

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
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



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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 growing¹, 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 habitats². 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.

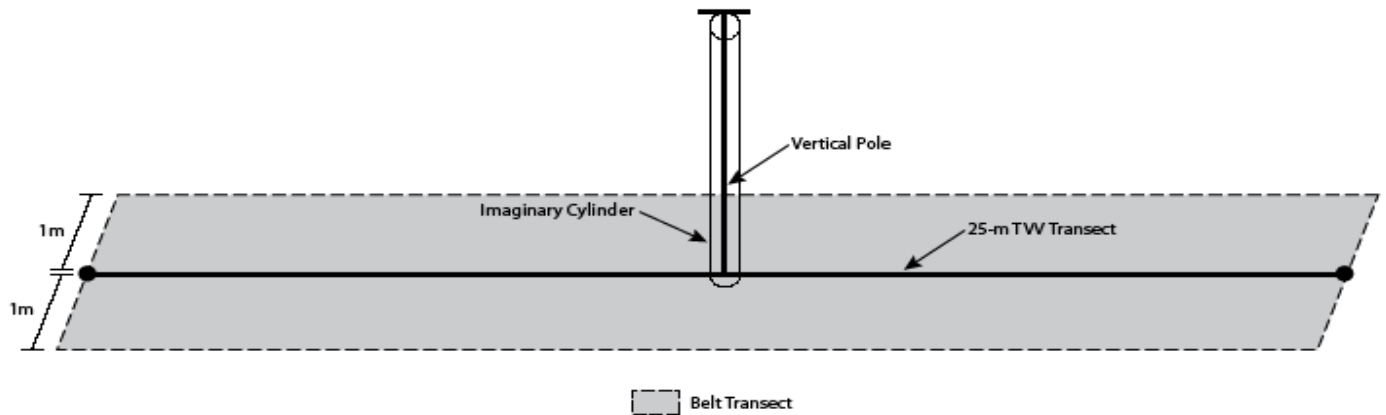
2.2.3 Data Collection



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 straight 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



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														
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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:

$$\text{TVV} = \text{Sum of } h / (10n)$$

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. $\text{TVV} = 501/250 = 2.004$.

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 m². 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:

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

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

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

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 rationale 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 m² or 3,380 ft²)
- Square plots: 15–20 m per side (225 m²–400 m² or 2,422 ft²– 4,306 ft²)
- Rectangular plots: 15 m x 20 m (300 m² or 3,229 ft²)

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 added³.

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 trees⁴. 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:

$$11 \text{ trees}/1,256 \text{ m}^2 (0.31 \text{ acre}) = \text{X trees}/4,047 \text{ m}^2 (1 \text{ acre}) = 35.4 \text{ trees/acre}$$

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

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APPENDICES

APPENDIX A
Blank TVV Transect Data Form

VEGETATION VOLUME DATA SHEET



Location:

Transect #

Date:

Personnel:

UTM (NAD 83)
Transect start:

UTM (NAD 83)
Transect end:

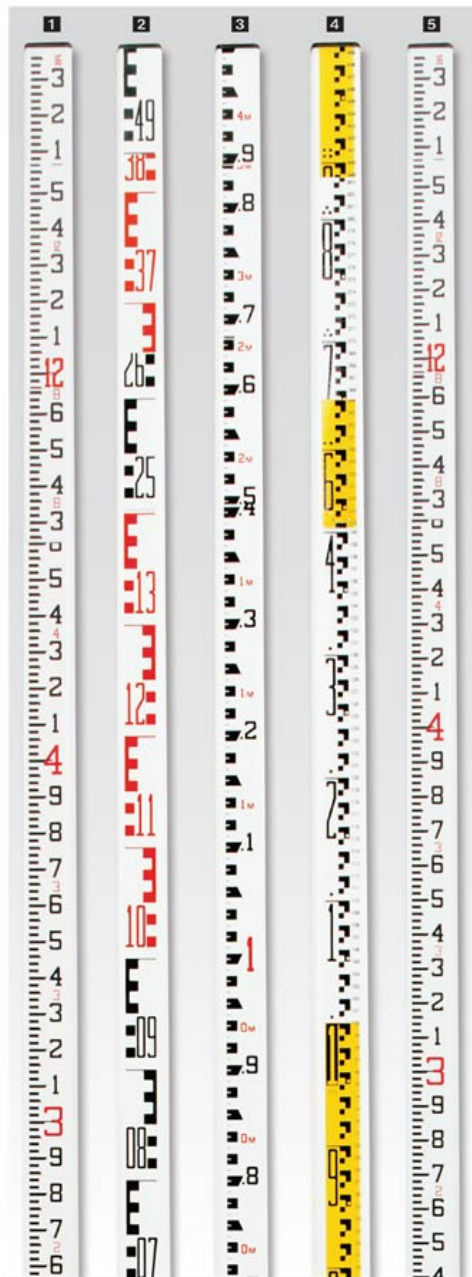
	Horizontal Transect Samples (# of cubic decimeters containing woody perennial vegetation within each vertical meter)																								
Vertical cubic meters	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1																									
2																									
3																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



