TEXAS BRUSH CONTROL PROGRAM
NORTH CONCHO RIVER WATERSHED PROJECT
FY 2000-2001 MONITORING REPORT

2000-483-333

Prepared By

UPPER COLORADO RIVER AUTHORITY

For The

TEXAS STATE SOIL AND WATER CONSERVATION BOARD

August , 2001

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1.0 Introduction

The Upper Colorado River Authority (UCRA) was awarded a contract from the Texas State Soil And Water Conservation Board (TSSWCB) on September 1, 1999 to provide services that would result in the effective monitoring and assessment of the effects of the on-going brush control program on the North Concho River watershed. The monitoring program proposed by the UCRA consisted of a multi-task program including paired watershed studies, groundwater monitoring and surface water flow measurements. Since work on the contract began, several other study elements have been added, including monitoring to assess the effects of mechanical brush clearing on erosion losses.

The purpose of this report is to provide the TSSWCB with a detailed summary of the work conducted on this contract and to report any significant observations or identified hydrologic trends that have resulted from the brush eradication efforts completed through the end of the contract period. Work progress on each of the proposed work tasks is reported in the following report sections and significant observations and special work efforts are identified.

Status of the brush control program through the end of the contract period is described below based on information provided by the TSSWCB. This information indicates that 200 land unit requests have been received with 133 conservation plans prepared and approved. The total area requested is now at 708,756 acres and 478,121 acres have been planned. 96 contracts have been issued to treat 183,761 acres at a state cost of $7,162,782.54. Total contracted expenditures including landowner costs is now at $9,812,030.88. The total area of the program watershed is approximately 950,000 acres. The ongoing drought conditions that have plagued the region since 1998 have resulted in conditions within the program area that are not optimum for aerial spraying of mesquite. As a result, the only brush removal work ongoing or accomplished to date is essentially mechanical removal. Currently, approximately 65,000 acres under contract have been certified as complete and considerable additional work is ongoing. See figure 9 for map of watershed area locations contracted and completed. Although a significant amount of brush clearing has been completed or is presently underway, the total acreage of work compared to the planned acreage of work still remains small. It is recognized that due to the level of completed brush removal and the on-going drought, any basin wide water resource benefits may be difficult to measure at this time. For this reason, the UCRA has focused initial detailed monitoring attention to determine benefits on sub-basins within which substantial control efforts have been made. Recent observations of these sub-basins are described in this report.

recovery rates within the riparian zone from up dip portions of the aquifer in the absence of brush influences. One example of this type of evaluation is the records from the USGS station near Carlsbad, Texas. A large perennial pool exists at the site of this station that is very reflective of groundwater conditions adjacent to the stream. During most of the summer and early fall months, water levels within this pool were observed to be much below the "0" flow elevation and declining. On October 24, 2000 rainfall in the area resulted in a storm water runoff event. This storm event filled the pool at the site and resulted in a significant flood flow rate (2150 cfs daily mean) for a short period. Following this, the stream flow rate declined gradually for many weeks until a "0" stream flow was essentially encountered again on November 17, 2000. This was a return to the pre rainfall condition. Beginning on December 23, 2000,however, the record indicates that a gradual and steady increase in stream flow (and gauge height) began which reached the 2.3 cfs level on January 22, 2001. This return to base flow conditions had not been accompanied by any rainfall conditions that contributed directly to the stream flow and was due to the up dip contributions of the aquifer to the alluvial aquifer adjacent to the stream. According to staff observations, brush species in the area generally managed to hold on to their foliage until December 11-13, 2000, when, according to Weather Service records, temperatures of 25,22 and 26 degrees F. respectively, was experienced. The actual first 32 degree day was on November 8, 2000. On December 23, 2000 (or approximately 10 days following the low temperatures) the flow record indicates that perennial flows began and were increasing. After that time, the hydraulic gradient (gauge height) increased from approximately 3.53 on December 22, 2000 to 3.69 on January 22, 2001. This is a height increase of 0.16 ft. (1.92 in.) in approximately 30 days. It is likely that an approximate 2 in. per month increase in the hydraulic gradient (and accompanying increase in base flow) occurs most years until the spring onset of plant foliage. This increase may likely be irrespective of normal climatic conditions. A graphic display of the gauge heights and stream flows at this site from October, 2000 through January 22, 2001 is shown on Figure 3. Area climatic records from the Weather Service for the period is included in the appendix.

Another use of the stream flow records that are being presently collected has been to further evaluate storm event runoff characteristics under the current "brush" condition. A rare storm event that occurred only over the upper portions of the watershed on March 22, 2000 allowed an accurate assessment of the effects of dry stream beds on watershed runoff potential. It was determined that approximately 45% of the watershed runoff yield was lost to the dry streambed. A memorandum describing this investigation is included in the appendix to this report. The UCRA investigators believe that extensive brush removal will result in a return to near perennial stream flow conditions and saturated stream alluvial deposits thus largely eliminating "channel losses" from the watershed yield potential.

A recent (August 17,2001) rainfall event over a large portion of the watershed further illustrated storm event characteristics under the current "brush" condition and also may have provided an early indication of "positive" results of the brush removal program. three sub basins within the watershed have been selected for intensive study in the next contract period. These were selected due to the amount of brush removal work completed

2.0 Paired Watershed Studies

Two sets of paired watersheds have been developed and equipped to determine the effects of brush control on the total water budget of each. One set of watersheds is located within predominately juniper cover and the other set is located within predominately mesquite cover. One watershed of each type will be treated to remove cover, while the other will remain untreated. Each watershed has been equipped with Campbell Scientific Data Loggers and sensors to automatically record evapotranspiration using Bowen ratio/energy balance methods. Data collected includes precipitation (quantity and rate), wind speed and direction, air temperature, relative humidity, dew point, soil moisture and several other parameters. In addition, the total surface water discharge and ground water levels will be monitored. Since installation of the equipment, program staff have visited the sites on a weekly basis to check equipment, provide any necessary maintenance and to download the accumulated data into a lap top computer. This data was then electronically submitted to the Blackland Research Center in Temple for tabulation and review. The initial two year contract period had been established as a monitoring period to collect preliminary baseline data from all sites prior to brush removal. After September 1, 2001, it has been planned to remove brush from one of the sites in each paired sets. Location of the paired watershed sites is shown on Figure 1. This task has been removed from the North Concho Monitoring program for the FY 2002-2003 period. This work will be ongoing, however, within the Texas Brush Control Program Research Project also being administered by the UCRA. In addition, the technical support and operation of the project has been transferred from TAMES to the Texas Institute for Applied Environmental Research, Tarleton State University.

3.0 Surface Water Monitoring

Prior to this monitoring project, two USGS maintained stream flow measurement stations existed on the North Concho River. With project funds, the UCRA has established two additional USGS stream flow stations on the river at critical locations. One has been installed immediately upstream of O.C. Fisher Reservoir and the other is located at the source springs of the river on the "U" Ranch north of Sterling City. Also, additional flow monitoring sites have been established on the river by the UCRA to monitor perennial flows. These sites are visited periodically to gauge perennial base stream flows, and with the USGS data, provide a good "snapshot" of the entire stream reach flow characteristics at regular points in time. The location of the surface water stations are shown on Figure 2.

