PIMA COUNTY REGIONAL FLOOD CONTROL DISTRICT
ADMINISTRATIVE PROCEDURE

PROCEDURE NO.: ADM–225 **EFFECTIVE DATE: March 1, 2016**

PROCEDURE NAME: Regulated Riparian Habitat Mitigation Requirements for Pima County Department of Transportation Roadway Projects.

PURPOSE: A procedure to determine mitigation requirements for Pima County Department of Transportation (DOT) roadway projects impacting more than 1/3 acre of regulated riparian habitat (RRH).

This procedure shall establish minimum mitigation criteria and provide guidance to staff in the design and review of DOT roadway projects impacted by RRH mitigation requirements.

BACKGROUND: Section 16.30.030 of the Floodplain Management Ordinance (Ordinance) establishes the applicability of Chapter 16.30, *Watercourse and Riparian Habitat Protection and Mitigation Requirements,* to Pima County projects.

Pursuant to Section 16.12.020.A, the Board of Supervisor's review and approval requirement pursuant to Section 16.30.050.B and D is not applicable. However, DOT improvement plans are to be provided to the District for review and comment.

In November 2002, following adoption of the riparian protection requirements, the Deputy County Administrator issued a directive that all departments apply Chapter 16.30 of the Ordinance and the associated Riparian Classification Maps (RCM) and guidelines to all new or ongoing projects and programs (Appendix A). The requirements of Chapter 16.30 also apply to Pima County (PC) projects located within incorporated jurisdictions. Impacts to RRH in excess of 1/3 acre require mitigation in accordance with the Ordinance and *Regulated Riparian Habitat Mitigation Standards and Implementation Guidelines* (Onsite Guidelines).

In 2003, upon recommendation by the Environmentally Sensitive Roadway Design Panel (Panel), DOT updated the Pima County Roadway Design Manual to include Chapter 4, *Environmentally Sensitive Roadway Design Guidelines* (ESR) (Appendix B). The ESR guidelines were developed to satisfy U.S. Fish and Wildlife Service requirements for impacts to threatened and endangered species and were applied to projects located within or crossing Environmentally Sensitive Lands (ESL). ESL is defined as lands that are unique and ecologically or culturally sensitive and include the following:

- Sonoran Desert Conservation Plan (SDCP) Biological Core
- SDCP Multi-Use or Recovery Area
- SDCP Important Riparian Areas
- Agriculture within Recovery Area
- Existing Development
- Scientific Research Area
- High or Moderate Archaeological Sensitivity Zone or a Priority Cultural Resource
- Historic Roadway or Route
- Scenic Route

Prior to the Panel's recommendation, the SDCP Science and Technical Advisory Team (STAT) initiated a review of the impact of roads on wildlife and natural resources. Results of this review are compiled in a report entitled, *The Effects of Roads on Natural Resources (SDCP, 2002)*, which emphasizes the importance of riparian corridors. The report is prefaced by a memorandum from the County Administrator stating that, *"Effective wildlife crossing at key points on high-volume roads should be recommended…and standards for minimizing road-building in high value habitats should be set."* The ESR is a result of this recommendation.

In January 2010, DOT made the decision to follow ESR for all new roadway projects, regardless of the ESL status, to meet Native Plant Preservation Ordinance (NPPO) requirements (Appendix C).

The use of ESR design principles also fulfills the Ordinance requirement to avoid and minimize impacts to RRH. The ESR requires design teams to assess environmental factors affecting the project early in the planning process and incorporate design features that avoid, minimize, and/or mitigate impacts to cultural, biological, and historical resources, providing specific mitigation measures for impacts to ESL.

The District compared RRH mitigation requirements with ESR guideline requirements (Appendix B, D, and E) and determined that use of the ESR guidelines provides mitigation comparable to the Onsite Guidelines for temporary impacts. Therefore, requirements outlined in the ESR may be used in combination with the Onsite Guidelines and/or *Regulated Riparian Habitat Offsite Mitigation Guidelines for Unincorporated Pima County* (Offsite Guidelines) to achieve compliance with the Ordinance. This procedure provides the framework for working within the three guidelines.

PROCEDURE: Riparian habitat corridors facilitate the movement of native flora and fauna to support healthy plant and wildlife populations. Improvements to existing roadways and construction of new roadways shall follow the procedures in this document to avoid, minimize and mitigate impacts of roadway projects on riparian corridors.

I. Avoid and Minimize Disturbance to RRH

All roadway projects shall adhere to ESR design requirements for avoiding and minimizing impacts to biological resources when RRH is present. The ESR requires the design team to analyze information from studies completed to assess the biological resources within the proposed project area in order to address "*major design issues that impact the environment and to formalize design solutions*" and to develop "*a conceptual design that incorporates the most effective resource preservation and enhancement treatments*" (DOT, 2003). This process of data analysis is called the Biological Resources Process (Appendix B).

Design considerations to assist in avoiding and minimizing impacts to RRH include:

- Reduce the overall footprint of the project area by reducing lane, shoulder, bridge, median, or bike lane widths, allowing flow from more frequent flood events to cross a road, and other modifications that mitigate impacts.
- Assess wildlife patterns and breeding times during the design phase and schedule work when impacts to wildlife species is least damaging.
- Prioritize alternatives that preserve natural drainage patterns.

II. Calculating RRH Disturbance

After the alternatives have been analyzed and selected for avoiding and minimizing impacts to RRH, the total RRH disturbance shall be determined.

To determine disturbance, first calculate the amount of disturbance resulting from construction of the roadway project. Next, calculate areas disturbed prior to the effective date of the RCM (Appendix F, TECH–104) and exempt disturbances (Appendix F, TECH–004), and then subtract both from the total disturbance calculation. If the remaining disturbance exceeds 1/3 acre, a Riparian Habitat Mitigation Plan (RHMP) is required.

III. Plantable RRH Mitigation Requirements

"Plantable RRH" is an area of riparian habitat that will be disturbed during construction, but will be mitigated upon completion. The mitigation guidelines for Plantable RRH are as follows;

A. Onsite Mitigation Requirement:
    1. The mitigation requirement will be based on a 1:1 ratio of the amount of disturbance, regardless of the RRH classification. For example, the disturbance of 1 acre of RRH requires the planting of the appropriate number of trees and shrubs for 1 acre of the designated habitat classification using the default values provided in the Guidelines or by an onsite vegetation survey.

or,

B. Vegetation Replacement Requirement:
    1. Replace riparian vegetation at a 1:1 ratio in accordance with ESR (Appendix B and D), or
    2. Use the Relevé Method, completed in accordance with ESR (Appendix B and D) to determine plant replacement requirements including planting density (trees and shrubs per acre) and species richness for both container plants and seed mix. Alternatively, DOT may use plant replacement ratios and watershed specific plant lists found in the Onsite Guidelines.

and,

C. Plant sizes shall adhere to requirements found in Section 2 of the Onsite Guidelines and in Appendix D.

IV. Remaining Disturbance Mitigation Requirements (Permanent Disturbance)

"Permanent Disturbance" is an area of riparian habitat that will be disturbed during construction, but cannot be mitigated upon completion, such as paved areas. The mitigation guidelines for Permanent Disturbance are as follows.

The Onsite Guidelines shall be used for the mitigation requirements, which may entail a mitigation ratio of 1:1 or 1.5:1. If the mitigation area requirement exceeds the available area for mitigation, there are other onsite or offsite options available:

A. Onsite Mitigation. When the mitigation area requirement exceeds the available area for mitigation and onsite mitigation is available in other project areas, two options are available:

    1. Identify degraded riparian corridors located within the project area that are not mapped under the RCM and that can be restored. The proposed mitigation area must be able to support a similar plant density and species richness to the disturbed RRH, or
    2. In areas where installation of container plants is not feasible, DOT may propose mitigation that combines application of a native seed mix (species determined using a Relevé Method, see Appendix D) and an Invasive Species Management Plan (ISMP). Section 201-3.04 of the Special Provisions (Appendix G) may be used to satisfy the ISMP requirement if implemented by DOT maintenance staff through the long-term maintenance period. The hydroseeded area will be monitored and treated for invasive species in accordance with Section 201-3.04 for a period of five (5) years or until adjacent mitigation areas have reached the establishment period as outlined in Appendix F, whichever occurs first. An example ISMP and Section 201-3.04 are provided in Appendix G.

B. Offsite Mitigation. When the mitigation area requirement exceeds the available area for mitigation and other onsite options are not feasible, offsite mitigation will be required. Offsite mitigation options include:

1. In-lieu Fee Option. Contribution of an in-lieu fee (ILF) to the District's mitigation bank for purchase of high value riparian habitat in Pima County (Appendix I).
2. Land Transfer Option. DOT may transfer existing DOT property or purchase land in fee simple and transfer ownership to the District. The land must contain riparian habitat of equivalent or greater value than the disturbed riparian habitat.
3. Mitigation on Offsite Parcel. Mitigation may occur on an offsite parcel of land if the parcel is located near the project area or near other Pima County parcels with protected riparian resources, is in need of enhancement or restoration, and is able to support restored riparian vegetation. The mitigated parcel shall provide similar ecological function to the disturbed riparian habitat by providing similar Total Vegetative Volume (TVV), density and species richness and provide connectivity to an adjacent RRH or riparian corridor. In certain cases, parcels owned by the District may be available for mitigation with a Memorandum of Understanding (MOU) between the departments. Contact the District to obtain approval for mitigation on District-owned property.

V. ESR Considerations

The following ESR guidance shall be considered during project design and preparation of the RHMP:

A. Mitigation plans shall be developed in conjunction with Pima County, Arizona Game and Fish Department and U.S. Fish and Wildlife Service. Additionally, if onsite mitigation is chosen to fulfill U.S. Army Corps of Engineers' (Corps) requirements, mitigation for Title 16 may overlap, provided that Corps requirements meet or exceed Title 16 requirements for onsite mitigation.

B. The project shall include a monitoring component to ensure that mitigation goals are accomplished. Follow additional requirements provided in Appendix H, *Riparian Habitat Monitoring Agreement for Pima County Roadway Projects* and in Appendix D.

C. For improvements to existing roadways, design considerations shall include ways to reduce fragmentation by improving connectivity of wildlife corridors, restoring historic drainage patterns (after evaluating the effect of such action on existing vegetation/habitat/public safety), and incorporating roadway elements that reduce impacts to wildlife species found within the project area. Examples include reducing roadway design speeds or providing appropriately designed and sized wildlife crossings.

LIST OF APPENDICES

APPENDIX A – Revised Riparian Classification Maps Memo from John Bernal, dated November 14, 2002.

APPENDIX B – Pima County Roadway Design Manual Chapter 4: Environmentally Sensitive Roadway Design Guidelines

APPENDIX C – Plant Salvage Standards on County Transportation Improvement Projects Memo from John Bernal, dated January 4, 2010.

APPENDIX D – Update Appendix 4D of the Environmentally Sensitive Roadway Design Guidelines, Pima County DOT Roadway Design Manual, memo dated June 2015.

APPENDIX E – ESR and RRH Comparison Chart

APPENDIX F – District Technical Policies and Procedures

APPENDIX G – Invasive Species Management Plan for Linear Projects – Example and Special Provisions Section 201-3.04

APPENDIX H – Riparian Habitat Monitoring Agreement for Pima County Roadway Projects and General Notes

APPENDIX I – Offsite Guidelines Appendix F: ILF Calculation Method

APPENDIX J – Literature Cited

APPENDIX A

Revised Riparian Classification Maps Memo from John Bernal, dated November 14, 2002.

MEMORANDUM

Public Works Administration

PUBLIC WORKS
pima county

DATE: November 14, 2002

TO: Suzanne Shields, Deputy Director
Transportation & Flood Control District

FROM: John M. Bernal
Deputy County Administrator

RE: **Revised Riparian Classification Maps**

Attached is the November 12th memorandum that you recently sent to me advising of the recent revisions to the riparian habitat maps. As your memorandum indicates, these maps are available for immediate use via the intranet in the development of our capital improvement projects and in the application of the floodprone land acquisition program within the Flood Control District.

Please note that the use of these revised maps for regulatory purposes will not take place until the appropriate adoption process by the Flood Control District Board of Directors. Therefore, the maps may not be used for regulatory purposes until this formal adoption process is completed sometime during calendar year 2003.

The appropriate Public Works Departments are hereby furnished with a copy of this memorandum with direction to apply these updated maps to their ongoing projects and programs and I am appreciative of any guidance and feedback that you may provide in response to their questions regarding this matter.

JMB:jgs

Attachment

C: Kurt Weinrich, Director, DOT/FCD
Kathleen M. Chavez, Director, WWM
Rafael Payan, Director, NRPR
Carmine DeBonis, Director, DSD
Maeveen Behan, Assistant to the County Administrator
Susan Miller, Environmental Compliance Manger, PWA
Thomas Helfrich, Division Manager, DOT/FCD
Julia Fonseca, Program Manager, DOT/FCD

2059

MEMORANDUM

Department of Transportation & Flood Control District
Deputy Director's Office - Flood Control District

DATE: November 12, 2002

TO: John Bernal, P.E.
Deputy County Administrator

FROM: Suzanne Shields, P.E.
Deputy Director

SUBJECT: **Revised Riparian Classification Maps**

The purpose of this memorandum is to advise you that the Flood Control District staff have completed the revisions to the riparian habitat maps, based on technical data generated from various Sonoran Desert Conservation Plan (SDCP) studies, as well as additional field investigations conducted by our consultants.

The revisions take into consideration new information on riparian area distribution, as well as data regarding plant species, vegetation structure, density, and water availability. The mapped areas are consistent with the Conservation Land Use System, as adopted by the Board of Supervisors.

These new maps are termed "draft riparian classification" maps for regulation purposes under the Floodplain and Erosion Hazard Management Ordinance(Ordinance). Background information about the methods and sources of the data that was used to prepare the new maps are attached. These maps are also available for inspection and internal use at http://www.dot.co.pima.az.us/gis/maps/mapguide/hmtest.mwf.

Staff is working with the County Attorney to have the Flood Control Board of Directors formally adopt the revised maps for regulatory use. The new maps require adoption via the same process as other revisions to the Ordinance. Therefore, the new maps may not be used for regulatory purposes until formal adoption is completed, which is expected in 2003.

Contingent on your approval, we will begin using the revised maps immediately to ensure we are consistent with the SDCP, and for use with the CIP and FLAP programs. In addition, I am recommending that the Public Works Department use these maps when analyzing potential project benefits and impacts.

SS/tj
Attachment

c: Kurt Weinrich, P. E., Director
Maeveen Behan, Assistant to the County Administrator
Susan Miller, PW Environmental Program Manager
Thomas Helfrich, Division Manager
Julia Fonseca, Program Manager

APPROVED:

John M. Bernal, Deputy County Administrator - Public Works

11/13/02
Date

Map Revisions for the Riparian Habitat Mitigation Ordinance

By Julia Fonseca, Pima County Flood Control District, and John Regan, Technical Services

October 31, 2002

Background and Purpose

"Riparian" (literally "streamside") refers to those areas of higher moisture along watercourses and springs of any type, whether flow is ephemeral, intermittent or perennial.

On July 19, 1994 the Pima County Board of Supervisors (Board) adopted the Watercourse and Riparian Habitat Protection and Mitigation Requirements Ordinance 1994-FC2 (Ordinance). The intent of the Ordinance is to "enhance wildlife and recreation values where appropriate by preserving riparian vegetation along watercourses and floodplains".

The Ordinance was structured to encourage avoidance of damage to riparian areas but does not prohibit development within those areas. If a developer or property owner demonstrates that retaining the riparian vegetation is not possible, then mitigation of disturbed or destroyed vegetation is requ ired. The amount of mitigation is tied to a vegetation classification system.

The Ordinance has been effective in encouraging avoidance of damage to riparian plant communities (Danforth and Fonseca, 2000). One reason it is effective is that it covers a much broader zone than does the U. S. Army Corps of Engineers' jurisdiction. The Corps' jurisdiction is generally limited to the channel, or a subset of the channel. The channel is often the least well-vegetated portion of the riparian zone, and the one where natural disturbances are most frequent. By contrast, the Riparian Habitat Mitigation Ordinance covers the area occupied by riparian vegetation, however wide that may be (Figure 1).

Procedure for Developing the Existing "Riparian Habitat" Maps

The existing maps used for regulatory purposes are known as the "riparian habitat" maps. To develop them, a riparian committee comprised of scientists was called upon for help in the early 1990's. First, they refined the definition and classification system for riparian habitat specific to Pima County, and developed mitigation requirements. Later, a broad-based committee representing all factions of the community was formed to help develop final Ordinance language.

Following adoption of the riparian regulations, work on detailed riparian habitat maps commenced. The resulting riparian habitat maps were adopted into the Ordinance in 1994, and are still used for regulating development in riparian areas.

The Ordinance provides for three types of information to be used in defining and differentiating riparian habitats: species composition, vegetation density and the availability of water. This information is used to classify riparian vegetation as hydromesoriparian, or xeroriparian class A, B, C or D. The original (1994) hydromesoriparian classifications were developed based on aerial reconnaissance

flights to observe where riparian forests were located, and information about the availability of surface or groundwater. Xeroriparian classes were related to specific ranges of total vegetation volume inferred from multi-spectral LANDSAT images from the early 1990's.

When the Science Technical Advisory Team (STAT) commenced its work on the Sonoran Desert Conservation Plan, the riparian habitat maps were reviewed, along with maps available from other agencies. On the basis of review of existing information (Fonseca, 1999a, 1999b), the STAT determined that a special effort would be needed to improve riparian area classification and delineation. One of the problems identified with the existing riparian habitat maps was the boundaries between plant communities with different species and structures were not mapped. Plant species and structure are important variables affecting the distribution of many wildlife species. Another was that many riparian areas were not already mapped, and the basis for distinguishing hydromesoriparian areas from xeroriparian areas was not well documented.

New studies performed for the Sonoran Desert Conservation Plan (SDCP) include mapping based on plant community structure and composition, vegetation density and the availability of water. The next section documents the process used to revise the riparian habitat maps using new data from the Sonoran Desert Conservation Plan.

Procedure for Revising Hydromesoriparian Classifications

Hydromesoriparian habitats are defined in Pima County ordinance by the presence of obligate or preferential riparian plants. Plant communities may be dominated by "species that are also found in drier habitats (e.g. mesquite), but contain some preferential riparian plant species such as ash or netleaf hackberry." The ordinance further states that such areas are generally associated with perennial or intermittent watercourses or shallow groundwater.

These definitions are the basis for revisions to the distribution of hydromesoriparian habitats. The riparian classification used for the SDCP differentiates plant communities based on the presence of preferential riparian plants and their structure (e.g. grassland versus forest). Using the Brown, Lowe and Pase system, all plant communities which are known to have obligate or preferential riparian plants, or have structures (canopy height or density) not attained outside riparian areas were considered hydromesoriparian. Plant communities were mapped by Harris (2000).

In addition, the water resource mapping conducted by Pima Association of Governments (2000), which identifies perennial and intermittent flow reaches, and shallow groundwater, was used as a basis for identifying hydromesoriparian areas. If shallow groundwater, perennial or intermittent flow is available, the polygon representing the riparian plant community is considered hydromesoriparian. This includes polygons which were not mapped as having preferential riparian plants. By including all vegetation associated with these water resources, this approach is conservative of riparian habitats.

In addition to Harris (2000) and PAG (2000), other investigations were used to decide whether a riparian area (called a polygon, in terms of geographic information systems) should be considered hydromesoriparian. For instance, in the Black Wash area southwest of Tucson, some areas originally mapped as having mesoriparian structure or species by Harris (2000) were revised to reflect an absence of such features based on field investigation.

In several locations, the boundaries delineating riparian areas by Harris (2000) were changed. This occurred principally in the Tanque Verde corridor upstream of Houghton Road, where the boundaries of the hydromesoriparian were enlarged based on field verification conducted by Westland Resources. This is an area where there are many requests for removal of riparian vegetation due to urban development.

Another area where riparian polygons were modified was along the effluent-dominated Santa Cruz River. Some inadvertent inclusions of upland vegetation and roadways were removed from the riparian polygons. Staff also reviewed overlays of polygon boundaries to determine the influence of effluent on the riparian communities. In a few other areas, polygons which included golf courses and smal areas of upland were removed.

Finally, spring symbols were added to represent the locations of known springs. Plant communities in association with springs and cienegas are included in the ordinance, but previously no data on their distribution had been included in the regulatory maps. An inventory of springs prepared for the Sonoran Desert Conservation Plan was the basis of the spring mapping. Vegetation associated with springs should be considered hydromesoriparian vegetation.

Procedure for Revising Xeroriparian Delineations

Riparian polygons not designated hydromesoriparian are considered xeroriparian. Lateral boundaries were delineated using digital orthophotography at a scale of 1:24,000. Vegetation and geomorphological evidence of hydrological patterns were used to identify the boundaries (Harris, 2000). The ordinance defines xeroriparian habitat as generally possessing ephemeral water supply and a species composition which is similar to adjacent upland areas. Structurally, the vegetation may be larger or denser. The ordinance distinguishes among four classes of xeroriparian habitats, based on total vegetation volume.

Differences among "xeroriparian" areas can be differentiated using Normalized Difference Vegetation Index (NDVI) values, which provide some consistent, relative data about vegetative conditions along streams. NDVI values are related to the reflectance of land and vegetation features on the landscape, as sensed by satellites. In Pima County, NDVI values have been found to relate to the vegetation leaf volume along riparian areas (SWCA, 1993). Vegetation volume is an indicator of plant productivity and also has been correlated to breeding bird densities (SWCA, 1993). Information about vegetation structure is not provided by the NDVI values.

To differentiate xeroriparian habitats into the four classes, the riparian plant community polygons from the SDCP were superimposed on June 2000 LANDSAT satellite imagery. Precipitation can cause a rapid change in the spectral characteristics in arid ecosystems (David Schaub, personal communication, 2001). District staff verified that the imagery was taken before the onset of the summer monsoonal rains, meaning that variation due differences in rainfall, plant growth and soil moisture is minimized.

An analysis of the new satellite mosaic was prepared by Terrasystems Incorporated. The imagery was processed using the normalized difference vegetation index (NDVI) for riparian vegetation. This index is a mathematical equation that relates to the reflectance in infrared and near-infrared spectral bands of LANDSAT–these portions of the electromagnetic spectrum are useful for vegetation characteristics.

The NDVI of the pixels which fell within riparian polygons were averaged within each riparian polygons. Because the LANDSAT sensors have changed over the years, resolution has increased from 30 to 15 meters and because different weather-related conditions exist in the new imagery compared to the old imagery, it is not appropriate to use the 1994 NDVI values to distinguish the four classes. Instead, an initial classification based on ten equal increments was created. Four classes A through D were then differentiated on the basis of a "natural breaks" algorithm. The first five equal increments were combined into class A on the basis of the distribution review, which showed that many of these increments would already be classified as hydromesoriparian based on species composition, structure, or water availability. The lowest natural break was selected as class D.

Map Revisions Relating to Applicability

The riparian mapping for the Sonoran Desert Conservation Plan was conducted for areas having the potential for significant future land degradation, including certain areas managed by U. S. Forest Service and Bureau of Land Management. Mapping did not extend into Wilderness areas, National Parks, tribal lands and Wildlife Refuges.

The Riparian Habitat Mitigation Ordinance applies only to unincorporated Pima County. Therefore the revised regulatory maps will depict administrative boundaries of tribal, federal, and municipal jurisdictions. Where available, we will depict the classifications, but the degree of protection offered to riparian areas outside unincorporated Pima County will remain at the discretion of the jurisdiction. Other jurisdictions may use different methods to classify and protect these areas.

Results

Figure 2 displays all hydromesoriparian and xeroriparian areas in eastern Pima County.
Hydromesoriparian areas are not evenly distributed. They are almost exclusively located in eastern Pima County (Figure 2). Arivaca Creek, Tanque Verde Creek, San

Pedro River, and Cienega Creek are examples of some of the larger hydromesoriparian corridors.

Class A xeroriparian areas are very limited in extent, in part because most of the areas with high NDVI values (and hence high vegetation volume) are already classified as hydromesoriparian, Most of the Class A xeroriparian areas are located ir the headwaters of streams in the Coronado National Forest. Class A xeroriparian areas in unincorporated Pima County exist at lower elevations along some of the west-side tributaries of Altar Wash, along tributaries of Sabino Canyon, and several other locations.

Class B riparian areas are much more extensive. Most of the large areas exist in the Altar Valley. Also extensive, but more broadly distributed than B are the Class C areas.

Xeroriparian areas with the lowest NDVI values (class D) are not protected under the current County ordinance. These areas occur primarily in western Pima County, in the broad sandy bed of the Santa Cruz River outside the effluent-dominated reach, outside the main channels of the lower Brawley Wash, and in distributary flow zone: in the Santa Rita piedmont south of Tucson. There are 11,681 acres of class D xeroriparian in unincorporated Pima County.

The elimination of riparian areas is evident in Figure 2 in areas where urbanization, mining and agriculture has eliminated them. Central Tucson, the mines west of Green Valley and portions of Avra Valley exemplify areas where riparian areas have been highly fragmented or eliminated due to current land uses.

Riparian classifications are absent in National Wildlife Refuges and Wilderness Areas tribal lands, and National Parks. Vegetation mapping did not occur in these areas. All springs are shown in Figure 2 regardless of jurisdictions.

Figure 3 shows riparian areas within the jurisdiction of the Pima County Flood Control District.

<u>Regulatory Significance</u>

The primary significance of the revised maps is that there are many more riparian areas than were previously encompassed by the regulatory maps. The newly mapped riparian areas are found throughout the County, and derive from the natural resource inventory and analyses done for the Sonoran Desert Conservation Plan.

Second, several hydromesoriparian areas have been re-classified as a result of improved information about water resources and vegetation. Two examples of watercourses that should be considered xeroriparian but which are currently regulated as hydromesoriparian include portions of the Cañada del Oro Wash north of Catalina State Park and south of Pinal County, and Woodland Hills Wash, which is a tributary of Sabino Creek. Examples of current xeroriparian areas that should be

considered hydromesoriparian include Agua Verde Creek, Black Wash, Davidson Canyon, and Sopori Wash.

Third, the boundaries of some previously regulated riparian areas have changed based on new riparian studies. Examples of changes include areas along watercourses in the Tortolita piedmont, Tanque Verde Creek, and Davidson Canyon.

Fourth, some of the xeroriparian classifications have changed. Changes go both ways, from higher to lower (e.g. B to C) and from lower to higher (e.g. from C to B).

Recommendations

1. It is recommended that the Pima County Board of Supervisors, acting as the Pime County Flood Control District Board of Directors, adopt the new "riparian classification maps" for regulatory purposes.

2. It is recommended that the Board direct staff to continue to gather data on vegetation and water availability that may affect the classifications, and evaluate new data periodically to determine if additional map revisions are warranted.

References

Brown, D. E., C. H. Lowe, and C. P. Pase, 1979. A digitized classification system for the biotic communities of North America, with community (series) and association examples for the Southwest. J. Ariz. Nev. Acad. Sci. 14 (Suppl. 1): 1-16.

Danforth, C. and J. Fonseca, 2000. Pima County's Riparian Habitat Mitigation Ordinance: Effectiveness Review. Prepared for the Sonoran Desert Conservation Plan.

Fonseca, J., 1999a. An Evaluation of Previous Riparian Vegetation Mapping Efforts for the Sonoran Desert Conservation Plan. Prepared for the Science Technical Advisory Team.

Fonseca, J. ,1999b. An Evaluation of Previous Vegetation Mapping Efforts for the Sonoran Desert Conservation Plan. Prepared for the Science Technical Advisory Team.

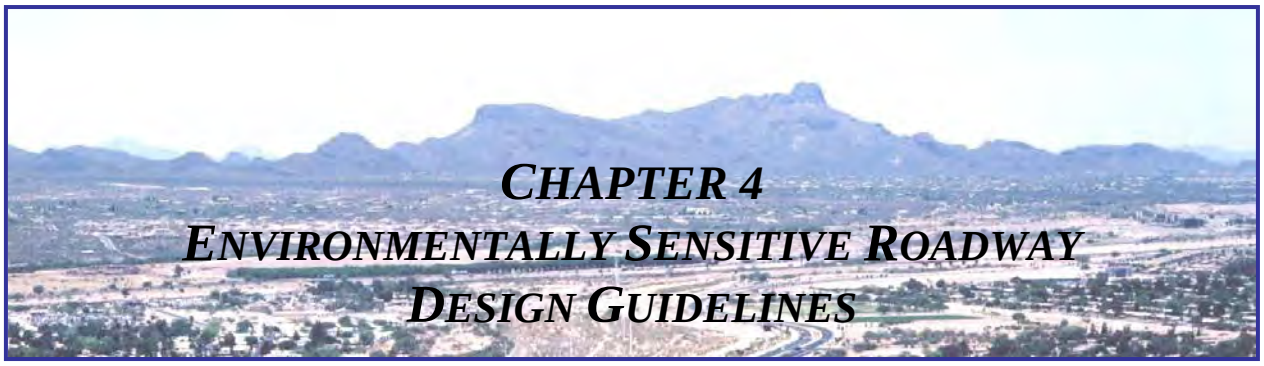
Harris Environmental Group, 2000. Sonoran Desert Conservation Plan. Riparian Vegetation Mapping and Classification. Final report prepared for Pima County.

Pima Association of Governments (PAG), 2000. GIS coverage of Perennial Streams, Intermittent Streams, and Areas of Shallow Groundwater. Final Project Report, prepared for the Sonoran Desert Conservation Plan.

SWCA, 1993. Riparian Habitat Definition and Classification System Technical Report. Prepared for Pima County Department of Transportation and Flood Control District.

APPENDIX B

Pima County Roadway Design Manual Chapter 4:
Environmentally Sensitive Roadway Design Guidelines



CHAPTER 4
ENVIRONMENTALLY SENSITIVE ROADWAY DESIGN GUIDELINES

4.1 INTRODUCTION

The Environmentally Sensitive Roadway Design Panel (the Panel) developed general recommendations for roadway improvement projects within environmentally sensitive areas in July 2001. The Panel was formed in response to community concerns about potential conflict between preserving environmentally sensitive areas, transportation design and construction practices, and the ongoing need for infrastructure improvements. The Panel's initial goal was to develop special design guidelines that would bridge the gap between community concerns and the County's design of new or improved roadways in environmentally sensitive areas.

The Panel re-convened in 2002 to expand upon its initial recommendations. The 2002 Panel consisted of experts from multiple disciplines. Members included roadway engineers, wildlife biologists, cultural resources experts, and a landscape architect. The resulting guidelines, presented in this chapter, provide roadway design specifications that will minimize impacts to our region's resources. The approach defined in this chapter is intended to provide roadway design teams with environmental information early in the design effort. This information should allow design teams to adjust specific design elements to better account for biological, cultural, and historic resources in the roadway corridor. Additionally, the chapter provides some mitigation tools necessary to conduct transportation projects in environmentally sensitive lands. For example, greater flexibility in the range of acceptable design values for specific roadway features is identified for ESR design. This document is not, however, an exhaustive resource of mitigation ideas. Further information on how to treat or mitigate potential effects of roadway projects can be obtained from pertinent websites that are cited in this chapter and listed in Appendix 4-A.

4.2 ENVIRONMENTALLY SENSITIVE LANDS AND ROADWAY DESIGNATION

Environmentally Sensitive Lands (ESL) are those areas that are unique and ecologically or culturally sensitive. The public has made known its interest in and the importance of these areas. In Pima County, ESL are determined by certain Sonoran Desert Conservation Plan (SDCP) Conservation Lands System categories and/or the designation of a Scenic and/or Historic Route. ESL may exhibit several characteristics, such as the presence of habitat for special status species (e.g., endangered species), vegetation communities that are growing in scarcity (e.g., cottonwood-willow riparian plant community), cultural resources (e.g., historic buildings), and designated scenic routes. A transportation project within ESL is defined as an ESR and should be designed and constructed to minimize disturbances to the area resources. Specifically, an ESR is a roadway that meets any of the following criteria:

- Location within or crossing any of the areas on the SDCP Conservation Lands System Map, which are identified as:
  - Biological Core
  - Multi-Use or Recovery Area
  - Important Riparian Area
  - Agriculture within Recovery Area
  - Existing Development
  - Scientific Research Area
- Location within or crossing a High or Moderate Archaeological Sensitivity Zone or a Priority Cultural Resource
- Identified as a Historic Roadway or Route
- Identified as a Scenic Route

The information referenced in criteria A and B above, with the exception of Priority Cultural Resources, is found on the Pima County Website (see Appendix 4-B). Scenic Routes are identified on the *Pima County Major Streets and Scenic Routes Plan* (see Appendix 4-A).

Examples of the website maps used to determine ESR criteria are presented in Appendix 4-C. From the SDCP Conservation Lands System Map, the example project area, shown in red, clearly involves three ESR criteria: (1) High Archaeological Sensitivity Zone, (2) Multiple Use or Recovery Area, and (3) Important Riparian Area. The *Pima County Major Streets and Scenic Routes Plan* indicates that the project area also meets the ESR criteria of being a designated Major Scenic Route. The Historic Roadways or Routes data layers will be developed in the future and posted on the web. Map data on Priority Cultural Resources is restricted. The Pima County Cultural Resources Office should be contacted to determine if a roadway project meets the ESR criteria of being located within or crossing a Priority Cultural Resource or is a known historic roadway or route. To access site-specific information on the Pima County website, "zoom in" to a scale of 1:128,000.

4.3 ENVIRONMENTAL RESOURCE ASSESSMENT AND MITIGATION PROCESS

Once it is determined that a project will contain roadways that meet the ESR criteria, there are a number of steps that the responsible party must take. These steps are related to the following three design elements, which are discussed in Sections 4.4, 4.5, and 4.6 respectively.

- Biological Resource Preservation and/or Enhancement
- Cultural or Historic Resource Preservation and/or Enhancement
- Visual and Aesthetic Resource Preservation and/or Enhancement

A process has been developed for each of these resource design elements. The process begins with the discovery/identification of the individual resources within each element, which produces initial inventories for each resource element. The next stage of the process is an inventory analysis in which the Design Team assesses the potential impacts of the project on each of the resources and then identifies potential treatment options. Design elements used to create these treatment options may include:

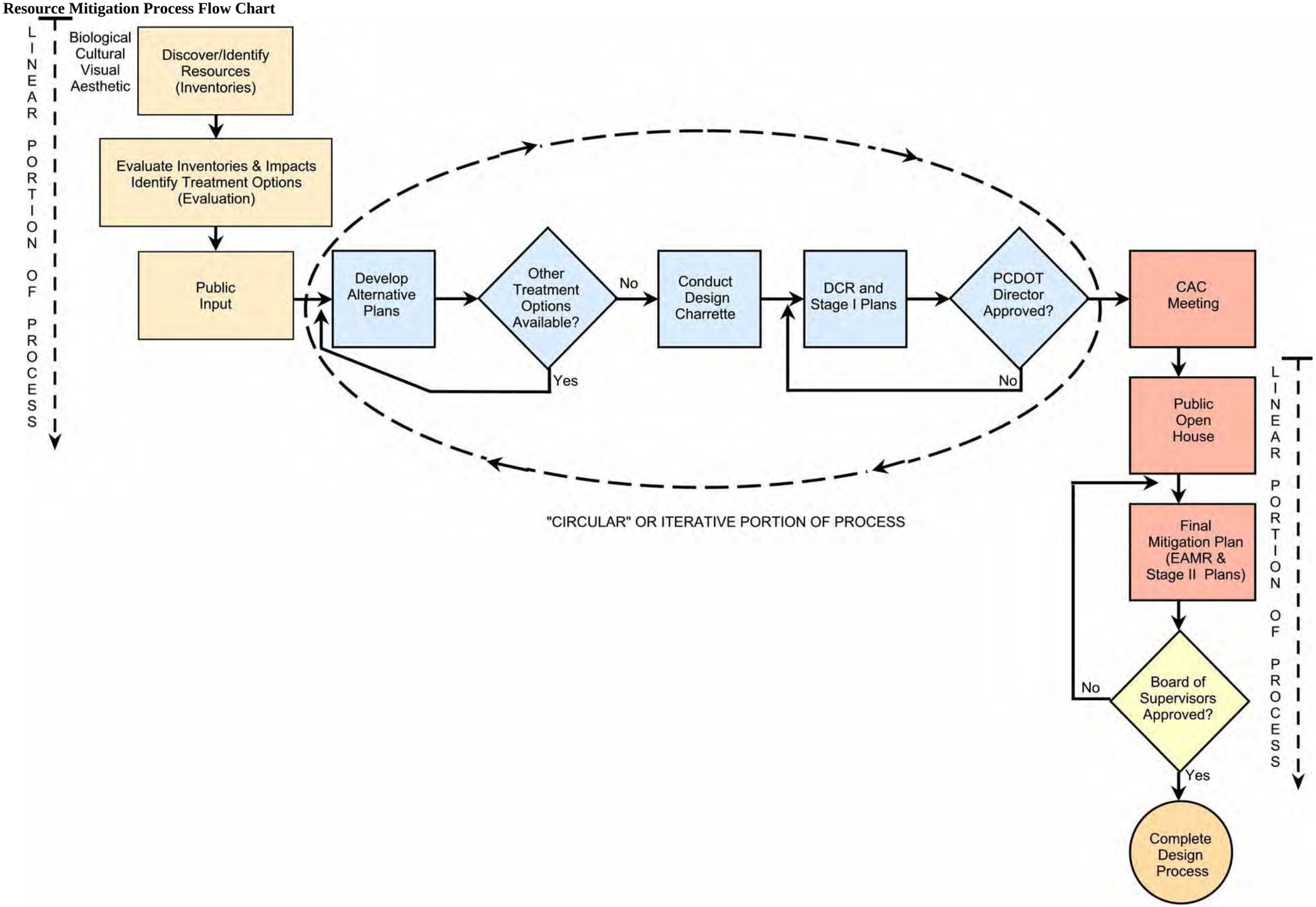
- Art
- Lighting
- Bicycle facility
- Noise wall or other abatement
- Bridge structural elements
- Pavement type/surface
- Construction phasing/sequencing
- Signage
- Cultural inventory/treatment
- Utility locations
- Drainage and culvert design
- Viewsheds
- Equestrian facilities
- Vegetation preservation/management
- Landscape Improvements
- Wildlife crossings

Sufficient information has now been gathered to allow the Design Team to solicit public input and initial reaction to the inventories and to the array of possible treatments/mitigation measures. The public input may take several forms, including CAC meetings, public open houses, or other outreach techniques as deemed appropriate.

Up to this point in the process, the Design Team has been operating in a linear mode, with resource studies being conducted separately from each other. The process now enters the stage in which the individual assessments are combined and various holistic solutions coalesce. This is a dynamic stage, with feedback loops that promote an "iterative" or "circular" process. The stage begins with the Design Team performing a functional analysis based on the treatments/mitigation measures that were previously examined by the public. Next, in a design charrette (i.e., an intensive workshop), the Design Team analyzes the opportunities and constraints of the project. The objective is to discuss major design issues that impact the environment and to formalize design solutions. The outcome of the charrette is a conceptual design that incorporates the most effective resource preservation and enhancement treatments. This conceptual design is then incorporated into the Design Concept Report (DCR), which documents the planning process (see Chapter 3, Section 3.17). The DCR is submitted to Pima County for review and comment.

With the completion of the DCR, the design concept is presented to the public for review and comment. Again, the public involvement may take several forms, including CAC meetings, public open houses, or other public outreach techniques as appropriate. The public involvement is a precursor to finalization of the mitigation portion of the EAMR (see Chapter 3, Section 3.18) and the approval of the Pima County Board of Supervisors. Board approval triggers the completion of the construction documents through the standard roadway development procedures of Pima County's *Community Participation and Mitigation Ordinance* (see Chapter 1, Appendix 1-A). Figure 4-1 summarizes the Environmental Resource Mitigation Process.

Figure 4-1
Environmental Resource Mitigation Process Flow Chart



4.4 BIOLOGICAL RESOURCE PROCESS

This section describes steps to identify biological resources and evaluate the impacts of proposed roadway projects. In addition to determining the presence/absence of special status species and their habitat, this process also measures vegetation so that appropriate re-vegetation of the site can be undertaken. For ESR projects, vegetation measurement shall be conducted by a qualified biologist/botanist or registered landscape architect and will consist of following two procedures: (1) Tree Caliper Measurement and (2) the Releve Method. Appendix 4-D provides a detailed description of vegetation measurement, while Appendix 4-E and Appendix 4-F provide information regarding appropriate plant species and landscaping guidelines, respectively. Since ESRs are located in ESL, it is imperative that the post-project environment duplicate the pre-project environment to the greatest extent possible.

In addition, all projects must address and comply with all Pima County environmental ordinances (e.g., Riparian, Buffer Overlay), with the exception of the Pima County Native Plant Preservation Ordinance (NPPO). **The NPPO protects only certain species, and does not serve to recreate complete plant assemblages; therefore, the Pima County NPPO does not apply to ESR projects.**

Steps in the Process

Following are the key steps in the Biological Resource Process. Key terms are defined at the end of this section.

Step 1: Discover/Identify Existing Resources

Step 1 consists of researching background information and conducting site visits and surveys as appropriate.

Background Information[1]

- Contact the USFWS through its website (see Appendix 4-B) and the AGFD by letter/future website to request information on special status species in the project area.
- Determine whether the project area lies within or in close proximity to any SDCP Conservation Land System designations for the project area, including Critical Landscape Linkages. For this purpose, the project area is defined as 1/4 mile from the project right-of-way.
- Determine distance of project to or inclusion within SDCP Priority Conservation Areas and or Modeled Potential Habitat for any of the SDCP Priority Vulnerable Species.
- Determine if the project area is within (or contains portions of) riparian areas inventoried as part of the SDCP Riparian Study (termed Harris Riparian on MapGuide).

[1] The Pima County MapGuide web page (see Appendix 4-A) can be used to access the information needed for Step 1: B, C, D, and E. To access detailed information such as the Conservation Land System, "zoom in" to a scale of 1:128,000.

- Determine if the project area is within a designated Preserve Area.
- Determine if the project area is within (or contains portions of) riparian areas classified as Title 16 Floodplain and Erosion Hazard Management Watercourses as determined by Pima County Code (see Appendix 4-B for relevant website).

Conduct Site Visit and Various Surveys

- Conduct site visit to determine if habitat for any special status species exists.
- Conduct species-specific surveys for federally protected Threatened and Endangered Species as warranted based on habitat outcome.
- Inventory plants using the two methodologies outlined in Appendix 4-D to measure the vegetation. Do not use the Pima County NPPO measurement techniques. In some instances, the project area (or portions thereof) may have been previously graded or disturbed. If this is the case, vegetation in an adjacent undisturbed area will serve as a representative. To measure adjacent vegetation use the sampling method described in Appendix 4-D.
- Document presence of any special elements (e.g., springs, caves).
- Coordinate with Pima County staff to determine if there are any concerns including those of non-special status species. Coordination may include meetings with USFWS and AGFD.
- Determine location for specific biological linkages, if any.

Step 2: Evaluate Effects

- Evaluate effects (impacts) to SDCP Riparian areas, if any.
- Evaluate effects (impacts) to habitat of any special status species (from USFWS and AGFD responses).
- Evaluate effects (impacts) to special status species (from USFWS response and AGFD response) known to be present on the project site.
- Conduct any additional surveys and site visits as needed or directed.
- Determine if the project meets the development density for the specific SDCP Conservation Land System Classification designation.
- Evaluate effects (impacts) to non-special status species and biological linkages based on outcome of meeting with Pima County staff.

Step 3: Identify Potential Conservation Measures/Treatment Options
(with assistance from USFWS and AGFD)

- Determine if SDCP Riparian areas, Title 16 Watercourses, and special status species habitat can be avoided to minimize effects to special status species.
- Determine appropriate mitigation measures (e.g., conservation easements, re-vegetation, road crossing design, off-site compensation) for project area based on special status species presence. Additional site visits may be needed.

- Submit assessment to appropriate agencies for concurrence.
- Monitor project to assure mitigation measures have been accomplished.

Key Definitions

Special Status Species: Defined as federally protected threatened and endangered species, Sonoran Desert Priority Vulnerable Species, plant species protected by the Arizona Native Plant Law, Bureau of Land Management/U.S. Forest Service Sensitive Species, and species identified by AGFD as Wildlife Species of Special Concern.

Priority Conservation Area: An area that supports essential (core) habitat for Priority Vulnerable Species (see below) based on expert knowledge. There are four levels of conservation areas. Definitions of each level can be found in the Biological Information on MapGuide, For Use By Public Works Staff, July 2002.

Modeled Potential Habitat: The County mapped environmental characteristics (e.g., riparian areas, elevation, soil composition) and known species locations using GIS. These maps were compared to known habitat requirements for each of the Pima County vulnerable species to determine the potential distribution of that habitat across Pima County. On the website, a High-Medium-Low color scale is used to depict the distribution of potential habitat.

Priority Vulnerable Species: These consist of 55 species of concern within Pima County that are proposed for protection under the Conservation Lands System.

4.5 CULTURAL RESOURCES PROCESS

The effect of construction on cultural resources must be considered as a part of roadway planning and design. Cultural resources are those places and things that have been created by the people who have lived, over many centuries, in what is today Pima County. These resources include: archaeological resources, historic resources, historic roads, and traditional cultural places. Cultural resources collectively represent Pima County's prehistory and history over many thousands of years, providing tangible links to our heritage. These resources are fragile, finite, irreplaceable, and non-renewable, and have scientific, educational, recreational, aesthetic, and spiritual values.

Pima County has determined that protecting cultural resources is in the public interest. Consequently, these resources must be considered during project planning and design. To facilitate planning and design, this section defines cultural resources, explains how their value is determined, describes the cultural resource review process, and examines treatment options that can be used to mitigate effects should cultural resources be impacted by a proposed Pima County roadway project.

Key Terms

Here, the term *cultural resource* is used to refer broadly to four kinds of phenomena: (1) archaeological resources, (2) historic resources, (3) historic roads, and (4) traditional cultural places. Following established Pima County protocol (Pima County, August 2000), cultural resources are defined below.

Figure 4-2: *A 2500-year old house floor found on the flood plain of the Santa Cruz River is an archaeological resource.*

Archaeological resources are any material remains of past human life or activities that are preserved in their original setting and are important to understanding prehistory or history. These sites or districts may include occupation sites; work areas; farming sites; burials/other funerary remains; artifacts; campsites; hearths; rock art; intaglios; trails; battle sites; religious or ceremonial sites, caves and rock shelters; architectural/other remains of structures of all kinds, including pit houses, pueblo rooms, adobe or rock foundations; and other domestic features, usually dating from prehistoric or aboriginal periods, or from historic periods at least 50 years old, for which only archaeological vestiges remain. This definition has been broadly applied to include prehistoric and historic sites of all time periods, functions, and spatial distributions, extending from the earliest human occupation some 12,000 years ago to the 20th century.

Historic resources are sites, districts, structures, objects, or other evidences of human activities that represent facets of the history of the nation, state, or locality. Also included are places where significant historical or unusual events occurred even if no evidence of the event remains, and places associated with persons significant in our history that have gained importance in the last 50 years.

Historic resources include a wide variety of sites, buildings, structures, and objects, including residences, commercial establishments, engineered features such as roads and bridges, schools, churches, military forts, cemeteries, parks, streetscapes, and properties that are listed on the National Register of Historic Places either individually or as groups of properties defined as districts.

Figure 4-3: *A 19th century Queen Anne revival style house in Tucson is a historic resource.*

Historic roads, while technically a subset of historic resources, are of particular relevance and importance to roadway design and construction. Consequently, a historic road is considered here as a discrete resource type. Historic roads have contributed to our culture in a meaningful way through design, experience, or association. This quality may be based on aesthetic, engineering, or cultural significance. Roads with aesthetic qualities are generally designed to enhance traveler experience by passing through parks or scenic landscapes. Roads with significant engineering qualities exhibit functional characteristics where design and technology are combined to facilitate efficient transportation. Historic roads may also be important as corridors or routes across the landscape that were used during broadly defined periods of exploration, migration, and settlement. In some cases, the original surfaces of historic roads may no longer exist.

