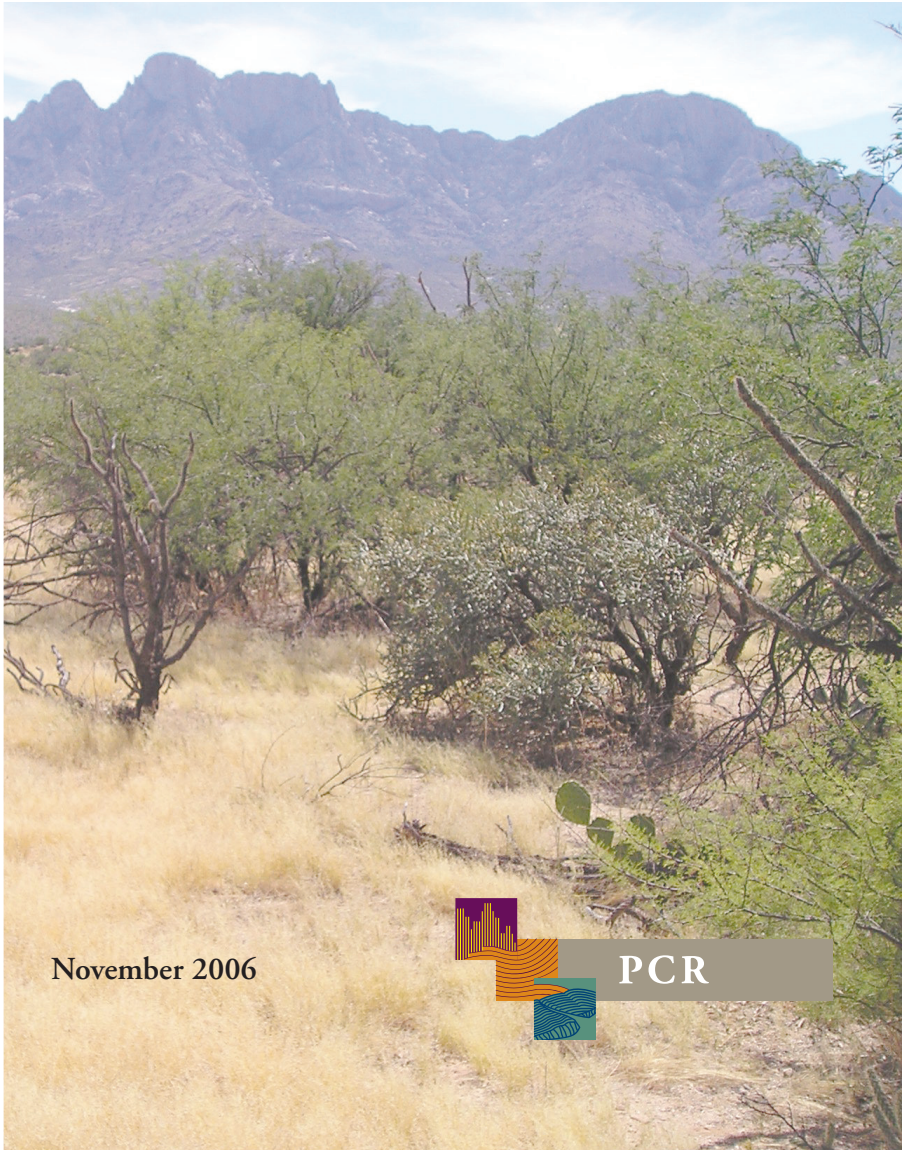
Rancho Vistoso Xero-Riparian Restoration Project

Pima County, Arizona



November 2006

PCR

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Pima County, Arizona

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RANCHO VISTOSO XERO-RIPARIAN RESTORATION PROJECT NARRATIVE

1.0 INTRODUCTION

Pima County (the "County") and Stone Canyon, L.L.C., an Arizona limited liability company ("Stone Canyon") entered into a development agreement, recorded in Docket 11754 at Page 2682, on March 12, 2002, in the official records of Pima County (the "Development Agreement") which created the Honey Bee-Big Wash Biological Corridor.

In Section 4.4 of the Development Agreement, Stone Canyon agreed to restore sixty-seven (67) acres of riparian vegetation within the "Big Wash" floodplain area in Rancho Vistoso Neighborhood 4 by not later than March 12, 2007. Such restoration was to be performed in accordance with a riparian restoration plan to be approved by the Pima County Regional Flood Control District (the "District"). Stone Canyon agreed to pay all costs associated with restoration and to post a sufficient performance bond. If Stone Canyon failed to complete the restoration, the County could make a demand on the performance bond to complete the restoration.

Pursuant to the Development Agreement, by special warranty deed dated July 10, 2002, and recorded at Docket 11864, Page 756 in the official records of Pima County, Vistoso Holdings, L.L.C. conveyed approximately 148.13 acres of the Big Wash/Open Space to Pima County subject to the terms of the Development Agreement.

Vistoso Partners, L.L.C. is now the developer of the Rancho Vistoso project and in that capacity may perform certain Stone Canyon obligations under the Development Agreement. Vistoso wants to begin work on the restoration of the Big Wash (the "Project") pursuant to a restoration plan approved by the District in order to fulfill its restoration obligation under the Development Agreement. The restoration plan for the Project will include a Xeroriparian Restoration Project Narrative (the "Narrative"), a Grading Plan, an Irrigation Plan, a Planting Plan, a hydraulic model, and a sediment report (collectively the "Restoration Plan"). The Project will include restoration of the original sixty-seven (67) acres as agreed to in the Development Agreement, plus an additional ten (10) acres (the "Property"), all of which Property is located within the Town of Oro Valley (the "Town"). The Project is designed to include the removal of no more than 141,392 cubic yards of material from the Property.

The Project will be completed in conjunction with the development of an approximately 114-acre commercial/retail center called Oro Valley Marketplace, located east of and immediately adjacent to the Big Wash and also in the Town. Because the Project will be

completed as part of the overall development of the Oro Valley Marketplace, the Town will be responsible for review and approval of the Grading, Planting and Irrigation Plans in the Restoration Plan, for the requirement and release of assurances (if any) and performance bonds, for issuance of all construction and building permits, and for final inspection and approval of all construction. Accordingly, the success of the Project will require close cooperation and coordination between Vistoso and the developer of Oro Valley Marketplace, the Town, the County and the District.

1.1 Site Description

This narrative portion of the plan provides guidelines for restoring natural vegetation on 77 acres of former agricultural land and degraded woodland. The restoration site is within the town of Oro Valley, located approximately 14 miles north of the City of Tucson, Arizona. (Figure 1, *Regional Map*, on page 3). The site is south of Tangerine Road and west of Highway 77 and can be found on the U.S. Geological Survey (USGS) 7.5-minute Oro Valley topographic quadrangle, Sections 5, T. 12 S., R. 14 E., as shown in Figure 2, *Vicinity Map*, on page 4. The site is located adjacent to existing xero-riparian habitats along Big Wash, a tributary to the Canada del Oro Wash. This project was first conceptualized in 2001 (PCR, 2001) and this report represents a further development of the design.

Land use in the area surrounding the restoration site is a mix of residential development and open space. Topography ranges from gently sloping in the western potion of the restoration site to nearly level in the abandoned agricultural field. Elevations range from approximately 2,639 feet above mean sea level (MSL) to 2,685 feet above MSL. Big Wash is part of an unbroken corridor linking the Tortolita Mountains to the north with the Canada del Oro drainage and the Santa Cruz River to the south.

The goal of the project is to replace the low diversity, ruderal vegetation currently on-site with a more diverse mix of native vegetation. The project will widen the riparian habitat corridor of the adjacent Big Wash using sources of water associated with the proposed development to the north and east of the restoration area. It will provide habitat for a variety of wildlife and be sustainable long-term. The design and vegetating of the site will take into account the hydrologic, soil, and topographic requirements necessary for sustainable restoration.

Areas of upland habitat are included in the design to increase habitat diversity and to salvage existing site vegetation, much of which transplants readily. An additional goal is to create an aesthetically appealing, natural backdrop for the proposed adjacent commercial development. In this way, development can be accommodated while maintaining the features that make the region unique.