The existing low level of brush removal within the basin generally prevents the program flow data collected to be utilized to monitor flow responses resulting from brush work. Within the basin as a whole. It is being collected, however, to provide a good record of existing (brush) base flows under various climatic and seasonal conditions. In addition, this data is currently being utilized (with general climatic data) to evaluate annual changes in groundwater levels and subsequent stream flows due to the elimination of evapotranspiration water losses from brush during the winter dormant period. This information is extremely valuable because it provides an estimate of groundwater

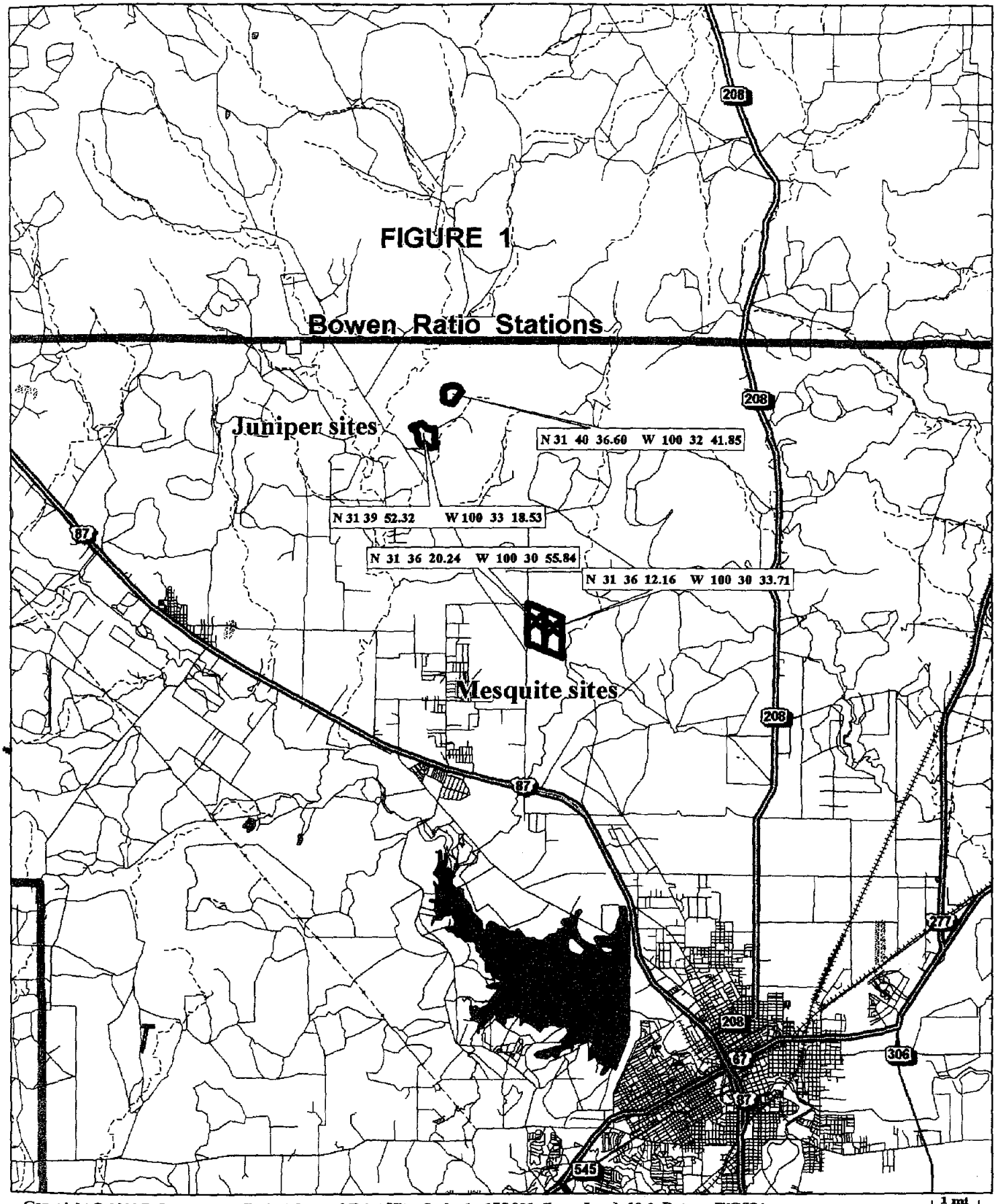
FIGURE 1
Bowen Ratio Stations
Juniper sites
N 31 40 36.60 W 100 32 41.85
N 31 39 52.32 W 100 33 18.53
N 31 36 20.24 W 100 30 55.84
N 31 36 12.16 W 100 30 33.71
Mesquite sites
208
87
277
306
67
545
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1 mi

