DRAFT

Special Elements

Sonoran Desert Conservation and Comprehensive Plan 2002

MEMORANDUM

Date: March 18, 2002

To: The Honorable Chair and Members
Pima County Board of Supervisors

From: C.H. Huckelberry
County Administrator

Re: **Special Elements in Reserve Design**

I. Background

The attached study documents the representation of aspects of biodiversity within both the existing system of protected land and the biologically preferred alternative of the Sonoran Desert Conservation Plan. In the practice and implementation of principles of conservation biology, it is necessary to think not only in terms of species, but also in terms of vegetation communities. Planning with a focus on species is often called the fine filter approach, while planning with a focus on plant communities and larger landscape ecological processes has been called the coarse filter approach. Because these methods serve as an effective check and balance on one another, aspects of both were incorporated into the design of the Sonoran Desert Conservation Plan. This memorandum introduces the attached study which provides a detailed look at the twenty-one special element conservation targets that were considered by the Science Technical Advisory Team for the Sonoran Desert Conservation Plan.

II. Percent of Communities Within the Biologically Preferred Alternative

The chart below reflects the percent of selected vegetation communities in all of Pima County (including lands owned by the Native American Nations) that are found within the biologically preferred alternative.

VEGETATION	TOTAL SQ MILES IN PIMA CO	% IN BIO RESERVE
Palo Verde - Saguaro	4819.6 sq mi	28.1 %
Creosote - Bursage	1529.4 sq mi	62.7 %
Mixed Grass - Scrub	1525.3 sq mi	93.4 %
Encinal	269.9 sq mi	92.1 %
Scrub - Grassland	210.6 sq mi	96.9 %

Sonoran Desertscrub	198.3 sq mi	78.1 %
Oak Pine	43.1 sq mi	81 %
Mesquite Forest	41.4 sq mi	92.5 %
Manzanita	23.7 sq mi	36 %
Pine	18.9 sq mi	97 %
Mixed Sclerophyll	16.9 sq mi	85.6 %
Creosote Tarbush	16.2 sq mi	96.5 %
Saltbush	15.6 sq mi	100 %
Sonoran Riparian Scrub	11 sq mi	93.8 %
Riparian Scrub	9.8 sq mi	36 %
Oak Pine	9.6 sq mi	100 %
Int. Rip. Decid. Forest	9.1 sq mi	100 %
RM Pine Forest	7.9 sq mi	100 %
Cottonwood-willow	5.3 sq mi	99.1 %
Sacaton	4.3 sq mi	100 %

III. Coverage of Study

Pages twelve through twenty-five of the study describe the conservation targets in detail, grouping these by categories of:

- Grassland Conservation Targets
- Desertscrub Conservation Targets
- Riparian Area Conservation Targets
- Middle to High Elevation Conservation Targets
- Other Landscape Conservation Targets

Eighteen maps reflect the location of these areas and form the appendix of the study.

IV. Study Conclusion and Recommendations

The *Special Elements* study makes these conclusions:

- "The final reserve design, known as the Conservation Land System for the Sonoran Desert Conservation Plan, was developed using the spatial distribution of vegetation communities and certain landscape features, not just information about the habitat potential for individual plants or animals."

- "Certain plant communities and landscape features, called special elements, were used to constrain or influence the location of the exterior and interior reserve boundaries."

- "The Conservation Land System, if implemented, would improve the permanency of protection offered to [vegetation types not well protected in the existing reserves] and other vegetation types."

- "Future changes in the protection given to native vegetation communities will not be sufficient to arrest or reverse the historic and ongoing losses in some plant communities. This is particularly true for plant communities such as sacaton and Sonoran cottonwood-willow forest, for which the Science Technical Advisory Team has adopted restoration goals."

- "This report also recommends a goal of restoring 1000 acres of mesquite bosque, in light of historic losses of this vegetation community type along the Santa Cruz River, and ongoing losses in the Tanque Verde valley and elsewhere. This would be in addition to the mitigation efforts needed due to future losses."

The study recommends that inventories be undertaken of water bodies, talus slopes, caves and limestone outcrops in order to improve the state of current knowledge. More detailed mapping of vegetation communities and more information about the condition of special elements such as sacaton grass and cottonwood willow is also suggested. These inventories will become important components of the Sonoran Desert Conservation Plan.

Attachment

Representation of Vegetation Communities and Special Elements in Reserve Design

Table of Contents

Figures

Representation of Vegetation Communities and Special Elements in Reserve Design
Prepared for the Sonoran Desert Conservation Plan
By Julia Fonseca and Neva Connolly, Pima County Flood Control District

Purpose

The purpose of this report is to document how well certain aspects of the biodiversity of Pima County are represented in the existing reserve system, as well as in the biologically preferred alternative. The type of biodiversity discussed in this report is not species biodiversity, but the diversity of plant communities and other landscape features deemed important for conservation by various scientific experts. This report will discuss the rationale used by the Science Technical Advisory Team for selecting "special element" conservation targets and document how the special element Geographic Information System (GIS) layers were developed. Each special element is described, including biological significance, major threats, and distribution within Pima County.

Box 1: The fine filter approach

The conservation of rare species is one of several strategies used in conservation planning. Haufler (et. al 1999) describes the "fine filter" approach as planning based on the needs of individual species or guild of species, and providing for the needs of those species. Usually, the fine filter approach is applied due to legal requirements (the Endangered Species Act) or mandates that force focus on individual species needs (Haufler et al., 1999).

The fine filter approach to conservation planning offers many advantages. The information is collected at an in-depth level and applied to a larger scale (Wall et al., 1999). Information obtained from a fine filter approach can be integrated with a large-scale, coarse filter approach. It offers flexibility and provides a continuous planning and monitoring process (Wall et al., 1999).

The fine filter approach is a time consuming process. The information must be constantly updated and managed accordingly. The feasibility of this approach must also be considered when dealing with large areas with highly variable environments, or small areas with high species densities. Conserving rare species may not achieve broader wildlife conservation goals. Landscape level approaches that protect entire species assemblages as well as ecosystems have been suggested by many conservation biologists (Noss and Cooperrider, 1994).

Background

The biological goal of the Sonoran Desert Conservation Plan (SDCP) is to ensure the long-term survival of the full spectrum of plants and animals that are indigenous to Pima County through maintaining or improving the habitat conditions and ecosystem functions necessary for their survival (Pima County, 2000). As part of this effort and for greatest efficiency in protecting the full range of Pima County's species, from the common to extremely rare, a representation of all viable, native plant community types must be conserved within the planning area (Anderson, et al., 1999).

Many of the special element conservation targets are plant community types that can be classified using the Brown, Lowe and Pase (BLP) vegetation classification system. Other special elements cannot be represented using the BLP system, yet represent important habitat for large numbers of individual species, such as talus slopes for talus snails, or caves, adits, and bridges for bats. The report will focus on the selection, description, and importance of each special element conservation target and its relevance to the SDCP.

Protecting Pima County's indigenous species will require more than individual species' habitat conservation. Recommendations for maintaining native biodiversity include representing all native ecosystem types across all natural variations; maintaining viable populations of all native species in natural patterns of abundance and distribution; maintain natural functions, such as disturbance regimes, hydrological cycles, nutrient cycles, and biotic interactions, and maintain landscapes and ecological communities to be responsive to environmental change (Noss and Coopperider, 1994).

There are several strategies used in conservation planning. One approach is known as the fine filter approach, using planning based on the needs of individual species (see Box 1). Another strategy commonly used in the coarse filter approach, usually involving conservation of large areas of land (see Box 2). Applied alone, both of these approaches have flaws that need to be addressed for successful conservation planning. Using a conservation strategy combining both approaches, the coarse filter/fine filter approach, incorporates the key components of biodiversity while overcoming knowledge gaps (Marshall, et al., 2000).

Coarse Filter/Fine Filter Approach

The conservation of species and communities can be achieved through a coarse filter/fine filter approach. The Nature Conservancy (Marshall, et al., 2000) lists four advantages to this approach:

- This approach evaluates biodiversity at two different scales, emphasizing the habitats in which the ecoregion's species inhabit.
- The fine filter/coarse filter maximizes the number of species represented.
- Captures the variability of ecological conditions in which the species occurs.
- Helps compensate for data gaps that result from uneven species inventories.

In the design of the biologically preferred alternative for the SDCP, biologists and planners are using aspects of both the coarse filter and fine filter approaches. The conservation lands system consists of the biological core, scientifically significant lands,

Box 2: The coarse filter approach

Without a complete inventory and assessment of each species in an ecological community, conservation of the majority of the species depends on selecting communities that represent full examples of the flora and fauna (Anderson et al., 1999). The coarse filter approach is represented by ecological groups, or assemblages of plant species that are found in recurring patterns across the landscape. They generally occur at a larger scale than individual species so abiotic elements (soil types, micro-climates) that support biodiversity and ecological processes are caught. In this way, the coarse filter is used to represent the vast majority of species in the ecoregion, from plants, to insects, to soil microbes (Marshall, et al., 2000).

Advantages of the coarse filter approach include efficiency and cost-effectiveness, and the assumed ability to protect all that occurs within the ecosystem (Noss and Cooperrider, 1994). A limitation to coarse filter based on vegetation is that natural communities are dynamic entities, always changing in space and time. Plant communities are also subject to changes due to climatic variability (Scalero, et al., 2001). In order to compensate for non-stable communities, the full array of physical habitats should be represented, from the highest elevations, to the lowest elevations, the wettest sites, and the driest sites, from all soil types and topoclimates. More ideally, the physical habitats represented should be unfragmented, so that species can shift from distributions in response to environmental change (Noss and Cooperrider, 1994).

landscape linkages, critical habitat core, multiple use lands, and urban buffer areas. The biological core includes areas of exceptionally high biological value to be managed primarily for biological conservation and consists of areas of high potential habitat for 3 or more priority vulnerable species, priority conservation areas for 5 or more priority vulnerable species, special element constraints, and mesoriparian corridors. The biological core area was established using species and some of the narrowly distributed special elements, an example of using the fine filter approach.

The multiple-use areas of the biologically-preferred alternative were defined in part by including some of the widely distributed special elements, such as high-priority scrub grassland, saltbush and ironwood desert scrub.

In October 2001, the STAT invited two conservation biologists, Dr. Reed Noss and Laura Hood Watchman, to review the methodology used to develop the biologically preferred alternative. In their peer review comments, Noss and Watchman concluded:

> *More use of a coarse filter is needed to balance the fine-filter approach of the Plan. The SDCP is oriented toward the habitat requirements of some 55 priority vulnerable species, mesoriparian communities, and a variety of special elements (mostly rare plant communities, but also certain physical habitats and features such as bat roosts). This fine-filter approach does not necessarily assure that all plant communities and environmental features will be represented adequately in the planning area. In particular, matrix communities such as paloverde-mixed cacti and creosote-bursage may be under-represented in a reserve design, as are some other communities such as xeroriparian. This under-representation, in turn, could affect long-term ecological processes and population viability for a number of species. Hence, most modern conservation planning processes (e.g., in Australia and the ecoregional plans of The Nature Conservancy) set representation targets for all communities and habitats. SITES [computer software] can be used to accomplish these representation goals efficiently.*

The STAT had previously requested an accounting of the amount of certain matrix communities covered by the biologically preferred reserve design, but had not requested evaluation of all of the plant communities which comprise the land cover developed for the Sonoran Desert Conservation Plan. In response to the peer review comment above, this report will describe the representation of all plant communities in existing reserves and in the biologically preferred alternative.

The peer reviewers reiterated elsewhere in their comments that *"natural community conservation goals could be added."* Ideally, these goals (called representation targets in the previous quote) would be set in advance for all plant communities, so that the amount of each plant community in various alternatives could be determined.

In response to this comment, the STAT reviewed the representation of each plant community and special element relative to the penultimate version of biologically-preferred alternative. Results of that review will be discussed in subsequent portions of this report.

Problems with Conservation Targets

When the special element conservation targets are applied to the reserve design system alone, the area may be too small to successfully support native biota. The area may be subject to edge effects, natural disasters, and lack of connectivity, successfully isolated species within this "island."

Conservation at the community or ecosystem level demands attention to ecological processes, such as fire, hydrological cycles, and nutrient recycling. These processes need to be maintained for native biodiversity to exist. Many areas in Pima County would need extensive management to restore certain ecological processes. Grasslands would need a fire regime restored. Hydrologic cycles have been altered by water diversions and flood control structures throughout the county. Due to human welfare reasons, it may be impractical and unsafe to remove critical flood control structures or restore fire.

GAP analysis of plant communities

In order to address the concerns of the peer reviewers, the STAT reviewed the representation of all plant communities and species' habitats in the draft of the biologically preferred alternative. The STAT saw no deficiencies in the representation of plant communities with regard to the biologically preferred alternative. Subsequently, the reserve design was revised by incorporating new data on land cover and new input from experts on habitat models.

The conservation land system for the Sonoran Desert Conservation Land System will take decades to assemble. For this reason, we use a technique called gap analysis to look at the difference between today's level of conservation offered to various plant communities and the level proposed in the biologically preferred alternative.

The purpose of the Gap Analysis Program (GAP) is to provide state, regional, and national assessments of the conservation status of vertebrate species and land cover types of the United States, and to facilitate the use of this information for land management activities (Scott and Jennings, 1997). The GAP uses a scale of 1 through 4 to represent the degree of management commitment to biodiversity maintenance. A status of 1 denotes the highest, most permanent level of commitment, while a status of 4 represents the lowest level of commitment, or an unknown status (Crist and Csuti, 1997). Prescribed management, not land ownership, is the primary determinant in assigning status. Another key attribute is the permanence of protection of biodiversity maintenance through legal and institutional arrangements.

GAP uses the following criteria and assumptions to determine management status for land units (Crist and Csuti, 1997).

- *Permanence of protection from conversion of natural land cover to unnatural.* The assumption is that retention of natural land cover is fundamental in maintaining biodiversity.

- *Relative amount of the land unit managed for natural land cover.* Five percent was set as the maximum amount of land that can be managed in an unnatural state and still be considered "status 1."

- *Inclusiveness of management.* The assumption is that land managed to maintain all of its elements rather than managed for one species will maintain biodiversity better. Land managed for a "keystone" stone species is considered inclusive of all elements.

- *Type of management and degree that it is mandated through legal and institutional arrangements*. The assumptions are that management practices which allows or mimics natural disturbance events such as fire will maintain more biodiversity than will land units that suppress disturbance.

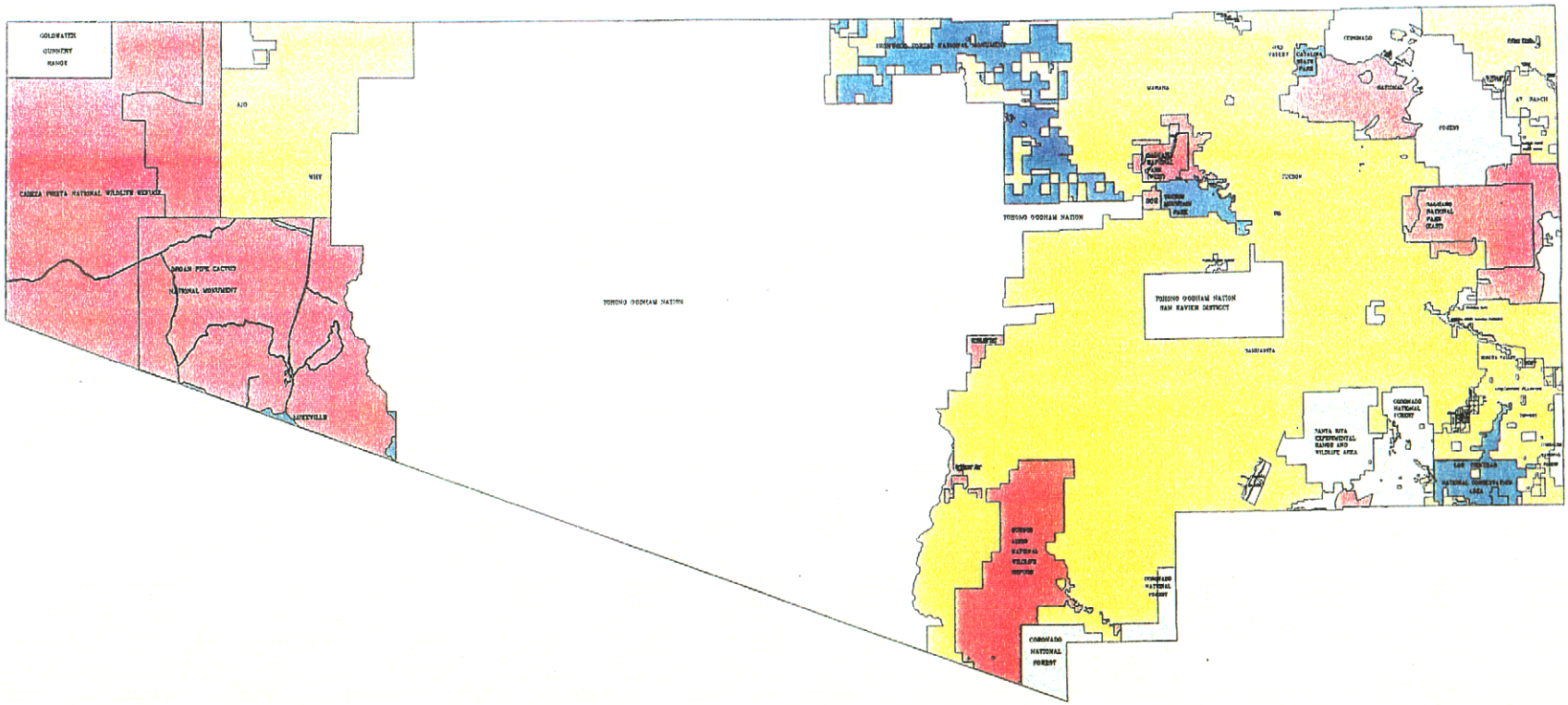
Using the above criteria, the management status categories can be defined. GAP status 1 and 2 lands have permanent protection against removal of natural vegetation, so they are the most secure. Gap status 3 lands, in many cases offer more security for plant communities than status 4 lands, but the protection is not permanent (3a), or some amount of removal of vegetation communities is allowed (3b). Figure 1 shows what portions of the landscape are in which GAP status.