Figure 4-4: *The bridge over Cienega Creek, built in 1921 is a historic road feature.*

Traditional cultural places are important because of their association with a living community's cultural practices or beliefs that are: (a) rooted in community history and (b) important in maintaining the continuing cultural identity of the community. The cultural significance of a traditional cultural place is derived from the role the property plays in historically rooted beliefs, customs, and practices of a community. Cultural resources that meet this definition are typically, but not exclusively, identified as significant to Native American communities. Examples include places where traditional plants used in ceremony are gathered, natural landscape features associated with an event or figure important in creation myths, or springs revered because of life giving water.

Figure 4-5: *The Santa Rita shrine on Arivaca Road is a place of traditional cultural value.*

National Register of Historic Places

The National Register of Historic Places is the nation's honor roll of places considered important to the American public on the national, regional and/ or local level. The Register was created as part of the National Historic Preservation Act of 1966, and is maintained by the National Park

Service (NPS). NPS developed criteria to assess the eligibility of cultural resources for listing in the Register. Pima County applies these criteria to all public works projects when cultural resources may be affected. Only cultural resources that are listed or are eligible for listing in the National Register are considered for further treatments/mitigation. The criteria are defined in the U.S. Department of the Interior Regulations 36 CFR Part 60. To be eligible, a cultural resource must be 50 or more years old and meet at least one of the criteria listed below.

"The quality of significance in American history, architecture, archaeology, engineering and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:

a. that are associated with events that have made a significant contribution to broad patterns of history; or
b. that are associated with the lives of persons significant in our past; or
c. that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
d. that have yielded, or have the potential to yield, information important in prehistory or history."

National Register determinations are made during a review process that is specifically designed to assess and treat impacts to cultural resources during public works projects.

Steps in the Process

To determine whether a proposed road project must follow the ESR review process because of the presence of cultural resources, the map of archaeological sensitivity zones should be consulted. This map is presented on the Pima County website (see Appendix 4-B). Projects located within the high or medium sensitivity zone will be treated as ESRs, and subject to the guidelines presented below. Additionally, specific cultural resources may be affected for which further information is needed. The Pima County Cultural Resources Office should be contacted with a letter and vicinity map that detail the nature and location of the project. The staff will determine whether the project could potentially affect priority cultural resources – that is places that have been determined by Pima County to be of extraordinary importance to the history and culture of the County. Road projects that will affect these priority sites will be required to follow the review process outlined below.

The review process that Pima County follows for assessing and treating the effects of public works projects on cultural resources mirrors the federal process as detailed in federal regulations at 36 CFR 800. Table 4-1, presented at the end of this section, outlines the process steps.

Step One: Identify and Assess Cultural Resources

The first step involves collecting data on cultural resources within the project area as defined by the Pima County Department of Transportation. A professional archaeological consultant, along

with a registered architect if warranted, conducts background research to determine whether or not the project area has previously been surveyed to current standards. This researched information should include: what cultural resources are known within the project area, who did the work, when it was done, how it was done, and what was found. Often, additional information is needed and the archaeologist conducts a field survey of the project area. The results of the background research and survey are documented in a report, which is reviewed by the staff of the Pima County Cultural Resources Office. If no cultural resources will be affected by the proposed project, the process ends and the cultural resource requirements for the project have been met.

If cultural resources are located within the project area, they are assessed based on the National Register criteria discussed previously. The staff of the Pima County Cultural Resource Office consults with the SHPO in Phoenix by sending the SHPO a copy of the survey report to make a National Register determination. In some cases, other parties such as state and federal agencies are consulted if they have regulatory involvement in the project. To assess National Register eligibility, on occasion additional information may be needed that requires subsurface testing to characterize the nature of archaeological deposits. The findings are documented in a report and sent to the consulting parties as needed. Once National Register determinations have been completed for all the cultural resources that may be affected, the project then goes to the next step in the review process.

Step Two: Evaluate Effects to National Register Eligible Cultural Resources

The second step entails the professional architectural consultant and/or registered architect evaluating the potential effects of the proposed project on those qualities that make the cultural resources located in the project area eligible for listing in the National Register. If the effects will be adverse, then treatment options for either avoiding effects or mitigating those effects are formulated, and a plan is prepared by a professional archaeologist or architect as applicable. Examples of various treatment options are provided in Table 4-2 and further discussed in Section 4.7. These options may include avoiding cultural resources through project redesign, or preserving them in place using physical barriers to ensure their protection. Rehabilitation and reuse are also treatment options where cultural resources are incorporated into the design of the project. Another option is to relocate the resource, if practical, to another location. Lastly, treatment can consist of data recovery to record and analyze information that would otherwise be lost through construction. Which treatment option is selected will depend on the types of cultural resources that will be affected and what can most practically be achieved given limitations of time and money.

Treatment options will be further refined as a result of the design charrette (see first page of Section 4.3) during which potential impacts are evaluated with the road Design Team. Once the project design is selected, the preferred treatment option is detailed in the mitigation plan, which is submitted to the SHPO and other consulting parties for their review and comment. The mitigation plan is then revised as needed to reach agreement on the best course of action to be taken.

Step Three: Implement Mitigation Plan

The last step in the review process involves implementing the mitigation plan to either avoid the National Register eligible cultural resources or conduct a program to mitigate adverse effects to those resources. This will require coordinating the work with the construction phasing discussed in Section 4.4. As a matter of convention, once any required mitigation fieldwork is completed, then, upon approval by staff of the Pima County Cultural Resource Office, construction may begin in the project area while laboratory research, analysis, artifact curation and report preparation is ongoing. When the report is complete, the SHPO is consulted one last time to ensure that the end result of the mitigation plan is acceptable, although by this time road construction may already be underway or even finished. Copies of a final report are sent to all relevant parties.

Conclusion

Pima County recognizes the importance of considering the effects of its actions on cultural resources and has determined as a matter of policy that steps should be taken to avoid or lessen these effects. Public works projects have been subject to this policy since 1983 and the cultural resources review process has been consistently included in Pima County roadway projects since 1989.

Avoidance of cultural resources or preservation in place is always the preferred means of mitigating potential effects of road construction. Cultural resources are finite in number and so each one that is lost is another that will not be available for future generations. Typically, the cultural resource review process is engaged during the environmental assessment phase of project planning, and the survey is conducted once plans have been developed. However, opportunities for avoidance and preservation in place are often limited because not enough is known about cultural resources before design begins. The ESR procedures described in this chapter incorporate more cultural resource information earlier in the planning process, encouraging a collaborative approach between project designers and cultural resource professionals to achieve preservation more often.

For more information about historic preservation related topics, consult the applicable websites listed in Appendix 4-B.

Table 4-1
Cultural Resources Review Process

Identify/Assess Resources			**Evaluation of Effects**	**Mitigation of Effects**
Resource Types	*Inventory/ Testing*	*National Register Criteria*	*Treatment Options/Planning*	*Mitigation Plan*
- Archaeological - Historic - Historic Roads - Traditional Cultural Places	- Background Research - Informant Interview - Field Survey - Field Testing	- Apply NR Criteria a. Historic Events b. Historic People c. Type, Period, Method, etc. d. Information Potential	- Avoidance - Preserve/Protect - Rehab/Reuse - Relocate - Mitigate/Record	- Implement Plan - Complete Field Work - Proceed with Road Project
	Report Prepared		Mitigation Plan Prepared	Mitigation Report Prepared
	Internal Review	External Review	Internal/External Review	Internal/External Review
		Consult w/SHPO and other parties as needed	Consult w/SHPO and other parties as needed	Consult w/SHPO and other parties as needed

Table 4-2
Examples of Treatment Options by Cultural Resource Type

Archaeological Resources: **Sites, Objects, Districts/Complexes**	**Historic Resources:** **Buildings, Structures, Objects, Districts, Landscapes**
Treatment Options - **Avoidance** Redesign Realign - **Preserve/Protect** Intentional Burial Physical Barriers Covenants/Easements Donation - **Data Recovery** Testing/Excavation Mapping, photography, records research Informant Interview	Treatment Options - **Avoidance** Redesign Realign - **Preserve/Protect** Covenants/Easements Donation - **Restore/Reuse/Retrofit** Restore to original condition. Incorporate historic elements into new design - **Relocate** Move from harms way - **Record/research** Drawings, photography, records research Informant Interview
Historic Roads: **Aesthetic, Engineered, Cultural**	**Traditional Cultural Places:** **Shrines, Burials, Rock Art, Gathering Places, Natural Features, Springs/Drainages, Landscapes**
Treatment Options - **Avoidance** Redesign Realign - **Adaptive Reuse** Incorporate historic elements into new design Retain historic setting - **Record/Research** Drawings, photography, records research Informant interview - **Public Information/Education** Signage, information kiosks, popular publications, lectures	Treatment Options - **Avoidance** Redesign Realign - **Preserve/Protect** Intentional Burial or reburial - **Restore/Reuse** Repair Provide new access to - **Relocate** Move away from harm - **Record/Research** Map, photograph (if appropriate), research Informant interview - **Ceremonial Treatment** On site ceremony/ritual

4.6 VISUAL AND AESTHETIC RESOURCE PROCESS

This section provides an overview discussion of the process to: (1) identify visual and aesthetic resources, (2) analyze and evaluate the visual impacts associated with different types of roadway projects, and (3) develop treatments/mitigation measures to address impacts to important visual resources and to maintain and/or enhance the aesthetic character of the roadway corridor.

Key References

The following documents may be reviewed in conjunction with the process outlined in this section and shown in Figure 4-6. The Visual and Aesthetic Resource Evaluation Process for ESR design projects is based on a combination of the principles presented in seven documents on visual analysis included in Appendix 4-A.

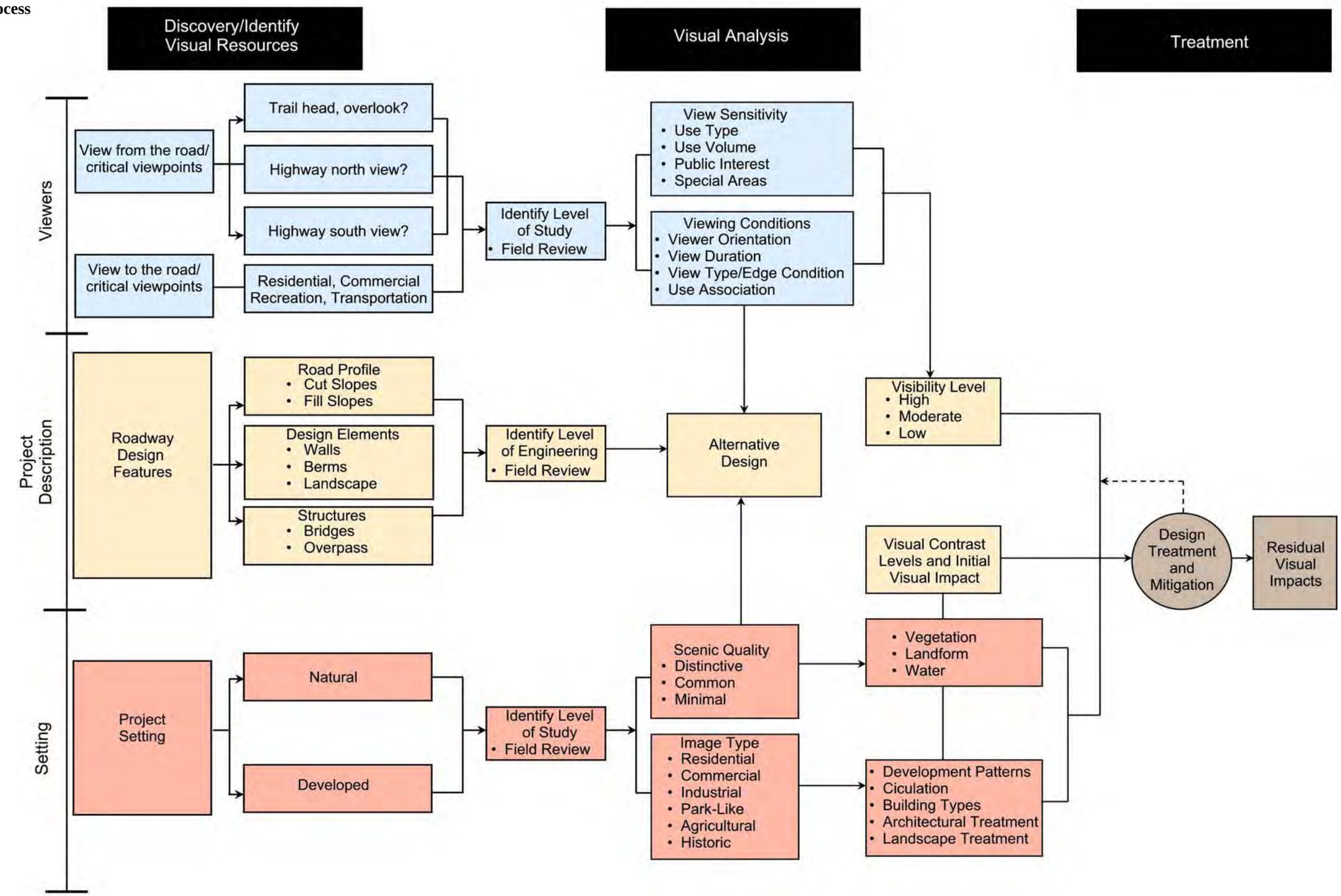
Highlighted below are steps for characterizing visual resources within a project area, evaluating the effects of the project on those resources, and developing and prioritizing treatments/mitigation measures to mitigate the project effects. These steps are intended as guidelines for the integration of aesthetic considerations into the planning and design of roadway projects. Appendix 4-G provides a more detailed discussion of the specific techniques that may be used to conduct this process.

Steps in the Process

Step 1: Discovery/Identification of Visual Resources

The first step in the Visual and Aesthetic Resource Evaluation includes a field review to identify and inventory the visual elements associated with (1) viewers from and to the roadway area, (2) the setting of the project, and (3) elements of the project that will result in a change to the setting.

Figure 4-6
Environmentally Sensitive Roadway Design
Visual Resource Study Process



The intent of this step is to initially characterize the visual resources, to identify those elements of the project that may affect those resources, and to determine the potential level of visual analysis and treatment required for the project. Also during this step, any specific visual practices and standards of agencies that have jurisdiction in the project area should be identified.

Viewers

From the Roadway – Include roadway users (vehicle occupants and in some cases bicyclists) as well as special viewpoints associated with the roadway (trailheads, scenic overlooks, rest areas etc.). It is important to note that when identifying highway viewers, both directions of traffic should be considered in the evaluation. In situations where sidewalks or trails are a part of the project, views from these facilities should be considered.

To the Roadway – Include adjacent property users, including those involved in residential, commercial, industrial, and recreational uses.

Setting

Landscape settings of proposed roadway projects may be natural or developed. Natural settings are those that consist of elements including landform, vegetation, and water and that demonstrate little if any human modifications or disturbance. (Natural settings may include ranching and grazing lands.) Developed settings include those areas in which residential, commercial, industrial, recreational, or agricultural (e.g., cotton fields, orchards) uses have been established.

Project Description

In order to evaluate the effects of a proposed roadway project on the viewers and the setting, it is important that project design features (including potential treatments/mitigation measures) be well defined. In some cases, the project description may entail the development of a new road, requiring the removal of vegetation within an entire corridor area and the modification of landform through grading (cut and fill slopes). Other projects may include only the widening of an existing roadway, resulting in selective vegetation clearing and the use of retaining walls. Finally, some projects may only involve the addition of small project features to address very localized issues (e.g., barriers, landscaping, guardrails, lighting, signage).

Step 2: Conduct Visual Analysis

The visual analysis begins with identifying initial visual impacts, which are based on the effects that the proposed project will have on the views from and to the roadway and contrasted with the existing views from and to the roadway. The level of this analysis should be determined at the conclusion of Step 1, including a confirmation of specific tasks and the level of detail required for the analysis. Following is an overview of the tasks that may be required for the visual analysis. A detailed description of these tasks, with examples, is provided in Appendix 4-F.

Viewers

The analysis of viewers includes (1) the sensitivity of users with views from and to the project, and (2) the viewing conditions, or variables, associated with those views. Collectively, this information may be used to determine overall visibility levels (i.e., high, moderate, or low) associated with the different types of viewers that may have views from, or to the roadway.

Sensitivity of Viewers – Viewer sensitivity levels are the measure of viewer concern for change in scenic quality or the image of a particular setting in which a roadway is being developed, modified, or improved. Criteria for the identification of viewer sensitivity include user type, user volume, public interest (national, state, or local), and association with special areas or unique viewer expectations (e.g., scenic highways, special recreational areas, or historic areas).

Viewing Conditions – Viewing conditions are defined by a set of viewer variables that assist in characterizing views from and to the roadway project from sensitive view locations, and include the following:

- *Viewer Orientation:* including parallel versus perpendicular views from the road
- *Duration of View:* including consideration for roadway speed limit
- *View Distance:* near foreground to background
- *Visibility/Edge Condition:* open, filtered, or screened
- *Viewer Use Association:* viewer expectations and special designation areas
- *Silhouette:* contrast of element with sky
- *Magnitude:* size of element

Visibility Level Synthesis – Using these criteria, a synthesis of overall visibility levels may be assigned to segments of the road characterizing views from and to the roadway area, as well as from specific viewing locations associated with the roadway (as necessary).

Setting

Analysis of the project setting includes the characterization of similar patterns of landform, vegetation, land use, and unique features. Description of these factors permits an evaluation of the potential effect of the proposed roadway design project in conjunction with scenic quality (natural setting), or visual image types (developed settings).

Natural Setting – Natural landscapes or settings may be characterized based on similar patterns of the following elements:

- Landform
- Color
- Vegetation
- Scarcity

- Water
- Cultural Modifications (including ranching and grazing)

These elements are combined to determine the overall scenic quality of the natural setting. In general, those areas with greatest diversity exhibit the highest level of scenic quality, while areas with little or no variety are considered less visually appealing.

Developed Settings – The visual image of developed settings (counterpart to scenic quality in a natural setting) is based on types of use and development patterns that are defined by visual character, land use patterns, and viewer orientation. The visual character is concerned with the composition of design elements including form, line, color, and texture. These elements influence the visual dominance, and focus within each setting. In general, these patterns may be classified into five image types: residential, commercial, park-like, industrial, and open/agricultural images.

Visual Contrast

As warranted, the visual contrast analysis is a systematic process that is used to analyze the potential visual impacts of the proposed roadway improvement and associated activities. The degree to which the roadway project affects the visual and aesthetic quality of a natural or developed setting depends on the contrast created between the project and the existing setting. The contrast can be measured by comparing the design features associated with the project description with the major features in the existing setting (natural or developed). The basic design elements of form, line, color, and texture are used to make this comparison and to describe the visual contrast created by the project in a natural setting, while the effects to image type are used to define contrast in developed areas. Using this information, the impacts may be summarized to discuss the modification to the natural setting or visual image type of an area and the effects to views from and to the roadway.

This analysis process provides a means for determining the visual impacts and for identifying the measures and treatments to mitigate these impacts. It is important that potential mitigation measures be identified early in the process since their identification will assist in project design and the development of specific alternatives.

Step 3: Identify Optional Treatment

The purpose of this step of the visual resource and aesthetics evaluation process is to identify potential treatment options that may be utilized to enhance viewing conditions and/or address the impacts to viewers and the project setting as previously defined. This step focuses specifically on the selection of relevant design elements or treatments as earlier described, the evaluation of how these solutions address visual and aesthetic opportunities and impacts, and how treatments/mitigation measures should be prioritized for implementation. Examples of design treatments/mitigation measures, and how these measures may be applied to different types of roadway projects are presented in Section 4.7.

4.7 MITIGATION TOOLS

Mitigation of environmental impacts can take many forms. Depending upon perspective, certain mitigation measures may be more desirable than others. Within the context of this ESR design guide, it is important to define the range of possible mitigation measures that may be available to designers, and to help them choose the most appropriate ones for implementation. The following sections represent a toolbox to assist designers with the process of identifying, assessing and selecting treatment options and roadway design techniques that best satisfy the environmental preservation and enhancement goals of each project.

Environmentally Sensitive Roadway Design Guidelines

Many sources currently exist for design of roadway facilities, ranging from local to national. The primary references for Pima County projects are listed below. These publications provide guidance to designers, offering a full scope of acceptable and safe design criteria.

- Chapters 2 and 3 of this manual
- American Association of Transportation Officials, *Policy on Geometric Design of Highways and Streets,* 2001. *(AASHTO Policy 2001)*
- AASHTO, *Roadside Design Guide*, 2002 (*AASHTO Guide 2002*)
- AASHTO, 1996, and revisions 1997 - 1999, *Standard Specifications for Highway Bridges*

There are a number of key roadway elements that impact ESR designs. These elements range from design speed (impacting the driver's ability to see and avoid wildlife on the roadway) to lane widths (impacting overall roadway width and resultant resource disturbance) to drainage design (facilitating wildlife crossings and enhancing riparian habitats). The potential variation within each of these elements can have minimal to devastating impacts on environmental resources. For example, a four-lane arterial road can range in width from 96 feet to 70 feet. Over a one-mile project length, that 26-foot difference could mean the preservation of over three acres of environmentally sensitive land. Other design elements can also have major impacts.

Guidelines follow for minimizing impacts on ESR projects. These guidelines are broken down into Roadway Elements and Construction Phasing.

<u>Roadway Elements</u>

The list below provides suggested limits for key elements of the ESR design. In all cases, the final approval of the use of these design criteria is the responsibility of the County Project Manager and the County Department of Transportation Engineering Manager.

- *Design Speed/Posted Speed:* ESR design speed should be 30 to 50 miles per hour, with the posted speed 5 mph less that the design speed.
- *Lane Width:* ESR lane widths can be the minimum widths shown in Chapter 2, Table 2-1.

- *Shoulder Width:* ESR paved shoulder width is 6 to 9 feet, with 6 feet as the standard width. The designer has a range of acceptable values to narrow the road width, widen the shoulder, or to allow for a wider median while maintaining a given total width.
- *Bridge Width:* ESR bridge geometrics follow current RDM and AASHTO guidelines.
- *Bridge Structural Capacity:* ESR bridge structure follows AASHTO guidelines.
- *Superelevation Rate (horizontal alignment):* Maximum rates are 0.08 and 0.06 for rural and urban/suburban roads, respectively, for design speeds of 45 mph and above. For design speeds of 40 mph and below, apply the simplified curve formula, $e + f = V^2 / 15R$, as described on pages 192-198 of *AASHTO 2001 Policy*. The designer can use these higher rates to reduce the radius of the horizontal curve.
- *Vertical Alignment:* See *AASHTO 2001*. The designer needs to consider the specific conditions (biological, cultural, historical) along the ESR corridor and may lengthen the vertical curve if warranted. Shortening of vertical curves should be done only through the Pima County design exception process.
- *Grade:* Maximum grade of 10% is allowed in mountainous areas, 5% in rolling terrain. The designer can use steeper grades to reduce cuts and fills.
- *Stopping Sight Distance:* See *AASHTO 2001*.
- *Cross Slope:* 2% for through lanes and shoulders.
- *Number of Through Lanes:* Maximum of 4-lanes (2 per direction).
- *Vertical Clearance:* See *AASHTO 2001*.
- *Horizontal Clearance:* For ESR design speeds between 30 mph and 45 mph, the horizontal clearance (from face of curb to obstruction) is 2.0 feet minimum for curb sections. For sections with no curb, the minimum clearance is 10 feet (measured from through travel lane to obstruction). For an ESR design speed of 50 mph along an uncurbed roadway, the designer should use the clear zone distance from the *AASHTO Roadside Design Guide*. When the roadway has curbs, an ESR design speed of 50 mph requires a 2.0-foot minimum horizontal clearance.
- *Median Width:* For ESR projects, the required horizontal clearance to obstructions in medians corresponds to item M., above. Width of median can vary from 20 to 40 feet. At signalized intersections, a maximum width of 30 feet should be used. Note that a tree having an expected mature diameter greater than 4 inches is considered an obstruction, while lesser vegetation or landscape may not be an obstruction.
- *Alternative Modes:* Bus pullouts and pedestrian sidewalks all must be assessed for impacts, and width reduction (or elimination) may be necessary depending on the resources being impacted. ESR roadways will include bicycle lanes with a 6-foot standard width, but in constrained circumstances this width may be reduced by 1 foot.
- *Drainage:* See Pima County *Roadway Design Manual*. The designer may wish to call for larger than required drainage culverts to allow for wildlife crossings. Additionally, the designer may choose to allow flows more frequent than the 100-year event ($Q<Q_{100}$) to flow across the road if circumstances warrant this type of treatment.

- *Noise:* Noise walls are considered appropriate only when shown to enhance biological or cultural/historical resources or to mitigate negative impacts on these resources. The ESR designer is encouraged to use "barrier" mitigation wherever possible, including rubberized asphalt pavements.
- *Right-of-Way:* ESR corridors (150 to 300 feet) may be planned for wider-than-normal public rights-of-way to enhance or to mitigate impacts of the road design.

Construction Phasing

Historically, roadway contractors have had a great deal of flexibility in scheduling construction activities. Once a project has been awarded, the site becomes the contractor's responsibility – essentially his/her property – for the duration of the contract. As a general rule, the first activity to commence is site clearing and grubbing and the relocation of affected utilities that are in the way. This particular activity can have immediate and negative effects on natural and cultural resources. These impacts may continue for the entire duration of the project, creating unexpected and irreversible environmental impacts. Other construction activities also affect natural and cultural resources.

Wildlife travel patterns, important seasonality issues (such as breeding), and significant features should be identified during the design phase of the project. Construction specifications and sequencing of work need to address these issues. For most ESR projects, it is advisable for the designer to develop construction-sequencing plans as a part of the contract documents. This will help ensure that the construction team properly implements the environmental goals of the project, and that the contractor is afforded a workable project while creating/maintaining corridors or habitat.

Biological Resource Conservation Treatments/mitigation Options

Biological resources (e.g., riparian areas, special status species habitat) of ESR projects within ESL should be preserved. The project area should be evaluated to determine if SDCP Riparian areas, Title 16 Watercourses, and special status species habitat are avoidable. If avoidance is not possible, there are several option for treatments/mitigation measures. These include, but are not limited to:

- Conservation Easements
- Revegetation
- Wildlife Road Crossing Design
- Off-site Compensation

All mitigation plans, especially those concerning special status species, should be developed in conjunction with Pima County, AGFD, and USFWS. Projects should include a monitoring component to ensure that treatments/mitigation measures have been accomplished. The options for treatments/mitigation measures are presented in more detail below.

Conservation Easements

A conservation easement is a legal agreement voluntarily entered into by a property owner and a qualified conservation organization such as a land trust or government agency. The easement contains permanent restrictions on the use or development of land in order to protect its conservation values. Easement restrictions vary greatly between agencies/organizations.

Revegetation

Revegetation of all ESR areas shall be done with the appropriate plant species, including seed mix plants. Every effort should be made to revegetate with plant species that were removed and/or are commonly found in the project environment, matching density, relative location patterns (e.g., small cactus under shrubs), slope, and soil preferences whenever possible. A list of plants native to Pima County is presented in Appendix 4-E. These plants should be used in all ESR areas. Certain plant species shall not be used under any circumstances (see also Appendix 4-E). All transplant vegetation and seed mixes are to be planted and irrigated correctly. Planting and irrigation guidelines are presented in Appendix 4-F. Trees with anticipated mature diameter of 4 inches or greater should not be located in medians or within clear zones. Vegetation should not be located at intersection corners or in medians that would restrict driver visibility to oncoming or crossing vehicles.

Wildlife Road Crossing Design

Land bridges, herp walls, lighted crossings, and bridges that span rather than cut drainages are all features that could be incorporated into Pima County transportation plans. In northwestern Arizona, the Federal Highway Administration (FHWA) is planning to construct a land bridge near Lake Havasu to allow bighorn sheep to cross Interstate 40. A Florida land bridge serves dual purposes: the edges are vegetated with native species with a sand base for animal passage, and the center is designed for pedestrian and equestrian use.

Figure 4-7: *Example of a large wildlife crossing.*

Wildlife walls and fences funnel animals to designated crossings. Sound walls are an effective barrier to wildlife and can serve as wildlife walls as well. However, 10-foot sound/noise walls are not the ideal addition to the landscape, and their use for ESR design is discouraged. Shorter walls can be just as effective for wildlife. A wall 3-4 feet high will allow birds to fly over while encouraging other wildlife species to use designated crossings.

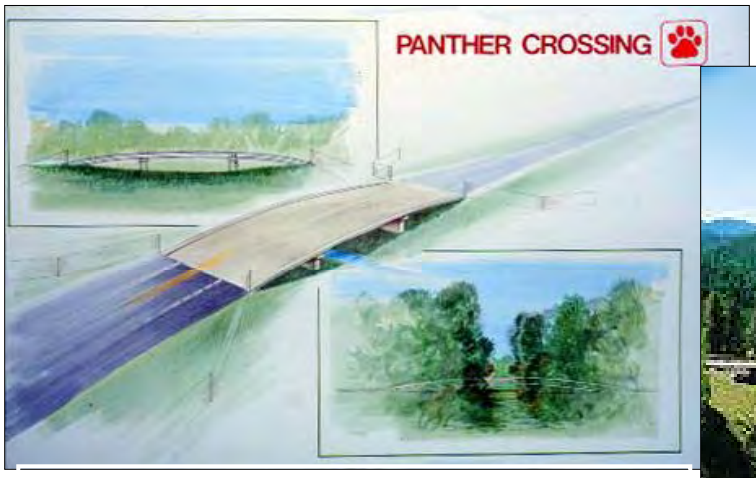
Figure 4-8: *Herp wall along a roadway.*

Herp walls are designed specifically to funnel lizards, snakes, small turtles and amphibians into designated crossings (Figure 4-8). Herp walls are smooth, short walls placed along the edge of the road that have a top lip that prevents reptiles and amphibians from crawling onto the road.

Lighting is another very important and often overlooked component of effective wildlife crossing design. Lizards and snakes prefer bright, warm habitats to cool, dark tunnels, therefore culverts intended for wildlife are not always conducive to the habitat requirements of reptiles. Additionally, deer will not enter a dark tunnel with an exit that is perceived to be very small (perceived exit size is dependent on size and length of crossing structure) or that may conceal predators. Incorporating light into these structures encourages more animals to use them. Grates can be placed in the road or medians to allow natural sunlight into the crossing, or solar lights can be placed in the interior. (See University of Arizona pedestrian underpasses as an example of solar lighting in a tunnel.)

Crossings designed for one species may not serve other species. For example, design of roads in pygmy-owl habitat incorporate native vegetation to the edge of the road to allow adequate crossings. However, vegetation should be kept away from the edge of the road to discourage other animals from crossing in areas other than designated crossings. It is important to identify the target species or group of animals so that appropriate designs are chosen.

In some instances, bridges that completely span a drainage are more effective than traditional box culvert design (Figure 4-9). Larger mammals (e.g., deer, bear) are more likely to use a wide-open crossing rather than a closed box culvert. Such crossings also preserve riparian habitat by spanning entire floodplains, rather than only floodways with associated destruction of adjacent overbank areas that contain considerable amounts of riparian habitat.



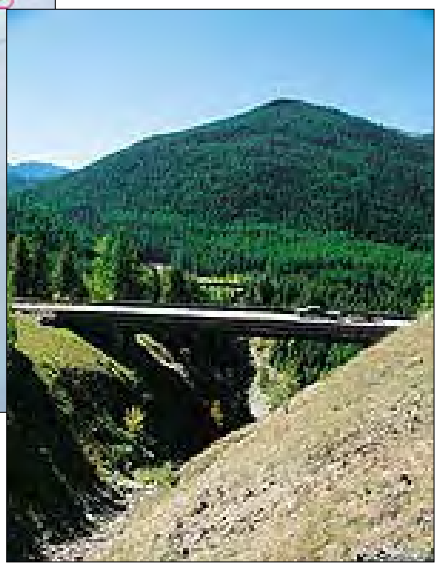


Figure 4-9: *Examples of bridges designed to span drainages.*

An important aspect of designing a wildlife crossing is determining the most effective placement for wildlife use. Corridor studies using landscape topography, wildlife ecology, computer modeling, and radio-telemetry techniques are all valuable resources for determining appropriate crossing locations. These studies should be conducted during the "Discover/Identify Existing Resources" stage of the Biological Resource Process. (See Section 4.4 of this document.)

The following is a list of tools for creating wildlife crossings. It is not exhaustive since each species may require unique design features tailored to their needs.

- Install speed humps, speed tables, traffic circles, or other "traffic calming" elements to slow traffic
- Set lower speed limits
- Provide wildlife friendly lighting to discourage wildlife from foraging near the road (i.e., avoid bright lights that attract insects, thereby attracting insectivores)
- Widen clear zones to deter wildlife from the edge of road
- Install wildlife crossing signs to inform motorists
- Install large lighted culverts for large mammal crossings
- Install small lighted culverts for smaller wildlife
- Install herp walls to encourage reptiles and amphibians to use appropriate culverts
- Install grates in medians to allow natural sunlight into culverts
- Use solar lighting to illuminate dark culverts
- Plant native vegetation in medians and other landscape/re-vegetated areas
- Span drainage floodways when feasible
- Create land bridges
- Conduct a wildlife corridor study to determine best placement of wildlife crossings
- Create "escape cover" around wildlife crossings by using dense native vegetation
- Eliminate "escape cover" (i.e., vegetation) near hazardous areas to deter wildlife from crossing road
- Use fencing in conjunction with plant material to guide wildlife to appropriate crossings

Additional sources of information on wildlife crossings are provided in Appendix 4-C of this document.

Off-Site Compensation

Off-site Compensation also is referred to as a *conservation bank.* Like a financial bank, a conservation bank is a place that contains important resources, in this case natural resources. The conservation bank protects these resources just like a bank protects money. When a project is planned that will impact endangered species or other natural resources, such as wetlands,

credits in a conservation bank can be purchased. The bank owner then uses the money to protect the resources in the bank.

Traditionally, project developers have been asked to preserve a portion of the area they are developing. Often this is a good policy. However, sometimes it may be better for endangered species to have larger areas protected in banks. It also is more efficient and cost effective to manage a bank instead of small, isolated properties.

The term "mitigation bank" is sometimes used to refer to conservation banks. This is appropriate in the case of non-Federal projects and projects that require U.S. Army Corps of Engineers wetlands permits. Federal law allows non-Federal property owners, such as private landowners, corporations, tribes, or state or local governments, to *mitigate*, i.e., compensate for, impacts to the environment.

Appendix 4-B includes an address for a USFWS website that contains more information on conservation banks.

Cultural Resources Treatment Options

As discussed in Section 4.5 the cultural resource review process consists of three steps: (1) identification and assessment, (2) evaluation, and (3) treatment. Treatment is the stage in the process in which the characteristics that make a cultural resource important are protected, or the effects of project related disturbance to those characteristics are mitigated prior to construction. The measures used to accomplish treatment range from complete avoidance of cultural resources to research and recording prior to their destruction through construction.

When cultural resources are identified within a proposed road right-of-way, the manner in which potential effects can be treated will vary depending on a host of factors including, but not limited to, the resource type and the characteristics that make it important, its location within the proposed right-of-way, whether it is possible or even desirable to avoid the resource, limitations of time and money, and public awareness of and sentiment regarding the resource. For this reason, engineers and designers are advised to consult with the Pima County Cultural Resources Manager during the planning and design stages of ESR projects. By law, state and federal agencies may also need to be consulted before a consensus can be reached on the proper treatment for a cultural resource that may be affected by road construction.

Typically, if archaeological sites cannot be avoided, a data recovery program is developed identifying a set of research questions and methods that guide field and laboratory work. The objective is to collect the information content of the site before it is lost to construction and to add new information to a body of knowledge of how people lived in the past. Buildings, structures, and other engineered features, such as roads and bridges, are typically recorded in the field and through archival research to capture the history of their design, construction, and use over time. This work is usually done in reference to broad themes in American history on the national, state, and local levels to provide meaningful context to the research. On occasion, cultural resources valued by traditional communities, such as Native American communities, may be affected by a proposed road project. In these instances, experts in applied anthropology

use a combination of fieldwork, oral interview and archival research to recover information about these resources and to work with the communities to conduct appropriate means of treating effects. Treatment can be time consuming and expensive, requiring careful planning so that the work can be done well in advance of construction but after enough of the planning has been done to identify potential effects on the ground.

To provide a sense of the kinds of treatment that may be employed in road construction projects, Tables 4-3 through 4-6 contain typical treatment options for each resource type and corresponding design recommendations for how to achieve treatment. Each table lists the treatment options from top to bottom in a range from the most beneficial to cultural resources to the least beneficial. Avoidance and preservation in place is always the preferred treatment option. This means that impacts to cultural resources are deliberately avoided and preservation measures are adopted to ensure protection. It is important to note that treatment often involves a combination of treatment options to mitigate the effects of construction on cultural resources. Tables 3 through 6 are not intended to be comprehensive or exhaustive. Each ESR project that may affect cultural resources will involve unique circumstances, so alternative treatment options may be possible with different design implications.

Table 4-3
Archaeological Resources: Sites, Objects, Districts/Complexes

Treatment Options	Design Recommendations
- **Avoidance** Redesign Realign	- Include a buffer zone of 50 feet minimum between the edge of the construction zone and the edge of the archaeological resource to ensure avoidance.
- **Preserve/Protect** Intentional Burial Physical Barriers Covenants/Easements Donation	- Add 12-24 inches of topsoil to "cap" the resource by intentional burial. Archaeological testing must be conducted prior to capping. - Fencing, earthen berms, or other permanent barriers can be used to ensure avoidance in conjunction with a buffer zone. - Covenants and easements are legal instruments to ensure avoidance. Same design implications as avoidance. - Donation can occur as a part of avoidance strategy where preservation responsibility is assumed by a third party. Same design implications as avoidance.
- **Data Recovery** Testing/Excavation Mapping, photography, records research Informant Interview	- Data recovery collects information through scientific investigation in accordance with the Secretary of the Interior's Standards and Guidelines. No design implications.

Table 4-4
Historic Resources: Buildings, Structures, Objects, Districts, Landscapes

Treatment Options	Design Recommendations
- **Avoidance** Redesign Realign	- Include a buffer zone of 50 feet minimum between the edge of the construction zone and the edge of the historic resources to ensure avoidance.
- **Preserve/Protect** Covenants/Easements Donation	- Design to minimize road vibrations that may affect nearby historic resources. Do not add visual elements, such as lighting or signage, that may detract from historic character. Use landscaping and/or public art to enhance historic feeling and association. - Covenants and easements are legal instruments to ensure avoidance. Same design implications as avoidance. - Donation can occur as part of an avoidance strategy where preservation responsibility is assumed by a third party. Same design implications as avoidance.
- **Restore/Reuse/Retrofit** Restore to original condition Incorporate historic elements into new design	- Requires modifying a historic resource in accordance with the Secretary of the Interior's Standards and Guidelines. Design implications are situational and may be significant.
- **Relocate** Move from harm	- Removal of historic resource from project area as an alternative to demolition. Requires design input for site of relocation.
- **Record/Research** Drawings, photography, records research Informant Interview	- Recover information in accordance with the Secretary of the Interior's Standards and Guidelines. Consult with knowledgeable individuals prior to demolition. No design implications.

Table 4-5
Historic Roads: Aesthetic, Engineered, Cultural

Treatment Options	Design Recommendations
- **Avoidance** Redesign Realign	- Include a buffer zone of 50 feet minimum between the edge of the construction zone and the edge of the resources to ensure avoidance.
- **Adaptive Reuse** Incorporate historic elements into new design Retain historic setting Mitigate road noise	- Reduce traffic speeds. Retain historic elevations, lane widths, shoulders and road curvature. Do not add new sidewalks, curbs or lighting. Use landscaping to preserve rural feeling and association where appropriate. Use rubberized asphalt to dampen road noise.
- **Record/Research** Drawings, photography, records research Informant interview	- Recover information in accordance with the Secretary of the Interior's Standards and Guidelines. No design implications.
- **Information/Education** Signage, information kiosks, popular publications, lectures	- Place information kiosks/signage in highly visible areas with roadside turnoffs to provide public access. Use in conjunction with recordation and research.

Table 4-6
Traditional Cultural Places:
Shrines, Burials, Rock Art, Gathering Places, Natural Features, Springs/Drainages, Landscapes

Treatment Options	Design Recommendations
- **Avoidance** Redesign Realign	- Wide buffers are recommended. Distances established through negotiations with traditional community. Design implications are situational and may be significant.
- **Preserve/Protect** Intentional burial or reburial	- Human graves are to be treated in accordance with state law and the wishes of lineal descendants or those culturally affiliated. This may require removal and reburial outside of the project area prior to construction. No direct design implication.
- **Restore/Reuse** Repair Provide new access to resource	- Restore for reuse, and/or provide new access to resource. Design implications are situational and require negotiations with traditional community.
- **Relocate** Move from harm	- Relocate to outside of the project right-of-way. Project design implication may be minimal.
- **Record/Research** Map, photograph (if appropriate), research Informant interview	- Recover information in accordance with the Secretary of the Interior's Standards and Guidelines. Consult with knowledgeable individuals prior to disturbance. No direct design implications.
- **Ceremonial Treatment** On site ceremony/ritual	- Possible outgrowth of above. On site ritual treatment required before resource disturbance. No design implications.

Visual and Aesthetic Resource Treatments/mitigation Options

As described in Section 4.6, the purpose of this step of the Visual and Aesthetic Resource Evaluation Process is to identify and prioritize potential design treatments/mitigation measures that may be used to maintain or enhance views in ESL in which roadway projects are proposed. This step focuses specifically on the selection of relevant design elements, treatments, or mitigation measures and the evaluation of how these solutions address visual and aesthetic impacts and opportunities. As part of this step, the areas identified for visual mitigation may be prioritized to meet visual goals, as well as other environmental and design goals for the project. Depending on the specific project, monitoring the implementation of the selected treatments/mitigation measures may be required during and following construction.

Following are a listing of sample types of treatments/ mitigation measures. This list is followed by three case examples illustrating how these measures can effectively address visual and aesthetic concerns.

<u>Sample Treatments/Mitigation Measures</u>

As described in Section 4.7 and illustrated in Figure 4-6, the development of treatments/ mitigation measures is the "circular" portion of the visual resource analysis process, which focuses on the identification of alternative plans. These alternative plans, which include design treatments/mitigation measures, are evaluated based on: (1) their effects to the visibility level of

views about which people care and (2) their ability to reduce the contrast of proposed roadway design features within natural or developed settings and to enhance the overall aesthetic of the roadway corridor.

Visibility Levels

Measures that are typically used to address visibility concerns are related to either the "screening" of undesirable views, or the "opening" of views to areas of high scenic quality or to areas that are aesthetically pleasing (e.g., developed setting). Techniques for screening include, but are not limited to, the use of vegetation, landform (e.g., berming), or structural elements (e.g., walls, fences, planters). In general, the opening of views is accomplished most often through selective clearing, or the removal of vegetation, and/or through the elimination or modification of roadside elements and structures (e.g., billboards). In making the determination regarding either the screening or opening of views, viewer orientation and duration of views are especially critical, along with the character or setting of the area being viewed.

Setting

The key to identifying appropriate treatments and measures to mitigate impacts to the setting is to determine the contrast between the proposed roadway project (including specific design elements) and the natural and/or developed character of the project area. In those areas where the contrast is pronounced, using elements that repeat the general form, line, color, and/or texture of the surrounding area will help to reduce that contrast, resulting in a project that better blends with its setting. This applies to all of the following examples.

Vegetative Treatments – The addition of new landscaping enhancements to existing landscaping and re-vegetation or reclamation practices should be consistent with the existing or planned setting of an area.

Landform Treatments – Minimizing the amount of cut and/or fill slopes (alignment) and the use of berms, slope laybacks, and rock sculpting can be effective measures to reduce the contrast of roadway features (especially in a natural setting). When using retaining walls, consideration for the size, form, color, and texture of materials is important.

Structural and Design Treatments – The addition of structures, including walls, bridges, and overpasses (vehicular and pedestrian), as well as detailed design elements including lighting, signage, and pavement types/surfaces should (where possible) not detract from the scenic quality of a natural area and should act as unifying elements in developed settings. In selective cases, however, these elements may be created to serve as public art also and, therefore, be intended to attract attention.

Case Examples

Following are examples of alternative design treatments/mitigation measures that may be developed for different types of roadway projects.

Case 1: Development of a New Road

Project requires the location of a small portion of new roadway, resulting in the removal of vegetation within an entire corridor area and modification of landform through grading (i.e., cut and fill slopes), including the modification of drainages. The results of the visual analysis may indicate moderate to high visual impacts to both the setting and the viewers' viewing experience, especially if the impacts are within a natural area with distinctive scenic quality elements and a high level of viewer sensitivity and visibility both from and to the new section of road.

Analysis may also show that construction of the new roadway could result in strong contrast to landform based on cut and fill requirements and on the removal of vegetation within the corridor area. Design treatments/mitigation measures that could assist in reducing contrast and enhancing the aesthetic character of the corridor may include, but are not limited to:

- Color treated retaining walls to addresses form and color contrast associated with significant landform modifications.
- Selective clearing, re-vegetation and reclamation, and landscaping to reduce form, line, color and texture contrast associated with removal of vegetation within the entire corridor. Focus of revegetation and reclamation may be concentrated in the drainage areas since those areas tend to be of higher scenic quality.
- Use of small bridges to address the contrast associated with grading and some vegetation removal. This option could, however, simply end up adding structures in an otherwise natural setting. The introduction of bridges, therefore, should be carefully considered.
- Landform modification through berming, slope modification, and rock sculpting.

Case 2: Widening of an Existing Roadway

Project requires addition of another lane, resulting in modest vegetation clearing, but no significant additional landform modification (e.g., grading). The vegetation clearing could either enhance or detract from views from and to the road depending upon the location of the clearing. Key to this evaluation is the type and volume of users in the area, and the scenic quality or developed image of the setting. If the setting is natural, then the quality of the setting should be identified as distinctive, common, or minimal. If the setting is developed, the widening could affect the current image of the area based on the image type or open up views to undesirable areas. Design treatments/mitigation measures that could assist in enhancing views could include, but are not limited to:

- Selective clearing, transplanting, and or replacement of vegetation in a manner that complements views from the road (e.g., opens up views to distinctive natural features or maintains screened views to industrial areas).
- Selection of vegetation types that are complementary to the surrounding area.
- Selective use of berming, fencing, or walls to screen views as appropriate.

Case 3: Roadway Improvement Resulting in the Addition of Pedestrian Access and Signage

Project requires signage and traffic control, resulting in possible placement of elements/features that could impair the visual quality of the setting. Treatments/mitigation measures that could help reduce visual clutter and impaired views include design features, such as signage, lighting, paving, and use of berms, that are compatible with the forms, colors, and textures of the surrounding image types, whether residential, park-like, or commercial.

4-8 POST-CONSTRUCTION ASSESSMENT

At the post-construction stage of the ESR design process, project impacts on environmental resources have been identified, treatment options considered, mitigation plans developed, and construction completed. As the operations phase of the roadway commences, the community has the opportunity to observe the effectiveness of its investment in the environmental mitigation effort. A number of the treatments/mitigation measures presented in this chapter, as well as many of the treatments/mitigation measures that will be created as a result of implementing the ESR process, will have limited documentation of long-term effectiveness. To ensure that the implemented preservation and enhancement plans are accomplishing their stated goals, it is imperative that follow-up studies of these projects be conducted.

If the purpose of post-construction assessment is to ensure the effectiveness of mitigation efforts, the first step is to clearly define the goals. Goals will be developed through the process outlined in previous sections of this guide, particularly Section 4.3. Environmental goals of a given project should be clearly communicated to all stakeholders as the project proceeds from planning to design to construction and eventually to operation. Some of the goals will be short-term, intended to preserve resources through the disruption created by construction. Others will be longer-term, such as pygmy owl corridor enhancement, and will need long-term follow-up monitoring to assess effectiveness.