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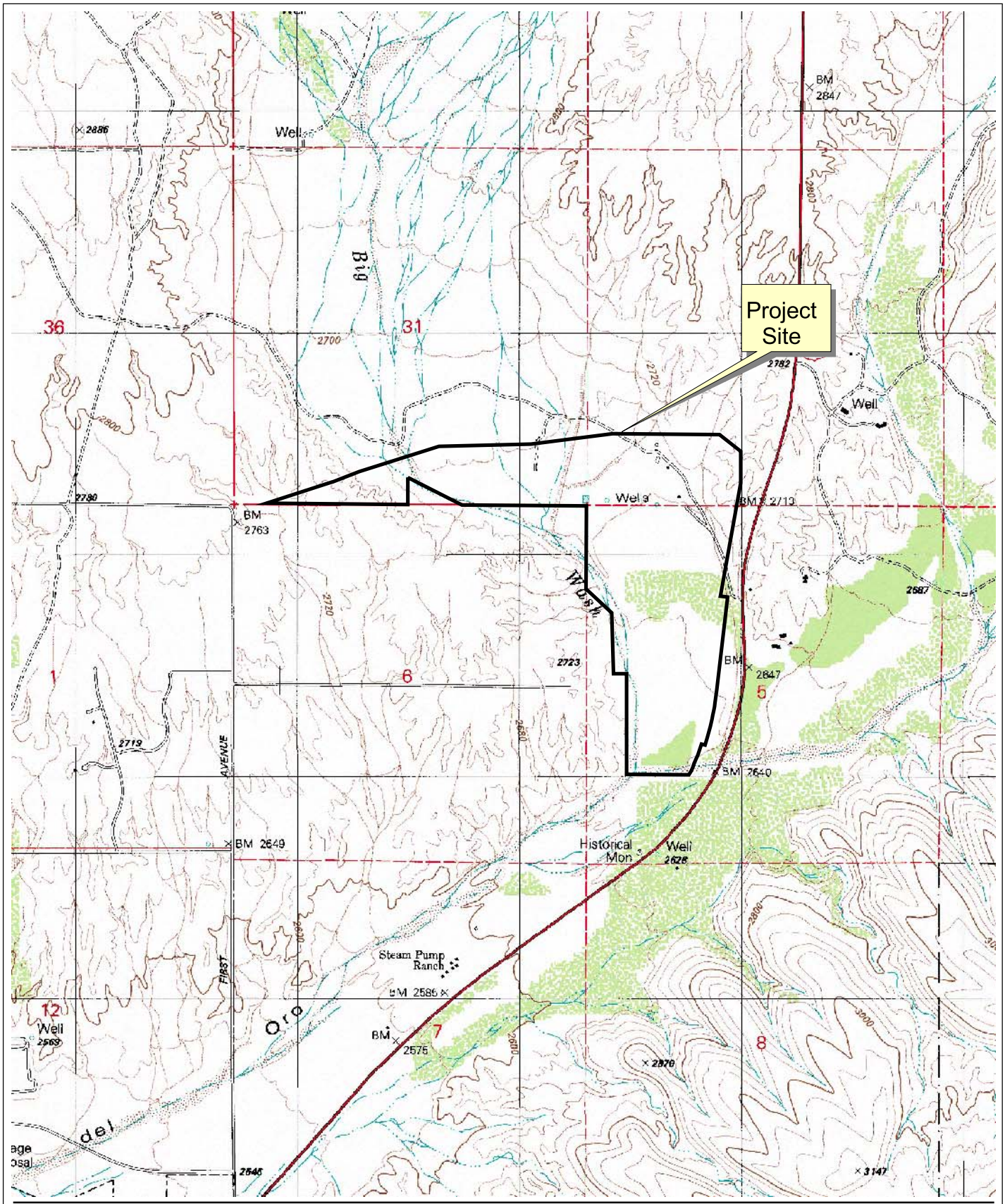
No scale

Source: MapQuest , 2005.

Figure 1
Rancho Vistoso Xeroriparian Restoration Project
Regional Map



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2000 0 2000 Feet

Source: USGS Topographic Series (Oro Valley, AZ); PCR Services Corporation, 2005.

Figure 2
Rancho Vistoso Xeroriparian Restoration Project Vicinity Map

This restoration plan provides guidelines for each stage of restoration: soil management and amendments, salvage and reuse of plant material, weed control, planting and seeding techniques, erosion control, monitoring protocols, maintenance schedule, and success criteria. It is anticipated that the project will meet the performance standards within five years of implementation. While maintenance is necessary during the initial three years, there will be no maintenance other than weed removal during the final two years. This will verify that the restoration is sustainable long-term.

2.0 REFERENCE SITE DATA COLLECTION

A PCR team of biologists and restoration specialists visited the site on September 22-23, 2005 in order to assess vegetation and physical characteristics of natural reference sites and to evaluate restoration opportunities. Several follow up visits were also carried out. The reference data were used to develop conceptual vegetative communities, plant palettes, guidelines for the sequence of restoration activities, and appropriate success criteria the site. Since soil characteristics are a crucial determinant of the vegetation that a site will support, particular attention was paid to information derived from the Pima County Soil Survey, Eastern Part (2003).

2.1 Reference Site Methods and Analysis

The vegetation of nearby natural areas was characterized in a series of reference plots. Vegetative patterns were observed and seven plots were selected to represent site variability. Each plot had uniform physical and vegetative characteristics. The reference plots encompassed areas ranging from approximately 16,000-ft^2 (0.37 acres) to 40,000-ft^2 (0.9 acre). This size was selected based on standard recommendations for shrub communities (Barbour et al, 1999). GPS coordinates were noted for each plot.

Vegetative cover and structure were measured by a releve procedure (Bonham, 1989). This involved making a species list for the bounded plot and assigning a cover category for each species. Cover was estimated for each stratum (groundcover, shrub, and tree layers) based on absolute contribution of each species to the total cover. Shrub and tree density of the riparian woodland was measured within a belt transect with dimensions of 400 x 20 feet. Environmental data were collected to document factors responsible for vegetation patterns. These included observations of elevation relative to stream channels, landscape position, land use history, soil texture, and evidence of flooding.