Table 1 shows the distribution of plant communities relative to its occurrence in Pima County, inclusive of the Tohono O'odham Nation. The distribution is expressed as square miles, in the third column. The third column total of 8,810.5 square miles reflects a loss of 389.5 square miles due to urbanization, agriculture and mining.

The fourth column shows the percentage of the vegetation type in existing reserves, which are lands having a GAP management status of 1 through 3. The percentage is expressed relative to the SDCP planning areas, which excludes the Tohono O'odham Nation. The value of zero percent for cattail and Interior cottonwood-willow is due to the small total area of these rare types in Pima County. Plant communities whch are not well-represented in existing reserve system included Chihuahuan creosote-tarbush (BLP 153.21) and Chihuahuan mixed scrub (BLP 153.26), which have less than 15% of their occurrence in existing reserves. For this reason, the biologically preferred alternative includes these Chihuahuan plant communities.

The fifth column shows the percentage of the vegetation type as it is found in Pima County, inclusive of the tribal lands, relative to the biological reserve. If implemented, the biological reserve would do a good job protecting many types of vegetation. The biological reserve

GAP Status of Pima County



PIMA COUNTY DEPARTMENT OF TRANSPORTATION
TECHNICAL SERVICES

Pima County Technical Services
201 North Stone Avenue - 9th Floor
Tucson, Arizona 85701-1207
(520)740-6670 - FAX:(520)798-3429
http://www.dot.co.pima.az.us

The information depicted on this display is the result of digital analyses performed on a variety of databases provided and maintained by several governmental agencies. The accuracy of the information presented is limited to the collective accuracy of these databases on the date of the analysis. The Pima County Department of Transportation Technical Services Division makes no claims regarding the accuracy of the information depicted herein.

This product is subject to the Department of Transportation Technical Services Division's Use Restriction Agreement.

GAP STATUS:

- 1A, 1B
- 2
- 3A, 3B
- 4
- Outside Plan Area

N

Scale: 1: 250,000

Plotted: 12/26/01

\rimba4\special\floodveg\amls\gap.aml OP

Figure 1

Table 1: Vegetation in Existing Reserves and Proposed Biological Reserve

BLP	Vegetation	Total Area (Square Miles) in Pima County	Percent in existing reserve in Plan Area (Sq. Mi.)	Percent of Total BLP in Bio. Reserve
122.3	RM conifer forest	0.3	100.0	100.0
122.31	RM doug fir-white fir	1.8	100.0	100.0
122.32	RM pine forest	7.9	100.0	100.0
122.41	pinyon juniper	1.1	100.0	100.0
122.61	doug fir-mixed conifer	1.1	100.0	97.8
122.62	pine	18.9	93.1	97.0
123.3	oak-pine	9.6	83.0	100.0
123.31	encinal	269.9	97.9	92.1
123.32	oak-pine	43.1	98.5	81.0
123.5	cypress forest	0.2	100.0	100.0
124.71	xeroriparian mesquite	0.9	100.0	100.0
133.32	manzanita	23.7	100.0	36.0
133.36	mixed sclerophyll	16.9	97.4	85.6
143.1	scrub-grassland	210.6	80.9	96.9
143.14	sacaton	4.3	93.0	100.0
143.15	mixed grass-scrub	1525.3	81.2	93.4
143.16	scrub disclimax	3.3	100.0	100.0
153.21	creosote-tarbush	16.2	13.6	96.5
153.26	chih mixed scrub	5.5	13.0	100.0
154.1	son desertscrub	198.3	79.5	78.1
154.11	creosote-bursage	1529.4	96.1	62.7
154.12	palo verde-saguaro	4819.6	93.5	28.1
154.15	agave-bursage	0.1	100.0	100.0
154.17	saltbush	15.6	100.0	100.0
223.2	Int. rip. decid. Forest	9.1	85.2	100.0
223.21	Interior cw-willow	0.0	0.0	100.0
223.22	mixed rip. Decid. Forest	1.8	87.5	100.0
224.52	mesquite forest	41.4	85.6	92.5
224.53	cottonwood-willow	5.3	94.4	99.1
234.7	Son riparian scrub	11.0	52.4	93.8
234.71	riparian scrub	9.8	96.7	36.0
234.72	riparian scrub	0.0		100.0
244.71	cattail	0.0	0.0	100.0
244.75	saltgrass	0.1		100.0
254.7	strand	8.2	54.2	88.3
254.72	strand (annual)	0.2		98.8
Total		8,810.5		

Blanks indicate BLP not present for the indicated category.
0.0 indicates that area is less than 1/10th square mile.

would offer a low percentage of protection to manzanita (36%), and palo verde-saguaro (28%) and riparian scrub (36%). Comparing the fifth column to the fourth, we can see that the existing reserve system already provides a great deal of protection for these plant communities.

Special Elements

Special elements are landscape features which were used in reserve design. A total of 21 special element conservation targets have been chosen by the Science and Technical Advisory Team (STAT) (Table 2). All but low elevation valley floors were used to guide reserve design. A number of the special elements were first defined by experts as potentially vulnerable plant communities within Pima County (Fonseca and Scalero, 1999). The list was continually revised by the STAT as more information was gathered, data layers were added to the GIS, and reserve design guidelines were developed.

Conservation goals were assigned to each special element. A constraint goal means that the STAT would prefer to encompass all occurrences of that feature in all reserve design alternatives, regardless of size. A preference goal means that they suggest including as many sites as possible, in larger management units only. Special element constraints and preferences were used in part to define the biological core of the conservation lands system (see RECON, 2001).

Management goals for the special elements include the categories "Restore" and "Manage." These goals are intended to show elements that have been so reduced over time that there is now a desire to restore them or to manage them against further loss.

When determining conservation areas, STAT considered the following rules or strategies (STAT, 2001).

- Preference of patches that are adjacent to reserved areas; should not assume, however, that the responsible agencies will change management strategies for their lands to more stringent standards held by the STAT.

- Preference of patches that link conservation targets to one another; conservation targets adjacent to one another are preferred over those that are isolated.

- Areas with varied ages of plants are preferred over those with only one age group; good for some communities such as Ironwood and riparian, but especially for saguaro communities.

- Preference of patches that capture the continuum of the landscape over an elevation gradient.

- Preference of patches that provide a linkage corridor to other protected areas; especially true for oak ecotone conservation target.

"Special Element" Conservation Targets--revised November 26, 2001

Table 2

Conservation Target	Goal	BLP Series	BLP Class	Data Layer	Source	Shapefile*	Comments on creation of shapefiles
unincised floodplain with grass/ contributing watershed	constraint/ preference	Unincised floodplain	143.1	Harris-incised+rainfall (David refining)	fplain_p coverage (3/19/01)	unincised.shp watershed.shp	selected "unincised floodplain" from coverage selected "contributing watershed" from coverage
sacaton	constraint/restore	Sacaton-scrub	143.14	vegetation/land cover (David refining)	saca_p coverage (3/19/01) grassland coverage (4/18/01) comp_veg_new coverage (11/23/01)	sacaton_nov01.shp	merged sacaton hab-type from saca_p coverage, "sacaton grassland" from grassland coverage, and seriesblp = "143.14" from comp_veg_new coverage
native upland grassland	preference	Mixed-grass-scrub	143.15	vegetation/land cover	grassland coverage (4/18/01)	grassland.shp	excluded polys labeled "exclusion - i.e., hole in poly" and "sacaton grassland"
desert scrub	accounting	Creosotebush-bursage	154.11	vegetation/land cover	comp_veg_new coverage (11/23/01)	creosote-bursage.shp	selected seriesblp = "154.11" (includes XR) from coverage
desert scrub	accounting	Paloverde-mixed cacti	154.12	vegetation/land cover	comp_veg_new coverage (11/23/01)	paloverde.shp	selected seriesblp = "154.12" (includes XR,U) from coverage
desert scrub	preference	Ironwood	154.12/154.13	PAG vegetation/land cover + other	ironwood_27 coverage (4/10/01) orgpipe_veg coverage	ironwood.shp	merged ironwood_27 ironwood = "yes" with orgpipe_veg orgblp = "154.1216" [note: orov_iron polys (11/19/01) already covered in ironwood.shp]
desert scrub	preference	Saltbush	154.17	PAG vegetation/land cover	comp_veg_new coverage (11/23/01)	saltbush_nov01.shp	selected seriesblp = "154.17" from coverage
riparian	constraint	Int. SW riparian deciduous forest	223.2	vegetation/land cover	comp_veg_new coverage (11/23/01)	intsw_rip_nov01.shp	selected seriesblp = "223.20" (includes U), "223.21", or "223.22"
riparian	constraint /restore	Mesquite	224.52	vegetation/land cover	comp_veg_new coverage (11/23/01)	mesquite_nov01.shp	selected seriesblp = "224.52" (includes U) from coverage
riparian	constraint/restore	Cottonwood-willow (Son.)	224.53	vegetation/land cover	comp_veg_new coverage (11/23/01)	cot-will_son_nov01.shp	selected seriesblp = "224.53" (includes U) from coverage
riparian	constraint	Sonoran Riparian scrub	234.71/154.1XR	vegetation/land cover	comp_veg_new coverage (11/23/01)	rip_scrub_nov01.shp	selected redef = "234.71", "154.10XR", "154.11XR", or "154.12XR"
aquatic/wetlands	constraint	Cattail	244.71	Cattail	comp_veg_new coverage (11/23/01)	cattail_nov01.shp	selected seriesblp = "244.71" from coverage
perennial/intermittent streams	constraint	n/a	n/a	Streams - effluent?	pstreams_up coverage (1/23/01) istreams_up coverage (1/23/01)	pstreams_buf300ft.shp istreams_buf300ft.shp	coverages buffered by 300ft
springs/cienegas	constraint	n/a	n/a	prioritized springs/cienegas	springs_apr01 coverage (4/18/01)	springs_buf300ft.shp	coverage buffered by 300ft
oak/grassland ecotone	preference	Oak/oak savanna w/ des. grassland	123.31/143.1	vegetation/land cover	oakeco_buf coverage (2/22/01)	oak_grass.shp	selected inside = "100" from coverage
mixed conifer	constraint	Douglas-fir-mixed conifer	122.61	vegetation/land cover	comp_veg_new coverage (11/23/01)	mix_conifer_nov01.shp	selected seriesblp = "122.61" from coverage
talus slopes	constraint	n/a	n/a	PAG landform	gis\shapefiles\talus_new.shp (from 1/31/01 ags_landform coverage)	talus_nov01.shp	selected landform = 65 from ags_landform coverage
caves and occupied adits	constraints	n/a	n/a	adits from cave coverages	gis\shapefiles\batcaves_habitat.shp (from 6/27/01 batcaves2 coverage)	batcaves_buf2640ft.shp	selected batcaves2 locations containing species, buffered 2640ft (0.5mi)
bat roosts (bridges)	management	n/a	n/a		bat_bridges coverage (10/30/00)	bat_bridges.shp	
low elevation valley floors	accounting	n/a	n/a	PAG landform + elevation			
limestone outcrop	preference	n/a	n/a	PAG geology + carbonates	gis\shapefiles\pag_limestone.shp (from pag_geol coverage)	limestone.shp	selected geology = 9- from pag_geol coverage
						* note: shapefiles are in m:\jobs\3273b\gis\special_elems	

Grassland Conservation Targets

The STAT has selected sacaton, native upland grasslands, and unincised grassy floodplains and the corresponding watersheds above them as special elements. Grassland communities are threatened with development and poor land use and fire management, and the introduction of non-indigenous grass species. Historic cattle overstocking have degraded grasslands and reduced species diversity (Fonseca and Scalero, 1999).

STAT had a series of discussions on grasslands inclusion as special elements. Grasslands are extensive throughout Pima County. Originally, the goal for all grassland types was "preference." After discussion, it was decided that unincised floodplains with grass and sacaton grasslands would be changed from preference to constraint, based on the limited areas of these targets within Pima County (STAT subcommittee notes, 1/25/01). It was also decided that grasslands dominated by non-indigenous species should not be discounted, although grasslands dominated by natives would take precedence.

Through a series of several meetings with county staff, RECON, and Dan Robinette from the NRCS, 15 grassland areas within Pima County were prioritized for areas of higher conservation value (see Appendix A). These grassland areas consisted of Type A: existing grasslands with low percentage of shrub invasion and low percentage of non-native grasslands; Type B: shrub-grassland with low percentage of non-native grasses that could be restored by increasing fire frequency to reduce percentage of shrubs; and Type C: sacaton bottom lands.

Unincised Floodplain Dominated by Warm-Season Grasses/ BLP Class 143.1

Very few grassland floodplains remain unincised within Pima County. Because of the historic loss of this element, and the role of unincised grassy floodplains in storing sediment and regulating flows to downstream watersheds, this target is an important one for conservation.

This element has a distribution that is primarily within the Chihuahuan ecoregion, though also occurs as small disjunct patches in the Sonoran Desert ecoregion. It occurs in small, linear patches. The STAT recommends that unincised grassy floodplains be considered constraints in reserve design. This element occurs in the Las Cienegas National Conservation Area and along Arivaca Creek (Figure 2).

In order to conserve this target, it is important to maintain or improve hydrologic functioning of the contributing watershed. Therefore, preference was given to a reserve design that captured the entire watershed surrounding and contributing to unincised grassy floodplains. It may not be possible to maintain patches of this element if the natural cover in the watershed around the patch is subjected to urbanization or overgrazing. In addition, roadway development and attendant floodplain encroachments, channelization and bank protection should be regarded as compromises to the likelihood of persistence. Maintaining a high

degree of vegetative cover in the floodplain is important to hydrologic functioning, to provide roughness to dissipate the energy of flood flows.

Possible locations known to experts were identified. The feature was mapped using the Harris riparian mapping and staff expertise. Aerial photographs in selected areas were reviewed to confirm whether the floodplain was unincised, and to guide selection of lateral boundaries. Topographic maps were used to identify watershed boundaries.

Sacaton Grassland/ BLP Class 143.14

Sacaton is a perennial bunch grass, reaching heights up to 6.5 feet. Sacaton grasslands once occurred on millions of acres of riparian grasslands, reaching highest densities along low-elevation desert streams flowing through valley bottoms (Gori, 1997). Sacaton provides bedding and cover for many species of mammals such as peccaries, deer, and small mammals such as mice and rats. In southeastern Arizona, sacaton produce large amounts of biomass that may slow runoff, enhance filtration, and trap sediments. In floodplains, sacaton is important for impeding erosion during flash flood occurrences (Essser, 1995).

Sacaton grows mainly on low alluvial flats, bottomlands, and arroyos subject to flooding. It generally grows on sand, sandy loam, silty clay loam and saline soils. Sacaton must have a direct connection to groundwater. Depths to water of 5 m (15 ft) or shallower should be considered as viable during conservation or restoration efforts.

Sacaton stands have been severely degraded by channelization, erosion, and overgrazing. They are now present in only 5 percent of their original range (Esser, 1995).

The STAT has identified the sacaton grassland as a constraint, with the additional goal of restoration in suitable areas. Sacaton grasslands occur in small patches along floodplains (Figure 3). Sacaton grasslands were mapped using GAP vegetation, information from U. S. Bureau of Land Management, staff expertise and expert review.

Upland Grasslands/Mixed Grass-Scrub BLP Class 143.15

Because of the historic conversion of this element to desert scrub and the contemporary market forces to fragment this otherwise extensive patch-type, this target is important for conservation.

The mixed grass-scrub community has a distribution that is relatively widespread among ecoregions. This series occurs between 3500 to 4900 feet in elevation on a variety of soils. This semidesert grassland adjoins the Sonoran, Mojave and Chihuahuan desertscrub, but has the greatest affinity with the Chihuahuan Desert (Bennett et al., 1999).

The grassland community consists of mixed stands of perennial bunch-grasses and annual grasses of uniform statue with scattered shrubs and succulents. Total vegetation cover ranges from 15 to 85 percent (Bennett et al., 1999). Grass height ranges from 0.9 to 2 feet tall, with shrubs reaching up to 9 feet tall. During good winter rain years, this series has a

spectacular wildflower display. Figure 4a shows an example of a mixed grassland community.

Cattle grazing during the last 200 years has altered the appearance of this grasslands. Heavy grazing reduced bunch grass vigor, disturbed soil encouraged establishment of annual grasses, and favored growth of plants unpalatable to cattle (Bennett et al., 1999). Suppression of fires has protected non-fire resistant plants at the expense of fire-tolerant grasses. Even light fire will check the growth and spread of thin barked species such as mesquite. Heavy grazing and fire exclusion have permitted the proliferation of invasive shrubs and cacti. The intense and prolonged drought of the 1950s (Swetnam and Betancourt, 1998), as well as regional warming trends (Balling, et al. 1998), may also be affecting species composition and structure.

Dan Robinette, NRCS, identified Type A, Type B, and a mixture of A and B grasslands within Pima County (see Figure 4). Fifteen areas, including Type C grasslands (sacaton grasslands), were identified as higher priority conservation areas. These areas are listed in Appendix A. Additionally, Tobosa was identified a unique grassland type, but was not mapped at the scale of Pima County. This community is limited in Pima County outside the Tohono O'odham Indian Reservation, but is more common elsewhere in southeastern Arizona and southwestern New Mexico. Small patches are found on state lands south of I-10 and west of Corona de Tucson.