The Design Team has the primary responsibility of developing assessment programs for ESR projects, even though the team will not typically be engaged by Pima County post-construction. The design of monitoring programs should be scientifically valid, with adequate frequency of measurements, and should be consistently applied to as many projects as possible to build a significant base of assessment data as quickly as possible. These assessment programs should be designed to be carried out by Pima County's existing operations and resource management personnel, so that the cost of collecting follow-up data does not adversely affect the ability to implement the programs.

Once the feedback information has begun to flow through to Pima County, a structure is needed to receive and analyze that information. A standing staff committee, with appropriate consultant support, should be formed and tasked with managing this important monitoring of data. On a regular basis, the committee should review the information that has been gathered and assess the success of the mitigation plans that were initially created for the individual projects under review. The committee should, when possible, contact the original authors of the project's environmental goals and follow-up programs to receive their input. Finally, evaluating the effectiveness of the mitigation plans and implementing suitable actions should close the feedback loop. Possible actions could include further treatments/mitigation measures, abandonment of efforts, direction to ongoing Design Team, and modification of monitoring schemes.

APPENDIX 4-A
Chapter 4 References

Note: These documents are revised periodically; therefore users should double check that they have the specific version of the document specified in this chapter, or, if the reference is undated, that they have the most recent version.

- American Association of State Highway and Transportation Officials. 2001. *A Policy on Geometric Design of Highways and Streets*.
- ———. 2002. *Roadside Design Guide*.
- American Society of Landscape Architects. 1979 . *Visual Impact Assessment for Highway Projects*. Washington, D.C.: U.S. Department of Transportation, Federal Highway Administration.
- Bonham, C. D. 1989. *Measurements for Terrestrial Vegetation*. John Wiley & Sons, Inc.
- Hornbeck, L.H. and Okerlund Jr., G.A. 1971. *Visual Values for the Highway User*. Washington, D.C.: U.S. Department of Transportation, Federal Highway Administration.
- U.S. Department of Agriculture. U.S. Forest Service. 1974. *National Forest Landscape Management*, Vol. 2, Chapter 1. Handbook Number 462.
- ———. 1977. *National Forest Landscape Management*. Vol. 2, Chap. 4, "Roads." Handbook Number 483.
- ———. 1995. *Landscape Aesthetics, A Handbook for Scenery Management*. Handbook
- ———. 1995. *Visual Prioritization Process, User's Manual.* Prepared for the U.S. Department of Transportation, Federal Highway Administration.
- U.S. Department of Interior, Bureau of Land Management. 1984. *Visual Resource Management System.* Manuals 8410 and 8431.

APPENDIX 4-B
Websites

1. Arizona Department of Transportation cultural resource program with additional links: http://www.dot.state.az.us/ABOUT/envplan/cultural.html#environmental

2. Arizona State Historic Preservation Office and its programs: http://www.pr.state.az.us/partnerships/shpo/shpo.html

3. Arizona State Museum: http://www.statemuseum.arizona.edu

4. Pima County:

   Website MapGuide for information on Biological Core, Multi-Use or Recovery Area, Important Riparian Area, Agriculture within Recovery Area, Existing Development, Scientific Research Area, and Archaeological Sensitivity Zone: http://www.dot.co.pima.az.us/gis/maps/mapguide/mgmap.cfm?path=/cmo/sdcpmaps/sdcp.mwf

   Pima County Major Street and Scenic Routes Plan

   http://www.dot.co.pima.az.us/gis/maps/majscenic/MSSRc02_01.pdf

   Title 16 Floodplain and Erosion Hazard Management Watercourses
   http://www.dot.co.pima.az.us/flood/riparian

5. National Register of Historic Places, maintained by the National Park Service, including properties listed in Pima County: http://www.cr.nps.gov/nr/

6. Southern Arizona Division of the State Historical Society: http://www.arizonahistoricalsociety.org/

7. U. S. Fish and Wildlife Service:
   Special Status Species: http://arizonaes.fws.gov
   Conservation Banks: http://sacramento.fws.gov/es/cons_bank.htm

8. Wildlife Crossing Information
   Proceedings of the International Conference on Ecology and Transportation 2001: http://itre.ncsu.edu/cte/ICOET/ICOET2001.html

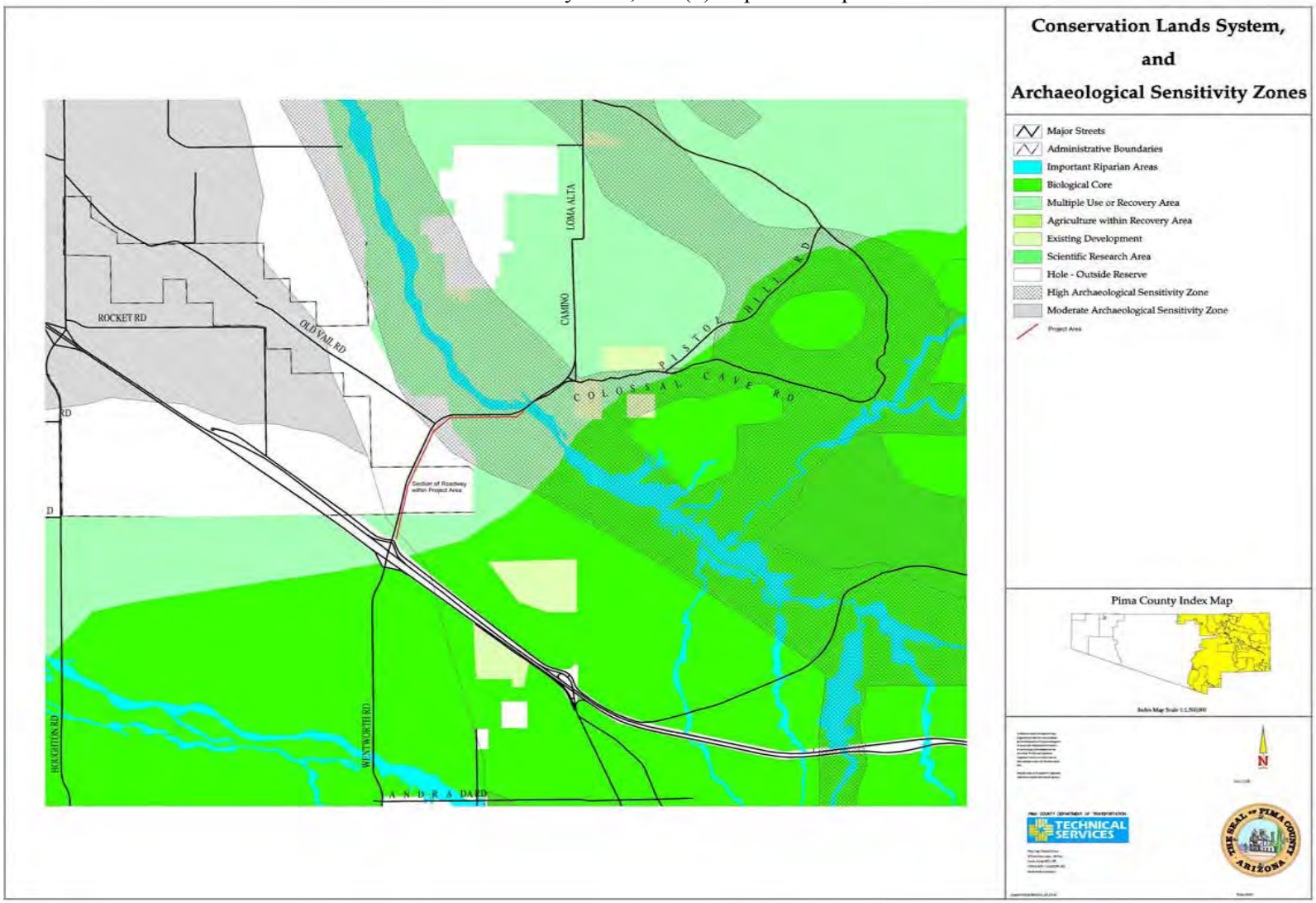
   The Humane Society: http://www.hsus.org/ace/13409

   The Defenders of Wildlife; Habitat and Highways Campaign: http://www.defenders.org/habitat/highways/

   Federal Highway Administration; Critter Crossings
   http://www.fhwa.dot.gov/environment/wildlifecrossings/

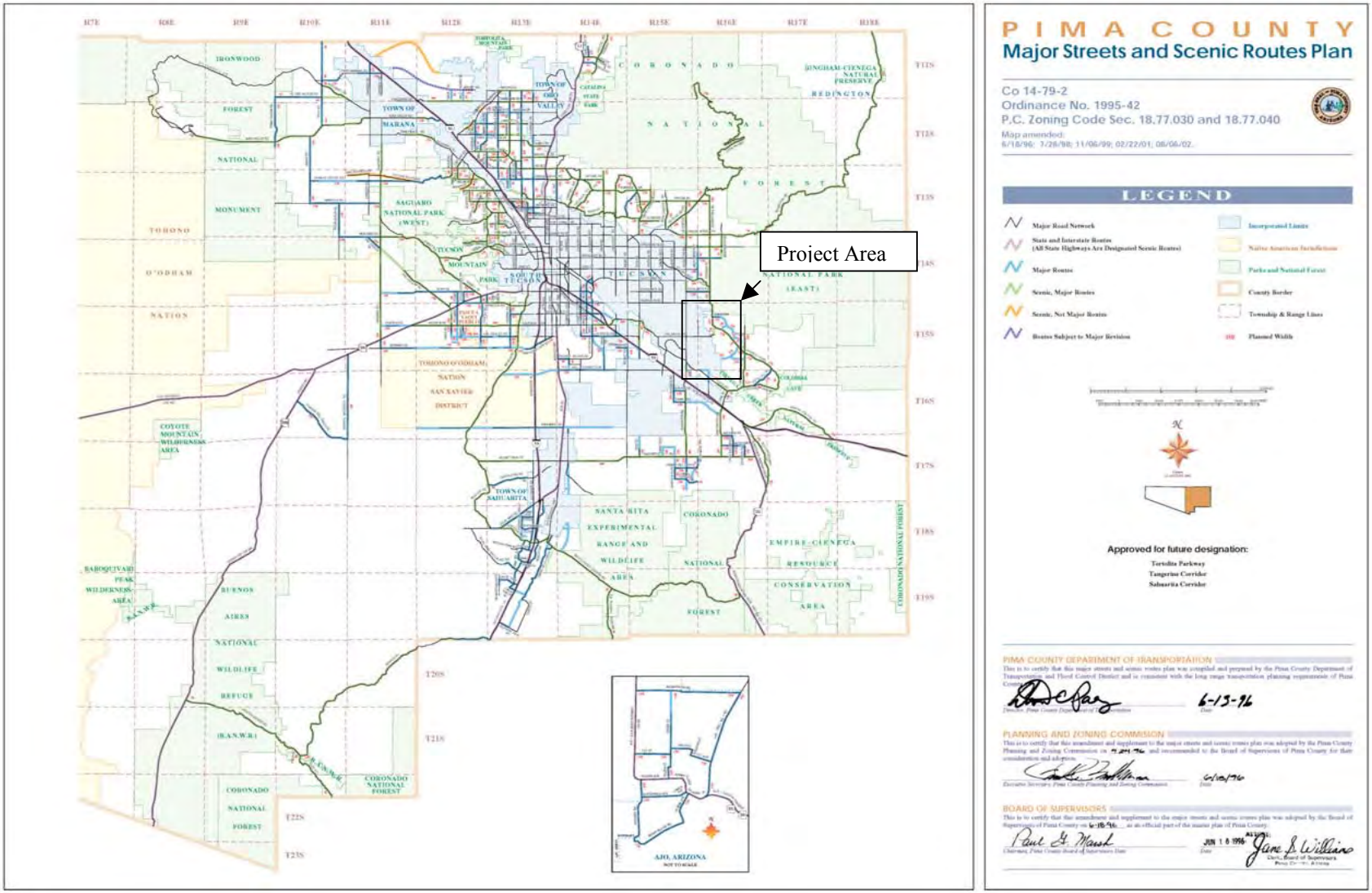
APPENDIX 4-C
Sample ESR Project Maps

Map 1: The example project area, shown in red, clearly involves three ESR criteria: (1) High Archaeological Sensitivity Zone, (2) Multiple Use or Recovery Area, and (3) Important Riparian Area.



APPENDIX 4-C, continued

Map 2: The Pima County Major Streets and Scenic Routes Plan indicates that the project area also meets the ESR criteria of being a designated Major Scenic Route.



APPENDIX 4-D
Vegetation Measurement

As part of the biological resource identification process, the vegetation of the project area should be accurately characterized so that appropriate re-vegetation can occur upon completion. The goal is to recreate the entire pre-project vegetation community as closely as possible. The current Pima County Native Plant Preservation Ordinance (NPPO) will not accomplish this because not all plants on a site are protected by the NPPO. Also, in some instances the area has been degraded prior to the start of the project, leaving no vegetation framework to adequately determine how to re-vegetate the area. The following methods utilize species diversity and density measures to accomplish the goal of vegetation re-creation.

Species diversity requires the identification of all species present in the project area. ***Density*** refers to the actual number of plants per a given area.

Steps in Measurement Process

Measuring vegetation is a two-step process as described below.

<u>Step 1: Inventory of Protected Plant Species</u>

Complete an inventory of all saguaros and Pima County protected tree species. Saguaros and protected trees should be assess for viability and transplantability as well as documenting size and location (in a manner similar to the Native Plant Preservation inventory requirements.) The diameter of all protected trees (including non-viable individuals) is measured with a forestry caliper (at 24 inches from the ground), and all trees greater than or equal to 3 inches are to be inventoried. For trees that have multiple stems at the point of caliper measure, the largest 3 stems are measured, and the individual is included in the inventory if the sum is greater than 3 inches. The diameter measurements are totaled for each protected species.

Mitigation of trees shall be based upon total caliper inch for each species and the existing densities as determined by the Releve Method or other approved methods (see Step 2 below). Mitigation for each species shall be calculated by multiplying 125% of the sum caliper inch by the percentage of the site that is disturbed outside of the development envelope. Replanting density must match pre-project conditions as closely as possible. The final caliper inch value is to be distributed into appropriately sized trees. For example, if the pre-project site contained ten (10) mesquite trees, all over 10 inches in diameter, it is not appropriate to replant using a larger number of smaller trees to attain the appropriate caliper inch value.

Example

- 100 caliper inch of palo verde
- 10-acre site where 25% remains disturbed outside of the development envelope, i.e., 2.5 acres of plantable area remains

Result: 100 cal inch x 25% x 125% = 31.25 cal inches that must be replaced in the 2.5 acres

Mitigation of saguaros will be 1:1. Preserve in place as many saguaros and other cactus as possible. Only those saguaros 10 feet high and under that are assessed as being viable and transplantable should be considered for salvaging. Replacement saguaros shall be in the 4 to 6 foot range. Special consideration shall be given to individual specimen species.

The Releve Method will be used to determine the seed mix, and assist the landscape designer in determining the appropriate number of other cactus and non-protected tree and shrub species that will be appropriate in the landscaping in the various vegetation entities.

Cactus not required for the revegetation should be offered to neighbors or non-profit succulent or plant organizations. Permits will be required from the Arizona Department of Agriculture for transplanting cactus protected by the Arizona Native Plant Law.

Step 2: Determine Seed Mix and Re-Planting Densities

The **Releve Method** is a widely recognized technique that vegetation ecologists use to sample an area for such variables as species diversity, cover, density, and abundance (Bonham 1989). This technique uses circular plots (releves) to obtain the information necessary to assess a vegetation community to develop appropriate re-seeding and re-vegetation parameters. The method will be employed to produce two types of information that will be used for two purposes: (1) to determine a seed mix and (2) to determine the re-planting density of Pima County protected cactus and shrub species.

This method should be applied in the spring and fall to most accurately measure the annual/ephemeral flora. If the area to be re-seeded is degraded prior to the project, this method should be applied to a nearby site with undisturbed vegetation and similar topography. Density measurements will be used to determine appropriate numbers for the re-planting of all Pima County protected cactus and shrub species.

It is crucial that the personnel conducting this method are highly skilled in plant identification, including ephemeral/annual species.

Following are the steps in the Releve Method, as modified for application to transportation construction projects:

a. **Entitation.** Once the project area is defined, field personnel visually assess how many *vegetation entities* (discrete assemblages of species) are represented. If the area is relatively homogenous, with the same assemblage of species represented throughout, then there is only one (1) entity to be sampled. In many instances, however, there will be two (2) or more discrete species assemblages. In the Sonoran Desert, a common example is an upland community with a wash running though it. The wash may contain an assemblage of species distinct from the surrounding uplands.

b. **Establishment of Plots.** Each entity will be sampled with random circular plots (releves). The appropriate number and size of these plots will depend upon the size and diversity of the project area. The larger and/or more diverse an entity is, the more and/or larger plots are

required to accurately sample the area. In a typical Arizona Uplands community in Pima County, a general rule of thumb would be a minimum of four (4) 20-foot radius plots per acre for small projects. A project area should have a minimum of five (5) plots, regardless of size.

The locations of plots must be established *randomly*. The investigator should not *choose* where to establish plots (for example, in a location convenient to the desired outcome). Instead, locations must be chosen in an unbiased fashion. Here are several approaches to accomplishing this task:

- Entities can be defined on a topographic map of the project area in the field, and then transferred to a mapping program such as Arc View. A common feature of mapping software is a random-point generator. The investigator can ask the program to randomly distribute a given number of points onto the map, and obtain Global Positioning System coordinates for those points. It is then possible to navigate to those exact coordinates in the field to set up the releves.
- Releves can be located across a project area in a systematic way by applying a grid overlay. Releves can then be located at regular intervals (for example, every 500 meters). An advantage of this method is the ability to easily add more points if necessary by adding to the grid.

c. **Data Collection.** Once at a random plot location, the center of the plot and plot boundaries are temporarily defined with flagging. Every species of plant is identified and individuals of the species are counted, including ephemeral/annual species. Unknown plants are collected and brought to the University of Arizona Herbarium or to a qualified botanist for positive identification.

Field personnel also record species present in the area that are not captured by the releves. These plants are listed in parentheses. If the releves are not capturing species that appear to be dominant in the landscape, then additional and/or larger releves are required.

Applying the Releve Method to ESR Projects

<u>Using the Releve Method to Determine Replanting Densities</u>

Once the releves have been completed, a master list of all species with density values is produced *for each entity sampled*. For each entity, density values are individually averaged for all species. The average values are used to determine the appropriate replanting densities per acre for tree, shrub and cactus species. Some of these values may not be used in the final landscaping plan because the Tree Caliper Measurement Method and saguaro replanting requirements will be used to determine replanting densities for species that were inventories The species list should be evaluated to exclude invasive.

See Table 1 for an example.

Using the Releve Method to Determine Seed Mix Composition

The master list is evaluated to exclude invasive or non-native species. Next, each species is evaluated for availability of seed; if there is no seed source available, then those species are omitted from consideration in the seed mix. In many cases, a particular species will be recorded as present in the area, but absent from the actual releve (indicated by parentheses). These plants are considered for inclusion in the seed mix at low levels.

The density values for all species to be included in the seed mix are totaled. In addition, most cactus species (except saguaro) are excluded because the seeds are not commercially available and live plants will be included in the replanting. The mean for each species is then divided by the total number of plants to arrive at a seed mix percentage value. These values are then adjusted for availability and size through consultation with seed experts. These values will be the basis for the finalized seed mix. It may become necessary to adjust the PLS/acre or species composition because of changes in seed availability. Table 1 is a spreadsheet that presents hypothetical releve data, including all plant species present, density values, and conversion to seed mix percentages.

In order for this process to be effective, it is imperative to contract seed suppliers ***as early as possible in order to ensure availability, especially because many of the species included are not generally collected because of lack of demand.***

Table 1. Hypothetical Releve Analysis. In this example, all large shrubs, trees, subshrubs, forbs, and grasses have been included in the seed mix (except for the invasive grass species *Pennisetum ciliare*). Re-planting densities were calculated for cactus species.

	Density (plants per 20 ft releve, 0.028 acre)					**Average (per 20 ft releve, 0.028 acre)**	% of seed mix	**Average (per 20 ft releve, 0.028 acre)**	re-planting density (per acre)
	Releve 1	**Releve 2**	**Releve 3**	**Releve 4**	**Releve 5**				
Large Shrubs and Trees									
Acacia constricta	1	0	3	1	3	**1.6**	**1.5**		
Fouquieria splendens	3	0	2	0	1	**1.2**	**1**		
Larrea tridentata	6	2	4	3	5	**4**	**3.6**		
Parkinsonia microphylla	0	0	2	4	0	**1.2**	**1**		
Prosopis velutina	0	1	2	1	0	**0.8**	**0.8**		
Cacti									
Carnegiea gigantea	0	2	0	1	0			**0.6**	**21.4**
Echinocereus fasciculatus	3	2	0	6	1			**2.4**	**85.7**
Ferocactus wislizeni	0	1	2	1	1			**1**	**35.7**
Mammillaria grahamii	4	5	8	0	5			**4.4**	**157**
Opuntia engelmanii	1	2	1	0	1			**1**	**35.7**
Opuntia versicolor	0	1	1	0	0			**0.4**	**14.2**
Subshrubs, Forbs, and Grasses									
Abutilon incanum	0	1	4	0	3	**1.6**	**1.5**		
Ambrosia deltoidea	23	15	19	24	4	**17**	**15.5**		
Bouteloua aristidoides	4	6	9	5	1	**5**	**4.5**		
Encelia farinosa	9	17	2	8	6	**8.4**	**7.6**		
Erioneuron pulchellum	55	42	30	24	10	**32.2**	**29.3**		
Lesquerella gordonii	0	11	4	8	0	**4.6**	**4.1**		
Muhlenbergia porteri	5	1	7	4	0	**3.4**	**3**		
Pennisetum ciliare	1	0	0	1	3	**0**			
Psilostrophe cooperi	2	4	6	4	0	**3.2**	**3**		
Senna covesii	1	6	4	9	0	**4**	**3.6**		
Zinnia acerosa	16	22	16	30	24	**21.6**	**20**		
					total	**109.8**	**100%**		

APPENDIX 4-E
Pima County Approved Plant Species for Environmentally Sensitive Roadways

Trees		Minimum Size
Arizona (Velvet) Ash	*Fraxinus velutina*	15 gal.
Arizona Sycamore	*Platanus wrightii*	15 gal.
Arizona Walnut	*Juglans major*	15 gal.
Arizona White Oak	*Quercus arizonica*	24" box
Blue Palo Verde	*P. florida*	15 gal.
Desert (Sweet) Acacia	*Acacia smallii*	15 gal.
Desert Willow	*Chilopsis linearis*	15 gal.
Foothill Palo Verde	*Parkinsonia microphylla*	24" box
Fremont Cottonwood	*Populus fremontii*	15 gal.
Goodding Willow	*Salix gooddingii*	15 gal.
Ironwood	*Olneya tesota*	24" box
Mesquite	*Prosopis velutina*	15 gal.
Mexican Blue Oak	*Quercus oblongifolia*	24" box
Mexican Elder	*Sambucus mexicana*	15 gal.
Net Leaf Hackberry	*Celtis reticulata*	15 gal.
Texas Mulberry	*Morus microphylla*	15 gal.
Western Soapberry	*Sapindus saponaria*	15 gal.

Shrubs and Subshrubs		Minimum Size
All Scale	*Atriplex polycarpa*	5 gal.
Arizona Rosewood	*Vauquelinia californica*	15 gal.
California Buckwheat	*Eriogonum fasciculatum*	1 gal.
Catclaw Acacia	*Acacia greggii*	5 gal.
Creosote Bush	*Larrea tridentata*	5 gal.
Desert Fern	*Lysiloma microphylla*	15 gal
Desert Hackberry	*Celtis pallida*	5 gal.
Desert Senna	*Senna covesii*	1 gal.
Fairy Duster	*Calliandra eriophylla*	5 gal.
Four-wing Saltbush	*Atriplex canescens*	5 gal.
Indigo-bush	*Dalea greggii*	5 gal.
Long-leaved Joint Fir	*Ephedra trifurca*	5 gal.
Mimosa	*Mimosa dysocarpa*	5 gal.
New Mexico Locust	*Robinia neomexicana*	5 gal.
Red Barberry	*Berberis haematocarpa*	5 gal.
Shrub Live Oak	*Quercus turbinella*	15 gal.
Wait-a-minute Bush	*Mimosa biuncifera*	5 gal.
Whitethorn Acacia	*Acacia constricta*	5 gal.

Shrubs and Subshrubs - *continued*		**Minimum Size**
Brittlebush	*Encelia farinosa*	5 gal.
California Buck-thorn	*Rhamnus californica*	5 gal.
Chuperosa	*Beloperone californica*	5 gal.
Desert Honeysuckle	*Anisacanthus thurberi*	5 gal.
Desert Lavender	*Hyptis emoryi*	1 gal.
Desert Olive	*Forestiera neomexicana*	5 gal.
Desert Zinnia	*Zinnia acerosa*	1 gal.
Golden Eye	*Viguiera deltoidea*	1 gal.
Gray-thorn, Gray-leaved Abrojo	*Zizyphus obtusifolia*	5 gal.
Hop Bush	*Dodonea viscosa*	5 gal.
Jojoba	*Simmondsia chinensis*	5 gal.
Limber Bush	*Jatropha cardiophylla*	1 gal.
Mexican Manzanita	*Arctostaphylos pungens*	5 gal.
Ocotillo	*Fouquieria splendens*	8 cane
Paper Flower	*Psilostrophe cooperi*	1 gal.
Rayless Encelia	*Encelia frutescens*	5 gal.
Rock Sage	*Salvia pinguifolia*	5 gal.
Seep Willow	*Baccharis glutinosa*	5 gal.
Silk Tassel	*Garrya wrightii*	5 gal.
Squaw Bush	*Rhus trilobata*	5 gal.
Squaw Bush	*Condalia warnockii*	5 gal.
Sugar Sumac	*Rhus ovata*	5 gal.
Triangle-leaf Bursage	*Ambrosia deltoidea*	1 gal.
Trumpet Flower	*Tecoma stans*	5 gal.
Turpentine Bush	*Ericameria laricifolia*	1 gal.
White bursage	*Ambrosia dumosa*	1 gal.
White-stemmed Milkweed	*Asclepias albicans*	5 gal.

Cacti and Other Succulents		
Banana Yucca	*Yucca baccata*	5 gal.
Barrel Cactus	*Ferocactus wislizenii*	6”
Barrel Cactus	*Ferocactus covillei*	6”
Bigelow Nolina	*Nolina bigelovii*	5 gal.
Buckhorn Cholla	*Opuntia acanthocarpa*	2’
Cane Cholla	*Opuntia spinosior*	2’
Chain-fruit Cholla	*Opuntia fulgida*	2’
Desert Night-blooming Cactus	*Peniocereus greggii*	5 gal.
Desert Spoon	*Dasylirion wheeleri*	5 gal.
Engelmann Prickly Pear	*Opuntia engelmannii*	5 pad
Golden-flowered Agave	*Agave chrysantha*	5 gal.

Cacti and Other Succulents - *continued*		**Minimum Size**
Hedgehog Cactus	*Echinocereus engelmannii*	1 gal.
Hedgehog Cactus	*Echinocereus fasciculatus*	1 gal.
Palmer Agave	*Agave palmeri*	5 gal.
Pincushion Cactus	*Mammillaria microcarpa*	1 gal.
Purple Prickly Pear	*Opuntia violacea*	5 pad
Saguaro	*Carnegiea gigantea*	4’
Soaptree Yucca	*Yucca elata*	5 gal.
Staghorn Cholla	*Opuntia versicolor*	2’
Teddy Bear Cactus	*Opuntia bigelovii*	2’

Herbs		**Lbs./Acre**
Adonis Blazing Star	*Mentzelia multiflora*	1
American Carrot	*Daucus pusillus*	1
Arizona Lupine	*Lupinus arizonicus*	1
Bluedicks	*Dichelostemma pulchellum*	1
Desert Lupine	*Lupinus sparsiflorus*	1
Desert Mallow	*Sphaeralcea ambigua*	1
Desert Mariposa	*Calochortus kennedyi*	1
Eriastrum	*Eriastrum diffusum*	1
Four O’ Clock	*Mirabilis bigelovii*	1
Gordon Bladderpod	*Lesquerella gordoni*	1
Indian Root	*Aristolochia watsoni*	1
Lance-leaved Ditaxis	*Ditaxis lanceolata*	1
Large Yellow Evening Primrose	*Oenothera primiveris*	1
Larkspur	*Delphinium scaposum*	1
Lizard Tail	*Gaura parviflora*	1
Long-capsuled Primrose	*Camissonia chamaeneroides*	1
Mexican Gold Poppy	*Eschscholtzia mexicana*	1
Orange Caltrop	*Kallstroemia grandiflora*	1
Prickly Poppy	*Argemone* sp.	1
Rock Gilia	*Gilia scopulorum*	1
Sand Verbena	*Abronia* sp.	1
Small-flowered Blazing Star	*Mentzelia albicaulis*	1
Spiderling	*Boerhaavia* sp.	1
Trailing Four O’ Clock	*Allionia incarnata*	1
Twist Flower	*Streptanthus arizonicus*	1
Virgin’s Bower	*Clematis drummondii*	1
White Desert Primrose	*Oenothera caespitosa*	1
White Prairie Clover	*Petalostemum candidum*	1

Herbs - *continued*		**Lbs./Acre**
Bigelow Linanthus	*Linanthus bigelovii*	1
Chia	*Salvia columbariae*	1
Common Horehound	*Marrubium vulgare*	1
Desert Bell	*Phacelia campanularia*	1
Desert Tobacco	*Nicotiana trigonophylla*	1
Goodding Verbena	*Verbena gooddingii*	1
Nama	*Nama demissum*	1
New Mexico Verbena	*Verbena neomexicana*	
Owl Clover	*Orthocarpus purpurascens*	1
Paintbrush	*Castilleja* sp.	1
Scorpionweed	*Phacelia crenulata*	1

Grasses and Grasslike Plants		
Alkali Sacaton	*Sporobolus airoides*	2
Arizona Cotton-top	*Digitaria californica*	1
Big Galleta	*Hilaria rigida*	3
Blue Grama	*Bouteloua gracilis*	2
Bluebunch Wheatgrass	*Agropyron spicatum*	2
Bush Muhly	*Muhlenbergia porteri*	2
Deer Grass	*Muhlenbergia rigens*	1
Feather Fingergrass	*Chloris virgata*	2
Hairy Grama	*Bouteloua hirsuta*	1
Needle and Thread Grass	*Stipa comata*	2
New Mexico Feathergrass	*Stipa neomexicana*	1
Purple Threeawn	*Aristida purpurea*	2
Red Threeawn	*Aristida longiseta*	2
Sand Dropseed	*Sporobolus cryptandrus*	3
Sideoats Grama	*Bouteloua curtipendula*	2
Slim Tridens	*Tridens muticus*	2
Southern Cattail	*Typha domingensis*	2
Spider Grass	*Aristida ternipes*	1
Spike Dropseed	*Sporobolus contractus*	2
Tanglehead	*Heteropogon contortus*	2
Three-square Bulrush	*Scirpus americanus*	1
Tobosa Grass	*Hilaria mutica*	2
Western Wheatgrass	*Agropyron smithii*	3

Inappropriate Species. ***DO NOT USE THE FOLLOWING PLANTS.***	
Buffle Grass	*Pennisetum ciliare*
Downy Chess	*Bromus tectorum*
Fountain Grass	*Pennisetum setaceum*
Giant Reed	*Arundo donax*
Red Brome	*Bromus rubens*
Mediterranean/Arabian Grass	*Schismus* sp.
Wild Oat	*Avena* sp.

APPENDIX 4-F
Landscaping Guidelines

A. Plant Materials

- Comply with approved plant list with minimum allowed sizes (see Appendix 4-D)
- Encourage contract growing for plant species currently unavailable
- Plant material to be grown and stockpiled by Pima County

B. Planting Guidelines (Native Plants)

- Planting pit should be five (5) times *wider* than rootball, but no *deeper* than rootball
- Planting pit should have minimum drainage of 6 inches of water in one-half hour
- Four (4) vertical cuts about ¼ inch deep should be made 4 (four) times around rootball and twice on bottom
- Top of rootball should be level or slightly above soil surface
- Planting pit should be backfilled with approved backfill mix. Water should be allowed to settle (do not pack)
- After water is absorbed and soil settled, remainder of pit should be filled with backfill mix and lightly tamped to grade
- Do not prune unnecessarily. Pruning should be done immediately after planting. Up to 1/3 of growth should be removed, including all deadwood, sucker growth, and bruised and broken branches

Hydromulching

- Seed should be fresh, clean, and latest season's crop
- Seed rates are expressed as pounds of pure live seed per acre
- Fertilizer should be commercially produced with a guaranteed analysis of 16-20-0, ammonium phosphate
- Fiber should be virgin wood cellulose fiber with no growth or germination inhibiting factors. Ph range should be between 4.5 and 6.5
- Tackifier should be plantago organic muciloid tackifier, which is an organic muciloid liquid concentrate diluted with water and containing no agents toxic to seed germination
- Soil sulfur should be agriculture grade, 99.5 % sulfur
- Soil should be tilled to a depth of 6 inches
- All weeds and other undesirable vegetation should be uprooted
- Seedbed should be watered to a depth of at least 4 inches immediately after seeding. Water should be applied at such a rate as to prevent puddling or erosion.

Site Soil

- Topsoil and backfill should be native unamended soil, free of objectionable material and toxins harmful to plant growth
- Ph should range between 6.5 and 8.0
- Soil should be screened to pass through a 3/8 inch sieve

C. Irrigation

The purpose of irrigation zoning is to:

- Create irrigation zones based on specific water needs of plant materials
- Conserve water
- Create healthier growing environments
- Achieve higher success rates in plant longevity
- Provide more efficient long-term maintenance

Irrigation components should be standardized for ease of maintenance as follows:

- PVC in right-of-way, no drip polyline
- Low flow bubblers on trees
- Drip on shrubs/groundcover with multiport emitters
- Spray on hydroseed

APPENDIX 4-G
Visual and Aesthetic Resource Evaluation Process

The procedures outlined in this appendix include detailed and specific techniques for characterizing and evaluating visual and aesthetic resources. The implementation of specific procedures and the level of detail associated with this evaluation process should be determined on a case-by-case basis, and applied accordingly as determined in Step 1 below. Specific evaluation tables that have been included as a part of this process are presented as examples (including ratings). Such tables should be used as necessary and modified according to specific conditions.

Steps in Process

Step 1: Discovery/Identification of Visual and Aesthetic Resources

The first step in the Visual and Aesthetic Resource Evaluation (see Figure 4-6 of Chapter) includes a field review by the study team resulting in the identification and inventory of the visual elements associated with (1) viewers from and to the roadway area, (2) the setting of the project, and (3) elements of the project that will result in a change to the setting. The intent of this step is to initially characterize the visual resources, to identify those elements of the project that may have an effect on these resources, and to determine the potential level of analysis and treatment required for the project. Also during this step any specific visual practices and standards of agencies that have jurisdiction in the project area should be identified (e.g., FHWA, U.S. Forest Service, Bureau of Land Management).

Viewers

From the Roadway – Viewers from the roadway include roadway users (i.e., motorists and bicyclists), as well as viewers at special viewpoints associated with the roadway (e.g., trailheads, scenic overlooks, rest areas). When identifying roadway viewers, both directions of traffic should be considered in the evaluation. In situations where additional sidewalks or pathways are a part of the project, the associated views should also be considered.

To the Roadway – Viewers to the roadway include roadway "neighbors," who may consist of users of adjacent residences, businesses, and industrial and recreational facilities.

Setting

Landscape settings of proposed roadway projects may be natural or developed. Natural settings are those that consist of landform, vegetation, and/or water elements, and that demonstrate little if any man-made modifications or disturbance. (Natural settings may include ranching and grazing lands if they do not dominate or detract from natural conditions, i.e., over-grazing.) Developed settings include those areas in which residential, commercial, industrial, recreational, or agricultural uses (e.g., cotton fields, orchards) have been established.

Project Description

To evaluate the effects of a proposed roadway project on the setting and views from and to the roadway, project design features should be well defined. For example, projects may entail (a) the development of a new road requiring the removal of vegetation within an entire corridor area and the modification of landform through grading (cut and fill slopes), (b) only the widening of an existing roadway, resulting in selective vegetation clearing, and the use of retaining walls, or (c) only the addition of small project features to address very localized issues (e.g., barriers, landscaping guard rails, lighting, signage).

Step 2: Visual Analysis

The visual analysis begins with identifying initial visual impacts, which are based on the effects of the proposed project on the setting and views from and to the roadway and contrasted with the existing views from and to the roadway.

Viewers

The analysis of project effects on potential viewers includes the sensitivity of users with views from and to the project from key observation points, the viewing conditions, and any variables associated with those views. Collectively, this information is used to determine the overall visibility levels (high, moderate, or low) of users with views from and to the roadway.

Viewer Sensitivity – Viewer sensitivity measures peoples' concern for change in scenic quality or the image of a particular setting in which a roadway is being developed, modified, or improved. Criteria for the identification of viewer sensitivity include user type (e.g., transportation, residential, recreational); user volume (high, moderate, or low); public interest (national, state, or local); and association with special areas or unique viewer expectations (e.g., scenic highways, special recreational, historic areas). Table 1 shows how these criteria may be used to identify sensitivity levels (high, moderate, or low).

Viewing Conditions – Viewing conditions are defined by a set of viewer variable criteria that assists in characterizing views from and to the roadway with the project in place. Table 2 illustrates three possible condition levels (high, medium, low) associated with the following viewer variable criteria:

- Viewer Orientation, including parallel versus perpendicular views from the road
- Duration of View, including consideration for roadway speed limit
- View Distance, near foreground to background
- Visibility/Edge Condition, open, filtered or screened

Visibility Level Synthesis – Using the criteria presented in Tables 1 and 2, a synthesis of overall visibility levels is assigned to segments of the road characterizing views from and to the roadway area, as well as from specific viewing locations associated with the roadway (e.g., overlooks and trailheads). Table 3 presents a sample visual level synthesis.

Table 1
Sample Sensitivity Level Evaluation

Location (Key Observation Points)	**User Type**[1]	**Use Volume**	**Public Interest**[2]	**Special Areas**	**Sensitivity Level**
Travel Routes/Trails					
U.S. Highway 17	Res, Rec, SS	High	N,S,L	–	High
Lower Bushcreek Road	Res, Rec, SS	High	N,S,L	Planned Scenic Byway	High
Big Canyon Road	Rec, SS	High	N,S,L	Planned National Recreation Area	High
County Road 1 (Historic Tour)	Res, Rec, SS	High	N,S,L	Bar "S" Historic Ranch	High
Use Areas					
Sonoran Monument	Rec, SS	High	N,S,L	–	High
USFS Campgrounds					High
Big Mountain	Rec, SS	Moderate	N,S,L	–	
Green Meadows	Rec, SS	Moderate	N,S,L	–	
Creekside Campground	Rec, SS	Moderate	N,S,L	–	
Red Mountain Campground	Rec, SS	Moderate	N,S,L	–	
Travel Routes/Trails					
Cedar/Trail Creek Road	Res, Rec, SS	Moderate	S,L	–	Moderate
Lower Wildflower Road	Res, Rec, SS	Moderate	L	–	Moderate
Wildhorn Road	Res, Rec, SS	Moderate	L	–	Moderate
Fox Flats Road	Comm	Moderate	S????, L	–	Moderate
Arizona Gulch Road	Res, Rec, SS	Moderate	L	–	Moderate
Divide Road N. (County 2)	Res, Rec, SS	Moderate	L	–	Moderate
Travel Routes/Use Areas					
Highline Business Park	Comm	Moderate	L	Industrial Area	Low
Business Loop 156	Truck route	High	L	Light Industrial Area	Low

[1]*Residential (Res), Recreation (Rec), Sight Seeing (SS), Commuters (Comm)*
[2]*National (N), State (S), Local (L)*

Table 2
Sample Viewing Condition Evaluation

Viewer Variable Criteria	Viewing Condition Level		
	High	**Moderate**	**Low**
Viewer Orientation – perpendicular vs. parallel views	Viewer attracted, or directed specifically to or from the proposed roadway action	Viewer is neither strongly attracted/directed toward nor away from the location of the proposed roadway action	Viewer attracted or directed away from the location of the proposed roadway action
Duration – considers speed of travel	View is continual or fixed (e.g., residential areas, resorts)	View is intermediate or temporal (e.g., roads and highways, parks, overlooks, campgrounds, commercial areas)	View is brief (e.g., perpendicular road crossings)
Distance – views from and to the roadway	Views from or to the roadway are within the near foreground area (immediate right-of-way), and the foreground area (edge of right-of-way to 0.25 mile)	Views from or to the roadway are within the middle-ground area (0.25 to 3 miles)	Views from or to the roadway are within the background area (3 to 5 miles and beyond)
Visibility – the "edge condition" of the roadway	Views from or to the roadway are open	Views from or to the roadway are partially screened or filtered	Views from or to the roadway are screened or blocked

Table 3
Sample Visibility Level Synthesis

	Viewer Variables		
Location *(Key Observation Point)*	**Sensitivity Level**	**Viewer Orientation**	**Distance**
Wildhorn Road	M	M	L
Sonoran Monument	H	M	H

Setting

Analysis of the project setting includes the characterization of similar patterns of landform, vegetation, land use, and unique features by units. Characterizing these factors permits an evaluation of the potential effect of the proposed roadway project in conjunction with scenic quality (i.e., natural setting), or visual image types (i.e., developed settings).

Natural Setting – Natural landscapes or settings may be characterized in units based on similar patterns of the following elements:

- *Landform*: Topography becomes more interesting as it gets steeper, more massive, or more severely or universally sculpted. Outstanding landforms may be monumental (mountains) or subtle, including low rolling hills or flat valley bottoms, displaying few, if any, interesting landscape features.

- *Vegetation*: Plant life is considered in terms of the variety of patterns, forms, and textures it creates, including short-lived displays when they are known to be recurring or spectacular. Consideration may also be given to smaller scale vegetation features that add striking and intriguing detail elements to the landscape (e.g., Joshua trees, saguaro cactus, ponderosa pine).
- *Water*: Water adds movement or serenity to a scene. The degree to which water dominates the scene may often be the primary consideration in selecting a scenic quality rating (particularly in Arizona).
- *Color*: Overall color(s) of the basic components of the landscape (e.g., soil, rock, vegetation) as they appear during seasons or periods of high use is considered.
- *Scarcity:* Scarcity provides an opportunity to give added importance to one or all of the scenic features that appear to be relatively unique or rare within the region of the proposed roadway project.
- *Cultural Modifications:* Cultural modifications to the landform/water and vegetation and in the addition of structures should be considered for possible enhancement of or detraction from the scenery in a natural setting. Such modifications may complement or improve the scenic quality of a unit or, conversely, may become a negative intrusion and detract from the scenery in a natural setting. Ranching activities, hacienda, and historic settings should all be considered.

The six natural setting elements above are combined (i.e., added) to determine the overall scenic quality of the natural setting as illustrated in Table 5. Three potential ranges of scenic quality are used to express the landscape scenic value of each unit within the context of views from and to the road in a natural setting:

- *Distinctive Scenic Quality:* These units are natural areas containing the greatest diversity of features such as landform, vegetative patterns, water forms, and rock formations that are of an unusual or outstanding visual quality not common in the surrounding area.
- *Common Scenic Quality:* These units are natural areas containing features with a variety of landforms and vegetative patterns that tend to be common throughout the surrounding area and are not outstanding in visual quality.
- *Minimal Scenic Quality:* These units are natural areas characterized by little or no variety of landform and vegetation, and may include specific locations that have been culturally modified in a negative fashion.

It is important to note that the terms used to define the range of scenic quality may need to be modified for public outreach since, for example, an individual living in an area of "minimal scenic quality" may not consider it to be minimal.

Developed Settings – The visual image of developed settings (counterpart to scenic quality in a natural setting) is based on types of use and development patterns that are defined by visual character, planning concepts, and viewer orientation. Visual character regards the composition of design elements including form, line, color, and texture. These elements influence visual dominance and focus within each setting. The planning concept is primarily based on circulation

and building types. Circulation and building types act as major organizing elements that structure the visual environment. Circulation types may include gridded, curvilinear, loop-road, and cul-de-sacs. Building types may be clustered, detached, or attached building placements. Orientation of views from these areas is based on the planning concept. Inward oriented patterns tend to be structured, often with a layout that responds to a central focus or feature. Outward oriented development patterns often have a random or open character.

In general, these patterns may be grouped and classified into the following five image types:

- *Residential Image Type:* A variety of development patterns that display an integration of the visual character and planning concept. There is often a strong repetition of design elements that are organized around circulation patterns.
- *Commercial Image Type:* Clustered development patterns with high visibility and often orientated specifically to the roadway. Structures and architectural treatments are often highly unified.
- *Park–Like Image Type:* Open and landscaped areas that dominate the development pattern, including active recreation areas as well as other greenbelt open space. Many of the light industrial, office park, and institutional development patterns fit this context as well. In these patterns, a central building or group of buildings generally are placed in an open space setting giving the development a park-like image.
- *Industrial Image Type:* Development patterns in which structures dominate the visual character. Buildings and facilities are often large scale and complex. Open space treatment is limited primarily to the perimeter of the development and is not integrated into the overall planning concept.
- *Open/Agricultural Image Type:* Patterns that lack formal development and are generally vacant, rural, or used for crop production. The agricultural image may vary according to the time of year and type of crop.

Similar to the natural setting, special consideration may be given to those image types that are of an historic nature or that exhibit unique architectural features. For example, a commercial area in a historic downtown location should be given special consideration.

Visual Contrast

The visual contrast analysis is a systematic process that is used to analyze the potential visual impacts of the proposed roadway project and associated activities. The degree to which the roadway project affects the visual and aesthetic quality of a natural or developed setting depends on the contrast between the setting with the project in place and the existing setting without the project in place. The contrast can be measured by comparing the design features associated with the project description with the major features in the existing setting (natural or developed). The basic design elements of form, line, color and texture are used to make this comparison and to describe the visual contrast created by the project in a natural setting, while the effects to image type are used to define contrast in developed areas.

Table 5
Sample Scenic Quality Evaluation Chart

Key Factors	Scenic Quality Rating Criteria and Score*		
Landform	High vertical relief as expressed in prominent cliffs, spires, or massive rock outcrops, or severe surface variations or highly eroded formations including major badlands or dunes, or detail features dominant and exceptionally striking and intriguing. **5**	Steep canyons, mesas, buttes, cinder cones, and drumlin, or interesting erosion patterns or variety in size and shape of landforms, or detail features that are interesting though not dominant or exceptional. **3**	Low rolling hills, foothills, or flat valley bottoms, or few or no interesting landscape features. **1**
Vegetation	A variety of vegetative types as expressed in interesting forms, textures, and patterns. **5**	Some variety of vegetation, but only one or two major types. **3**	Little or no variety or contrast in vegetation. **1**
Water	Clear and clean appearing, still, or cascading white water, any of which are a dominant factor in the landscape. **5**	Flowing or still, but not dominant in the landscape. **3**	Absent or present, but not noticeable. **0**
Color	Rich color combinations, variety or vivid color or pleasing contrasts in the soil, rock, vegetation, and water. . **5**	Some intensity of variety in colors and contrast of the soil, rock, and vegetation, but not a dominant scenic element. **3**	Subtle color variations, contrast, or interest, generally mute tones. **1**
Influence of Adjacent Scenery	Adjacent scenery that greatly enhances visual quality. **5**	Adjacent scenery moderately enhances overall visual quality. **3**	Adjacent scenery has little or no influence on overall visual quality. **0**
Scarcity	One of a kind, unusually memorable, or very rare within region. Consistent chance for exceptional wildlife or wildflower viewing, etc. **5**	Distinctive, though somewhat similar to others within the region. **3**	Interesting within the setting, but fairly common within the region. **1**
Cultural Modifications	Modifications add favorably to visual variety (may include ranching or historic features). **5**	Modifications add little or no visual variety to the area. **0**	Modifications are extensive and scenic qualities are substantially reduced. **-4**

Scenic Quality
Distinctive = 19 or more
Common = 12 to 18
Minimal = 11 or less

This analysis process provides a means for determining the visual impacts and for identifying the treatment and measures to mitigate these impacts (see Step 3 below). Where possible this process should be employed early on to assist as a design tool during both project planning and design.

