be likely to improve. Several functions involve the variable Flood Prone Area (FPA), which measures the degree to which the stream is confined within a man-made channel or gully. Eleven of the 24 study transects sampled in 2017 were scored as 4, defined as "FPA is confined and <1.5 bankfull width", indicating that the stream reach was confined in a gully. Discharge from MAR-5 has evidently scoured the channel in numerous areas, and continues to aggravate the gullying problem. However, the construction of a three-way flow splitter box in 2017 and subsequent distribution of water into a secondary channel and tertiary pond has markedly improved the channeling problem and distributed the flow over a larger area.

4. SUMMARY

The initiation of water discharge from MAR-5 into the Gila River in August 2015 created a strip of wetland, called the "wetted area", that varied in width and degree of saturation with the amount of discharge and distance from the source. The pre-discharge vegetation of the area was a sparse collection of upland woody shrubs (four-wing saltbush, mesquite, jimmyweed, desert broom) with desert forbs (*Atriplex rosea, Tiquilia plicata,* and Russian thistle) and Bermudagrass. Saltcedar and Athel Tamarix were present at low cover. There were no cattails. After a few months of discharge, the water was turned off and the area was re-sampled in late November-early December 2015, by which time the cover of Bermudagrass had increased almost ten-fold, barnyard grass had become common, and the woody shrubs had increased in cover and density.

The area was re-sampled a year later in November-December 2016. Bermudagrass and barnyard grass continued to increase in cover, while cattails and the grass Mexican sprangletop (*Leptochloa fusca*) became common. Russian thistle was very common, and had increased in cover from 1.6 percent before discharge to 7.0 percent. Jimmyweed and the invasive saltcedar increased in cover, density, and volume. Thousands of saltcedar recruits had appeared since the previous year.

The data recorded in November 2017 showed a continuation of these trends. The grasses Bermudagrass, barnyard grass, and Mexican sprangletop together with cattails contributed over 50-percent cover, as contrasted to the total herbaceous cover of 8.3 percent in June 2015. Shrub cover for most species was steady or had declined slightly, except for saltcedar. The density of saltcedars had increased from 11 to 352 per hectare over the period June 2015 to November 2017.

Vegetation cover decreases with distance downstream from the MAR-5 discharge site, from an average cover of 86 percent in the six transects closest to MAR-5 to 33 percent in the farthest six. The most distant transect (Transect 37) had only 11-percent vegetation cover in November 2017.

The modification to the MAR-5 discharge facility in 2017 resulted in an increase in the wetted area from 53.9 to 123.4 acres; however, the amount of discharge was not increased.

Future discharge of water will probably result in increased production of vegetation in the wetted area, especially of cattails, Bermudagrass, barnyard grass, saltcedar, and mesquite. Upland woody species, including jimmyweed, desert broom, and saltbush, may decline in the wetted area because they cannot tolerate frequent inundation (Stromberg 1993). More desirable species, such as Goodding's willow, may require a shorter dry period to become established and persist (Lite and Stromberg 2005, Stromberg 1997).

5. REFERENCES

Arizona Department of Agriculture. 2005. "Prohibited, Regulated and Restricted Noxious Weeds (1 May 2006)." U.S. Department of Agriculture. https://plants.usda.gov/java/noxious?rptType=State&statefips=04.

Burks-Copes, Kelly A., and Antisa C. Webb. 2003. Tres Rios del Norte (Pima County, Arizona) Ecosystem Restoration Functional Assessment Using HGM, Analysis, Results and Documentation Draft Report. *Environmental Laboratory ERDC/EL XX-03-X*: U.S. Army Corps of Engineer Research and Development Center.

Lichvar, R. W., D. L. Banks, W. N. Kirchner, and N. C. Melvin. 2016. "State of Arizona 2016 Wetland Plant List, The National Wetland Plant List: 2016 wetland ratings." *Phytoneuron* 30:1-17.

Lite, S.J., and J.C. Stromberg. 2005. "Surface Water and Ground-water Thresholds for Maintaining *Populus–Salix* forests, San Pedro River, Arizona." *Biological Conservation* 125:153-167.

Northam, E., W. Meyer, J. Arnold-Musa, E. Carrillo, K. Egen, and M. Hershdorfer. 2016. Non-native, Invasive Plants of Arizona. *Conservation Districts and RC&D Areas of Arizona, and the Universtity of Arizona Cooperative Extension*, edited by L. D. Howery: Reviewed 2016, Published 2009, 1st Edition 2001. 84.