Desertscrub Conservation Targets

The Sonoran Desert covers approximately 100,000 square miles and includes most of the southern half of Arizona, southeastern California, most of the Baja California peninsula, the islands of the Gulf of California, and much of the state of Sonora, Mexico (ASDM, 1998). Visually dominant plants include leguminous trees and columnar cacti. Over 2,000 species of plants are supported in this biome (ASDM, 1998).

Ironwood Desert Scrub/ BLP Class 154.12/154.13

Ironwood primarily occurs in two BLP series, Paloverde-Mixed Cacti (154.12), and Brittlebush-Ironwood (154.13) series. This element has been chosen by STAT to protect thermally buffered, structurally and biologically diverse desert scrub. This extensive patch type is being fragmented by urban development within Pima County. Ironwood trees have a distribution that is restricted to the Sonoran Desert ecoregion, in dry locales below 2500 feet in elevation. Within this distribution, the element consists of large patches, largely situated on alluvial bajadas (Figure 5).

Ironwood trees have immense ecological value in the Sonoran Desert. Functioning as oases

Figure 4a:
An example of upland grassland/mixed grass scrub.
Highway 83 near Empire-Cienaga. BLP Class 143.15

Figure 6a:
An example of a saltbush desert scrub community.
Christopher Columbus Park (north parking lot). BLP Class 154.17

of fertile and sheltered environment within a challenging desert landscape, the ironwood tree harbors and supports nearly 150 bird species, 230 plant species, 62 reptile and amphibians, 64 mammals, and countless numbers of invertebrates.

This series was mapped using the PAG 208 maps, Harris Oro Valley vegetation mapping, and expert review.

Saltbush Desert Scrub/ BLP Class 154.17

This element was chosen to protect a type of desert scrub that has suffered disproportionate loss due to urban development, agriculture and overgrazing. Saltbush (*Atriplex polycarpa* and *A. canescens*) communities provide good cover for small animals such as the shovel-nosed snake, and are a palatable browse for larger animals like the Sonoran Pronghorn (Species of Concern, 1999).

This element has a distribution that is restricted to the Sonoran Desert ecoregion. Within this distribution, the element consists of small, widely separated patches, usually in association with valley floors or gently sloping, fine-grained alluvial plains. Plants in this series include plant species that are indicators of disturbance, Russian thistle (*Suaeda*), Saltbush (*Atriplex spp.*), and Amaranth (*Amaranthus spp.*) (Bennett et al., 1999). Vegetation cover varies from 10 to 20 percent, though disturbed communities may have almost 100 percent cover. Shrub stands are usually uniform with shrub heights of 2 to 3 feet. This series usually has low plant species diversity (Bennett et al., 1999). Figure 6a shows an example of a saltbush community.

While once widespread, this series has suffered historic losses. Disjunct patches of saltbush remain in Organ Pipe Cactus National Monument, a small linear patch on the Santa Cruz River, and several larger patches in the Tohono O'odham reservation (Figure 6).

Because of its limited patch size and historic loss, the STAT recommends 100 percent conservation of this element in reserve design. This element was mapped using Organ Pipe Cactus National Monument vegetation mapping, Santa Cruz River vegetation mapping, and GAP vegetation mapping.

Riparian Area Conservation Targets

Aquatic environments, wetlands, and riparian woodlands are considered a high priority for conservation planning, due to their supporting an extremely high number of priority vulnerable species. Primary threats to these environments include groundwater pumping, water diversion, and the establishment of non-indigenous species.

Riparian areas occur in linear patches along water courses. These areas are essential to 60 to 75 percent of Arizona residential wildlife species to sustain populations, yet only occur on 0.5 percent of the state's total land (Arizona Riparian Council, 1994). A high number of extirpated and imperiled species are associated with these habitat types (Fonseca and Regan, 2001).

Cottonwood-willow (Sonoran and Interior Southwest)/BLP Class 223.21 and 224.53

The cottonwood-willow series (includes BLP class 223.21 and 224.53) has been recommended by STAT as a constraint to be included in the reserve design. Over 90 percent of this plant community has been lost due to the lowering of the water table by groundwater pumping. This series is highly diverse and is of high value to wildlife.

This plant community consists of an overstory of Fremont Cottonwood (*Populus fremontii*) and Goodding Willow (*Salix gooddingii*) or Bonpland Willow (*Salix boplandiana*) trees. The understory varies from grasses, to shrubs, vines, and wetland plants. Several hundred species of plants can occur within this community (Wolden and Stromberg 1997 in USFWS, 2001).

The cottonwood-willow series is found within two biomes described by the Brown, Lowe and Pase classification system used for the Sonoran Desert Conservation Plan. The biomes are the Sonoran Riparian and Oasis Forest biome (224.5 in Brown et al. (1979)) and the Interior Southwest Riparian Deciduous Forest and Woodland (223.2 in Brown et al. (1979)). The biomes differ based on climate, with the former located within a subtropical climatic zone and the latter within a warm-temperate climatic zone (Brown, 1982).

This series is found along alluvial floodplains of large, low gradient perennial streams at elevations below 4500 feet (Figure 7). Cottonwood-willow patches occur as small, linear patch features because of their reliance on dependable water sources. For optimum forest development, the groundwater table is usually less than 10 feet below the floodplain surface (Stromberg, 1994).

The STAT recommends that all occurrences of cottonwood-willow forest be maintained for the SDCP. This goal is related to the importance of this community to a wide variety of species. An additional 3000 acres of cottonwood willow forest is recommended for augmentation through restoration (Fonseca and Regan, 2001). The biologically preferred alternative would manage an acreage that includes more than 6000 acres of suitable habitat. The suitability analysis is not mapped for the special elements.

This feature was mapped using a GIS coverage obtained from results of the report, *Riparian Vegetation Mapping and Classification*, Sonoran Desert Conservation Plan, Final Report (Harris et al, 2000). The maps can be viewed at http://nteim.dot1.co.pima.az.us/eim/dcp/.

Mixed broadleaf Interior Southwest or Riparian Deciduous Forest/ BLP Class 223.22

This riparian series is typically found at elevations of 4000 to 6000 feet in sheltered hydro- and mesoriparian canyons and washes where available moisture is high. Plant species diversity is very high with the most important trees being Fremont Cottonwood, Goodding Willow, Velvet Ash, Arizona Black Walnut (*Juglans major*), and Arizona Sycamore (*Plantanus wrightii*) (Bennett, et al., 1999). This series is important for wildlife. The mixed broadleaf community occurs in narrow, linear patches (Figure 8).

The STAT recommends that all occurrences of riparian vegetation be maintained for the Sonoran Desert Conservation Plan. Almost 88 percent of this series occurs in unprotected land, or GAP Status 4.

This series was mapped using the Harris riparian mapping, Saguaro National Park vegetation mapping, GAP vegetation mapping, and TNC's vegetation mapping of the San Pedro River.

Mesquite Woodland/ BLP Class 224.52

This riparian series occurs at low to middle-elevations (1500 to 4000 feet) along desert washes and intermittent streams where subsurface water is sufficient to support common overstory species such as Velvet Mesquite and Netleaf Hackberry (Bennett et al., 1999). Along perennial and intermittent streams, this type may occupy a higher elevation stream terrace, located above cottonwood-willow riparian habitats. Stands may be dominated by mesquite, or contain many other associated species, most commonly: Desert Hackberry (*Celtis pallida*), Netleaf Hackberry (*Celtis reticulata*), Mexican Elderberry (*Sambucus mexicana*), and *Acacia* species. Understory species consist of Wolfberry (*Lycium spp.*), Graythorn (*Ziziphus obtusifolia*), and other grasses and forbs. These areas form bosques, with mesquite trees forming a closed upper canopy and an open or dense understory. Mesquite bosques are found on old alluvial floodplains. Typically, bosques require groundwater no deeper than 45 feet. Mesquite bosques once lined the major watercourses of Arizona, although almost 90 percent of the bosques have been cut for firewood, charcoal, or converted to agricultural use (Bennett et al., 1999).

This element was chosen to protect a type of riparian community that has suffered disproportionate losses due to urban development and agriculture. Historic losses of mesquite woodland within Pima County have primarily occurred along the Santa Cruz and Rillito rivers. Over 2000 acres of this riparian plant community were lost due to groundwater depletion in the vicinity of San Xavier Mission alone, by 1962 (Halpenny, 1962), and as much as another 1000 acres has been degraded since then.

A review of the effectiveness of Pima County's Riparian Habitat Mitigation Ordinances (Danforth and Foseca, 2001) found that the ordinance has not been effective in preserving vegetation along Tanque Verde Creek, which is primarily mesquite bosque. In addition, the viability of mesquite bosque may be threatened by groundwater pumping along several watercourses in Pima County (PAG, 2001b); (Hill et al, 2001); (Baird et al., 2001).

A target value for restoration of 1,000 acres of mesquite woodland seems not unreasonable to offset historic and future losses. This would be in addition to mitigation efforts related to future losses that might occur under the Sonoran Desert Conservation Plan.

A reserve design preference for existing mesquite bosques that are in areas where future water needs are low might be advisable. Restoration location preferences will depend upon a wider variety of considerations. This series is restricted to the Sonoran Desert ecoregion, and occurs in linear patches along stream courses (Figure 9).

The mesquite series was mapped using the Harris riparian mapping, Saguaro National Park vegetation mapping, GAP vegetation mapping, and TNC's vegetation mapping of the San Pedro River.

Sonoran Riparian Scrub/ BLP Class 234.71 and 154.XR

This element was chosen to protect a common, biologically diverse type of riparian community, which is increasingly fragmented by development. Confined to areas with recurrent flooding, these habitats are becoming less common as riparian lands are converted to agriculture, urbanization, and mining (Bennett et al., 1999). Plants commonly found in this community include Catclaw Acacia (*Acacia greggii*), Desert Broom (*Baccharis sarothroides*), and mesquite. Shrub height averages 4 to 7 feet, with scattered plants reaching 12 feet tall. Total vegetation cover can vary from 50 to 100 percent (Bennett et al., 1999).

This element has a distribution that is limited to the Sonoran ecoregion. Within this distribution, riparian scrub consists of small, linear patches along primarily ephemeral watercourses (Figure 10). Much of this series is outside of existing reserve boundaries.

Relative to other riparian communities selected as special conservation targets, this element is more abundant. However, this element is a vital habitat constituent for many wildlife species, including a number of Sonoran Desert Conservation Plan priority species. This element was mapped based on Harris riparian vegetation mapping.

Cattail/ BLP Class 244.71

Cattail communities are typical along the shores of ponds or lakes with a stable water level at all elevations between 1,075 and 6,000 feet. Cattails are less commonly found around springs and cienegas, especially those with constant water levels. Soils are typically anaerobic or hydric.

Cattail species (*Typha latifolia or T.domingensis*) are dominant, but may be mixed with Bulrush species (*Scirpus spp.*), Reed (*Juncus spp.*), and Sedge (*Carex spp.*) species. This series generally forms closed single-layer stands of perennial plants reaching heights of 5 to 16 feet. Total vegetation cover is 30 to 100 percent (Bennett et al., 1999).

Cattails are limited to areas of permanent water and have a small distribution within Pima County. This community occurs in small, extremely localized patches at Quitobaquito and Bingham Cienega (Figure 11). STAT recommends the 100 percent inclusion of this series as a constraint in the reserve design.

Perennial/intermittent streams, Springs and Cienegas

The STAT considers aquatic environments of these types to be a high priority for conservation planning, a belief which was also expressed in discussions during expert interviews Fonseca, et al., 1999, Linwood Smith, pers. comm.). These environments are rapidly disappearing throughout the United States, including Pima County. Diversion of water

and desiccation of these environments has caused extirpation of at least five fish species in Pima County. A large number of species listed within this report either live in aquatic or riparian habitats, or utilize them in some way. Primary threats include groundwater pumping, which has reduced water tables needed to sustain these ecosystems, and the establishment of introduced species.

Because these features support a high number of species, and are relatively rare throughout the county, STAT has recommended these targets as a constraint, or 100 percent inclusion within the reserve design. These elements follow linear stream courses, or are found in small, restricted patches.

The perennial and intermittent streams element was represented using PAG's GIS coverage of springs and intermittent springs (Figure 12) (PAG, 2000). PAG's work identifies springs and streams in Pima County, based on literature search, aerial photograph interpretation, previous mapping, field notes of experts, and limited field investigations by PAG staff. The report, *Springs in Pima County*, continued this line of work, defining, discussing, and documenting springs and cienegas within Pima County (Figure 13)(Scalero and Fonseca, 2000).

Middle to High Elevation Conservation Targets

Two conservation targets are found within mid-to high elevations within Pima County: the Oak Scrub Grassland ecotone and the Douglas Fir Mixed Conifer community.

Oak Scrub-Grassland Ecotone/ BLP Class 123.31/143.1

Oak woodlands and Scrub Grasslands are recognized as plant biomes with high levels of plant diversity (McLaughlin, 1995). Plant diversity in 0.1 hectare plots in the Catalina Mountains suggest open oak woodland (n = 58) and desert grassland (n = 46) plant communities offer the highest species diversity among all upland plant communities. The ecotonal boundary between these two communities falls in between the BLP Scrub-Grasslands/Semi-desert Grassland (143.1) biome, and the Encinal Oak (123.31) series. Figure 14a shows an example of an oak scrub-grassland ecotone.

The ecotone between these plant community types usually occurs near the mountains fronts, an area of high topographic and geologic diversity (Figure 14). Ideally, this community should be conserved in large, unfragmented areas, serving to protect species diversity in the area, as well as providing a movement corridor for larger wildlife species such as bears and mountain lions.

To represent this mid-elevation diversity, this ecotonal element was created using the PAG land cover maps. A half-mile buffer was applied along the locations where oak woodland or oak savannah meets grassland or mesquite-scrub combinations. The PAG land cover was used in this element instead of the Sonoran Desert Conservation Plan's existing land cover, because to represent the PAG classification system discriminates more oak and grass-scrub

mixtures more finely than does the existing Sonoran Desert Conservation Plan's land cover map.

Douglas fir-Mixed conifer/ BLP Class 122.61

This element is found at elevations between 6,000 and 8,700 feet, but may extend lower on north facing slopes or in deep canyons. Soils are usually shallow, rocky, and either igneous or sedimentary in origin. Dominant species include Douglas fir (*Pseudotsuga menziesii*), white fir (*Abies concolor*), and any of several pine (*Pinus spp.*). Fire plays a role in maintaining typical stand structure and age classes. The presence of aspen, oaks, and manzanita are indicators of frequent fire. Mature mixed conifer forest are often dense, with high canopy coverage and a heavy litter layer which restricts growth (Brown, 1982). Figure 15a shows an example of a mixed conifer community.

This element was represented using GAP mapping as well as vegetation mapping from Saguaro National Park (Figure 15). Almost 100 percent of this community is protected within Saguaro National Park or the Coronado National Forest (Connolly et al., 1999). Seven out of a total of 1737 acres (0.4%) of Douglas fir-mixed conifer occur on unreserved land in Pima County. This element occurs as a linear patch in the Santa Catalina Mountains.

This element was selected by STAT for 100 percent inclusion within the reserve design.

Other Landscape Conservation Targets

Some communities contain "indicator species," which identify climates, soil conditions, and other factors that are favorable to listed and unlisted species in the Pima County area (Fonseca and Scalero, 1999). STAT has recommended talus slopes, caves and adits, bridges that act as bat roosts, limestone outcrops, and low elevation valley floors as conservation targets.

Talus slopes

Talus slopes are loose accumulations of rock debris, generally found in small patches at the base of steep bedrock exposures. These slopes create thermally sheltered conditions by virtue of the heating of rock masses, and the shaded, moist conditions that many species find as suitable habitat. Within many of the talus slopes in Pima County dwell talus snails, a relict population of snails. Figure 16a shows an example of a talus slope.

Over 30 species of talus snails have been identified within the Pima County area. Talus slopes have been recommended by STAT as a constraint (100 percent coverage in the reserve design) to avoid the possibility of missing a yet undiscovered talus snail species. Talus slopes are naturally patchy. Talus slopes can also provide habitat for other invertebrates and many species of rodents.