The steps in the visual contrast analysis for natural and developed settings are as follows:

Natural Setting – The steps for evaluating the contrast in a natural setting include the following:

- *Obtain Project Description:* To effectively evaluate the visual impacts of a proposed new or modified roadway, obtain a detailed project description. The level of detail in the description should be commensurate with the type of project proposed.
- *Select Key Observation Points (KOPs):* The contrast rating should be done from the most critical viewpoints associated with views from and to the roadway. Factors that should be used in selecting critical viewpoints are a by-product of the viewer analysis (see Step 2 in this Appendix 4-F) and should include the number and sensitivity of viewers and the orientation and duration of views.
- *Prepare Visual Simulation (Optional):* Visual simulation is an invaluable tool for effective evaluation of impacts. Simulations are strongly recommended for potentially high impact or special projects. The level of sophistication should be commensurate with the quality of the visual resource and the severity of the anticipated impact. Simulations help public groups visualize and respond to roadway development proposals, which makes public participation in the planning process more effective.

The contrast rating process should be completed in the field from the selected KOPs and/or through the use of photographs taken from KOP locations. The process may be undertaken by a landscape architect team that is trained in visual resource assessment or by an individual landscape architect, depending on the sensitivity and impacts of the project and the availability of qualified personnel.

The contrast rating is completed by determining the degree of contrast (e.g., strong, moderate, weak, or none) that the introduction of roadway design features could have on the features of the natural setting (e.g., landform/water, vegetation, structures). As illustrated in Table 6, this rating is accomplished by evaluating changes in the setting to form, line, color, and texture for each of the design features. In general, the contrast ratings are expressed as follows:

- *No Contrast:* Design features associated with the proposed roadway are not visible or perceived from or to the roadway.
- *Weak Contrast:* Design features associated with the proposed roadway can be seen but do not attract attention to views from or to the roadway.
- *Moderate Contrast:* Design features associated with the proposed roadway begin to attract attention and begin to dominate the views from or to the roadway.
- *Strong Contrast:* Design features associated with the proposed roadway cannot be overlooked and dominate views from or to the roadway.

Table 6
Sample Visual Contrast Rating Worksheet

Project Information			
Project Name: _____			
Key Observation Point: _____			
Date: _____			
Existing Landscape Characteristics			
	Land/Water	**Vegetation**	**Structures**
Form			
Line			
Color			
Texture			
Proposed Activity Description			
	Land/Water	**Vegetation**	**Structures**
Form			
Line			
Color			
Texture			

Contrast Rating ☐ Short Term ☐ Long Term

DEGREE OF CONTRAST		**FEATURES**												*Levels of change* ☐ Very Low ☐ Low ☐ Moderate ☐ High
		Land/Water Body				**Vegetation**				**Structures**				
		Strong	**Moderate**	**Weak**	**None**	**Strong**	**Moderate**	**Weak**	**None**	**Strong**	**Moderate**	**Weak**	**None**	*Does project design meet visual resource management objectives? (if applicable)* ☐ Yes ☐ No Explain. (Continue on reverse, if necessary)
FEATURES	**Form**													*Additional mitigating measures recommended* ☐ Yes ☐ No (If "yes," describe. Continue on reverse side if necessary)
	Line													
	Color													
	Texture													

The results of the contrast analysis may be combined with the viewer visibility levels (Table 3) and used to determine the level of change, or visual impact that the proposed project will have on the natural setting as viewed from and to the roadway (Table 7).Furthermore, the contrast analysis will assist in identifying design treatments or mitigation measures that will reduce the visual impacts to an acceptable level and/or enhance the natural setting. If the project is located on land administered by the U.S. Bureau of Land Management or the U.S. Forest Service, the contrast analysis is used to determine whether a project complies with agency visual management objectives.

Table 7
Sample Visual Impact Model

	Overall Viewer Visibility Levels		
Visual Contrast	**High**	**Moderate**	**Low**
High	High Impact	High Impact	Moderate Impact
Moderate	High Impact	Moderate Impact	Low Impact
Low	Moderate Impact	Low Impact	Low Impact

Developed Setting – Similar to the evaluation of contrast in the natural setting, evaluating the contrast in developed areas also requires the definition of the design features associated with the project description. In developed settings, this often may include the use of walls and other structural treatments, as well as consideration for detailed design elements including signage, lighting, associated pedestrian facilities, and landscape treatments.

These design features are then analyzed in conjunction with the visual image types previously identified, and used to document effects to the following:

- *Circulation:* Do the design features associated with the proposed roadway disrupt existing circulation patterns and access to any of the image types associated with the developed setting?
- *Structural:* Do the design features associated with the proposed roadway require structural removal, or affect existing building location and design continuity?
- *Open Space Modifications:* Do the design features associated with the proposed roadway result in the removal or alteration of existing open space within or surrounding the image type?
- *Viewer Orientation:* Do the design features associated with the proposed roadway change significant views either from or to the roadway, including the consideration of effects on viewer orientation within each image type?

Using this information, the impacts may be summarized to discuss the modification to the development pattern or visual image, and effects to views from and to the roadway.

Step 3 - Design Treatment or Mitigation Measures

The purpose of this step of the Visual and Aesthetics Resource Evaluation Process is to identify potential treatment options that may be utilized to enhance viewing conditions and/or address the impacts to views from and to the roadway as previously discussed. This step focuses specifically on the selection of relevant design elements or treatments to mitigate effects; the evaluation of the effects of the measures on addressing visual and aesthetic opportunities and impacts, and the prioritization of identified treatments/mitigation measures.

As described earlier and indicated in Figure 1, this is a "circular" portion of the process that allows for the identification of alternative plans, including design treatments/mitigation measures that are evaluated based on (1) effects to the visibility level associated with sensitive views, and (2) ability to reduce contrast of proposed roadway design features in either a natural or developed setting and to enhance the overall aesthetic of the roadway corridor.

Examples of design treatment and mitigation measures that may be applied to different types of roadway projects are described in Section IV, Mitigation Tools, of this guide.

MEMORANDUM

Department of Transportation

DATE: July 6, 2010

TO: Consultants with current or future DOT contracts

FROM: Ellen Barth Alster, RLA, LEED AP, Senior Landscape Architect

SUBJECT: Update to Step 1 of Appendix 4D of the Environmentally Sensitive Roadway Design Guidelines, Pima County DOT Roadway Design Manual

This memo is an update to both the Introduction and Step 1: Inventory of Protected Plant Species in Appendix 4D of the Environmentally Sensitive Roadway Design Guidelines. It shall substitute for the existing sections. The new name for this section shall be "Step 1: Inventory and Mitigation Calculations for Protected Plant Species"

Introduction

ESR roadways are designed and maintained to preserve the natural character and vegetation density of the area and provide habitat for specific species. The objective is to leave the landscape as natural appearing as possible. Every effort should be made to revegetate with plant species that were removed and/or are commonly found in the project environment, matching density, relative location patterns (e.g. small cactus under shrubs), slope and soil preferences. This process involves inventorying and measuring existing vegetation. The next step is calculating mitigation requirements based on the inventory. These inventories shall be used as a basis for recreating the existing plant communities in new roadway landscaping. They are not intended to be used for plant salvage.

The two types of required Vegetation Measurement are listed below. The first inventory is of all saguaros and Pima County Protected Trees over 3" in caliper (the only exception to the 3" requirement is acacias - only acacias over 8" caliper are required to be inventoried). This inventory is done for the entire project area to be disturbed by construction. The second type of inventory is a sampling which is used to determine densities and types of shrubs, cacti, succulents, and seed mixes.

Inventory Type	What to Inventory	Inventory Area	Inventory Purpose
Saguaros and Pima County Protected Trees	○ All Saguaros ○ All Pima County Protected Trees > 3" caliper (see list under Step 1 below)	Entire disturbed project area of site (cut and fill limits) plus 10' beyond these limits	○ To determine number and sizes of saguaros that should be replaced ○ To determine replacements for Pima County protected tree species
All Other Plants	All plants in determined sampling area. Shall include each specific type of plant community in the project area.	Circular sampling areas (releves). These vary in size and quantity according to the project.	○ To determine seed mix ○ To determine replanting density of Pima county protected cactus and shrub species. This value shall be used as a guide in replanting the remainder of the species.

Step 1: Inventory of Protected Plant Species

A. Determine ESR Multiplier by the following method:

- Calculate disturbed area of project. Disturbed area of project is defined as 10' offset from the project cut and fill limits.
- Calculate the plantable area. Plantable area is defined as the disturbed project area that can be planted with trees and saguaros. It excludes the following:
  - Road
  - Unpaved area between and curb and sidewalk
  - 10' offset from water and sewer lines and manholes
  - Medians
  - 10' offset from pavement edge if no curb
  - Sight Visibility Triangle (SVT)
  - Drainage structures
- ESR multiplier = plantable area / disturbed project area

B. Complete a full inventory of the entire disturbed project area for saguaros and Pima County protected tree species. These plants include:

Scientific Name	Common Name	Minimum Size
Acacia constricta	Whitethorn Acacia	8" Caliper
Acacia greggii	Catclaw Acacia	8" Caliper
Carnegiea gigantea	Saguaro	All
Chilopsis linearis	Desert Willow	3" Caliper
Celtis reticulata	Canyon Hackberry	3" Caliper
Olneya tesota	Ironwood	3" Caliper
Parkinsonia floridum	Blue Palo Verde	3" Caliper
Parkinsonia microphyllum	Foothills Palo Verde	3" Caliper
Prosopis velutina	Velvet Mesquite	3" Caliper
Prosopis pubescens	Screwbean Mesquite	3" Caliper

Notes:

- Only the species listed above are required to be inventoried and only the disturbed area needs to be inventoried.
- If the entire site happened to be inventoried including non-disturbed areas, the trees in the non-disturbed areas should not be included in the total caliper inches.

Assess and document the following for each tree:

1. Caliper
   - Measure 24" above ground with forestry caliper
   - For multi-trunked species, the largest 3 trunks are measured. The species is included if the sum of the trunks is greater than or equal to 3"
2. Location
   - GPS coordinate points should be recorded for each tree species.

C. Calculate mitigation requirements for protected trees and saguaros

Trees:

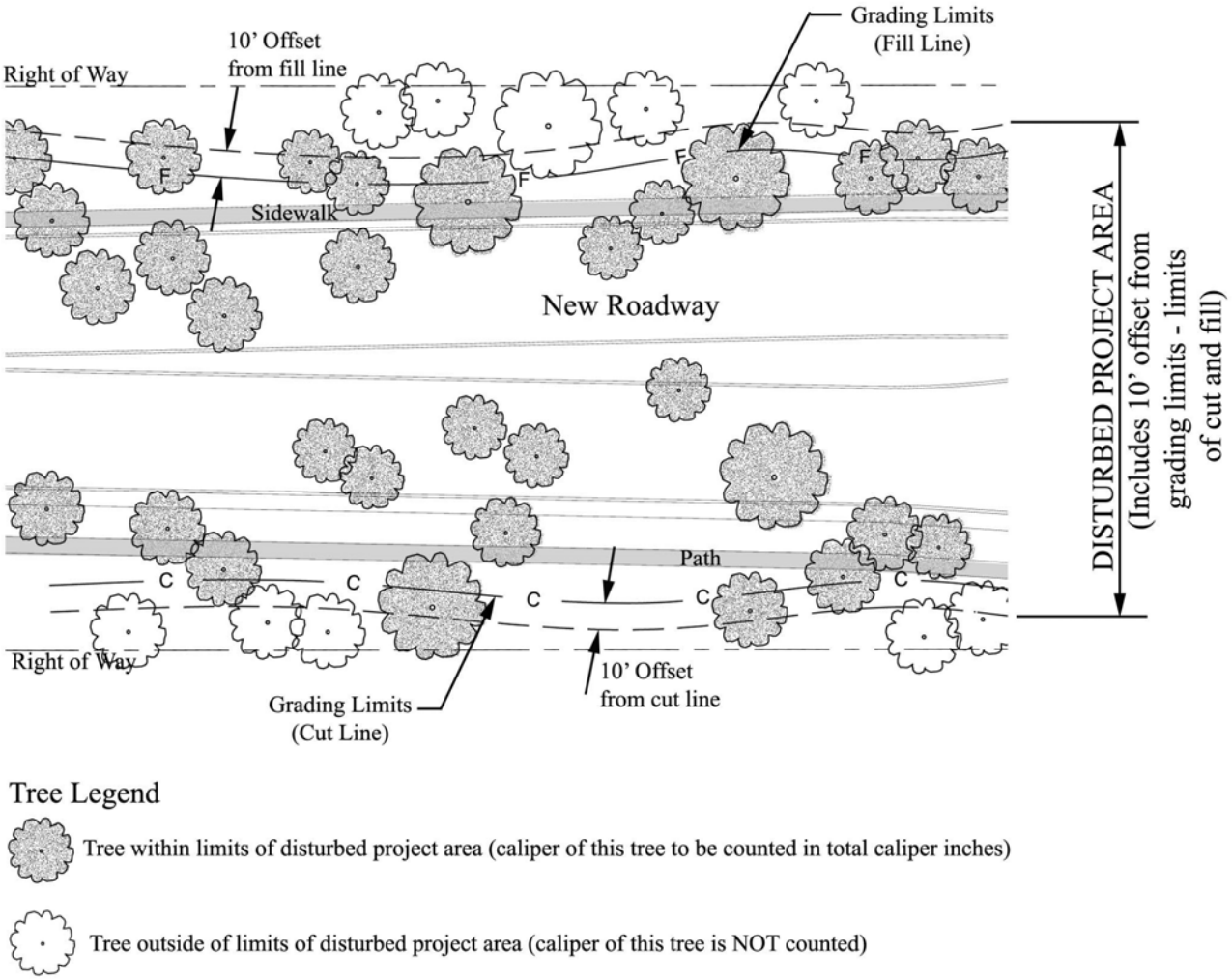
- Add up total caliper inches for each species of tree in the project area that will be disturbed only. Do not include caliper inches for trees in undisturbed areas that will not be impacted by development. (SEE DIAGRAM BELOW)
- Mitigation/species = Total Caliper inches x 125% x ESR ratio

Example:

- 100 caliper inch of palo verde in a disturbed site area of 10 acres. (The overall project area r/w to r/w may be larger than these 10 acres, but **only** the caliper inches in the ***disturbed area*** are counted).
- Only 2.5 acres of the 10 acres are plantable (the rest is roadway, clear zone, drainage, etc.)

Result: 100 cal inch x 125% x ESR multiplier = 31.25 cal inches that must be replaced in the 2.5 acres of disturbed acres

NOTE: ESR Multiplier = Plantable Area/Disturbed Project Area or 2.5 acres/10 acres = 25%



Saguaro:

- Mitigate saguaros at 1:1
- Saguaros will be replaced with replacement saguaros that are as close in height to the original saguaro being removed up to an 8' maximum height for replacement saguaros.
- Replacement standards will be as follows:

Inventoried Saguaro	Minimum Replacement Size
0-2'	1-2'
2-4'	2-4'
4-6'	4-6'
6-8'	6-8'
Over 8'	8' maximum ht.

Example:

- Site contains 10 saguaros. See the table below for replacement sizes.

Inventoried Saguaros	Height of Inventoried Saguaros	Minimum Replacement Size
1	10'	8'
2	12'	8'
3	6'	4-6'
4	4'	4-6'
5	4'	4-6'
6	8'	6-8'
7	2'	2-4'
8	5'	4-6'
9	7'	6-8'
10	15'	8'

D. Convert Total Caliper Inches for Required Tree Mitigation

The final caliper inch value for protected tree species is to be distributed into appropriately sized trees to the extent possible, based on plant availability. A demonstrated effort must be made to mitigate using a variety of plant sizes.

Example:

For a given project, it is determined that 31.25" of caliper inches for Parkinsonia floridum (Blue Palo Verde) need to be replaced. The total inventoried plants = 100 caliper inches. They are originally distributed as follows:

ORIGINAL TREE INVENTORY

Tree #	Tree Species	Caliper Inches
1	Parkinsonia floridum	18
2	Parkinsonia floridum	16
3	Parkinsonia floridum	12
4	Parkinsonia floridum	9
5	Parkinsonia floridum	9
6	Parkinsonia floridum	8
7	Parkinsonia floridum	7
8	Parkinsonia floridum	6
9	Parkinsonia floridum	5
10	Parkinsonia floridum	4
11	Parkinsonia floridum	3
12	Parkinsonia floridum	3
Total Caliper Inches =		**100**

In order to distribute the replacement mitigation trees into a variety of sizes, determine the original distribution of sizes:

DISTRIBUTION OF TREE SIZES IN ORIGINAL INVENTORY

Size ranges	# of Trees	Percentage as Total # of Trees	Total # Required Caliper Inches
> 12"	2	2 trees/12 trees =**17%**	17% x 31.25 =**4.8**
8-12"	3	3 trees/12 trees =**25%**	25% x 31.25=**7.2**
6-8"	3	2 trees/12 trees = **25%**	25% x 31.25=**7.2**
< 6"	5	5 trees/12 trees = **42%**	42% x 31.25 =**12.0**
Totals		**100%**	**31.3**

The next step, once it is determined how many caliper inches are in each size range, is to translate these ratios into sizes of plants that are commercially available. The largest size container available is assumed to be 48" box, with (4) different sizes of plants to be used.

CALCULATING DISTRIBUTION OF TREE SIZES*

Original Caliper Size of Tree	Replacement Container Size	Caliper Inches per Container	Required Caliper Inches/Caliper Inches per Container	Actual # of Trees per each container size
>12".	48" Box	6	4.8/6=.**8**	**1**
8-12"	36" Box	4	7.2/4=**1.8**	**2**
6-8"	24" Box	2	7.2/2.5=**2.9**	**3**
<6"	15 Gal.	1	12/1=**12.0**	**12**

***The largest caliper tree sizes shall be planted 100' within either side of wash areas**

In the process of distributing the required caliper inches among container grown plants, use the standards specified below:

Container Size Tree	Caliper Inches per Container
15 Gal.	1
24"Box	2.5
36" Box	4
48" Box	6

This method assumes a variety of sizes is commercially available. In the event that the required tree species and saguaros cannot be found in the required sizes, the consultant shall proceed by doing the following:

1. Submit a list of nurseries contacted to Pima County's Landscape Architect.

2. Upon reviewing this list, the landscape architect may require additional plant sources be contacted

3. The County Landscape Architect will make a final determination that all possible tree sources have been contacted before allowing smaller tree sizes to be used to meet the ESR requirement or to allow substitution of tree species

4. It is recognized that plant availability may change between the time construction plans are done and the time the project is built. Therefore, if the tree species and sizes specified on the plans are not available at the start of construction, the contractor must verify this by submitting a list of nurseries contacted to the county landscape architect. The county landscape architect may advise one of the following:

   a) Require additional nurseries to be contacted

   b) Make an adjustment to the trees required based on caliper sizes available

   c) Allow alternate species to be used for tree mitigation. Under no circumstance will alternate species be allowed to be used to mitigate for ironwood trees (Olneya tesota).

E. Allow for Plant Salvage:

For plants in the right of way that will conflict with new construction, PCDOT is providing the opportunity for them to be salvaged by other government agencies and non-profit native plant organizations. Permits will be required from the Arizona Department of Agriculture for transplanting all plant material protected by the Arizona Native Plant Law. PCDOT Right of Way Use Permits will need to be obtained prior to any work being performed it the right of way.

APPENDIX C

Plant Salvage Standards on County Transportation Improvement Projects Memo from John Bernal, dated January 4, 2010.

MEMORANDUM

Date: January 4, 2010

To: John Bernal
Deputy County Administrator for Public Works

Priscilla Cornelio, Director
Transportation Department

From: C.H. Huckelberry
County Administrator

Re: **Plant Salvage Standards on County Transportation Improvement Projects**

As we have previously discussed, our new environmentally sensitive roadway standards were adopted after my November 16, 2000 memorandum directing compliance with Pima County's Native Plant Preservation Ordinance (NPPO) on all County projects. Hence, it would be appropriate to utilize the environmentally sensitive roadway standards, where they apply, to County projects. Where they do not apply, it is no longer necessary nor appropriate to utilize the NPPO, which was designed primarily for new development projects with substantial grading and clearing of native vegetation.

Transportation improvements projects, on the other hand, particularly in built up urban areas where the project consists primarily of widening an existing corridor, have already been significantly degraded or depleted or native vegetation; hence, the inappropriate application of the NPPO.

This memorandum supersedes my November 16, 2000 memorandum, which no longer applies to County transportation improvement projects.

CHH/mjk

Attachment

APPENDIX D

Update Appendix 4D of the Environmentally Sensitive Roadway Design Guidelines, Pima County DOT Roadway Design Manual, memo dated June 2015.

MEMORANDUM

Department of Transportation

DATE: July 2015

TO: Consultants with current or future DOT contracts

FROM: Ellen Barth Alster, RLA, LEED AP, Senior Landscape Architect

SUBJECT: Update Appendix 4D of the Environmentally Sensitive Roadway Design Guidelines, Pima County DOT Roadway Design Manual.

This memo is an update to Appendix 4D of the Environmentally Sensitive Roadway Design Guidelines. It shall substitute for the existing Appendix 4D. It also includes an additional section concerning Regulated Riparian Habitat (RRH) mitigation.

Introduction

Landscaping on Pima County roadways is designed and maintained to preserve the natural character and vegetation density of an area and provide habitat for specific species. The objective is to leave the landscape as natural appearing as possible. Every effort should be made to re-vegetate with plant species that were removed and/or are commonly found in the project environment, matching density, relative location patterns (e.g. small cactus under shrubs), and slope and soil preferences. This process involves inventorying and measuring existing vegetation. The next step is calculating mitigation requirements based on the inventory. These inventories shall be used as a basis for recreating the existing plant communities in new roadway landscaping, including the restoration of washes and riparian areas occurring within the overall project area. The inventories are intended to provide a full representation of the vegetative communities present on the project site, so that these communities can be recreated to the best extent possible.

The two types of required Vegetation Measurement are listed below. The first inventory is of all saguaros and Pima County Protected Trees over 3" in caliper (the only exception to the 3" requirement is acacias - only acacias over 8" caliper are required to be inventoried). This inventory is done for the entire project area to be disturbed by construction. The second type of inventory is a sampling which is used to determine densities and types of shrubs, cacti, succulents, and seed mixes.

Inventory Type	What to Inventory	Inventory Area	Inventory Purpose
Saguaros and Pima County Protected Trees	○ All Saguaros ○ All Pima County Protected Trees > 3" caliper (see list under Step 1 below)	Entire right-of-way area within project limits	○ To determine number and sizes of saguaros that should be replaced ○ To determine replacements for Pima County protected tree species
All Other Plants	All plants in determined sampling area. Shall include each specific type of plant community in the project area.	Circular sampling areas (releves). These vary in size and quantity according to the project.	○ To determine seed mix ○ To determine replanting density of Pima county protected cactus and shrub species. This value shall be used as a guide in replanting the remainder of the species.

STEP 1: INVENTORY OF PROTECTED PLANT SPECIES

A. Determine ESR Multiplier by the following method:

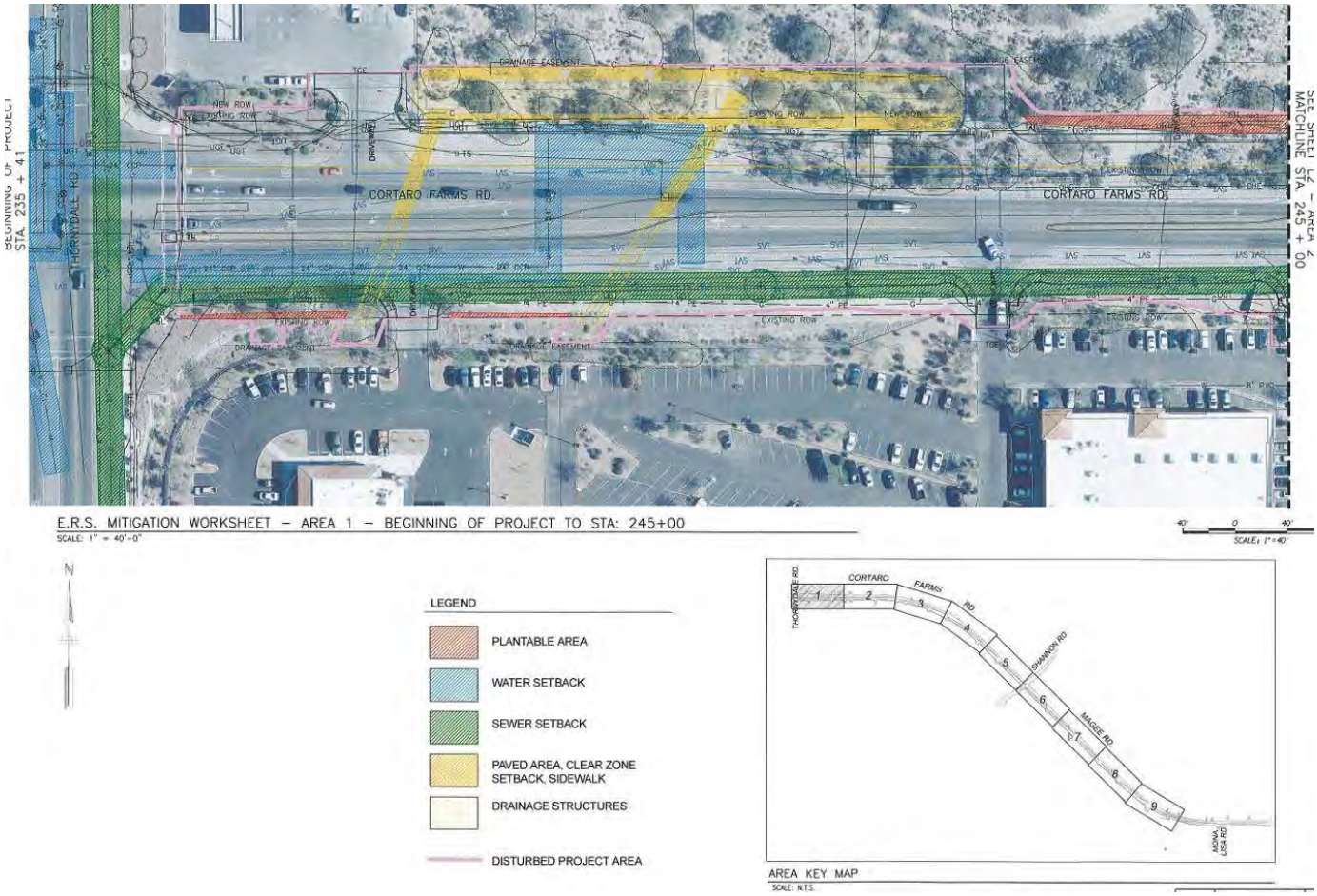
- Calculate disturbed area of project. Disturbed area of project is defined as 10' offset from the project cut and fill limits, including all drainage and utility improvements associated with the project. If the 10' offset falls beyond right of way limits, this area is not to be included, unless the area falls within an easement designated as part of the project limits.
- Calculate the plantable area. Plantable area is defined as the disturbed project area that can be planted with trees. It excludes the following:
  - Road
  - Unpaved area between and curb and sidewalk
  - Medians
  - 10' offset from pavement edge if no curb
  - Sight Visibility Triangle (SVT)
  - Drainage structures
  - Utility offsets for trees (shown below)

Utility	Offset
Wastewater.	16' from manholes Maintain clear area from manhole to street 10' from sewer line
Gas	8' from gas line
Electric	25' from pole Trees planted under power lines shall be no taller than 15' at mature height within 15' of power lines
Water	10' from water line
Communications	4' from cable line

NOTE: All utilities should be contacted for any policy updates since the date of this memo.

- ESR multiplier = plantable area / disturbed project area
- ESR may fluctuate throughout the project as drainage, slope and construction easements are refined throughout subsequent design phases. Utility disturbance areas may not be determined until late in the design process, requiring landscape and irrigation adjustments up until the end of the design phase. Consultant is to be aware of these changes and be prepared to update the plans after all utility disturbance is determined.
- Submit a diagram showing the plantable area for the entire project area as shown in the example on page 3.

STEP 1: INVENTORY OF PROTECTED PLANT SPECIES



SAMPLE SHEET SHOWING PLANTABLE AREA (AREA THAT CAN BE PLANTED WITH TREES)

STEP 1: INVENTORY OF PROTECTED PLANT SPECIES

B. Complete a full inventory of the entire disturbed project area for saguaros and Pima County protected tree species. These plants include:

Scientific Name	Common Name	Minimum Size
Acacia constricta	Whitethorn Acacia	8” Caliper
Acacia greggii	Catclaw Acacia	8” Caliper
Carnegiea gigantea	Saguaro	All
Chilopsis linearis	Desert Willow	3” Caliper
Celtis reticulata	Canyon Hackberry	3” Caliper
Olneya tesota	Ironwood	3” Caliper
Parkinsonia floridum	Blue Palo Verde	3” Caliper
Parkinsonia microphyllum	Foothills Palo Verde	3” Caliper
Prosopis velutina	Velvet Mesquite	3” Caliper
Prosopis pubescens	Screwbean Mesquite	3” Caliper

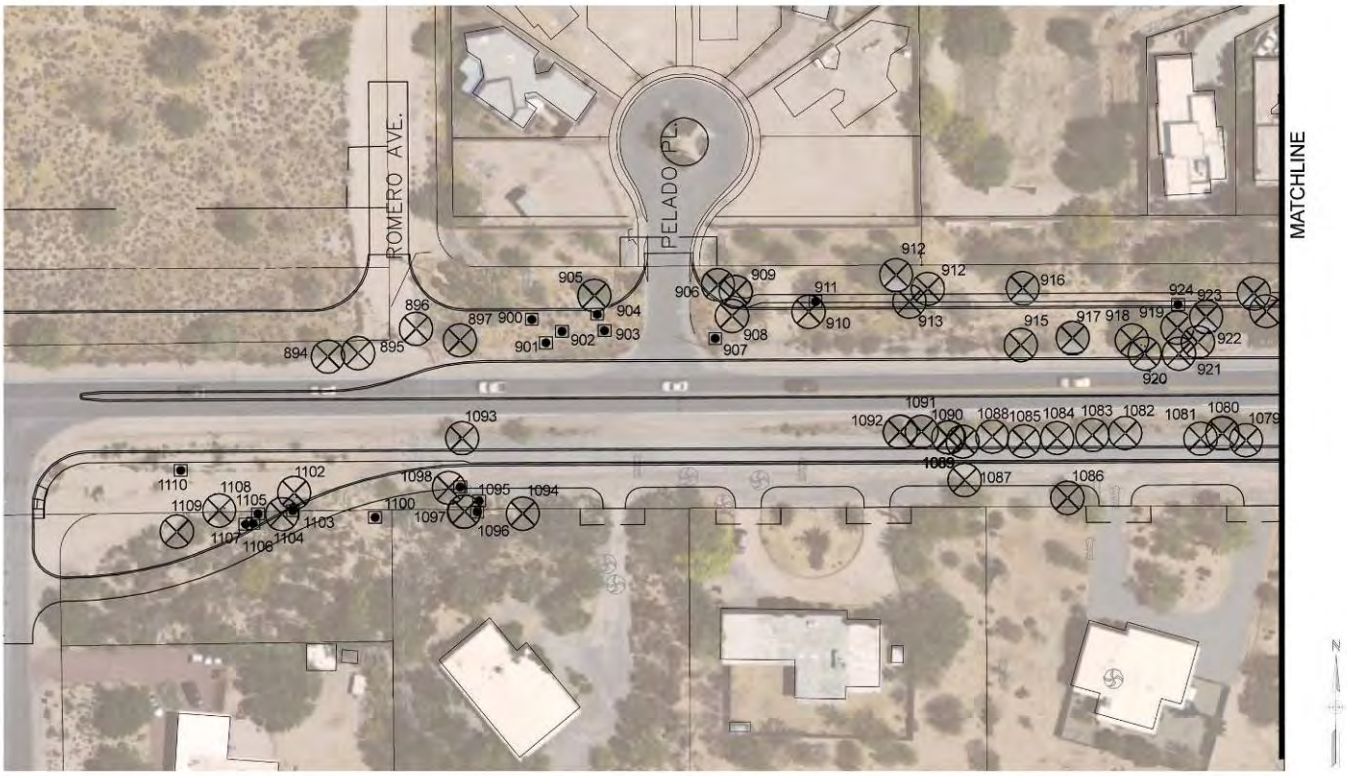
Notes:

- Only the species listed above are required to be inventoried and only the disturbed area needs to be inventoried.
- If the entire site happened to be inventoried including non-disturbed areas, the trees in the non-disturbed areas should not be included in the total caliper inches.

Assess and document the following for each tree:

1. Caliper
    - Measure 24” above ground with forestry caliper
    - For multi-trunked species, the largest 3 trunks are measured. The species is included if the sum of the trunks is greater than or equal to 3”
2. Location
    - Record GPS coordinate points for each tree and saguaro inventoried.
    - Locate trees and saguaros on air photo as shown in page 5.

STEP 1: INVENTORY OF PROTECTED PLANT SPECIES

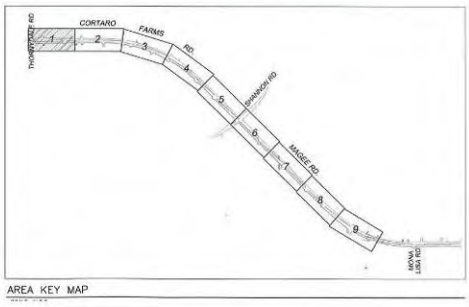


40' 0 40' 80'
SCALE: 1" = 40'

LEGEND

TREE (Number refers to inventory)

SAGUARO (Number refers to inventory)



SAMPLE NATIVE PLANT INVENTORY PLAN SHEET

ID #	Scientific Name	Common Name	Caliper	Height
119	Parkinsonia microphyllum	Foothills Verde	5	
120	Parkinsonia microphyllum	Foothills Verde	4	
121	Parkinsonia microphyllum	Foothills Verde	13	
123	Carnegiea gigantea	Saguaro		7
125	Carnegiea gigantea	Saguaro		8
128	Chilopsis linearis	Desert Willow	12	
131	Olneya tesota	Ironwood	9	
134	Carnegiea gigantea	Saguaro		6

SAMPLE NATIVE PLANT INVENTORY

- **Tree: indicate caliper inches**
- **Saguaro: indicate heights**

C. Calculate mitigation requirements for protected trees and saguaros

Trees:

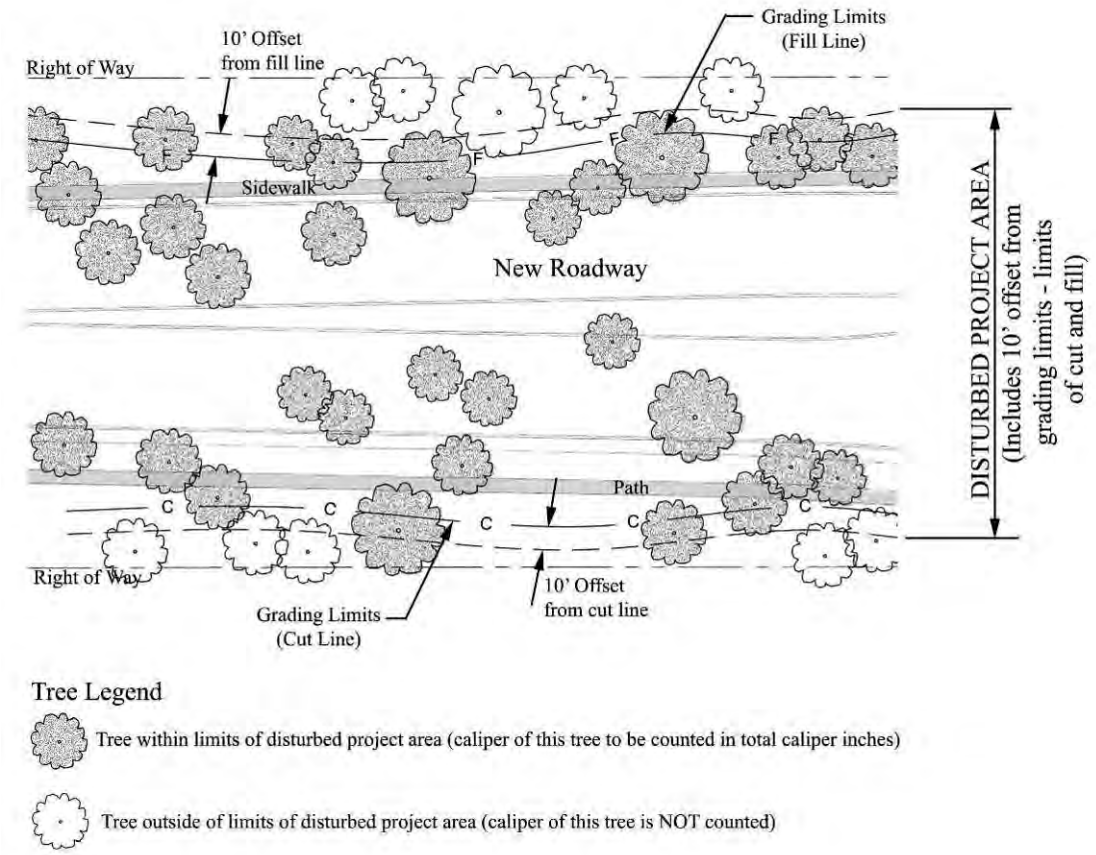
- Add up total caliper inches for each species of tree in the project area that will be disturbed only. Do not include caliper inches for trees in undisturbed areas that will not be impacted by development. (See Diagram Below)
- Mitigation/species = Total Caliper inches x 125% x ESR ratio

Example:

- 100 caliper inch of palo verde in a disturbed site area of 10 acres. (The overall project area r/w to r/w may be larger than these 10 acres, but **only** the caliper inches in the ***disturbed area*** are counted).
- Only 2.5 acres of the 10 acres are plantable (the rest is roadway, clear zone, drainage, etc.)

Result: 100 cal inch x 125% x ESR multiplier = 31.25 cal inches that must be replaced in the 2.5 acres of disturbed acres

NOTE: ESR Multiplier = Plantable Area/Disturbed Project Area or 2.5 acres/10 acres = 25%



STEP 1: INVENTORY OF PROTECTED PLANT SPECIES

Saguaro:

- Mitigate saguaros at 1:1
- Saguaros will be replaced with replacement saguaros that are as close in height to the original saguaro being removed up to an 8' maximum height for replacement saguaros.
- Replacement standards will be as follows:

Inventoried Saguaro	Minimum Replacement Size
0-2'	1-2'
2-4'	2-4'
4-6'	4-6'
6-8'	6-8'
Over 8'	8' maximum ht.

Example:

- Site contains 10 saguaros. See the table below for replacement sizes.

Inventoried Saguaros	Height of Inventoried Saguaros	Minimum Replacement Size
1	10'	8'
2	12'	8'
3	6'	4-6'
4	4'	4-6'
5	4'	4-6'
6	8'	6-8'
7	2'	2-4'
8	5'	4-6'
9	7'	6-8'
10	15'	8'

D. Convert Total Caliper Inches for Required Tree Mitigation

The final caliper inch value for protected tree species is to be distributed into appropriately sized trees to the extent possible, based on plant availability. A demonstrated effort must be made to mitigate using a variety of plant sizes.

Example:

For a given project, it is determined that 31.25" of caliper inches for Parkinsonia microphyllum, (Foothills Palo Verde) need to be replaced. The total inventoried plants = 100 caliper inches. They are originally distributed as follows:

STEP 1: INVENTORY OF PROTECTED PLANT SPECIES

ORIGINAL TREE INVENTORY

Tree #	Tree Species	Caliper Inches
1	Parkinsonia microphyllum	18
2	Parkinsonia microphyllum	16
3	Parkinsonia microphyllum	12
4	Parkinsonia microphyllum	9
5	Parkinsonia microphyllum	9
6	Parkinsonia microphyllum	8
7	Parkinsonia microphyllum	7
8	Parkinsonia microphyllum	6
9	Parkinsonia microphyllum	5
10	Parkinsonia microphyllum	4
11	Parkinsonia microphyllum	3
12	Parkinsonia microphyllum	3
Total Caliper Inches =		**100**

In order to distribute the replacement mitigation trees into a variety of sizes, determine the original distribution of sizes:

DISTRIBUTION OF TREE SIZES IN ORIGINAL INVENTORY

Size ranges	# of Trees	Percentage as Total # of Trees	Total # Required Caliper Inches
> 12"	2	2 trees/12 trees =**17%**	17% x 31.25 =**4.8**
8-12"	3	3 trees/12 trees =**25%**	25% x 31.25=**7.2**
6-8"	3	2 trees/12 trees = **25%**	25% x 31.25=**7.2**
< 6"	5	5 trees/12 trees = **42%**	42% x 31.25 =**12.0**
Totals		**100%**	**31.3**

The next step, once it is determined how many caliper inches are in each size range, is to translate these ratios into sizes of plants that are commercially available. The largest size container available is assumed to be 48" box, with (4) different sizes of plants to be used.

CALCULATING DISTRIBUTION OF TREE SIZES*

Original Caliper Size of Tree	Replacement Container Size	Caliper Inches per Container	Required Caliper Inches/Caliper Inches per Container	Actual # of Trees per each container size
>12".	48" Box	6	4.8/6=.**8**	**1**
8-12"	36" Box	4	7.2/4=**1.8**	**2**
6-8"	24" Box	2	7.2/2.5=**2.9**	**3**
<6"	15 Gal. or 24" tree pot	1	12/1=**12.0**	**12**

***The largest caliper tree sizes shall be planted 100' within either side of wash areas**

STEP 1: INVENTORY OF PROTECTED PLANT SPECIES

In the process of distributing the required caliper inches among container grown plants, use the standards specified below:

Container Size Tree	Caliper Inches per Container
15 Gal. or 24" tree pot	1
24"Box	2.5
36" Box	4
48" Box	6

This method assumes a variety of sizes is commercially available. In the event that the required tree species and saguaros cannot be found in the required sizes, the consultant shall proceed by doing the following:

1. Submit a list of nurseries contacted to Pima County's Landscape Architect.

2. Upon reviewing this list, the landscape architect may require additional plant sources be contacted

3. The County Landscape Architect will make a final determination that all possible tree sources have been contacted before allowing smaller tree sizes to be used to meet the ESR requirement or to allow substitution of tree species

4. It is recognized that plant availability may change between the time construction plans are done and the time the project is built. Therefore, if the tree species and sizes specified on the plans are not available at the start of construction, the contractor must verify this by submitting a list of nurseries contacted to the county landscape architect. The county landscape architect may advise one of the following:

   a) Require additional nurseries to be contacted

   b) Make an adjustment to the trees required based on caliper sizes available

   c) Allow alternate species to be used for tree mitigation. Under no circumstance will alternate species be allowed to be used to mitigate for ironwood trees (Olneya tesota).

E. Allow for Plant Salvage:

For plants in the right of way that will conflict with new construction, PCDOT is providing the opportunity for them to be salvaged by other government agencies and non-profit native plant organizations. Permits will be required from the Arizona Department of Agriculture for transplanting all plant material protected by the Arizona Native Plant Law. PCDOT Right of Way Use Permits will need to be obtained prior to any work being performed it the right of way.

STEP 2: COMPREHENSIVE PLANT SAMPLING – RELEVE PROCESS

The purpose of this second step is to establish a basis for all other planting (not included in Step 1), used to mitigate the impacts of roadway construction projects through revegetation.

The **Releve Method** is a technique that vegetation ecologists use to sample an area for such variables as species diversity, cover, density, and abundance. It attempts to document the entire biotic plant community in the project area prior to roadway construction, so that the disturbed areas can be restored to as close to original condition as possible post construction. Circular plots (releves) are used to inventory and record each species present. Information obtained is extrapolated from these representative samples and used throughout the entire project. Releve survey results shall be used to determine the following:

(1) Tree and shrub species to be planted with tree pots provided by the Pima County Native Plant Nursery
(2) Cacti and succulents to be planted from containers provided by the Pima County Native Plant Nursery
(3) Seed mixes

It is critical that the personnel conducting this method are highly skilled in plant identification, including annual species.

Follow these steps:

A. Conduct releve:

1. **Determine number of vegetation entities:**
   Assess visually the number of *vegetation entities* (discrete assemblages of species) represented within a project area.
   - Establish one (1) entity in areas with the same assemblage of species represented throughout.
   - Establish two (2) or more entities for most roadway projects. Typical projects might include an upland community with a wash running though it, where the wash contains an assemblage of species distinct from the surrounding uplands. T he upland community would be one entity, while the wash community is a second entity. Additionally, washes may contain more than one entity.

2. **Determine the required number of releve plots:**
   Locate circular plots (releves) that are representative of the plant assemblages or communities. The appropriate number and size of these plots will depend upon the size and diversity of the project area.
   - Relatively homogenous projects require fewer releves, while project areas having multiple vegetation entities require a greater number of releves.
   - It is the responsibility of the project manager to meet with the Pima County DOT staff landscape architect to determine the number of releves required before the project scope is developed.

STEP 2: COMPREHENSIVE PLANT SAMPLING – RELEVE PROCESS

3. Locate releve plots

- Locate plots to be as representative of each vegetation entity as possible. Preliminary assessment of plots may be determined via PimaMaps or other digital tools, but final locations require onsite field visits to be determined.
- Establish 20' radius plots as a general rule. Plot sizes may increase or decrease in size due to site specific circumstances with the approval of the Pima County DOT landscape architect.
- Locate plots in areas adjacent to the project, if limited vegetation is present within the project area due to prior site disturbance. Locate these offsite plots in undisturbed areas with similar topography.
- Define center of plot and plot boundaries with flagging. Document flagged areas with GPS or other means so that they can be re-established if flagging is removed prior to the second releve being done.
- Map releve locations and include this information in the releve submittal to the Pima County staff landscape architect.

MAP OF RELEVE LOCATIONS

STEP 2: COMPREHENSIVE PLANT SAMPLING – RELEVE PROCESS

5. **Collect releve data (See Column A in Table 1):**

- Identify every species of a plant present within the releve, including annual species.
- Collect unknown plants and bring to the University of Arizona Herbarium or to a qualified botanist for positive identification.
- Include single species of plants that are not represented within the releve but fall within 10' of the releve boundary
- If the releves are not capturing species that appear to be dominant in the landscape, then additional and/or larger releves are required.
- Provide releve inventory data as illustrated in the columns labeled "A" in Table 1. The example shows five releves (five surveyed plots).
- Indicate invasive species as shown in the sample provided in Table 1 (See Column C).

6. **Calculate average plant densities per releve (See column B in Table 2):**

Example:

Acacia constricta was inventoried in five separate releves. Total these five areas:

1 (Releve 1) + 0 (Releve 2) + 3 (Releve 3) + 1 (Releve 4) + 3 (Releve 5) = 8 plants

Next, calculate average density:

Total number of plants for each species / number of releves = Average density per releve

8 plants/5 releves =1.6 plants per releve

7. **Repeat entire inventory process two separate times:**

- Measure the releve twice (spring and fall) to accurately capture the annual flora. On larger PCDOT projects there is typically sufficient design time to allow for two releves to occur.
- It is recognized that it may not always be possible on smaller projects with shorter design timeframes to repeat the process two times.
- It is recognized that there may not be signs of enough vegetative diversity to justify repeating the process twice. If this is the case, the reasoning why the releve was not repeated shall be documented.