Stromberg, J.C. 1993. "Fremont Cottonwood-Goodding Willow Riparian Forests: A Review of Their Ecology, Threats, and Recovery Potential." *Journal of the Arizona-Nevada Academy of Science* 26 (3):97-110.

______. 1997. "Growth and Survivorship of Fremont Cottonwood, Goodding Willow, and Salt Cedar Seedlings after Large Floods in Central Arizona." *Great Basin Naturalist* 57 (3):198-208.

Webb, Antisa C., and Kelly A. Burks-Copes. 2009. A Planning-based Wetlands Functional Assessment Model for Southern Arizona's Arid Riverine Systems and Their Associated Riparian Habitats, Final Report. *Environmental Laboratory ERCD/LAB TR-09-X*. Vicksburg, Mississippi: U.S. Army Corps of Engineer Research and Development Center. 132.

FIGURES

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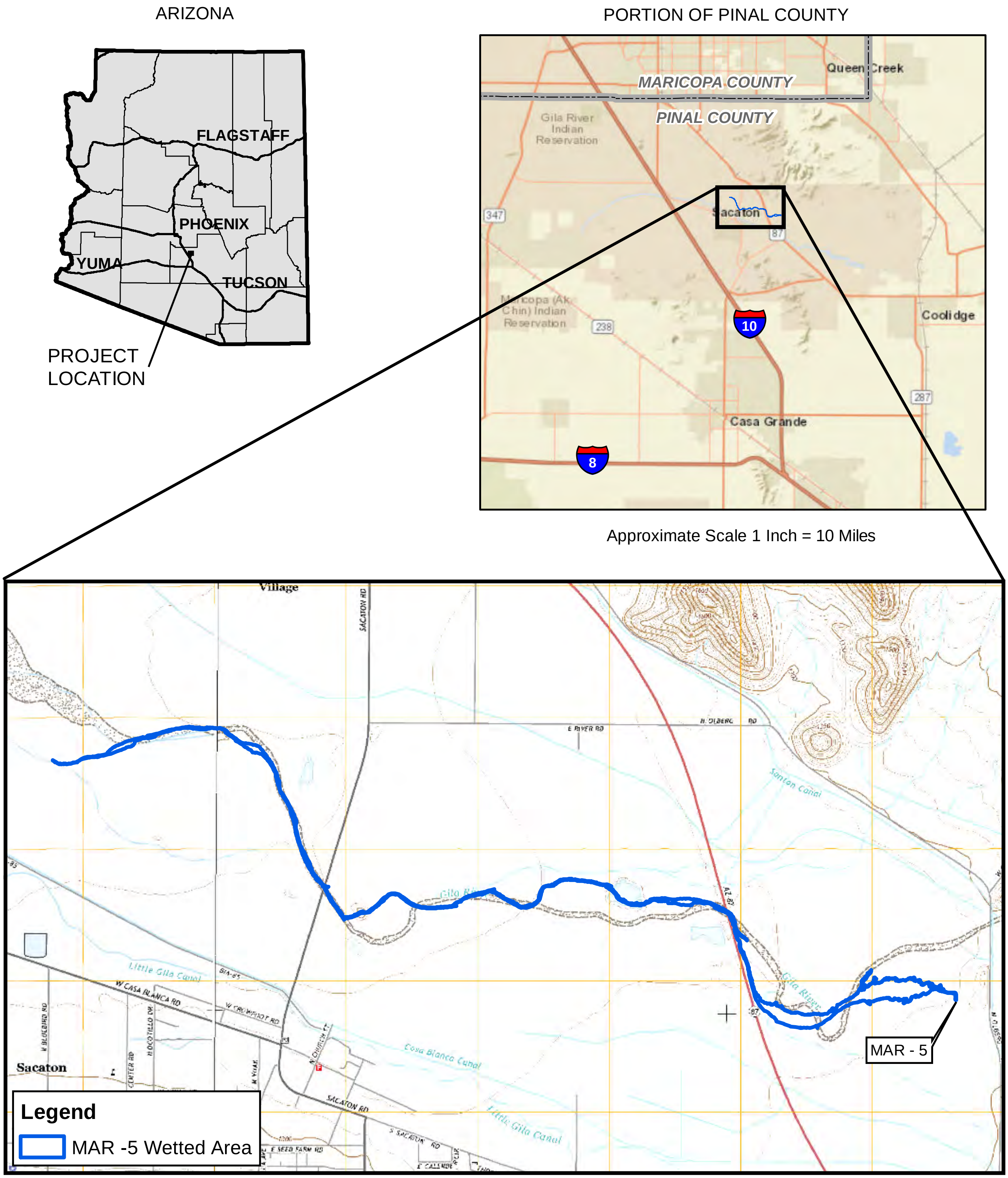