2.2 Plant Communities

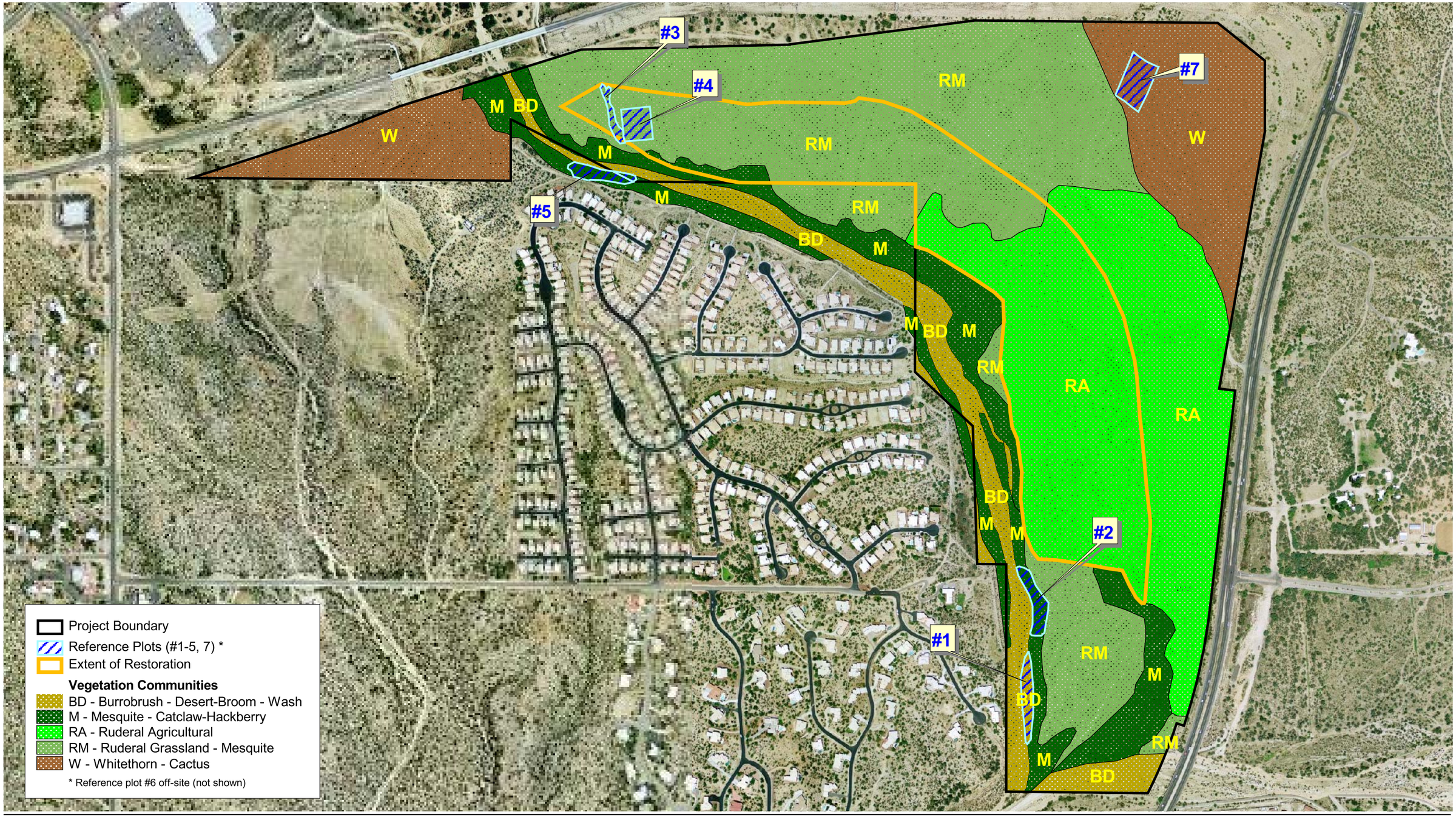
The vegetative community concepts developed in the reference plots were applied in mapping the project site and adjacent areas. Five vegetative communities were characterized and mapped: burrobrush-desert broom shrubland, mesquite-catclaw-hackberry forest, whitethorn-cactus scrub, mesquite woodland, and a ruderal community of grasses and forbs. A map showing the distribution of the plant communities and reference plots is shown in Figure 3, *Existing Vegetation and Reference Plots*, on page 7. Representative photographs of the native plant communities are shown in Photographs 1 to 3 of Figure 4, *Reference Plant Community Photographs*, on page 8. Species diversity and cover data are provided in Appendix A, *Reference Data*. The communities are described in detail as follows:

Burrobrush-Desert Broom

This association occurs at the lowest elevation areas along the Big Wash and includes the actual wash, the shrub-dominated islands, and low terraces. The elevation ranges between 0 and 1.5 feet above the bottom of the wash. Periodic flooding scours the site, removing vegetation and preventing establishment of most tree species. The soils in the channel are a mixture of sand, gravel and cobbles (Riverwash series) while the islands and terraces have a thin capping of sandy loam material over a coarser substrate. The dominant plant is burrobrush (*Hymenoclea salsola*) with desert broom (*Baccharis sarothroides*) as a sub-dominant. In higher elevation areas where scouring is less intense, pigweed (*Amaranthus palmeri*) is a sub-dominant. Species richness is high and includes various bunch grasses such as bristlegrass (*Setaria macrostachya*), bush muhly (*Muhlenbergia porteri*), alkalia sacaton (*Sporobolus airoides)*, and sideoats grama (*Bouteloua curtipendula*). Numerous forbs are also present such as tabaquillo (*Nicotiana obtusifolia*), sacred datura (*Datura wrightii*), bluestem pricklepoppy (*Argemone pleicantha*), and devil's claw (*Proboscidea parviflora*).

Mesquite-Catclaw-Hackberry

This forest community occurs in bands lining the main channels of the Big Wash where it occupies the banks and terraces. Elevations range from approximately 1 to 3 feet above the bottom of the wash. Flooding occurs regularly, though at lower intensity than in the adjacent wash. The soil is mapped as the Arizo series, a sandy, excessively drained, alluvial soil that also includes thin strata of finer textured soil. The surface texture observed was sandy loam. The less intense scouring relative to the burrobrush community has allowed a more mature community to develop. Mesquite dominates the tree layer with lesser contributions of catclaw (*Acacia greggii*), hackberry (*Celtis pallida*), and blue palo verde (*Cercidium floridum*). There is a distinct shrub layer of wolfberry (*Lycium andersonii*), rabbitbrush (*Chrysothamnus nauseosus*), gray thorn (*Ziziphus obtusifolia*) and small individuals of the previously described tree species. Several vines occur within the shrub layer including Texas virgin bower (*Clematis drummondii)*,



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600 0 600 Feet

Source: USGS Aerial (2002); WLB, 2005; PCR Services Corporation, 2005.

Figure 3
Rancho Vistoso Xeroriparian Restoration Project
Existing Vegetation and Reference Plots

Photograph 1: Burrobrush-Desert Broom at center wash.

Photograph 2: Mesquite-Catclaw-Hackberry at edge of wash.

Photograph 3: Whitethorn-Cactus in nearby uplands.

Photograph 4: Cacti in degraded ruderal grassland adjacent to mesquite.

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Figure 4
Rancho Vistoso Xeroriparian Restoration Project
Reference Plant Community Photographs

Source: PCR Services Corporation, 2005.

wild cucumber (*Marah gilensis)*, milkweed (*Sarcostemma sp*.), and coyote melon (*Cucurbita digitata*). The ground cover is a mix of species such as Arizona cottontop (*Digitaria californica*), white-haired bristlegrass (*Setaria macrostachya*), *Solanum* sp., pigweed (*Amaranthus* sp.), mustard (*Descurainia pinnata*) and brome grasses (*Bromus* spp.).

Whitethorn-Cactus

This upland scrub community has a diverse mix of short trees and shrubs. It occurs on gently to moderately sloping bajadas mostly at the northeastern part of the site. Soils are mapped as Sasabe-Caralampi complex, a variable soil with generally higher clay content than in the riparian zone. Whitethorn (*Acacia constricta*) replaces mesquite as the dominant tree species and various species of prickly pear, cholla, and barrel cacti (*Opuntia and Ferocactus* spp.) are co-dominants. Little leaf palo verde (*Cercidium microphyllum*) is an important subdominant. The groundcover is dominated by various asters such as desert brittle bush (*Encelia farinosa*), snakeweed (*Gutierezia sarothrae*) and various non-native grasses (*Schismus* and *Bromus sp*.). Possible remnants of a similar community were also observed in association with the riparian mesquite forests. Here the association occurs at sites further from the stream channel and at slightly higher elevations, approximately 3-5 feet above the wash. A degraded version of this community with scattered cacti is shown in photograph 4 of Figure 4, *Reference Plant Community Photographs*.

Annual Grassland-Semi-desert Grassland

Scattered mesquite trees, grasses (*Bouteloua*, *Bromus*, and *Schismus* spp.), and a few forbs (*Amaranthus* sp., *Descurainia* sp.) comprise this woodland community. It occurs on gently sloping land higher in elevation than the mesquite-catclaw-hackberry community and is seldom scoured by flooding. The site is dissected by a series of ephemeral washes lined with mesquite trees. In areas away from the washes, mesquite trees are widely scattered. The soil is mapped as the Comoro series, a well-drained soil of alluvial fans that is characterized by uniform sandy loam textures to a depth of at least 60 inches. The mesquite trees are relatively stunted by comparison to those on the lower terraces and this may reflect the greater soil depth to water. The vegetation in these areas shows a long history of grazing which has converted the original vegetation to a low diversity and ruderal condition.

Ruderal Grasses and Forbs

This area on the southeast part of the site was used to grow field crops and was recently abandoned. The field appears to have been artificially smoothed in order to optimize crop production and lacks the microtopography that characterizes natural habitats. A berm has been constructed on the west side of the field, possibly to protect the field from flooding. The soil is

also mapped as Comoro sandy loam. A few weedy species dominate the area and contribute little to overall habitat quality.