Figure 14a:
Oak scrub/grassland. Santa Rita Mountains in the distance.
BLP Class 123.31/143.1

Figure 15a:
An example of a mixed conifer community along the Catalina Highway.
BLP Class 122.61

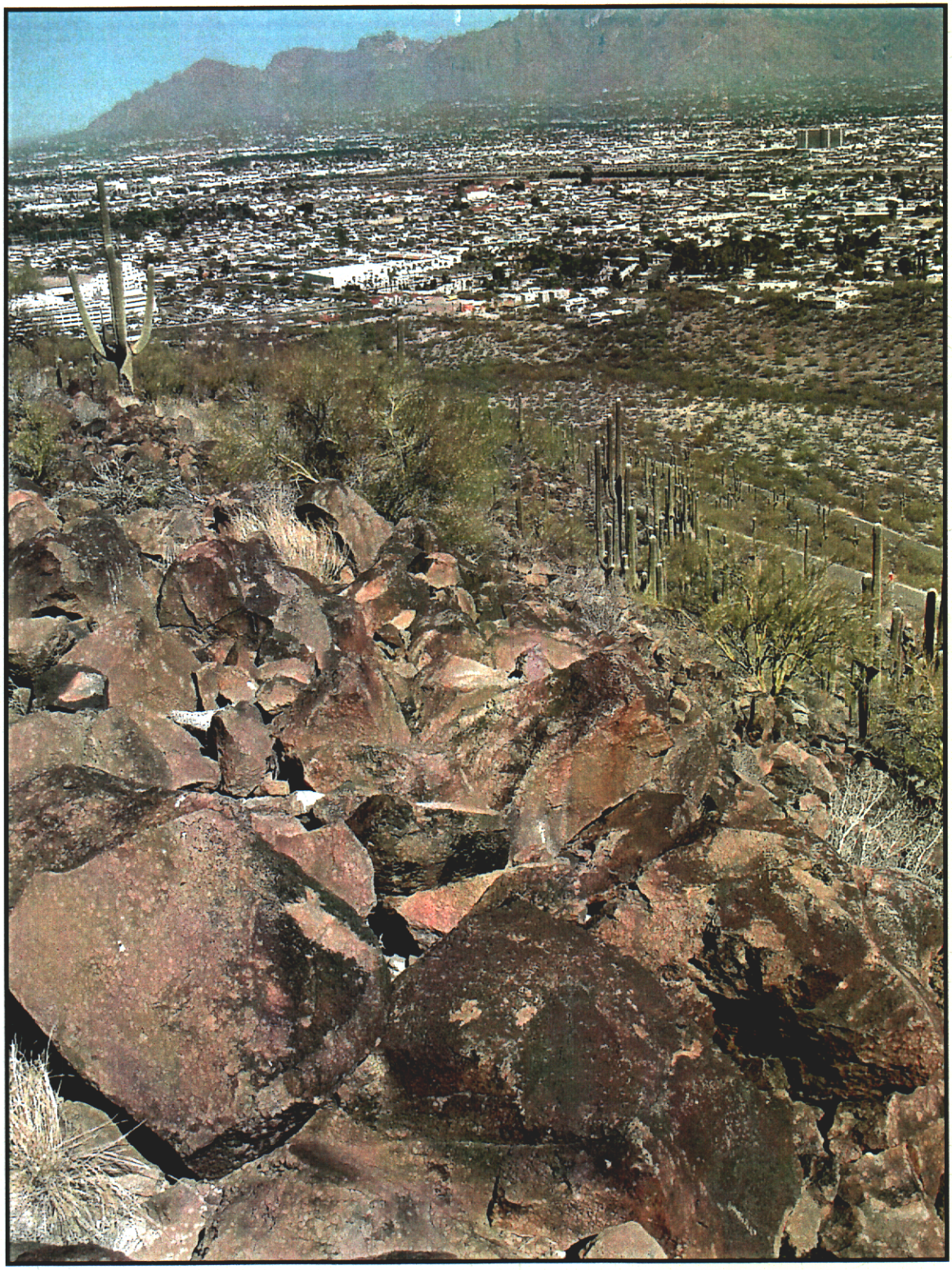


Figure 16a:
An example of a talus slope.
Tumamoc Hill, looking downslope.

Talus slopes were represented using PAG 208 mapping (Figure 16). This special element is likely to be under-represented due to the small size of this feature relative to the scale of the PAG 208 mapping. Inventory of talus slopes should occur as areas are incorporated into the SDCP conservation lands system.

Caves and Adits

Most caves found in southern Arizona occur in limestone formations. Caves are repositories of information on natural resources and human history, containing information on anthropologic, archaeologic, geologic, paleontologic, and mineralogic resources. Cave dwelling animals are often specially adapted to cave conditions and can not survive outside of that environment.

Caves provide habitat for many species of bats, as well as many other species. Because of the significance of caves, STAT has selected this element for 100 percent inclusion within the reserve design.

Abandoned adits, tunnel openings into underground mines, can be suitable for habitat for cave dwelling species of bats. Some adits may be used as maternity roosts. Adits occupied by bats have been recommended by STAT to be included as a constraint.

Caves and adits (Figure 17) were represented using cave coverages developed by Pima County by digitizing all such features identified on U. S. Geological Survey topographic quadrangles at a scale of 1:24,000. Sites known to have bats were accounted for in a separate locational analysis performed for each species as part of the habitat modeling effort (RECON, 2001a).
This special element is likely to be under-represented due to the small size of the features and because many caves and adits have yet to be studied for their bat features. Inventory of caves and adits and an assessment of their biological conservation value should occur as areas are incorporated into the SDCP conservation lands system.

Bat Bridges

There are many bridges within Pima County that provide suitable habitat for bat species. The STAT has designated these bridges as a management concern.

This element was compiled by using data gathered by Sandy Wolfe, a University of Arizona student researching bridge use by bat species. While sites in the urban area are well documented by her work, bridges in more remote areas are not. An assessment of the biological conservation value of bridges should occur as areas are incorporated into the SDCP conservation lands system.

Limestone Outcrop

Limestone outcrops of predominately Paleozoic age are recognized as a special element because they have the potential to harbor species with restricted distribution, such as cave invertebrates, bats and rare plants.

Limestone outcrops of this type are generally locally important locations of aquifer recharge due to their fractured and porous nature. Aquifers overlain with by limestone outcrops are more easily contaminated because there is no soil to attenuate pollutant loadings, and the transit time to the aquifer is short.

McAuliffe (1995) noted that the topographic diversity offered by limestone bedrock is high, and contributes to species richness. For example, soil-filled solution pockets are relatively moist environments, while unfractured bedrock presents a very xeric microenvironment. Deep fractures store moisture for woody plants with deep roots. The physical characteristics of limestone may provide thermal amelioration during episodes of extreme cold, which allows some plants and ground-dwelling insects to extend their distributional limits on limestone outcrops.

This element is distributed in small patches around the periphery of large mountain blocks (Figure 18). Losses of this special element to limestone and marble mining (Twin Peak, Santa Ritas) and to suburban development (Vail area) are ongoing.

The limestone outcrop element was represented using PAG 208 mapping and a carbonates layer developed for Pima County by the U. S. Geological Survey Mineral Resources Branch. Due to the scale of the previous mapping efforts, small outcrops of limestone may not be represented. Inventory of limestone outcrops and an assessment of their biological conservation value should occur as areas are incorporated into the SDCP conservation lands system.

Low Elevation Valley Floors

A GIS coverage of this conservation target is in development.

Conclusion

The final reserve design, known as the Conservation Land System for the Sonoran Desert Conservation Plan, was developed using the spatial distribution of vegetation communities and certain landscape features, not just information about the habitat potential for individual plants or animals. Certain plant communities and landscape features, called special elements, were used to constrain or influence the location of the exterior and interior reserve boundaries.

The existing reserve system, comprised of those areas having GAP land management status 1, 2 or 3, does a good job of representing all but the Chihuahuan mixed scrub and creosote-

tarbush plant communities. The Conservation Land System, if implemented, would improve the permanency of protection offered to these and other vegetation types.

Future changes in the protection given to native vegetation communities will not be sufficient to arrest or reverse the historic or ongoing losses in some plant communities. This is particularly true for plant communities such as sacaton and Sonoran cottonwood-willow forest, for which the Science Technical Advisory Team has adopted restoration goals. This report also recommends a goal of restoring 1000 acres of mesquite bosque, in light of historic losses of this vegetation community type along the Santa Cruz River, and ongoing losses in the Tanque Verde valley and elsewhere. This would be in additional to the mitigation efforts needed due to future losses.

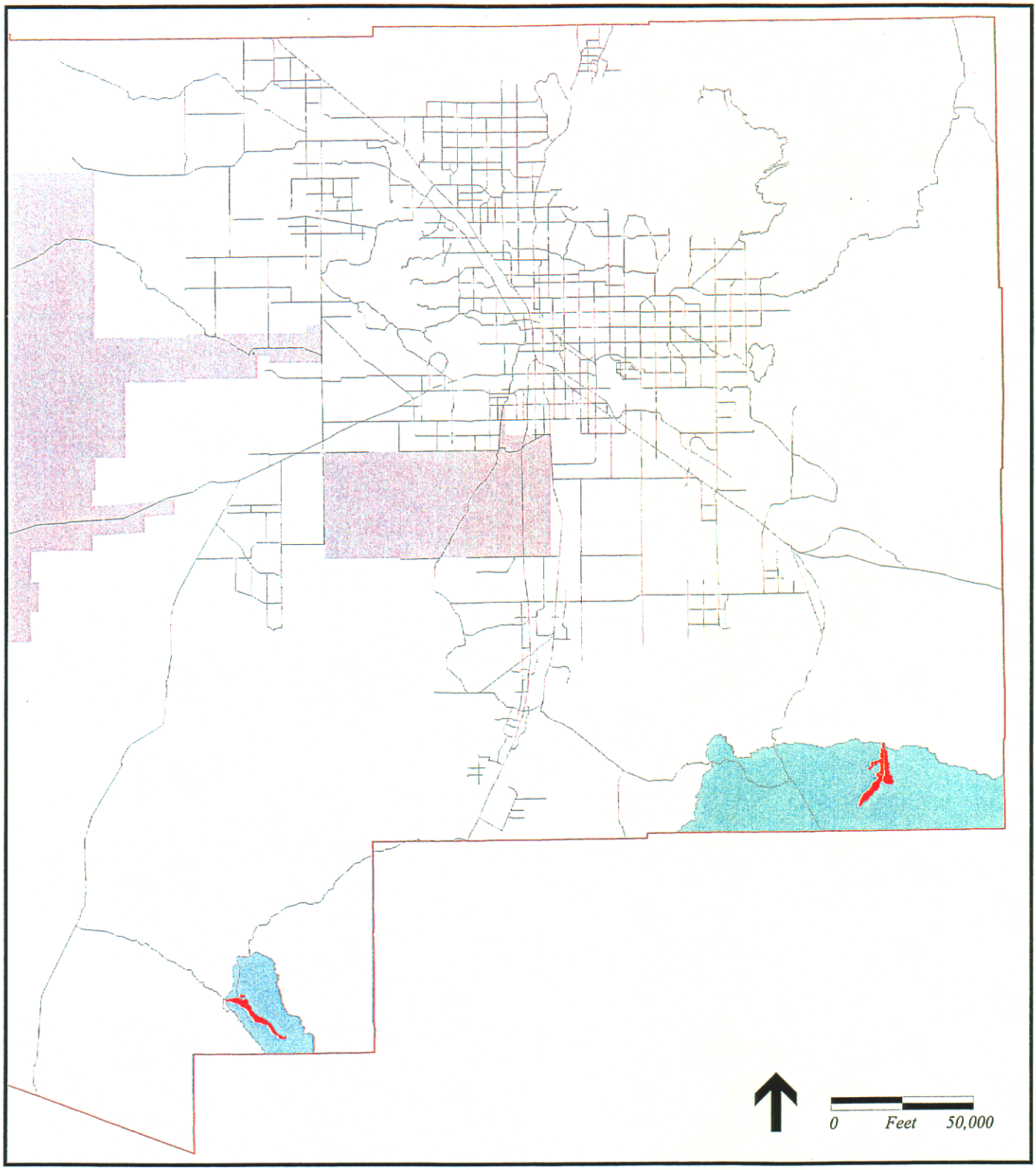
There are many ways to improve protection and management of the biodiversity represented by special elements and vegetation communities. Because many of the special elements are patchy with small distributions, detailed mapping will be useful. Some special elements, such as talus slopes, caves/adits, limestone outcrops, and tobosa grasslands, are better mapped at the site level. Implementing basic inventory throughout the conservation lands design system will help to compensate for deficiencies in the current state of knowledge.

Specific recommendations for inventories include:

- Water bodies need to be identified and classified. Field identification will be needed for the location of springs, stock tanks, and streams. Water permanence should be identified, as well as associated flora and fauna. For streams and springs, flow length and discharged should be measured.

- The distribution of vegetation communities should be mapped to the association level or better. The distribution of each unit should be mapped, as well as the condition of the special elements, such as sacaton grass and cottonwood-willow series.

- Talus slopes, caves, and limestone outcrops are small-scale landscape features whose occurrence should be inventoried as sites are added to the conservation lands system. The conservation value of adits and bridges should be evaluated at the site level as areas containing these features are added to the conservation lands system.



Unincised floodplain (constraint)
Contributing watershed (preference)

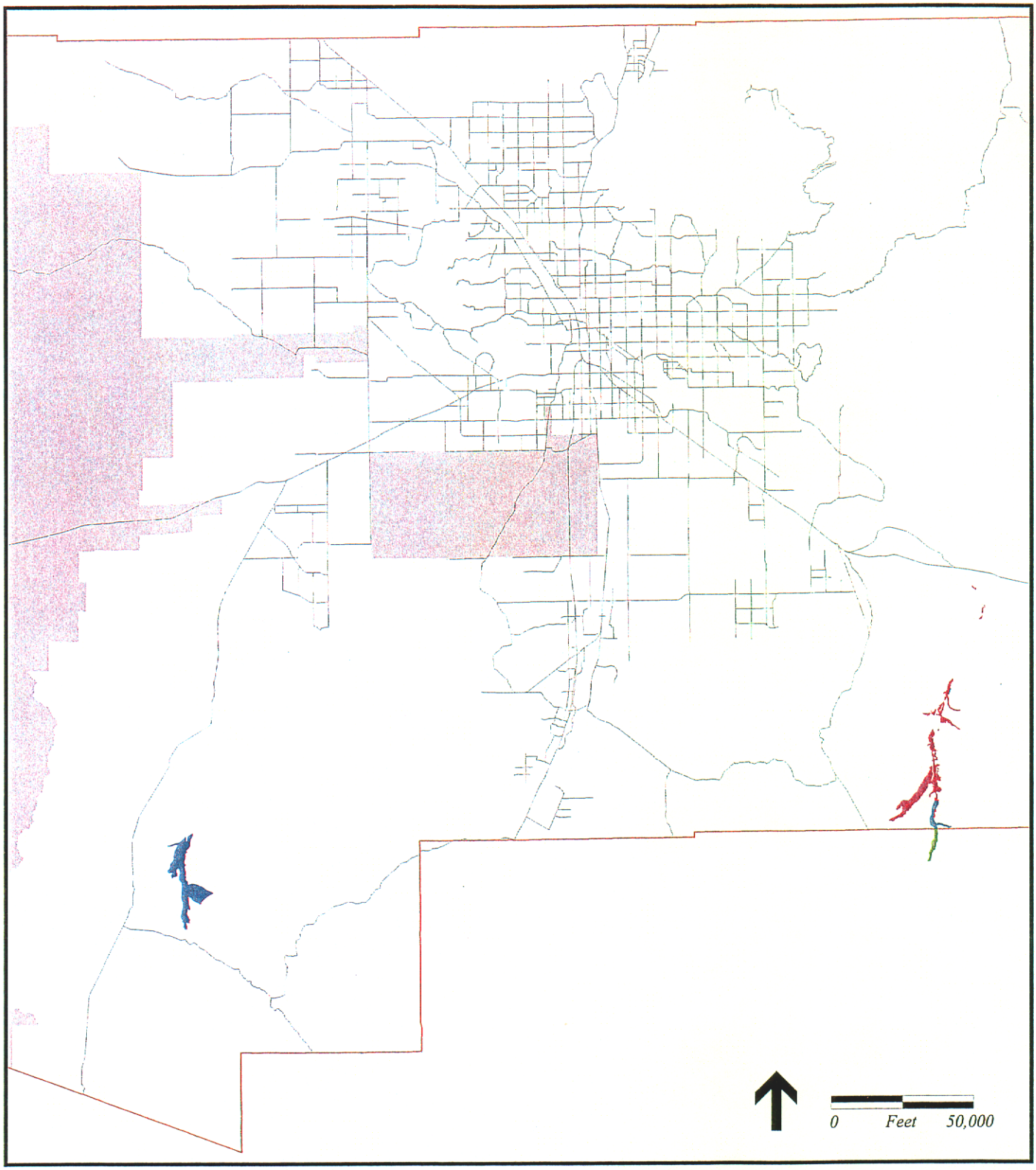
Major roads
Tohono O'Odham Nation
Pima County

Special Element (Contraint/Preference)