MAR-5 Wetted Area in
T4S, R6E, Portions of Sections 8-11, 13, and 14,
Pinal County, Arizona,
Sacaton and Gila Butte SE USGS 7.5' Quadrangles (2014)
Image Source: ArcGIS Online, World Street Map

RESOLUTION COPPER GRIC MAR-5

2017 Vegetation Monitoring Memo

VICINITY MAP

Figure 1

N

0 1,800 3,600 Feet

0 600 1,200 Meters

WestLand Resources

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WestLand Resources

T4S, R6E, Portions of Sections 9-11, 13, and 14,
Pinal County, Arizona,
Gila Butte and Sacaton USGS 7.5' Quadrangles
Projection: UTM NAD83, Zone 12
Photo Source: ArcGIS Online

0 600 1,200 Feet

0 200 400 Meters

N

Legend

- Stake Locations
- Transect Locations
- MAR 5 100cfs Predicted Wetted Area

RESOLUTION COPPER GRIC MAR - 5

2017 Vegetation Monitoring Memo

VEGETATION MONITORING TRANSECTS - JUNE 2015

Figure 2

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WestLand Resources

Wetted Area found within:
T4S, R6E, Portions of Sections 8-11, 13, and 14,
Pinal County, Arizona.
Image Source: 2015 USDA NAIP Orthophoto
Data Sources: BLM PLSS section data, GRIC BIA
Allotment data provided by Paul Shorthair, Land Use Ordinance Officer.
Department of Land Use Planning and Zoning, Gila River Indian Community.
We received 4 scanned images from Paul Shorhair. They were rectified to
the NAIP 2015 imagery and the red lines on these maps were delineated
as BIA Allotment Lines

N

0 800 1,600 Feet

0 0.25 0.5 Miles

Legend

- Access Point
- Transcect Point 2016
- AccessRoute
- Transect Line 2016
- Approximate BIA Allotment Lines
- MAR -5 Wetted Area
- PLSSFirstDivision (Sections)

RESOLUTION COPPER GRIC MAR - 5
2017 Vegetation Monitoring Memo

VEGETATION MONITORING TRANSECTS - NOVEMBER 2016
Figure 3

Path: M:\Jobs\800's\807.131\ENV\GRIC\Gric_MAR5_2017VegMonitoringMemo\MXD\Fig04_GRIC_MAR_5_Vegetation_Monitoring.mxd Date: 3/21/2018 User: rwitzke

T4S, R6E, Portions of Sections 8 - 14,
Pinal County, Arizona.
Gila Butte SE and Sacaton USGS 7.5' Quadrangles
Image Source: Pleiades Satellite Imagery 10/28/2017