STEP 2: COMPREHENSIVE PLANT SAMPLING – RELEVE PROCESS

TABLE 1

These five columns indicate the 5 releve plots. The number of columns will vary depending on the number of releves

	A					B	C
	Density (plants per 20' radius releve)					**Average Density (per 20' radius releve)**	**Invasive (check box if applicable)**
	Releve 1	**Releve 2**	**Releve 3**	**Releve 4**	**Releve 5**		
Large Shrubs and Trees							
Acacia constricta	1	0	3	1	3	**1.6**	
Larrea tridentata	6	2	4	3	5	**4**	
Parkinsonia microphylla	0	0	2	4	0	**1.2**	
Prosopis velutina	0	1	2	1	0	**0.8**	
Cacti/Succulents							
Carnegiea gigantea	0	2	0	1	0	**0.6**	
Echinocereus fasciculatus	3	2	0	6	1	**2.4**	
Ferocactus wislizeni	0	1	2	1	1	**1**	
Fouquieria splendens	1	0	2	0	1	**0.8**	
Mammillaria grahamii	4	5	8	0	5	**4.4**	
Opuntia engelmanii	1	2	1	0	1	**1**	
Opuntia versicolor	0	1	1	0	0	**0.4**	
Subshrubs, Forbs, and Grasses							
Abutilon incanum	0	1	4	0	3	**1.6**	
Ambrosia deltoidea	23	15	19	24	4	**17**	
Bouteloua aristidoides	4	6	9	5	1	**5**	
Encelia farinosa	9	17	2	8	6	**8.4**	
Erioneuron pulchellum	55	42	30	24	10	**32.2**	
Lesquerella gordonii	0	11	4	8	0	**4.6**	
Muhlenbergia porteri	5	1	7	4	0	**3.4**	
Pennisetum ciliare (Buffelgrass)	12	2	5	6	0	**5**	**x**
Psilostrophe cooperi	2	4	6	4	0	**3.2**	
Senna covesii	1	6	4	9	0	**4**	
Zinnia acerosa	16	22	16	30	24	**21.6**	
					total	**104.4**	

B. Calculate per acre replanting densities for tree pots and container plants

Per acre replanting densities are shown for the example of Ferocactus wislizenii (Barrel Cactus – highlighted in teal in Table 2 next page)

STEP 2: COMPREHENSIVE PLANT SAMPLING – RELEVE PROCESS

Example: Calculate the replanting density for barrel cactus:

a. Convert the square foot (SF) area of the releve plot to acres:

- First, find the square foot (SF) area of the 20' radius releve

Area of a circle = $\Pi \times r^2$

$3.14 \times 20^2 = 1256$ SF

- Second, convert SF to acres. Area of 1 acre = 43,560 SF

1256 SF / 43,560 SF = .029 acres

Replanting density for Ferocactus wislizeni =1 plants per releve/.029 acre =35 plants/acre

Table 2: Calculating Replanting Densities for Tree Pots and Container Plants

	Average (per 20'radius releve, 0.029 acre)	Replanting Density per acre
Trees/shrubs		
Acacia constricta	1.6	55
Parkinsonia microphylla	1.2	42
Prosopis velutina	0.8	28
Cacti/succulents		
Carnegiea gigantea	0.6	21
Echinocereus fasciculatus	2.4	83
Ferocactus wislizeni	1	35
Mammillaria grahamii	4.4	152
Fouquieria splendens	0.8	28
Opuntia engelmanii	1	35
Opuntia versicolor	0.4	14

Notes:
Species highlighted in yellow or green have mitigation requirements satisfied under Step 1. Landscape consultant may chose to add additional 5 gal. plants in these species, depending on the specific situation, but this is not required.

Numbers for replanting densities are recommended guidelines, not mandates. Use of plants depends on specific planting environment

C. Determine Seed Mix

The main goal for re-vegetation is to re-establish the plant community present before disturbance. This can prove challenging as the plant community existing on the site prior to construction may represent a late seral (successional) plant community with long-lived perennials. Disturbance of the soils provides an optimal environment for establishment of ruderals or weedy annual plants. Seed mixes attempting to immediately re-establish perennial grasses and shrubs may have a difficult time establishing in the newly-disturbed soils. These later successional plants may have difficulty competing with annual weedy species and aggressive exotics including buffelgrass and fountain grass.

STEP 2: COMPREHENSIVE PLANT SAMPLING – RELEVE PROCESS

The Natural Resources Conservation Service (NCRS) of the United States Department of Agriculture recommends that seed mixes intended for restoration should try to establish an early to mid-seral community of native annual forbs and grasses that can effectively compete with invasive exotic species and can set the stage for re-establishment of the original native late seral (and more perennial) plant community over time. If the seedbank in the project soil has not been removed or covered over during project grading, the original plant community will regenerate over time. The emphasis in the seed mix should be on native annual forbs and grasses that will germinate quickly and provide cover. Some perennial grasses and tree and shrub species should also be included.

1. **Determine relative percentages of plants not included in the container plantings**.

   The first step in selecting a seed mix is to take each native plant relative to the total number of plant species and determine its percentage relative to the total number of plant species. Do not include plant species represented in the container plantings.

Hypothetical Seed Mix – First Step

	Average (per 20' radius releve, 0.029 acre)	% of Seed Mix	Pure Live Seed per 20 Pounds per Acre	Availability
Trees/Shrubs				
Larrea tridentata	**4**	3.8	.76	Yes
Subshrubs, Forbs, and				
Abutilon incanum	1.6	1.5	.30	No
Ambrosia deltoidea	17	16.2	3.24	Yes
Encelia farinosa	8.4	8.0	1.6	Yes
Lesquerella gordonii	4.6	4.4	.88	Yes
Psilostrophe cooperi	3.2	3.0	.60	Yes
Senna covesii	4	3.8	.76	Yes
Zinnia acerosa	21.6	20.6	4.12	Yes
Grasses				
Bouteloua aristidoides	5	4.8	.96	Yes
Erioneuron pulchellum	32.2	30.7	6.14	Yes
Muhlenbergia porteri	3.4	3.2	.64	Yes
	104.4	**100%**	**20**	

Notes:
Trees and large shrubs are generally not included in the seed mix for roadway projects due to setback restrictions, clear zone issues, and site visibility triangles. In riparian areas where these don't apply, larger shrubs and trees are to be included.

Seed mixes are to be adjusted for seed availability.

2. **Select seed mix using first step for general guidance. A seed mix should be developed by the consultant using the following criteria:**

   - Provide 20 to 25# PLS (pure live seed)/acre depending on project conditions
   - Provide up to 50% of seed mix as native grasses depending on project conditions.
   - Include species that germinate in both the warm and cool weather

STEP 2: COMPREHENSIVE PLANT SAMPLING – RELEVE PROCESS

Hypothetical Seed Mix – Second Step

	Pure Live Seed per 20 Pounds per Acre	Comment
Trees/Shrubs		
Larrea tridentata	1	
Subshrubs, Forbs, and		
Abutilon incanum	1.0	
Ambrosia deltoidea	0.5	
Encelia farinosa	2.0	
Lesquerella gordonii	0.5	
Psilostrophe cooperi	1.0	
Senna covesii	1.0	
Zinnia acerosa	1.0	
Grasses		
Aristida purpurea	3.0	Added because germinates well and will help re-stabilize slopes
Bouteloua aristidoides	2.0	
Erioneuron pulchellum	6.0	
Muhlenbergia porteri	1.0	
	20.0	

Notes:
Trees and large shrubs are generally not included in the seed mix for roadway projects due to setback restrictions, clear zone issues, and site visibility triangles. In riparian areas where these don't apply, larger shrubs and trees are to be included.

Seed mixes are to be adjusted for seed availability.

Proposed seed mixes shall be submitted to the Pima County landscape architect, along with all the data documenting the consultant's work. The Pima County landscape architect will assist and advise the consultant as to the final composition of the seed mix, based on the additional following considerations:

- Are there steep slopes that will be subject to erosion?
- Is the soil sandy and subject to greater erosion?
- Is there buffelgrass in the area? (If so, the percentage of native grasses to force quick cover should be increased)
- What time of year will the project be seeded? If this is known, what will germinate the quickest?
- Is the seed mix in a riparian mitigation area? If so, RFCD staff may provide additional seed mix recommendations.

STEP 3: REGULATED RIPARIAN HABITAT MITIGATION

Wherever Pima County Regulated Riparian Habitat (RRH) occurs on a r oad project, an additional step is required.

Pima County roadway projects regularly cross Regulated Riparian Habitat (RRH). The Riparian Classification Maps (RCM), which can be viewed on Pima County PimaMaps, show the location of RRH. When RRH occurs on a roadway project, mitigation for impacts is required whenever disturbance exceeds 1/3 acre. M itigation areas serve as a t ransition between the constructed roadway and adjoining natural areas, ensuring that roadway projects remain consistent with Pima County's overall goal of conserving and protecting floodplains and riparian corridors.

This section provides a step by step guide to the procedure to be followed when RRH occurs on roadway projects. The steps are:

A. Calculate RRH Disturbance/Locate mitigation areas/Determine type of mitigation.
   - Confirm accuracy of mapped areas
   - Calculate impacts. If impacts are greater than 1/3 of an acre, the remainder of Step 3 shall be followed.
   - Determine type of mitigation: o nsite mitigation and/or in-lieu fee (ILF). Onsite riparian mitigation is encouraged by the RFCD to the maximum extent practicable. If the required mitigation exceeds the amount of space available within the project area, then ILF can be paid for the remaining acreage. See "D" for calculating ILF.
   - If less than 1/3 acre of disturbance, submit exhibit showing the project footprint and mapped riparian area overlaid on an aerial photograph. C alculate disturbance for each type of RRH present and submit to RFCD. No further action is required.

B. Prepare Planting Plan and Riparian Habitat Summary sheets

C. Submit planting plans and RRH Summary Sheets to PCDOT and RFCD staff for review and approval.

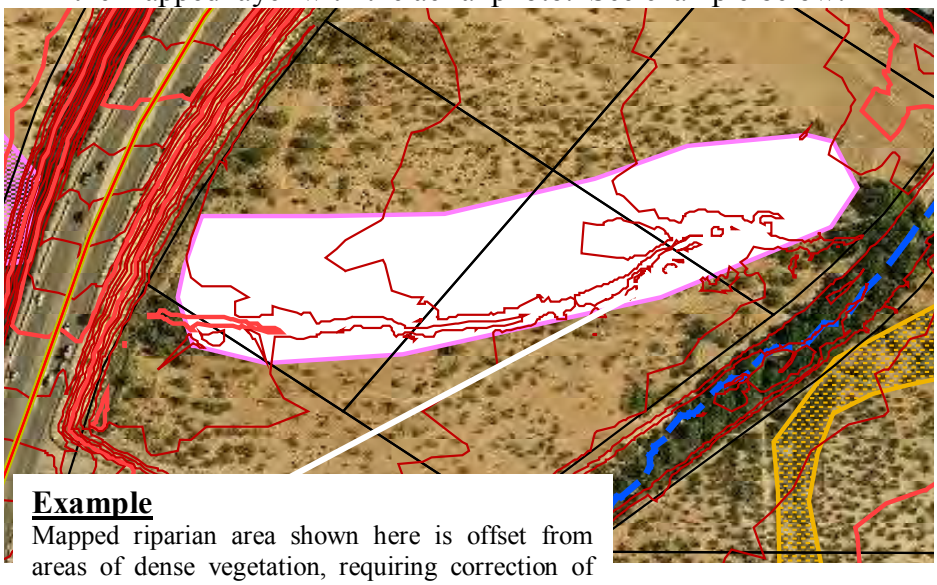
D. Calculate in lieu fee (ILF)

STEP 3: REGULATED RIPARIAN HABITAT MITIGATION

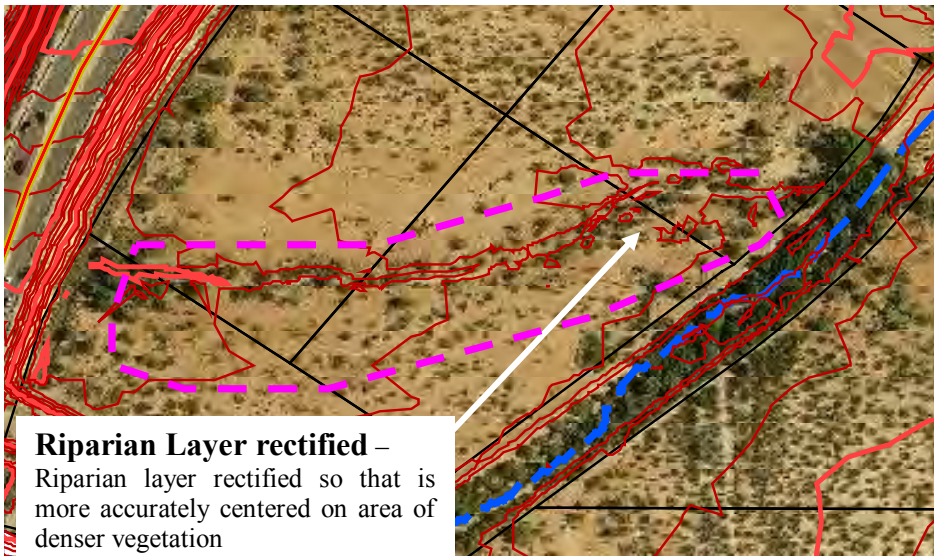
A. Calculate RRH Disturbance, locate mitigation areas, and determine type of mitigation.

1. **Confirm the accuracy of the mapped RRH**.
   - **Turn on riparian layers within Pima County PimaMaps:**
     - First turn on "Riparian Habitat - Pima County Ordinance 2005-FC2, Effective 10/20/2005" layer to determine the location of regulated riparian habitat.
     - Next turn on "IRA Underlying Classification" layer to determine the underlying class of habitat of Important Riparian Areas (IRA) (if applicable)

   - **Confirm the accuracy of the mapped RRH.** Occasionally the mapped RRH layer is incorrectly rectified with the GIS parcel base and aerial photograph. Prior to calculating disturbance of RRH, the consultant shall meet with Pima County Regional Flood Control District (RFCD) staff, if necessary, to rectify the mapped layer with the aerial photo. See example below:



Example
Mapped riparian area shown here is offset from areas of dense vegetation, requiring correction of PimaMaps layer with aerial photo.



Riparian Layer rectified –
Riparian layer rectified so that is more accurately centered on area of denser vegetation

STEP 3: REGULATED RIPARIAN HABITAT MITIGATION

2. **Define RRH disturbance within project limits.** See table below:

Type of Disturbance	Definition	Examples
Un-plantable RRH	Permanently modified land that cannot support riparian habitat.	• Concrete bridge abutments • Drainage structures • Pavement • Utility Easements • Significantly altered topography that does not support riparian vegetation. • Altered drainage patterns that divert flows away from existing riparian corridors
Plantable RRH	Land that may be altered during the construction process, but where habitat can be restored to pre-existing conditions	• Temporary project staging area/materials storage • Temporary construction access
Exempt Disturbances	Disturbances that do not count toward the 1/3 acre threshold	* Temporary disturbance of a sandy bottom wash * WUS (Waters of the US) mitigated through the U.S. Army Corps of Engineers permitting process

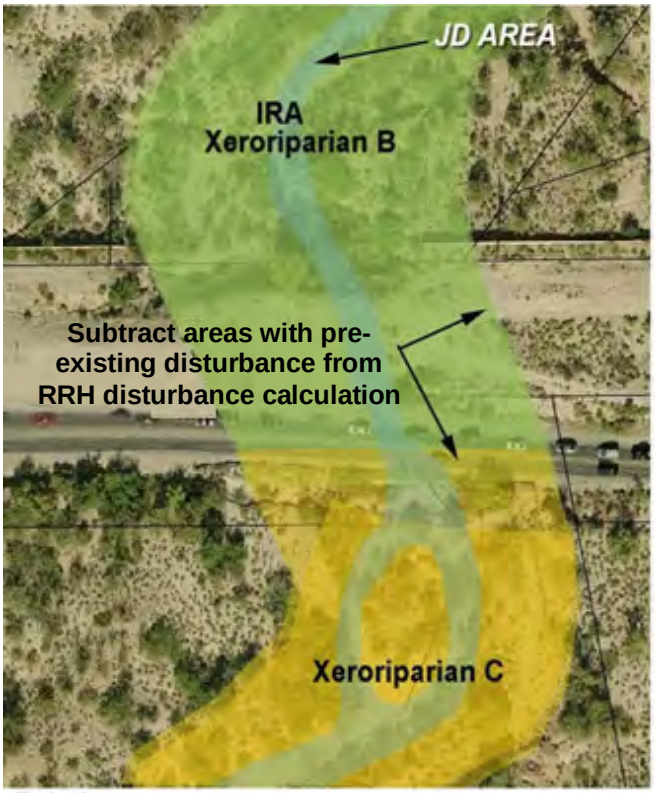
- Subtract areas within the mapped RRH that were disturbed prior to the effective date of the Riparian Classification Maps (either August 1998 or October 2005). Pre-existing disturbance is determined through review of historic aerial photography, available through Pima County PimaMaps and may include existing pavement and structures where vegetation has been disturbed and remains disturbed. An example is provided on page 20. Please contact RFCD staff for the 1998 RCM. The 2005 RCM can be viewed on PimaMaps.

- Subtract Exempt disturbances.

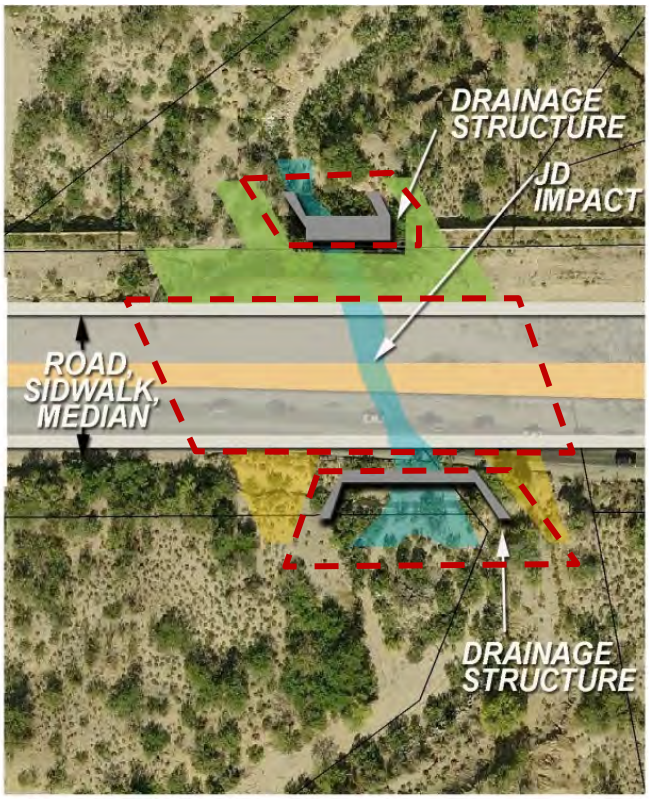
Note:
If determination of the pre-existing disturbance is unclear, please contact RFCD staff to discuss and resolve prior to submitting the RRH Summary Sheets.

STEP 3: REGULATED RIPARIAN HABITAT MITIGATION

Example:



Existing



Proposed Roadway Impacts

STEP 3: REGULATED RIPARIAN HABITAT MITIGATION

3. **Determine mitigation requirement, based on RRH disturbance.** (See pages 25 and 27 for example.) Follow the table below to determine acreage and other requirements:

Classification	Preferred Mitigation Option – Provide mitigation area within project area	Other Requirements – All RRH Disturbance	Alternate Option
RRH – all classes except IRA & Class H Plantable RRH Un-plantable RRH	**1:1 replacement**; for each acre disturbed, an acre shall be replaced in kind	• Use releve data (Step 2) to determine plant species composition and seed mix in mitigation areas. • Choose method for determining plant replacement ratio: p lant releve data (step 2, pages 10-16) or table below. • Minimum tree size is 15 gal or 24" tree pot • Minimum shrub size is 5 gal or 15" tree pot. • Mitigation trees determined in Step 1 may be used toward meeting the riparian habitat mitigation requirement. • Mitigation area shall be located within Plantable RRH. Mitigation areas may also be placed adjacent to existing riparian corridors, within areas that can support riparian habitat of a similar density and structure to the habitat that was disturbed. • If mitigation areas are proposed outside of the active floodplain, man-made features such as water harvesting basins shall be used to establish riparian habitat. • When no mitigation area is available adjacent to disturbed RRH within project area, other riparian corridors that are not mapped as RRH may be used for mitigation if they are able to support riparian vegetation (i.e. topography has not been modified) • Riparian mitigation areas shall be maintained using best management practices for invasive species according to PCDOT Special Provisions 201. Monitoring agreement shall be followed (see page 26)	In Lieu Fee (ILF) • **See #5, page 23 and #7, page 23-24**
IRA and Class H Plantable RRH	**1:1 replacement**; for each acre disturbed, an acre shall be replaced in kind		
IRA and Class H Un-plantable and Plantable RRH that will not be mitigated onsite	**1:1.5 replacement**; for each acre disturbed, 1.5 acres shall be replaced in kind		

Plant Replacement Ratio (quantity/acre)

Class	Trees/acre	Shrubs/acre
XA	75	90
XB	60	80
XC	45	70
XD	30	Like density
H	90	100

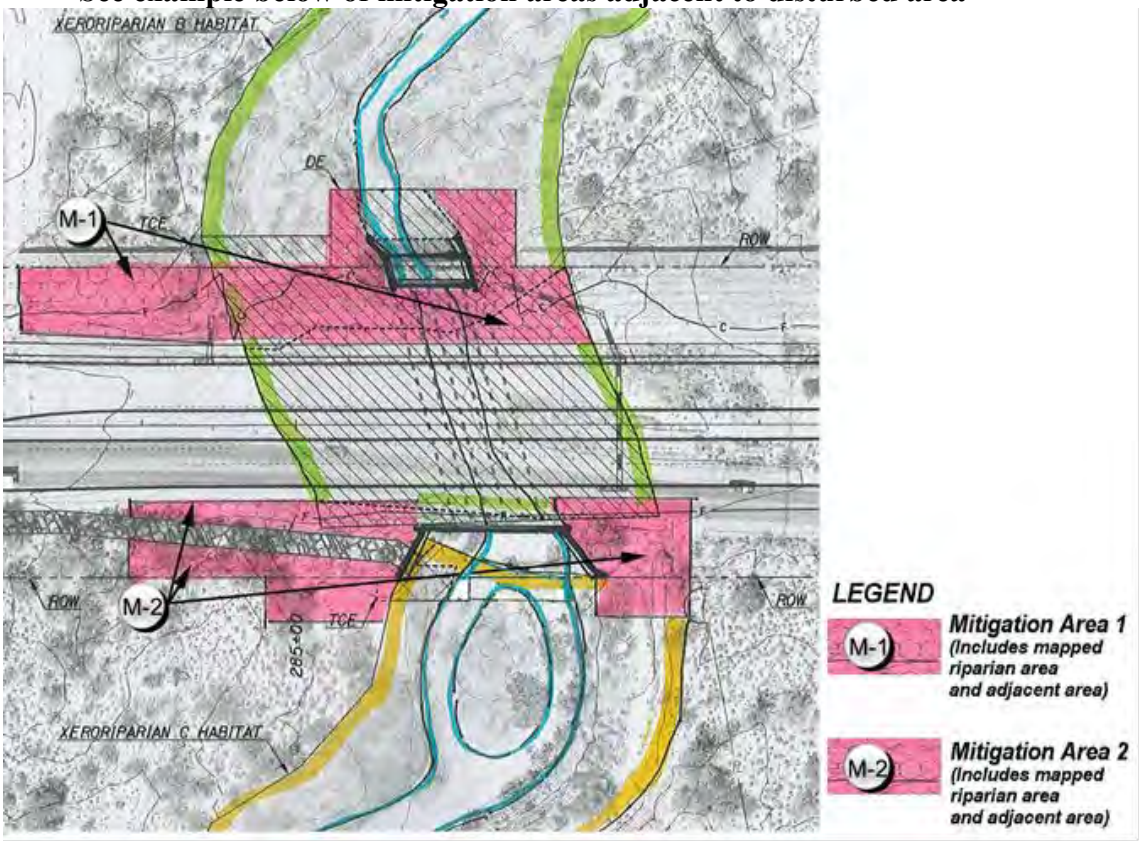
STEP 3: REGULATED RIPARIAN HABITAT MITIGATION

4. **Locate areas for riparian mitigation.** Areas that can support riparian mitigation include:
   - Low lying areas adjacent to existing regulated riparian habitat (RRH) or wash corridors
   - Partially disturbed RRH that can support additional plants
   - Un-mapped riparian/wash corridors
   - Banks and overbank areas of washes. Where braided or sheet flow occurs, vegetation can be supported in and near minor flow patterns, as long as flows will not be diverted from the established general drainage pattern.
   - Constructed water harvesting basins adjacent to existing RRH or wash corridors

Areas that are considered un-plantable:

- Where maintenance access is needed
- Areas limited by utility presence. See page 2.
- Directly upstream or downstream of culverts. Provide a 20' buffer around culvert inlets and outlets
- On a hill slope or other elevated topography that will not support riparian vegetation
- Active flow areas of washes

See example below of mitigation areas adjacent to disturbed area



Example of Locating Riparian Mitigation Area

STEP 3: REGULATED RIPARIAN HABITAT MITIGATION

5. **Determine if payment of in-lieu fee (ILF) is necessary.** If insufficient mitigation area is available within or adjoining to the project area, a partial ILF may be paid to RFCD's mitigation bank for purchase of high value riparian habitat in Pima County. ILF cost estimates shall be prepared in accordance with the ***Regulated Riparian Habitat Offsite Mitigation Guidelines for Unincorporated Pima County***, ***Appendix F,*** and #7, page 22.

6. **Prepare summary sheet of riparian impacts (RRH Summary Sheet).**
   See checklists below for information to be included on the RRH Summary Cover Sheet and RRH Summary Sheets. Examples of these sheets are on page 24 and 26.

   Review all work with PCDOT staff landscape architect and RFCD staff before moving on to planting plan preparation. See page 28-29 for planting plan preparation.

   RRH Summary Cover Sheet Checklist (Example on page 25)
   Plans shall include the following:
   - Location map
   - Project number and name
   - Project overview, justification for disturbance of RRH
   - RRH Monitoring Agreement and General Notes (see page 26 for Monitoring Agreement template)
   - Mitigation calculations summary table
   - Summary table of plant releve data measured within the RRH (page 13, Table 1)

   RRH Summary Sheet Checklist (Example on page 25)
   Plans shall include the following:
   - Scale and north arrow
   - Legend
   - Most recent aerial photograph; use as a base for the summary sheets
   - RRH limits
   - Limits of disturbance. Use hatching to distinguish between types of disturbance listed in the summary table
   - Proposed mitigation areas
   - Mitigation area reference table. Label and number each mitigation area and reference the corresponding sheet within the landscape plan
   -

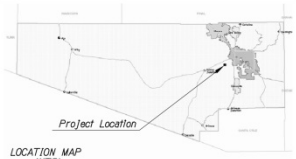
7. **Calculate in-lieu fee (ILF) when applicable.** Appendix F of the ***Regulated Riparian Habitat Offsite Mitigation Guidelines for Unincorporated Pima County***, ***November 2011*** shall be used as a guide in calculating ILF, for mitigation areas that cannot be accommodated within the project area:

STEP 3: REGULATED RIPARIAN HABITAT MITIGATION

- Refer to the criteria for "Commercial and Subdivision Development" within Appendix F
- Consult with PCDOT for the most current pricing on required items
- Assume that maintenance costs are 45% of total container plant material cost, regardless of habitat type.

STEP 3: REGULATED RIPARIAN HABITAT MITIGATION

RRH Summary Cover Sheet Example



LOCATION MAP
(NTS)

PROJECT OVERVIEW

The Pima County Department of Transportation (PCDOT), in conjunction with the Federal Highway Administration (FHWA) and Regional Transportation Authority (RTA), proposes to widen 2.91 miles of Valencia Road from two lanes to four lanes from approximately 0.4 mile west of Wade Road to approximately 0.3 mile west of Mark Road. The project includes providing paved shoulders in each direction, a raised, landscaped median, a paved sidewalk along the north side of Valencia Road from Wade Road to Camino Verde and asphalt path along the south side of Valencia Road from Camino Verde to Mark Road. Several existing dip crossings of Valencia Road and open channels will be replaced with new culverts, in addition to constructing roadside drainage ditches.

There are 8 locations within the project limits that contain designated riparian habitat. Xeroriparian B and C habitat will be impacted at two unnamed washes at Wade Road and east of Star Diamond Place and Important Riparian Area habitat with underlying classification of Hydro/mesoriparian or mesoriparian H and Xeroriparian B will be impacted at Black Wash and numerous unnamed washes. The disturbance is due to drainage improvements and avoidance of these areas is not feasible.

The project area lies in the Arizona Upland subdivision of Sonoran desertscrub biotic community. The project area is characterized by a combination of arid vegetation types associated with desertscrub, xeroriparian, disturbed upland and landscape planting. Dominant species in the area include whitethorn acacia (Acacia constricta), catclaw acacia (Acacia greggii), desert hackberry (Celtis ehrenbergiana), jumping cholla (Cylindropuntia fulgida var. fulgida), blue palo verde (Parkinsonia florida) velvet mesquite (Prosopis velutina), creosote bush (Larrea tridentata) and Foothills palo verde (Parkinsonia microphyllum).

RRH MONITORING AGREEMENT AND GENERAL NOTES

1. Pima County DOT agrees to preserve and protect mitigation areas within Transportation's roadway project area as follows: Pima County DOT agrees to actively maintain the mitigated area until a minimum of 80% of the plants originally planted as 15 gallon or smaller in size are living and actively growing (without significant dieback or loss) after 1 year without supplemental irrigation. Plants larger than 15 gallon in size will be irrigated in accordance with USFWS requirements. Maintenance activities shall include, but not be limited to, the regular operation of the irrigation system, the replacement of dead trees and shrubs, and the removal of noxious and/or invasive plant species.
2. Mitigation area(s) to be left in a natural state. No disturbance shall occur within the mitigation area(s). Such disturbance includes but is not limited to secondary impacts such as fencing, intensive landscaping, etc.
3. Mitigation area(s) shall be seeded with a minimum of 12 species determined from the roadway project ESR Releve Report. Plant species shall be selected from releves completed within riparian habitat areas. Seeding methods include; hydroseeding, drill seeding with crimped straw mulch or broadcast seeding and raking into seedbed with straw or other approved mulch. These species are identified as Seed Mix 'A' (HSA) in Section 805 of the Special Provisions. Of the 12 species, 4 shall be shrubs, 4 shall be annuals/perennials/vines, and 4 shall be grasses. If plant species listed in Seed Mix 'A' (HSA) are unavailable, replacements species from the Releve Report (riparian releves) and/or approved (Class H or Xeroriparian (select based on habitat type present)) plant list may be selected based upon availability. Any changes to the seed mix shall be noted on the first monitoring plan submittal.
4. Once plants originally planted as 15 gallon or smaller in size have established (approximately 1 to 3 years after installation), supplemental irrigation will be decreased in accordance with Appendix C of the Guidelines.
5. RHMP implementation shall be completed by the first growing season following completion of construction, which is projected to be March-May, 2015.
6. A monitoring plan, in accordance with the Guidelines, will be submitted annually until a minimum of 80% of the plants originally planted as 15 gallon or smaller in size are living and actively growing (without significant dieback or loss) after 1 year without supplemental irrigation.
Any changes from the approved RHMP shall be noted on the monitoring plan submittal." Submittals shall be labeled "Annual Monitoring Report for PCDOT Project #4RTVMW and sent to the following address:
Pima County Regional Flood Control District
ATTN: Water Resources Division Staff
97 E. Congress Street, 2nd floor
Tucson, AZ 85701
The assigned PCDOT monitor for this project is Ellen Alster.
7. Riparian habitat to be preserved shall be fenced for protection during construction using minimum 4-foot high orange mesh barricade fencing. Protective fencing must remain in place throughout construction.

TABLE 1 - SUMMARY OF MITIGATION AREA REQUIREMENT

24-April-2014 2:41 PM

Riparian Class & temporary or permanent impact	Riparian Area Impacted (SF)	Previously Disturbed Area to be Subtracted	JD Area to be Subtracted when applicable	Total Adjusted Impacted Area (SF)	Mitigation Ratio	Mitigation Area Required (Acre)
Xeroriparian B (plantable)	2,943	0	342	2,601	1	0.06
Xeroriparian B (un-plantable)	13,717	10,596	284	2,837	1	0.07
Xeroriparian C (plantable)	3,190	0	355	2,835	1	0.07
Xeroriparian C (un-plantable)	20,312	7,155	3,234	9,923	1	0.23
IRA / XB (plantable)	37,920	6,068	1,558	30,294	1	0.70
IRA / XB (un-plantable)	222,316	109,784	4,843	107,689	1.5	3.71
IRA / H (plantable)	24,617	6,136	1,575	16,906	1	0.39
IRA / H (un-plantable)	192,190	94,162	4,154	93,874	1.5	3.23
			TOTAL MITIGATION AREA REQUIRED			**8.44**
			TOTAL PROPOSED MITIGATION AREAS			**3.35**
			Ratio of Proposed Riparian Mitigation Area/Required			0.40
			BALANCE OF MITIGATION (to be provided via in-lieu fee)			**5.09**

TABLE 2 - MITIGATION TREE AND SHRUB REQUIREMENTS

24-April-2014 2:41 PM

Riparian Class	Riparian Area Impacted (Acre)	Tree and Shrub Requirements (per acre of dist.)	Tree and Shrub Totals (per Riparian Class)	Tree and Shrub Totals (to place in available Mitigation Area: 3.35 ac)
Xeroriparian B (plantable and unplantable)	0.13	60 Trees 80 Shrubs	8 10	3 4
Xeroriparian C (plantable and unplantable)	0.30	45 Trees 70 Shrubs	14 21	5 8
IRA / XB (plantable)	0.70	60 Trees 80 Shrubs	42 56	17 22
IRA / XB (un-plantable)	3.71	60 Trees 80 Shrubs	222 297	88 118
IRA / H (plantable)	0.39	90 Trees 100 Shrubs	35 39	14 15
IRA / H (un-plantable)	3.23	90 Trees 100 Shrubs	291 323	115 128
			Total Trees	**243**
			Total Shrubs	**296**

Tree and shrub requirement numbers determined by using mitigation requirements as set forth in Pima County Flood Control District "Regulated Riparian Habitat Mitigation Standards and Implementation Guidelines". (page 36 & 39)

TABLE 3 - SUMMARY OF MITIGATION REPLANTING REQUIREMENT DENSITY/NUMBERS BY SPECIES

24-April-2014 2:40 PM

Botanical Name	Common Name	Total Density	Average Density (3 releves)	Invasive	Releve Density per Acre	Releve Density Total Mitigation Area (acres) 3.35	Releve % by Species	Replanting # by Species*
Trees								
Acacia constricta	whitethorn acacia	16	5.33		183.91	616	0.41	100
Acacia greggii	catclaw acacia	0	0.00		0.00	0	0.00	0
Olneya tesota	ironwood	1	0.33		11.49	39	0.03	6
Parkinsonia florida	blue palo verde	5	1.67		57.47	193	0.13	31
Prosopis velutina	velvet mesquite	17	5.67		195.40	655	0.44	106
					Total	1502		**243**
Shrubs/Cacti								
Ambrosia ambrosioides	canyon ragweed	0	0.00		0.00	0	0.00	0
Ambrosia deltoidea	triangle-leaf bursage	1	0.33		34.48	116	0.01	3
Atriplex canescens	fourwing saltbush	2	0.67		68.97	231	0.02	6
Baccharis sarothroides	desert broom	6	2.00	x	0.00	0	0.00	0
Bothriochloa barbinodis	cane bluestem	0	0.00		0.00	0	0.00	0
Celtis pallida	desert hackberry	1	0.33		34.48	116	0.01	3
Gutierrezia sarothrae	snakeweed	10	3.33		344.83	1155	0.10	30
Heteropogon contortus	tanglehead	0	0.00		0.00	0	0.00	0
Hilaria mutica	tobosagrass	0	0.00		0.00	0	0.00	0
Isocoma tenuisecta	burrowweed	66	22.00		2275.86	7624	0.67	199
Larrea tridentata	creosote	1	0.33		34.48	116	0.01	3
Lycium andersonii	anderson wolfberry	17	5.67		586.21	1964	0.17	51
Opuntia leptocaulis	christmas cactus	0	0.00		0.00	0	0.00	0
Pappophorum vaginatum	whiplash pappusgrass	0	0.00		0.00	0	0.00	0
Psilostrophe cooperi	paperflower	0	0.00		0.00	0	0.00	0
Sporobolus airoides	alkali sacaton	0	0.00		0.00	0	0.00	0
Ziziphus obtusifolia	graythorn	0	0.00		0.00	0	0.00	0
					Total	11321		**296**

*Total tree and shrub replanting numbers taken from Table 2

Priscilla S. Cornelio, P.E., Director

Pima County Department of Transportation

No.	Revision Description	Date
1	Revised Areas	08/2012
2	Revised Areas	10/2012
3	Final Revision per PCRFCD	11/2012
4	Revised Areas (waterline)	12/2013

Engineer

		Date
Designed	CJ, LR,	04/2014
Drawn	CJ	04/2014
Checked	LR	04/2014
Proj. LA	LR	04/2014

Design Consulting

VALENCIA ROAD
WADE ROAD TO MARK ROAD
PROJECT NO. 4RTVMW

Scales | Horiz. 1"=160 @ 11x17 | RRH-1 | Page XX of XX

STEP 3: REGULATED RIPARIAN HABITAT MITIGATION

RRH MONITORING AGREEMENT AND GENERAL NOTES
To be added to all PCDOT plans that include areas of RRH mitigation

Pima County DOT agrees to preserve and protect mitigation areas within Transportations' roadway project area as follows: Pima County DOT agrees to actively maintain the mitigated area until a minimum of 80% of the plants originally planted as 15 gallon or smaller in size are living and actively growing (without significant dieback or loss) after 1 year without supplemental irrigation. Plants larger than 15 gallon in size will be irrigated in accordance with USFWS requirements. Maintenance activities shall include, but not be limited to, the regular operation of the irrigation system, the replacement of dead trees and shrubs, and the removal of noxious and/or invasive plant species.

Additional General Notes:

1. Mitigation area(s) to be left in a natural state. No disturbance shall occur within the mitigation area(s). Such disturbance includes but is not limited to secondary impacts such as fencing, intensive landscaping, etc.

2. Mitigation area shall be seeded with a minimum of 12 species determined from the roadway project ESR Releve Report. Plant species shall be selected from releves completed within riparian habitat areas. Seeding methods include; hydroseeding, drill seeding with crimped straw mulch or broadcast seeding and raking into seedbed with straw or other approved mulch. These species are listed in the Riparian Seed Mix on Sheet xxxxx of the Landscape Plan. Of the 12 species, 4 shall be shrubs, 4 shall be annuals/perennials/vines, and 4 shall be grasses. If plant species listed in the Riparian Seed Mix are unavailable, replacements species from the Releve Report (riparian releves) and/or approved (Class H or Xeroriparian (*select based on habitat type present)*) plant list may be selected based upon availability. Any changes to the seed mix shall be noted on the first monitoring plan submittal.

3. Once plants originally planted as 15 gallon or smaller in size have established (approximately 1 to 3 years after installation), supplemental irrigation will be decreased in accordance with Appendix C of the Guidelines.

4. RHMP implementation shall be completed by the first growing season following completion of construction, which is projected to be (select one season) March-May, 20XX/July-September, 20XX/September-November, 20XX.

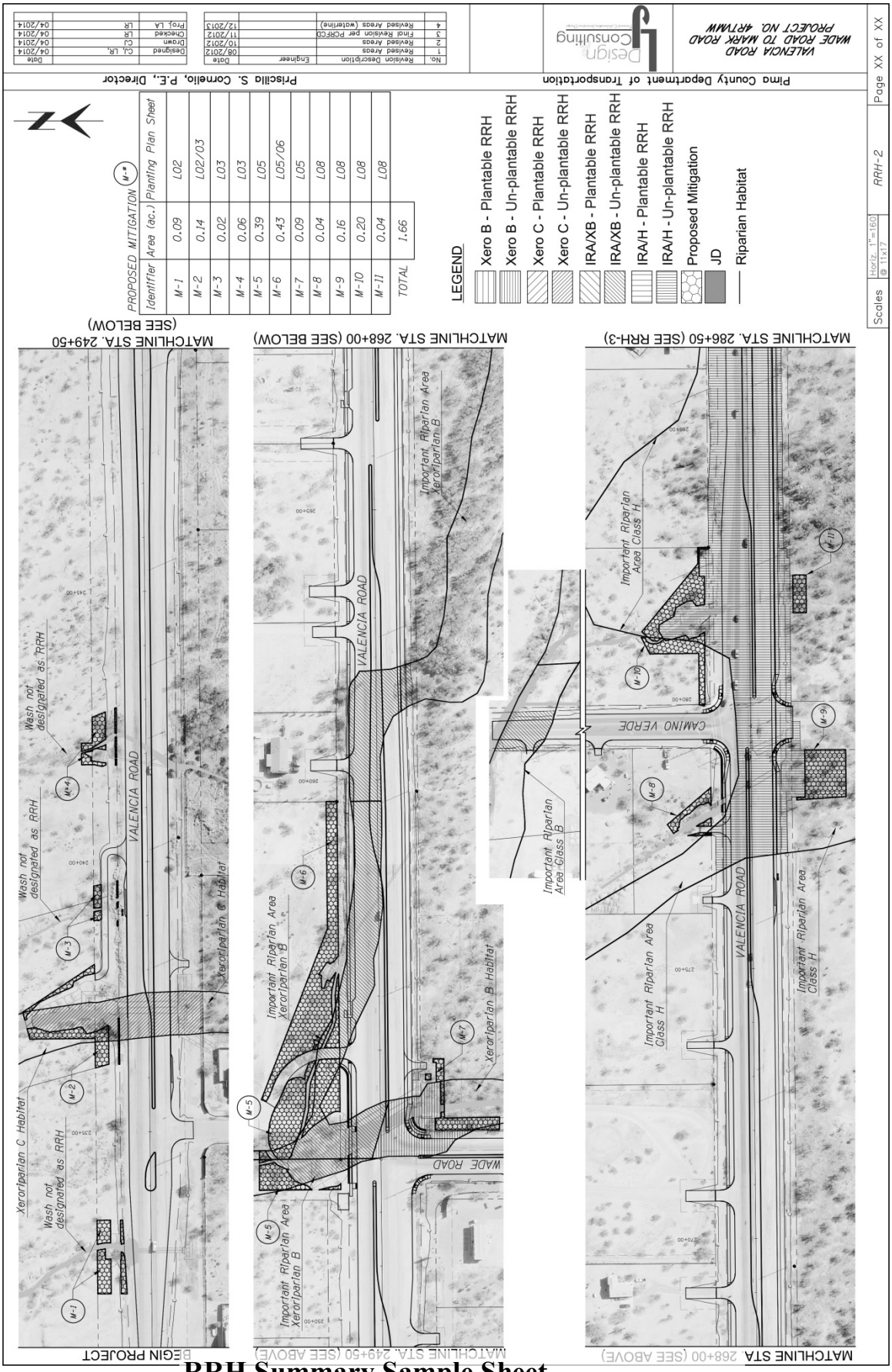
5. A monitoring plan, in accordance with the Guidelines, will be submitted annually until a minimum of 80% of the plants originally planted as 15 gallon or smaller in size are living and actively growing (without significant dieback or loss) after 1 year without supplemental irrigation. Any changes from the approved RHMP shall be noted on the monitoring plan submittal." Submittals shall be labeled "Annual Monitoring Report for PCDOT Project #XXXXXX" and sent to the following address:

Pima County Regional Flood Control District
ATTN: Water Resources Division Staff
97 E. Congress Street, 2nd floor
Tucson, AZ 85701

(***Select one of the following comments below***):
The assigned PCDOT monitor for this project is _____ OR
The assigned PCDOT division/section that will monitor this project is _____

6. Riparian habitat to be preserved shall be fenced for protection during construction using minimum 4-foot high orange mesh barricade fencing. Protective fencing must remain in place throughout construction.

STEP 3: REGULATED RIPARIAN HABITAT MITIGATION



RRH Summary Sample Sheet

STEP 3: REGULATED RIPARIAN HABITAT MITIGATION

B. Prepare Planting Plan

The plan shall delineate mitigation areas as shown in the example on page 28. T he mitigation areas shall be planted using plant densities and species composition provided in the RRH Summary sheets.

- Areas highlighted in yellow show RRH mitigation areas. Also show JD areas, shaded in gray in example on page 28.
- Label mitigation areas with identifier used in the RRH Summary Sheets (example, "M-1"," M-2", "M-3", etc.)
- Identify riparian habitat seed mix on the plan or in the Special Provisions, which is most appropriate for the project.
- Ensure plant species and quantities used within the mitigation areas match plant species and quantities found in the RRH Summary sheets.

Other considerations in planting mitigation areas include:

- Placing larger trees in/near wash crossings per U.S. Fish and Wildlife Service requirements
- Maximizing planting areas on upstream side of road where ponding may occur
- Reducing planting densities on downstream side of road where water flow may be reduced

C. Submit the following items for review by RFCD and PCDOT staff:

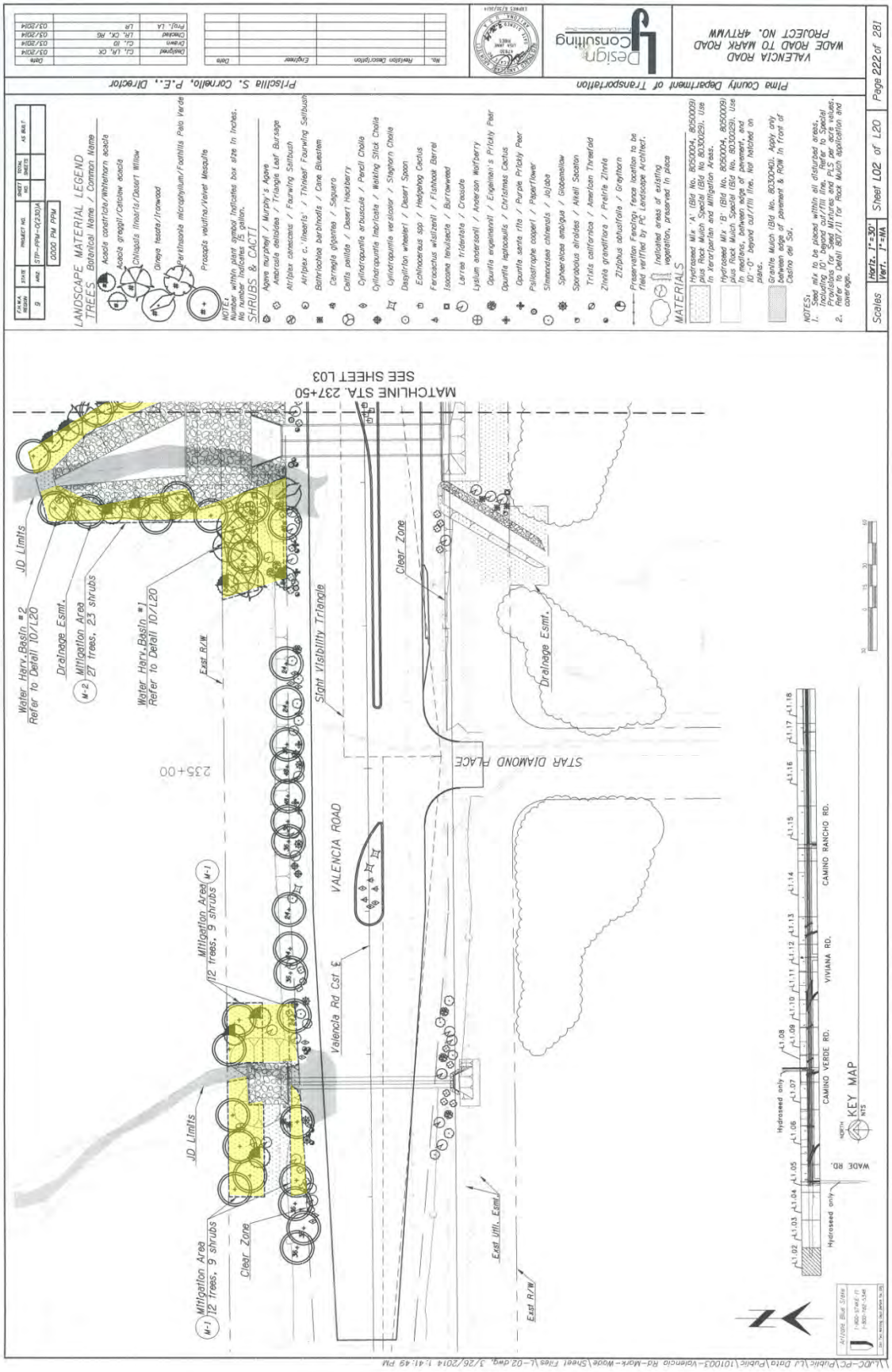
For internal review by PCDOT and RFCD staff only:

- RRH Summary Sheets (requirements found on page 23)
- ILF calculations when applicable. See #7, page 23-24.