3.0 RESTORATION TECHNIQUES

3.1 Proposed Vegetation

The current vegetation of the proposed restoration site is dominated by annual grassland-semi-desert grassland in the northwest part and ruderal agricultural land in the southeast part. Grading to an average depth of 18 inches is proposed for all ruderal areas and parts of the Annual Semi-desert Grassland. Upon completion of grading, the site will be restored to three community types: 1) Burrobrush / Streambed, 2) Annual Grassland-Mesquite Woodland, enhanced by supplemental plantings characteristic of the Whitethorn-Cactus community, and 3) Mesquite-Catclaw-Hackberry. These are appropriate target plant communities since the restoration site has similar elevation, soil, and topography as nearby natural areas that are occupied by these vegetation types. A pre- and post-restoration comparison of the approximate acreages of plant communities is shown in Table 1, *Projected Change in Vegetation Types*, on page 11. The proposed restoration will increase both the diversity and quality of habitat types on-site. Restoration will involve excavating a series of channels that will intermittently transmit water from the adjacent proposed development into the restored area. These channels will vary in depth and width with gentle side slopes. The restoration plan will duplicate the zones observed in the existing on-site mesquite woodland where the channels are lined by relatively dense stands of mesquite trees and shrubs while the remaining areas are occupied by widely scattered mesquite trees and a groundcover of annual and perennial grasses and forbs. The locations of these zones are shown in Appendix B, *Proposed Restoration Planting Zone*.

Due to the limited range in topography resulting from the proposed grading, it is not possible to duplicate the full range of habitats observed in the reference sites. However, certain components of each plant community will be used in the plant palettes.

A **burrobrush**-dominated zone (Hydroseed Zone of Appendix B) will be planted at the bottom of the graded intermittent stream channels. The burrobrush will be supplemented by the species comprising the seed mix. The seed mix is designed to be suitable for a wide range of habitat types. This habitat type requires periodic scouring events in order to maintain itself. The hydrology sources identified in the engineering plan will feed into the stream channels and thereby supply water and periodic scouring to the system.

The intermittent stream channels will be lined with a zone of **mesquite-catclaw-hackberry** vegetation (Streambank Planting Area of Appendix B) occupying both the channel banks and an approximately 20- to 50-foot wide band to either side. This band will slope gently

Table 1

Projected Change in Vegetation Types

Plant Community	Pre-restoration (acres)	Post-restoration (acres)
Ruderal Agricultural Land	44.5	0
Semi-desert Grassland	31.0*	29.5*
Mesquite-Catclaw-Hackberry	1.5	33.2
Burrobrush/ Streambed	0	14.3

** Includes 5.5 acres of existing vegetation to be preserved in place.*

Source: PCR and WLB

toward the stream channel. Proximity to surface and subsurface water will sustain relatively dense vegetation (planted at a rate of 235 trees and shrubs per acre). The banks and lower slopes may be subject to occasional flooding but the severity will be less than that which will occur in the stream channel.

The areas further from the intermittent stream channels and higher in elevation will be planted with xeric vegetation (Upland Planting Area of Appendix B) composed of widely spaced trees and shrubs dominated by mesquite, whitethorn acacia, foothill palo verde, and various cacti. Where there are no trees currently in place (e.g., areas mapped as Ruderal Agricultural), plantings will be installed at a density of 135 trees and shrubs per acre. However, at the northernmost portion of the restoration area (mapped as Ruderal Grassland-Mesquite), there are numerous mesquite trees. Many of these trees will be left in place as described in the Native Plant Preservation Plan and the area will be enhanced by planting additional trees, shrubs, and cacti at a rate of 65 plants per acre or one half the density used in the Ruderal Agricultural areas of the Upland Planting Area. Container plantings will be derived from a combination of on-site salvaged plant material and nursery grown plants.

This proposed pattern of restored vegetation considers the site hydrology and duplicates natural patterns of vegetation. As described in Section 3.3, the design also considers soil conditions which are important in ensuring long-term viability of the restoration.

3.2 Importance of Site Contouring

In order to establish more highly functioning habitat in place of the current ruderal agricultural habitats, some modification of the site topography is necessary. This is presented in Appendix C, *The Proposed Restoration Grading Plan*. A series of intermittent streambeds will be created to carry water from the development north and east of the site through the restoration area. This microtopography will concentrate scarce water in drainage ways and thereby create niches for a variety of species of differing tolerance for drought. The unnaturally level surface of

the agricultural field distributes water in a uniform pattern. While this is ideal for production of annual crops, it is unfavorable for the growth of a variety of native perennials. Without the proposed topographic modifications and the planting design using perennial native plants, the site will remain dominated by annuals that complete their life cycle in a short period.

A secondary benefit of the grading plan is that it allows the establishment of a steady, gradual grade that will prevent water ponding and mosquito breeding within the stream channels.

3.3 Soil Characteristic of Restoration Site

The underlying soil characteristics must be considered in the restoration design. Layers with unfavorable physical or chemical properties could prevent vegetation establishment. The USDA Natural Resources Conservation Service publishes soil surveys for most counties in the United States. These inventories of soil resources provide invaluable information on the distribution and characteristics of each soil series. Soil maps and descriptions from the Pima County Soil Survey (2003) indicate that the soil series of the restoration site is Comoro sandy loam (Coarse-loamy, mixed, superactive, calcareous, thermic Ustic Torrifluvents). The soil material of the profile is generally friable, non-sticky, non-plastic, loam textures. From a physical perspective, these characteristics are ideal for plant establishment since plant available water holding capacity is relatively high and yet the material is not likely to become excessively hard upon drying. Indeed, the soil description indicates that plant roots typically extend throughout the entire profile. Therefore, the removal of 1 – 1.5 feet of soil material does not appear to present significant physical problems relative to establishing vegetation.

From a chemical perspective, the subsoil material is slightly more alkaline than the topsoil ("A horizon") layer, a pH of 8.0 vs. pH 7.5. However, the pH difference is not sufficient to prevent plant establishment and the gradual deposition of organic matter over time, will lower the pH of the new soil surface. Of greater concern is the probable lack of certain nutrients, particularly nitrogen, in the subsoil material. Soil nitrogen is associated with organic matter and the lack of this primary plant nutrient could impede revegetation. Fortunately, keystone species of the restoration plan such as mesquite, catclaw, and whitethorn are all leguminous trees capable of fixing atmospheric nitrogen through a root symbiosis with various *Rhizobium* species. Their presence in the plant palette will initiate the nitrogen cycling that will allow other plant species that do not fix nitrogen to become established as well. Deficiencies in phosphorous and potassium will be tested for and can be remedied through use of appropriate fertilizers as necessary. Thus, the chemistry of the subsoil material does not appear to present significant problems to restoration. These predictions regarding soil properties have been confirmed in a recent soils study conducted by Western Technologies for the site (Tembo and Harris, 2005).

3.4 Soil Management

Several soil management issues need to be addressed in the course of restoration. The heavy equipment used for grading may compact the underlying soil, particularly if there is any moisture in the soil at the time of grading. Mechanical loosening ("ripping") of the soil may be necessary to reverse any compaction caused by grading and to incorporate various soil amendments. Use of imprinting and pitting will be important to increase infiltration and conserve scarce water resources. The exposure of large areas of bare soil presents an erosion hazard from wind and water. This will be mitigated by applications of hydromulch to any disturbed areas of soil.

These operations also have the potential to enhance capture of wind blown weed seeds. This hazard will be addressed by ensuring that hydroseeding takes place at an optimum time so that competition from native seedlings may exclude non-native weeds. The monitoring schedule described in section 4.1 will be frequent enough to ensure that any weed infestations are removed become they become established.

Imprinting will be conducted on graded areas as preparation for hydroseeding. The areas to be imprinted total 57.7 acres and include the areas described in the planting plan as Upland (former agricultural field), Streambank, and Stream channel planting areas. Imprinting is a tillage operation that creates small divots in the soil to a depth of 4 – 6 inches. It breaks up sealed crusts and enhances infiltration and vegetation establishment. It offers similar benefits to pitting but at a smaller scale. It is less effective on sandy soils where wind erosion can quickly erase the imprints. However, at this site, the sandy loam soils should retain the imprints.