Legend

Transect Line
MAR-5 Wetted Area

RESOLUTION COPPER GRIC MAR-5
2017 Vegetation Monitoring Memo

VEGETATION MONITORING TRANSECTS - NOVEMBER 2017
Figure 4

WestLand Resources

0 750 1,500 Feet
0 250 500 Meters

N

APPENDIX A

Repeat Photographic Documentation of Vegetation Monitoring Transects

Photo 1. Transect 1a, 10 degrees. June 2015

Photo 2. Transect 1a, 90 degrees. November 2015

Photo 3. Transect 1a, 90 degrees. November/December 2016

Photo 4. Transect 1a, 10 degrees. November 2017

Photo 5. Transect 2a, 23 degrees. June 2015

Photo 6. Transect 2a, 23 degrees. November 2015

Photo 7. Transect 2a, 340 degrees. November 2016

Photo 8. Transect 2a, 345 degrees. November 2017

WestLand Resources

Repeat Photographs of Vegetation Monitoring Transects
Appendix A
Photopage 2

Photo 9. Transect 3a, 10 degrees. June 2015

Photo 11. Transect 3a, 10 degrees. November 2016

Photo 10. Transect 3a, 10 degrees. November 2015

Photo 12. Transect 3a, 10 degrees. November 2017

Photo 13. Transect 4a, 342 degrees. June 2015

Photo 15. Transect 4a, 340 degrees. November 2016

Photo 14. Transect 4a, 315 degrees. November 2015

Photo 16. Transect 4a, 315 degrees. November 2017

Photo 17. Transect 5a, 0 degrees. June 2015

Photo 18. Transect 5a, 0 degrees. November 2015

Photo 19. Transect 5a, 0 degrees. November 2016

Photo 20. Transect 5a, 330 degrees. November 2017

Photo 21. Transect 6a, 340 degrees. June 2015

Photo 22. Transect 6a, 340 degrees. November 2016

Photo 23. Transect 6a, 340 degrees. November 2016

Photo 24. Transect 6a, 340 degrees. November 2017

Photo 25. Transect 7a, 158 degrees. June 2015

Photo 26. Transect 7a, 158 degrees. November 2015

Photo 27. Transect 7a, 158 degrees. November 2016

Photo 28. Transect 7a, 158 degrees. November 2017

Photo 29. Transect 8a, 80 degrees. June 2015

Photo 30. Transect 8a, 80 degrees. November 2015

Photo 31. Transect 8a, 80 degrees. November 2016

Photo 32. Transect 8a, 30 degrees. November 2017

Photo 33. Transcect 9a, 72 degrees. June 2015

Photo 34. Transect 9a, 72 degrees. November 2015

Photo 35. Transect 9a, 72 degrees. November 2016

Photo 36. Transect 9a, 60 degrees. November 2017

Photo 37. Transect 10a, 86 degrees. June 2015

Photo 38. Transect 10a, 90 degrees. November 2015

Photo 39. Transect 10a, 90 degrees. November 2016

Photo 40. Transect 11a, 82 degrees. June 2015

Photo 41. Transect 11a, 90 degrees. November 2015

Photo 42. Transect 11a, 90 degrees. November 2016

Photo 43. Transect 12a, 67 degrees. June 2015

Photo 45. Transect 12a, 67 degrees. November 2016

Photo 44. Transect 12a, 67 degrees. November 2015

Photo 46. Transect 12a, 67 degrees. November 2017

Photo 47. Transect 13a, 5 degrees. June 2015

Photo 48. Transect 13a, 5 degrees. November 2015

Photo 49. Transect 13a, 5 degrees. November 2016

Photo 50. Transect 13a, 5 degrees. November 2017

Photo 51. Transect 14a, 0 degrees. June 2015