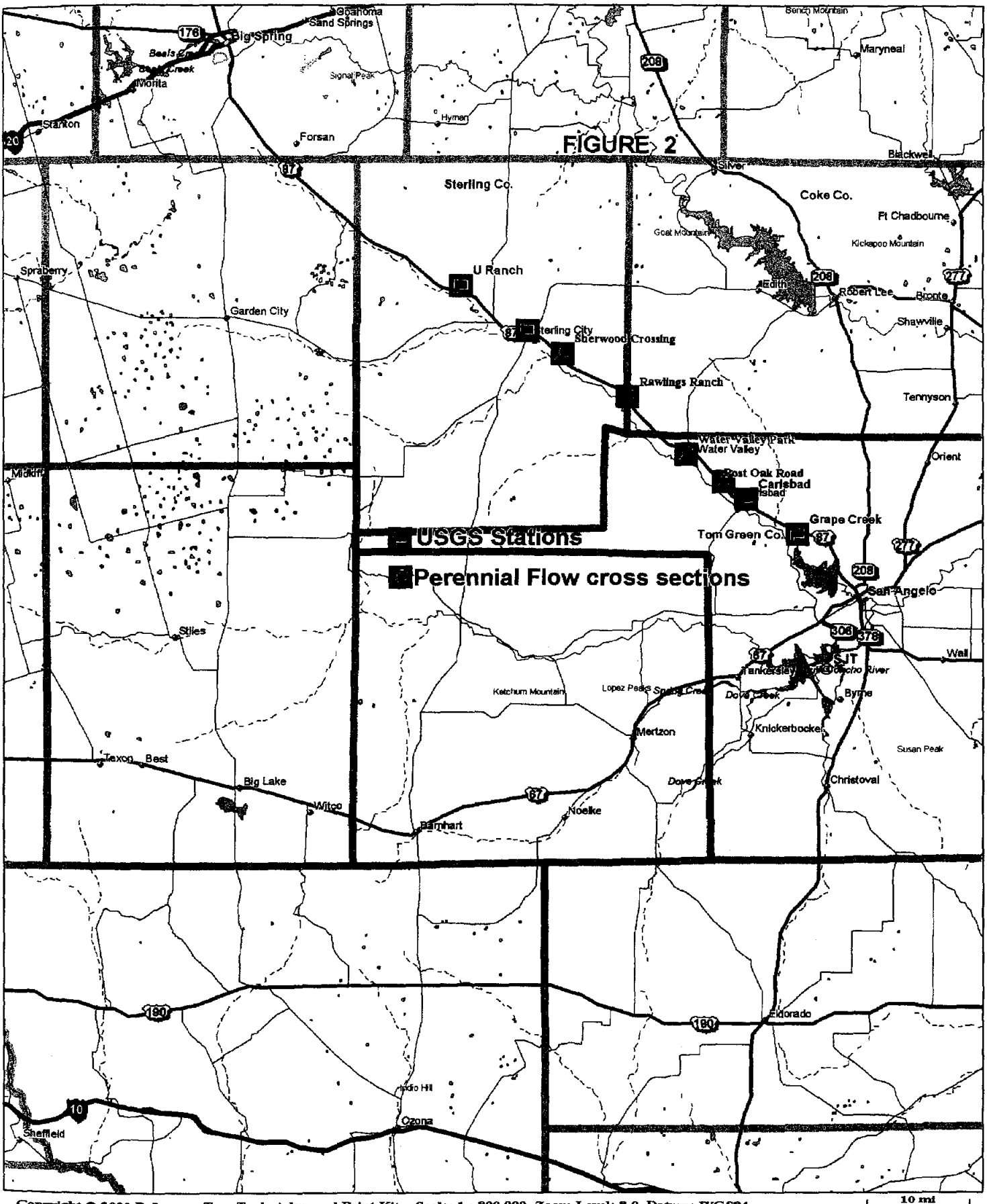
FIGURE 2
USGS Stations
Perennial Flow cross sections
Big Spring
Stanton
Forsan
Sterling Co.
Coke Co.
Ft Chadbourne
Silver
Blackwell
Maryneal
Bench Mountain
Signal Peak
Hyman
Goat Mountain
Kickapoo Mountain
Spraberry
Garden City
U Ranch
Sterling City
Sherwood Crossing
Rawlings Ranch
Robert Lee
Bronte
Shawville
Tennyson
Water Valley
Orient
Post Oak Road
Carlsbad
Grape Creek
Tom Green Co.
San Angelo
Midkiff
Stiles
Ketchum Mountain
Lopez Peaks
Dove Creek
Byrne
Knickerbocker
Mertzon
Susan Peak
Christoval
Texon
Best
Big Lake
Wilco
Barnhart
Noelke
Eldorado
Indio Hill
Ozona
Sheffield
SJT
Wall
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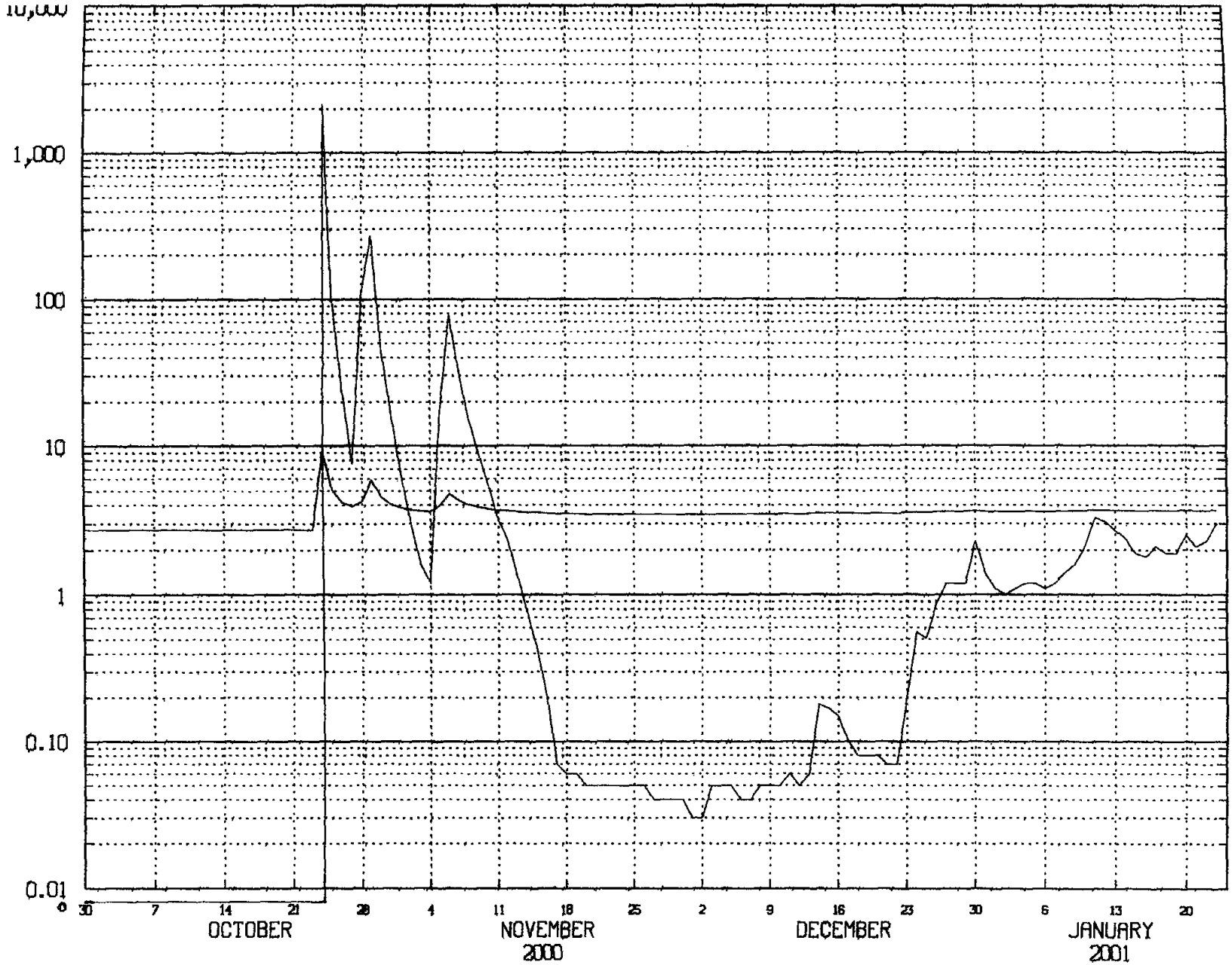

08134000 N CONCHO RV NR CARLSBAD, TX
MEAN DAILY GAGE HEIGHT (FEET), FROM DCP

08134000 N CONCHO RV NR CARLSBAD, TX
MEAN DAILY DISCHARGE (CFS)

FIGURE 3

to date or other unique characteristics within the sub basins and early indications of response. Two of the sub basins, Chalk Creek and Grape Creek received rainfall during the August 17 event and as a result, both creeks experienced rainfall runoff. Since no other adjacent sub basins produced runoff it could be theorized that the brush removal efforts within these two sub basins enhanced this observed response. Further discussion of the sub basin responses is included under the report section "Special Monitoring Activities". A post event analysis of the runoff indicated peak flows on the creeks at 257 CFS for Grape Creek and 169 CFS for Chalk Creek. It is estimated that total watershed yields were 130 and 100 acre feet respectively for Grape Creek and Chalk Creek. Although the flows on Chalk Creek effectively closed a County Road low water crossing on the North Concho River (Post Oak Road) the effects of both creek flows on the River were minimal. This was due to the extremely dry conditions of the River bed itself and the associated shallow alluvial aquifers. The Chalk Creek flows were never measured at the USGS station at Carlsbad located approximately three miles below the confluence. The Grape Creek flows were never measured at the USGS station at the FM 2288 bridge also located approximately three miles below the confluence. This observation clearly illustrates the effects of the lack of perennial stream flows and saturated aquifers on storm water runoff yields.

