DRAFT

COUNTY ADMINISTRATOR'S OFFICE

PIMA COUNTY GOVERNMENTAL CENTER
130 W. CONGRESS, TUCSON, AZ 85701-1317
(520) 740-8661 FAX (520) 740-8171

C. H. HUCKELBERRY
County Administrator

June 7, 2001

James Keene, City Manager
City of Tucson
P.O. Box 27210
Tucson, AZ 85726-7210

Re: ***Groundwater Changes in the Tanque Verde Valley***

Dear Mr. Keene:

On January 16, 2001 the draft *Groundwater Level Changes in the Tanque Verde Valley* study was issued. You responded on March 23, 2001 with the letter found at Attachment 1. I am forwarding two documents for your information. The first is the Pima County staff *Response to Tucson Water Comments*, dated May 16, 2001 (Attachment 2). The second is *An Evaluation of Hydrologic and Riparian Resources in Saguaro National Park,* which was forwarded to Tucson Water staff upon publication in March of 2001 (Attachment 3). You will find that the response by County staff clarifies misunderstandings that formed the basis of comments sent by Tucson Water in March of 2001. The study conducted by Saguaro National Park East finds that groundwater withdrawals pose a threat to middle basin riparian areas. As you know, a subsequent analysis of the data by the Arizona Department of Water Resources led to the understanding that the January 2001 draft of *Groundwater Changes in the Tanque Verde Valley* actually underestimated the amount of groundwater pumping in the area. We will finalize the *Groundwater Changes in the Tanque Verde Valley* study based on all of the comments and information that we have received. We remain concerned about the impact of groundwater withdrawals in the area, but look forward to facilitating a rational and responsible discussion of potential solutions to this and other water resource issues in Pima County.

Sincerely,

C. Huckelberry

C.H. Huckelberry
Pima County Administrator

c: The Honorable Chairman and Members, Pima County Board of Supervisors

Attachment 1

CITY OF
TUCSON
OFFICE OF THE
CITY MANAGER

March 23, 2001

Mr. C.H. Huckelberry, County Administrator
Pima County Administration Building
130 West Congress, 10th Floor
Tucson, Arizona 85701

RE: Groundwater Level Changes in the Tanque Verde Valley

Dear Mr. Huckelberry:

The City of Tucson appreciates the opportunity to provide comments on the *Groundwater Level Changes in the Tanque Verde Valley (Tanque Verde)* report prepared by Pima County under the mantle of the Sonoran Desert Conservation Plan. Although I forwarded some brief observations based on a quick first-read of the report in early February, I advised you then that I had directed City staff to analyze the report with the intention to forward more in-depth comments upon completion of that review.

The City's comments (attached) are the result of a review of the *Tanque Verde* report by technical staff at Tucson Water. Obviously, a more timely review could have been provided to Pima County staff had a more inclusive and open peer review process been conducted. As I've indicated before, I believe the opportunity to fully participate in the study and report development process would provide interested parties with relevant expertise the best forum for sharing understanding and technical insight. Absent this opportunity, the resulting studies generally suffer from a more narrow perspective that does not fully appreciate the complexity of all the issues involved.

I believe that is the case with the *Tanque Verde* report, and that the primary weakness is its limited scope and cursory analysis. The report does not fully consider local hydrogeologic conditions and therefore does not adequately address the potential importance of those conditions to the results of the study. Further, the report totally ignores more direct and imminent impacts on local riparian growth in the form of land development and encroaching urbanization.

CITY HALL
P.O. BOX 27210
TUCSON, ARIZONA 85726-7210
PHONE: (520) 791-4204
FAX: (520) 791-5198

The City's comments can be grouped into four major categories of issues and concerns:

1. Perched Groundwater

- The report did not acknowledge the documented occurrence of perched groundwater in the study area. This is a significant omission, and its relevance is discussed in many of the other comments.

- Riparian trees depend on shallow regional groundwater, and/or shallow perched water to meet their water-supply needs. The occurrence of perched water is one of the more likely reasons why observed areas of good mesquite vigor occur even though the depth to groundwater is below the critical water level referenced in the report.

- The riparian vegetation in this area depends to some degree on seasonally recharged perched water zones and has, for many decades, had to adapt to water-level fluctuations of large magnitude. This adaptation may impact the long-term growth of some riparian trees to a greater extent than would regional water-level declines that commonly occur below the critical depth for most riparian trees.

2. Riparian Stress Factors

- The County report acknowledged that mesquites in the study area sometime exhibit poor vigor in places where regional groundwater levels appear to be shallow enough to support the trees. This would tend to indicate that variables other than the depth to water in the regional groundwater system are likely involved.

- The report did not consider the potentially adverse effect that frequent, large fluctuations in groundwater levels may have on tree vigor—even where the depth to water is more shallow than the critical depth for mesquites. Large fluctuations in water level frequently occur and represent a degree of environmental instability that could impact the long-term health and vigor of riparian trees.

- Drought and wet-year cycles impact the amount of water annually flowing in Tanque Verde Creek—a flow which is directly related to the magnitudes of rise and fall in groundwater level.

- Water-level fluctuations are probably greater now than they were in the historical past when regional groundwater and perched levels were less differentiated, were more stable, and were closer to land surface.

- Mesquites growing adjacent to ephemeral streams like Tanque Verde Creek benefit from overbank flooding and bank storage. Such flooding recharges shallow groundwater and seasonally provides riparian trees with a supplemental source of water supply. This strongly suggests that the health of the local mesquite bosque may directly benefit from the complete or partial removal of any existing bank

stabilization/channelization along Aqua Caliente Wash, Sabino Creek, and Tanque Verde Creek. As Pima County considers such construction proposals in the future, the potential deleterious effects of these projects on riparian growth should also be factored into the analysis.

3. Clarifications and Misrepresentations

- The County's water-budget analysis underestimates water budget credits and leads the reader to overestimate the debits to prove its point. Without actually running a water-budget calculation, the study concludes that debits significantly exceed credits and hence concludes that regional groundwater in the study area is being over-pumped to the detriment of riparian trees.

- The water-level presentation in Table 1 of the County report is misleading, only offering water levels collected in 1990, 1992, and 1999 for purposes of comparison. The table gives the impression that only water-level declines occurred after 1992 overlooking the fact that significant stream flows occurred in subsequent years and groundwater levels rose in most wells in 1993, 1995, and 1998.

- Regional water-level declines associated with regional pumpage over many years have resulted in the progressive advancement of water-level declines toward the edge of the regional aquifer, which includes the study area. The County's recommendation that pumping be reduced in wells in the immediate vicinity of the Tanque Verde Valley would have minimal effect on local water levels if an off-setting increase in pumping is required at more distant wells to meet the water-supply needs of on-going development in the northeast area.

- Transferring pumpage from the Tanque Verde Valley area to other areas increases the possibility of creating problems in those areas such as increasing the potential for additional land subsidence and the associated costs to the community.

- Reductions in pumpage at local private wells, especially those that tap into shallow groundwater, would have a direct and positive benefit on perched water levels in the study area. The latter are particularly important since in some areas, riparian growth is to some degree dependent on perched water as a source of supply.

4. Growth Issues

- A more direct and immediate way to address long-term water-level impacts to the local area is to reduce the development pressure in the northeastern part of the Tucson basin. Since the Tanque Verde Valley and surrounding areas are unincorporated, implementation of such an approach would fall within the jurisdictional control of Pima County.

- Groundwater pumping in the northeast area primarily supports local water demand and development. Local water demand is already so large that additional groundwater supply has to be conveyed to the northeast area from other portions of the Central Well Field. Development pressure in the area will further acerbate the growth of water demand and the corresponding need for additional supply.

- The County report ignores the direct and imminent threat of on going land uses and urban development in Tanque Verde Valley. Construction activity associated with such development has physically displaced riparian growth. Bulldozers may in fact pose the most immediate and direct threat to riparian trees and shrubs in the riparian corridor and in surrounding areas.

- To more completely evaluate significant threats to riparian growth, a comprehensive assessment should document the historical impact of land development and the resulting physical removal of vegetation (trees and shrubs) over time.

Certainly one approach to minimizing the effect of regional (as opposed to just local) pumping is to maximize use of renewable water supplies (CAP water and reclaimed water) in the metropolitan Tucson area. Over the long term, this maximization of use, and the associated reduction of municipal groundwater pumping, will have an increasing positive effect on water levels on a regional basis. Implementation of the Clearwater Renewable Resource Facility on May 3rd of this year will be the first step toward maximizing use of CAP water and reducing municipal pumping in Tucson Water's Central Well Field.

The City of Tucson does appreciate the opportunity to provide comments on the *Tanque Verde* report. However, I believe better use of City staff time and expertise, and a better product for the SDCP development process would have resulted had Pima County invited City staff to actively participate, at a minimum through peer review, in development of the *Tanque Verde* report.

Respectfully submitted,

James R. Keene
City Manager

C: City of Tucson Mayor and Council Members
Pima County Board of Supervisors
David Modeer, Tucson Water Director
Tom Swanson, P.A.G.

COMMENT ON PIMA COUNTY REPORT
Groundwater Level Changes in the Tanque Verde Valley
March 14, 2001

Background

Pima County conducted an assessment of recent changes in groundwater level along a reach of Tanque Verde Creek to evaluate the extent to which such changes impact local riparian growth (Hill and others, 2001). The County's assessment was to serve as an update to an earlier study performed by Stromberg and others (1992). The final draft of the County report, *Groundwater Level Changes in the Tanque Verde Valley*, was issued in January 2001 under the mantle of the draft Sonoran Desert Conservation Plan (Pima County, 1998).

General and Specific Comments

This review was conducted by technical staff at the City of Tucson Water Department (Tucson Water) after the final draft of the report had already been issued. A more timely review would have been provided to Pima County staff if a more inclusive peer review process had been conducted.

The overall weakness of the County's assessment is its limited scope and cursory analysis. The study did not consider other available information which would have provided greater breadth and depth to the assessment. A more comprehensive evaluation would have more accurately characterized existing and potential future impacts on riparian growth in the study area. This in turn would have provided additional recommendations to help address current impacts to riparian growth as well as potential ones in the near and long terms. The County's report did not fully take into account local hydrogeologic conditions and hence could not adequately address their potential importance. In addition, the County study is mute with regard to more direct and imminent impacts on local riparian growth in the form of land development and encroaching urbanization.

The specific comments provided below address only the more substantive points with special attention given to accuracy and completeness. Suggestions are offered which may point the way to future multi-disciplinary research and analysis.

Comment #1: The report did not acknowledge the documented occurrence of perched groundwater in the study area. This is a significant omission, and its relevance is discussed in many of the comments that follow. Review of water-level data indicates that the spatial superposition of perched (shallow) and regional (deep) groundwater zones occurs. This is most clearly illustrated in Figure 1 (next page) where both shallow (perched) and deep (regional) water levels are observed in City wells C-075A and C-075B, respectively. The two wells are only 75 feet apart and approximately 250 feet from Tanque Verde Creek.