Photo 52. Transect 14a, 0 degrees. November 2015

Photo 53. Transect 14a, 0 degrees. November 2016

Photo 54. Transect 14a, 340 degrees. November 2016

Photo 55. Transect 15a, 350 degrees. June 2015

Photo 56. Transect 15a, 350 degrees. November 2015

Photo 57. Transect 15a, 350 degrees. November 2016

Photo 58. Transect 15a, 340 degrees. November 2017

Photo 59. Transect 17a, 40 degrees. June 2015

Photo 60. Transect 17a, 40 degrees. November 2015

Photo 61. Transect 17a, 40 degrees. November 2016

Photo 62. Transect 17a, 10 degrees. November 2017

Photo 63. Transect 19a, 320 degrees. June 2015

Photo 64. Transect 19a, 320 degrees. November 2015

Photo 65. Transect 19a, 320 degrees. November 2016

Photo 66. Transect 19a, 305 degrees. November 2017

Photo 67. Transect 22a, 335 degrees. June 2015

Photo 68. Transect 22a, 335 degrees. November 2015

Photo 69. Transect 22a, 335 degrees. November 2016

Photo 70. Transect 22a, 310 degrees. November 2017

Photo 71. Transect 24a, 350 degrees. June 2015

Photo 72. Transect 24a, 350 degrees. November 2015

Photo 73. Transect 24a, 350 degrees. November 2016

Photo 74. Transect 24a, 340 degrees. November 2017

Photo 75. Transect 25a, 10 degrees. June 2015

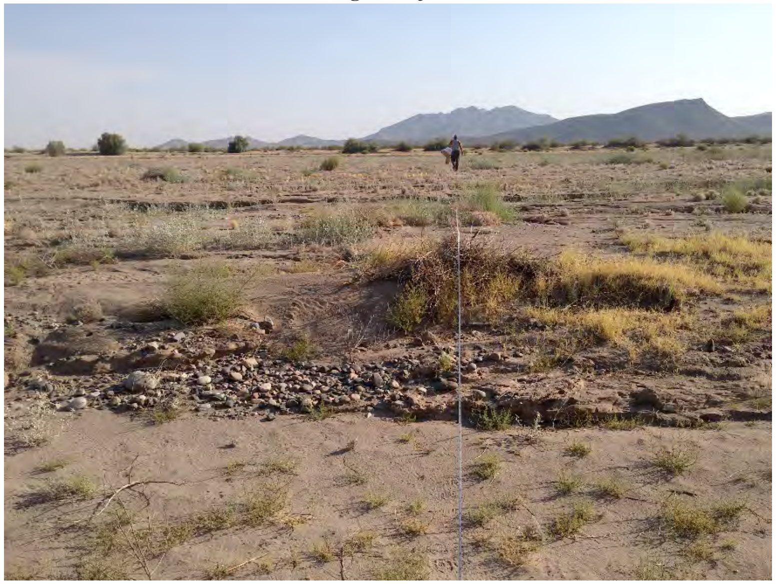

Photo 76. Transect 25a, 10 degrees. November 2015

Photo 77. Transect 25a, 10 degrees. November 2016

Photo 78. Transect 27a, 328 degrees. June 2015

Photo 79. Transect 27a, 328 degrees. November 2015

Photo 80. Transect 27a, 328 degrees. November 2016

Photo 81. Transect 27a, 320 degrees. November 2017

Photo 82. Transect 28a, 333 degrees. June 2015

Photo 83. Transect 28a, 333 degrees. November 2015

Photo 84. Transect 28a, 333 degrees. November 2016

Photo 85. Transect 28a, 340 degrees. November 2017

Photo 86. Transect 31a, 50 degrees. June 2015

Photo 87. Transect 31a, 50 degrees. November 2015

Photo 88. Transect 31a, 50 degrees. November 2016

Photo 89. Transect 31a, 60 degrees. November 2017

Photo 90. Transect 33a, 54 degrees. June 2015

Photo 91. Transect 33a, 54 degrees. November 2015

Photo 92. Transect 33a, 54 degrees. November 2016

Photo 93. Transect 33a, 60 degrees. November 2017

Photo 94. Transect 35a, 48 degrees. June 2015

Photo 95. Transect 35a, 48 degrees. November 2015

Photo 96. Transect 35a, 48 degrees. November 2016

Photo 97. Transect 35a, 40 degrees. November 2017

Photo 98. Transect 36a, 324 degrees, June 2015

Photo 99. Transect 36a, 324 degrees. November 2015

Photo 100. Transect 36a, 20 degrees. November 2016

Photo 101. Transect 36a, 20 degrees. November 2017

Photo 102. Transect 37a, 0 degrees. June 2015

Photo 104. Transect 37a, 0 degrees. November 2016

Photo 103. 37a, 0 degrees. November 2015

Photo 105. Transect 37a, 10 degrees. November 2017

APPENDIX B

Table 2 from Tres Rios del Norte (Pima County, Arizona) Ecosystem Restoration Functional Assessment Using HGM, December 2003, Analyses, Results, and Documentation Draft Report