For inclusion in roadway construction document set

- Planting Sheets:
  RRH Mitigation Areas will be noted on planting plans. Include correct plant quantities, species composition, and seed mix. See Planting Sheet example on page 29.

STEP 3: REGULATED RIPARIAN HABITAT MITIGATION



RRH Sample Planting Plan Sheet

APPENDIX E

ESR and RRH Comparison Chart

Appendix E - Comparision of Plant Replacement Ratios

Riparian Habitat Classification	Quantity of Trees/Acre	Required Sizes	Quantity of Trees/Acre - Option to Basic Requirement (all 15 gallon, reduce quanity by 20%)	Shrubs/Acre
Xeroriparian Class A habitat	75	50% 15 gal., 50% 5 gal.	60	90 shrubs/acre of disturbance
Important Riparian Areas w/ underlying Class A	113	50% 15 gal., 50% 5 gal.	90	90 shrubs/acre of disturbance (x 1.5 for IRA) = 135
Xeroriparian Class B habitat	60	50% 15 gal., 50% 5 gal.	48	80 shrubs/acre of disturbance
Important Riparian Areas w/ underlying Class A	90	50% 15 gal., 50% 5 gal.	72	80 shrubs/acre of disturbance x 1.5 (x 1.5 for IRA) = 120
Xeroriparian Class C habitat	45	50% 15 gal., 50% 5 gal.	36	70 shrubs/acre of disturbance
Important Riparian Areas w/ underlying Class A	68	50% 15 gal., 50% 5 gal.	54	70 shrubs/acre of disturbance x (x 1.5 for IRA) = 105
Xeroriparian Class D habitat	30	50% 15 gal., 50% 5 gal.	24	Replace in like-kind and density
Important Riparian Areas w/ underlying Class D	45	50% 15 gal., 50% 5 gal.	36	Replace in like-kind and density
Class H and Important Riparian Area w/ underlying Class H	135	100% 15 gal	na	90 shrubs/acre of disturbance x 1.5 (x 1.5) = 135
PCDOT Environmentally Sensitive Roadway (ESR) Sample Projects*	**Quantity of Trees/Acre**	**Required Sizes**	**Quantity of Trees/Acre - Option to Basic Requirement (all 15 gallon, reduce quanity by 20%)**	**Shrubs/Acre**
-La Canada - Ina to Calle Concordia	143	15 gallon to 48" box (min. size 15 gallon)	na	Not Specified, but based on releve survey
-Sunrise - Craycroft to Kolb	90	15 gallon to 48" box (min. size 15 gallon)	na	Not Specified, but based on releve survey
-Craycroft - River to Sunrise	103	15 gallon to 48" box (min. size 15 gallon)	na	Not Specified, but based on releve survey
-Magee - first phase	107	15 gallon to 48" box (min. size 15 gallon)	na	Not Specified, but based on releve survey
-River - Campbell to Alvernon	139	15 gallon to 48" box (min. size 15 gallon)	na	Not Specified, but based on releve survey

*Plant quantities based on onsite plant survey

APPENDIX F

District Technical Policies and Procedures

Technical Policy, TECH-004

Delineating Regulated Riparian Habitat Disturbance

PIMA COUNTY REGIONAL FLOOD CONTROL DISTRICT
TECHNICAL POLICY

POLICY NO.: Technical Policy, TECH-004 EFFECTIVE DATE: **March 19, 2014**

POLICY NAME: Delineating Regulated Riparian Habitat Disturbance

PURPOSE: To clarify Section 16.30.040 regarding how to delineate Regulated Riparian Habitat (RRH) disturbance.

BACKGROUND:
Section 16.30.040 of the Floodplain Management Ordinance (Ordinance) states the "*...proposed development will be reviewed for impacts to mapped riparian habitat whenever more than 1/3 of an acre of a property's regulated riparian habitat is disturbed.*" However, the Ordinance does not describe how to delineate the areas of disturbance, which is needed in order to determine if, or when, the mitigation threshold is reached.

When RRH cannot be avoided, the extent of disturbance resulting from new development must be delineated. Different types of development have different impacts during and after construction. These types of disturbances may be temporary or permanent, or may result in either partial or complete disturbance of RRH. To ensure consistency among review staff when delineating RRH disturbance, this procedure will distinguish between these types of disturbances, define a "project" and describe how to calculate RRH disturbance for each project.

POLICY:

A. Defining Disturbance – Types of Disturbance

In order to determine if mitigation is required, or to determine the amount of mitigation required, the type of disturbance, as defined below, should be considered.

1. *Complete disturbance of RRH*. Complete disturbance of RRH is defined as any area that has been graded whereby all vegetation has been removed. In most cases, improvements will be constructed within the disturbed area and full mitigation will be required. Types of complete disturbance include:
    a. Clearing: The substantial removal of vegetation.
    b. Excavation: The artificial (i.e., mechanical, manual, blasting or other such) means for removal of earth material.
    c. Grubbing: The removal of trees and other large plants by their roots.
    d. Filling: The placement of earth material upon an existing grade.

2. *Partial disturbance of RRH*. Partial disturbance of RRH is defined as any area where vegetation has been partially removed ("brushing") or where the total vegetation volume and diversity of the riparian plant community has been reduced. Types of partial disturbances include:
    a. Disturbance that removes understory vegetation (small trees, shrubs, perennials, annuals, and grasses), woody debris and/or organic matter while preserving mature

trees. When understory vegetation has been removed but trees have been preserved-in-place.

b. Disturbance for fire prevention. In certain areas of Pima County, the local fire district may require the creation of defensible space around existing structures. Within the defensible space, which shall be a distance no greater than 30 feet from the perimeter of the structure, vegetation can be thinned and/or pruned in accordance with local fire district directives. Documentation from the local fire district is necessary in order to establish this as disturbance that does not require mitigation.

3. *Temporary disturbance of RRH*. Temporary disturbance is defined as a disturbance that is expected to return to natural conditions, including grading within the sandy bottom of natural channels that are devoid of native vegetation, or the trimming of vegetation, without removing it, when no recurrent or long-term use is anticipated.

B. Cumulative Disturbance - Definition of a Project:

Disturbance that occurs after the effective date of the RCM is cumulatively counted toward the 1/3 acre mitigation trigger. Once 1/3 acre disturbance is reached, mitigation is required for the entire amount of disturbance and for each subsequent disturbance. However, for large scale development, including the disturbance that results from required off-site improvements or from the estimation of disturbance for future development within the project area, such as blocks within a block plat, can be punitive. Establishing a 1/3 of an acre threshold on a per project basis offsets the unintended consequence that might occur due to the size or scale of a development. This would apply to development that does not chose alternate mitigation strategies such as the Habitat Conservation Plan. For the purpose of determining cumulative disturbance of RRH, the following definitions of project shall apply unless specific conditions are established through a rezoning, specific plan, etc:

1. Master block plat: The spine roads and major utilities will be considered a single project. Each block will be considered a separate project and will have its own review at the time of development
2. Development of a subdivision:
    a. When mass grading occurs, this is a single project and shall include any RRH disturbance within the subdivision lots in addition to disturbances associated with streets, utilities and other infrastructure,
    b. When large lots are proposed (no mass grading), the project will not include future disturbances related to development of the individual lot by the property owner.
3. Development Plan: A development plan will be considered an individual project.
4. Off-site improvements: Any off-site improvements required to support any new development will be considered a separate project.
5. Improvement plans: Improvement plans that not associated with an approved plat, or development plan, or an improvement plan associated with an older subdivision plat (ex. New Tucson) will be considered an individual project.
6. Private access easement: When the grading of a private access easement is proposed with the development of a single residential lot, impacts for both the easement and lot will be reviewed as one project.
    a. In cases where an access easement traverses RRH on property owned by someone other than the applicant, the easement shall be treated as an individual project. When

the use of an easement disturbs greater than 1/3 acre RRH, the applicant (user) shall be responsible for mitigation. The in-lieu fee option shall be used to mitigate for disturbance, unless there is a suitable area available on the applicant's property for onsite mitigation.

C. Exempt Disturbances – Those that do not count toward the 1/3 acre threshold:

The following disturbances do not count toward the 1/3 acre mitigation threshold regardless of when they occurred:

1. The disturbance of areas designated as jurisdictional Waters of the U.S. (WUS) by the U.S. Army Corps of Engineers <u>and</u> which will be mitigated through the Corps permitting process. The disturbed acreage of WUS located within mapped RRH that will be mitigated can be subtracted from the total acreage of RRH disturbance in order to not double count the disturbance and mitigation.
2. Temporary disturbances as defined in Section A.
3. Removal of noxious and invasive plants.
4. Disturbance for the creation of walking paths and trails that are identified within the Eastern Pima County Trails Master Plan or other trails required by Pima County. Additionally, disturbance for trails that are nominally no wider than 4 feet, avoids disturbance by weaving around mature vegetation and other sensitive areas, remains at-grade, and remains natural soil.
5. For road projects, only the area located within the grading limits shall be counted as disturbance. Other areas located within the road right-of-way that will not be disturbed during construction are not counted toward the 1/3 acre mitigation threshold.

D. Calculating Disturbances for commonly proposed improvements:

Unless specific information, evidence and/or procedures are provided showing less construction disturbance, the following procedures shall be used to calculate riparian habitat disturbance:

1. Grading limits for new structures: A minimum grading envelope that extends 15 feet from the perimeter of the structure shall be shown. A lesser distance, not less than 5 feet, may be proposed if protective fencing is used to delineate the grading envelope. In this case the following note shall be placed on the site plan:

   Preserved riparian habitat shall be protected during construction using protective fencing. Protective fencing must be located as shown on the site plan and must remain in place throughout the construction and development process.
2. Disturbance caused by utility trenches: An assumed width of 5 feet shall be used for utility trench construction. Multiply the linear footage of the trench within RRH by 5 feet to calculate the disturbance.
3. Disturbance caused by the septic system: Disturbance shall be calculated for the entire septic system, including all piping, the septic tank, the distribution box, and disposal area. An additional 5 feet of disturbance around the perimeter of the disposal area shall be provided. The reserve area is not counted as disturbance until such time when the reserve is needed and a septic permit obtained.
4. Disturbance caused by block wall or fence:

a) For standard decorative block walls and fences, disturbance shall be calculated by assuming a disturbance width of 5 feet. Multiply the linear footage of the wall within RRH by 5 feet to calculate the disturbance.
b) Disturbance for structural wall or retaining wall must be shown on a detail of the construction method used on the site plan.
c) For all open type fencing, (e.g. split rail, corral or barbed/smooth wire fencing), a width of 5 feet shall be used unless the applicant can demonstrate that the construction method used will be less disruptive. Within Important Riparian Areas, site specific placement of posts and fencing will be necessary to avoid mature vegetation and to minimize disturbance by locating the fence to avoid unique features such as mature tree species specific to riparian areas (such as Fremont cottonwood (*Populus fremontii*), Arizona sycamore (*Platanus wrightii*), and Arizona black walnut (*Juglans major*)) and existing drainage patterns or swales containing denser, more diverse vegetation.
d) When a perimeter block wall is located within Important Riparian Areas, sections of open type fencing shall be included in the wall design.

5. Disturbance caused by enclosing an area: Unless fifty percent of the wall is constructed of open-type fencing, wrought iron panels, or an equivalent type barrier, the entire area that is enclosed by a wall or fence shall be calculated as disturbed.
6. Private access easement: When the grading of a private access easement is proposed with the development of a single residential lot, impacts for both the easement and lot will be reviewed as one project.
7. Horse and other livestock grazing for residential or commercial primary uses: Pastures located within RRH shall be considered partial disturbance and counted toward the 1/3 acre mitigation threshold. RRH that is fenced-off to permanently exclude livestock will be considered preserved and does not count toward the 1/3 acre mitigation threshold.
8. Disturbance associated with an approved Site Construction Permit. The grading limits shown on the approved Site Construction Permit shall be used to calculate riparian habitat disturbance.
9. Mitigation for Partial Disturbance of RRH understory vegetation will not include the cost of replacing trees.

E. Disturbance of less than 1/3 acre RRH:

All projects will be reviewed by the District for impacts to RRH. By reviewing a project, staff can assist applicants with site planning that will avoid and/or minimize impacts to RRH, prevent the need for a riparian habitat mitigation plan, and ensure that floodplain function and riparian resources are preserved (see Technical Policy-024, *Avoiding Regulated Riparian Habitat Requirement*).

APPROVED BY:

Suzanne Shields 3/25/2014

Suzanne Shields
Director Date

Original Policy Approved:
Date(s) Revised:

Technical Procedure, TECH-104

Evaluating and Adjusting the Riparian Classification Maps

PIMA COUNTY REGIONAL FLOOD CONTROL DISTRICT
TECHNICAL PROCEDURE

POLICY NO.: Technical Procedure, TECH-104 EFFECTIVE DATE: **March 19, 2014**

PRODECURE NAME: Evaluating and Adjusting the Riparian Classification Maps

PURPOSE: To establish a clear and consistent approach to evaluating the extent and classification of the Riparian Classification Maps (RCM) to account for spatial error, age of disturbance relative to the effective date of the RCM, and accuracy of the classification.

BACKGROUND: Section 16.30.080.B of the Floodplain Management Ordinance (Ordinance) states that: "*Where a question arises as to the location of any regulated riparian habitat or Important Riparian Area, the question shall be decided by the Chief Engineer consistent with riparian habitat standards adopted by the Board.*"

Some questions regarding interpretation of the Riparian Classification Maps arise more frequently than others. Specifically, they include projection errors when comparing the Riparian Classification Maps to aerial photos and the parcel base, determining when disturbance of regulated riparian habitat occurred as relative to the effective date of the Riparian Classification Maps, and confirming the accuracy of the riparian habitat classification based on site conditions.

This procedure will provide guidance on how these interpretations should be made and how these interpretations can be memorialized so that they can be consistently applied as appropriate.

PROCEDURE:

I. Effective date of the Riparian Classification Maps (RCM)

Disturbances that occur after the RCMs became effective are the only disturbances that shall be counted. The following RCM effective dates shall be used:

<u>1994 Riparian Classification Maps</u> (commonly known as the "1999 RCM") became effective on August 13, 1998 for all development, unless specifically called out on the development plan or subdivision plat approved prior to this date.

<u>2005 Riparian Classification Maps</u> became effective on October 20, 2005 for all development.

The following typical scenarios show how to determine when disturbances should be counted:

A. Subdivision Plats and Development Plans:

For plats or development plans that were approved prior to the effective date of the RCM, any new disturbances on individual lots that occur after the effective date of the RCM shall be counted toward 1/3 acre of disturbance on that lot. For example, custom lot subdivisions frequently obtain a grading plan for infrastructure, such as roads and utilities, but leave the lots ungraded until purchased and developed by the new owner. Although the plat may have been approved prior to adoption of the RCM, each building permit application is considered a new project and falls under current regulatory requirements. There are a few exceptions to this approach and administrative plat notes have been added to these subdivisions, which state these exceptions.

B. Single-lot Development:

Disturbance of regulated riparian habitat (RRH) that occurred prior to the effective date of the RCM is considered pre-existing and does not count toward the 1/3 acre mitigation threshold, unless native vegetation has regrown within the disturbed area, or a portion thereof. In this case, the new disturbance within this area will count toward the 1/3 acre mitigation threshold, although a different riparian classification may be applied.

Current and historical aerial photography shall be used to estimate when disturbance of RRH occurred and determine whether the disturbance occurred before or after the effective date of the RCM. If the disturbance occurred near the effective date of the RCM and aerial photographs cannot provide a definite determination, historical permits for the property are reviewed to determine if the improvement was permitted prior to the effective date of the RCM. If it cannot be verified that the disturbance occurred prior to the effective date of the RCM, the disturbance will be considered pre-existing.

Upon completion of the evaluation, the determination shall be documented in the permit file and used to determine if cumulative disturbance exceeds 1/3 of acre. Only those disturbances occurring after the effective date of the RCM are considered cumulative and will be counted toward the 1/3 acre mitigation threshold. Disturbances existing prior to the effective date will not be counted.

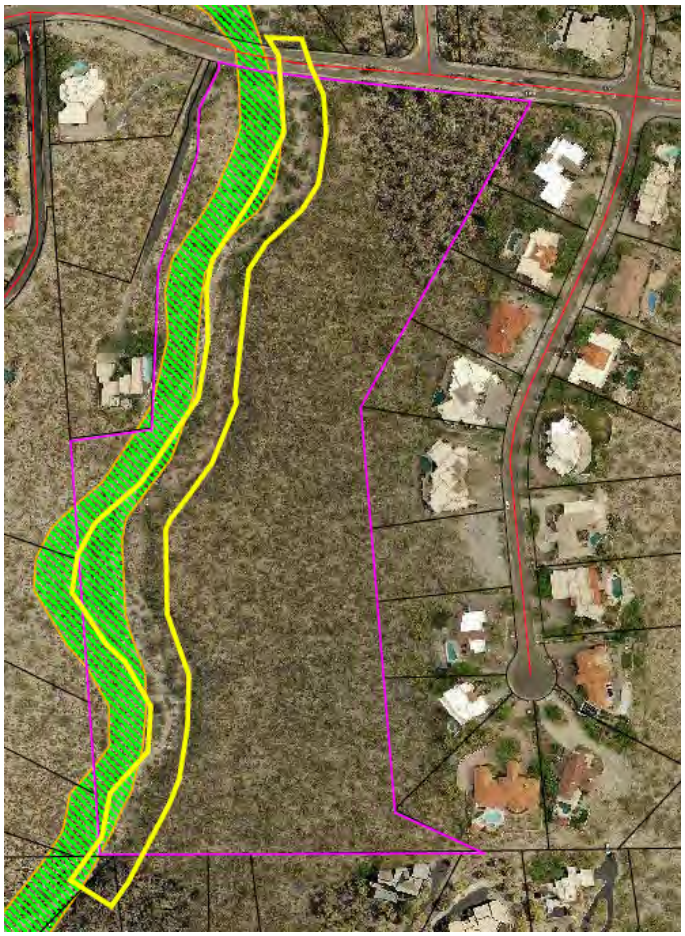
When disturbances are of natural origin, such as erosion, fire, or frost, a qualified professional may present information to establish modified riparian boundaries or classification in accordance with *Technical Policy TECH-116*.

II. Accounting for projection issues of the Riparian Classification Maps:

The RCM were developed at a planning scale level. The use of broad-based planning maps, in combination with mapping projection issues when the RCM are overlain with aerial photography sometimes results in riparian habitat boundaries incorrectly aligned with the actual location of riparian habitat on the project site. The following tips will help determine if the RRH boundary is correctly aligned with the aerial photograph when there are no obvious vegetation boundaries visible. Answer the following questions in this order to determine if the RRH boundary requires rectification:

1. Is the RRH polygon centered over the denser, larger vegetation adjacent to the sandy bottom wash channel?
2. Is the RRH polygon centered over and aligned with the 100-year floodplain limit?
3. Is the RRH correctly aligned over the lowest elevations of the watercourse?
    - If available, utilize ground surface topography to help correctly align the RRH.

Example of an RRH polygon “shifted” (yellow polygon) to align with the wash and actual location of the riparian vegetation:



Upon request by the applicant of a single lot development, or upon submittal of an exhibit associated with a subdivision plat or development plan, District staff shall review and adjust RCM boundaries, as appropriate, when a projection issue is confirmed. These adjustments shall nominally maintain the width, length and overall area of the RRH polygon. Any adjustment shall be completed by the District as a separate action and shall not delay the permitting process.

When adjustments are warranted, the District may revise the RCM as follows:

1) Adjustments shall be made to an entire reach of habitat rather than just the individual parcel being evaluated. This typically would include the length between connections to other mapped riparian habitat and which usually coincides with upstream and downstream confluences.

2) A review of other active permits in the affected area shall occur so that the decision is equally and uniformly applied.

3) When the transition between the riparian and upland areas is gradual, the line shall be drawn at the location where the habitat is clearly upland, based on factors such as species composition, vegetation density, and topography. However, the width should not exceed the original width of the RCM at that location.

4) The areal extent of the existing and proposed boundaries shall be compared in order to ensure the area is nominally the same.

5) The rectification is subject to approval by the Floodplain Administrator.

6) Once approved, the modified polygon shall be provided to the Information Management Section for incorporation into the GIS. The following information is necessary:

   a. Tax parcel ID number, north arrow and scale,
   b. RRH boundary and classification designation,
   c. Proposed modified boundary,
   d. Property boundaries of the affected reach,
   e. Topography and floodplain boundaries, if known

III. Important Riparian Areas with no underlying riparian classification

The Maeveen Marie Behan Conservation Lands System (CLS) designation Important Riparian Area (IRA) was adopted by the Pima County Board of Supervisors as part of the Pima County Comprehensive Plan in December 2001 and updated in June 2005 and is considered during development planning. These areas are subject to specific land use standards for development that is requesting a rezoning, Specific Plan, or certain Conditional Uses. At the planning level, the CLS provides direction to consider not only the riparian habitat but also the associated upland areas, and other open space area for the purposes of wildlife connectivity and the preservation of intact wildlife corridors, among other things. For this reason the IRA identified within the CLS may contain additional areas that are not in the adopted RCMs, and are beyond the scope of the District to regulate.

When projects do not need these planning level discretionary actions, the standard for development is authorized pursuant to Floodplain Management Ordinance, whose authority is limited to watercourse and adjacent floodprone areas. As such, these additional upland areas are not subject to regulation or mitigation requirements pursuant to the riparian habitat regulation found in the Floodplain Ordinance. Only those portions of Important Riparian Area that have an underlying riparian classification are subject to the mitigation standards, including the 1/3 acre disturbance threshold.

IV. Adjusting the Classification of RRH or Making Boundary Modifications to the RCM:

If an applicant feels the classification of the RRH is not correct or would desire to make a major boundary shift which affects the areal extent of the RRH, the applicant shall provide technical data to redefine the boundary and/or class of riparian habitat found on the project site using methods outlined in Technical Procedure 116, *Quantitative Methods for Onsite Vegetation Survey of Regulated Riparian Habitat*

APPROVED BY:

Suzanne Shields 3/25/2014

Suzanne Shields
Director Date

Original Policy Approved:
Date(s) Revised:

Technical Procedure, TECH-116

Quantitative Methods for Regulated Riparian Habitat (RRH) Boundary Modifications and Onsite Vegetation Surveys

PIMA COUNTY REGIONAL FLOOD CONTROL DISTRICT
TECHNICAL PROCEDURE

PROCEDURE NO.: Technical Procedure, TECH-116 EFFECTIVE DATE: November 15, 2013

PROCEDURE NAME: Quantitative Methods for Regulated Riparian Habitat (RRH) Boundary Modifications and Onsite Vegetation Surveys

PURPOSE: Delineation of riparian habitat boundaries and characterization of RRH to reflect site conditions for purposes of mitigation of Class H and Xeroriparian Class A-D under Chapter 16.30, Floodplain and Erosion Hazard Management Ordinance No. 2010-FC5 (Ordinance).

BACKGROUND:

The purpose of Chapter 16.30, *Watercourse and Riparian Habitat Protection and Mitigation Requirements*, is to "promote stable flow and sediment transport conditions, preserve natural floodplain functions, and provide watercourse management by preserving and/or enhancing riparian vegetation and habitat along watercourses and floodplains..." To meet the purpose of Chapter 16.30, Riparian Classification Maps (RCM) were created to indicate the location of riparian habitat along watercourses and floodplains. In addition to the RCM, *Regulated Riparian Habitat Mitigation Standards and Implementation Guidelines* (Guidelines) were developed to establish onsite mitigation requirements when greater than 1/3 acre of RRH is disturbed.

The RCM were produced at a scale of 1" = 2000' using digital orthophotography, 2000 LANDSAT satellite imagery, and data prepared for the Sonoran Desert Conservation Plan, such as water resource and plant community structure and composition mapping. These Maps provide a general location of RRH within unincorporated Pima County. Due to photo rectification issues, i.e., the shifting of RRH polygons relative to the parcel and aerial photograph bases, and the scale at which the Maps were created, habitat boundaries shown on the GIS-based RCM may not accurately reflect the actual location of RRH onsite. Additionally, the Xeroriparian classification system is based on the Total Vegetation Volume (TVV) of riparian habitat within Pima County. The TVV was measured from satellite imagery and averaged for each classification, resulting in average values across the landscape. Mitigation requirements provided in the Guidelines for each class of riparian habitat are based upon these average values.

Per Section 16.30.080.B, if an applicant feels the RCM do not accurately reflect site conditions in regards to vegetation density outlined in the Guidelines, delineation of the RRH limits relative to the parcel base, or extent of riparian habitat as shown on the RCM, they may submit technical data for consideration by the Chief Engineer using the guidelines outlined in this procedure.

APPROVED BY:

Suzanne Shields

Suzanne Shields
Director Date 11/15/2013

Original Procedure Approved: November 15, 2013
Date(s) Revised:

Modification of Regulated Riparian Habitat (RRH) Boundaries

General Method:

Identify and delineate homogenous vegetation units along a watercourse using a combination of aerial photographs, topographic maps, on-the-ground photographs, field observation and field survey by a qualified professional.

The report titled *Map Revisions for the Riparian Habitat Mitigation Ordinance* provides an explanation of mapping techniques used to develop the Riparian Classification Maps and may be viewed at: http://www.pima.gov/cmo/sdcp/reports/d25/129MAPRE.PDF

Important Riparian Areas (IRA):

IRA boundary modifications are not allowed. IRA were developed to minimize fragmentation of important biological corridors essential to the survival of plants and animals indigenous to Pima County, and to provide an integrated framework of natural open space within Pima County. IRA polygons were originally adopted by the Pima County Board of Supervisors through the Comprehensive Plan, which incorporates land use guidance consistent with the conservation goals of the Sonoran Desert Conservation Plan (SDCP) through implementation of the Conservation Land System (CLS). The CLS and associated Conservation Guidelines guide land use decisions, such as rezonings, specific plan requests, Comprehensive Plan amendments and Type II and Type III conditional use permits.

In October 2005, the 2005-FC2 Ordinance was adopted, along with updated Riparian Classification Maps (RCM) that incorporated IRA polygons for regulation under Title 16. The Ordinance promotes avoidance and minimization of disturbance to IRA on properties with an existing land use. These boundaries are used for review not only by the District, but also by other Pima County departments.

IRA is almost always associated with an underlying class of habitat and while the IRA boundaries shown on the adopted RCM cannot be modified, boundaries and mitigation requirements for the underlying class of riparian habitat may be modified in accordance with this Procedure in order to more accurately reflect onsite conditions. IRA without underlying classification is not subject to the requirements of Title 16 as applied during development review, building permitting, or capital improvement projects, but will be considered during planning and zoning level review.

Hydroriparian and Mesoriparian Habitat (Class H):

For Class H, field verification of RRH boundaries shall document the presence of indicator plant species as well as size and density of plants moving out laterally from the watercourse. Plant communities shall be classified using the Brown, Lowe and Pase (BLP) System to the 6th BLP classification level (association) and communities which are known to have obligate or preferential riparian plants, or have structures (canopy height or density) not attained outside riparian areas shall be considered hydroriparian or mesoriparian (Class H). Other physical features to consider and document are the presence of perennial or intermittent water, springs, depth to ground water, in addition to soil type, channel morphology, and connectivity or contiguity of habitat units and continuity of the associated drainage system. Data used to determine Class H habitat, such as groundwater mapping, Harris Riparian Maps, etc., can be viewed on the Sonoran Desert Conservation Plan Mapguide website: (http://gis.pima.gov/maps/sdcp/).

Xeroriparian Habitat (Class XA-XD):

For xeroriparian classifications the Total Vegetation Volume (TVV), which measures the gradation of plant size and density indicating the transition from riparian to upland plant communities, was used to classify each type of xeroriparian habitat. Field verification of xeroriparian boundaries shall consider TVV along with other factors such as plant species composition, contiguity of vegetation units, continuity of the drainage system and hydrological/geomorphological features generally associated with riparian habitat.

Boundary Delineation Method for Boundary Modifications:

Minor boundary modifications are defined as changes to the outer limits of mapped RRH to align with topography, floodplain and riparian vegetation based upon field verified site conditions, and may follow submittal requirements outlined in *Technical Policy 104 – Evaluating and Adjusting Riparian Classification Maps*.

Major boundary modifications, which propose removing extensive acreage of mapped RRH from a property or project site, shall provide an onsite vegetation survey as outlined in Section 2.0 of the *Standard Operating Procedure: Quantitative Methods for Regulated Riparian Habitat Boundary Modifications and Onsite Vegetation Surveys*, for review and approval by the District.

Onsite Vegetation Survey: Determining or Classifying Regulated Riparian Habitat and its Boundaries and Plant Community Characteristics within a Mapped Regulated Riparian Habitat Boundary

For purposes of calculating mitigation requirements for disturbance to RRH or when the applicant believes site conditions vary from the mapped RRH (major boundary modifications and/or total vegetation volume estimates), either of two sampling methods may be used. Methods include; 1) Total Vegetation Volume (TVV) and Belt Transects, or 2) Plot sampling.

TVV and Belt Transects – The TVV and belt transect sampling method can be used to determine or classify RRH and its boundaries by providing a detailed analysis of plant community structure and composition. The TVV and belt transect sampling method approved for use by the District is a vertical line-intercept technique and can be found in Section 2.0 of this Procedure.

Plot Sampling – Plot sampling (also called quadrat sampling) is used to define plant community characteristics, including cover type, frequency, and density. The plot sampling method approved for use by the District is found in Section 3.0 of this Procedure.

Onsite Vegetation Survey submittals are subject to District review and approval.

Standard Operating Procedure: Quantitative Methods for Regulated Riparian Habitat Boundary Modifications and Onsite Vegetation Surveys

Prepared for
Pima County Regional Flood Control District
Water Resources Division
97 East Congress, Second Floor
Tucson, AZ 85701

Prepared by
RECON Environmental, Inc.
525 West Wetmore Road, Suite 111
Tucson, AZ 85705
P 520.325.9977 F 520.293.3051

RECON Number 5074
June 10, 2009

Carianne S. Funicelli, Vegetation Ecologist

TABLE OF CONTENTS

1.0 Introduction 1

2.0 Regulated Riparian Habitat Determination and Boundary Modifications 1

2.1 Total Vegetation Volume and Belt Transects 1

2.2 Methodology 1

2.2.1 Field Equipment and Supplies 1

2.2.2 Sample Design 2

2.2.3 Data Collection 4

2.2.4 Data Analysis 7

2.3 Reporting 9

3.0 On-site Vegetation Characterization 9

3.1 Plot Sampling 10

3.2 Methodology 10

3.2.1 Field Equipment 10

3.2.2 Sample Design 11

3.2.3 Data Collection 12

3.2.4 Data Analysis 13

3.3 Reporting 14

4.0 Literature Cited 14

PHOTOGRAPH

1: Transect Data Collection Team 4

FIGURES

1: Diagrammatic Representation of the TVV Transect and Belt Transect 5

2: Vegetation Volume Data Sheet Example 6

TABLE

1: TVV Parameters for Xeroriparian Designations 8

APPENDICES

A: Blank TVV Data Sheet

B: Example of One Type of Telescoping Rod for TVV Measurements

C: Examples of Transect Configurations for Different Sites

D: Example Summary Table for TVV Transects

E: Blank On-site Vegetation Charaterization Plot Data Form

F: Example Summary Table for Plot Data

1.0 Introduction

Chapter 16.30 of the Ordinance, *Watercourse and Riparian Habitat Protection and Mitigation Requirements*, requires preservation, enhancement and/or mitigation of riparian habitat along watercourses and floodplains. The following procedures provide guidance to an applicant when a question arises as to the location, extent, and/or plant density and composition of riparian habitat on a property or project site by outlining vegetation measurement and characterization methods to determine and classify regulated riparian habitat.

Standard Operating Procedures (SOP) for two quantitative methods of vegetation measurement are presented in this document. The first method, which combines Total Vegetation Volume (TVV) and belt transects, can be used to determine or classify regulated riparian habitat and its boundaries. The second method, a plot (or quadrat) method, can be used to characterize on-site vegetation to assist in developing a riparian habitat mitigation plan.

2.0 Regulated Riparian Habitat Determination and Boundary Modifications

2.1 Total Vegetation Volume and Belt Transects

TVV has been shown to correlate statistically with breeding bird densities and to be an indicator of riparian habitat values in the Southwest (Mills et al. 1991a, 1991b). Pima County Regional Flood Control District (District) has used this indicator of habitat value to verify and classify regulated riparian habitat in the context of the Ordinance (SWCA 1993 and Harris Environmental Group 2000). The SOP for this method combines the work of the District, consultants, and researchers (MacArthur and Horn [1969], Mills et al. [1991a, 1991b], Stromberg et al. [1992, 1993]) into a modified procedure that is both streamlined and effective in determining TVV. Specifically, it updates recent work by Westland Resources (2008), which has been used as the basic framework for the SOP.

2.2 Methodology

2.2.1 Field equipment and Supplies

2.2.1.1 Standard

- Aerial photograph and map of project area
- Data forms (Appendix A)
- Measuring tape in metric units (25 meters [m])

- A telescoping pole marked in decimeter (dm) sections, at least 6 m in height. An example is shown in Appendix B. These are available from forestry or surveying suppliers, or can be constructed.
- Two 12–16” lengths of rebar (or other stake material)
- Hammer for installing rebar
- Global Positioning System (GPS) unit
- Digital camera

2.2.1.2 Optional

- Additional 12–16” lengths of rebar (or other stake material), if transects will be permanent
- Plastic rebar safety caps, if transects will be permanent

2.2.2 Sample Design

The following considerations will ensure the sample design used for a TVV transect sampling event will be configured in a manner that provides appropriate information in determining the areal extent of riparian habitat within a given location. Decisions and assumptions regarding sample entities, sample size, and transect configuration should be clearly described in the final report to the District.

2.2.2.1 Seasonality

Ideally, maximum TVV values for a given area should be obtained when perennial vegetation is actively growing[1], although measurements can be taken at any time of year. This is an important consideration when interpreting TVV results. For example, TVV values recorded during winter or extended drought when perennial species are deciduous or dormant may be lower than at the same location during active growth; if measurements taken during dormancy reflect a value that is just shy of a particular xeroriparian class, it may be reasonable to assume the higher designation. The converse, however, is not appropriate—the intent of the measurement is to capture the maximum TVV represented by a site. Interpretations are subject to District approval.

2.2.2.2 Sample entities

[1] The most recent Riparian Classification Maps are based on June 2000 LANDSAT satellite imagery.

The first step in configuring the transect measurement sample design is to segregate the site into sample entities—areas on the ground within which transects will be established. Usually these entities correspond to different vegetation communities (e.g., regulated riparian habitat and the adjacent uplands would represent two different sample entities). Mueller–Dombois and Ellenberg (1974) used the following three requirements to define a sample stand (entity):

1. The area should be large enough to include all species belonging to the plant community.

2. The habitat should be relatively uniform throughout the area.

3. The amount of plant cover should be as homogenous as possible.

Sample entities, for the purposes of TVV, can usually be identified on aerial maps prior to fieldwork. Usually the boundary between upland vegetation and more densely vegetated riparian areas will allow these areas to be easily distinguishable. If there is more than one sample entity, transects will be located in each and in a manner such that each transect is fully contained within one sample entity (i.e., does not cross into another entity).

2.2.2.3 Sample Size

The number of transects established within each sample entity should be sufficient to document the range of vegetation conditions within the entity and to provide a reasonable estimate of the average TVV for that unit. A general rule of thumb would be a minimum of three TVV transects per sample entity.

2.2.2.4 TVV Transect Configuration

Transects should be distributed throughout the sample entity in a manner that captures the variability within the sample entity. Transects can be either located randomly within a sample entity or according to an orderly sampling scheme (e.g., on a grid, at regular intervals) as long as a sample entity is accurately described by the number of transects and their orientation within the sample entity.

Riparian and xeroriparian vegetation communities are linear landscape features that follow watercourses and thus result in linear sample entities. For smaller washes where strand (or wash bottom) habitat are mapped as part of the same delineated riparian habitat, sampling should be conducted in a fashion that includes (proportionately) both strand and terrace habitats[2]. For large wash and river systems (e.g., the Rillito River), transects should run parallel to the strand habitat but not include it. In this circumstance the strand would be considered a separate sample entity from the adjacent floodplain terrace and would have a separate set of transects to characterize its vegetation if

---

[2] For small washes, transects should not be placed entirely in the strand habitat. This is only appropriate when the wash is large enough to warrant measuring the strand habitat as a separate entity, as in the Rillito River.

deemed necessary by the District. Any variation from these general sampling guidelines should be clearly explained in the report.

See Appendix C for examples of TVV transect configuration for different circumstances.

2.2.3 Data Collection

Photograph 1. Transect data collection team.

In the field, a team of 2–3 people will be needed to establish, read, and record TVV transect data (Photograph 1). One person will be the data recorder, responsible for clearly and legibly entering data onto the data forms. The other 1–2 people will be responsible for setting up the transect and calling out data to the recorder. Below is a step-by-step description of how TVV transects are conducted.

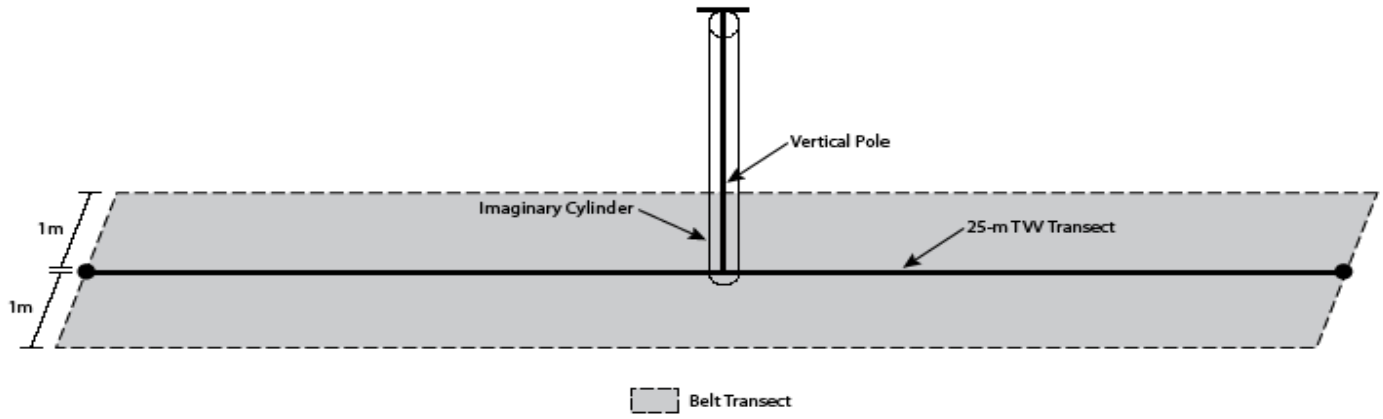
1. Arrive at transect start location. Drive one length of rebar into the ground at the start point and pull measuring tape in a <u>straight</u> line (transect), 25 m in length. The goal is to capture the variation in vegetation forms that may exist within the plant community, therefore, avoid moving the transect into open areas, away from densely vegetated areas that would fall within the straight transect line. Install a second length of rebar at the end point. Keep tape at a height that will allow for easy reading.

2. Record location using a GPS unit (be sure to also indicate the coordinate system and datum used). This will allow for accurate mapping on an aerial photograph for the report.

3. Take digital photographs of the vegetation present from each transect end looking back at other end of transect.

4. If the transects will be permanent, install plastic rebar safety caps on the rebar ends.

5. At 1-m intervals horizontally along the 25-m transect, place the telescoping pole vertically to conduct TVV sampling. This technique samples a series of cylinders starting from the ground surface to the top of the vegetation canopy. Each cylinder is 1 dm high with a 1 dm radius, resulting in a volume of 3.1415 dm^3. See Figure 1 for a diagrammatic representation of the transect setup. Reading the transect involves recording the presence or absence of woody perennial vegetation (including live, dormant, or dead material) within each cylinder. Woody perennial vegetation excludes perennials such as bunchgrasses.



- One “hit” is recorded for each 1-dm cylinder above the ground in which woody perennial vegetation occurs within 1 dm of the pole, regardless of how much vegetation is within the cylinder. If no woody perennial vegetation is present within the 1-dm cylinder, the cylinder is not counted.

- The number of (1-dm cylinder) hits possible within each meter layer ranges from 0 to 10—no more than one hit is possible for each dm segment.

- Plant species information is not recorded.

- Figure 2 shows an example data form and how it relates to the vegetation present.

VEGETATION VOLUME DATA SHEET

RECON

Location: Canyon **Transect** 6 **Date:** 16-Jan-09 **Personnel:**

UTM (NAD 83) Transect start: 533483 / 3532965 **UTM (NAD 83) Transect end:** 533496 / 3532949

	Horizontal Transect Samples (# of cubic decimeters containing vegetation within each vertical meter)																								
Vertical cubic meters	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	6	10	1	9	1	4	2	3	3	3	7	5	5	7	8	4	3	5	3	10	10	10	5	8	5
2	1	4	1	3	3	1	3	7	4	2	2	3	5	0	5	5	3	2	7	4	4	4	1	4	2
3		5	1	6	3	0	5	7	7	2	2	0	0	1	5	3	9	10	2			0	6	0	4
4		1	4	2	1	6	2	7	3	2	2	0	0		3	3	2	0	1			1	8	2	7
5					2	5	3	1	9	5	1	8	2		4			1					4	3	3
6					8	7	2	5	5	0	0												4		
7						1	1	3	9	4	3														
8							6	8	8	8															
9									8	8															
10																									
11																									
12																									
13																									
14																									
15																									
16																									
17																									
18																									
19																									
20																									
TOTAL																									

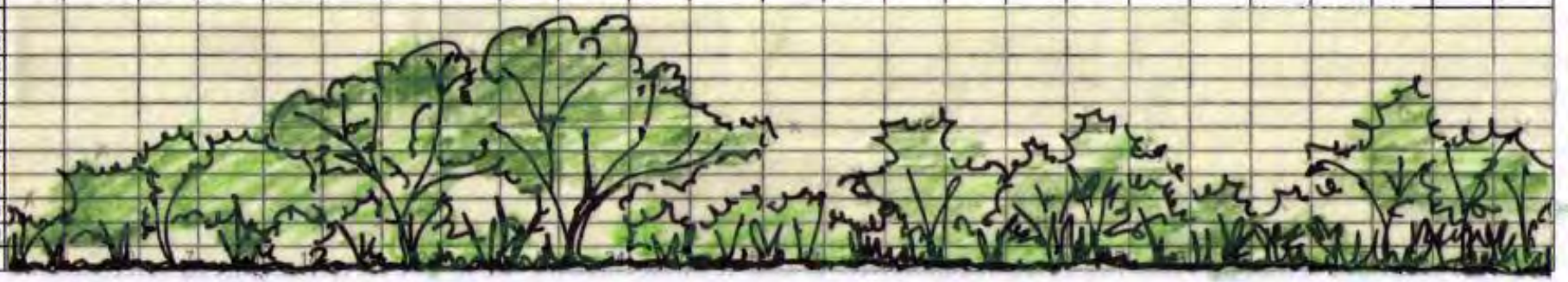


Figure 2. Vegetation Volume Data Sheet—example showing how the vegetation volume measurements correspond to the vegetation structure present on the ground.

6. Conduct belt transect (see Figure 1). Personnel conducting this portion of the method will need to be able to identify the plant species within the belt transect. Belt transects are added directly to the already established TVV transect to gather density and diversity information to more completely characterize the vegetation. Information is recorded from within a 1 m wide swath on each side of the transect and can either be measured at the same time as TVV is measured or after TVV has been measured:

    - Diversity: On each side of the 25-m horizontal transect, record all species present (within 1 m of the transect).

    - Density: For woody perennials (and perennial grass if desired), count all individuals (live, dormant, or dead) that are rooted within the 2 m x 25 m belt transect.

7. Ensure that the data form (Appendix A) is filled out completely and all pertinent notes recorded.

8. Remove rebar lengths if the transects are not intended to be permanent.

2.2.4 Data Analysis

2.2.4.1 TVV Transects

The TVV for each transect is calculated through the following equation:

TVV = Sum of h / (10n)

Where:

n = number of sample points along the transect (this will be 25 for a standard 25 m transect)

h = the number of 1 dm cylinders with woody perennial vegetation hits

For example, in the TVV transect shown in Figure 2, there were 501 total hits. TVV = 501/250 = 2.004.

For each sample entity, the TVV values for each transect should be presented individually; a mean should also be calculated and presented for each sample entity. The Ordinance provides for three types of information to be used in defining and differentiating riparian habitats: species composition, vegetation density, and availability of water. This information is used to classify riparian vegetation as hydro-mesoriparian, or xeroriparian class A, B, C, or D (Fonseca and Regan 2002). For xeroriparian habitats, the TVV values of transects within an entity can be used to classify the type of regulated riparian habitat present, utilizing values listed in Table 1. For hydro-mesoriparian

habitats, classification is based not only on TVV, but also on the availability of water and the presence of preferential plant species. Therefore, the TVV method cannot be applied to hydro-mesoriparian plant communities without also assessing these additional characteristics. Boundaries of these areas are determined through analysis of aerial photographs, ground surface topography, 100-year floodplain limits (if available), and on-the-ground observations in conjunction with the TVV transect information.

TABLE 1
TVV PARAMETERS FOR XERORIPARIAN DESIGNATIONS

Habitat Type	Total Vegetative Volume (TVV)
Xeroriparian A	Greater than 0.856 cubic meter per square meter (m^3/m^2)
Xeroriparian B	Less than or equal to 0.856 m^3/m^2 and greater than 0.675 m^3/m^2
Xeroriparian C	Less than or equal to 0.675 m^3/m^2 and greater than 0.500 m^3/m^2
Xeroriparian D	Less than or equal to 0.500 m^3/m^2

2.2.4.2 Belt Transects

Diversity and density values can be informative in describing the overall habitat composition and quality.

Diversity

Species recorded in the belt transects can be compiled by sample entity or by project area to describe the diversity of plant species present in the project area.

Density

Counts of perennial species result in a density of individual species per 50 m^2. These values can be averaged and extrapolated to whatever area (e.g., number of catclaw acacia shrubs per acre) is meaningful for the information desired. Please note that it may make sense to use the size of the proposed disturbance for this calculation.