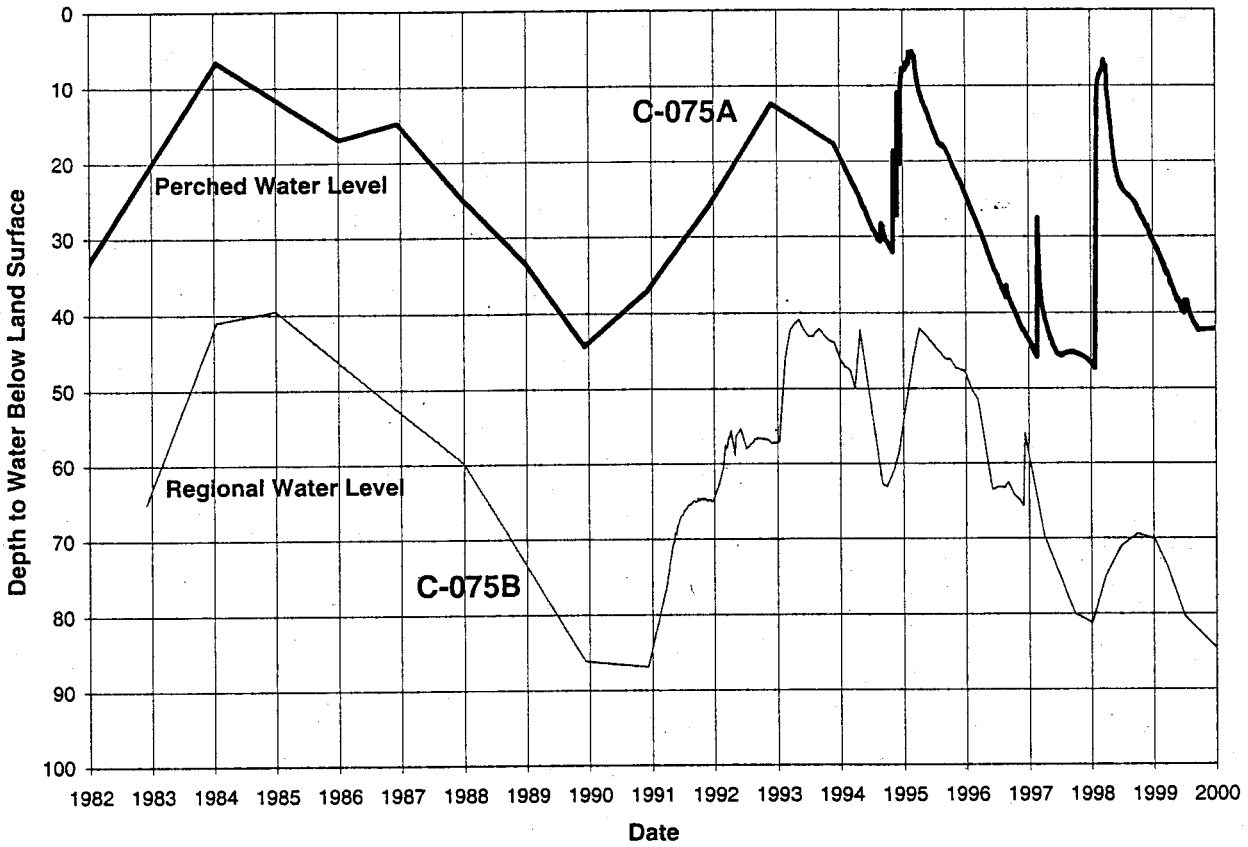


Figure 1: Static Water Level Hydrographs of Wells C-075A and C-075B

The occurrence of perched groundwater is not unique to this area. It has been observed along other stream-channel reaches in the Tucson basin. A few of the many references which discuss the occurrence of perched water in proximity to local stream channels include Davies (2000), Pool & Schmidt (1997), Dulaney (1992), CH2M Hill (1992), Tucson Water (1989), Wilson & Schmidt (1979), and Wilson & DeCook (1968). Careful review of Figure 4 in the County report indicates the occurrence of perched water in the immediate study area. Had a review of Tucson Water's data files been conducted, it would have indicated that perched water has been documented in City well C-083A which lies about 2.5 miles west of well C-075A and about one-quarter mile south of Tanque Verde Creek. Further investigation could include a survey that would document the occurrence of cascading (and hence perched) water in the many private wells within the County's study area.

Comment #2: Riparian trees depend on vadose zone moisture, shallow regional groundwater, and/or perched water to meet their water-supply needs. The occurrence of perched water is one of the more likely reasons why observed areas of good mesquite vigor occur even though the depth to groundwater should, according to Stromberg and others (1992), result in "near-lethal" stress to trees. In other words, the benefits to riparian growth in areas where the regional water table has dropped below the critical depth indicated in the County's report is likely due to the presence of perched groundwater. This concept is briefly alluded to in the County's report as a

theoretical possibility. The allusion, however, was a passing comment and no effort was made to further investigate and evaluate the concept in order to assess its substance and significance.

Comment #3: The County report acknowledged that mesquites in the study area can also exhibit poor vigor in places where regional groundwater levels appear to be shallow enough to support the trees. This would tend to indicate that variables other than the depth to water in the regional groundwater system are likely involved.

One factor which may have an adverse effect on tree vigor is the frequent, large magnitude fluctuations in water levels in both regional and perched water zones—especially where the depth to water is less than the "near-lethal" critical depth referenced in the County report. Meko (1991) noted in his tree-ring study that tree stress, indicated by narrow tree-ring widths, could result not only from water-level declines but also from unusually shallow water levels. Similarly, Tucson Water (1989) noted in an earlier report that cyclic water-level fluctuations of 50 feet or more could potentially stress some local riparian vegetation. Such fluctuations represent a degree of environmental instability which could, in conjunction with other stress factors, impact the health and vigor of riparian trees.

Comment #4: Drought and wet-year cycles directly impact the annual amount of water flowing in Tanque Verde Creek which in turn determines the amount of natural recharge that occurs along the channel reach. The magnitude of annual discharges in a given year and the frequency of natural streamflows are directly related to the rise and fall of groundwater levels.

Due to declines associated with historical groundwater withdrawals from the regional aquifer and the development of a perched system in all or parts of the area, water-level fluctuations are probably greater now than they were prior to the 1950s. In the historical past, regional groundwater and perched water levels were less differentiated, more stable, and closer to land surface. Because of shallower water levels, there was less subsurface storage available and this likely resulted in greater rejected recharge. This would have caused streamflows to continue further downstream and to persist for longer periods of time.

Some of the riparian vegetation in this area, especially the younger mesquites noted by Meko (1991), likely depend to some degree on seasonally recharged perched water zones. For many decades, such trees have had to adapt to water-level fluctuations of greater magnitude than had historically been the case. This adaptation would have more impact on the long-term growth of riparian trees than would regional water-level declines which occur below the critical water-level depth referenced in the County report.

Comment #5: Because the County report did not document the existence of perched groundwater, it could not evaluate its possible relationship to the regional groundwater system. This would have been an important factor to consider when the County developed its recommendations for its study. For purposes of discussion, this relationship can be viewed from two perspectives, and their differences are in terms of degree—they are not mutually exclusive.

Under the first perspective, perched groundwater is to a large degree independent or separate from the regional aquifer system. Given this condition, the hydraulic connection between

perched and deeper regional groundwater would be minimal. This means that groundwater pumping from wells screened only in the deeper regional system would have little if any immediate effect on perched water levels. To the extent that perched groundwater provides support to local riparian growth, local water-level changes in the deeper regional groundwater system would have little impact on such growth.

Review of well test results shown on Figure 2 indicates that deep regional groundwater and perched water are not hydraulically connected in the immediate vicinity of City wells C-075A and C-075B. It is a reasonable assumption that nearby deep wells which only withdraw water from the deep regional groundwater system would also have minimal if any impact on perched water levels. However, wells which have casing perforations that intercept subflow (i.e. perched or shallow regional groundwater in the recent alluvium) would more directly compete with riparian trees for water supply. This would be true of many exempt and non-exempt privately-owned wells located within the riparian corridor identified by the County.

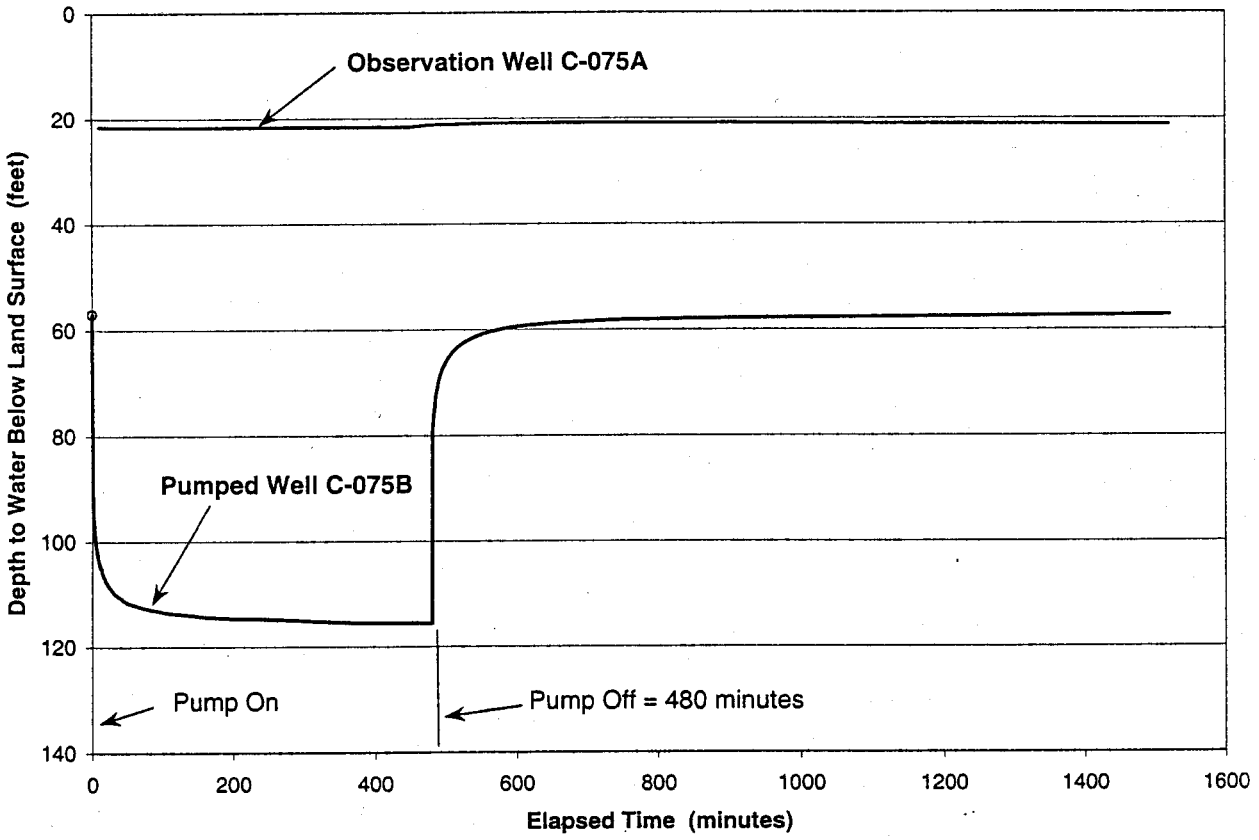


Figure 2: Pump Test of Well C-075B, Using Well C-075A as the Observation Well September 20, 1983

Under the second perspective, the impeding sediments or the layer interface which supports the perched system is areally continuous and at some distance merges with the regional groundwater system to form a single undifferentiated aquifer. Given this condition, a hydraulic connection between perched and regional groundwater would exist, and the extent of that connection would depend on the distance between a given pumping well and the undifferentiated aquifer. The

farther any pumping well is from the undifferentiated aquifer, the less immediate the impact of that hydraulic connection. Wells, however, which tap directly into the undifferentiated aquifer such as in the eastern part of the study area would directly impact shallow groundwater levels and hence the discharge of subflow from that area. Such wells would more directly compete with riparian trees for water supply.