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	4.75 lbs.	43574	\$153.50
25' in feet/10ths/100ths	7.75 lbs.	43500	\$179.50
	2+		\$169.50
16' in feet/inches/8ths	4.75 lbs.	43576	\$153.50
25' in feet/inches/8ths	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

6412

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	4.75 lbs.	43578	\$159.00
7.6m in m/dm/cm	7.5 lbs.	43503	\$184.00

3 Philadelphia Style Metric

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

4 "1/2" Centimeter Style Metric

5.0 meter	4.5 lbs.	43583	\$159.00
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Replacement Sections for 43578

0m to 1.4m	2 lbs.	43539	\$47.75
1.4m to 2.6m	2 lbs.	43540	\$44.25
2.6m to 3.8m	2 lbs.	43541	\$39.95
3.7m to 5.0m	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	4.75 lbs.	43587	\$158.00
25' in feet/10ths/100ths/m/dm/cm/0.5 cm	7.5 lbs.	43505	\$184.00

- English
 Metric
 Combination English and Metric
 Oversize. Ships at Oversize rate. See Shipping Information for details.

APPENDIX C

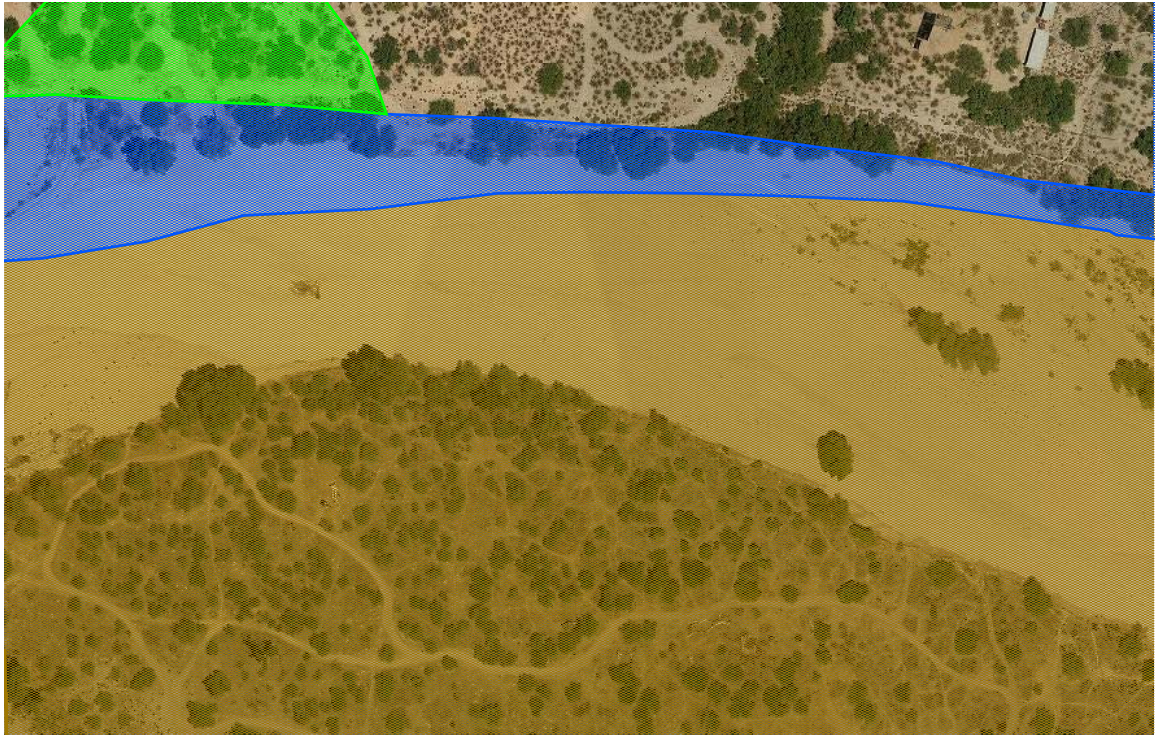
Examples of Transect Configurations for Different Sites