4.0 Groundwater Monitoring

Monitoring wells have been located primarily in Sterling and Northern Tom Green Counties. The location of these wells is shown on figure 4. Most of the wells in Sterling County that are being utilized are wells on which a long history of water level records exists due to measurements by the Texas Water Development Board and the Sterling County Underground Water Conservation District. These wells will be most valuable to the program in evaluation of short and long term changes in the aquifer hydraulic gradient. The wells in Tom Green County have been located by UCRA staff based on location, accessibility and use. Additional wells may be located and utilized as required by on going data collections and evaluation. The wells were initially monitored on a twice yearly basis, but after 9-1-01 they were monitored quarterly. All of the accumulated groundwater data is included in the appendix to this report. This data will be utilized by the investigators on both a short term and long term basis as the monitoring program continues and the brush removal effort moves toward completion. Isolated Sub basin perennial responses will be the result of localized hydraulic gradient changes that are not reflective of the basin wide condition. Since existing climatic conditions including rainfall should be similar within the basin, these anomalies will likely be due to ecological changes brought about by the brush control program. The basin wide hydraulic gradient also needs to be monitored on a regular basis to measure and record normal changes due to climatic and seasonal differences and to document any long term trends in changes that also may be due to ecologic changes brought about by the brush control program. In addition, the previous report section has described the role of ground water monitoring in documenting the relationship between up dip aquifers, aquifers within the riparian zone and stream base flows.

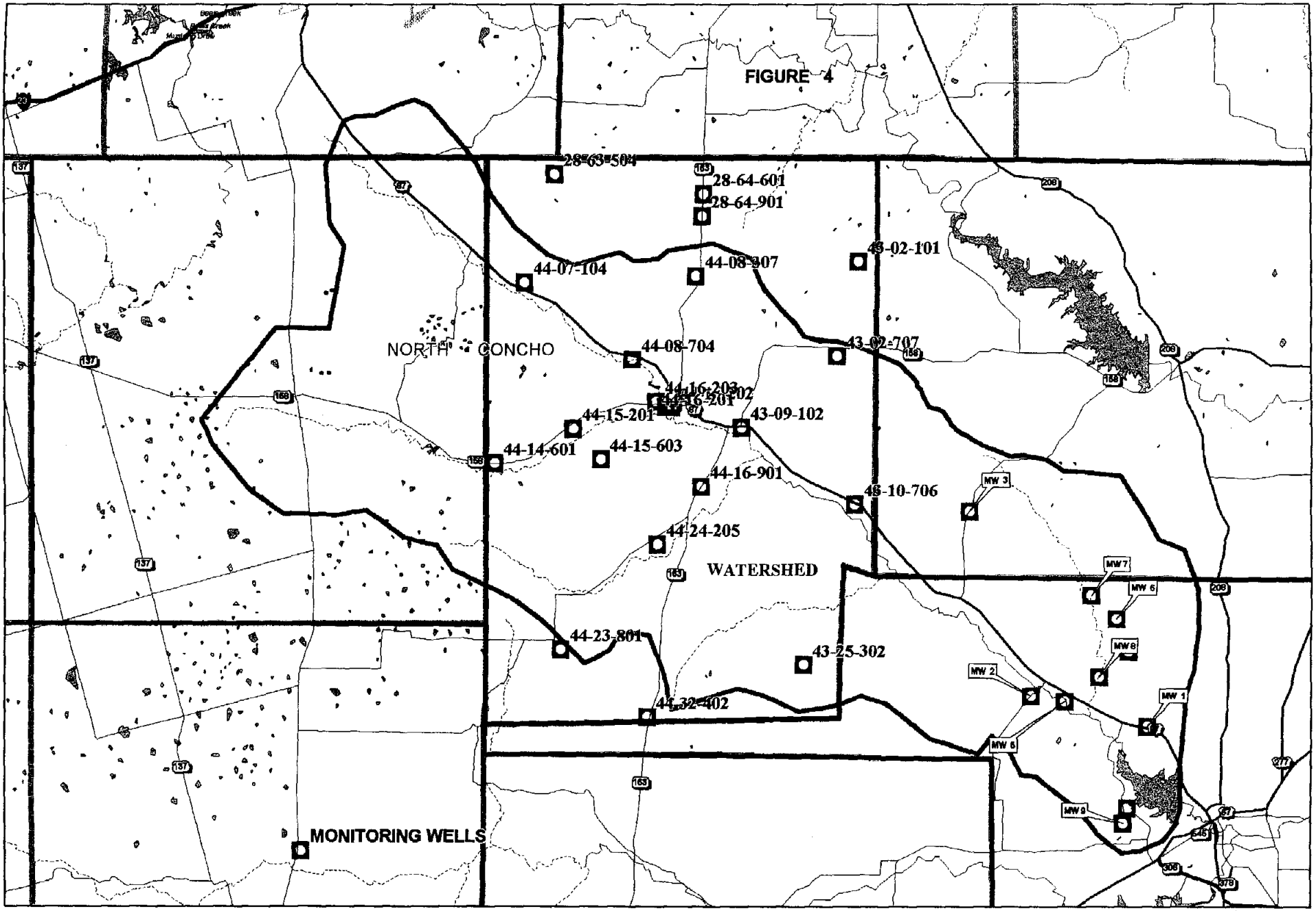
FIGURE 4
28-63-504
28-64-601
28-64-901
43-02-101
44-07-104
44-08-907
NORTH CONCHO
44-08-704
43-02-707
44-16-203
44-16-201
44-16-202
44-15-201
43-09-102
44-14-601
44-15-603
44-16-901
43-10-706
MW 3
44-24-205
WATERSHED
MW 7
MW 6
MW 8
44-23-801
43-25-302
MW 2
MW 1
44-32-402
MW 5
MW 9
MONITORING WELLS
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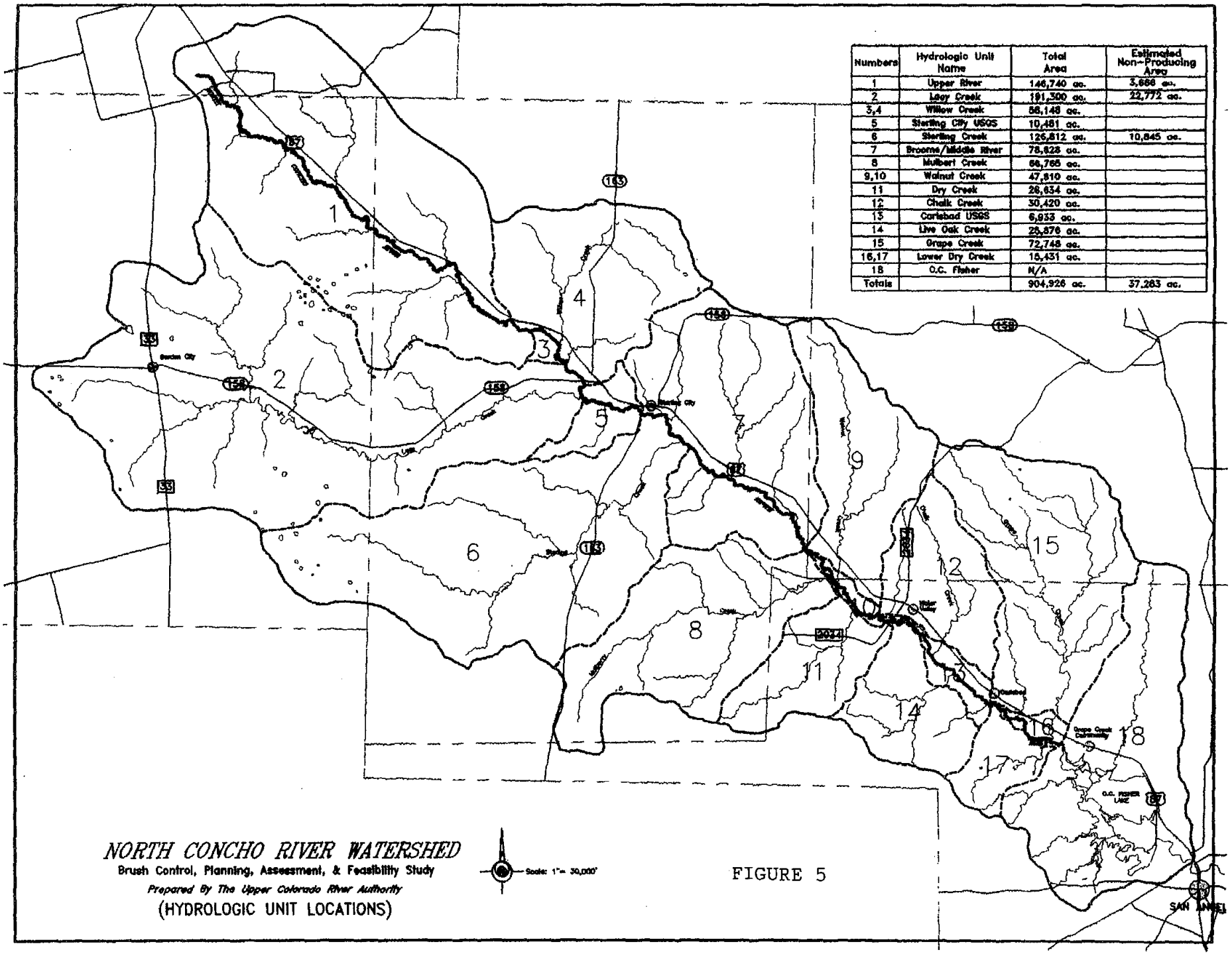
10 mi