With either perspective, the collective drawdown impact of many pumping wells (even those miles away) on regional groundwater levels could be significant over time if the overall pumpage exceeds stream-channel recharge and groundwater underflow entering the larger area. The cumulative drawdown effects of many pumping wells over an extended period of time could cause regional groundwater levels to decline along the edge of the regional aquifer and hence in the vicinity of the study area. To the extent that such declines have occurred, they have contributed to the gradual development of a divided (perched and regional) groundwater system in the local area.

Further analysis on historical water-level declines could include a review of an early account by Smith (1910) and historical water-level data collected by the University of Arizona (UA) some of which go back to the 1890s and early 1900s. Parts of the original UA data set are preserved in the collected papers of Harold Schwalen (n.d.) as well as in other on-campus repositories. Additional review of water-level data assembled by CH2M Hill (1988) would provide a summary of historical water level changes which have occurred basin-wide from the late 1940s to the mid 1980s.

Comment #6: The County's water budget analysis focuses on the area in and immediately around Tanque Verde Creek. The report considers some credit/debit elements of the budget but excluded stream-channel recharge from Sabino Creek (2,700 acre-ft/yr) as well as mountain-front recharge (2,400 acre-ft/yr) from its analysis (Osterkamp, 1973). These elements would collectively contribute to groundwater underflow entering the study area and hence should be added to the credit side of the ledger. The report also documented average annual pumping statistics for the study area but then confuses the matter by alluding to groundwater withdrawals from a significantly larger area—the Northeast area. Credits and debits from differently sized areas were implicitly being compared. Thus, the County's water-budget analysis underestimates water budget credits and leads the reader to overestimate the debits. Without actually running a water-budget calculation, the County analysis proceeds to conclude that debits significantly exceed credits and hence (regional) groundwater in the study area is being over-pumped to the detriment of riparian trees.

As a matter of record, Burkham (1970) analyzed streamflow infiltration losses along selected channels in the Tucson basin. Burkham's average annual statistics may serve as surrogate estimates of average annual stream-channel recharge; however, researchers commonly believe that between 75 and 90 percent of the infiltrated water recharges the aquifer with the balance lost to evaporation and transpiration (Burkham, 1970; Davidson, 1973). Burkham also noted that the "...extremes in the annual volumes of infiltration are estimated to range from zero to more than four times the average annual volume." This deviation around the statistical annual average reflects the huge fluctuation in streamflow discharges from year to year. Such variability is

mirrored in the groundwater system as perched and regional groundwater levels fluctuate in response to changes in streamflow and hence recharge.

Commonly used estimates of average annual infiltration loss (Burkham, 1970) and stream-channel recharge (Osterkamp, 1973) may underestimate current rates. Burkham (1970) based his study on available streamflow records from U.S. Geological Survey gaging stations between 1936 and 1963. During a large part of this period, regional groundwater levels were shallower in a larger part of the study area; thus, there was less subsurface storage available for sustained infiltration losses and hence for stream-channel recharge. Given that the regional groundwater level is currently deeper in some areas than it was during Burkham's period of record, less rejected recharge is occurring during streamflow events. This means that the average annual estimate of stream-channel recharge along channel reaches in and around the study area are probably conservative.

Comment #7: Graphical and tabular portrayals of water level data should cover a sufficient interval of time to reflect longer-term trends. The many superimposed well hydrographs shown on Figure 4 of the report would have been more meaningful if they included data collected prior to December 1987 (the first date shown in the time series). The inclusion of additional available data would have provided a more complete understanding of longer term trends and hence a more meaningful assessment when evaluating the significance of water levels at any given point in time. Given the limited information provided in the County report, the reader would not know that prior to December 1987, wet years resulted in water-level rises on par with those seen in the 1990s. By December 1987, however, water levels were mostly downward trending because it was the beginning of a multi-year drought cycle which continued into 1990. Beginning the graph on the declining leg of a longer-term water-level oscillation provides a very limited and potentially misleading representation of the longer-term trend.

The water-level data presented in Table 1 of the County report did not accurately represent what actually occurred in the 1990s. Table 1 only includes water levels collected in 1990, 1992, and 1999 for purposes of comparison; all other data in the intervening years were ignored. The report states that data from 1990 were included in the table because a significant water resource influence occurred in that year. What is also particularly significant about 1990 is that it had the lowest dip in water levels after a multi-year period of drought. This multi-year drought reduced natural recharge to both perched and regional groundwater systems which in turn may have been reflected in the vitality of some riparian trees. A review of Table 1 can leave the reader with the impression that only water-level declines occurred after 1992 and overlooks the fact that significant streamflows and recharge occurred in subsequent years. Because of the subsequent flows and associated recharge, water levels rose in most wells in 1993, 1995, and 1998. Changes in water level should be viewed completely and over a long enough period of time to give the interpretation of the data sufficient context and hence meaning.

The report also emphasized that the reduction in pumpage due to the direct delivery of CAP water was the reason for the water-level rise in 1993. This ignores the fact that the annual discharge in Tanque Verde Creek in 1993 was the highest of record in the 1990s and would by far account for the largest part of the documented water-level rise in that year. Also, as a matter

of record, the direct delivery of CAP water was suspended in October 1994--not in December 1993 as stated in the report.

Comment #8: According to the U.S. Geological Survey, the study area is located on the basin margin and hence close to the edge of the regional groundwater system (Hanson & Benedict, 1994; Anderson, 1988; and Davidson 1973). Over many years, regional water-level declines associated with regional pumpage have resulted in the progressive advancement of water-level declines toward the edge of the regional aquifer (which includes the County's study area). The County's recommendation that pumping be reduced in wells in the immediate vicinity of the Tanque Verde Valley would have minimal effect on local water levels if an off-setting increase in pumping is required at more distant wells to meet the water-supply needs of on-going development in the northeast area. In addition, transferring pumpage to other areas also increases the possibility of creating problems in those areas such as increasing the potential for additional land subsidence.

Comment #9: One approach to minimizing the effect of regional (as opposed to just local) pumping is to maximize the use of renewable water supplies (CAP water and reclaimed water) in the metropolitan Tucson area. This is the shared goal of both Tucson Water and the Arizona Department of Water Resources. Over the long term, this maximization of use, and hence the reduction of municipal pumpage, will have an increasing positive effect on water levels not only in the County's immediate study area but also more regionally. The Clearwater Renewable Resource Facility will become operational in April 2001. It's commencement of operations will be the first step toward maximizing the use of CAP water and reducing municipal pumping in Tucson Water's Central Well Field area.

Comment #10: Stromberg and others (1992) noted that mesquites growing adjacent to ephemeral streams (like Tanque Verde Creek) benefit from overbank flooding and bank storage. Such flooding recharges shallow groundwater and seasonally provides riparian trees with a supplemental source of water supply. This strongly suggests that the health of the local mesquite bosque may directly benefit from the complete or partial removal of any existing bank stabilization/channelization along Aqua Caliente Wash, Sabino Creek, and Tanque Verde Creek. When evaluating future bank stabilization proposals, the potential adverse effects of such projects on riparian growth should be prominently factored into the analysis.

Comment #11: A more direct and immediate way to address long-term water-level impacts to the local area is to reduce the development pressure in the northeastern part of the Tucson basin. Since the Tanque Verde Valley and surrounding areas are unincorporated, implementation of such an approach would fall within the jurisdictional control of Pima County. Groundwater pumping in the northeast area primarily supports local water demand and development. Local demand is already so large that additional groundwater supply has to be conveyed from other portions of the Central Well Field to the northeast area. Development pressure in the area will further acerbate the growth of water demand and the corresponding need for additional supply.

Comment #12: Related to the above, the report ignores the direct and imminent threat of on-going land uses and urban development in Tanque Verde Valley. Construction activity associated with such development has physically displaced riparian growth. Bulldozers may in

fact pose the most immediate and direct threat to riparian trees and shrubs in the riparian corridor and in surrounding areas. In order to more completely evaluate all significant threats to riparian growth, a comprehensive assessment should document the historical impact of land development and the resulting physical removal of vegetation (trees and shrubs) over time. Again, this area remains unincorporated and hence all development is within the jurisdictional control of Pima County.

The 1941 aerial map which was used in the County report to denote the riparian corridor can serve as a baseline against which subsequent developmental changes can be assessed over time. It may also be possible to use *Landsat* imagery to help document the reduction in riparian growth and the advance of higher density development in recent years (University of Arizona, 1991).

Conclusions

The County's study is part of a larger planning process which will address both conservation and development issues. When conducting planning-related studies, it is important to consider all significant factors, and this can only be done through complete and thorough analyses. The County's study, conducted under the mantle of the County's Sonoran Desert Conservation Plan, did not fully investigate the key factors which should be taken into account when considering the present and future disposition of riparian trees in the area.

This County study would have benefited from additional peer review. Had the opportunity been extended, the report would have taken into account additional information which would have given the study greater depth and technical credence. The recommendations included in the County report are worthwhile to consider, but they should also be considered incomplete since a more comprehensive assessment was not conducted. Any such assessment should include an evaluation of increasing urbanization and land development in the area. These factors may pose a more immediate and direct threat to the health of riparian trees. Meaningful recommendations which seek to protect and/or restore riparian growth in the Tanque Verde Valley should take these and other potential stress factors into account.

REFERENCES

Anderson, S.R., 1988. *Potential for aquifer compaction, land subsidence, and earth fissures in the Tucson basin, Pima County, Arizona*, U.S. Geological Survey: Hydrologic Investigations Atlas HA-713.

Burkham, D.E., 1970. *Depletion of streamflow by infiltration in the main channels of the Tucson basin, southeastern Arizona*, U.S. Geological Survey: Water-Supply Paper 1939-B.

CH2M Hill, 1992. *Rillito Recharge Project Technical Memorandum No. 1: Rillito Project Site Recommendations*, prepared for the Arizona Department of Water Resources in cooperation with Tucson Water and the Pima County Flood Control District.

CH2M Hill, 1988. *Hydrogeologic evaluations for recharge sites*, Tucson Recharge Feasibility Assessment (Phase A), prepared in association with Errol L. Montgomery & Associates and L.G. Wilson for the City of Tucson Water Department.

Davidson, E.S., 1973. *Geohydrology and water resources of the Tucson basin, Arizona*, U.S. Geological Survey: Water-Supply Paper 1939-E.

Davies, Darian, 2000. *A study of perched mound growth and dissipation: potential effects on artificial recharge efficiency*, Master's thesis: Department of Hydrology and Water Resources, University of Arizona.