3.5 Soil Amendments

Soil samples have been collected from several areas within the site (Tembo and Harris, 2005). A recognized commercial laboratory conducted soil fertility analysis and United Horticultural Supply provided amendment recommendations. PCR has reviewed the recommendations and proposes that the graded portions of the site be amended with gypsum at a rate of approximately 1100 lbs/ acre and K-Mag at a rate of approximately 220 lbs/ acre. Gypsum additions are necessary to improve soil structure, increase infiltration rates, and add supplemental sulfur. K-Mag is necessary to supplement the generally low to moderate levels of these nutrients. The proposal to add ammonium phosphate is not recommended since P levels in most areas are already moderate and additions of N are likely to promote weed growth. Slow release formulations of fertilizer may be included in the backfill mix of container shrubs and trees. Composted wood mulch will be applied to the soil surface around each planted shrub and tree but will not be incorporated in the soil of the entire site as proposed. A compost mixture should be included in the soil backfill of each planting hole to provide additional nutrients and moisture holding capacity. The ability of many plants to flourish in harsh environments with

nutrient poor soils depends on symbiotic relationships between vascular plants and soil microbes. In particular, mycorrhizal fungi facilitate uptake of soil nutrients and water. Mycorrhizal fungal inoculants shall be included in the hydroseed mix and container soil medium, particularly in those areas that do not receive applications of topsoil.

Nitrogen fixing bacteria such as *Rhizobium* form a symbiotic relationship with the plant roots of leguminous trees (family: Fabaceae) and are essential to providing nitrogen to the entire system. Planting stock of mesquite, catclaw, palo verde, and whitethorn shall be inoculated with appropriate *Rhizobium* species prior to planting.

The contractor shall salvage topsoil and plant debris from the adjacent parcel to the north after plant materials have been salvaged. Areas that are heavily infested with non-native invasive plants shall be avoided; special attention will be given to avoiding areas with buffelgrass (*Pennisetum cilare*), fountain grass (*P. setaceum*), and soft feather pappusgrass *Enneapogon cenchroides*). The contractor shall work with the Restoration Specialist to identify areas appropriate for topsoil salvage. Topsoil should be salvaged to a depth of 4 to 6 inches and stockpiled in areas not to exceed 3 feet in height. Topsoil shall be stored for as short a duration as possible so that seeds and organisms survive. Plant debris can be salvaged, shredded, and used as mulch for the restoration plantings or wildlife shelter piles. They shall be inspected by the Restoration Ecologist to insure that minimal invasive plant material is included.

3.6 Seeding Techniques

The contractor will make every effort possible to obtain seeds from within the Tucson Basin area. This area would roughly constitute a 20-mile radius from the project area, which includes portions of Pima and Pinal counties. There is a wide variety of public lands within this area on which permission might be granted to collect wild seed, including the Coronado National Forest, BLM land, Arizona State Trust Land, and Pima County Regional Flood Control District lands. Twenty miles is meant to be a rough guideline for “local”, not a strict rule. At least 50% of the seeds used for the restoration project should come from local wild collections (with preference for 100%), unless the contractor can demonstrate in detail why this is not possible.

A seed mix containing a variety of native groundcover and shrub species will be hydroseeded across 57.7 acres of the restoration site. No seeding will be provided in the nongraded areas of the upland planting zone as the groundcover in these areas is already occupied by many native annual grasses.

The seed mix contains a variety of grasses, forbs, perennial sub-shrubs, woody shrubs, and leguminous plants. Species selection is based on the “Oro Valley Approved Revegetation Seed Mix List”, recommendations from RECON Environmental, Inc., and additional species observed on-site. The mix contains species that will grow in a variety of environments; therefore separate seed mixes for the different zones are not necessary. Species selection and seeding rates

are shown in Table 2, *Groundcover and Shrub Seed Mix,* on page 16. The seed tags will be submitted to PCR before the seed is sown. Pima County must approve any deviation in the seed mixes prior to application. The mycorrhizal innoculum shall be added to the hydroseed mix at the time of application. The *Rhizobium* innoculum may be added to the leguminous seeds at this time. Seeding will be followed or combined with hydromulching to enhance moisture retention and erosion control. A recommended formulation of the hydromulch slurry includes wood fiber at 340 kg/ha and tackifier (soil stabilizer) at 135 kg/ha (Montalvo, 2002).

No overhead irrigation will be provided for the hydroseeded areas. Its germination will be dependant on natural rain cycles. Therefore, seeding should be timed to coincide with anticipated rainfall events. The soil must be moist at the time of hydroseeding in order to ensure establishment of seedlings. The soil surface should be relatively free of plant debris in order to ensure adequate seed-soil contact.

3.7 Container Plants

Container plants will be installed in a random pattern across the restoration site. The density of plantings will differ depending on the zone. The stream channel zone comprising 14.3 acres will be planted with burrobrush at a density of 235 shrubs per acre. The streambank zone comprising 33.2 acres will also be planted at a density of 235 trees + shrubs/ acre. The upland planting zone comprises two areas currently occupied by ruderal agricultural land (10.2 acres) and annual grassland-mesquite woodland (13.8 acres). The Ruderal Agricultural area will receive widely spaced individuals at approximately 130 trees + shrubs/ acre. The Ruderal Grassland-Mesquite area will be supplementally planted with approximately 65 trees + shrubs/ acre. The species for these zones are shown in Table 3, *Streambank Container Plants*, on page 17 and Table 4, *Upland Container Plants*, on page 17. The upland zone contains somewhat more xeric species typical of the whitethorn-cactus community while the streambank zone includes species more typical of the mesquite-catclaw-hackberry community. All planting stock should have well-developed, deep roots but the aboveground portion need not be a particular height. Mycorrhizal fungal inoculants shall be included in the container soil medium.

3.8 Salvaged Plant Material

A Native Plant Preservation and Salvage Plan has been prepared by the WLB Group for the Oro Valley Marketplace in accord with requirements of the Town of Oro Valley. This plan shows the approximate locations of all plants to be transplanted, preserved in place, and destroyed. Table 5, *Transplanted Plant Material*, on page 18 shows the quantities of salvaged trees, shrubs, and cacti available for restoration relative to total quantities needed. Some of the transplants will be used in landscaping the proposed commercial center but the remainder will be used in the restoration area. Although not included in the salvage plan, there are also considerable quantities of prickly pear and cholla cactus available on-site. An additional 111

Table 2

Groundcover and Shrub Seed Mix

Scientific Name	Common Name	Pounds live seed/ acre
*Acacia constricta**	Whitethorn	2
Ambrosia deltoidea	Bursage	2
Aristida purpurea	Purple three-awn	0.5
Aristida ternipes	Spidergrass	0.5
Atriplex canescens	Four-wing saltbush	1
Bothriochloa barbinodis	Cane beardgrass	0.5
Bouteloua aristidoides	Needlegrass grama	0.5
Bouteloua curtipendula	Sideoats grama	0.5
Clematis drummondii	Virgin's bower	0.5
Cucurbita digitata	Coyote melon	0.1
Datura wrightii	Sacred Datura	0.1
Digitaria californica	Arizona cottontop	1
Encelia farinosa	Desert brittlebush	1
Ericameria laricifolia	Turpentine bush	0.5
Gutierrizia sarothrae	Snakeweed	1
*Lupinus sparsiflorus**	Coulter's lupine	1
Lycium fremontii or L. berlandieri	Wolfberry	0.5
Muhlenbergia porteri	Bush muhly	1
Nicotiana trigonophylla	Desert tobacco	0.5
Plantago insularis	Indian wheat	1
Proboscidea parviflora	Devil's claw	0.1
Psilostrophe cooperi	Paper flower	1
Setaria macrostachya	Plains bristlegrass	0.5
Sporobolus airoides	Alkali sacaton	0.5
Sporobolus cryptandrus	Sand dropseed	0.5
Zinnia acerosa/ pumila	Desert zinnia	1

** Leguminous species should be inoculated with appropriate Rhizobium bacteria.*
The total hydroseeded area is 57.7 acres.
Source: PCR

individuals of Engelmann's prickly pear and 222 individuals of various cholla species shall be salvaged, maintained in a nursery area, and transplanted at the time of restoration.