Numbers	Hydrologic Unit Name	Total Area	Estimated Non-Producing Area
1	Upper River	146,740 ac.	3,666 ac.
2	Lagy Creek	191,300 ac.	22,772 ac.
3,4	Willow Creek	88,148 ac.	
5	Sterling City USGS	10,481 ac.	
6	Sterling Creek	126,812 ac.	10,845 ac.
7	Broome/Middle River	78,828 ac.	
8	Mulbert Creek	88,765 ac.	
9,10	Walnut Creek	47,810 ac.	
11	Dry Creek	28,634 ac.	
12	Chalk Creek	30,420 ac.	
13	Carlsbad USGS	6,933 ac.	
14	Live Oak Creek	28,876 ac.	
15	Grape Creek	72,748 ac.	
16,17	Lower Dry Creek	15,431 ac.	
18	O.C. Fisher	N/A	
Totals		904,926 ac.	37,283 ac.

FIGURE 5

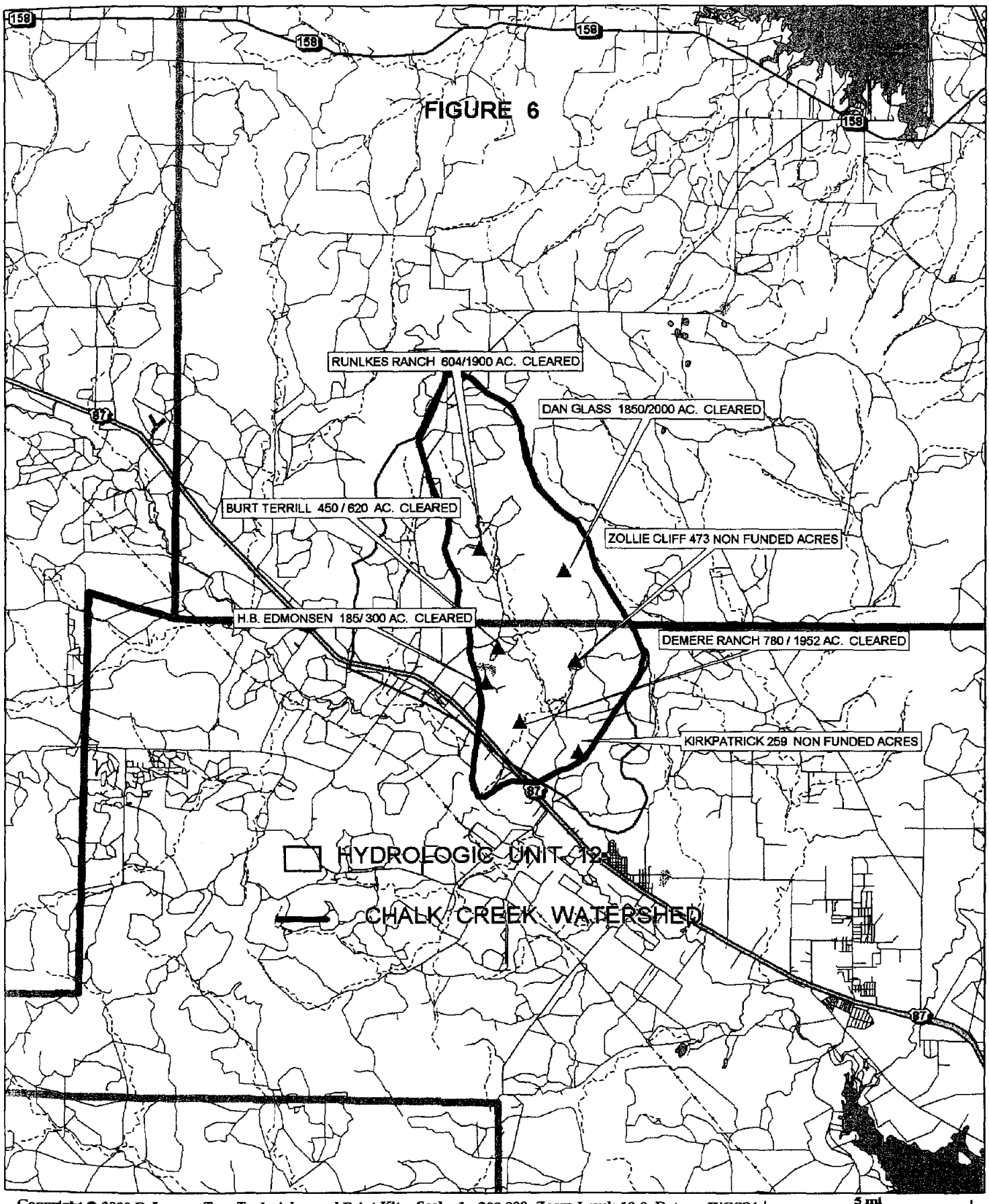


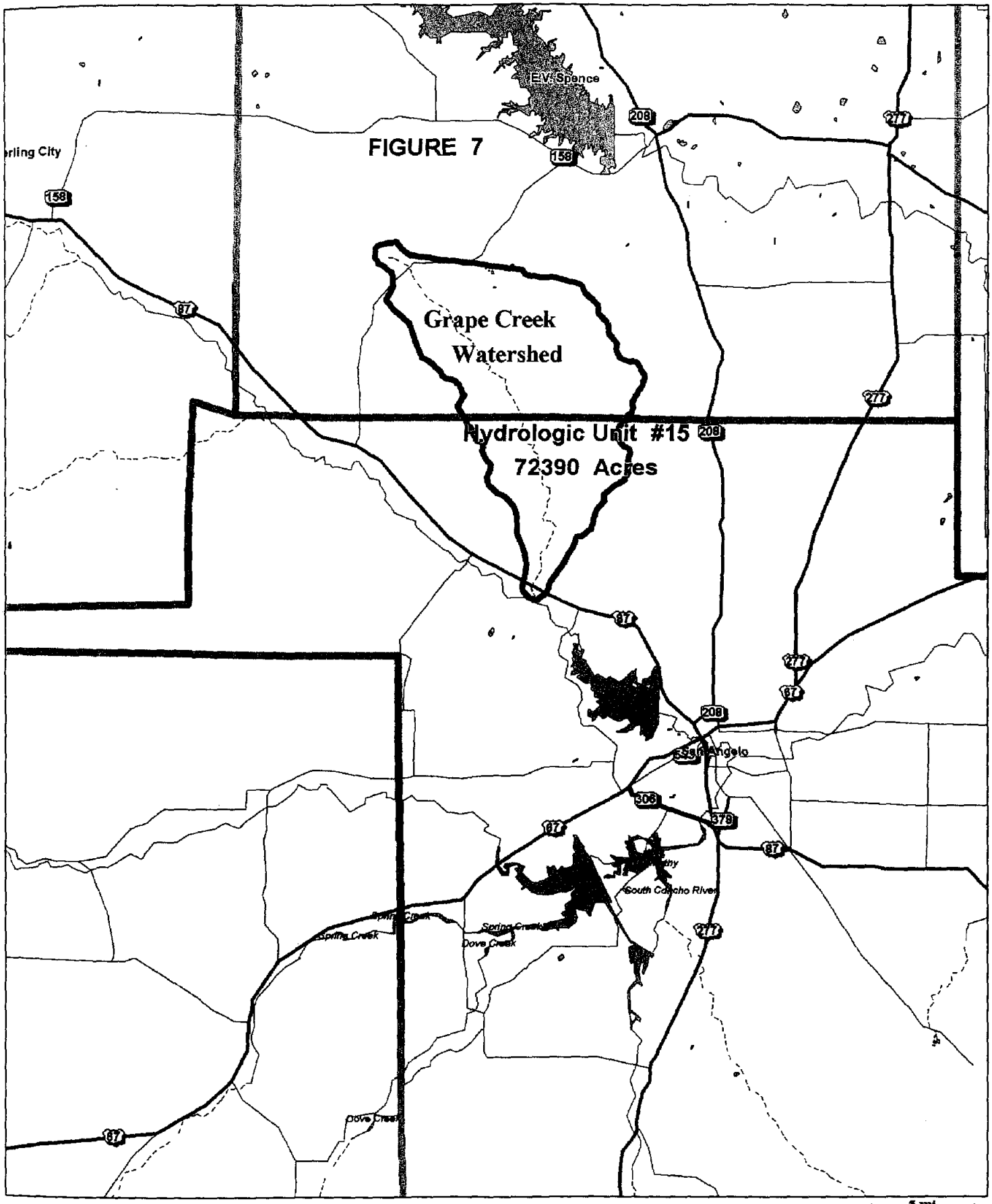
FIGURE 6
158
158
158
158
RUNLKES RANCH 604/1900 AC. CLEARED
DAN GLASS 1850/2000 AC. CLEARED
87
BURT TERRILL 450 / 620 AC. CLEARED
ZOLLIE CLIFF 473 NON FUNDED ACRES
H.B. EDMONSEN 185/ 300 AC. CLEARED
DEMERE RANCH 780 / 1952 AC. CLEARED
KIRKPATRICK 259 NON FUNDED ACRES
87
HYDROLOGIC UNIT 12
CHALK CREEK WATERSHED
87
Copyright © 2000 DeLorme. TopoTools Advanced Print Kit. Scale: 1 : 200,000 Zoom Level: 10-0 Datum: WGS84
5 mi

of springs and seeps becoming active and the creek running from late winter through July of 2000 and then again during the fall of the year. He also reported that a stock tank recently constructed on neighboring property becoming full without benefit of any rainfall following brush control on his property that was immediately up-dip of the pond. UCRA staff knowledge of the Chalk Creek watershed through research and personal experience indicates that the above observed groundwater responses are not typical of this area, particularly during record drought conditions. Preliminary conclusions are that the completed and on-going brush work within this watershed are having a dramatic effect on the water resources.

In addition to the above groundwater responses, the UCRA staff has been able to obtain preliminary indications of the effects of the watershed brush removal on runoff potential. The October 24 rainfall event previously described in this report that resulted in a peak flow rate at the Carlsbad USGS station of 2150 CFS owed much of its origins within the Chalk Creek watershed. From flood marks at the US Hwy.87 bridge it appears that flood flows down Chalk Creek may have contributed 40-60% of the flow at Carlsbad. In an earlier report section (Surface Water Monitoring) it was reported that a storm event experienced on August 17, 2001 also produced runoff from Chalk Creek. From flood marks, it was calculated that a peak flow rate of 169 cfs was experienced and it has been estimated that the watershed produced 100 acre feet of water from the storm. Except for Grape Creek (which has also had considerable work completed) no other adjacent sub basins produced runoff. While these observations are not completely definitive, they appear to be suggestive of the fact that brush control within Chalk Creek has resulted in increased sub basin yield.

Because of the preliminary indications, the typical topography and brush cover and the extent of planned and completed brush removal, this watershed has been selected by the UCRA to be a major part of the on-going monitoring program. This work will include detailed ground and surface water measurements and continued on-site observations.