Dulaney, Alan R., 1992. *Preliminary investigation of groundwater contamination in the Downtown Tucson area, Pima County, Arizona*. Arizona Department of Environmental Quality, Groundwater Hydrology Section.

Meko, David, 1991. *Pilot Study of Mesquite and Cottonwood Trees as Potential Hydrologic Indicators in the Tanque Verde Wash Area, Tucson, Arizona*, Laboratory of Tree-Ring Research, University of Arizona, Tucson.

Hanson, R.T., and J.F. Benedict, 1994. *Simulation of ground-water flow and potential land subsidence, Upper Santa Cruz Basin, Arizona*, U.S. Geological Survey: Water-Resources Investigations Report 93-4196.

Hill, Elizabeth, Julia Fonseca, and Staffan Schorr, 2001 (Draft). *Groundwater Level Changes in the Tanque Verde Valley*, prepared by the Pima County Flood Control District with assistance from the Pima Association of Governments.

Osterkamp, W.R., 1973. *Ground-water recharge in the Tucson, Arizona*, U.S. Geological Survey: Miscellaneous Investigations Series Map I-844-E.

Pima County, 1998 (Draft). *Sonoran Desert Conservation Plan*, Prepared by Pima County staff and released to the Pima County Board of Supervisors on October 21, 1998.

Pool, D.R., and Werner Schmidt, 1997. *Measurements of ground-water storage change and specific yield using the temporal-gravity method near Rillito Creek, Tucson, Arizona*: U.S. Geological Survey Water-Resources Investigations Report 97-4125.

Schwalen, H.C., [n.d.]. *Collected Papers 1916-1965*, AZ 563: Boxes 22 and 23, Library of Special Collections, University of Arizona, Tucson.

Smith, G.E.P., 1910. *Groundwater Supply and Irrigation in the Rillito Valley*, University of Arizona: Agricultural Experiment Station, Bulletin 64.

Stromberg, J.C., J.A. Tress, S.D. Wilkins, and S.D. Clark, 1992. Response of velvet mesquite to groundwater decline, *Journal of Arid Environments*, 23:45-58.

Tucson Water, 1989. *Northeast Area Water Level Decline Report*, Planning Division.

University of Arizona, 1991. *Final Report: A Multistage Remote Sensing Study to Assess and Monitor Relationships Between Groundwater and Riparian Habitat in the Tanque Verde Wash*, College of Agriculture: Arizona Remote Sensing Center, Office of Arid Lands Studies, and Advanced Resource Technology Program, Prepared for the City of Tucson Water Department.

Wilson, L.G., and K.J. DeCook, 1968. Field observations on changes in the subsurface water regime during influent seepage in the Santa Cruz River, *Water Resources Research*, 4(6), pages 1219-1234.

Wilson, L.G., and K.D. Schmidt, 1979. Monitoring perched ground water in the vadose zone, in *Establishment of Water Quality Monitoring Programs,* edited by L.G. Everett and K.D. Schmidt, pages 134-149, American Water Resources Association.

Attachment 2

RESPONSE TO TUCSON WATER COMMENTS

Groundwater Level Changes in the Tanque Verde Valley

May 16, 2001

BACKGROUND

The Pima County report "Groundwater Level Changes in the Tanque Verde Valley (2001)" was based upon a study conducted in 1990 by Dr. Juliet Stromberg and others, and published in "Response of Velvet Mesquite to Groundwater Decline" (1992). Pima County was initially interested in collecting well level data for the intervening years from the Stromberg study to present, feeling that correlation of groundwater levels associated with stress to mesquite trees would lead to a meaningful discussion of whether groundwater conditions have improved or worsened for mesquite bosque in the Tanque Verde Creek area. In addition, other water resource data was collected and integrated with the well level data in order to present a more complete picture of the area hydrology. Although the Pima County report was published independently of Tucson Water (TW), data on wells and pumping was collected from official reporting sources.

TW reviewed and commented on the Pima County report in a March 23, 2001 letter to Mr. Huckelberry, Pima County Administrator from Mr. James R. Keene, City Manager. This office welcomes TWs' input and offers the following responses to their comments.

1. Response to TW Comments #1,#2, #3, #4, and #5

In Comment #1 and elsewhere, TW states that Pima County never acknowledged the existence of perched aquifers in the study area. In fact, this topic was addressed several times.

Pima County reported in the Discussion Section (p. 17) that Well 11 (TW C-75A) showed a highly stressful depth to water, but that recent field observation at the well site did not show mortality or obvious dieback of mesquite. Pima County surmised that a perched aquifer tapped by nearby Well 10 (TW C-75B) might be sustaining these mesquite. In Comment #1 TW provides a graph showing the perched and regional aquifers at Wells 10 and 11, but fails to credit Pima County with noting this potential.

Pima County made two recommendations to provide more data on the depth to both regional and perched groundwater along with mesquite vigor: inventory casing descriptions (i.e. perforation intervals) of the 17 TW Wells, and conduct a current biologic assessment of mesquite around the Tucson Wells. Pima County specifically says that these recommendations were made to provide explanations of lack of obvious dieback where regional water levels appear to be lethal, i.e. perched aquifer conditions.

In the Conclusion Section, (p. 19) Pima County pointed out that some of the mesquite bosque north of Tanque Verde Creek may be maintained by a perched aquifer, and that these perched aquifer conditions may be mitigating the impacts of groundwater pumping where the greatest declines occur in the regional aquifer. Notwithstanding these points, the existence of perched aquifers should not preclude the effect of continuing regional groundwater decline. The compromised regional aquifer has suffered declines due to historic groundwater withdrawal, and, given the correct geologic

conditions, has acutely differentiated in some areas into regional and perched water zones. As TW described (comment #4), the historic regional aquifer was less differentiated from the perched zone, providing 'more stable' water levels and reducing extreme water level fluctuations in the perched zone. Thus the existence of a perched aquifer is a result of extended, cumulative groundwater withdrawal; the mesquite bosque is being asked to adapt in the short and long-term to a mechanically altered groundwater situation. As the Stromberg study emphasizes, early warning stress indicators should be monitored to determine whether the mesquite are being stressed to such a degree that existence of the bosque is threatened.

A response is made here to TW Comment #1 which states that perched aquifer conditions have been documented at Well C-83A (Pima County Report Well 14). This was not evident in the annual static water levels for this well which, according to Pima County research, varied between 80 and 110 feet below ground surface during the study time period. These deep water levels correspond to that of the regional aquifer. TW did not explain their conclusion of perched groundwater. As was the case of Well 10, Well 14 is also in close proximity to an active production well, Well 15 (TW C-83B). Unlike Wells 10 and 11, however, the annual static water levels vary little between Wells 14 and 15, so perched conditions are not apparent.

The same lack of obvious mesquite dieback near Wells 10 and 11 could provide evidence of perched water at Well 14. However, the Stromberg report tested plant water potentials in 1990 at Site 8, located approximately 1,300 feet from Well 14, and found mesquite exhibiting severe water stress during the early summer period of no surface flow. Groundwater depth was documented by Stromberg to be 85 ft. below ground surface at this site. In 1999 the water level at Well 14 was 106 feet below ground surface.

One explanation of the conflicting TW report of a perched aquifer and the Stomberg report of stressed mesquite is that the perched aquifer may have been substantially depleted by the multi-year drought which led up to 1990. In Comment #4 TW reports on the highly variable impact of flow events on recharge, an issue also examined by Pima County in the Recharge Response Section (p. 12). Although a general relationship between flow event and recharge was observed by Pima County, not all the wells supported the response pattern. The matter is further complicated by the unexamined issue of how recharge is divided between perched and regional groundwater. Highly variable annual flow events lead to highly variable recharge potentials, a subject that is further discussed in Response #2 regarding credits to the water budget.

TW reports in Comment #3 on the effect of natural cyclic water-level fluctuations of 50 feet or more and the potential stress this would cause some riparian vegetation. Pima County does not dispute the natural occurrence of groundwater fluctuations due to wet/dry conditions, or the short-term stress of mesquites adapting to these fluctuations. However, as TW notes, groundwater level fluctuations are greater now than they were in the 1950s, due to the development of perched water systems caused by the declining regional water level. In addition, Pima County's comparison of 1947 water levels to 1999 (Pima County Report Figure 6), shows that the regional water table has dropped substantially, from 20 feet to greater than 100 feet in wells downstream of the TVC/Agua Caliente confluence. The effect of increasingly disparate groundwater fluctuations in conjunction with decades of continuing regional declines may have impacted the long-term vigor of the bosque. The Stromberg study focused on mature mesquite trees, but recommended further study on the stress

response of young mesquite. The rooting depth of younger trees would be considerably shallower and excessive perched aquifer fluctuations would increase stress and mortality. The loss of young trees would necessarily limit the life expectancy of the bosque.

Pima County agrees that a review of the depth of withdrawals associated with shallow non-exempt wells in areas where mesquites show stress, but the regional well levels are adequate might be useful. This might indicate significant withdrawals of perched groundwater by private well-owners. Quantifying withdrawals by exempt users would not be possible since no official documentation is available.

2. Response to TW Comment #6

TW felt Pima County was comparing unequal areas for the credit and debit water budget ledger. Pima County's study area was determined by Stromberg et al.1992. This study area did not extend downgradient of Sabino Creek. The average annual recharge for two locations is cited both upstream and downstream of Sabino Creek (p. 14).

Water budget credits for Tanque Verde Creek up to the Sabino Creek confluence in the form of annual channel infiltration were reported to be 4800 ac-ft/yr (Burkham 1970). Pima County agrees that this value should be augmented by 1000 ac-ft/yr due to mountain front infiltration (Osterkamp 1973). Thus the total annual recharge infiltration credit could be 5800 ac-ft/yr, excluding Sabino Creek.

If the study area were extended to Sabino Canyon Road and included Sabino Creek, TW estimates there could be 7,500 ac-ft/yr channel infiltration (Burkham 1970) and 2,400 ac-ft/yr mountain front infiltration (Osterkamp 1973), bringing the total annual recharge infiltration to 9,900 ac-ft/yr.

Groundwater withdrawal constitutes a substantial debit in the water budget. To quantify this amount, Pima County utilized data from the Pima Association of Governments (PAG), who, in turn, utilized Arizona Dept. of Water Resources (ADWR) well databases. A subsequent, independent review of the well data by ADWR found discrepancies in the ADWR databases. These are described in the text following Table 1.

The following table compares withdrawals as queried by ADWR to those provided by PAG for the Pima County report. Following are possible explanations/reasons for the discrepancies between the numbers reported for the Pima County study and those reported by ADWR.

There are differences between three databases:

- Version 3 (V3) of the ADWR Well Registry CD-ROM (the source for the Sonoran Desert Conservation Plan report, written by PAG);
- The internal ADWR well registry database (the source for the independent ADWR query)
- Version 5 (V5) of the ADWR Well Registry CD-ROM (published after the Pima County report)

After Pima County's Groundwater Level report was published, ADWR was asked to independently assess the water use data. ADWR utilized their internal well registry database. A discrepancy was noted between the number of water wells used by ADWR and what was published in the Pima County report. ADWR found 42 Tucson Water wells in the study area (plus one cancelled well), accounting for an average annual withdrawal of 6980 ac-ft. PAG had reported to Pima County that there were 25 Tucson Water wells with an average annual withdrawal of 4404 ac-ft. Therefore, there is a discrepancy of 17 TW wells accounting for roughly 2600 ac-ft of withdrawal.