Unincised Floodplain with Contributing Watershed

M:\jobs\3273b\gis\aprs\special_elems_dec01.apr\floodplain 12/12/01

Figure 2



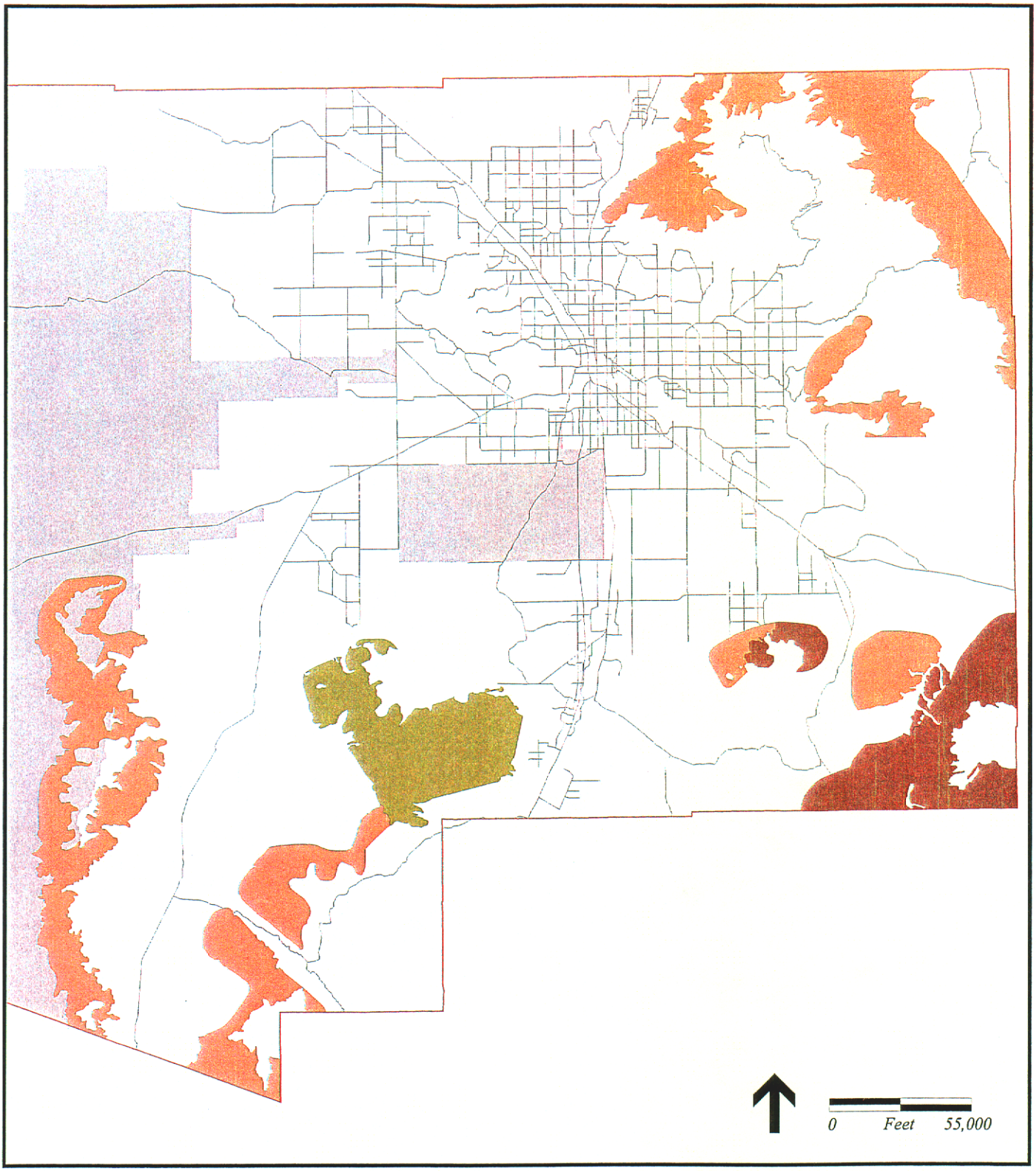
Mesquite Bosque/Sacaton Grass Communities
Sacaton Grass Communities
Sacaton Grassland
Major roads
Tohono O'Odham Nation
Pima County

Special Element (Contraint/Restore)

Sacaton

M:\jobs\3273b\gis\aprs\special_elems_dec01.apr\sacaton 12/12/01

Figure 3



Grassland - dominated by native grasses with low percentage of shrub invasion (Type A)
Grassland - dominated by scrub, needs fire, low percentage of non-native grasses (Type B)
Grassland - mixture of Type A and Type B grasslands

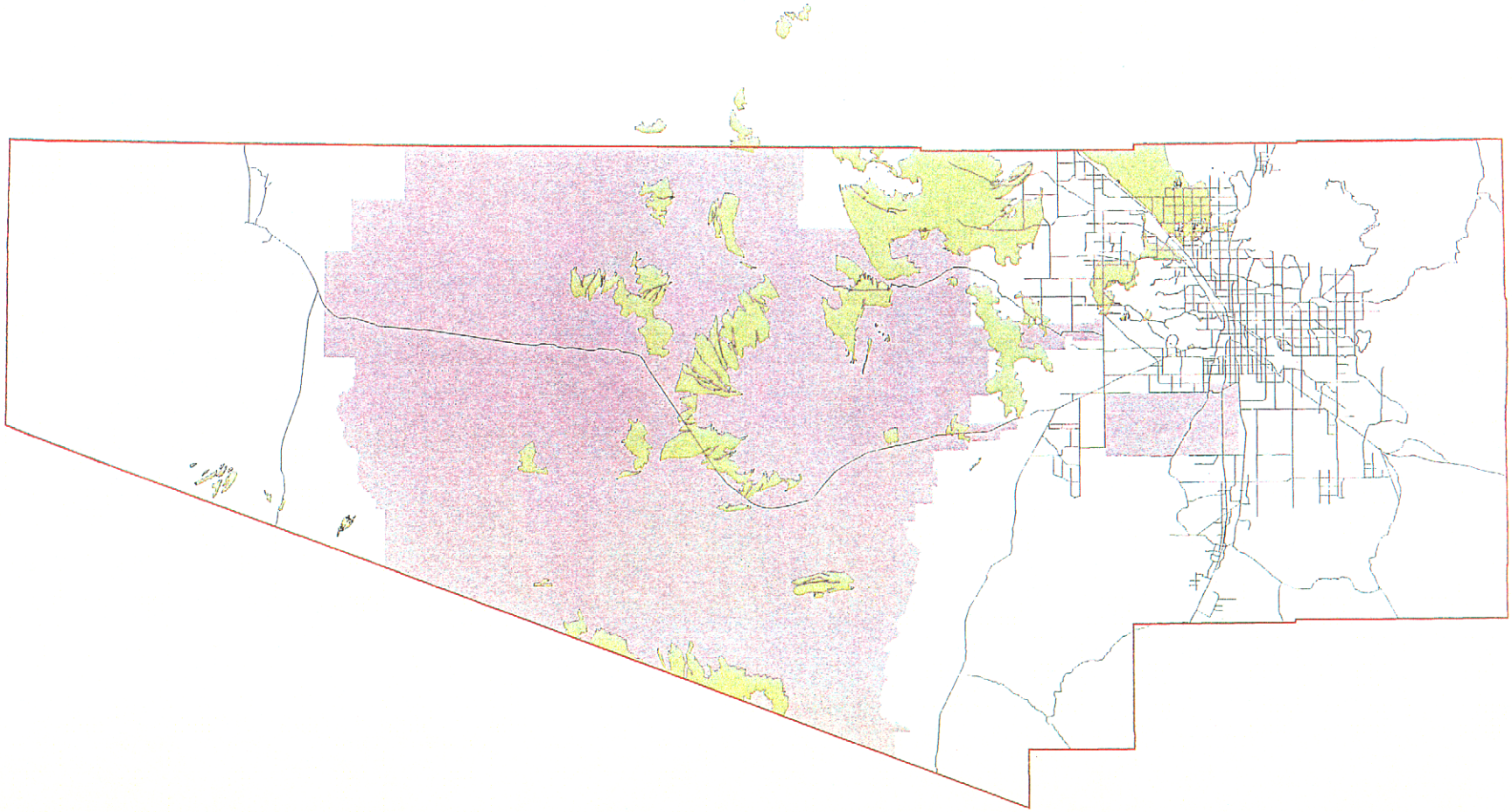
Major roads
Tohono O'Odham Nation
Pima County

Special Element (Preference)

Native Upland Grassland

M:\jobs\3273b\gis\aprs\special_elems_dec01.apr\grassland 12/12/01

Figure 4



Major roads
Tohono O'Odham Nation
Pima County
Ironwood

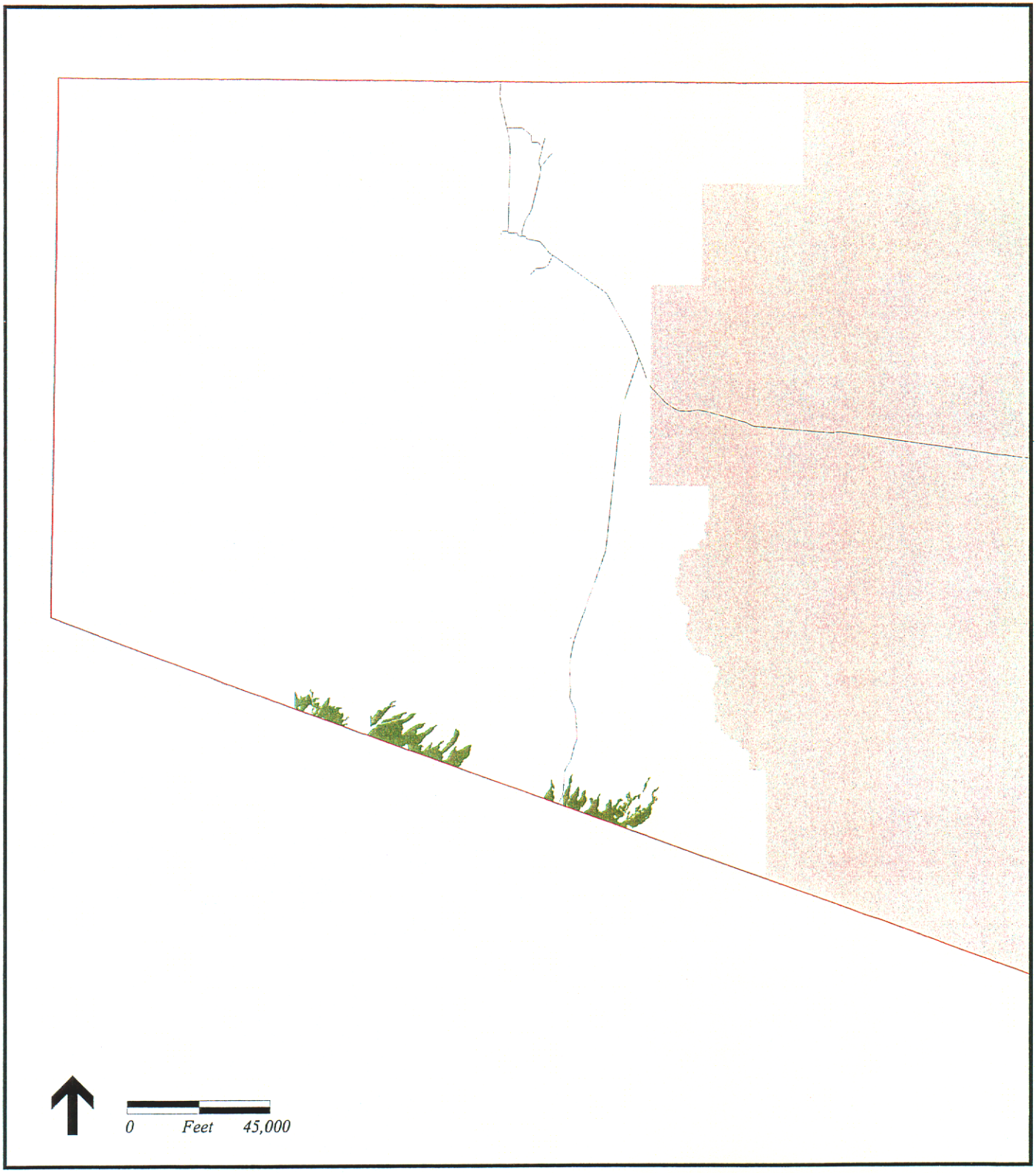
0 Feet 100,000

Special Element (Preference)

Ironwood

M:\jobs\3273b\gis\aprs\special_elems_dec01.apr\ironwood 12/12/01

Figure 5



Saltbush

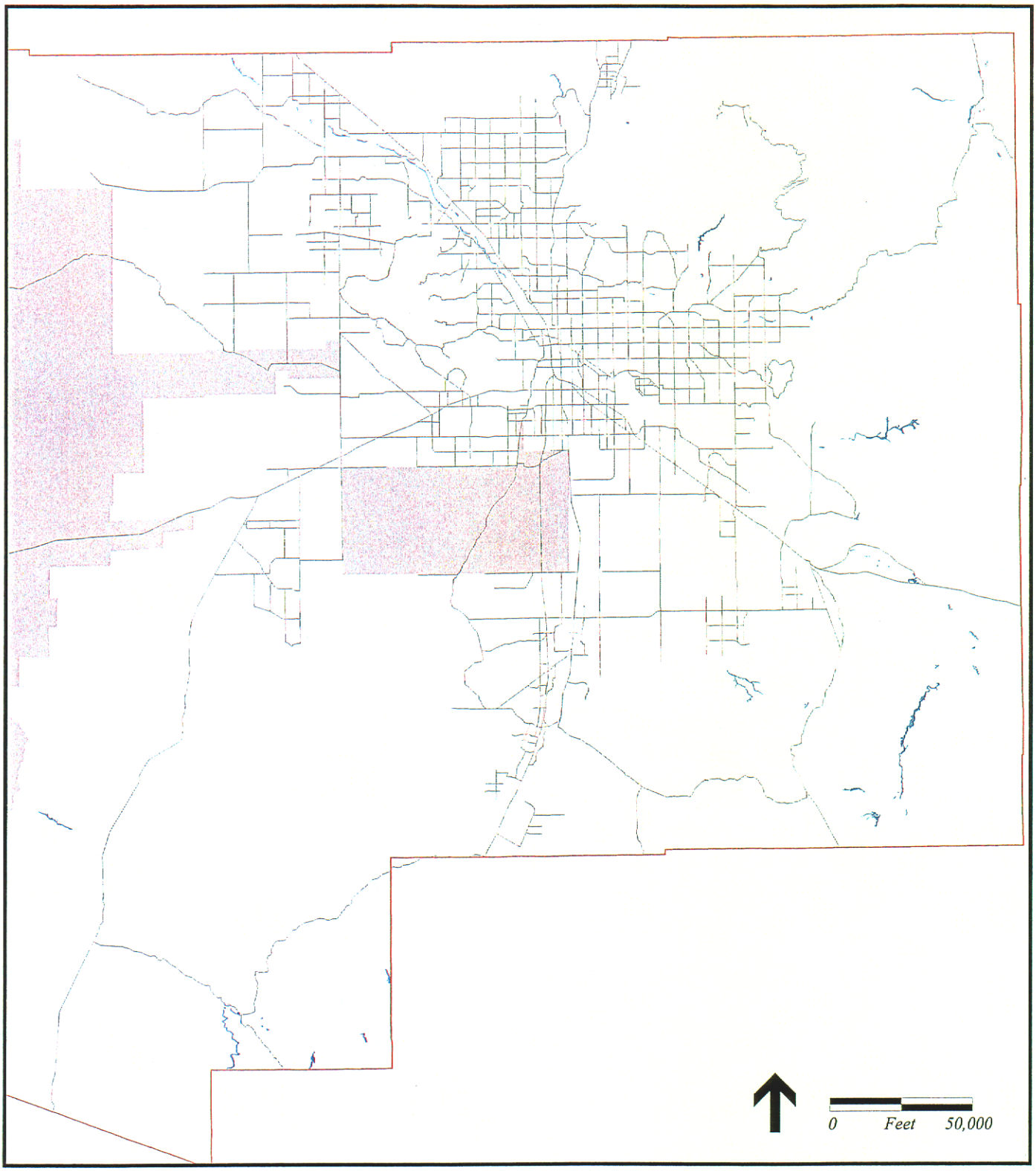
Major roads
Tohono O'Odham Nation
Pima County

Special Element (Preference)

Saltbush

M:\jobs\3273b\gis\aprs\special_elems_dec01.apr\saltbush 12/12/01

Figure 6



Sonoran cottonwood-willow

Major roads

Tohono O'Odham Nation

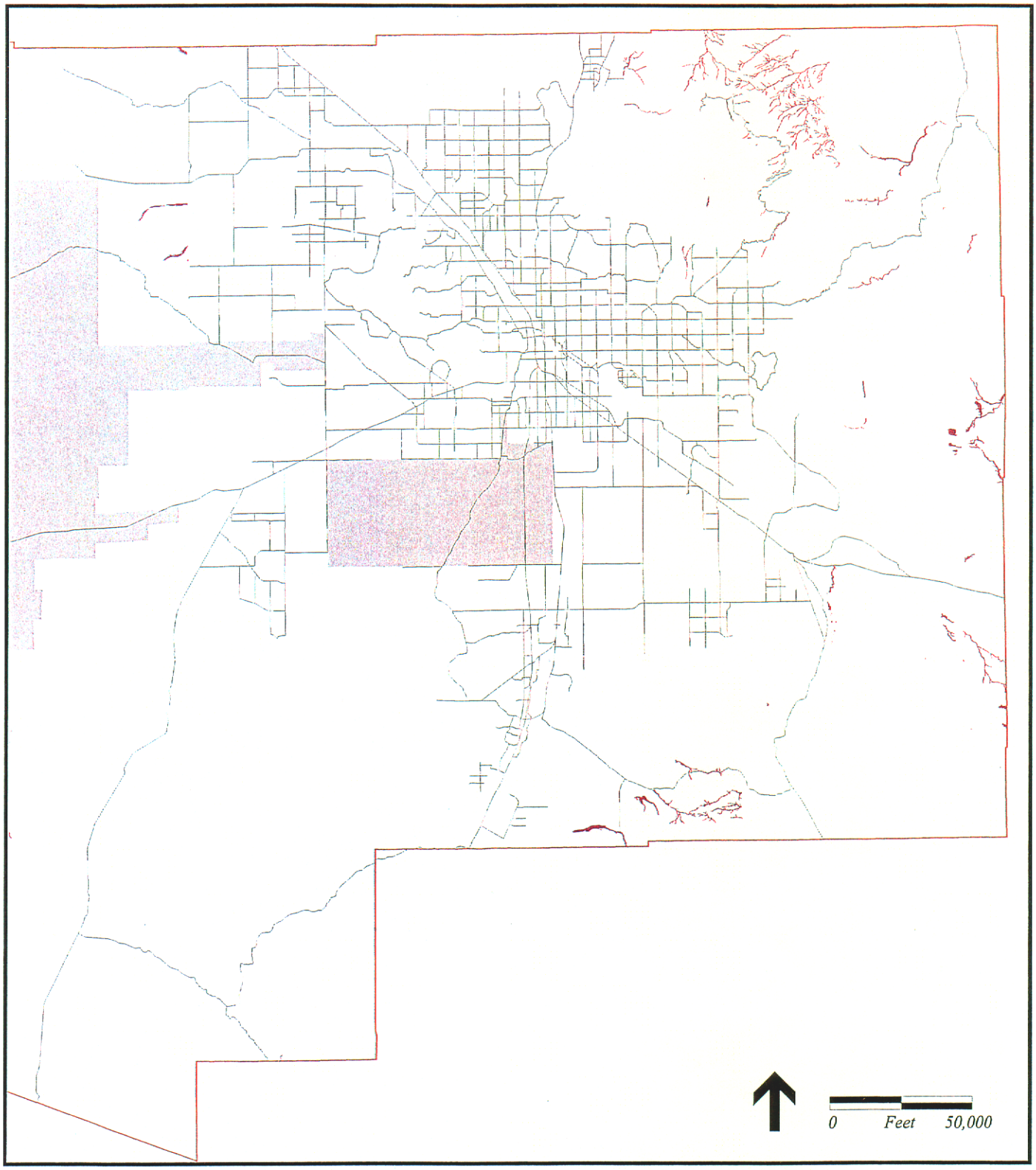
Pima County

Special Element (Constraint/Restore)