Table 2. Functions in the Arizona Riverine HGM Model

Code	Name	Description
CHANNELDYN	Function 1: Maintenance of Characteristic Channel Dynamics	Physical processes and structural attributes that maintain characteristic channel dynamics. These include flow characteristics, bedload, in-channel coarse woody debris, and potential coarse woody debris inputs, channel dimensions, and other physical features (e.g. bank vegetation, slope).
WATSTORENR	Function 2: Dynamic Surface Water Storage/Energy Dissipation	Dynamic water storage and dissipation of energy at bankfull and greater discharges. These are a function of channel width, depth, bedload, bank roughness (coarse woody debris, vegetation, etc.), presence and number of in-channel coarse woody debris jams, and connectivity to off-channel pits, ponds, and secondary channels.
WATSTORLNG	Function 3: Long Term Surface Water Storage	The capability of a wetland to temporarily store (retain) surface water for long durations; associated with standing water not moving over the surface. Water sources may be overbank flow, overland flow, and/or channelized flow from uplands, or direct precipitation.
WATSTORSUB	Function 4: Dynamic Subsurface Water Storage	Availability of water storage beneath the wetland surface. Storage capacity becomes available due to periodic drawdown of water table.
NUTRIENT	Function 5: Nutrient Cycling	Abiotic and biotic processes that convert elements from one form to another; primarily recycling processes.
ELEMENTS	Function 6: Detention of Imported Elements and Compounds	The detention of imported nutrients, contaminants, and other elements or compounds.
DETPARTICL	Function 7: Detention of Particles	Deposition and detention of inorganic and organic particulates (>0.45 um) from the water column, primarily through physical processes.
PLANTS	Function 8: Maintain Characteristic Plant Communities	Species composition and physical characteristics of living plant biomass. The emphasis is on the dynamics and structure of the plant community as revealed by the species of TVVs, shrubs, seedlings, saplings, and herbs and by the physical characteristics of the vegetation.
HABSTRUCT	Function 9: Maintain Spatial Structure of Habitat	The capacity of a wetland to support animal populations and guilds by providing heterogeneous habitats.
INTERSPERS	Function 10: Maintain Interspersion and Connectivity	The capacity of the wetland to permit aquatic organisms to enter and leave the wetland via permanent of ephemeral surface channels, overbank flow, or unconfined hyporheic gravel aquifers. The capacity of the wetland to permit access of terrestrial or aerial organisms to contiguous areas of food and cover.

APPENDIX C

Functional Capacity Index (FCI) Scores of Functions Evaluated, for all Sampling Periods

Appendix C. Functional Capacity Index (FCI) Scores[1] of Functions Evaluated for all Sampling Periods[2]

Transect	CHANNELDYN	WATSTORENR	WATSTORLNG	WATSTORSUB	NUTRIENT	ELEMENTS	DETPARTICL	PLANTS	HABSTRUCT	INTERSPERS	Average
November-December 2015											
1	-	-	-	-	-	-	-	-	-	-	-
2	0.25	0.57	0.50	0.50	0.13	0.35	0.28	0.23	0.23	0.23	0.33
3	0.25	0.57	0.50	0.50	0.08	0.30	0.28	0.20	0.20	0.23	0.31
4	0.50	1.000	0.50	0.50	0.37	0.41	0.67	0.62	0.63	0.52	0.57
5	0.25	0.55	0.50	0.50	0.07	0.31	0.28	0.14	0.20	0.23	0.30
6	0.58	0.55	0.50	0.50	0.07	0.31	0.32	0.22	0.21	0.23	0.35
7	0.50	0.59	0.50	0.50	0.28	0.40	0.34	0.22	0.24	0.23	0.38
8	0.50	0.56	0.50	0.50	0.08	0.32	0.31	0.27	0.23	0.23	0.35
9	0.50	0.65	0.60	0.50	0.19	0.39	0.45	0.13	0.23	0.25	0.39
12	0.50	0.61	0.69	0.50	0.04	0.25	0.44	0.10	0.23	0.25	0.36
13	0.50	0.55	0.50	0.50	0.02	0.30	0.30	0.12	0.22	0.23	0.32
14	0.67	0.73	0.50	0.50	0.04	0.31	0.42	0.21	0.23	0.23	0.38
15	0.83	0.99	0.50	0.50	0.03	0.30	0.67	0.33	0.64	0.71	0.55
17	0.83	0.99	0.50	0.50	0.03	0.31	0.67	0.00	0.55	0.71	0.51
19	0.67	1.000	0.50	0.50	0.04	0.30	0.68	0.00	0.66	0.71	0.51
22	0.83	0.99	0.50	0.50	0.05	0.32	0.68	0.31	0.57	0.71	0.55
24	0.83	0.99	0.50	0.50	0.05	0.31	0.68	0.20	0.67	0.71	0.55
27	-	-	-	-	-	-	-	-	-	-	-
28	0.83	0.99	0.50	0.50	0.06	0.33	0.68	0.00	0.18	0.25	0.43
31	0.83	0.99	0.50	0.50	0.04	0.27	0.67	0.07	0.23	0.23	0.43
33	0.83	0.99	0.50	0.50	0.06	0.32	0.67	0.10	0.23	0.23	0.44
35	0.83	0.99	0.50	0.50	0.08	0.31	0.67	0.00	0.65	0.64	0.52
36	0.83	0.99	0.50	0.50	0.04	0.30	0.67	0.16	0.60	0.60	0.52
37	0.83	0.99	0.50	0.50	0.06	0.33	0.67	0.20	0.62	0.52	0.52
Average	**0.64**	**0.81**	**0.51**	**0.50**	**0.09**	**0.32**	**0.52**	**0.17**	**0.38**	**0.40**	**0.44**
November-December 2016											
1	-	-	-	-	-	-	-	-	-	-	-
2	0.58	0.66	0.84	0.50	0.30	0.53	0.45	0.30	0.23	0.25	0.46
3	0.58	0.65	0.84	0.50	0.22	0.46	0.44	0.29	0.23	0.25	0.45
4	0.58	0.72	0.84	0.50	0.57	0.68	0.48	0.32	0.23	0.25	0.52