This can be explained in the following ways:

- A difference in study area is a factor in the discrepancies. ADWR considered wells one mile further downstream than PAG. ADWR and PAG also might have used different base maps. In essence, the study area is defined by the meander of TV creek, the location of Wentworth Rd, and the location of the Sabino Creek confluence. Unless the base maps of the creeks and streets matched up exactly, there would be some differences in the wells selected.

- The Pima County report listed 25 Tucson Water wells. V3 showed 7 wells were missing from the report and V5 showed 17 wells missing from the report.

- PAG provided Pima County with data for water use in Tanque Verde Valley from the database (V3 query) that was created for an SDCP study, however a portion of the creek within the study area was ephemeral and therefore was not included in that assessment. Within this gap, there are 3 Tucson Water wells, which account for over 1700 ac-ft of the 2600 ac-ft withdrawal discrepancy.

ADWR feels that the V5 well registry CD is the most accurate. Overall, 17 wells were left out of the Pima County report due to errors in the Well Registry Versions and oversight by PAG staff. Of the 17 wells, 5 can account for the withdrawals not included in the Pima County report (2600 ac-ft).

Although the explanations for the various discrepancies are complex, overall it seems likely that average groundwater pumping estimates provided by PAG and used by Pima County were underestimated at 6545 ac-ft/yr (Pima County Report Table 2). PAG mistakenly did not identify 1700 ac-ft/yr of pumping within the study area, and ADWR found an additional 900 ac-ft/yr within the extended study area. Therefore, revised pumping amounts could range from 8,245 to 9,145 ac-ft/yr. Comparison to the estimated infiltration recharge of 9,900 ac-ft/yr (inclusive of Sabino Creek) suggests that the current usage only perpetuates the depleted aquifer conditions, particularly during drier than average conditions.

Evapotranspiration is also a debit factor and was estimated by Pima County at 3000 ac-ft/yr (p. 15), forming a considerable portion of the water budget debit.

The credit/debit comparison is also heavily influenced by the variability of annual natural recharge which, although increasing in wet years, is reduced in dry years. Pima County recognized the long term effect of drought and wet year cycles on groundwater levels, however when consumer demand is highest as it is during low-recharge years, the concurrent pumpage forms an additional stress on

groundwater levels. No water provider reduces pumping to compensate for drought/low recharge cycles, as far as we know. Consequently, restoration of the water table to mesquite sustaining levels has not and cannot be accomplished under this scenario.

Groundwater withdrawals in the TVV were also noted by Saguaro National Park East in their study, "An Evaluation of Hydrologic and Riparian Resources in Saguaro National Park, Tucson, Arizona " (January, 2001). An area of mesquite bosque on an upper tributary to the TVC was evaluated in this report, along with groundwater level declines analyzed from 15 Tucson Water wells in the area. A cumulative average decline of 56 feet was noted from Sept. 1994 to Sept. 2000. This observation led the report to conclude that the tributary and bosque is very likely threatened by increasing downstream groundwater withdrawals.

3. Response to TW Comment #7

Water level data was shown for years 1988 to 1999 because, prior to that time, the TW Static Water Level data was inconsistent for the 17 wells used in the study. Pima County feels this 11 year period of time was adequate to determine that groundwater levels have not been increasing (i.e. recovering) since the 1990 Stromberg study and portions of the mesquite bosque are still subject to the severe stress imposed by extremely low water levels.

Table 1 in the Pima County report was formed to compare well levels in two water resource significant years, 1990 and 1992. The context of these years within the 11 year study period is explained in the text and graphically presented in Figure 5: Depth to Water. Pima County notes that water levels were generally declining prior to 1990 and then responded to a 1990 summer flood.

The water level rise in 1993 can be attributed to the combination of CAP delivery (with associated supply well shutdown) and a significant flood/recharge event. The flood event is not "ignored" as TW states; flow data is summarized on Page 12, graphically illustrated on Figure 8 and pointed out in the Discussion Section. Further, Figure 5- Depth to Water, shows CAP and the flood event in the context of the 11 year groundwater level measurements.

4. Response to TW Comment #8 and #9

TW takes exception to the Pima County recommendation to reduce pumping in the TVC area, as compensatory pumping would then be required at more distant wells, and the regional aquifer would still decline with the effect felt in the TVC area, the "edge" of the regional aquifer. Reducing pumping in the TVV has an immediate effect on the TVC regional aquifer levels as shown by TW in Comment #5, where Figure 2 is a graph of the effect of ceasing pumping at Well C-075B. The water table immediately climbs from nearly 120 feet to 60 feet. If pumping were reduced or eliminated in the TVV over a period of time to benefit from recharge events, the regional aquifer might recover to levels closer to the perched aquifer. This undifferentiated condition would lessen current excessive groundwater fluctuations.

If compensatory pumping was begun away from the TVV (i.e. west of the fault delimiter), it seems unlikely that regional groundwater levels in the structurally distinct TVV would decline at the same accelerated rate which has occurred due to local pumping. However, it is not the intent of the Pima

County to advocate transferring pumping from one problem area to another, especially to the Central Wellfield where land subsidence has accompanied water table decline. The Pima County emphasizes that the renewable sources of CAP and reclaimed water will provide the opportunity for the retirement or partial retirement of TW wells in the TVV, without the need to compensate at distant wells.

5. Response to TW Comments #10, #11 and #12

The Pima County report was developed under the auspices of the Sonoran Desert Conservation Plan, a regional planning tool currently being developed by Pima County and based on ecological science, natural resources assessment and evaluation. This comprehensive document will ultimately identify sensitive and unique biological communities in order to direct the inevitable development growth away from these areas. The mesquite bosque of the Tanque Verde Creek area represents a unique biological community in close proximity to metropolitan Tucson. It is under increasing development pressure which Pima County is currently handling in the following ways:

> Under the Floodprone Land Acquisition Program (FLAP), owners of land which is unsuitable for development due to floodplain, floodway and/or erosion hazard concerns, have the option of selling to Pima County. Along the TVC , Pima County has thus purchased several parcels of floodprone property and is committed to preserving their existing riparian habitat.
>
> Under the Watercourse and Riparian Habitat Protection and Mitigation Requirement (as revised in1998) of the Floodplain and Erosion Hazard Management Ordinance, any development that occurs in a mapped hydromesoriparian habitat, as much of the property adjacent to the Tanque Verde Creek is, must follow mitigation guidelines. Property developers are first encouraged to avoid habitat. If that is not possible, mitigation consists of restoring (onsite) 1-1/2 times the average mapped number of native trees and shrubs that would have occurred in the disturbed area. In the TVC area approximately 5 acres of disturbed habitat has been revegetated under this Ordinance. In October, 2000, District staff reviewed the effectiveness of the Ordinance and found strengths and weaknesses in its application. The detailed report, including recommendations to make the Ordinance a more effective tool for preservation and restoration, is attached with this comment response.

Bank protection, as pointed out by TW in Comment #10, may be compromising the health of mesquite that could benefit from overbank flooding and bank storage. Pima County staff support the recommendation of limiting future structural bank stabilization and, to the extent reasonably possible, removing existing stabilization.

Pima County also agrees that a comprehensive assessment should be made of the historical impact of land development and the resulting physical removal of vegetation over time.

MEMORANDUM

Date: October 20, 2000

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

From: C.H. Huckelberry
County Administrator

Re: **Improving the Riparian Habitat Mitigation Ordinance and Floodplain Regulations**

I. Overview

This memorandum describes (1) the potential applicability to Pima County of a national initiative to institute reforms in floodplain management based on the general failure of the National Flood Insurance Program and federal flood assistance to improve annual rates of flood damage; and (2) an assessment of the effectiveness of Pima County's Riparian Habitat Mitigation Ordinance (attachment). Recommendations offered by the Association of State Floodplain Managers and by County staff are included in this memorandum. Finally, in this memorandum I am instructing staff, consistent with the Board's direction on September 26, 2000, to form an inter-departmental team and formulate specific proposals for the Board's consideration as part of the Riparian Protection Element of the Sonoran Desert Conservation Plan, and the major plan amendment to the comprehensive plan.

II. Pima County's Floodplain Regulations in Light of the National "Good Neighbor" Policy

A. Background and Findings -- Despite 30 years of the National Flood Insurance Program and 75 years of federal flood control assistance, annual flood damage in the nation continues to worsen. The Association of State Floodplain Managers, a national organization for floodplain professionals, believes that this trend is the unnecessary result of spending too much time debating issues of individual standards while not stepping back and evaluating the collective impact of approaches. The Association is proposing a new policy that is based on the premise of allowing no adverse impact by landowners on adjacent properties. In other words, a *no adverse impact floodplain is one in which the actions of one property owner do not have a negative impact on the flood risk to other properties,* as measured by flood peaks, flood stage, flood velocity, overbank storage, erosion and sedimentation. The new "good neighbor" floodplain policies that the Association recommends are:

- Individual actions that create adverse impacts will be allowed only in communities that have developed and adopted a comprehensive river plan, and only if the adverse impacts are confined to the planning area and mitigated within it. Such a comprehensive plan would specify acceptable levels of impact, combined with appropriate mitigation measures, and a plan for implementation. This puts local communities in charge of their own development.

- The no adverse impact standard would virtually ensure that future development activities in the floodplain are part of a locally adopted plan. This removes the mentality that floodplain management standards are something imposed by the federal government, and will encourage localities to develop comprehensive strategies that can incorporate various community needs through a range of programs and approaches.

- With the no adverse impact standard, and the accompanying federal recognition of the local comprehensive plan as the acceptable standard in the communities that do have plans, federal resources could be spent on mitigation and other long-term strategies instead of on interpreting standards.

- Because of its flexibility and emphasis on local planning, the no adverse impact floodplain sets the stage for providing incentives that will recognize and reward communities that take strong mitigation actions.

The ongoing development of the Sonoran Desert Conservation Plan, which includes all major federal stakeholder agencies, and the upcoming major plan amendment of the comprehensive plan provide the opportunity to consider including the principles of this national initiative in Pima County planning.

B. Pima County's Current Floodplain Regulations – The Pima County Code (Title 16) states:

- *Natural flood-prone areas, stream, washes, arroyos, river and drainage courses, whenever possible be preserved in their natural riverine condition and that any land use proposal which utilizes this approach be considered superior to all others.*

- *Any human habitation or structural developments which limit natural processes within floodprone or erosion hazard areas be discouraged and limited to the extent allowable by law.*

Because the current county Code is tiered to the standards of the National Flood Insurance Program, however, which allows the floodplain to be filled until flood elevations increase by up to one foot, the Flood Control District approves plans and carries out projects that can have the effect of increasing flood peaks, flood stage and velocities, decreasing overbank storage, and altering erosion and sedimentation.

The National Flood Insurance Program generally imposes no consideration for effects such as velocity, overbank storage and sediment transport.