Sonoran Cottonwood-Willow

M:\jobs\3273b\gis\aprs\special_elems_dec01.apr\son cot-wil 12/12/01

Figure 7



Interior SW riparian deciduous forest

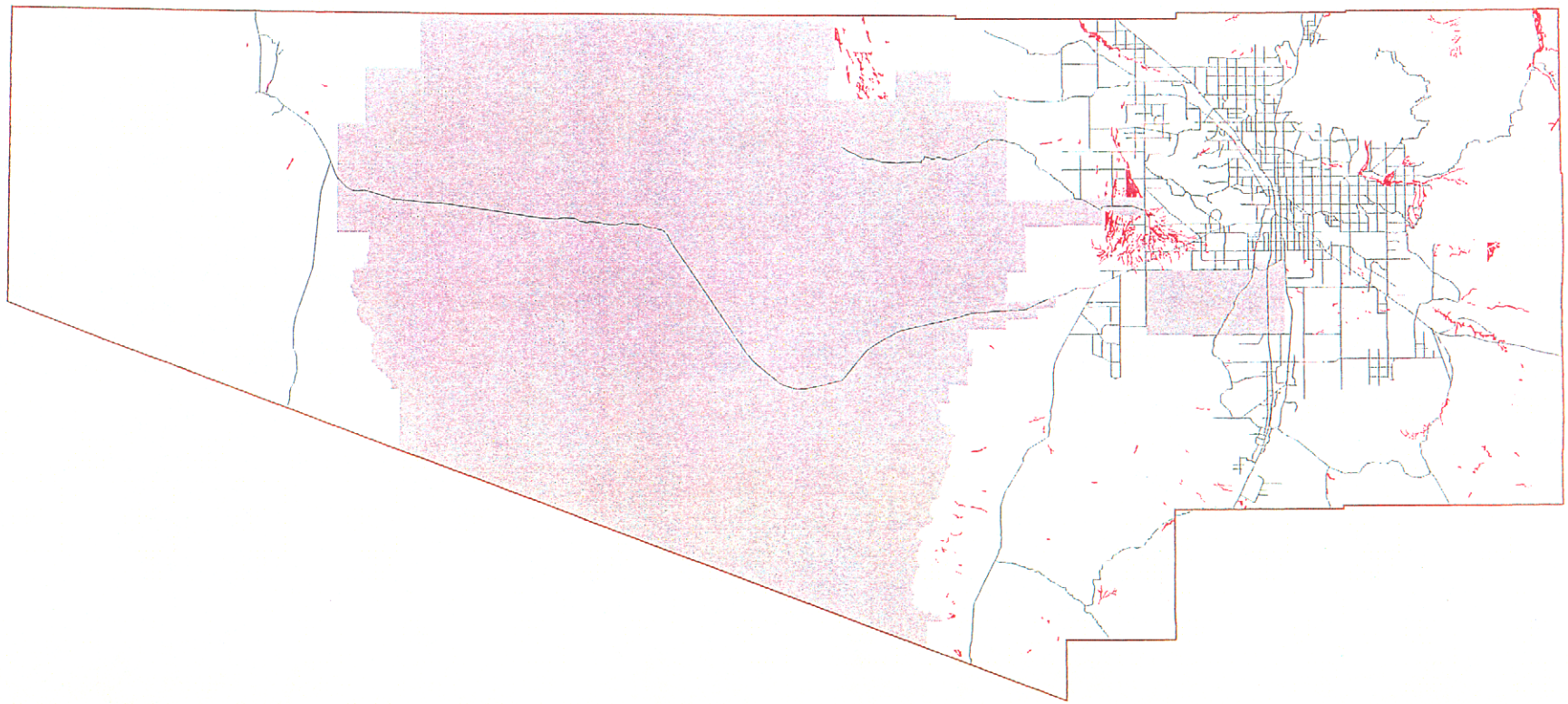
Major roads
Tohono O'Odham Nation
Pima County

Special Element (Constraint)

Int. SW Riparian Deciduous Forest

M:\jobs\3273b\gis\aprs\special_elems_dec01.apr\intsw rip forest 12/12/01

Figure 8



Major roads
Tohono O'Odham Nation
Pima County

Mesquite

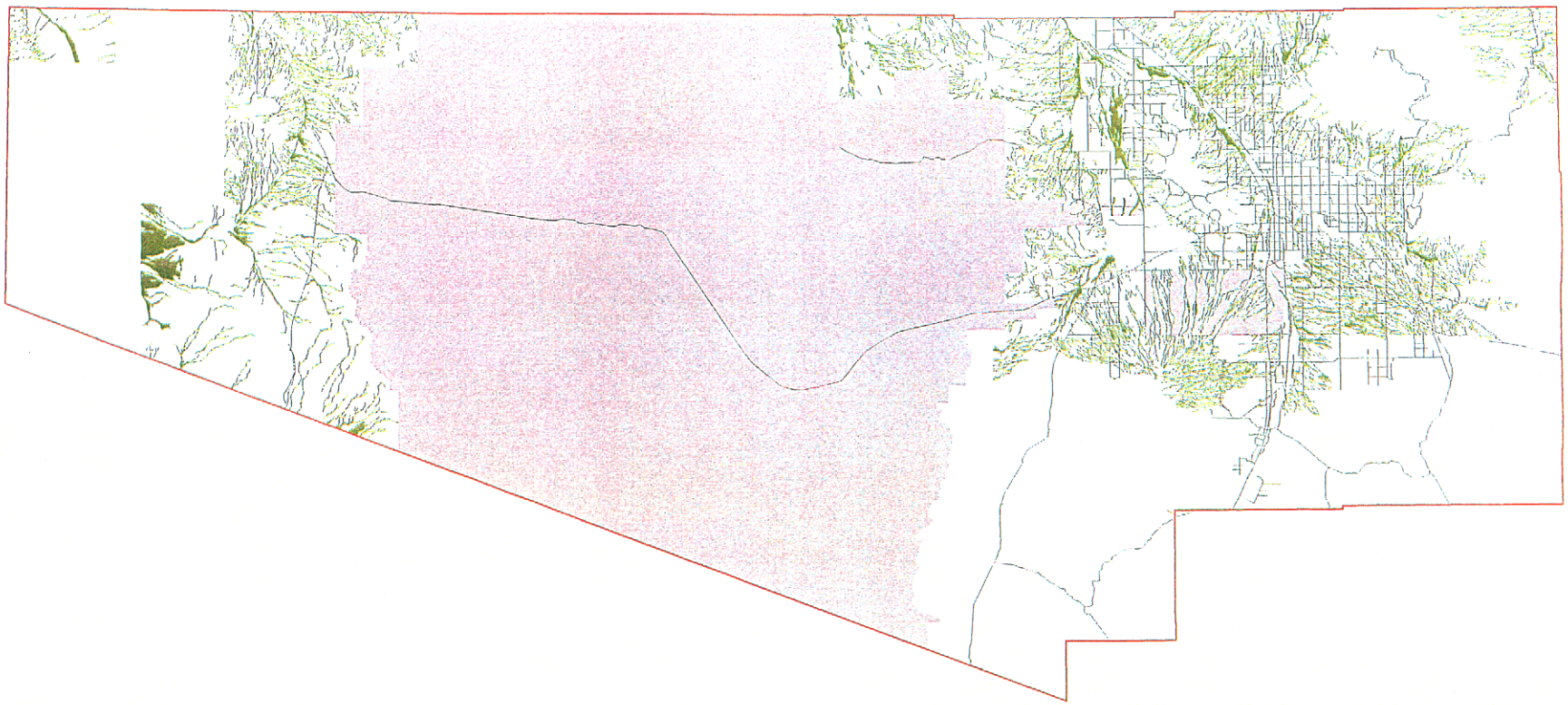
0 Feet 100,000

Special Element (Constraint/Restore)

Mesquite

M:\jobs\3273b\gis\aprs\special_elems_dec01.apr\mesquite 12/12/01

Figure 9



Major roads
Tohono O'Odham Nation
Pima County
Sonoran riparian scrub

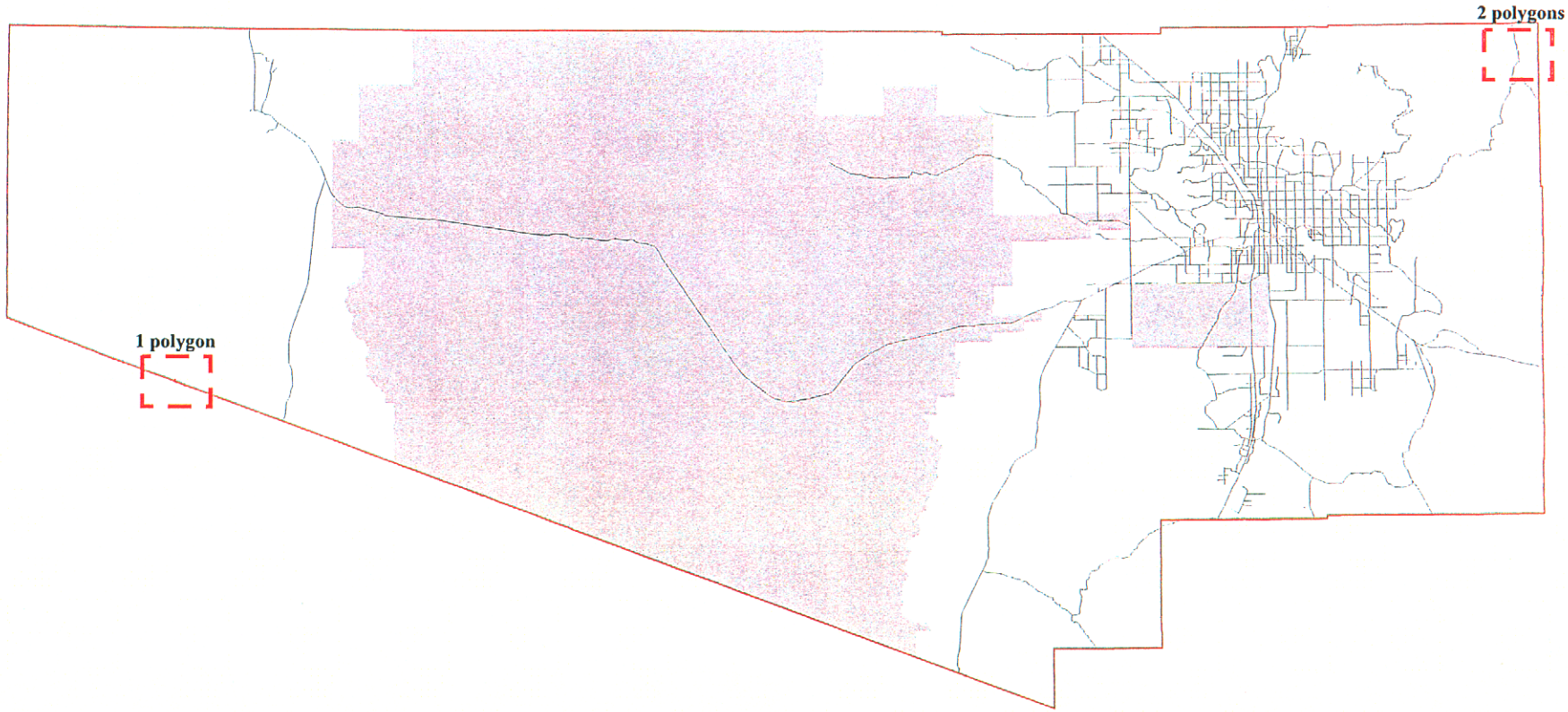
0 Feet 100,000

Special Element (Constraint)

Sonoran Riparian Scrub

M:\jobs\3273b\gis\aprs\special_elems_dec01.apr\son rip scrub 12/12/01

Figure 10



Major roads
Tohono O'Odham Nation
Pima County

Cattail

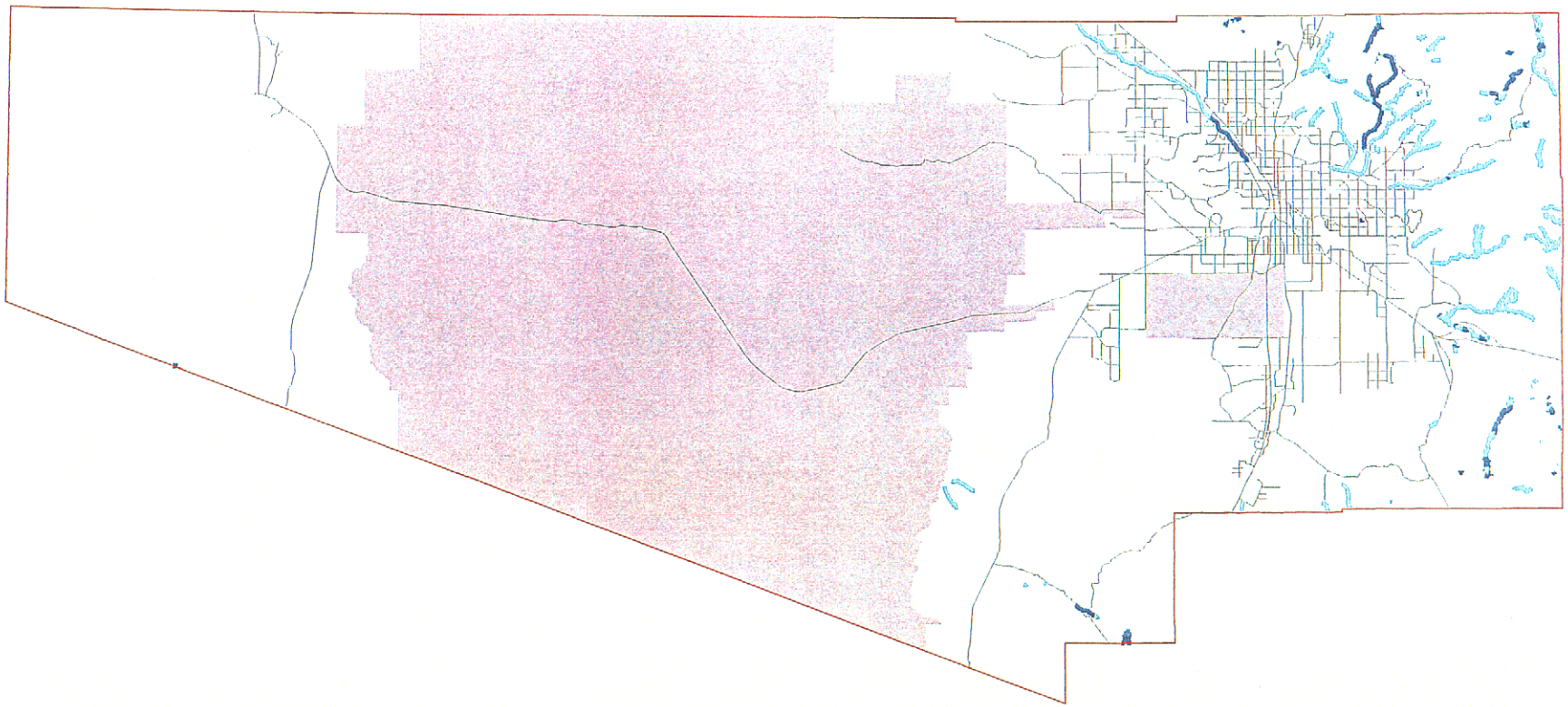
0 Feet 100,000

Special Element (Constraint)

Cattail

M:\jobs\3273b\gis\aprs\special_elems_dec01.apr\cattail 12/12/01

Figure 11



Major roads
Tohono O'Odham Nation
Pima County

Perennial stream (constraint)
Intermittent stream (constraint)