5.3 ***Observations within the Grape Creek sub basin:*** Another sub-basin that has received substantial early brush removal efforts is hydrologic unit 15, the Grape Creek watershed. This watershed contains approximately 72,390 acres and its location is shown on figure 7. The feasibility report identified this watershed as containing 25,767 acres of heavy mixed brush, 15,033 acres of heavy cedar brush and 4,536 acres of moderate mixed brush. Heavy and moderate brush was estimated to cover approximately 63% of the sub-basin. The sub-basin was modeled as producing 4,172 acre feet of additional water annually with 100% of the brush removed. This sub-basin was selected for intensive study due to the extent of early brush work accomplished and a potential hydrologic response. The sub-basin will receive intensive monitoring during the coming contract period. The anticipated hydrologic response from this sub-basin may have begun to be manifested late in this contract period. An August 2001 rainfall event described earlier in this report produced a peak storm flow in the creek at the U.S. Highway 87 bridge of 257 CFS and has been estimated to have delivered 230 acre feet of storm water to the North Concho River. This runoff response was not observed on any adjacent sub-basins. As stated previously, none of the water produced by the sub-basin reached the USGS



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gauging station at FM 2288 a distance from the confluence of 2.9 miles. This observation indicates that more than 80 acre feet per mile of river is required to effect flows within the dry river bed. Figure 10 is a location map for the North Concho River between the confluence of Grape Creek and F.M. 2288.

5.4 ***Observations within the Sterling Creek sub basin:*** Sterling Creek is an extremely large sub-basin (hydrologic unit 6) within the watershed and contains some 126,287 acres.The location of this sub-basin is shown on figure 8. Heavy and moderate brush was identified within the feasibility report as only covering approximately 25% of the sub-basin. The sub-basin was modeled as producing 345 acre feet of additional water with 100% of the heavy and moderate brush removed. Sterling Creek is a historical perennial stream and was selected for intensive study because of the apparent creek flow response to recent brush removal efforts on the Harwood Ranch. Only a limited number of acres of bush was removed from the Ranch, but the acreage was located along the riparian zone of Sterling Creek. The Creek displayed a rapid and immediate change to perennial characteristics following the work. Considering the lack of rainfall within the watershed, this observation has been considered by the investigators as being a significant response. Considerable work is planned within this sub-basin during the next contract period.

5.5 ***Mapping of Brush Removal Progress Within Watershed:***

The UCRA is currently cooperating with the local staff of the TSSWCB to prepare digitized maps of the watersheds to include all topographic features, the location of landowners under contract, specific areas under contract, work areas certified, location of flow and groundwater stations and the location of all site specific monitoring projects. It is anticipated that the mapping effort will be brought up to date early in the next contract period and continuously updated thereafter. Figure 9 is an example of the digitized watershed mapping (without topographic features) locating contract areas, areas completed, etc.

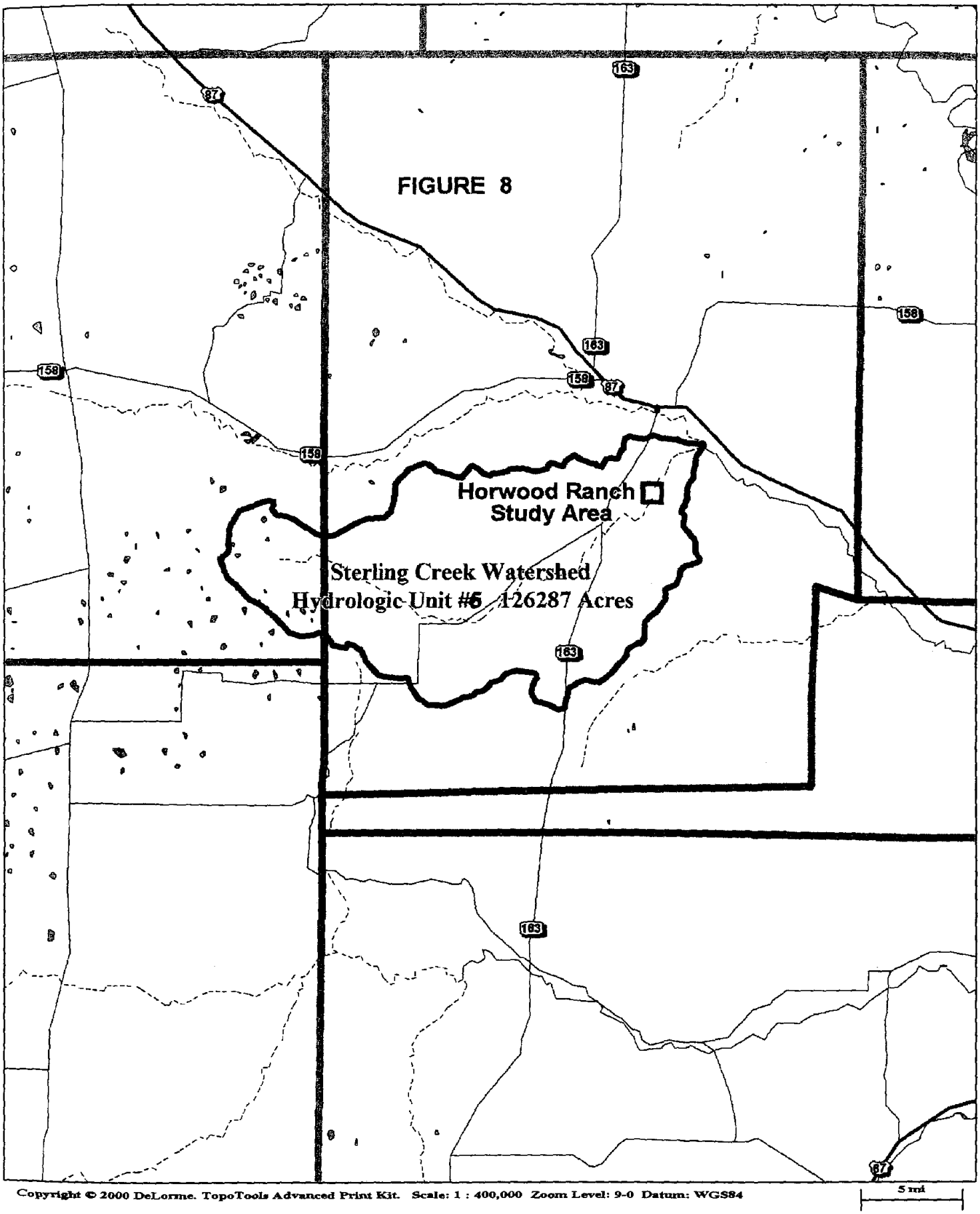
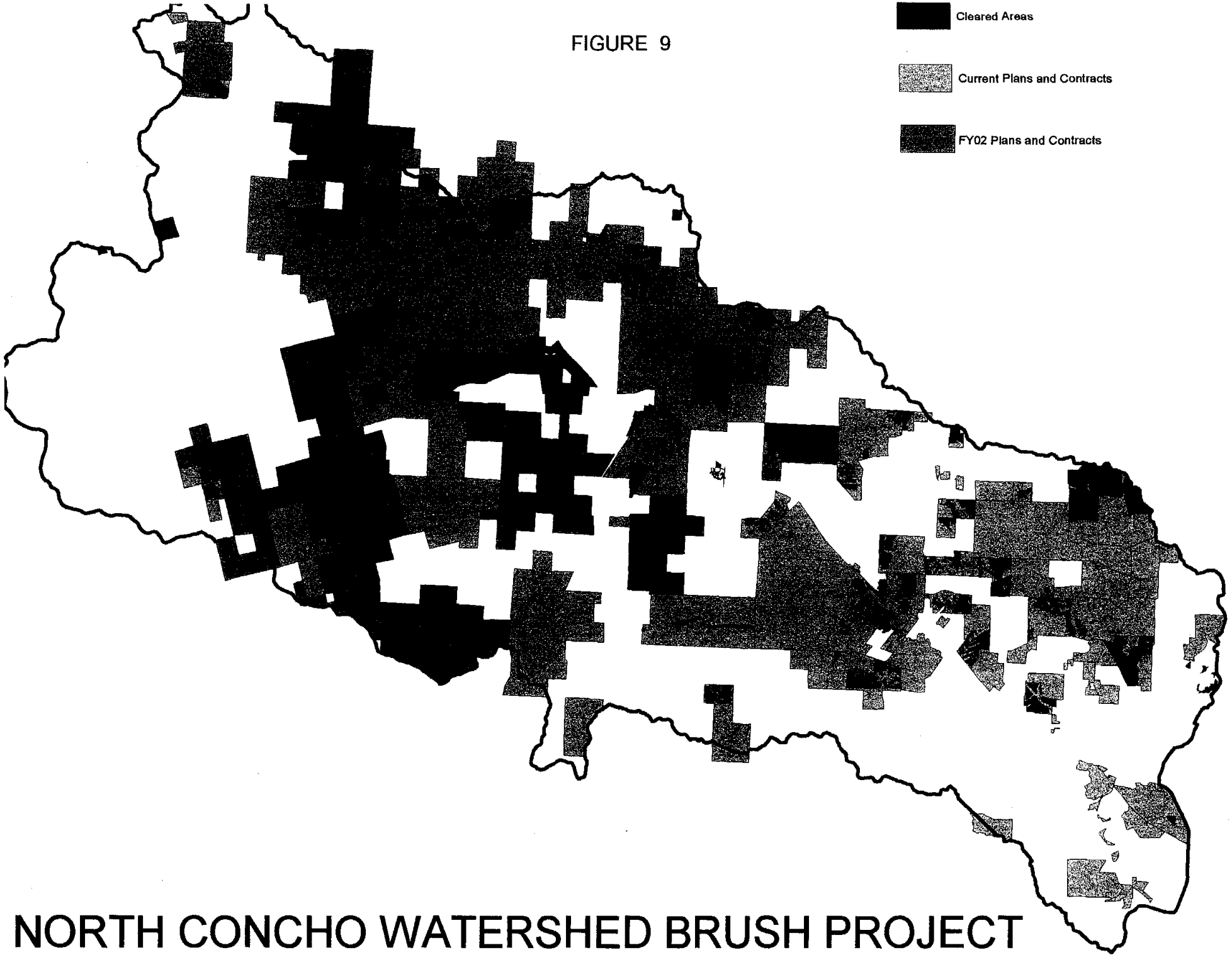