The best time to salvage plants is when the soil is dry and plants are still dormant and relatively resistant to disturbance. Plants will be salvaged with a backhoe, tree spade, or by hand. If a backhoe or tree spade is used, the plant and a significant amount of roots and soil should be excavated and transported. Summer transplanting may be desirable for some plants such as mesquite. Most species will recover faster from transplanting if the top is cut back to eliminate transpiration pressure while the roots adjust. If a plant is being transplanted bare root, a loam slurry can be used on the roots.

Table 3

Streambank Container Plants

Scientific Name	Common Name	%	Total numbers
Acacia greggi	Catclaw	4	312
Celtis pallida	Hackberry	17	1326
Cercidium floridum	Blue palo verde	5	390
Chilopsis linearis	Desert willow	3	235
Clematis drummondii	Virgin's bower	1	78
*Hymenoclea salsola**	Burrobrush/cheesebush	-	3360
Lycium andersonii	Anderson wolfberry	10	780
Prosopsis velutina	Mesquite	40	3120
Olneya tesota	Ironwood	10	780
Ziziphus obtusifolia	Grey thorn	10	780

* *Hymenoclea shall be restricted to the bottom of the streambed and planted at a density of 235 shrubs per acre.*
Source: PCR

Table 4

Upland Container Plants

Scientific Name	Common Name	%	Total numbers
Acacia constricta	Whitethorn acacia	15	333
Acacia greggii	Catclaw	5	111
Cercidium microphyllum	Little-leaf palo verde	20	445
Ferocactus wislizenii	Arizona barrel cactus	3	70
Opuntia engelmannii	Engelmann's prickly pear	5	111
*Opuntia spp.**	Cholla	10	222
Prosopsis velutina	Mesquite	40	889
Yucca elata	Soap plant	2	45

* *Cholla cacti may include O. arbuscula, spinosior, fulgida, versicolor, and leptocaulis.*
Source: PCR Services Corporation 2006

The salvaged plants shall be transplanted to a nursery site located immediately north of the restoration area as shown in the planting plan. The nursery shall be secured to prevent vandalism or theft and shall be supplied with an irrigation system to ensure plant survival. Upon completion of grading and installation of irrigation, these plants shall be transplanted to appropriate areas within the upland and streambank restoration zones.

3.9 Erosion Control

Erosion can be controlled in part by limiting runoff and maximizing infiltration using the imprinting methods described in section 3.4 and using the hydromulch slurry described in section

Table 5

Transplanted Plant Material

Scientific name	Common name	Number to be Transplanted	Total Needed for Restoration	Number Available for Restoration
Acacia constricta	Whitethorn	266	333	266
Acacia greggii	Catclaw	65	423	65
Carnegiea gigantea	Saguaro	3	0	0
Celtis pallida	Hackberry	58	1326	40
Cercidium floridum	Blue palo verde	129	390	43
Cercidium microphyllum	Foothill palo verde	61	445	25
Ferocactus wislizeni	Fish hook cactus	196	70	142
Prosopsis velutina	Mesquite	220	4009	68
Yucca elata	Soap tree yucca	7	45	7
Zizyphus obtusifolia	Grey thorn	41	780	41

Source: WLB Group and PCR

3.6. However, additional measures may be needed in areas susceptible to scour and gully formation with slopes greater than 3:1 ratios. Periodic erosion and deposition of sediment will be allowed to occur *within the bed of the washes* since this is an important form of disturbance that maintains the burrowbrush vegetation. The velocity from the channel with the Q100 of 1250 cfs is 4.4 fps. The velocity from the overland flow of Big Wash varies from 2.7 fps to 4.6 fps Erosion gullies in the streambank and upland areas will be evaluated by PCR and repaired if necessary. Detailed information regarding erosion control measures can be found in the Stormwater Pollution Prevention Plan (SWPPP).

3.10 Irrigation

It is the responsibility of the project developer to install a drip irrigation system throughout the site to provide planted shrubs and trees with a reliable source of water. WLB is preparing a conceptual irrigation plan describing the basic design and schematics (Appendix D, *Irrigation Plan*). Irrigation will also be provided to the on-site nursery area where transplanted stock will be maintained until restoration sites are ready. Natural rainfall will be relied upon to establish hydroseeded groundcovers.

3.11 Weed Control

Weed control will be the responsibility of the project developer. Weeds are defined as any plant that is not native to this region of Arizona. However, in the event that certain native plants are forming monotypic stands, the restoration specialist may recommend thinning as needed to ensure that diversity success criteria are met. Monthly scouting for weeds will be

performed throughout the year to identify infestations prior to flowering and seed production. The restoration specialist will coordinate with the landscape contractor to prioritize tasks and develop specific control strategies for each area.

A combination of hand pulling, weed-whipping, and herbicide strategies is recommended. Care will be taken to minimize ground disturbance when using mechanical methods of control because this can encourage germination of more weeds. Hand pulling is an effective option where weeds grow among native plants, and are few in number. However, for larger areas dominated by non-native plants, the restoration specialist may approve some of the following herbicides for use. For nonselective weed control, the following glyphosate concentrations can be used according to the type of application required: foliar spray application: a minimum of two percent, foliar wick application: a 33 percent solution. For control of broadleaved weeds, the following triclopyr concentrations can be used as per the product label: foliar spray application: 15 percent solution. Grass selective herbicides such as Fusilade (Fluazifop-P-butyl) or Poast (sethoxydim) may be applied as a post-emergent control technique in areas where the desirable vegetation consists of broadleaved plants.

The following weeds will be high priorities for control. Information related to their growth habits, timing of flowering, means of spread, effective control strategies, and predicted habitats are provided.

- Buffelgrass (*Pennisetum ciliare*) and fountain grass (*Pennisetum setaceum*) are shrubby, perennial, bunchgrass that can flower and set seed after rainy periods. Their shade and dense root system can exclude natives. They can carry fires and thereby damage established stands of native vegetation. Hand-pulling and herbicides are the best control options.

- Giant reed (*Arundo donax*) occupies drainageways and spreads primarily by rhizome fragments. Once established, stands can also spread into upland areas. It can be controlled by a combination of grass-selective herbicides and cutting the culm at the time of flowering.

- Johnson grass (*Sorgum halepense*) and Bermuda grass (*Cynodon dactylon*) are warm season grasses that produce abundant seed that can disperse to form new colonies. Once established, they spread rapidly by rhizomes to form dense stands that exclude natives. They tolerate a wide range of habitats but are especially problematic in moist or disturbed sites. It is difficult to eradicate once established and repeated herbicide applications may be necessary. Spraying will be a very important strategy for control.

- Red brome (*Bromus rubens*) is a cool season, shade-intolerant, annual grass that thrives in disturbed sites with poor soil. It is especially abundant during wet years and can produce dense stands that carry wildfires. Weed whipping prior to seed set and grass selective herbicides are control options.

- Russian thistle (*Salsola* spp.) is an annual subshrub dispersed by wind. It can be controlled by herbicides such as 2,4-D when small. Weed-whipping prior to flowering and seed set is another control option.

- Several exotic trees and woody shrubs can alter vegetation structure and ecosystem processes thereby preventing establishment of native vegetation. These include Mexican palo verde (*Parkinsonia aculeata*), Tamarisk (*Tamarix* spp.), tree tobacco (*Nicotiana glauca*), African sumac (*Rhus lancea*), and Chilean mesquite (*Prosopsis chilensis*). Hand pulling is an effective strategy when small but the cut-stump and glyphosate application procedure will be necessary once individuals become established. A weed wrench may also be effective in some cases.

The landscape contractor must have a pest control license for commercial application of herbicides. This requires that at least one individual employed by the business be in possession of a qualified applicator's license. If a qualified applicator is not present during the herbicide treatment, all applicators must have undergone the documented herbicide application training. Personnel must wear all protective clothing required by the law and follow all label directions and precautions. Herbicide preparation shall be allowed only in staging areas more than 100 feet from a stream course or body of water.