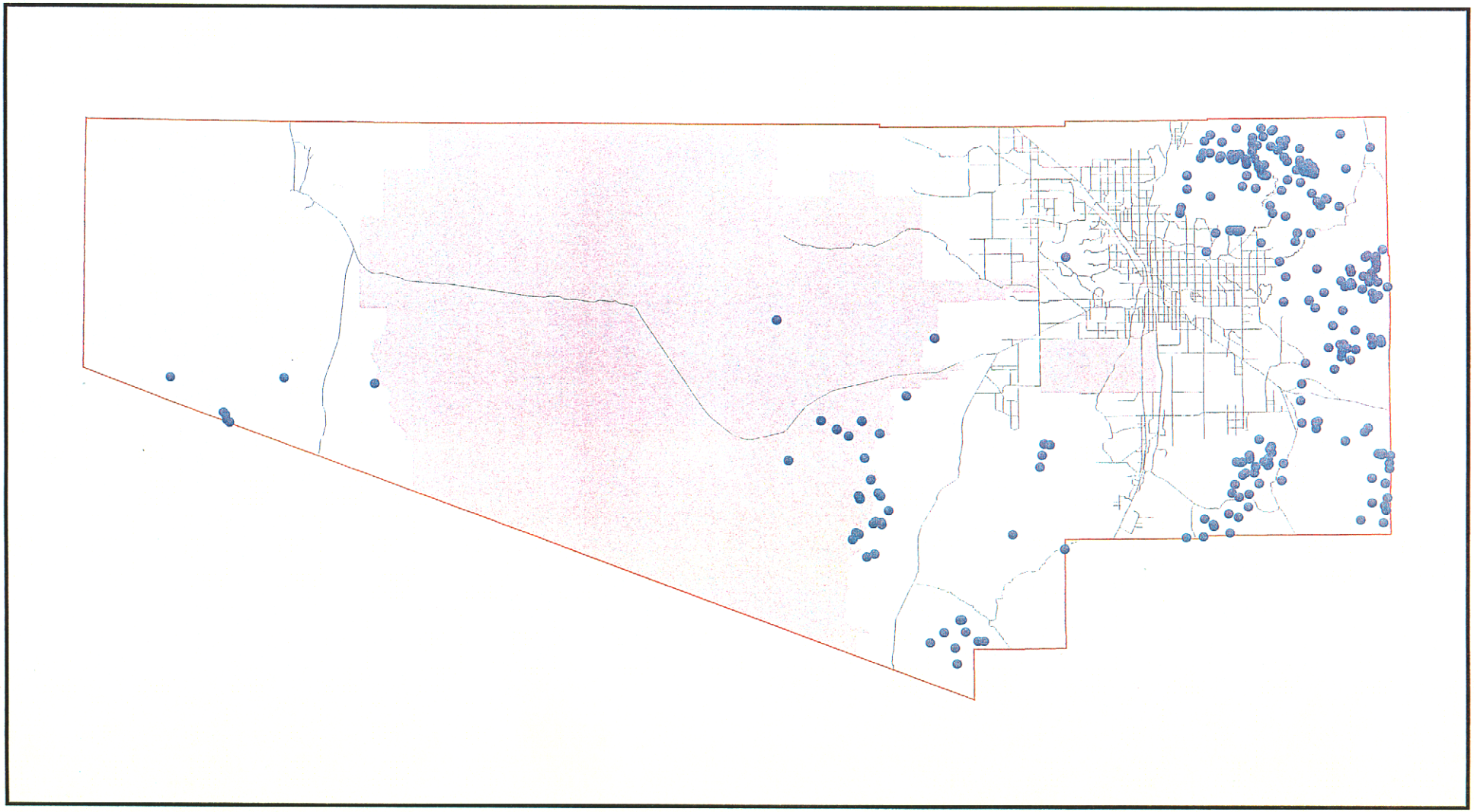
0 Feet 100,000

Special Element (Constraint)

Streams

M:\jobs\3273b\gis\aprs\special_elems_dec01.apr\streams 12/12/01

Figure 12



Major roads
Tohono O'Odham Nation
Pima County

Springs

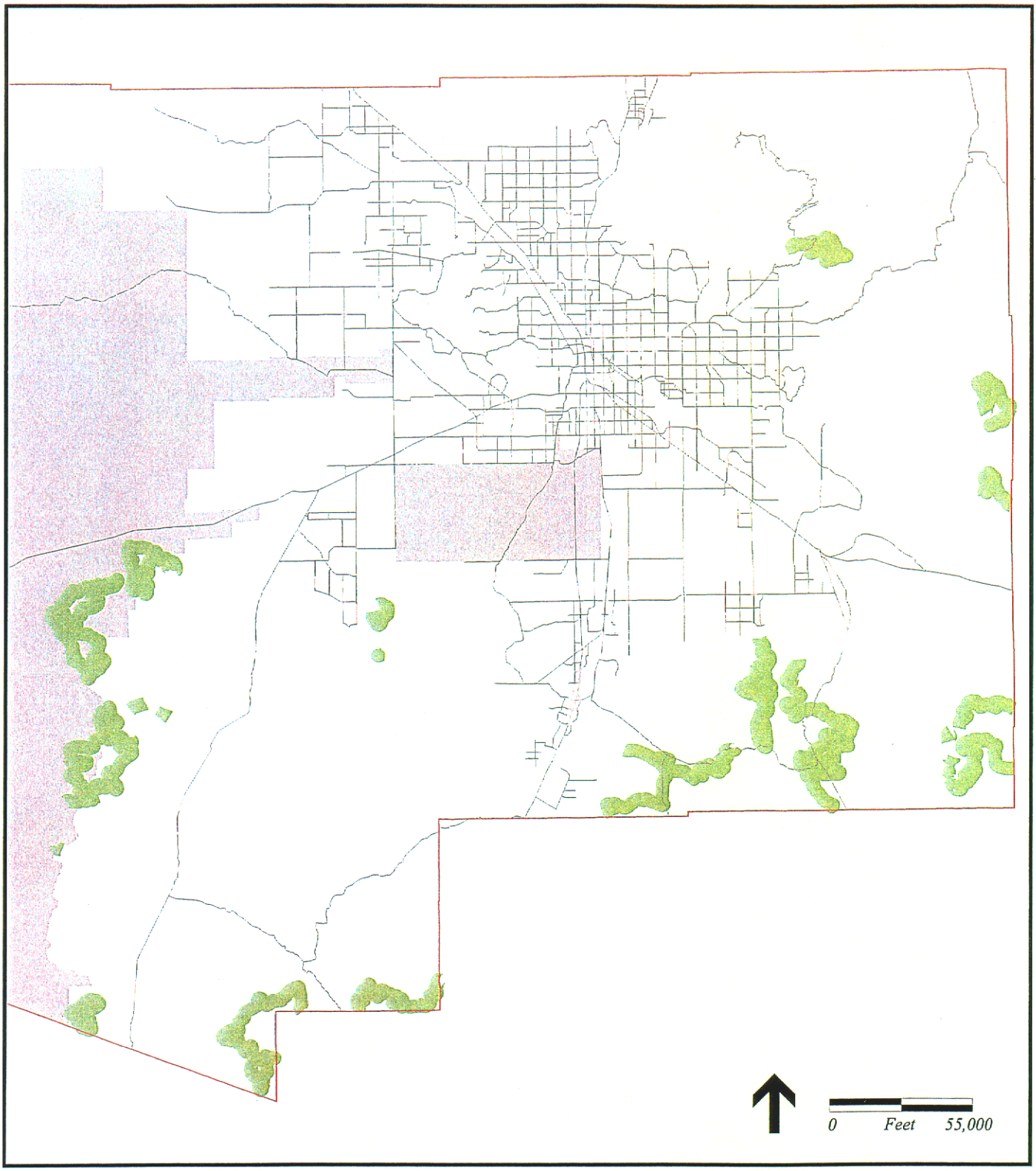
0 Feet 100,000

Special Element (Constraint)

Springs

M:\jobs\3273b\gis\aprs\special_elems_dec01.apr\springs 12/12/01

Figure 13



Oak/oak savanna with desert grassland

Major roads

Tohono O'Odham Nation

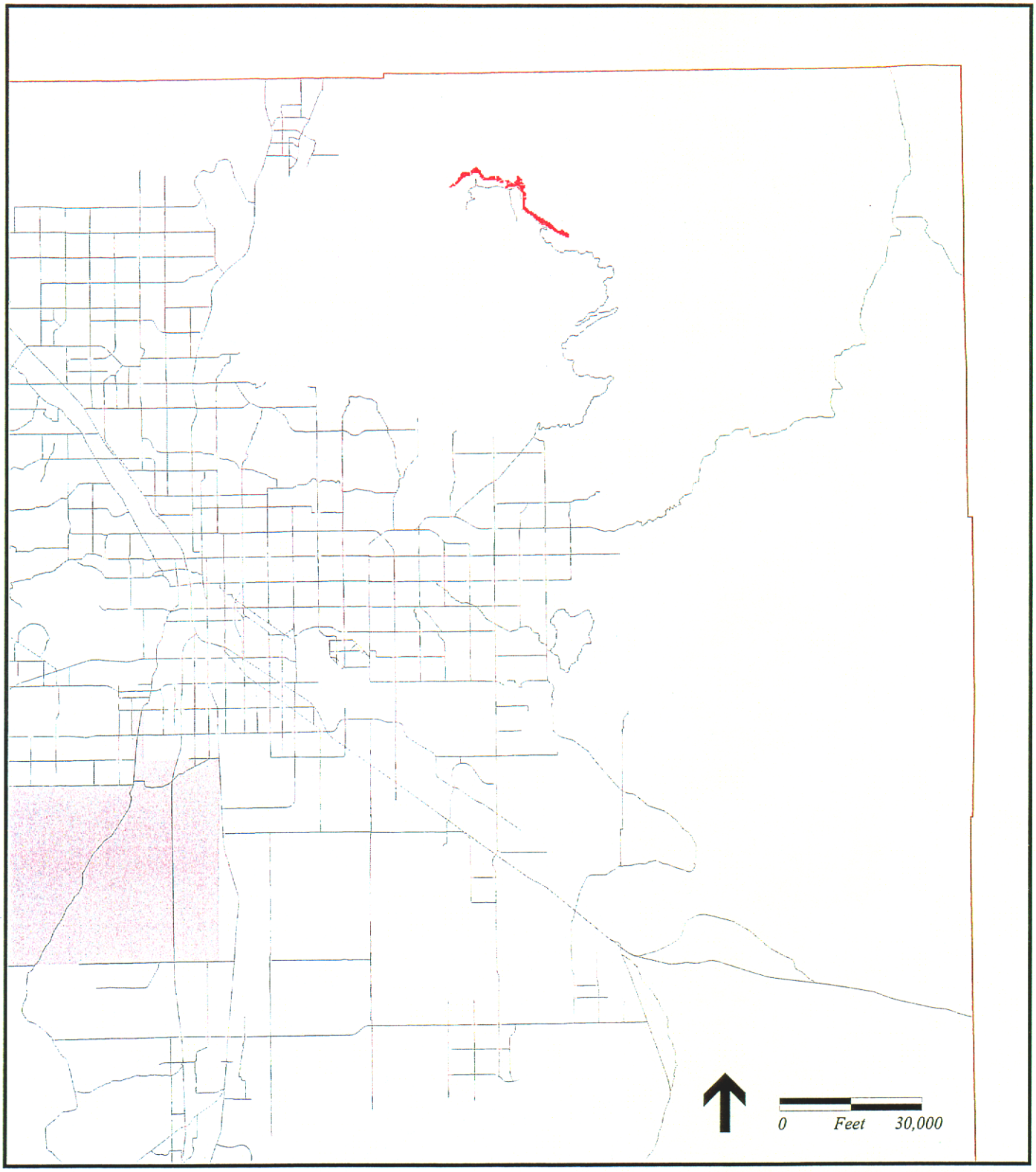
Pima County

Special Element (Preference)

Oak/Oak Savanna with Desert Grassland

M:\jobs\3273b\gis\aprs\special_elems_dec01.apr\oak_grass 12/12/01

Figure 14



Mixed conifer

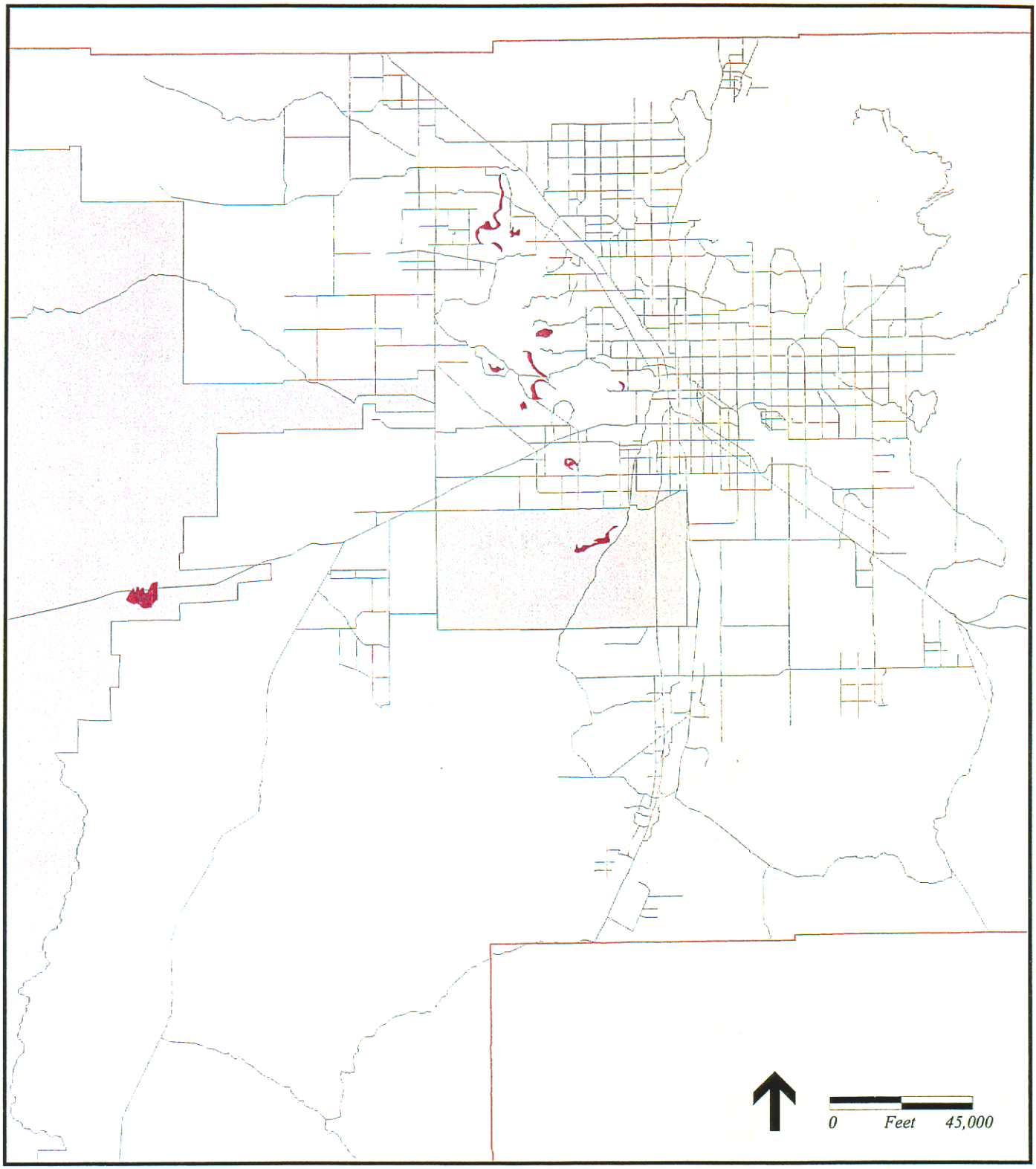
Major roads
Tohono O'Odham Nation
Pima County

Special Element (Constraint)

Mixed Conifer

M:\jobs\3273b\gis\aprs\special_elems_dec01.apr\conifer 12/12/01

Figure 15



Talus slopes

Major roads

Tohono O'Odham Nation

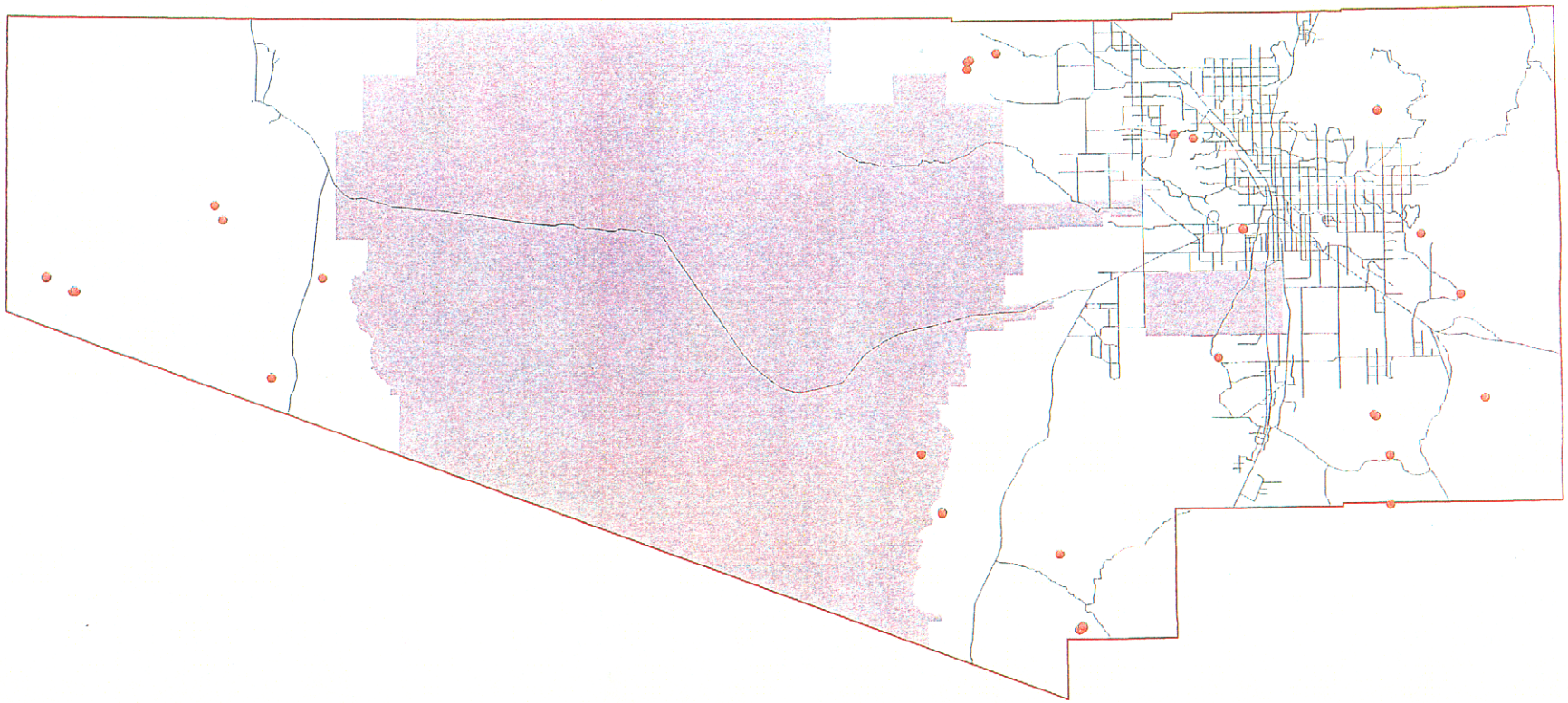
Pima County

Special Element (Constraint)