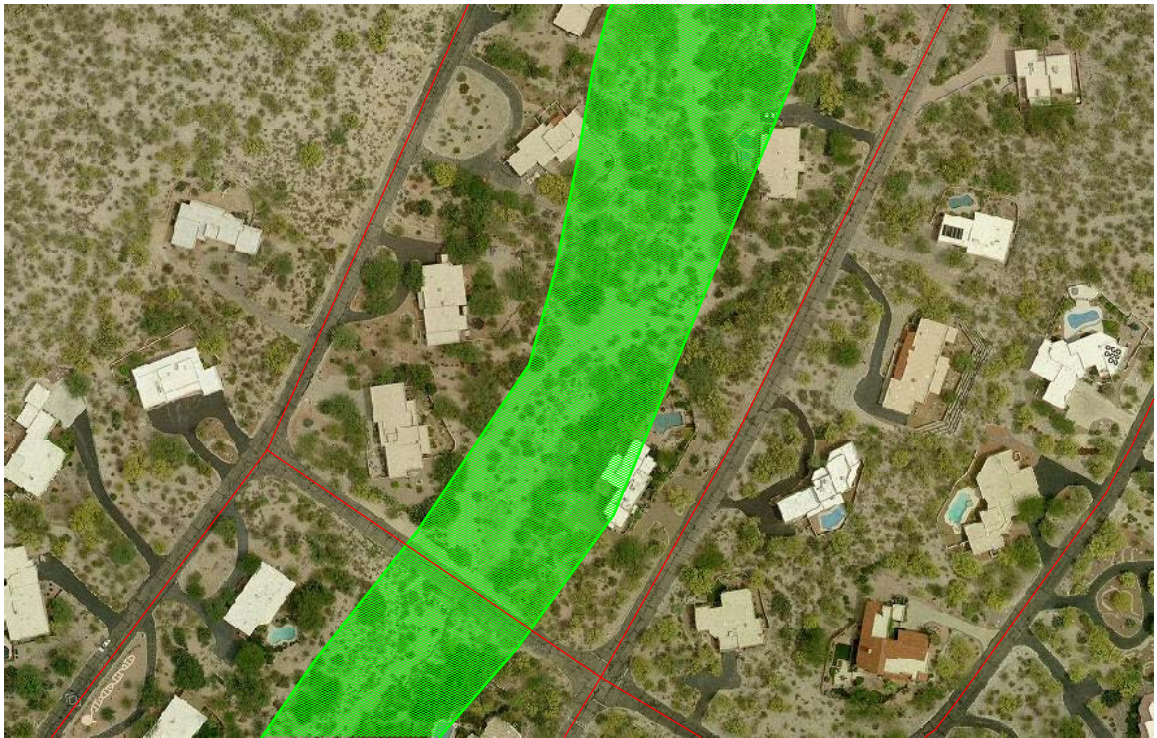
Example 1. Sheet Flooding Area. These photographs highlight the variations in vegetation density that can be observed in areas of sheet flooding. The shaded polygon represents Important Riparian Area with underlying Xeroriparian Class C habitat.



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

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.