3.12 Fire Management

Fire management access will be achieved by providing maintenance access lanes into the restoration area. These will be located around the entire perimeter with at least one lane through the middle of the site. These features will be at least 10 feet wide to allow vehicular access and will be maintained to eliminate any overhanging vegetation to a height of 10 feet. The locations of the vehicle access lanes are shown in Appendix B, *Proposed Restoration Planting Zone*.

The other management tool is elimination of certain densely growing, exotic, perennial bunch grasses such as fountain grass (*Pennisetum setaceum*), and buffelgrass (*Penisetum ciliare*). These plants are highly inflammable and can transmit fire to the less fire-adapted native vegetation. These grasses recover rapidly in the aftermath of fire while native desert vegetation is slow to recover. Therefore, the elimination of these weeds will not only reduce wildfire hazard to surrounding areas but also address a factor that could undermine the success of native plant colonization of the site. Annual grasses are generally lower growing but can also transmit fire. However, only non-native species will be controlled.

4.0 MONITORING AND MAINTENANCE

4.1 Restoration Schedule

The following is a general sequence of activities necessary for successful restoration.

a. Obtain all necessary State, County, and Federal permits necessary to begin the work.

b. Hire an experienced landscape contractor.

c. Concurrent with (b), contract the seed collection and growing out of plant material as described in section 3.6.

d. Hold a pre-construction meeting with the grading contractor, landscape contractor, the project proponent's representative, and the restoration specialist in order to coordinate activities.

e. Flag the limits of grading. An experienced and qualified materials monitor will be hired by the project proponent to oversee the grading process and excavation of soil.

f. Salvage plant material. Establish an on-site nursery area where this material can be maintained.

g. Conduct grading to establish appropriate site topography to support restoration design.

h. Establish designated access roads throughout the site for irrigation, fire control, and maintenance work.

i. Prepare and amend soils to ensure a suitable seedbed as per recommendations in sections 3.4 and 3.5 of this narrative and the Geotechnical Evaluation (Tembo and Harris, 2005).

j. Establish drip irrigation throughout the site.

k. Install container shrubs and trees at the densities specified.

l. Hydroseed all graded areas and include a hydromulch to stabilize the soil.

m. The restoration specialist shall conduct regular inspections in order to develop maintenance guidelines for the landscape contractor. Upon completion, inspections shall be conducted monthly during the first three months, quarterly during the initial two years, and semi-annually thereafter. Following each visit, letter reports outlining

the status of the project will be prepared and presented to project developer, landscape contractor, and Pima County.

n. The landscape contractor shall maintain the site every week during the initial 3-month period. Subsequent maintenance shall be conducted monthly for two years and then quarterly until the success criteria are met, typically a 5-year period.

o. The restoration specialist shall follow an established protocol described in section 4.3 to assess site status relative to the success criteria described in section 5.0. Results shall be presented in an annual monitoring report to Pima County.

p. Pima County shall deem the restoration project complete and release the client from its obligations to this restoration site when the success criteria are reached or within 5 (five) years after initial construction of the restoration project, whichever comes first.

4.2 Construction Monitoring

The project developer will hire both materials monitors and restoration monitors. The materials monitors will ensure that work does not exceed limits of construction and established volumes and that grading, excavation, compaction and stockpiling areas are being established per approved plans. An earthwork calculation method will be used to ensure that the maximum volume of excavated material does not exceed 141,392 yd^3. This involves the following four steps:

a. The contractor clears and pre-compacts the areas to be graded.

b. The project surveyor sets a grid of cut stakes based upon the approved grading plan. The hub elevations set are established as “the existing grade prior to excavation and export of material”.

c. The contractor grades the site and exports the material.

d. After grading is complete, the project surveyor “as-builts” the grading (based on the same grid pattern as previously staked) and the material export value is computed based upon comparing the hub elevations previously established to the as-built ground shots after grading.

Penalties for over-excavation are described in the restoration agreement. Material monitors shall observe all aspects of the restoration project grading and Big Wash stabilization through periodic inspections of the restoration site, materials stockpiles and bank stabilization. During the construction phase, restoration monitors will have access to on-site and off-site plant nurseries, salvaged plant storage areas, and topsoil stockpiles. Material monitors and restoration

monitors shall attend pre-construction meetings and shall have the power to stop work, if necessary, to enforce the agreements made with respect to the Plan.

4.3 Maintenance

PCR, acting as the restoration specialist, will provide maintenance guidelines that the landscape contractor will then implement. Maintenance consists of actions taken to ensure that the planted trees, shrubs, and groundcovers become established and provide the necessary cover, density, and diversity to meet success criteria. This includes supplemental planting, checking and maintaining irrigation lines, addressing soil fertility problems, and preventing excessive herbivory. It also includes repairing excessive erosion damage, removing weeds in a timely manner, and remedying mosquito and plant disease problems. Management strategies will need to be adjusted continually as site conditions change and develop. Management will be most intense during the bi-modal growing season and less intense during the remainder of the year.

The restoration specialist will inspect the site and the landscape contractor will maintain the site following the schedule provided in section 4.1. However, if persistent problems develop, then both parties shall schedule additional inspections as needed to correct the problems. The restoration specialist and landscape contractor shall meet on-site to review management needs. The restoration specialist will produce a memo for the landscape contractor and client after each inspection detailing specific action items. The restoration specialist and landscape contractor will work together closely to ensure that all recommendations are implemented promptly.

4.4 Annual Monitoring

PCR shall collect quantitative data on an annual basis from the site and use it to evaluate restoration status relative to success criteria. The annual report shall be submitted to Pima County Department of Transportation and Flood Control District. The report shall include a summary of methods, results of data analysis, an evaluation of site status relative to success criteria, management recommendations, and photos taken from designated photo stations that coincide with the locations of the transects or sample plots. Data for the first year monitoring report will be collected approximately one year after implementation of the restoration plan. However, the actual date may be shifted somewhat to coincide with a peak growth and flowering period (spring or early fall). Subsequent monitoring periods will be conducted at this same time each year. The following protocol will be used.

Density of woody plants will be measured within belt transects or circle plots. Vegetative cover will be measured using transect or releve methods (Bonham, 1989). Sufficient sampling units shall be established to provide an accurate estimate of overall vegetative condition. Locations of plots and transects will be randomly selected and marked with rebar stakes. GPS coordinates will be used to precisely identify the locations so that results between

different years can be compared. These data will be analyzed to provide an estimate of percent absolute cover by species, (both native and nonnative), percent cover by strata (groundcover, shrub, canopy layers), percent bare ground, and density of woody plants per acre.

Wildlife utilization will be noted and compiled in a tabular format. Observations of seedling recruitment, general vegetative health and mortality, presence of ponded or flowing water, and soil erosion will be noted. Site photographs will be taken on an annual basis from established photograph stations located in association with sample plots throughout the site.

Channel and floodplain geometry shall be monitored by surveying the 3, 5.08, 8, and 12 cross-sections from the post development floodplain model. The cross-sections shall be plotted to scale and must be on the same vertical datum as the models. The cross-sections are to be submitted to the Pima County Regional Flood Control District after the initial restoration and once a year until the end of the maintenance period. Annual monitoring will continue until the restoration project is complete as described in sections 4.1 (n) and 5.0.

5.0 SUCCESS CRITERIA

Success criteria are specific to each of the proposed vegetation types to be restored. The restored habitat will be deemed successful when the following criteria are met:

- Cover: Native, perennial plants shall provide 20 percent absolute cover after 2 years, and 50 percent cover after 5 years for the streambank and stream channel areas. Native, perennial plants shall provide 10 percent absolute cover after 2 years, and 25 percent cover after 5 years for the upland planting areas.

- Density: Average density of native woody shrubs and trees will be at least 235 individuals per acre for the streambank and stream channel plantings, and 130 for the upland planting areas.