Talus Slopes

M:\jobs\3273b\gis\aprs\special_elems_dec01.apr\talus 12/12/01

Figure 16



Major roads
Tohono O'Odham Nation
Pima County

Occupied Caves and Adits

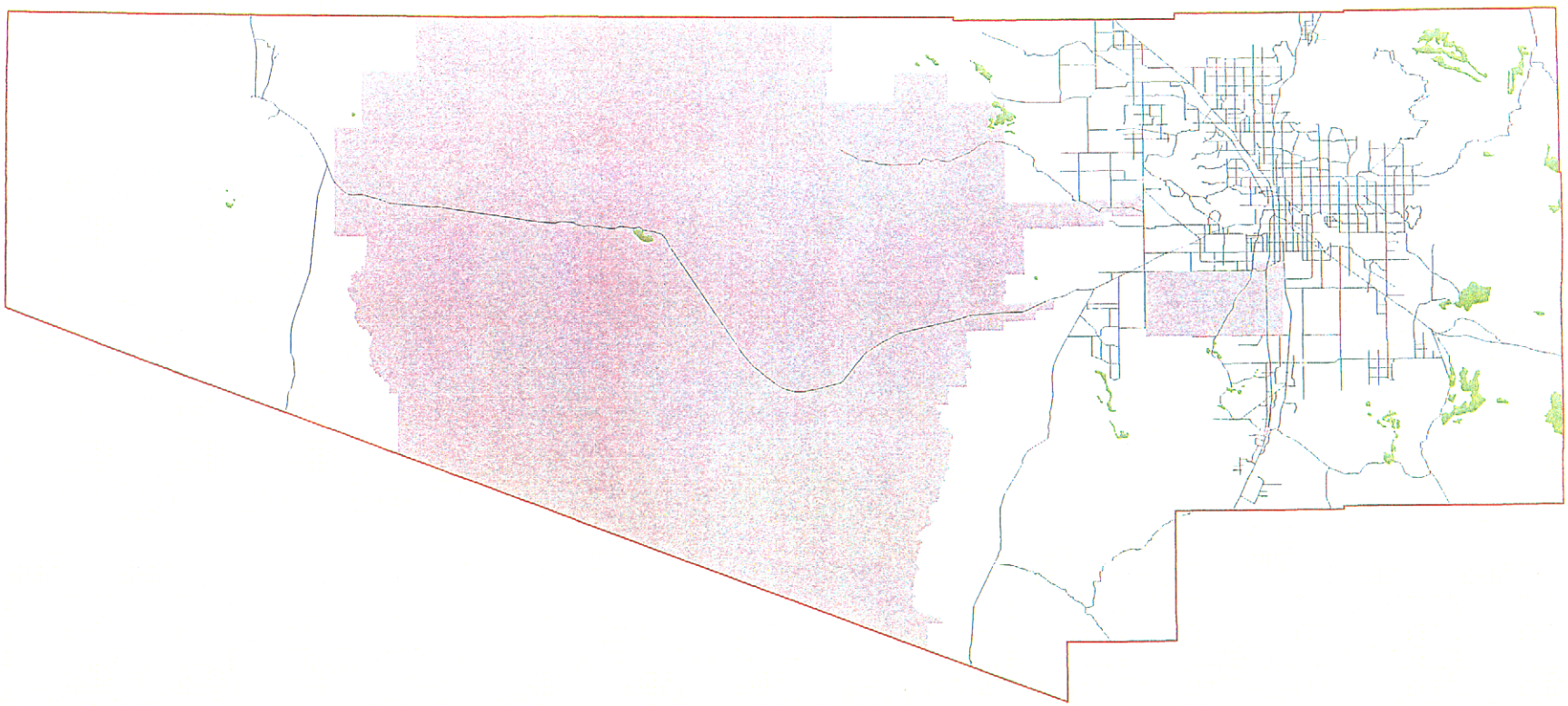
0 Feet 100,000

Special Element (Constraint)

Occupied Caves and Adits

M:\jobs\3273b\gis\aprs\special_elems_dec01.apr\bat caves 12/12/01

Figure 17



Major roads
Tohono O'Odham Nation
Pima County

Limestone

0 Feet 100,000

Special Element (Preference)

Limestone Outcrop

M:\jobs\3273b\gis\aprs\special_elems_dec01.apr\limestone 12/12/01

Figure 18

Bibliography

Anderson, M., P. Comer, D. Grossman, C. Groves, K. Poiani, M. Reed, R. Schneider, B. Vickery, and A. Weakley. 1999. Guidelines for Representing Ecological Communities in Ecoregional Conservation Plans. The Nature Conservancy, Arlington, VA. 74 pp.

Arizona Riparian Council. 1994. Arizona Riparian Council Factsheet: Riparian.

Arizona Sonoran Desert Museum. 1998. *Sonoran Desert Natural History Information.* Website http://www.dessertmuseum.org/sonora.html > May 8, 2001.

Baird, Kathryn, R. MacNish, and D.P. Guertin. 2001. An Evaluation of Hydrologic and Riparian Resources in Saguaro National Park, Tucson, Arizona. Department of Hydrology and Water Resources, University of Arizona.

Balling, R.C., Jr., J.M. Klopatek, M.L. Hildebrandt, C.K. Moritz, and C.J. Watts. 1998. Impacts or land degradation of historical temperature records from the Sonoran Desert. Climatic Change 40: 669-681.

Bennett, P.S., M.R. Kunzmann, and L.A. Graham. 1999. Descriptions of Arizona Vegetation Represented on the GAP Vegetation Map. Biological Resources Division, U.S. Geological Survey.

Brown, David E. Editor. 1982. *Biotic Communities of the American Southwest-United States and Mexico.* Desert Plants. Volume 4, Numbers 1-4. Published by the University of Arizona, for the Boyce Thompson Southwestern Arboretum.

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

Crist, Patrick J. and Blair Csuti. 1997. Gap Analysis: The assessment of the representation of biotic elements relative to land stewardship. Idaho Cooperative Fish and Wildlife Research Unit: Moscow, Idaho. http://www.gap.uidaho.edu/GAP/Handbook/SMC.htm

Connolly, Neva, Julia Fonseca, and John Regan. 1999. *Land Stewardship in Pima County.* Prepared for the Sonoran Desert Conservation Plan.

Danforth, C., and Julia Fonseca. 2001. Pima County's Riparian Habitat Mitigation Ordinance Effectiveness Review. Prepared for the Sonoran Desert Conservation Plan. Pima County Board of Supervisor's, Tucson, Arizona.

Esser, Lora L. 1995. *Sporobolus wrightii.* In U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (2001, July). Fire Effects Information System, [Online]. Available: http://www.fs.fed.us/database/feis/ August 28, 2001].

Fonseca, Julia and David Scalero. 1999. Determining Vulnerable Species Within Pima County, Arizona. A discussion paper for the Sonoran Desert Conservation Plan.

Fonseca, Julia and John Regan. 2001. Suitability Analysis and Representation Goals for Cottonwood-Willow Forest Habitat. Prepared for the Sonoran Desert Conservation Plan.

Gori, Dave, Jeffrey Cooper, Ed Wilk. 1997. "What is the Most Effective Technique for Restorating Sacaton (*Sporobolus wrightii*) at Patagonia-Sonoita Creek Preserve?" The Nature Conservancy.

Halpenny, L.C. 1962. Groundwater Resources within the San Xavier Indian Reservation and Proposals Relating to Leases for Development of Ground Water. Prepared for City of Tucson. Water Development Corporation.

Harris, L.K., J. Wennerlund and R. Duncan. 2000. Riparian Vegetation Mpapping and Classsification, Sonoran Desert Conservaiton Plan, Final Report. Prepared for Pma County, Tucson, AZ. Contract #07-30-h-127196-0100. 56pp.

Haufler, Jonathan B. "Chapter 2: Strategies for Conserving Terrestrial Biological Diversity." In Baydeck, Richard, Henry Campa III, and Jonathan B Haufler, et al. 1999. Practical Approaches to Conservation of Biological Diversity. Island Press: Washington, D.C.

Hill, Elizabeth, J. Fonseca, and S. Schorr. 2001. Groundwater Level Changes in the Tanque Verde Valley. Prepared for the Sonoran Desert Conservation Plan. Pima County Board of Supervisors, Tucson, Arizona.

Marshall, R.M., S. Anderson, M Barcher, P. Comer, S. Cornelius, R. Cox, A. Gondor, D. Gori, J. Humke, R. Paredes Aguilar, I.E. Parra, S. Schwartz. 2000. *An Ecological Analysis of Conservation Priorities in the Sonoran Desert Ecoregion.* Prepared by the Nature Conservancy Arizona Chapter, Sonoran Institute, and Instituto del Medio Ambiente y el Desarrollo Sustenable del Estado de Sonora with support from Department of Defense Legacy Program, Agency and Institutional Partners. 146 pp.

McAuliffe, J. R. and T. L. Burgess, 1995. Landscape complexity, soil development and vegetational diversity within a Sky Island piedmont. In DeBano, L. F., et al., editors. Biodiversity and Management of the Madrean Archipelago: The Sky Islands of Southwestern United States and Northwestern Mexico. U. S. D. A. Forest Service General Technical Report RM-GTR-264.

McLaughlin, Pima County Flood Control District., 1995. An overview of the flora of the Sky Islands, Southeastern Arizona: diversity, affinities and insularity. In DeBano, L. F., et al., editors. Biodiversity and Management of the Madrean Archipelago: The Sky Islands of Southwestern United States and Northwestern Mexico. U. S. D. A. Forest Service General Technical Report RM-GTR-264.

Noss, Reed and Allen Cooperrider. 1994. Saving Nature's Legacy. Protecting and Restoring Biodiversity. Island Press.

Pima Association of Governments (PAG). 2000. GIS Coverage of Perennial Streams in Pima County, Arizona. Prepared for the Sonoran Desert Conservation Plan.

PAG. 2000b. Water Usage Along Selected Streams in Pima County. Prepared for the Sonoran Desert Conservation Plan. Pima County Board of Supervisors, Tucson, Arizona.

Pima County. 2000. The Preliminary Sonoran Desert Conservation Plan. Pima County Administrator's Office. Tucson, AZ.

RECON. 2001. Reserve Design Process Update. Prepared for the Sonoran Desert Conservation Plan.

RECON. 2001a. Priority Vulnerable Species. Prepared for the Sonoran Desert Conservation Plan.

Scalero, David and J. Fonseca. 2000. Prioritization of Streams for Conservation in Pima County. Prepared for the Sonoran Desert Conservation Plan.

Scalero, David, Julia Fonseca, and Donald Ward. 2001. Climate Variability in Pima County and its Significance to the Sonoran Desert Conservation Plan. Prepared for the Sonoran Desert Conservation Plan.

Science and Technical Advisory Team. January 2001. STAT subcommittee review of the "Special Element" Conservation Targets. Included in the February 2001 STAT packet.

STAT subcommittee notes, January 25, 2001.

Scott, Micheal J. and Micheal D. Jennings. 1997. A description of the national gap analysis program. Biological Resources Division, U.S. Geological Survey: Moscow, Idaho. http://www.gap.uidaho.edu/gap

Stromberg, J. 1994. Ecosystem Profile: Fremont Cottonwood-Goodding Willow Forest, Part 1. Arizona Riparian Council Newsletter 7 (1):4-5.

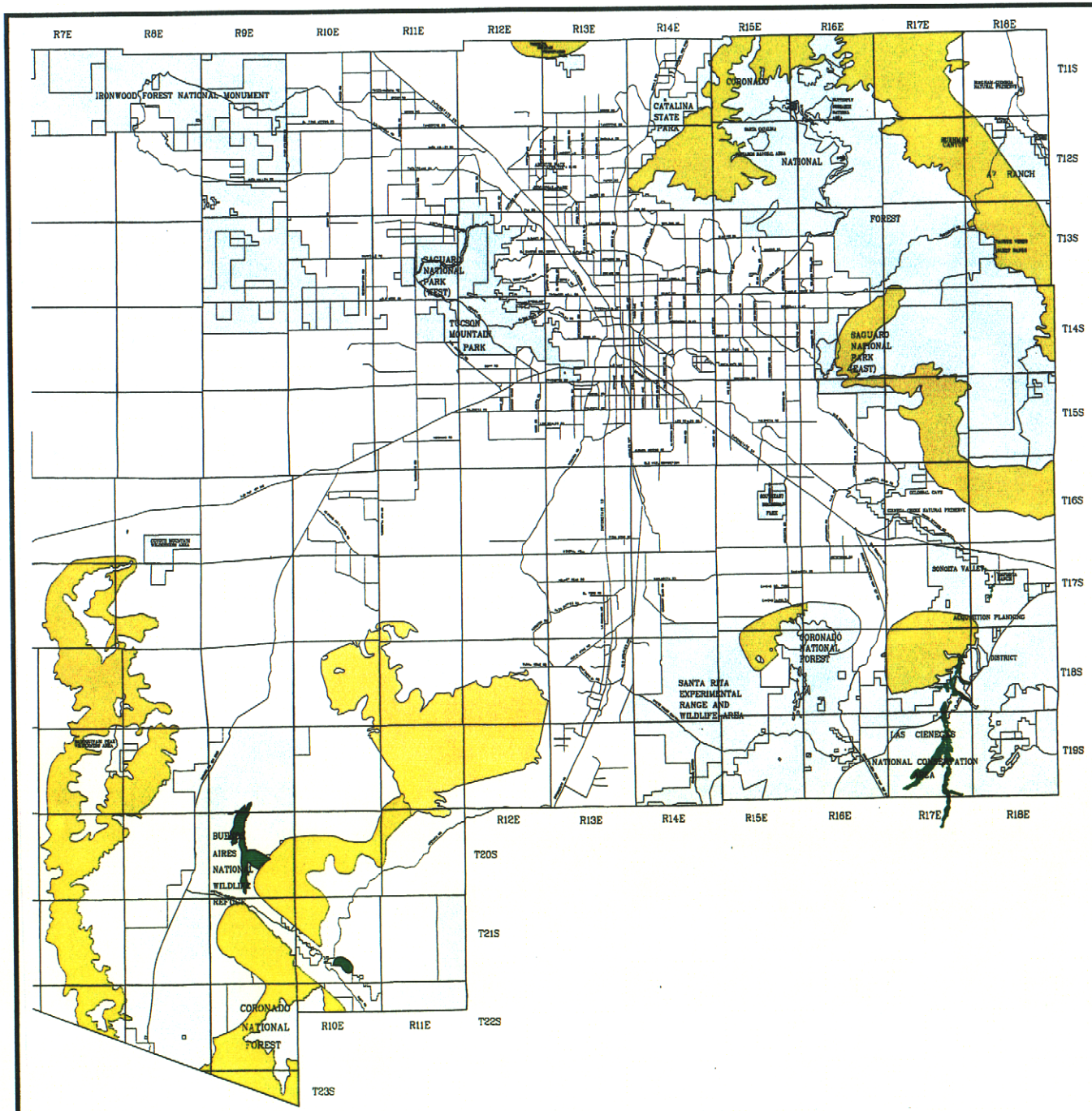
Swetnam, T.W., and J. Betancourt. 1998. Mesoscale disturbance and ecological response to decadal climatic variability in the American Southwest. Journal of Climate 11: 3128-3147.

Wolden and Stromberg. 1997. In U.S. Fish and Wildlife Service. 2001. Southwestern Willow Flycatcher Recovery Plan. Draft of April 2001.

Wall, William. 1999. "Chapter 8: Maintaining Biodiversity in an Intensively Managed Forest: A habitat-based planning process linked with a fine-filter adaptive management process." In

Baydeck, Richard, Henry Campa III, Jonathan B. Haufler, et al. Practical Approaches to Conservation of Biological Diversity. Island Press: Washington, D.C.

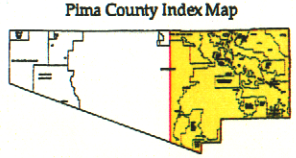
Appendix A



Native Grasslands

- Type A - Grassland - Dominated by native grasses with a low percentage of shrub invasion
- Type B - Grassland - Dominated by scrub, needs fire, low percentage of non-native grasses
- Mixture of Type A and Type B grasslands
- Type C - Sacaton grassland
- Existing Reserves
- Major Streets
- Township and Range

Pima County Index Map



Index Map Scale 1:1,500,000

The information depicted on this display is the result of digital analyses performed on a variety of databases developed and maintained by several governmental agencies. The accuracy of the information presented is limited to the collective accuracy of these databases on the date of the analysis. The Pima County Department of Transportation Technical Services Division makes no claims regarding the accuracy of the information depicted herein.

This product is subject to the Department of Transportation Technical Services Division's Use Restriction Agreement

Scale 1: 142,000

TECHNICAL SERVICES

Pima County Technical Services
201 North Stone Avenue - 8th Floor
Tucson, Arizona 85701-1207
(520) 740-6670 - FAX (520) 798-3429
http://www.dot.co.pima.az.us

/wombat/special/julia/grass/grasslnds3.eml

13-JUN-2001