For example: For 1 acre of proposed disturbance, three belt transects were established. They contained 3, 4, and 8 catclaw acacia shrubs, respectively. Those values could be used to calculate a mean density of catclaw acacia shrubs per acre:

$$3 + 4 + 8 = 15 \text{ catclaw acacia shrubs total per } 150\ m^2$$

$$150\ m^2 = 0.03707 \text{ acre}$$

$$15 \text{ catclaw acacia shrubs}/0.03707 \text{ acre} = 404.63 \text{ catclaw acacia shrubs per acre}$$

2.3 Reporting

The report for submittal to the District should contain at a minimum the following information:

1. Aerial photograph at an appropriate scale with the following items clearly labeled:

    - Project area
    - Regulated riparian habitat, 2005 Riparian Classification Map boundaries
    - Field mapped riparian habitat boundaries. The boundaries of homogenous riparian habitat units will be field verified and mapped on current aerial photographs, rectified to the proposed project's engineering and planning base maps. Mapping should be based upon 1"=200' aerial photographs and the basis and rational for the delineation of the riparian from upland habitat clearly articulated. When the transition of riparian and upland areas is gradual, the line shall be drawn at the point where the habitat is clearly upland based upon factors such as species composition, vegetation density, and topography.
    - Sampling entities
    - Transect locations
    - Proposed area of disturbance (if submitted with a development proposal)
    - Ground surface topography
    - 100-year floodplain limits, if available
    - Erosion Hazard Setback Limits, if available

2. Description of assumptions or reasoning for sample entity identification and sample design

3. Summary table with TVV values for each transect, mean TVV values for each entity, and UTM coordinates. See example summary table in Appendix D.

4. Field data forms

5. Photographs of transects

6. Other supporting data and evidence as appropriate

3.0 Onsite Vegetation Characterization

The goal of onsite mitigation is to recreate the plant cover, distribution, and species composition of the site prior to disturbance. Accurate data on plant community composition is necessary for planning and evaluating onsite mitigation areas. This can

be accomplished through a complete site inventory for small areas of disturbance, but for larger disturbances it may be more desirable to use a sampling technique to accurately estimate plant community characteristics that are of value.

3.1 Plot Sampling

Plot sampling (also called quadrat sampling) can be used to describe a variety of plant community characteristics. It is one of the simplest and most common sampling methods used by ecologists and conservation biologists to describe plant communities (Mueller–Dombois and Ellenberg 1974; Bonham 1989; Elzinga et al. 1998). For the purposes of creating a riparian habitat mitigation plan, the parameters of interest are diversity (species present) and density (number of species in a given area).

Plot sampling is used to define a plant community's characteristics for a much larger area than that actually sampled. Several randomly or subjectively selected sampling areas (plots) are used to collect physical data within the survey entity. "Subjectively selected" (for the purposes of this sampling method) means choosing sampling sites that are representative of the plant community. The collected data are then used to estimate the characteristics of the whole plant community (the mapped riparian habitat on the parcel). Multiple plots ensure that collected data present an accurate representation of the plant community that includes all of its variation.

3.2 Methodology

3.2.1 Field Equipment

3.2.1.1 Standard

- Aerial photograph and map of project area with 2005 Riparian Classification Map boundaries delineated
- Data forms (Appendix E)
- Measuring tape in metric units (25 m)
- One to four 12–16" lengths of rebar (or other stake material)
- Hammer for installing rebar
- Pin flags (string can be used for square or rectangular plots)
- Compass (if using square or rectangular plots)
- GPS unit
- Digital camera

3.2.1.2 Optional

- Additional 12–16” lengths of rebar, if plots will be permanent
- Plastic rebar safety caps, if plots will be permanent

3.2.2 Sample Design

The following considerations will ensure the sample design used for a plot sampling event will be configured in a manner to provide appropriate information for determining mitigation requirements. Decisions and assumptions regarding sample entities, sample size, and plot configuration should be clearly described in the report.

3.2.2.1 Sample entities

The first step in designing the plot sample design is to segregate the site into sample entities—areas on the ground within which plots will be established. Usually this will correspond to different vegetation communities (e.g., regulated riparian habitat and the adjacent uplands would represent two different sample entities). Mueller–Dombois and Ellenberg (1974) used the following three requirements to define a sample stand (entity):

1. The area should be large enough to include all species belonging to the plant community.
2. The habitat should be relatively uniform throughout the area.
3. The amount of plant cover should be as homogenous as possible.

Sample entities can usually be identified on aerial maps prior to fieldwork. Usually the boundary between upland vegetation and more densely vegetated riparian areas will allow these areas to be easily distinguishable. If there is more than one sample entity, plots will be located in each and in a manner such that each plot is fully contained within one sample entity (i.e., does not cross into another entity).

3.2.2.2 Plot Size and Shape

Plot size and shape should fit the nature of the vegetation community (i.e., mapped riparian habitat) to be sampled. Circular plots are generally recommended with these field mapping standards, as they are more efficient to accurately establish in the field. Plot size should be large enough to include a significant number of individual plants, representing all dominant species, but small enough that plants can be counted without duplication or omission of individuals. Below are suggested plot sizes that are usually appropriate for vegetation in Pima County, in the context of riparian habitat. Site characteristics may necessitate using a different plot size or shape (i.e., if the riparian vegetation entity is not wide enough); any deviations from these standard sizes should

be thoroughly described and justified in the report to the District. Plot shape and size should be the same throughout.

- Circular plots (preferred): 10-m radius (314 m^2 or 3,380 ft^2)
- Square plots: 15–20 m per side (225 m^2–400 m^2 or 2,422 ft^2– 4,306 ft^2)
- Rectangular plots: 15 m x 20 m (300 m^2 or 3,229 ft^2)

3.2.2.3 Sample Size (number of plots)

The number of plots conducted within each sample entity should be sufficient to characterize the range of vegetation condition within the entity. A general rule of thumb for xeroriparian areas in Pima County would be a minimum of three plots per sample entity, per acre, given the plot sizes suggested above. In certain circumstances, it may be necessary to sample more intensively in order to sufficiently describe the characteristics of the entity (mapped riparian habitat) being sampled. For example, if three plots are conducted in a sample entity but common shrubs and/or trees have not been recorded, additional plots should be added[3].

3.2.2.4 Plot Configuration

Plots should be distributed throughout the sample entity in a manner to capture all of the variability within that sample entity. Plots can be either located randomly within a sample entity or according to an orderly sampling scheme (e.g., on a grid, at regular intervals, etc.)—as long as the result is that the sample entity is accurately described by the plot number and arrangement. The sampling locations will be reviewed as part of the approval process, and must be representative of the area of regulated riparian habitat proposed for disturbance.

3.2.3 Data Collection

In the field, a team of two people will be needed to establish and read plots. One person will be the data recorder, responsible for clearly and legibly entering data onto the data forms. The other person will be responsible for setting up the plot and calling out the data to the recorder. Below is a step-by-step description of how the plots should be conducted.

1. Photograph representative areas within each sample entity. These photos may correspond to plot locations.

2. Set up plot, ensuring that it is located entirely within one vegetation entity.

    - **Circular plots:** arrive at the center point, install rebar, and use the meter tape to measure the radius, marking with pin flags.

---

[3] In this instance, the size of the plots should also be evaluated. Larger plots may record the diversity present more adequately.

- **Square or rectangular plots:** Set up plot using a compass to ensure true 90 degree corners. Install rebar. Mark edges with pin flags or string.

3. Record location using GPS (be sure to also indicate the units and datum used). This will allow for accurate mapping on an aerial photo for the report.

4. List all species rooted in the plot (live, dead, and dormant). Separate the list by using the following classifications:

   - Trees
   - Shrubs
   - Other Perennials
   - Annuals

5. Count and record the number of individuals of perennial tree and shrub species rooted within the plot (live, dead, and dormant). It may be helpful to separate the plot into sections to accomplish this accurately.

6. Note the presence and amount (percent cover) of noxious and/or invasive plant species, and map the invasives on the aerial photograph exhibit.

3.2.4 Data Analysis

For each entity sampled, calculate the mean (average) number of individuals per species based on the area of all plots in that entity. Extrapolate these values to a meaningful area (e.g. 1 acre or the proposed disturbance area) for each species as well as a total for shrubs and trees[4]. The mean value will be used to calculate the mitigation required, using the following formula:

$$\frac{\text{Total number of plants in all plots}}{\text{Total combined area of all plots}} = \frac{\text{X plants per area of interest}}{\text{Area of interest}}$$

Data in the summary table in Appendix F provides the following example calculation for all trees:

11 trees/1,256 m^2 (0.31 acre) = X trees/4,047m^2 (1 acre) = 35.4 trees/acre

Plant species to be used for mitigation should be the same as those removed, although, if the site has low plant diversity, for purposes of mitigation, species diversification is encouraged. The containerized plant replacement requirement in the Ordinance applies to trees and shrubs; other species will be included in the seed mix as appropriate and available. Substitutions and additions from the appropriate approved plant list may be made with the District's approval.

---

[4] Online conversion tools such as http://www.convert-me.com/en/convert/area can be used to assist in converting measurements between metric and U.S. standard systems.

3.3 Reporting

The report for submittal to the District should contain at a minimum the following information:

1. Aerial photograph at an appropriate scale with the following items clearly labeled:
    - Project area
    - Regulated riparian habitat boundaries (2005 Riparian Classification Maps)
    - Sampling entities
    - Plot locations, numerically labeled, to identify the plot relative to the data
2. Description of assumptions and reasoning for sample entities design and sample design
3. Summary table with all species listed (see Appendix F for example)
4. Summary table with species densities per plot; mean densities per species per entity (for tree and shrub species only); and extrapolated values for trees and shrubs for the area of interest (e.g. disturbance area or 1 acre). See Appendix F for an example summary table.
5. Field data forms
6. Representative photographs of each sample entity
7. Other supporting data and evidence as appropriate

4.0 Literature Cited

Bonham, Charles D.
1989 *Measurements for Terrestrial Vegetation*. John Wiley & Sons. 338 pp.

Elzinga, C.L., D.W. Salazar, and J.W. Willoughby
1998 Measuring and Monitoring Plant Populations. Bureau of Land Management Technical Reference 1730-1. Denver, CO. 492 pp.

Harris Environmental Group
2000 Sonoran Desert Conservation Plan. Riparian Vegetation Mapping and Classification. Final report prepared for Pima County.

Fonseca, J. and J. Regan
2002 Map Revisions for the Riparian Habitat Mitigation Ordinance. Prepared for the Sonoran Desert Conservation Plan.

MacArthur, R.H. and H.S. Horn
1969 Foliage Profile by Vertical Measurements. *Ecology* 50: 802-804.

Mills, G. Scott, J.B. Dunning, and J.M. Bates.
1991a Effects of Urbanization on Breeding Bird Community Structure in Southwestern Desert Habitats. *The Condor* 90: 416-428.
1991b The relationship between breeding bird density and vegetation volume. *The Wilson Bulletin* 103(3): 468-479.

Mueller–Dombois, Dieter and Heinz Ellenberg
1974 *Aims and Methods of Vegetation Ecology*. John Wiley & Sons, New York.

Stromberg, Juliet C., Tress, James A., Wilkins, Scott D. and Clark, Sheldon D.
1992 Response of Velvet Mesquite to Groundwater Decline. *Journal of Arid Environments* 23: 45-58.

Stromberg, Juliet C., Wilkins, Scott D., and Tress, James A.
1993 Vegetation-Hydrology Models: Implications for Management of *Prosopis Velutina* (Velvet Mesquite) Riparian Ecosystems. *Ecological Applications* 3(2): 307-314.

SWCA
1993 Riparian Habitat Definition and Classification System Technical Report. Prepared for Pima County Department of Transportation and Flood Control District.

Westland Resources
2008 Standard Operating Procedure: Measurement of Vegetation Volume. Prepared for Pima County Regional Flood Control District. May 2.

APPENDICES

APPENDIX A
Blank TVV Transect Data Form

VEGETATION VOLUME DATA SHEET

RECON

Location: **Transect #** **Date:** **Personnel:**

UTM (NAD 83)
Transect start:

UTM (NAD 83)
Transect end:

	Horizontal Transect Samples (# of cubic decimeters containing woody perennial vegetation within each vertical meter)																								
Vertical cubic meters	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																									
11																									
12																									
13																									
14																									
15																									
TOTAL																									

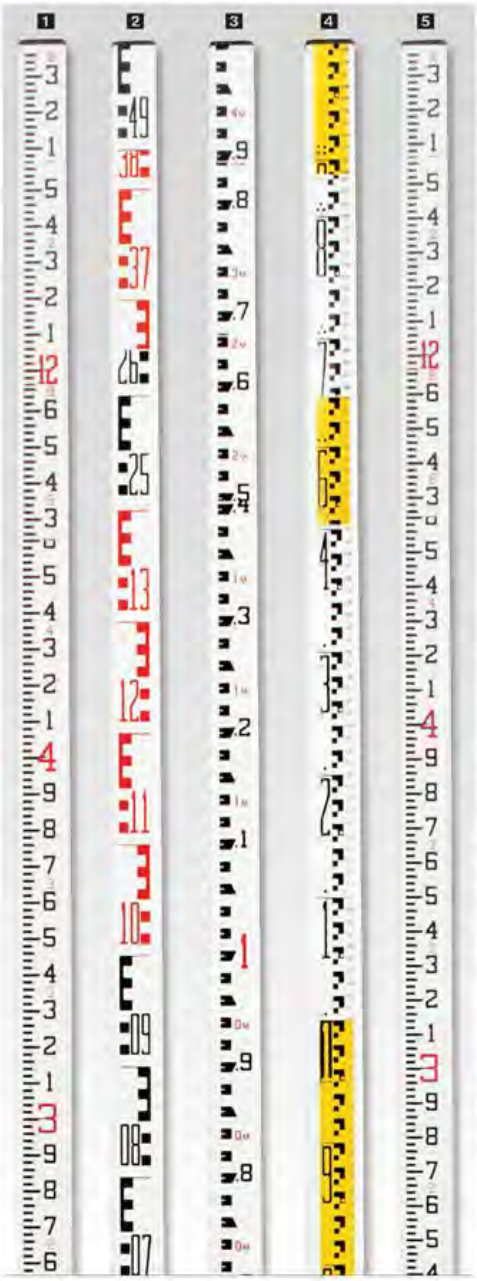
Tree and Shrub Density

species **stems per 50 m2**

Other Species Present within Belt Transect

species

APPENDIX B
Example of One Type of Telescoping Rod for TVV Measurements
(see #2 in the picture)



CRAIN Delivering Real Innovation

1 SVR Rectangular-Oval Shaped Telescoping Leveling/Measuring Rods

6411

New improved design!

- Shorter Collapsed length (58-1/2") for more convenient storage.
- Tighter locking mechanism features round buttons that resist jamming.
- New, sleeker design also features a lighter weight.
- New SVR rods come with a redesigned, stylish carrying case.

16' collapses to 59-1/4", while the 25' collapses to 58-1/2". Fiberglass construction and epoxy coating. Graduations are equal size the full length of rod. Red and white markings on back for stadia purposes. Can also be used as measuring rods – measurements are read at eye level. Markings are recessed for wear protection and epoxy-coated to resist fading and abrasions. Snap-together joint sections lock securely and separate easily for maintenance. The 16' models feature a square locking mechanism, and the 25' models feature a round locking mechanism. Protective case included with each rod.

16' in feet/10ths/100ths	E O	4.75 lbs.	43574	$153.50
25' in feet/10ths/100ths	E O	7.75 lbs.	43500	$179.50
			2+	$169.50
16' in feet/inches/8ths	E O	4.75 lbs.	43576	$153.50
25' in feet/inches/8ths	E O	7.75 lbs.	43501	$179.50
Carrying Case for 16' Rod		5 oz.	43520	$17.50
25' Replacement Case		9 oz.	43509	$11.25
Prism Mounting Adapter 5/8" x 11		4 oz.	43704	$15.75
Replacement Lock Set for 16'		8 oz.	43702	$24.95
Replacement Lock Set for 25'		9 oz.	43508	$34.95

Replacement Sections for 43574

0' to 4'	1.75 lbs.	43560	$47.75
4' to 8'	2 lbs.	43561	$44.25
8' to 12'	1.5 lbs.	43562	$39.95
12' to 16'	1.5 lbs.	43563	$36.50

Replacement Sections for 43576

0' to 4'	1.75 lbs.	43529	$47.75
4' to 8'	1.75 lbs.	43530	$44.25
8' to 12'	2 lbs.	43531	$39.95
12' to 16'	2 lbs.	43532	$36.50

Replacement Sections for 43500

0' to 5'	2 lbs.	43484	$52.75
5' to 9'	1.75 lbs.	43485	$49.50
9' to 13'	1.75 lbs.	43486	$47.75
13' to 17'	1.75 lbs.	43487	$44.25
17' to 21'	1.75 lbs.	43488	$39.95
21' to 25'	1.5 lbs.	43489	$36.50

Replacement Sections for 43501

0' to 5'	2 lbs.	43490	$52.75
5' to 9'	1.75 lbs.	43491	$49.50
9' to 13'	1.75 lbs.	43492	$47.75
13' to 17'	1.75 lbs.	43493	$44.25
17' to 21'	2 lbs.	43494	$39.95
21' to 25'	1.5 lbs.	43495	$36.50

Metric SVR Rectangular-Oval Rods

5628

Same quality rod as Crain® SVR Rectangular-Oval Shaped Telescoping Leveling/Measuring Rod with special metric markings. Protective case included.

2 "E" Style Metric

5.0m in m/dm/cm	M O	4.75 lbs.	43578	$159.00
7.6m in m/dm/cm	M O	7.5 lbs.	43503	$184.00

3 Philadelphia Style Metric

5.0 meter	M O	4.75 lbs.	43581	$159.00
7.6 meter	M O	7.5 lbs.	43504	$184.00

4 "1/2" Centimeter Style Metric

5.0 meter	M O	4.5 lbs.	43583	$159.00

Replacement Sections for 43578

0m to 1.4m	M	2 lbs.	43539	$47.75
1.4m to 2.6m	M	2 lbs.	43540	$44.25
2.6m to 3.8m	M	2 lbs.	43541	$39.95
3.7m to 5.0m	M	2 lbs.	43542	$36.50

5 Metric/English SVR Rectangular-Oval Rods

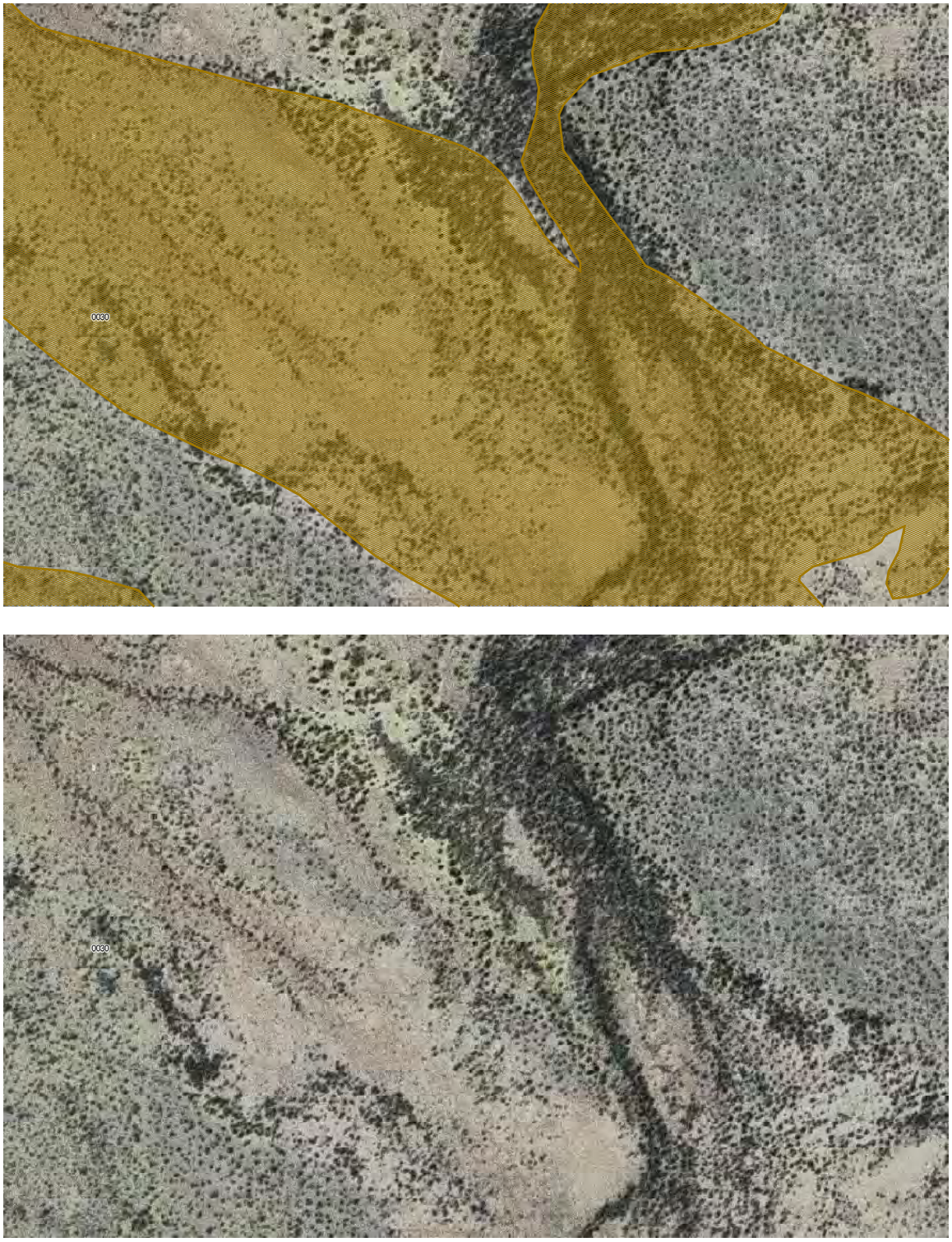
6412

Same quality rod as Crain® SVR Rectangular-Oval Shaped Telescoping Leveling/Measuring Rod with "1/2" Centimeter Style metric markings on one side and English markings on the reverse. Protective case included with each rod.

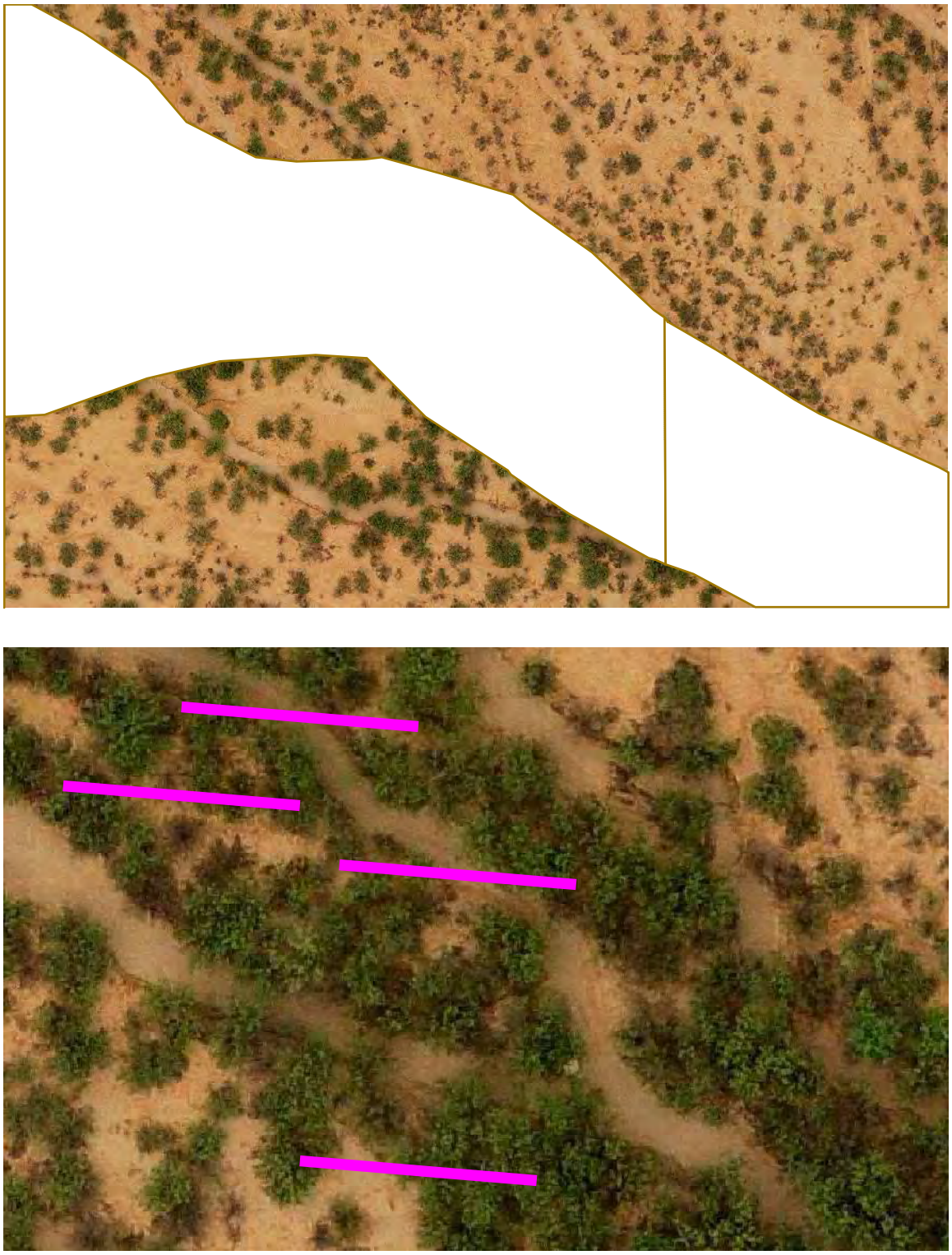
16' in feet/10ths/100ths/m/dm/cm/0.5 cm	C O	4.75 lbs.	43587	$158.00
25' in feet/10ths/100ths/m/dm/cm/0.5 cm	C O	7.5 lbs.	43505	$184.00

E English M Metric
C Combination English and Metric
O Oversize. Ships at Oversize rate. See Shipping information for details.

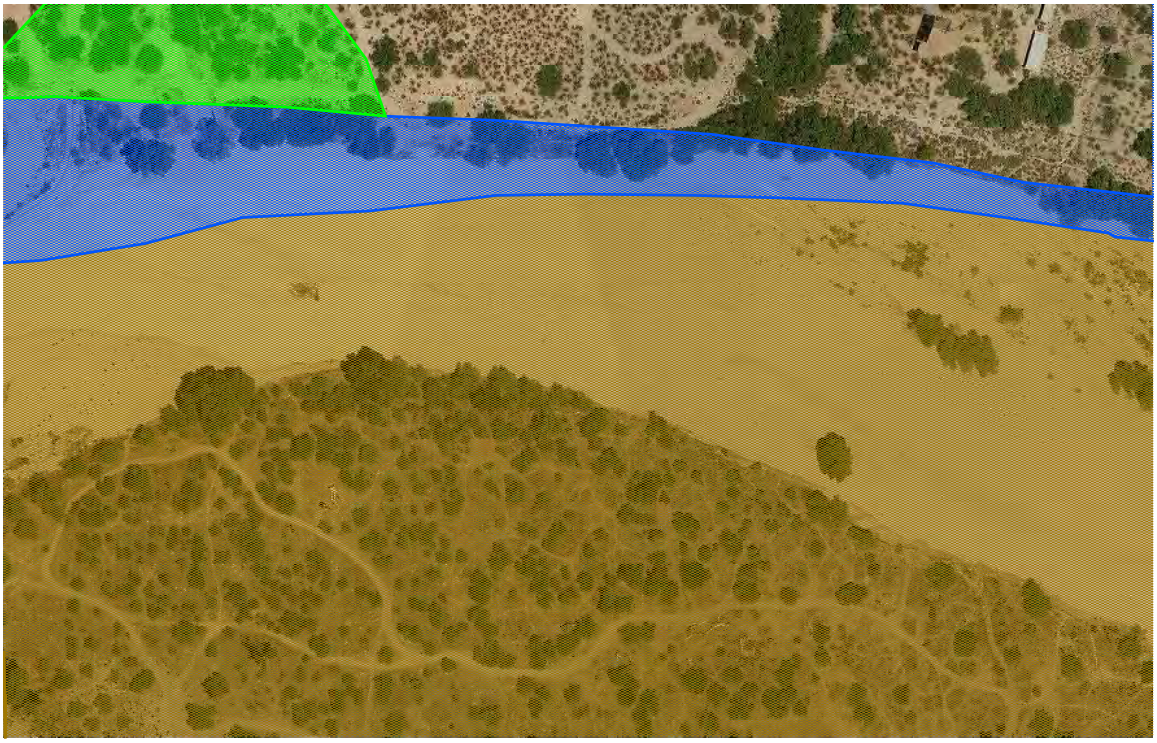
APPENDIX C
Examples of Transect Configurations for Different Sites



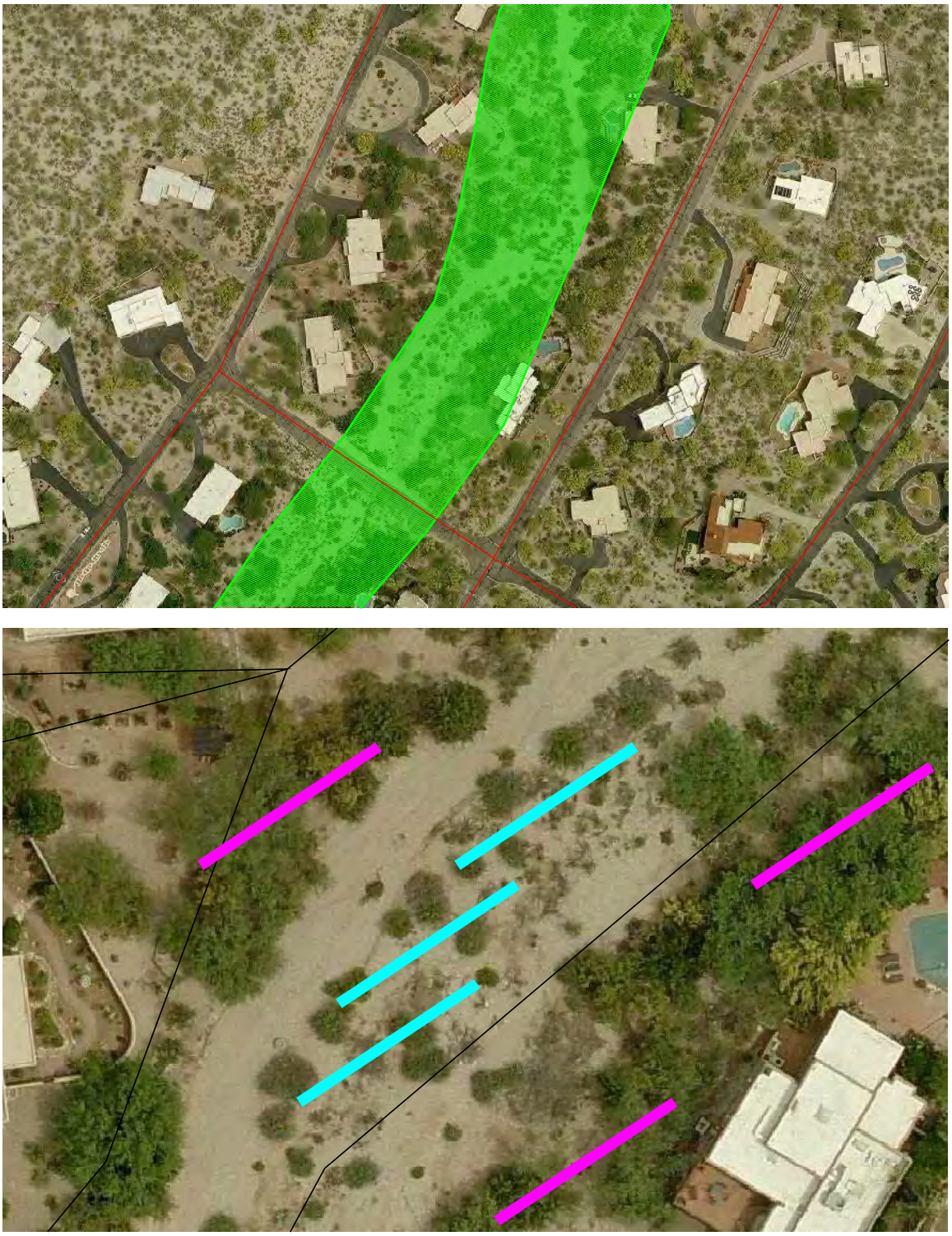
Example 1. Sheet Flooding Area. These photographs highlight the variations in vegetation density that can be observed in areas of sheet flooding. The shaded polygon represents Important Riparian Area with underlying Xeroriparian Class C habitat.



Example 2. Braided wash system with small channels. Photograph at top shows the general vicinity, and the bottom photograph is zoomed to the sample area. Here it is acceptable to place TVV transects across the sandy wash bottom, as long as the transects cover a representative sample of the vegetation.



Example 3. Large wash/river. Photograph at top shows the general vicinity with hydro-mesoriparian (blue), xeroriparian Class B habitat (green), and xeroriparian Class C habitat (gold); the bottom photograph is zoomed to the sample area, within xeroriparian Class C habitat. Transects are not placed in the wide sandy river bottom.



Example 4. Medium-sized wash with strand vegetation. Photograph at top shows the general vicinity with xeroriparian Class B habitat (green); the bottom photograph is zoomed to the sample area. In this example, there are 2 sampling entities. The pink transects are measuring the vegetation on the banks of the wash, and the blue transects are measuring the strand vegetation. Separate mean TVV values are calculated for each entity.

APPENDIX D
Example Summary Table for TVV Transects

	UTM Coordinates (NAD 1983)						
	Transect Start		Transect End				
Transect	Easting	Northing	Easting	Northing	TVV value	ENTITY (Habitat Type)	MEAN
1	**533579**	**3533060**	**533588**	**3533077**	1.136	bosque	**1.349**
2	**533591**	**3533145**	**533604**	**3533158**	1.172	bosque	
5	**533582**	**3533021**	**533590**	**3533037**	1.084	bosque	
6	**533639**	**3533007**	**533629**	**3533034**	2.004	bosque	
3	**533606**	**3532966**	**533584**	**3532961**	0.376	strand	**0.489**
4	**533483**	**3532965**	**533496**	**3532949**	0.54	strand	
7	**533489**	**3532973**	**533509**	**3532974**	0.552	strand	
8	**533442**	**3533081**	**533447**	**3533058**	0.264	upland	**0.288**
9	**533474**	**3533061**	**533472**	**3533040**	0.312	upland	

APPENDIX E
Blank On-site Vegetation Characterization Plot Data Form

On-site Vegetation Characterization Plot Data Sheet

Location: **Plot #** **Date:**

Plot shape (Circle one): **circle** **square** **rectangle**
Size:
UTM (NAD 83):

SPECIES:	NUMBER IN PLOT:
TREES	
SHRUBS	
LIST OTHER PERENNIALS	
LIST ANNUALS	
INVASIVE SPECIES NOTES:	
GENERAL NOTES:	

APPENDIX F
Example Summary Table for Plot Data

	Number of Individual Plants in Each 10-m Radius Plot (314 m^2)					
	Plot 1	**Plot 2**	**Plot 3**	**Plot 4**	**Total Number of Plants for All Plots (1,256 m^2)**	**Extrapolated Number of Plants per acre (4,047 m^2)**
TREES						
blue paloverde (*Parkinsonia florida*)	1	2	0	3	6	19.33
velvet mesquite (*Prosopis velutina*)	0	3	1	1	5	16.11
				TOTAL	**11**	**35.44**
SHRUBS						
bitter condalia (*Condalia warnockii*)	1	0	0	0	1	3.22
desert hackberry (*Celitis reticulata*)	3	0	0	1	4	12.89
gray thorn (*Zizyphus obtusifolia*)	0	0	1	1	2	6.44
white-thorn acacia (*Acacia constricta*)	4	0	2	1	7	22.55
wolfberry (*Lycium berlandieri*)	0	1	1	0	2	6.44
				TOTAL	**16**	**51.55**
OTHER PERENNIALS						
Bermuda grass (*Cynodon dactylon*)						
bristlegrass (*Setaria macrostachya*)						
buffelgrass (*Pennisetum ciliare*)						
bush muhly (*Muhlenbergia porteri*)						
deer grass (*Muhlenbergia rigens*)						
desert milkweed (*Sarcostemma cynanchoides*)						
globemallow (*Sphaeralcea ambigua*)						
sacaton (*Sporobolus wrightii*)						
sideoats grama (*Bouteloua curtipendula*)						
slimleaf bursage (*Ambrosia confertiflora*)						
snakeweed (*Gutierrezia sarothrae*)						
virgin's bower (*Clematis drummondii*)						
Wright's balsam apple (*Echinopepon wrightii*)						
ANNUALS						
Arizona poppy (*Kallstroemia grandiflora*)						
fleabane (*Erigeron divergens*)						
Mediterranean grass (*Schismus* sp.)						
Russian thistle (*Salsola* sp.)						
silverleaf nightshade (*Solanum eleagnifolium*)						

In this example, required mitigation container plantings would be 35 trees and 52 shrubs per acre. The species of container plants should be the same as those found in the plots. Any additions or substitutions are subject to District approval.

Management of invasive species (shaded) should be addressed in the mitigation plan; these species shall not be included in the planting plan.

UPRR-ADOT Pantano Grade Line Project
Invasive Species Monitoring and Remediation Plan

Introduction

This Invasive Species Monitoring and Remediation Plan herein establishes the on-site invasive species monitoring and remediation requirements for the UPRR-ADOT Pantano Grade Line Project.

Invasive species are often early-successional, pioneer species that are very successful at colonizing disturbed areas. They typically produce large quantities of easily-dispersible seeds that establish quickly and grow to out-compete natives for water, nutrients, and other resources. They may also spread vegetatively following disturbance. Some exotic plants, in particular many noxious and/or invasive weeds, can become established without soil disturbance. Once introduced into an area, these species can invade intact vegetative cover and displace native plants.

Disturbed areas such as road and railroad ROWs often harbor exotic plant species, including noxious and/or invasive weeds. Since the proposed railroad line will occur within and immediately adjacent to previously disturbed ROW, exotic plants including noxious and/or invasive weeds are already present along portions of the alignment.

UPRR-ADOT is committed to preventing the spread of noxious and/or invasive weeds along lands disturbed by its railroad line construction activities. This project proposed by UPRR-ADOT, the UPRR Pantano Grade Line, lies immediately upstream of the Cienega Preserve; a Pima County owned conservation area. To prevent the spread of invasive species into the preserve, UPRR-ADOT will be required to implement an Invasive Plant Species Management Plan within the disturbed Important Riparian Area/underlying Class H (IRA/H) habitat and contributing upland areas along the entire alignment of the new track construction to prevent the establishment and spread of noxious and/or invasive plants.

Preventative Measures

Communication with Agencies

- The contractor will contact the Water Resources Division – Pima County Flood Control District prior to starting work in each area to discuss specific noxious and/or invasive weed concerns and requirements.

- The contractor will wash vehicles (see below) after crossing through areas of known weed infestations as determined by agency personnel.
- The contractor will use approved seed mixes for reseeding (see below) as determined by agency and county personnel where reseeding is required.

Vehicle Washing

- The contractor will wash vehicles periodically during construction. Frequency of washing will depend on frequency of weed populations encountered as determined by project monitor at a minimum, vehicles and construction equipment will be washed before entering the project site for the first time.
- All washing of construction equipment will take place within an approved washing station.

Construction Techniques

- Ground disturbance will be minimized by the use of the least intrusive construction technique practicable for a given location.
- Off-ROW travel will not be allowed
- The contractor will avoid transporting contaminated materials, such as soils, gravel, mulch, hay/straw and sand.
- Hay and straw used for mulching will be certified by the pertinent state as free as of any noxious and/or invasive weeds.
- The contractor will reseed disturbed areas according to the Pima County Topsoil Stockpiling, Re-seeding, and Mulching Performance Standards.
- The contractor will use native seed mixes tested free of weed/invasive seed for revegetation. No species on the "State Noxious/InvasiveWeed List" will be included in revegetation seed mixes.

<u>Pre-Construction</u>

- A Pre-Construction Survey of the full expanse of lands within the Pantano Line construction easement in addition to lands adjacent to these areas will be conducted to assess the level of pre-existing invasive species occurrences. (A list of those invasive species that are subject to this plan is attached.) Percent cover, invasive species present, and approximate areal extent of existing infestations will be recorded. (Percent cover will be estimated utilizing the line transect methodology.) Upon completion of the Pre-Construction Survey, a report will be sent to the Pima County RFCD Water Resource Division (97 E. Congress Street, 2nd floor, Tucson, AZ 85701). At completion of the Pre-Construction Survey, all identified noxious and/or invasive weeds located within the designated Xeroriparian Class B (XB) habitat and Important Riparian Area (IRA) with underlying Class H (H) habitat, and contributing upland areas within the UPRR ROW adjacent to Cienega Creek shall be eradicated. Contributing uplands shall be defined as the watershed contributing to

Cienega Creek, upstream of the disturbed IRA/H habitat and within the disturbed UPRR ROW.

- Any areas found to have a total of 25% cover or greater of all existing invasive species outside of the designated riparian areas (IRA/H/XB) will not be subject to remedial treatment under this plan. Areas with a pre-existing total of 25% cover or greater of all existing invasive species are areas that exceed the capability of a single project to provide successful remediation.

  Invasive species in all other areas of less than 25% cover, as identified by the Pre-Construction Survey, will be subject to remediation as described herein.

Construction

- During construction the environmental compliance monitors designated for this project will be qualified to identify the presence or absence of noxious and/or invasive weeds along the proposed route, and existing population of weed infestations will be identified prior to construction. The weed monitor will keep ahead of construction crews to identify areas of concern. Areas where noxious weeds are prevalent will be flagged so that they are easily identifiable. A list of those invasive species that are to be monitored and remediated is attached. The environmental compliance monitors designated for this project will be qualified to identify the presence or absence of invasive species along the proposed route, and existing population of weed infestations will be identified prior to construction. The weed monitor will keep ahead of construction crews to identify areas of concern. Areas where noxious and/or invasive weeds are prevalent will be flagged so that they are easily identifiable.

Post Construction

The following monitoring and remediation measures will be implemented within the full expanse of the Pantano line 200' wide construction easement .

- On-site inspections will take place in April (Spring) and again in September (Fall) for five years, beginning in 2009.
- The on-site inspectors will be qualified to identify the presence or absence of invasive species.
- A list of those invasive species that are to be monitored and remediated is attached.
- For those areas that are subject to remediation as determined by the pre-construction survey, any invasive species on the attached list are to be mechanically removed. All individual plants (including roots and seed heads) will be removed and disposed of in a manner that avoids further dispersal.
- Initial removal will be initiated upon completion of construction and no later than December 2010. Subsequent removal efforts will be performed as part of April and September on-site inspections.
- Monitoring and remediation responsibilities will terminate in 2013 at the end of the 5-year monitoring plan period.

Communication

In addition to the Pre-Construction Survey, UPRR-ADOT will provide a total of two annual reports to Pima County Water Resources Division indicating results of the on-site inspections and (if needed) corrective measures. The first annual report will be submitted no later than August 1, 2009; the second annual reports will be submitted no later than January 1, 2010, January 1, 2011, January 1, 2012 and January 1, 2013.

Invasive Species to be Monitored & Remediated

Arundo donax – Giant Reed
Brassica tournefortii – Sahara mustard
Centaurea melitensis – Malta starthistle
Centaurea solatitalis – Yellow starthistle
Cynodon dactylon – Burmuda grass
Pennisetum spp – Invasive grasses including Buffelgrass & Fountain grass
Rhus lancea – African Sumac
Salsola collina – Slender Russian thistle
Salsola paulsenii – Barbwire Russian thistle
Salsola tragus, Salsola kali var. tenuifolia, Salsola kali-tragus – Prickly Russian Thistle
Tamarix spp. – Tamarisk, Salt Cedar

`

APPENDIX G

Invasive Species Management Plan for Linear Projects –
Example and Special Provisions Section 201-3.04

** USE IN CONJUNCTION WITH ITEM 2010001 - CLEARING AND GRUBBING, AND ALSO USE ITEM 2010003 - CLEARING AND GRUBBING (NOXIOUS AND INVASIVE SPECIES CONTROL) ON A FORCE ACCOUNT BASIS, FOR PROJECTS WHICH REQUIRE NOXIOUS PLANT CONTROL **

*** FENCING FOR PRESERVATION OF EXISTING VEGETATION TO REMAIN IN PLACE SHALL BE USED IN CONJUNCTION WITH ITEM 2010004 - PRESERVATION FENCING, AND THE UNIT OF MEASUREMENT IS LINEAR FOOT ***

(201NOX_PLANT_REM, 11/23/11)

SECTION 201 - CLEARING & GRUBBING of the Standard Specifications is revised to read:

201-1 DESCRIPTION

The work under this section shall consist of clearing, grubbing, removal and/or treatment of noxious or invasive plant species, removing and disposing of all trees, brush, vegetation, including, stumps, debris, rubbish, miscellaneous structures not covered under other contract items, and other objectionable matter from within the right-of-way, bridge construction area(s), road approaches, areas through which ditches and channels are to be constructed, and such other areas as may be specified in the Special Provisions.

Removal and/or treatment of noxious or invasive plant species shall take place prior to the start of clearing and grubbing, in accordance with Subsection 201-3.04.

Clearing and grubbing shall be performed in advance of embankment construction and grading operations and in accordance with the requirements of these specifications.

All vegetation identified on the project plans as being preserved-in-place or transplanted-on-site shall be protected from damage or destruction caused by the Contractor's operations by protective fencing or flagging. The locations of vegetation so identified on the project plans are approximate. Actual locations will be determined during the project walk-through specified in Subsection 201-3.01.

For the purpose of construction, existing vegetation on the project shall not be disturbed beyond the limits established in accordance with Subsection 201-3.01.

All objects designated on the project plans to remain shall be preserved from injury or defacement. Property and landscape shall be protected and restored in accordance with the requirements contained in Subsection 107-12.

201-2 MATERIALS

201-2.01 Herbicides

The use of herbicides shall be approved by the Engineer prior to starting construction.

Herbicide use shall be in compliance with the manufacturer's instructions. Application of herbicides shall be by a licensed applicator, in compliance with the requirements of A.R.S.32-2314 and A.A.C. R4-29-204. The licensed applicator shall be approved by the Engineer prior to commencement of the work.

Herbicides proposed in the plan for use on projects adjacent to BLM and or USFS Lands shall be in conformance with the following current environmental documents, including:

"Final Vegetation Treatments Using Herbicides Programmatic Environmental impact Statement for BLM" available electronically at *http://www.blm.gov/wo/st/en/prog/more/veg_eis.html*;

or the *"Environmental Assessment for Management of Noxious Weeds and Hazardous Vegetation on Public Roads on National Forest System Lands in Arizona"*, available electronically on the Arizona Memory Project website (Arizona State Library): *http://azmemory.lib.az.us/cdm4/item_viewer.php?CISOROOT=/feddocs&CISOPTR=486&CISOBOX=1&REC=6*

The Environmental Documents include lists of approved Herbicides, Mitigations and Best Management Practices.

201-3 CONSTRUCTION DETAILS

201-3.01 Clearing and Grubbing

The Engineer will establish the limits of areas to be cleared and grubbed, to be cleared but not grubbed, and/or areas, objects, landscape, or features that are designated to remain undisturbed. In general, the areas subject to clearing and grubbing shall include the road section, channels, ditches, structures, temporary approaches to bridges, detours and other areas shown on the project plans, or as directed by the Engineer. The Engineer will designate structures, debris, trees, brush and vegetation to be cleared where grubbing is not required. Clearing beyond the limits of construction shall be only where specified or directed.

Prior to commencement of clearing and grubbing operations, the Contractor, accompanied by the Engineer, shall inspect the project limits, in order to confirm areas and vegetation to be left undisturbed or transplanted.