- Exotics: Non-native, perennial groundcovers shall not exceed 10 percent absolute cover. Annual non-native grasses will not be counted in this 10 percent. No non-native woody plants shall be present. This includes but is not limited to giant reed, tamarisk, African sumac, Mexican paloverde, and tree tobacco.

- **Diversity:** The three restoration areas will have at least 60% of the native species richness relative to the reference sites sampled for this report (see Appendix A). Species richness may also be expressed relative to a reference site chosen by Pima County.

Pima County shall deem the restoration project complete and release the developer from its obligations to this restoration site when the success criteria are reached or within 5 years after the initial construction of the restoration project, whichever comes first. At that point Pima County shall assume the responsibility for the restoration site.

6.0 REFERENCES

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APPENDIX A: REFERENCE DATA

Species composition and cover for the three reference communities are presented in the following tables (See Table A-1 (Reference Data for Burrobrush-Desert Broom Community) on page 26, Table A-2 (Reference Data for Mesquite-Catclaw-Hackberry Community) on page 27, and Table A-3 (Reference Data for Whitethorn-Cactus Community) on page 29. Species richness in these reference plots is high though most species contribute only trace amounts to the total vegetative cover. Plots #3 and #4 shown in Figure 3 of the restoration plan are not shown due to their generally low diversity.

Table A-1

Reference Data for Burrobrush-Desert Broom Community (Plot 1)

Scientific name	Common name	% Tree cover	% Shrub cover	% Ground cover
Acacia greggii	Catclaw		3	
Amaranthus palmeri	Pigweed			17
Argemone pleicantha	Prickly poppy			< 1
Baccharis sarothroides	Desert broom		6	
Boerhaavia coulteri	Spiderling			< 1
Bouteloua curtipendula	Side-oats grama			1
Cercidium floridum	Blue palo verde	2		
Clematis drummondii	Virgin's bower			1
Colubrina californica	Snakewood			< 1
Cucurbita digitata	Coyote melon			2
Cuscuta sp.	Dodder			1
Datura wrightii	Sacred thorn apple			< 1
Eragrostic mexicana	Mexican love grass			< 1
Eriogonum wrightii	Buckwheat			< 1
Euphorbia micromera	Spurge			1
Euphorbia setiloba	Spurge			1
Hymenoclea salsola	Burrobrush		28	
Ipomoea hirsutula	Morning glory			2
Isocoma tenuisectus	Goldenbush			< 1
Nicotiana obtusifolia	Tabaquillo			3
Opuntia engelmannii	Engelman cactus			< 1
Opuntia arbuscula	Arizona pencil cholla			< 1
Prosopsis velutina	Velvet mesquite			< 1
Proboscidea parviflora	Devil's claw			< 1
Sarcostemma cynanchoides	Climbing milkweed			< 1
Setaria macrostachya	White-haired bristlegrass			1
Sporobolus wrightii	Dropseed			< 1

Source: PCR Services Corporation.

Table A-2

Reference Data for Mesquite-Catclaw-Hackberry Community (Plots 2, 5, and 6)

Scientific name	Common name	% Tree cover	% Shrub cover	% Ground cover
Acacia constricta	Whitethorn	<1	1	
Acacia greggii	Catclaw	12	5	
Amaranthus palmeri	Pigweed			19
Ambrosia ambrosioides	Ambrosia leaf ragweed			1
Ambrosia psilostrachya	Western ragweed			1
Amsinkia tesselata	Fiddleneck			<1
Aristolochia coryii	Pipewort			<1
Atriplex canescens	Four-wing saltbush		2	
Avena sp. [e]	Oats			<1
Baccharis sarothroides	Desert broom		2	
Boerhaavia gracillima	Spiderling			<1
Bouteloua aristoides	Needlegrama			10
Bouteloua barbata	Six-weeks grama			<1
Bouteloua curtipendula	Side oats grama			<1
Bouteloua parryi	Grama			<1
Bromus rubens[e]	Red brome			3
Celtis pallida	Hackberry	4	1	
Chloris virgata[e]	Feather fingergrass			<1
Chrysothamnus nauseosus	Rabbitbrush		1	
Cercidium floridum	Blue palo verde	2		
Clematis drummondii	Virgin's bower			2
Crassula connata	Crassula			<1
Cucurbita digitata	Coyote melon			<1
Cuscuta sp.	Dodder		<1	
Descurainia sp.	Tansy-mustard			16
Digitaria californica	Arizona cottontop			<1
Elymus elymoides	Squirreltail			<1
Enneapogon desvauxii	Nine-awned pappus grass			<1
Eragrostic mexicana	Mexican lovegrass			<1
Euphorbia hyssopifolia	Spurge			<1
Ferocactus wislizenii	Barrel cactus		<1	
Gutierrezia sarothrae	Snakeweed			<1
Ipomoea hirsutula	Morning glory			<1
Isocoma tenuisectus	Goldenbush			<1
Juglans arizonica	Arizona walnut		<1	
Leptochloa uninervia	Mexican sprangletop			<1
Lycium andersonii	Wolfberry		6	
Marah gilensis	Wild cucumber			<1
Marina parryi	No common name			3
Marrubium vulgare	Horehound			<1
Nicotiana obtusifolia	Tabaquillo			<1
Panicum arizonicum	Arizona panicum			<1

Table A-2 (Continued)

Reference Data for Mesquite-Catclaw-Hackberry Community (Plots 2, 5, and 6)

Scientific name	Common name	% Tree cover	% Shrub cover	% Ground cover
Panicum stramineum	Panicum			<1
Physalis wrightii	Ground cherry			<1
Prosopsis velutina	Velvet mesquite	45	3	
Phorodendron californicum	Mistletoe	<1		
Opuntia arbuscula	Pencil cholla		<1	
Opuntia versicolor	Staghorn cholla		<1	
Opuntia engelmannii	Engelmann cactus		<1	
Sarcostemma cynanchoides	Climbing milkweed			<1
Schismus sp. [e]	Mediterranean grass			3
Setaria macrostachya	White-haired bristlegrass			<1
Solanum eleagnifolium[e]	White horse nettle			<1
Sporobolus wrightii	Dropseed			<1
Yucca elata	Soap plant		<1	
Ziziphus obtusifolia	Gray thorn		2	

[e] *Exotic plant species*
Source: PCR Services Corporation.

Table A-3

Reference Data for Whitethorn-Cactus Community (Plot 7)

Scientific name	Common name	% Tree cover	% Shrub cover	% Ground cover
Acacia constricta	Whitethorn	25	3	
Acacia greggii	Catclaw		2	
Amsinkia tessellata	Fiddleneck			
Amaranthus fimbriatus	Pigweed			
Ambrosia ambrosioides	Ambrosia leaf ragweed			4
Bouteloua aristoides	Needlegrama			10
Bromus rubens[e]	Red brome			10
Cercidum microphyllum	Little leaf palo verde	12	3	
Celtis pallida	Hackberry		2	
Chloris virgata[e]	Feather fingergrass			2
Datura wrightii	Sacred datura			<1
Ericameria laricifolia	Goldenbush			3
Encelia farinosa	Desert brittlebush			2
Ferocactus wislizenii	Barrel cactus		2	
Gutierrezia sarothrae	Snakeweed			12
Isocoma tenuisectus	Goldenbush			4
Lycium andersonii	wolfberry		3	
Machaeranthera pinnatifida	No common name			<1
Opuntia arbuscula	Pencil cholla		2	
Opuntia sp.	cholla		1	
Opuntia fulgida	Chain fruit cholla	2	15	
Opuntia versicolor	Staghorn cholla		1	
Opuntia engelmannii	Engelmann cactus		6	
Opuntia leptocaulis	Christmas cactus		5	
Physalis wrightii	Ground cherry			<1
Proboscidea parviflora	Devil's claw			<1
Prosopsis velutina	Velvet mesquite	4		
Schismus sp. [e]	Mediterranean grass			20
Tidestromia oblongifolia	No common name			<1
Ziziphus obtusifolia	Grey thorn		<1	

Source: PCR Services Corporation.

APPENDIX B: PROPOSED RESTORATION PLANTING ZONE

APPENDIX C: PROPOSED RESTORATION GRADING PLAN

APPENDIX D: IRRIGATION PLAN

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