Appendix C. Functional Capacity Index (FCI) Scores[1] of Functions Evaluated for all Sampling Periods[2]

Transect	CHANNELDYN	WATSTORENR	WATSTORLNG	WATSTORSUB	NUTRIENT	ELEMENTS	DETPARTICL	PLANTS	HABSTRUCT	INTERSPERS	Average
13	0.58	0.62	0.97	0.50	0.05	0.46	0.43	0.26	0.22	0.25	0.44
14	0.67	0.79	0.97	0.50	0.13	0.50	0.56	0.27	0.23	0.25	0.49
15	1.00	1.00	0.97	0.50	0.24	0.58	0.84	0.65	0.64	0.78	0.73
17	1.00	1.00	0.97	0.50	0.04	0.46	0.82	0.89	0.64	0.78	0.71
19	1.00	1.00	0.97	0.50	0.08	0.48	0.82	0.55	0.63	0.78	0.68
22	1.00	1.00	0.97	0.50	0.07	0.48	0.82	0.88	0.63	0.78	0.72
24	1.00	1.00	0.97	0.50	0.09	0.46	0.83	0.75	0.65	0.78	0.71
27	1.00	1.00	0.97	0.50	0.24	0.60	0.84	0.76	0.63	0.78	0.74
28	0.83	1.00	0.91	0.50	0.16	0.50	0.83	0.22	0.23	0.28	0.55
31	0.83	1.00	0.91	0.50	0.28	0.56	0.83	0.23	0.22	0.25	0.57
33	1.00	1.00	0.97	0.50	0.25	0.54	0.84	0.25	0.23	0.25	0.59
35	1.00	1.00	0.91	0.50	0.05	0.41	0.83	0.72	0.66	0.71	0.68
36	0.83	1.00	0.84	0.50	0.06	0.41	0.80	0.58	0.59	0.67	0.63
37	0.83	1.00	0.84	0.50	0.22	0.52	0.82	0.54	0.59	0.60	0.65
Average	**0.84**	**0.94**	**0.92**	**0.50**	**0.18**	**0.51**	**0.72**	**0.50**	**0.44**	**0.51**	**0.61**
November 2017											
1	0.25	0.67	0.77	0.50	0.31	0.52	0.45	0.31	0.24	0.25	0.43
2	0.25	0.56	0.65	0.50	0.15	0.37	0.29	0.29	0.24	0.23	0.35
3	0.25	0.55	0.65	0.50	0.05	0.36	0.28	0.31	0.23	0.23	0.34
4	0.25	0.57	0.65	0.50	0.15	0.41	0.30	0.30	0.24	0.23	0.36
5	0.42	0.60	0.77	0.50	0.22	0.54	0.32	0.31	0.22	0.23	0.41
6	0.50	0.55	0.65	0.50	0.04	0.36	0.30	0.31	0.23	0.23	0.37
7	0.50	0.58	0.65	0.50	0.21	0.45	0.32	0.31	0.23	0.23	0.40
8	0.50	0.55	0.65	0.50	0.08	0.35	0.31	0.27	0.23	0.23	0.37
9	0.25	0.60	0.65	0.50	0.22	0.49	0.29	0.29	0.22	0.23	0.38
12	0.25	0.55	0.65	0.50	0.01	0.36	0.27	0.31	0.22	0.23	0.34
13	0.25	0.55	0.65	0.50	0.05	0.36	0.28	0.29	0.23	0.23	0.34
14	0.50	0.72	0.65	0.50	0.00	0.35	0.39	0.27	0.22	0.23	0.38
15	0.50	0.99	0.65	0.50	0.07	0.37	0.65	0.89	0.65	0.71	0.60
17	0.50	0.99	0.65	0.50	0.04	0.37	0.65	0.85	0.64	0.71	0.59
19	0.50	1.00	0.65	0.50	0.14	0.43	0.66	0.75	0.64	0.71	0.60