C. Effect of Amending the County's Floodplain Regulations – Amending the County Code by adopting a no adverse impact floodplain standard, similar to that proposed by the Association, would stem the loss of natural hydrologic and hydraulic functions. The Sonoran Desert Conservation Plan's riparian element has identified the loss of these natural functions as one factor causing losses to riparian and aquatic ecosystem. Amending the Code to reduce this loss would benefit certain wildlife species that use these ecosystems and contribute to the Section 10 Implementation Agreement with the United States Fish and Wildlife Service.

D. Instruction to Staff to Carry Out the Board's Direction of September 26, 2000 – By copy of this memorandum to staff in Development Services, Transportation, Wastewater Management, and the Flood Control District, my office will assemble and lead a team that considers how Pima County's conservation and comprehensive plans can reduce the cumulative impacts to natural floodplain hydrology and hydraulics. Since large, landscape-level decisions are made in the comprehensive land use plan, it will not be sufficient to simply amend the County Code. Rather, the first consideration to the cumulative hydrologic and hydraulic effects of developments should begin in the land use planning stage, before individual development and infrastructure plans are prepared. I am instructing staff to come up with recommendations about proceeding with the Association's "good neighbor" floodplain standards so such can be forwarded to the Board within the next 90 days. My office will coordinate this effort with federal agencies too, to ensure consistency with the Sonoran Desert Conservation Plan.

III. Pima County's Habitat Mitigation Ordinance – Effectiveness Review

A. Background and Findings -- During the last 45 days, members of staff have performed a review of the effectiveness of the 1994 Watercourse and Riparian Habitat Protection and Mitigation Requirements Ordinance. The attached report details the results of this investigation. In general, the study finds that:

- The Ordinance is working as intended to encourage avoidance of hydro-mesoriparian habitat (with the exception cited below), however, the original mapping omitted areas of xeroriparian habitat. The mid-1990s mapping has been greatly improved by the riparian mapping of the Sonoran Desert Conservation Plan, and such improvements can be reflected in an update of the Ordinance.

- The Ordinance is not effective in preventing fragmentation of hydro-mesoriparian habitat within broad riparian corridors and additional measures are needed to protect and restore these areas.

- Natural hydrologic functions are not protected by the Habitat Mitigation Ordinance and other methods, such as the national proposal discussed in the section above, are necessary adjuncts to the habitat mitigation ordinance.

B. Effectiveness Review – The study reviewed data since 1998 (the revision date of the Ordinance) and made site visits to formulate an assessment of the effectiveness of the Ordinance. Findings include:

- Since 1998, 33 mitigation plans have been submitted and all have been approved. Of the 33 plans, 27 have been for single family residences built in hydro-mesoriparian habitat. Habitat disturbance for each of these projects has been less than one half acre. Of the 33 plans, 6 development plans or plats have been subject to mitigation under the ordinance, and all are within xeroriparian habitat.

- Site visits to all mitigation plan projects shows that there is full compliance among completed projects with one exception. Despite the lack of an enforcement program, the mitigation plans to date are generally implemented by the landowner.

- The Ordinance establishes a preference for avoidance, and then onsite mitigation when avoidance is not possible, and then off site mitigation or banking as a last resort. Most of the mitigation has been onsite. The Ordinance does not, but should, require that the least damaging alternative be pursued.

- Avoidance is easier for large development projects that have a land base within which to site impacts than it is for single family projects working with a small land base, or commercial projects, which traditionally impact a larger percent of the project site. The Ordinance is not triggered in xero-riparian areas until 1/3 of the acre is impacted. In hydro-mesoriparian areas, which is considered to be of higher resource value, any amount of disturbance triggers the protection of the Ordinance.

- The average mitigation on a single family residence plan is 12 to 20 trees and a corresponding amount of shrubs and seeding.

- Mitigation banking has been an aspect of two private projects and another proposal is in process. County departments have mitigated impacts in compliance with the Ordinance, including Transportation, Parks and the Flood Control District.

- One of the major weaknesses of the existing Ordinance is that important xeroriparian areas are not included. Areas with total vegetation volume of a certain level were specifically not included. With improved mapping we can see the magnitude of the resource base that exists in drier areas but is not protected. From a practical perspective, compliance with federal endangered species law would probably be easier today, if during the last decade a multi-jurisdictional effort had protected the washes at the level delineated on the Harris Riparian Mapping found after page 7 of the attached report.

- Other weaknesses include that (1) hydrologic functions are not protected; (2) the Ordinance extends to structures, but not activities such as mining, agriculture, ranching, construction of transmission lines, or school district activity; (3) exotic species issues are not addressed; and (4) mitigation techniques need to be combined at times to create broader coverage.

C. Instruction to Staff to Carry Out the Board's Direction of September 26, 2000 – County staff, working in the assigned interdepartmental team and with federal agency staff through my office, will consider how the conservation and comprehensive plans might encompass the recommendations found on pages 9 and 10 of the attached report, which generally state:

- Consider the requirement that the least environmentally damaging alternative be selected for actions involving land that is designated critical habitat.
- Consider updating the Ordinance based on the improved riparian mapping that has been created through the Sonoran Desert Conservation Plan.
- Work with the federal agencies to align Section 402 and 404 permit standards under the Clean Water Act with county standards, in order to improve efficiency in the government permitting process and ensure consistency in protection of the resource base.
- Emphasize use of Floodprone Land Acquisition Program and bond monies to acquire riparian areas.
- Keep future development related infrastructure out of the riparian corridors.
- Tailor standards of protection to the priority of the watershed as defined by the Sonoran Desert Conservation Plan.
- Establish a meaningful monitoring and adaptive management program for riparian areas.

IV. Conclusion

As we carry out the Board's direction of September 26, 2000, each of the County ordinances and state and federal laws that effect the Sonoran Desert Conservation Plan and the major plan amendment to the comprehensive plan will be reviewed as the Riparian Mitigation Ordinance has in order to determine past effectiveness and future recommended adjustments in light of County planning efforts. These reports will be forthcoming to the Board on a regular basis.

c: Brook Keenan, Director, Transportation and Flood Control District
Carmine DeBonis, Interim Director, Development Services
Kathleen Chavez, Director, Wastewater Management
Maeveen Behan, Assistant to the County Administrator
Leo Smith, Floodplain Permit Manager
Jim Mazzocco, Planning Official
John Regan, Technical Services
Julia Fonseca, Flood Control District
Ben Changkakoti, Principal Planner
Carla Danforth, Flood Control District

Pima County's Riparian Habitat Mitigation Ordinance: Effectiveness Review

Prepared by Carla Danforth and Julia Fonseca
Pima County Flood Control District

Table of Contents

Pima County's Riparian Habitat Mitigation Ordinance

Effectiveness Review

Introduction

On July 19, 1994 the Pima County Board of Supervisors (Board) adopted the *Watercourse and Riparian Habitat Protection and Mitigation Requirements Ordinance 1994-FC2* (Ordinance). The purposes of the Ordinance are:

To enhance wildlife and recreation values where appropriate by preserving riparian vegetation along watercourses and floodplains and:

A. *Protect the valuable, limited and endangered natural riparian habitat resources of Pima County;*
B. *Provide an ecologically sound transition between riparian habitat communities and developed areas;*
C. *Assure the continuation of existing or natural functions, values and benefits provided by riparian habitat resources;*
D. *Promote an economic benefit to Pima County by providing the aesthetic, recreation and wildlife values of riparian habitat for the enjoyment of residents and visitors;*
E. *Promote natural erosion control; and*
F. *Promote continuity of xeroriparian habitat. (Ord. 1994-FC2 (part), 1994: Ord. 1998-FC2 Art. 10 (A), 1988.)*

The Ordinance was structured to encourage avoidance of riparian areas; it does not prohibit development within those areas. If a developer or property owner demonstrates avoidance of riparian habitat is not possible, then mitigation of disturbed habitat areas is required. Onsite mitigation to provide continuity of habitat is preferred, but offsite mitigation and mitigation banking options are available as alternative approaches to habitat conservation.

In 1998, four years after adoption of the riparian protection regulations, the community and the Board called for stronger all-around environmental regulations within Pima County. As part of that effort, the Ordinance was amended on July 14, 1998 so that the mitigation requirements now apply to all properties within unincorporated Pima County, not just those entering the rezoning or subdivision process. Other changes in the Ordinance text included: 1) any disturbance to hydro/mesoriparian habitat requires a mitigation plan approved by the Board, and 2) the mitigation trigger for the xeroriparian classes was to require a mitigation plan for disturbance of 1/3 acre or more.

Again, in 2000, as part of the Sonoran Desert Conservation Plan, ways to strengthen riparian habitat protection are being explored. This analysis finds that the current Ordinance is working as intended, to encourage avoidance of habitat by development. This is apparent by the small number of mitigation plans submitted. However, many

areas of xeroriparian habitat were overlooked by the original mapping, and hence have no regulatory protection. In addition, this report finds that the Ordinance is not effective at preventing fragmentation of hydro/mesoriparian habitat within broad riparian corridors. Additional measures will be needed to protect and restore these areas. Finally, other methods are needed to work in concert with this Ordinance to assure the continuation of natural hydrologic functions throughout Pima County.

History and Background of Ordinance Development

On July 16, 1991 the Board of Supervisors (Board) directed staff to begin preparation of a wash protection ordinance. This effort was driven by a desire of the community (mainly residents of the Catalina foothills) to preserve open space and vegetation along the washes. The Board asked staff to focus on regulations that would encourage developers, in particular, to protect riparian habitat. The resulting regulations, as recommended by the County Administrator's office were to "require specific mitigation for the removal of riparian vegetation within any defined floodplain of a wash having a discharge greater than 2,000 cfs when the aggregate area of disturbance within the floodplain exceeds one acre". The 2,000 cfs criteria was later dropped in favor of a habitat classification system.

Staff returned to the Board on April 7, 1992 with a draft of an Ordinance whose intent was to protect riparian habitat and to establish mitigation requirements for occurrences of unavoidable disturbances to riparian habitat. A definition was proposed for riparian habitat found in Pima County. Characteristics that typically identify riparian habitat in arid/semi-arid environments are: increased vegetation size and/or density along watercourses (areas with increased soil moisture compared to upland areas), or a change in plant species composition. The definition included three categories: hydroriparian, mesoriparian, and xeroriparian.

Because the majority of habitat found in Pima County is xeroriparian, this type of habitat was further subdivided into four classifications based on vegetation volume. Mitigation requirements were based on type of habitat being disturbed, with hydro/mesoriparian habitat considered the most rare and valuable, thus having the most stringent mitigation requirements. Since the classification system of habitat was based on total vegetation volume, the goal of the mitigation requirements is to replace the total vegetation volume of the disturbed habitat within five years.

Issues of application of the Ordinance were developed over the course of the next few months, with help of committees. A committee comprised of scientists was called upon for help in refining the definition and classification system for riparian habitat specific to Pima County, and development of mitigation requirements. Later, a broad-based committee representing all factions of the community was formed to help develop final Ordinance language. At the same time, regional habitat inventory maps were being developed. The "Pima County Watercourse and Riparian Habitat Protection and Mitigation Ordinance #1994-FC2" and the companion Zoning Code Text Amendment # 1994-113 "Modification of Development Standards in Riparian Areas" were adopted by the Board on

July 19, 1994. Following adoption of the riparian regulations, work on detailed riparian habitat maps commenced.