FIGURE 9



NORTH CONCHO WATERSHED BRUSH PROJECT

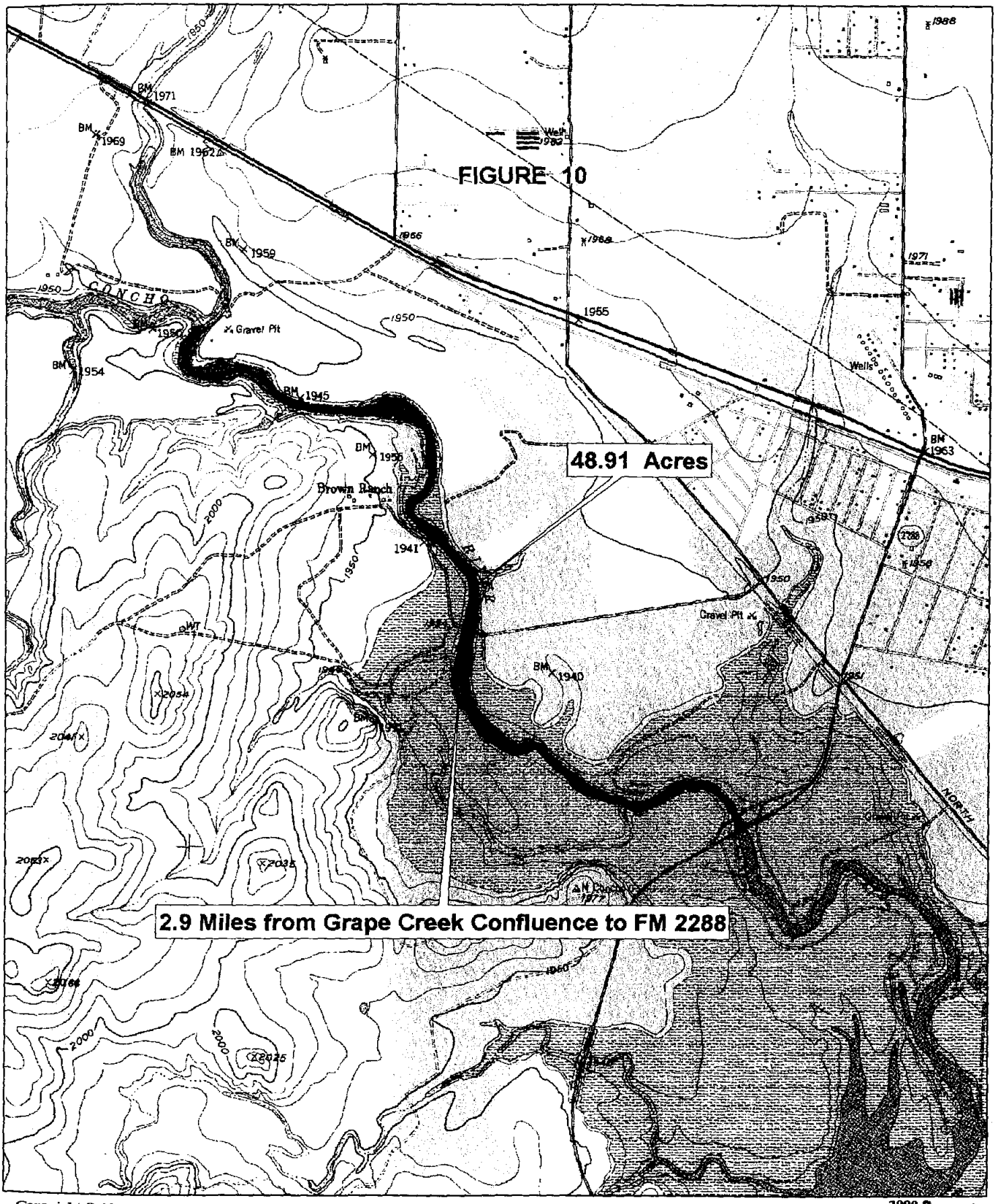


FIGURE 10
48.91 Acres
2.9 Miles from Grape Creek Confluence to FM 2288
CONCHO
Gravel Pit
Brown Ranch
Wells
BM 1971
BM 1969
BM 1962
BM 1959
BM 1954
BM 1945
BM 1956
BM 1940
BM 1963
1955
1950
1941
2000
2035
NORTH
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2000 ft