Appendix C. Functional Capacity Index (FCI) Scores[1] of Functions Evaluated for all Sampling Periods[2]

Transect	CHANNELDYN	WATSTORENR	WATSTORLNG	WATSTORSUB	NUTRIENT	ELEMENTS	DETPARTICL	PLANTS	HABSTRUCT	INTERSPERS	Average
22	0.50	0.99	0.65	0.50	0.07	0.37	0.66	0.84	0.66	0.71	0.59
24	0.50	1.00	0.65	0.50	0.15	0.41	0.68	0.80	0.69	0.71	0.61
27	0.50	1.00	0.65	0.50	0.31	0.54	0.68	0.82	0.65	0.71	0.64
28	0.50	1.00	0.65	0.50	0.23	0.45	0.71	0.27	0.25	0.25	0.48
31	0.50	1.00	0.65	0.50	0.22	0.47	0.67	0.25	0.23	0.23	0.47
33	0.50	1.00	0.77	0.50	0.12	0.43	0.78	0.23	0.22	0.25	0.48
35	0.50	0.99	0.58	0.50	0.02	0.33	0.64	0.81	0.63	0.64	0.56
36	0.50	1.00	0.69	0.50	0.04	0.33	0.77	0.67	0.61	0.67	0.58
37	0.50	1.00	0.69	0.50	0.06	0.34	0.77	0.50	0.60	0.60	0.56
Average	**0.42**	**0.80**	**0.66**	**0.50**	**0.12**	**0.41**	**0.51**	**0.47**	**0.38**	**0.40**	**0.47**

1 Scores range from 0 to 1, based on similarity to well-functioning reference sites; see **Appendix B** for description of functions.

2 Rows with no scores were not sampled during that period.

APPENDIX B

AGFD Letter to Resolution Copper on the Lower San Pedro River Wildlife Area In-Lieu Fee Program

(Dated April 15, 2019)

April 15, 2019

Vicki Peacey
Senior Manager Permits & Approvals
Resolution Copper
102 Magma Heights
Superior, AZ 85173

Ms. Peacey,

The Department maintains an In-Lieu-Fee (ILF) program for Army Corps of Engineers (ACOE) 404 permit mitigation in an effort to facilitate economic development while ensuring conservation of Arizona's natural resources. One of the ILF programs maintained by the Department is located on the Lower San Pedro River Wildlife Area (LSPRWA). Your organization has expressed interest in purchasing mitigation credits within this ILF site. As we have discussed, all Advanced Credits at our LSPRWA ILF site have been sold or obligated for sale.

That said, the first set of Project Specific Credits will become available after the site has met established performance standards for the first 50 Advanced Credits and full approval of the Development Plan is obtained from the ACOE. At this time, we anticipate full sale of the Advanced Credits will be completed by the end of calendar 2019 with the Development Plan submitted the ACOE in calendar 2020. The full conservation of the LSPRWA site will be implemented in phases to ensure ecological performance standards are being met and ACOE approvals obtained for each phase. The Department's LSPRWA has five phases of 130 credits each accounting for a total of 650 credits. These credit releases will be available for purchase over time and will be available to anyone requiring mitigation credits.

I want to thank you and your staff for taking the time to make the Department's staff aware of your program development and look forward to a continued excellent relationship with Resolution. Further, as the Department's obligation for prior credit commitments are fully met, the Department will consider making future credits available to Resolution Copper and other entities in need of mitigation credits. Additionally, the Department would like to offer assistance in working with Resolution Copper to investigate other mitigation opportunities as a result of project implementation of your mining plan of development,

Again, thanks for your organization's positive working approach with the Department.

Sincerely,

Jim deVos
Assistant Director Wildlife Management Division

azgfd.gov | 602.942.3000

5000 W. CAREFREE HIGHWAY, PHOENIX AZ 85086

Cc:

Craig McMullen, Assistant Director Field Operations Division
Jay Cook, Regional Supervisor Mesa
Keith Knutson, Chief Wildlife Contracts
Clayton Crowder, Chief Habitat Branch

AGFD #M19-04014607