Due to private property rights advocate's and ranching concerns 1994-FC2 applied only to properties undergoing the subdivision or rezoning process. The riparian regulations did not apply to individual lots and building permits. However, the regulations at that time applied (and still do apply) to Pima County property and any projects undertaken by the county. The regulations also apply to State land, but federal land and preserves were not included because they already enjoy a higher level of resource protection than this Ordinance affords. The politicians responded to the private property rights advocate's concerns by allowing development to take place if mitigation was performed. By adopting an Ordinance that was not prohibitive, the issue of "takings" on private land was avoided. The Ordinance provides, through modification of the Zoning Code, incentives or options of developing property in a manner that allows preservation of habitat.

Examples of these options include increased development density outside the habitat area (cluster development), decrease in the required amount of parking, relaxation of height/setback requirements, etc. in exchange for avoidance of riparian habitat. The current version of the Ordinance adopted in July 1998 applies to all properties within unincorporated Pima County.

Effectiveness Review

Mitigation Plan Statistics

Since the 1998 revision of the Ordinance, only 33 mitigation plans have been submitted and approved. None have been denied. Twenty-seven mitigation plans are for single family residences being built within hydro/mesoriparian habitats. All of the single family residence plans involved habitat disturbance of one-half acre or less. Six development plans or plats have been processed, all being built within xeroriparian habitats.

The Ordinance lists an order of preference for mitigation; the first choice is to encourage avoidance of habitat. If avoidance is not possible then onsite mitigation is the next choice. If onsite mitigation is not feasible, offsite mitigation or the mitigation banking option can be utilized.

Most of the mitigation has been performed onsite. Three of the single family plans involved trading mitigation between 3 adjacent lots. The lots are under the same ownership and plant densities were "traded" between the three in order to meet mitigation requirements for the overall area. One residential plan transferred mitigation to another lot located downstream. Transferring mitigation to nearby areas helps to prevent fragmentation of the habitat corridor.

The Board must review and approve hydro/mesoriparian mitigation plans before a construction permit can be issued. The reason this requirement was included in the Ordinance was to draw public attention to the amount of hydro/mesoriparian habitat being

disturbed. To date, the Board has approved all mitigation plans that have been submitted for their approval. Xeroriparian mitigation plans are reviewed and approved at the staff level.

Compliance Review

As part of assessing the effectiveness of the Ordinance in protecting habitat, field visits were made during August 2000 to each property having an approved mitigation plan. All but one of the projects that have been completed are in compliance with the plans. Many of the projects are still under construction. A statement included in the Floodplain Use Permit gives applicants until the first growing season following completion of construction to comply with the mitigation regulations.

Over the next few years as the mitigation plantings mature, the success of completed mitigation should be evaluated. The Ordinance classification system of habitat was based upon total vegetation volume (tvv) and natural water availability. The mitigation standards were developed with the goal of replacing the tvv of the disturbed habitat within five years of planting. Plant lists were developed for both hydro/mesoriparian and xeroriparian habitat that contain a range of the types of plants found within the different habitat classifications. The mitigation standards suggest use of a mixture of plant species that reflect the habitat that is being disturbed.

The mitigation requirements have been in place since mid-1995 following adoption of the habitat maps and mitigation standards by the Board. The five year establishment period for the first mitigation plans submitted under the Ordinance will conclude during the fall/winter season of 2000. During the next year a plan for evaluating the health and effectiveness of the mitigation should be developed.

Mitigation Plan Effectiveness

The Ordinance is accomplishing the goals set by the Board and the community at time of adoption. It is working the way it was intended - encouraging avoidance of the denser and moister riparian environments that have been mapped. This is particularly evident by the small number of mitigation plans being submitted. The Ordinance is successful in keeping most owners from "mass" grading their lots, and encourages more environmentally sensitive site planning.

Since the 1998 revision of the Ordinance (which now applies to all property), it is difficult on some lots to avoid hydro/mesoriparian habitat during development of single family residences (SFR). This is particularly true on Tanque Verde Creek where lot size leaves no option for avoidance within the broad riparian corridor. The trend in this area is to build large residences on relatively small lots, not providing much space for avoidance of habitat or mitigation. Since revision of the regulations, a larger number of hydro/mesoriparian mitigation plans are being submitted. Most mitigation plans are drawn to avoid disturbance of habitat as much as possible and mitigation involves planting small amounts of trees and shrubs. The average amount of mitigation for a SFR is 12-20 trees and a corresponding amount of shrubs and seeding.

Larger developments tend to be located outside of hydro/mesoriparian areas and have more acreage on which to avoid disturbance of habitat. Commercial developments tend to have less flexibility in their site design, and if located in a riparian area, leave little or no space in which to perform mitigation. Commercial developments are most likely to use the mitigation banking approach for project habitat mitigation.

Mitigation Banking

To date, two plans have incorporated mitigation banking, and one more residential plan requesting mitigation banking is currently in process. One commercial plat involved mitigation banking. The developer contributed monies to a restoration project located offsite. This restoration project is being used to meet the USFWS and Army Corps of Engineers 404 Permit mitigation requirements as well as the Ordinance mitigation requirements. The restoration project is being administered by The Tucson Audubon Society.

In this case, mitigation banking was the only option if the project was to be constructed. Commercial projects are the most likely candidates for mitigation banking. The residential lots utilizing mitigation banking are relatively small and heavily wooded. The size of the houses and associated improvements on most of these lots makes onsite mitigation difficult or impossible to accomplish.

Most of the single family residences within hydro/mesoriparian habitat could be eligible for mitigation banking, however it may be more valuable (from a biological viewpoint) to keep the habitat within the same area/watercourse reach. By mitigating onsite or in a nearby area, the habitat will become less fragmented. Continuity of habitat is important for wildlife. The small amount of funds that would be contributed to a mitigation bank by these individual lot owners would take a substantial amount of time to build to a level that could be used for habitat restoration by a public agency. In the meantime if funds are contributed in-lieu of onsite mitigation, habitat along these watercourses is being fragmented, adversely affecting wildlife. Once the habitat is gone, and replacement habitat is not available the animals will be forced to seek other areas for cover and forage (all of which are shrinking).

Mitigation plans for County projects have been implemented for transportation, parks, and flood control projects. No mitigation plans have been received from Pima County Wastewater Management. The requirements apply equally to private and public projects within unincorporated Pima County.

Ordinance Enforcement

A formal enforcement program has not yet been developed and implemented. Permit conditions requiring completion of the mitigation by a certain date, i.e., the next growing or planting season following construction should be a standard part of the permit. A standard FPUP is valid for one year from the date of issuance. The permit expiration date may need to be extended to allow property owners time to comply with the mitigation requirements. A typical residence takes 6-12 months to construct and mitigation should

be completed during the growing season following construction. Regular field inspection of the plans to ensure compliance should be scheduled. Field inspections are currently conducted periodically due to staff work loads.

Strengths and Weaknesses of the Ordinance

Community Acceptability

One strength of the riparian ordinance is that it is not prohibitive, in that it allows for development of private property with restrictions. By structuring the language in a non-prohibitive way, it was acceptable to the community and adopted by the Board of Supervisors (Board). If development were prohibited on private land because of habitat designations, then property owners would believe the Ordinance is "taking" the use of their land.

Mitigation Requirements

Another strength is the mitigation requirements are based on a scientifically sound and defensible vegetation classification system and mapping technique. Total vegetation volume is positively correlated with breeding bird densities. The intent of the mitigation is to replace total vegetation volume and structure through planting trees, shrubs and ground covers.

Classification and Mapping

The delineations of regulated habitats used by Pima County are a weakness. They are largely based on multi-spectral LANDSAT images from the early 1990's. The methodology used to classify the riparian areas fails to protect some of them because of their narrow size relative to the 30-meter LANDSAT pixels. Wide xeroriparian areas which did not meet vegetation volume thresholds were not protected either. Other riparian areas dropped out because the LANDSAT imagery was not rectified to the same base as the orthophotos. A minimum map length of 420 meters prevented some riparian segments from being protected.

For these and other reasons, the Science Technical Advisory Team recommended that the riparian vegetation maps be improved in the Sonoran Desert Conservation Plan. That work is underway, and it is expected that new mapping will be completed in December 2000.

Figure 1 presents an example of the current regulatory maps for the Tortolita Piedmont area. Most of the riparian zones along small watercourses in this area were not delineated. Riparian zones protected under Pima County's ordinance are shown in yellow on the top of Figure 1. Riparian zones which lie along small, fine-textured drainage networks were not protected under the Ordinance, despite their apparent importance to cactus ferruginous pygmy-owls as well as other animals.

The bottom of Figure 1 shows riparian areas delineated for the Sonoran Desert Conservation Plan (SDCP). These areas were mapped based on 1:24,000 USGS orthophoto quadrangles. The polygons differentiate riparian areas from uplands based on

tonal differences visible at that scale. The riparian areas are classified based on vegetation communities, not vegetation volumes. A previous report, entitled *Pima County Riparian Vegetation Mapping Pilot Study* (May 2000), summarizes the ongoing SDCP mapping effort and provides more information about these maps.

A comparison of the two figures shows that much xeroriparian vegetation is not protected by the current classification. One reason is that xeroriparian areas with a total vegetation volume less than 0.5 m^3/m^2 were deliberately excluded under County ordinance. This threshold value was chosen for Pima County's riparian habitat mitigation ordinance because it represents the upper limits of the vegetation volume of upland Sonoran Desertscrub and Semidesert Grassland biomes. In other words, only the xeroriparian vegetation that was denser than the densest desertscrub or grassland qualified for protection. As a result, few xeroriparian areas in the drier parts of Pima County qualified.

Rectification and Loss of Habitats

In November 1999, Westland Resources under contract with the District, verified the hydro/mesoriparian (H/M) map boundaries along Tanque Verde Creek upstream of Houghton Road. This work was undertaken because during administration, staff found some areas mapped as H/M habitat did not have sufficient vegetation volume to be protected.

Westland mapped H/M habitat using more recent aerial photography (dated October and November 1998) and verified the boundaries in the field. Comparison of the updated field mapping to the original H/M map layer revealed only minor differences. The outermost habitat boundaries on the satellite layer were essentially the same as the field-mapped boundaries. Larger differences were found on parcels where habitat had been altered since 1990 (the date of the satellite imagery used for the original mapping effort).