The Contractor shall flag all plants designated to be preserved-in-place and/or to be transplanted-on-site during the inspection. Designated plants may lie within and as well as be adjacent to the project limits. These areas shall be preserved with protective fencing, as described in Subsection 201-3.02. Flagging may be used to designate preserve in place areas prior to the installation of the protective fencing.

Removal of cacti and native plants shall be in accordance with the provisions of the "Native Plant Law" of the Arizona Revised Statutes, Chapter 7 and applicable local ordinances.

During the life of the contract the Engineer may order the clearing of any trees within the right-of-way that are determined to be hazardous or dead.

The Contractor shall prune all branches of trees less than 16 feet above any part of the roadway and less than 8 feet above or within 2 horizontal feet sidewalks, multi-use paths, traffic control cabinets and intersection site distance triangles and all branches which have been broken or injured during construction. All pruning shall be done by or be supervised by a certified arborist, in accordance with Section 806-3.05.

Whenever trees are felled or trimmed on/or adjacent to highways, all wood shall be immediately removed from the roadway or any area that would present a hazard to traffic. Grubbed stumps shall be moved immediately, at least 30 feet from the edge of pavement.

No trees, tree trunks, stumps or other debris shall be felled, sidecast or placed outside the limits of the right-of-way.

In embankment areas where the subgrade will be 5 feet or more above the original ground surface, trees, stumps and roots shall be cut off one foot or less above the original ground line or shall be completely removed as directed by the Engineer. No grubbing will be required unless in an area where a structure is to be built, piles are to be placed or driven, unsuitable material is to be removed or as may otherwise be specified in the project plans or Special Provisions.

Where trees or existing stumps are cleared and grubbing is not required, the tree trunk or existing stump shall be cut off not more than 6 inches above the original ground surface unless otherwise approved. Exposed stumps not required to be removed but which are within 30 feet of the edge of the pavement or are in a built-up area shall be chipped out to a depth of not less than 6 inches below the finished grade.

Cavities resulting from the grubbing or removal of stumps, trees, or other materials, except in areas to be excavated, shall be backfilled with material approved by the Engineer within seven calendar days after grubbing or removal of the stump, tree or other materials. The backfill material shall be uniformly compacted to a density of not less than 95 percent of the maximum density as determined in accordance with the requirements of the applicable test methods of the Arizona Department of Transportation Materials Testing Manual, as directed and approved by the Engineer. T he compacted surface shall remain firm and stable prior to and after placement of any cover material. Cleared organic and grubbed materials, debris, rubbish, and miscellaneous structures shall not be buried within the project limits.

All materials removed under this section shall be disposed of within seven calendar days after cutting, felling or removal unless otherwise approved, in writing, by the Engineer.

Burning of cleared organic materials is prohibited on or in proximity to the project site.

In the disposal of all tree trunks, stumps, brush, limbs, roots, vegetation and other debris, the Contractor shall comply with the requirements of Title 36, Public Health and Safety, Chapter 6, Article 8, Air Pollution of the Arizona Revised Statutes and with the Rules and Regulations for Air Pollution Control, Article 7, adopted by the Arizona Department of Health Services pursuant to the authority granted by Statute and as may otherwise be amended by local agency requirements.

Burning at other locations may be permitted only after the Contractor has obtained a permit from the Arizona Department of Health Services and from any other Federal, State, County or City Agency requiring such approval.

Unless otherwise specified in the Special Provisions, marketable timber and other vegetation not designated to remain shall become the property of the Contractor.

Combustible material free of invasive species may be reduced to chips of a maximum thickness of 1/2-inch and disposed of in areas between the slope lines and right-of-way lines as approved by the Engineer. The chips may either be buried or distributed uniformly on the ground surface and mixed with the underlying earth to such extent that the chips will not support combustion.

The roadway right-of-way and all other construction areas shall be left with a neat and finished appearance. No accumulation of material shall remain on, or adjacent to, the right-of-way or construction areas.

201-3.02 Vegetation Preserved-In-Place

Vegetation noted on the project plans to be preserved-in-place shall be pruned, as directed by the Engineer, to remove all damaged, deformed, diseased or dead growth. All pruning shall be done by or be supervised by a certified arborist in accordance with Section 806-3.05.

No construction material, equipment or vehicles shall be allowed within the drip line (edge of canopy) of trees to be preserved during the course of the construction.
Vegetation to be preserved-in-place shall be flagged, fenced and irrigated, as directed by the Engineer, to protect it from damage.

The Contractor shall provide and install all required fencing materials. Fencing will consist of high visibility orange, heavy duty High Density Polyethylene (HDPE) that is UV resistant. The fencing shall be four feet (4') tall. Fence posts will be either wood or metal and shall be suitable for the work intended and a minimum of six feet (6') long.

Fencing shall be installed at the drip line of each tree or group of trees. Fencing shall remain in place for the duration of construction operations. Fencing that is damaged or destroyed shall be repaired or replaced by the Contractor within 2 working days.

The Contractor shall be responsible for the protection of all vegetation which is to be preserved-in-place. Protection includes, but is not limited to, damage to major limbs, destruction of major root systems, scarring of the trunk and death.

Upon approval of the Engineer, the Contractor can correct minor damage to trees in conformance with the requirements of Subsections 806-3.06, 807-3.03 and this Subsection.

The Contractor, at no additional cost to the Agency, shall replace any vegetation identified as being preserved-in-place that is damaged or destroyed. Replacement vegetation shall be of the same genus and species and shall be of a similar caliper and canopy size. The Engineer shall approve all replacement plants prior to installation.

201-3.03 Salvaged and Transplanted Vegetation

The Contractor shall salvage vegetation that is flagged for transplanting. Salvage operations shall employ best local practice methods and experienced personnel, in conformance with Subsection 806-3.04(C).

When required, the Contractor shall construct a temporary holding nursery/area for plants salvaged from the site. The Contractor shall be responsible for all labor, materials, equipment, tools, and other resources necessary for the establishment and operation of the nursery. The nursery location shall be approved by the Engineer.

The on-site holding nursery shall be developed with an automatic drip irrigation system for all boxed trees and shrubs. The Contractor shall be responsible for the design, installation, operation, and subsequent removal of the irrigation system. The drip irrigation system shall be as approved by the Engineer. The Contractor shall provide a temporary water source for the holding nursery/ area and shall pay all fees for temporary connections, meters, and water used. All trees and shrubs shall be irrigated daily or at other interval approved by the Engineer. The daily application of water shall be sufficient to keep the entire soil volume within the root ball

continuously moist. Irrigation applications shall be adjusted based on changes in weather conditions.

Temporary fences to control access to the holding nursery, if deemed necessary by the contractor, shall be furnished, installed, maintained, and subsequently removed by the contractor.

The Contractor shall guarantee the survival and health of all plants salvaged and replanted as part of this contract. The salvaged native plant guarantee period shall extend through the end of the Landscaping Establishment Period. All plants which die during the guarantee period, for reasons other than acts-of-God and/or causes deliberate shall be replaced by the Contractor with plants of the same size and species.

Replacements shall be provided at the Contractor's expense;

To satisfy the plant guarantee requirements, the plant shall:

Exhibit healthy growth throughout the plant structure;

Be free from significant die back within branches or portions of the plant;

Be reasonably free from insects or other infestations that would reduce the plant's long-term potential for survival;

Be reasonably free from physical damage to the trunk, branches, or foliage that would reduce the plant's long term potential for survival.

201-3.04 Noxious and Invasive Vegetation

Prior to the start of construction, the Contractor shall retain the services of a person, subject to the approval of the Engineer, knowledgeable in identification of noxious and invasive plant species, such as; a Landscape Architect, registered in the State of Arizona; a certified arborist; biologist, horticulturist, or botanist with a degree in a plant oriented natural resource field; or a person holding a State of Arizona Office of Pest Management Applicator License in Category B3 (Right of Way and Weed Control) to survey the limits of the project in order to determine the presence of noxious or invasive plant species. Should the survey determine that noxious or invasive plant species are present within the limits of the project the Contractor shall treat the areas designated. Such treatments shall be completed and approved by the Engineer before ground disturbing or earthmoving activities occur in those areas. Areas of noxious and invasive vegetation infestation shall be mapped on a project site map or aerial photo of the project and shall be provided to the Engineer before work begins and when work is completed This map shall be updated throughout the duration of the project and placed in an appendix in the Stormwater Pollution Prevention Plan (SWPPP). In addition, all herbicides used at the site shall be listed in Section 1.9, Potential *Sources of Pollution*, of the SWPPP.

Noxious or Invasive Species that shall be treated include the following:

Scientific Name	**Common Name**
Acroptilan repens	Russian Knapweed

Alhagi maurorum	Camelthorn
Arundo donax	Giant Reed
Brassica tournefortii	Sahara Mustard
Bromus rubens	Red Brome
Bromus species	Other Brome species
Centaurea spp.	Starthistle species
Chondrilla juncea	Rush Skeletonweed
Cortaderia selloana	Pampas Grass
Cynodon dactylon	Bermudagrass
Eragrostis lehmanniana	Lehmann lovegrass
Erodium cicutarium	Redstem filaree
Hordeum murinum	Mouse Barley
Mesembryanthemum Nodiflorum	Slenderleaf Iceplant
Nicotina glauca	Tree Tobacco
Pennisetum ciliare	Buffelgrass
Pennisetum setaceum	Fountain Grass
Rhus lancea	African Sumac
Salsola species	Russian Thistle
Sorghum halepense	Johnsongrass
Sisymbrium ino	London Rocket
Sonchus asper	Spiny sowthistle
Tamarix spp.	Tamarix
Tribulus terrestris	Puncturevine

Removal of noxious and invasive plant species shall be by manual methods or, when appropriate, with the application of herbicides. Herbicides shall not be used in washes and right-of-way dip crossings classified as waters of the United States (WUS). Only manual removal of noxious and invasive species shall be allowed at these locations. Invasive species that are treated by herbicides can be left to decompose. Plants that are manually dug shall be put into large plastic bags with tie closures before removing from site. No portion of the root ball shall be left behind. Bags shall be disposed of in a landfill. Mowing or chopping of invasive species is prohibited.

In regard to buffelgrass and fountain grass, plants treated by chemical means must be sprayed before they develop seed heads or just as they are forming seed heads. Plants must be green and actively growing for herbicides to be effective; herbicides will be most effective when at least 50% of the plant is green material. Only targeted plants shall be sprayed. Targeted plants shall be sprayed so that the herbicide coats all leaves but does not run off.

For projects that include a requirement for landscape establishment, eradication of noxious and invasive plant species will be required throughout the landscape establishment period.

Care shall be taken in treating or removing noxious and invasive plant species to minimize seed re-infestation to the satisfaction of the Engineer.

The Contractor shall keep records of all herbicide applications, as outlined in Arizona Administrative Code R4-29-307. A copy of all Service Records shall be provided to the Engineer after each application. Treated areas shall be recorded on the project site map or project aerial photo as described previously. This map shall include all areas of noxious and invasive species removal, whether by manual or chemical means. T he Contractor shall be

responsible for the proper transport, storage, and application of all materials necessary for herbicide control treatments. Herbicides shall be applied by an Arizona licensed applicator in accordance with all federal, state, and local codes and regulations, as well as the recommendations of the manufacturer.

201-4 METHOD OF MEASUREMENT

Clearing and grubbing will be measured either on a lump sum basis or by the acre. Measurement by the acre will be to the nearest tenth of an acre measured on a horizontal plane.

No direct measurement will be made for protecting vegetation preserved-in-place, payment for which is considered as incidental to and included in other contract items.

No direct measurement will be made for salvaged and transplanted vegetation, payment for which is considered as incidental to and included in other contract items.

No direct measurement will be made for providing services of a Certified Arborist and the person knowledgeable in identification of noxious and invasive species, payment for which is considered as incidental to and included in other contract items.

All work required to eradicate and control noxious and invasive plant species, as described herein, by either manual means or with herbicides, will be completed on a force account basis, as approved and directed by the Engineer, in conformance with the requirements of Subsection 109-5.

All noxious and invasive plant species eradication in landscaped areas after construction shall be considered incidental to the work described in Section 807- Landscape Establishment.

201-5 BASIS OF PAYMENT

The accepted quantities of clearing and grubbing, measured as provided above, will be paid for at the contract lump sum price or by the acre as designated in the bidding schedule, including furnishing, placing and compacting the material required to fill the cavities resulting from the removal of tree stumps or other materials; the removal and disposal, in accordance with the provisions of all laws and ordinances, of cleared trees, brush, vegetation, stumps, debris, rubbish, miscellaneous structures and other objectionable matter; and the removal, storage and replanting of plant materials designated to be salvaged.

When measured on a lump sum basis, payments will be made monthly in proportion to the amount of work done as determined by the Engineer.

No payment will be made for clearing and grubbing outside the specified limits, unless such work is directed by the Engineer.

When clearing and grubbing is not included as a contract pay item, full compensation for any clearing and grubbing necessary to perform the construction operations designated on the project plans or specified in the Special Provisions shall be considered as included in the price of other contract items.

Payment for eradication of noxious or invasive plant species will be made in accordance with the provisions of Subsection 109-5. Payment will be inclusive of all labor, materials, equipment, herbicides and other eradication measures, removal and proper disposal of eradicated material,

mobilization, demobilization and remobilization necessary to complete the work in accordance with the project plans, Special Provisions or as directed by the Engineer.

The control of plant species not included on State or Federal noxious and invasive lists will be paid only when control is directed by the Engineer.

APPENDIX H

Riparian Habitat Monitoring Agreement for Pima County
Roadway Projects and General Notes

MEMORANDUM

Department of Transportation

DATE: February 8, 2011

TO: Consultants with RFCD Riparian Habitat Mitigation Requirement Requirements on Pima County Transportation Projects

FROM: Ellen Alster, RLA, Senior Landscape Architect

SUBJECT: Riparian Habitat Monitoring Agreement for Pima County Roadway Projects

This memo is an update to the Riparian Habitat Mitigation Plan (RHMP) monitoring agreement for Pima County transportation projects. This update only applies to Pima County transportation projects, and not to any other type of project where a RHMP is required. It shall substitute for the existing section from the Pima County Regional Flood Control District Regulated Riparian Habitat Mitigation Standards and Implementation Guidelines (page 30).

Existing wording in Guidelines in regard to required maintenance (page 30):

Your RHMP must include the statement: "The project owner, and/or the Owner's successors agree to preserve and protect the Mitigation Area for the duration of the project. Further, the project owner and/or their successors agree to actively maintain the mitigated area for a period of not less than five years. Maintenance activities shall include, but not be limited to, the regular operation of the irrigation system, the replacement of dead trees and shrubs, and the removal of noxious and/or invasive plant species.

Substitute the Following New Wording for DOT projects only:

Pima County DOT agrees to preserve and protect mitigation areas within Transportations' roadway project area as follows: Pima County DOT agrees to actively maintain the mitigated area until a minimum of 80% of the plants originally planted as 15 gallon or smaller in size are living and actively growing (without significant dieback or loss) after 1 year without supplemental irrigation. Plants larger than 15 gallon in size will be irrigated in accordance with USFWS requirements. Maintenance activities shall include, but not be limited to, the regular operation of the irrigation system, the replacement of dead trees and shrubs, and the removal of noxious and/or invasive plant species.

Additional General Notes:

1. Mitigation area(s) to be left in a natural state. No disturbance shall occur within the mitigation area(s). Such disturbance includes but is not limited to secondary impacts such as fencing, intensive landscaping, etc.

2. Mitigation area shall be seeded with a minimum of 12 species determined from the roadway project ESR Releve Report. Plant species shall be selected from releves completed within riparian habitat areas. Seeding methods include; hydroseeding, drill seeding with crimped straw mulch or broadcast seeding and raking into seedbed with straw or other approved mulch. These species are listed in the Riparian Seed Mix on Sheet xxxxx of the Landscape Plan. Of the 12

species, 4 shall be shrubs, 4 shall be annuals/perennials/vines, and 4 shall be grasses. If plant species listed in the Riparian Seed Mix are unavailable, replacements species from the Releve Report (riparian releves) and/or approved (Class H or Xeroriparian (*select based on habitat type present)*) plant list may be selected based upon availability. Any changes to the seed mix shall be noted on the first monitoring plan submittal.

3. Once plants originally planted as 15 gallon or smaller in size have established (approximately 1 to 3 years after installation), supplemental irrigation will be decreased in accordance with Appendix C of the Guidelines.

4. RHMP implementation shall be completed by the first growing season following completion of construction, which is projected to be (select one season) March-May, 20XX/July-September, 20XX/September-November, 20XX.

5. A monitoring plan, in accordance with the Guidelines, will be submitted annually until a minimum of 80% of the plants originally planted as 15 gallon or smaller in size are living and actively growing (without significant dieback or loss) after 1 year without supplemental irrigation. Any changes from the approved RHMP shall be noted on the monitoring plan submittal." Submittals shall be labeled "Annual Monitoring Report for PCDOT Project #XXXXXX" and sent to the following address:

   Pima County Regional Flood Control District
   ATTN: Water Resources Division Staff
   97 E. Congress Street, 2nd floor
   Tucson, AZ 85701

   (***Select one of the following comments below***):
   The assigned PCDOT monitor for this project is _____ OR
   The assigned PCDOT division/section that will monitor this project is _____

6. Riparian habitat to be preserved shall be fenced for protection during construction using minimum 4-foot high orange mesh barricade fencing. Protective fencing must remain in place throughout construction.

APPENDIX I

Offsite Guidelines Appendix F: ILF Calculation Method

Appendix I

REGULATED RIPARIAN HABITAT OFFSITE MITIGATION GUIDELINES FOR UNINCORPORATED PIMA COUNTY

November 2011

Prepared by

Pima County Regional Flood Control District
97 East Congress, Second Floor
Tucson, Arizona 85701
(520) 243-1800

And

SWCA Environmental Consultants
Tucson Office
343 West Franklin Street
Tucson, Arizona 85701
(520) 325-9194
www.swca.com

APPENDIX F

IN-LIEU FEE CALCULATION SPREADSHEET AND TUTORIAL

Appendix F. Determination of ILF Spreadsheet Costs

Commercial and Subdivision Development:

Plant Material (trees and shrubs): Costs include plant material obtained from local vendors and labor for installation. Costs were determined for 1-gallon, 5-gallon, and 15-gallon sized plants. Overall, ILF costs were calculated by averaging 12 commercial/residential ILF submittals obtained over a seven year period (2005-2011). Riparian habitat classification was not considered when averaging plant material costs.

Assumption(s): Cost includes both plant material and labor for installation.

Hydroseed: Cost assigned for hydroseeding (seed, mulch, tackifier, labor) is based on average costs received from actual ILF fee estimates. The costs were calculated by averaging 12 commercial/residential ILF submittals obtained over a seven year period (2005-2011). Riparian habitat classification was not considered when averaging hydroseed costs.

Assumption(s): Seed will be applied via hydroseed method.

Irrigation: Cost assigned for irrigation (materials and installation) is based on average costs received from actual ILF fee estimates. The costs were calculated by averaging 12 commercial/subdivision ILF submittals, obtained over a seven year period (2005-2011). To account for cost difference between the classes of habitat, the average value (averaged across habitat classifications) was used as the base irrigation cost for IRA/H ($2,661/acre). Once assigned, the base irrigation cost was reduced based on the number of plants installed. Tiered irrigation costs are provided in the following table:

Habitat Class	Trees	Shrubs	total # plants	% of base cost	Irrigation ($/ac)
IRA/H, H	135	150	285	100%	$2,661
IRA/XA	113	135	248	87%	$2,316
IRA/XB	90	120	210	74%	$1,961
IRA/XC	68	105	173	61%	$1,615
IRA/XD	45	75	120	42%	$1,120
XA	75	90	165	58%	$1,541
XB	60	80	140	49%	$1,307
XC	45	70	115	40%	$1,074
XD	30	50	80	28%	$747

After cost data was tabulated, the cost values were compared to total cost for plant material only (trees and shrubs) and a percentage was determined. Irrigation costs were determined to be approximately 30% of the total plant material costs. For example, if plant material cost for a project is $3,600.00, irrigation cost would be calculated as follows: $3,600 x 0.30 = **$1,080**.

Assumption(s): Although there will be a base cost for installing an irrigation system, regardless of the number of plants installed, it is known that cost for irrigation will decrease as the quantity of plants installed decrease. This premise was used when developing irrigation cost data.

Maintenance: Cost was calculated for five years of maintenance based on average costs received from actual ILF fee estimates. The costs were calculated by averaging 12 commercial/subdivision ILF submittals over a range of riparian habitat classifications. Out of 12 ILF submittals reviewed, only one provided maintenance costs for Class H habitat mitigation, and the value appeared excessively high compared to other cost data received (cost for maintenance of Class H was calculated to be $14,760 per acre, compared with an average cost of $3,730 per acre for xeroriparian habitat). Therefore, single-lot ILF fee submittals, which provided more comprehensive cost comparison data between Xeroriparian vs. Class H habitat, were reviewed. From the data, it was determined that maintenance costs for Class H habitat are typically 35% higher than maintenance costs

for xeroriparian habitat. A base cost for Class H ($5,035/acre) was calculated by adding 35% to the average base cost for xeroriparian habitat ($3,730/acre). Once assigned, the base maintenance cost was reduced based on the number of plants installed. Tiered maintenance costs are provided in the following table:

Habitat Class	Trees	Shrubs	total # plants	% of base cost	5-yr maintenance ($/ac)
IRA/H, H	135	150	285		$5,035
IRA/XA	113	135	248	100%	$3,730
IRA/XB	90	120	210	85%	$3,158
IRA/XC	68	105	173	70%	$2,602
IRA/XD	45	75	120	48%	$1,805
XA	75	90	165	67%	$2,482
XB	60	80	140	56%	$2,106
XC	45	70	115	46%	$1,730
XD	30	50	80	32%	$1,203

After cost data was tabulated, the cost values were compared to total cost for plant material only (trees and shrubs) and a percentage was determined. On average, maintenance costs were determined to be approximately 45% of total plant material costs, regardless of habitat type. For example, if plant material costs for a project equal $3,600.00, maintenance cost would be calculated as follows: $3,600 x 0.45 = $1,620.

Assumption(s): Although there will be a base cost for maintenance, regardless of the number of plants installed, it is known that maintenance costs will decrease as the quantity of plants installed decrease. This premise was used when developing maintenance cost data. The District used single-lot data to determine percentage of difference between xeroriparian and Class H maintenance costs, which should realistically reflect cost difference due to higher water use plant species and increased quantity of plants.

Monitoring: Monitoring costs were obtained from local consulting firms and are based on riparian habitat mitigation plans (RHMP) from approved development projects. Two projects were reviewed and monitoring costs calculated based on requirements outlined in the "*Riparian Habitat Mitigation Plan Annual Monitoring Report Checklist for Subdivision Plats and Development Plans*". Based on this analysis, an average cost of $1,500 per acre per year was calculated. For xeroriparian habitat, this would be equivalent to $4,500 over a three year period. For Class H and Important Riparian Areas, the value would increase to $11,250 over a five year period.

Single-lot Development

Plant Material (trees and shrubs): Plant material costs were obtained from local vendors and are based on average costs received from actual ILF fee estimates. The costs were calculated by averaging 5 single-lot ILF submittals obtained over a six year period (2006-2011). Costs were determined for 1-gallon, 5-gallon, and 15-gallon sized plants.

Assumption(s): Property owner will install plants, therefore labor costs are not included, only plant material costs.

Seeding: Seed cost is based on an average cost of seed per acre, obtained from local vendors.

Assumption(s): The property owner will purchase seed directly from the vendor and apply seed to the mitigation area by hand (broadcast seeding).

Irrigation: A cost was assigned for irrigation (materials and installation) based on average costs received from actual ILF fee estimates. The costs were calculated by averaging 5 single-lot ILF submittals obtained over a

six year period (2006-2011). Riparian habitat classification was not considered when averaging irrigation costs.

Assumption(s): Property owner will install a drip irrigation system.

Maintenance: Average maintenance cost is based on annual water requirements for plants, plant replacement at 5% over five years, and invasive species control (see calculations below). Maintenance costs are derived from actual estimates obtained from ILF proposals submitted over the past six years (2006-2011). Cost estimates are based on actual plant water use, using City of Tucson water rates (http://cms3.tucsonaz.gov/water/new-rates), plant replacement at 5% of the total number of plants installed, and invasive species control. Cost of maintenance for Xeroriparian vs. Class H habitat was determined separately and is shown in the ILF calculation spreadsheet.

Single-lot development – break-down of maintenance costs per acre:
Water for plants over 5 years (Class H) = $462/ac
Water for plants over 5 years (Xeroriparian - average taken for all classes of habitat (XA-XC)) = $183/ac
Replacement Plants (replace at 5%) for Class H = $461/ac
Replacement Plants (replace at 5%) for Xeroriparian (average taken for all classes of habitat (XA-XC)) = $303/ac
Invasive species control – purchase of 1 - 32 oz bottle of Roundup per year (makes 10 gallons of herbicide) = $125/ac

Maintenance cost for Class H = 462+461+125 = $1,048 (round to $1,050)
Maintenance cost for Xeroriparian = 183+303+125 = $611 (round to $610)

Assumption(s): Invasive species control is cost to purchase herbicide only, and it is assumed labor is performed by the property owner.

Monitoring: A monitoring cost was not assigned for single-lot ILF estimates since the property owner will be monitoring the site.

Assumption(s): Costs for monitoring will be minimal (e.g., cost for paper to draft report and postage to mail report).

Alternative to Using the ILF Spreadsheet Provided by the District

As an alternative to using standard cost estimates provided by the District, the applicant has the option to submit a reasonable cost estimate for the ILF, prepared by a qualified professional. The applicant may provide a cost estimate for the entire fee or determine costs for a portion of the fee, using District costs for the remaining portion(s) of the fee. Requirements for this option are outlined in Section 2 of the Guidelines.

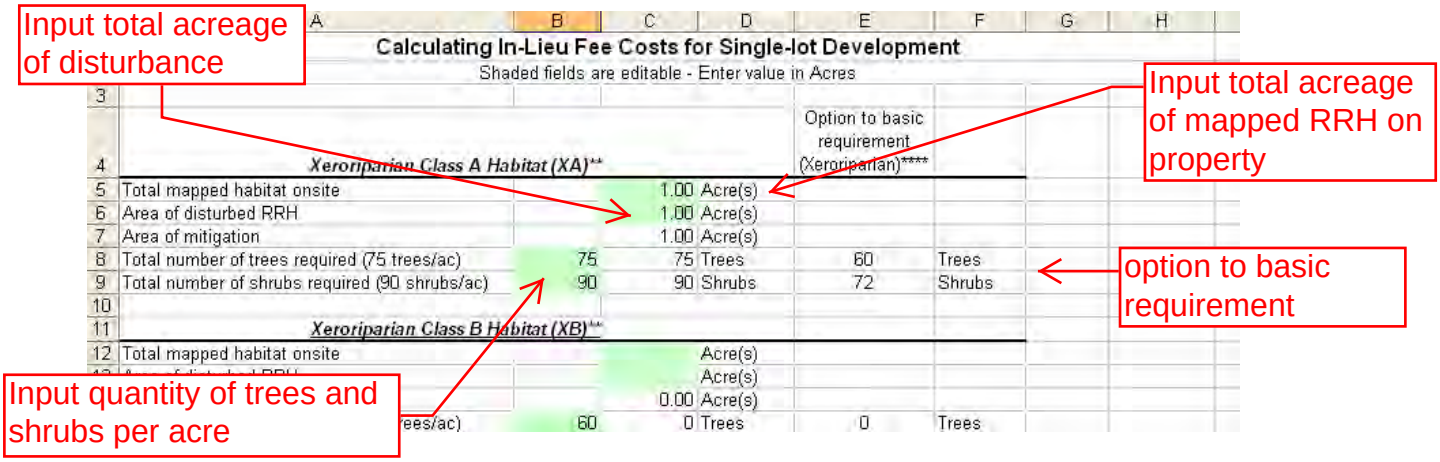
APPENDIX F. IN-LIEU FEE SPREADSHEET TUTORIAL

The following examples explain how to use the In-Lieu Fee (ILF) calculation spreadsheet. The color green indicates cells where data input is required while cells without color are locked from user input and will perform automatic calculations. Please follow examples below for a brief tutorial on how to use the spreadsheet.

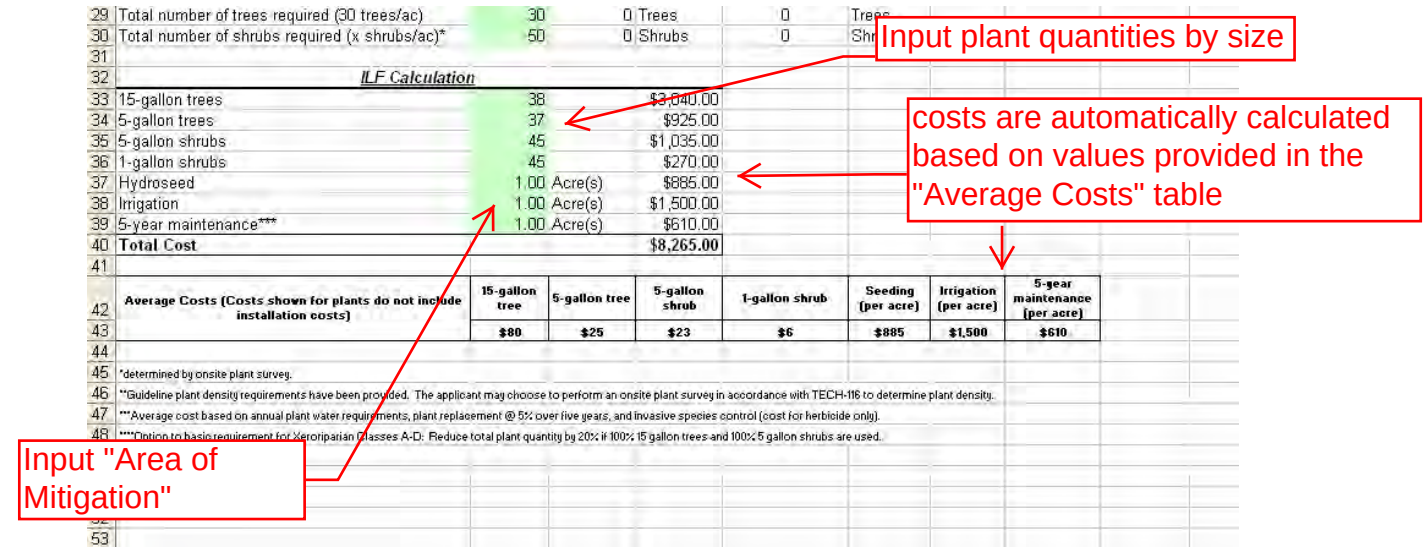
SINGLE-LOT DEVELOPMENT

Example 1. The first example shows the user how to input data into the ILF calculation spreadsheet for disturbance of Xeroriparian Class A habitat on a subdivided lot.

Step 1: Verify the class of Regulated Riparian Habitat (RRH) to be disturbed and then select the correct cells for data input.



Step 2: After inputting total acreage of RRH on the property (cell C5) and total disturbance of RRH (cell C6), scroll to the bottom of the spreadsheet and enter additional data to complete the calculation.



Step 3: The user will input plant quantity data calculated in cells C8 and C9 into cells B33 through B36. Divide plant quantities evenly between 15 gallon and 5 gallon size for trees and 5 gallon and 1 gallon size for shrubs unless "Option to Basic Requirements" was chosen. If this option is chosen, select data from cells E8 and E9 and input into cells B33 and B35 only (all 15 gallon size trees and 5 gallon size shrubs). Insert "Area

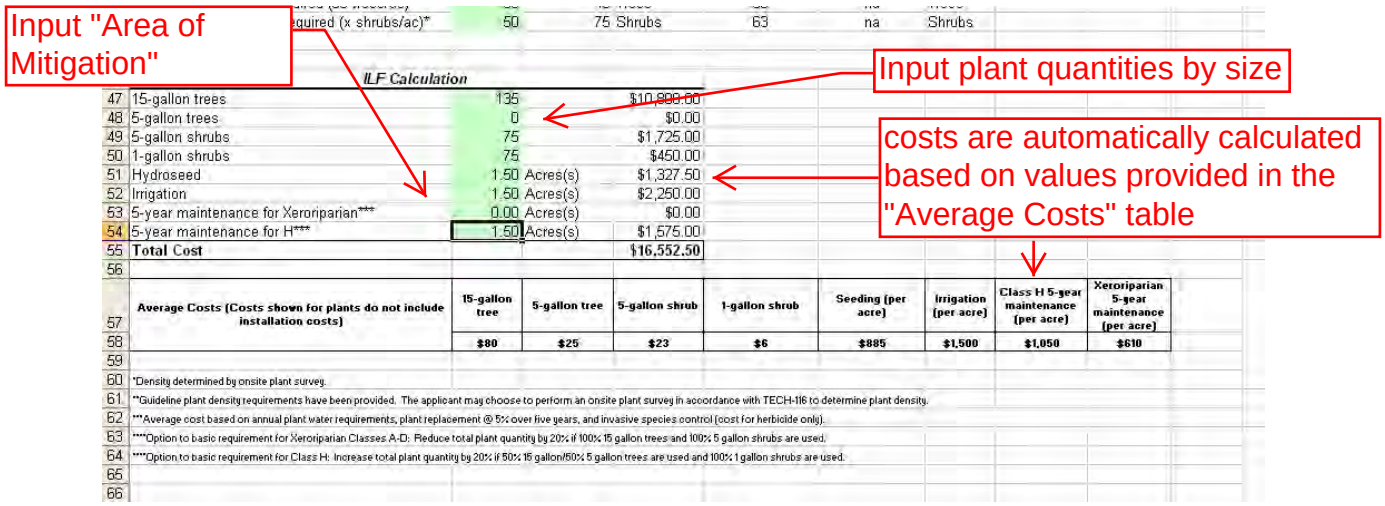
of mitigation" value from cell C7 into cells B37 through B39. The spreadsheet will automatically calculate the ILF from the "Average Costs" table (cells B43 through H43).

Example 2. The second example shows the user how to input data into the ILF calculation spreadsheet for disturbance of Class H habitat on a subdivided lot.

Step 1: Verify the class of RRH to be disturbed and then select the correct cells for data input.

	A	B	C	D	E	F	G
1–3	Calculating In-Lieu Fee Costs for Single-lot Development (Shaded fields are editable - Enter value in Acres)						
4							
5	*Class H or IRA w/ Underlying Class H Habitat (H or IRA/H)**				Option to basic requirement (Xeroriparian)****	Option to basic requirement (Class H)****	
6	Total mapped habitat onsite		1	Acre(s)			
7	Area of disturbed RRH		1	Acre(s)			
8	% of mapped habitat disturbed		100%	Acre(s)			
9	Area of mitigation		1.50	Acre(s)			
10	Total number of trees required (90 trees/ac)	90	135	Trees	na	162	Trees
11	Total number of shrubs required (100 shrubs/ac)	100	150	Shrubs	na	180	Shrubs
12							
13	*IRA w/ Underlying Xeroriparian Class A Habitat (IRA/XA)**						
14	Total mapped habitat onsite			Acre(s)			
15	Area of disturbed RRH			Acre(s)			
16	% of mapped habitat disturbed		#DIV/0!	Acre(s)			
17	Area of mitigation		0.00	Acre(s)			

Step 2: After inputting total acreage of RRH on the property (cell C6) and total disturbance of RRH (cell C7), scroll to the bottom of the spreadsheet and enter additional data to complete the calculation. Please note that for Class H habitat, the area of disturbance is mitigated at a ratio of 1:1.5.



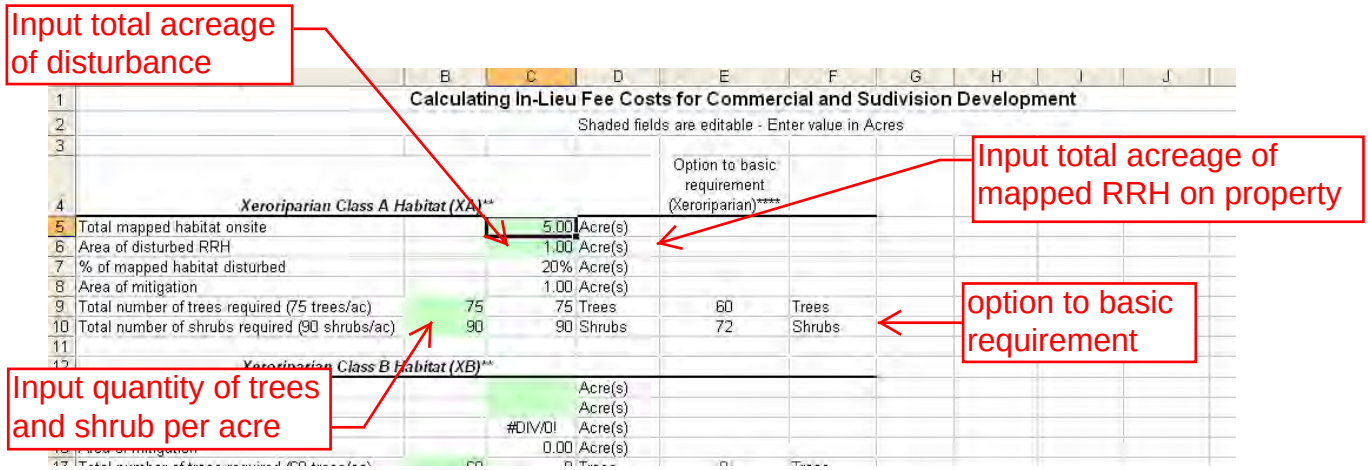
	equired (x shrubs/ac)*	50	75	Shrubs	63	na	Shrubs	
	ILF Calculation							
47	15-gallon trees	135		$10,800.00				
48	5-gallon trees	0		$0.00				
49	5-gallon shrubs	75		$1,725.00				
50	1-gallon shrubs	75		$450.00				
51	Hydroseed	1.50	Acres(s)	$1,327.50				
52	Irrigation	1.50	Acres(s)	$2,250.00				
53	5-year maintenance for Xeroriparian***	0.00	Acres(s)	$0.00				
54	5-year maintenance for H***	1.50	Acres(s)	$1,575.00				
55	**Total Cost**			**$16,552.50**				
56								
57	**Average Costs (Costs shown for plants do not include installation costs)**	**15-gallon tree**	**5-gallon tree**	**5-gallon shrub**	**1-gallon shrub**	**Seeding (per acre)**	**Irrigation (per acre)**	**Class H 5-year maintenance (per acre)**	**Xeroriparian 5-year maintenance (per acre)**
58		**$80**	**$25**	**$23**	**$6**	**$885**	**$1,500**	**$1,050**	**$610**
59									
60	*Density determined by onsite plant survey.								
61	**Guideline plant density requirements have been provided. The applicant may choose to perform an onsite plant survey in accordance with TECH-116 to determine plant density.								
62	***Average cost based on annual plant water requirements, plant replacement @ 5% over five years, and invasive species control (cost for herbicide only).								
63	****Option to basic requirement for Xeroriparian Classes A-D: Reduce total plant quantity by 20% if 100% 15 gallon trees and 100% 5 gallon shrubs are used.								
64	****Option to basic requirement for Class H: Increase total plant quantity by 20% if 50% 15 gallon/50% 5 gallon trees are used and 100% 1 gallon shrubs are used.								
65									
66									

Step 3: The user will input plant quantity data calculated in cells C10 and C11 into cells B47, B49, and B50. If "Option to Basic Requirements" is chosen allowing for 50% 15 gallon/50% 5 gallon size trees and 100% 1 gallon size shrubs, select values from cells F10 and F11 and input into cells B47 through B50. Insert "Area of mitigation" value from cell C9 into cells B51, B52 and B54. The spreadsheet will automatically calculate the ILF from the "Average Costs" table (cells B58 through H58).

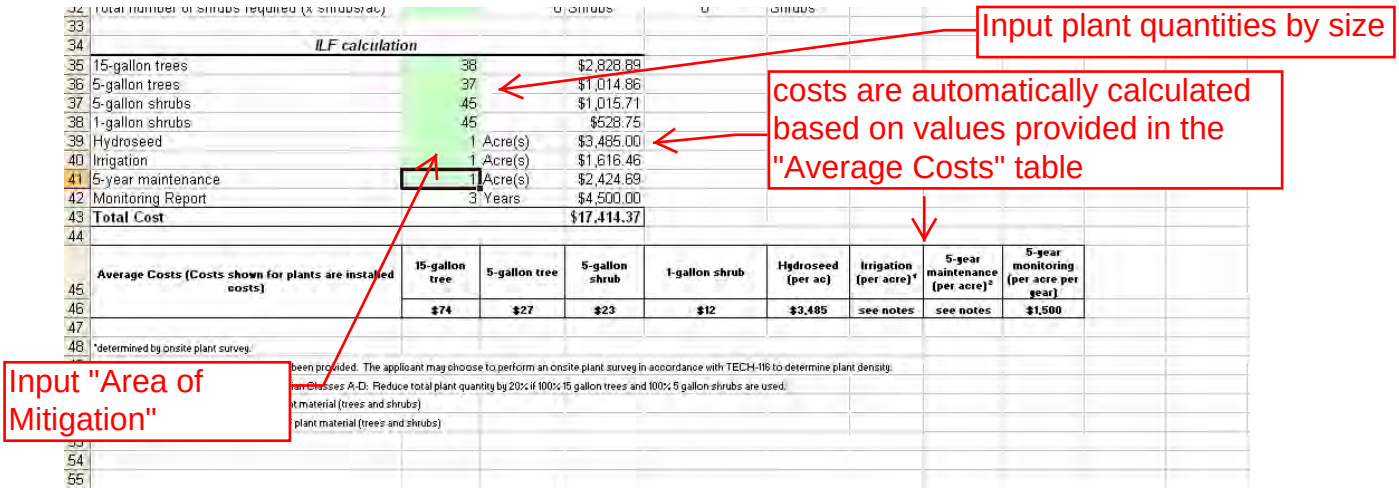
COMMERCIAL AND SUBDIVISION DEVELOPMENT

Example 3. The third example shows the user how to input data into the ILF calculation spreadsheet for disturbance of Xeroriparian Class A habitat due to projects undergoing the development review process.

Step 1: Verify the class of RRH to be disturbed and then select the correct cells for data input.



Step 2: After inputting total acreage of RRH on the property (cell C5) and total disturbance of RRH (cell C6), scroll to the bottom of the spreadsheet and enter additional data to complete the calculation.



Step 3: The user will input plant quantity data calculated in cells C9 and C10 into cells B35 through B38. Divide plant quantities evenly between 15 gallon and 5 gallon size for trees and 5 gallon and 1 gallon size for shrubs unless “Option to Basic Requirements” was chosen. If this option is chosen, select data from cells E9 and E10 and input into cells B35 and B37 only (all 15 gallon size trees and 5 gallon size shrubs). Insert “Area of mitigation” value from cell C8 into cells B39 through B41. The spreadsheet will automatically calculate the ILF from the “Average Costs” table (cells B46 through I46).

Example 4. The third example shows the user how to input data into the ILF calculation spreadsheet for disturbance of Class H habitat due to projects undergoing the development review process.

Step 1: Verify the class of RRH to be disturbed and then select the correct cells for data input.

Input quantity of trees and shrubs per acre

Input total acreage of mapped RRH on property

option to basic requirement

Input total acreage of disturbance

Calculating In-Lieu Fee Costs for Commercial and Subdivision Development

Shaded fields are editable - Enter value in Acres

	B	C	D	E	F	G
4	*Class H or IRA w/ Underlying Class H Habitat (H or IRA/H)***			Option to basic requirement (Xeroriparian)****	Option to basic requirement (Class H)****	
5	Total mapped habitat onsite		5.00 Acre(s)			
6	Area of disturbed RRH		1.00 Acre(s)			
7	% of mapped habitat disturbed		20% Acre(s)			
8	Area of mitigation		1.50 Acre(s)			
9	Total number of trees required (90 trees/ac)	90	135 Trees	na	162	Trees
10	Total number of shrubs required (100 shrubs/ac	100	150 Shrubs	na	180	Shrubs
11						
12	*IRA w/ Underlying Xeroriparian Class A Habitat (IRA/XA)***					
13	Total mapped habitat onsite		Acre(s)			
14	Area of disturbed RRH		Acre(s)			
15	% of mapped habitat disturbed		#DIV/0! Acre(s)			
16	Area of mitigation		0.00 Acre(s)			

Step 2: After inputting total acreage of RRH on the property (cell C5) and total disturbance of RRH (cell C6), scroll to the bottom of the spreadsheet and enter additional data to complete the calculation. Please note that for Class H habitat, the area of disturbance is mitigated at a ratio of 1:1.5.

Input "Area of Mitigation"

Input plant quantities by size

costs are automatically calculated based on values provided in the "Average Costs" table

	uired (x shrubs/ac)*	0 Shrubs	0	na	Shrubs		
	ILF Calculation						
46	15-gallon trees	135	$10,050.98				
47	5-gallon trees	0	$0.00				
48	5-gallon shrubs	75	$1,692.86				
49	1-gallon shrubs	75	$881.25				
50	Hydroseed	1.50 Acre(s)	$5,227.50				
51	Irrigation	1.50 Acre(s)	$3,787.23				
52	5-year maintenance	1.50 Acre(s)	$5,680.85				
53	Monitoring Report	5 Years	$11,250.00				
54	**Total Cost**		**$38,569.69**				
55							
56	**Average Costs (Costs shown for plants are installed costs)**	**15-gallon tree**	**5-gallon tree**	**5-gallon shrub**	**1-gallon shrub**	**Hydroseed (per acre)**	**Irrigation (per acre)[1]**	**5-year maintenance (per acre)[2]**	**5-year monitoring (per acre per year)**
57		**$74**	**$27**	**$23**	**$12**	**$3,485**	**see notes**	**see notes**	**$1,500**
58									
59	*Density determined by onsite plant survey.								
60	**Guideline plant density requirements have been provided. The applicant may choose to perform an onsite plant survey in accordance with TECH-116 to determine plant density.								
61	***Option to basic requirement for Xeroriparian Classes A-D: Reduce total plant quantity by 20% if 100% 15 gallon trees and 100% 5 gallon shrubs are used.								
62	****Option to basic requirement for Class H: Increase total plant quantity by 20% if 50% 15 gallon/50% 5 gallon trees are used and 100% 1 gallon shrubs are used.								
63	[1]Irrigation calculated as 30% the cost of plant material (trees and shrubs)								
64	[2]Maintenance calculated as 45% the cost of plant material (trees and shrubs)								
65									
66									

Step 3: The user will input plant quantity data calculated in cells C9 and C10 into cells B46, B48, and B49. If "Option to Basic Requirements" is chosen allowing for 50% 15 gallon/50% 5 gallon size trees and 100% 1 gallon size shrubs, select values from cells F9 and F10 and input into cells B46, B47, and B49. Insert "Area of mitigation" value from cell C8 into cells B50 through B52. The spreadsheet will automatically calculate the ILF from the "Average Costs" table (cells B57 through I57).

APPENDIX J

Literature Cited

Appendix J

Literature Cited

Bernal, John. January 2010. Plant Salvage Standards on County Transportation Improvement Projects. Internal memo to C.H. Huckelberry.

Kline, Natasha C. "The Effects of Roads on Natural Resources". A Primer Prepared for the SDCP. January, 2002 (draft memo from CHH dated February, 2002)

Pima County Roadway Design Manual, Chapter 4, Environmentally Sensitive Roadway Design Guidelines, Revised 2003.

Pima County Regional Flood Control District. *Regulated Riparian Habitat Mitigation Standards and Implementation Guidelines*. Adopted by Pima County Board of Supervisors in November 2011.

Pima County Regional Flood Control District. *Regulated Riparian Habitat Offsite Mitigation Guidelines for Unincorporated Pima County*. Adopted by Pima County Board of Supervisors in November 2011.