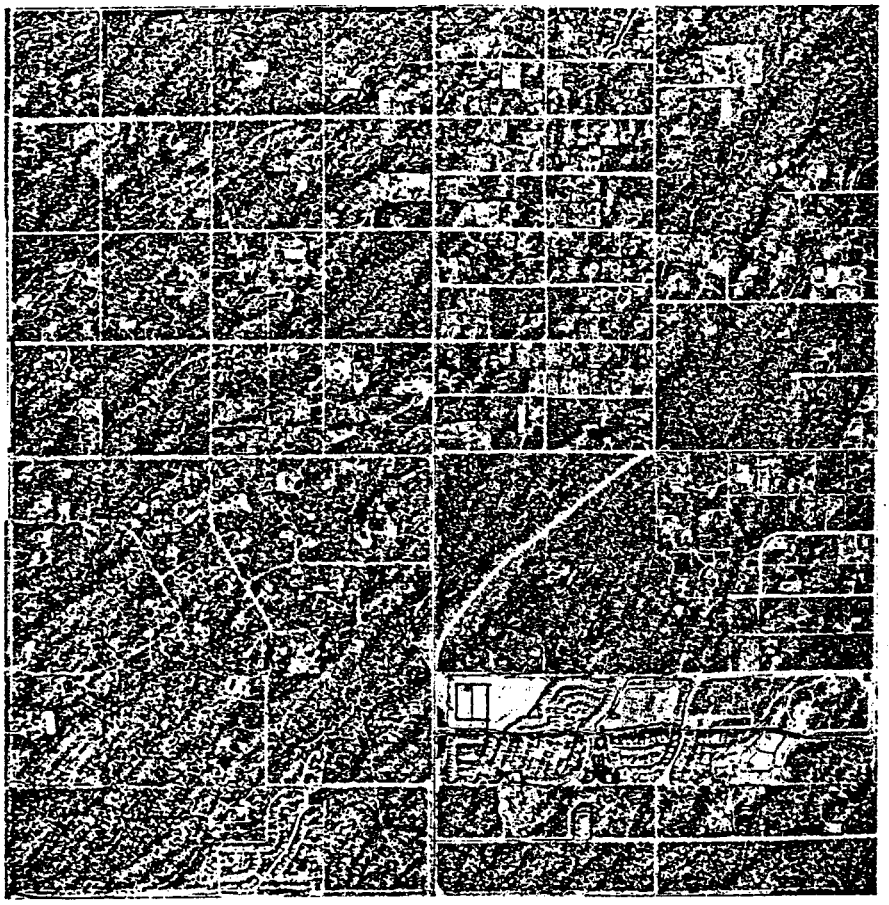
Comparison of the field mapped boundaries to the original boundaries revealed that problems in determining the correct location of the H/M habitat boundaries relative to property lines are due to rectification problems with the parcel base data and the overlaying habitat layer in the GIS system.

Least Damaging Alternatives

From a biological viewpoint, one weakness of the current Ordinance is that protected habitat can be disturbed, if mitigation is performed. An applicant is required to demonstrate the habitat disturbance cannot be avoided before preparing a mitigation plan. Department enforcement includes negotiation on placement of development relative to the habitat, and most applicants are willing to change their plans to avoid disturbing habitat as much as possible. However, the least environmentally damaging alternative is not required by staff or the Ordinance. Some applicants are inflexible, insisting on a development plan that disturbs habitat in lieu of a more sensitive plan.

Regulation Triggers

From a legal and property rights advocate viewpoint the mitigation trigger for xero-riparian habitat is a strength. To allow property owners use of their properties, the mitigation

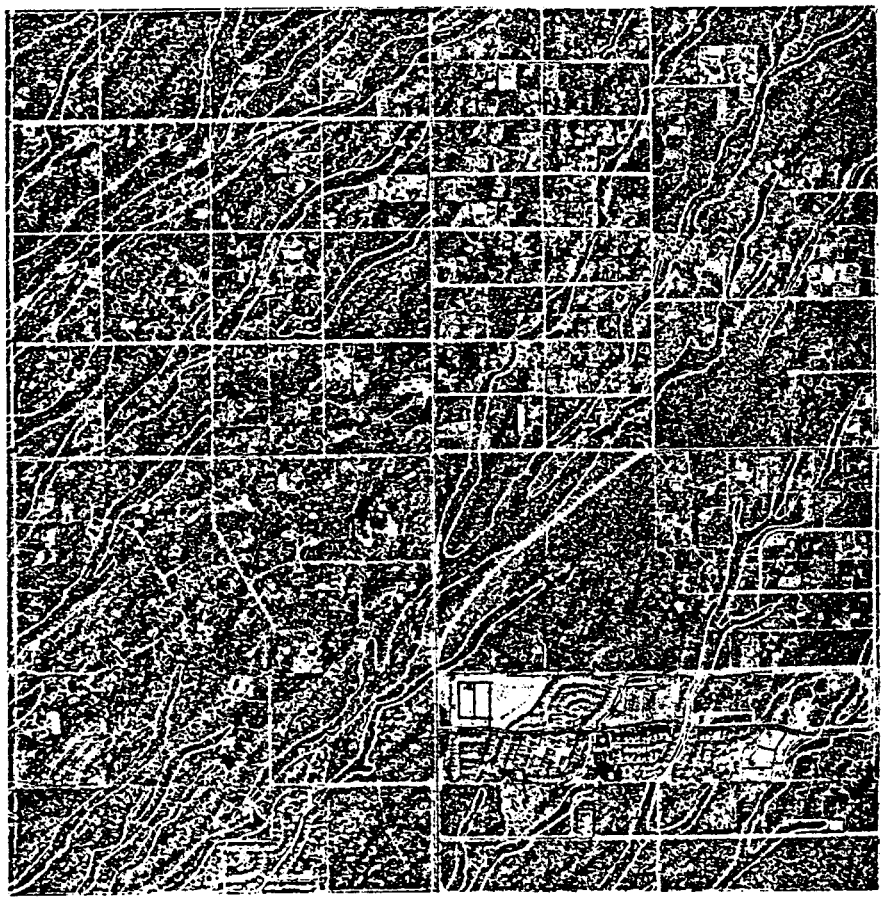


Pima County Riparian Habitat Mapping

Ruelas Canyon Quad

Riparian Habitat

Administrative Boundaries



Harris Riparian Habitat Mapping

Ruelas Canyon Quad

Riparian Habitat

Administrative Boundaries

Figure 1

trigger for xeroriparian habitat was set at 1/3 acre. By allowing habitat disturbance up to 1/3 acre before mitigation is required, most site plans can be designed so no habitat or only small areas are disturbed. Hydro/mesoriparian habitat is considered more valuable, thus the zero disturbance trigger.

In some areas of more diverse, biologically valuable xeroriparian habitat this trigger could promote habitat fragmentation by allowing incremental destruction of habitat on adjacent parcels. If disturbance continues at the present rate valuable habitat will be fragmented.

Plant Species Diversity

The mitigation being performed (if successful) will replace the vegetation volume, but may be of a different value from a biological viewpoint. Both habitat fragmentation and the replacement value of the mitigation is a growing concern along Tanque Verde Creek, where much of the county's remaining hydro/mesoriparian habitat is located. Most property owners opt for mitigation plans using mainly mesquite. Although mesquite provides valuable bird habitat, the mitigation areas may become less biologically diverse. Revision of the mitigation plant list requirements should be considered to ensure more diversity for better wildlife habitat.

Issues that a Mitigation Ordinance Cannot Address

The Ordinance only affects activities which require a floodplain use permit. Destruction of riparian vegetation is not regulated unless a structure is planned. Even if a structure is planned, permits are not required for mining, agriculture, ranching, and construction of electric transmission lines under state statutes. School districts are also exempt. These exemptions allow destruction of habitat without mitigation being performed (provided the project does not fall under federal laws that require habitat mitigation).

Other human uses may detrimentally affect riparian areas. Uses such as mowing or clearing of the understory vegetation for aesthetics or fire control, wood-cutting and grazing of livestock reduce total vegetative cover. The presence of pets (in particular domestic cats which prey on birds, lizards, and insects) and invasion of exotic plant species can affect the habitat quality of preserved or mitigated riparian areas.

In and of itself, hydrologic functions that support riparian systems are not protected. For instance, in the Tortolita piedmont, alteration of distributary flow characteristics can be expected to change sediment transport and peak discharges. Changing these characteristics will likely change the distribution and function of the riparian systems. Loss of over-bank storage along a watercourse, or depletion of sediment by gravel mining alters hydrologic functions. Groundwater pumping can decrease water table levels, another example of how hydrologic functions are not protected. Extension of roads, sewers, and bank stabilization to areas facilitates development at increased densities, with concomitant increases in groundwater pumping.

Separate measures to address hydrologic functions, invasion of exotic species, and habitat

destruction due to statutory exemptions will be needed. The ordinance itself is insufficient to protect ecosystem functions.

Alternative Approaches to Helping Protect Habitat

In rapidly developing urban areas working with the owners to develop site and/or mitigation plans to keep habitat intact and mitigation efforts onsite is important. To quote Bill Weeks, Vice President of The Nature Conservancy, discussing the conservancy's effectiveness, "Our organizational ethic is pragmatic and solution oriented. The long-term conservation of areas depends on the people who live in and around them". Without the cooperation of property owners long-term habitat protection is not possible.

On heavily wooded lots being developed for residential use, hydro/mesoriparian habitat mitigation ratio of 1.5:1 is often impossible to accomplish onsite. To help provide more continuous cover, mitigation techniques could be combined. For example, placing as much mitigation onsite as possible with the remainder being performed on another site within the same habitat corridor will serve to reduce habitat fragmentation. If a suitable offsite area is not available for the remainder of the mitigation requirements, contribution to a mitigation bank would be required. By using a more flexible approach to enforcing the regulations, property owners are more receptive to the Ordinance and less habitat is fragmented. Working with property owners for a mutually acceptable plan ensures future good stewardship of the property.

As outlined in the SDCP, the County can work more proactively with other agencies, environmental organizations, and landowners to find suitable locations for habitat restoration and mitigation. The banks could be administered by public agencies or private organizations. Flexibility in establishing mitigation banks is the key to successful habitat protection and restoration.

Establishment of a network of conservation easements using mitigation banking monies and other funding is a good tool for protection of existing habitat. Mitigation should be second choice to habitat protection, because revegetating riparian areas is challenging, and may not prove to be successful.

Recommendations:

Require the least environmentally damaging alternative be selected for any actions in designated pygmy-owl critical habitat and in high priority watersheds defined in the Sonoran Desert Conservation Plan.

Consider the revised riparian vegetation maps prepared for the Sonoran Desert Conservation Plan for adoption under the Ordinance.

Distribute the revised riparian vegetation maps to other resource agencies and encourage them to avoid these areas in the Section 404 Clean Water Act process.

Use the existing LANDSAT imagery processing as a basis for mitigation target volumes, unless and until better resolution information is available.

Emphasize use of the Floodprone Land Acquisition Program and bond monies to acquire riparian areas, especially hydromesic areas, and to establish conservation easements.

Do not extend roads, sewer easements, and bank stabilization infrastructure along riparian corridors.

Pursue multiple methods to protect all hydromesoriparian areas, such as purchase of property rights, surface/groundwater rights, extension of reclaimed water lines, formation of parks/preserves, development of multi-use corridors, planting of native vegetation on existing disturbed areas, physical barriers to close washes to off-road vehicles, and partnering with local conservation organizations, ranchers, agriculture, state and federal agencies, companies with large land holdings, developers, etc.

Implement an enforcement program to ensure mitigation is completed and maintained.

Provide a deadline for completion of mitigation, which may require extension of the Floodplain Use Permit time frame.

Accept a combination of onsite, offsite, and mitigation banking contributions, where appropriate.

Support stronger floodplain management regulations in high priority watersheds, as defined in the Sonoran Desert Conservation plan.

Evaluate the health and effectiveness of mitigation plantings in replacing lost vegetation volume.

Attachment 3