

WATER QUALITY ANALYSIS
OF
SIX SPRINGS IN GUADALUPE MOUNTAIN
NATIONAL PARK

Prepared by:

Michael Dick, Biologist
Texas Water Quality Board,
District 4

Samples collected & field
analysis performed by:

Michael Dick, Jerry Phillips,
and Jack Davis
Texas Water Quality Board,
District 10

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Guadalupe Mountains National Park

GUADALUPE MOUNTAINS

Guadalupe Mountains are located 55 miles southwest of Carlsbad, New Mexico, and 110 miles east of El Paso, Texas. The mountains are unique because of the exposure of Capitan Reef which is the most extensive fossil reef complex on record.

The mountain range is V-shaped with El Capitan, a 2,000 foot cliff at the point of the V in Texas and arms extending northeast and northwest into New Mexico. Elevations range from 3,650 feet at the base of the western escarpment to 8,751 feet on the summit of Guadalupe Peak.

The rocks which make up the Guadalupe Mountains were formed during the Permian period, 225 to 280 million years ago. An inland sea which covered more than 10,000 sq. miles of Texas and New Mexico controlled their formation. In shallow water near the shore of this sea, the Capitan barrier reef was built by lime-secreting algae and other organisms. As the reef grew upward and seaward upon talus broken loose by storms, sediments also were being deposited in a lagoon between the reef and the land. The arm of the reef which filled the Delaware Basin was cut off from the rest of the ocean, and the basin became excessively salty. Deposits of mineral salts gradually filled

the basin to the height of the reef and then layered deposits buried the dead reef.

A series of earth movements eventually raised the region several thousand feet and tilted its western end upward. Erosion cut away the softer sediments, and additional movements help shape the mountain range. The south face of the Guadalupe marks the location of the seaward face of Capitan Reef. Sediments deposited in the lagoon compose the range extending northward from the reef slope. The reef is shaped like a horseshoe which extends across 350 miles of western Texas and southeastern New Mexico. The majority of it is buried beneath the arid plain. The most extensive exposure is the 40 mile long eastern Guadalupe escarpment which stretches northward through Carlsbad Caverns National Park. It is also exposed in the Glass Mountains near Alpine and the Apache Mountains near Van Horn.

The springs studied in this report are major watering sites for many animals such as:

Elk	-	<u>Alces alies</u>
Mule Deer	-	<u>Odocoileus hemionus</u>
Gray Fox	-	<u>Vulpes sp</u>

Coyote	-	<u>Canis latram</u>
Bobcat	-	<u>Lynx rufus</u>
Black Bear	-	(occasional)
Cougar	-	<u>Felis concolor</u>
Birds	-	(200 species)
Reptiles	-	(amphibian, 20 species)

A rare mixture of biotic communities occurs in the Guadalupe Mountains. Species from the Rocky Mountain reach their southern and eastern limit and meet species from Mexico at the northern extent of their range. In lower elevation southwestern desert vegetation is typical as follows:

Creosotebush	-	✓ <u>Laurea dibaricata</u>
Lechuguilla	-	<u>Agave lechuguilla</u>
Parry	-	✓ <u>Agave Americana</u>
Yucca	-	<u>Yucca sp</u>
Sotol	-	<u>Dasyilirion sp</u>
Cholla	-	<u>Opuntierae sp</u>

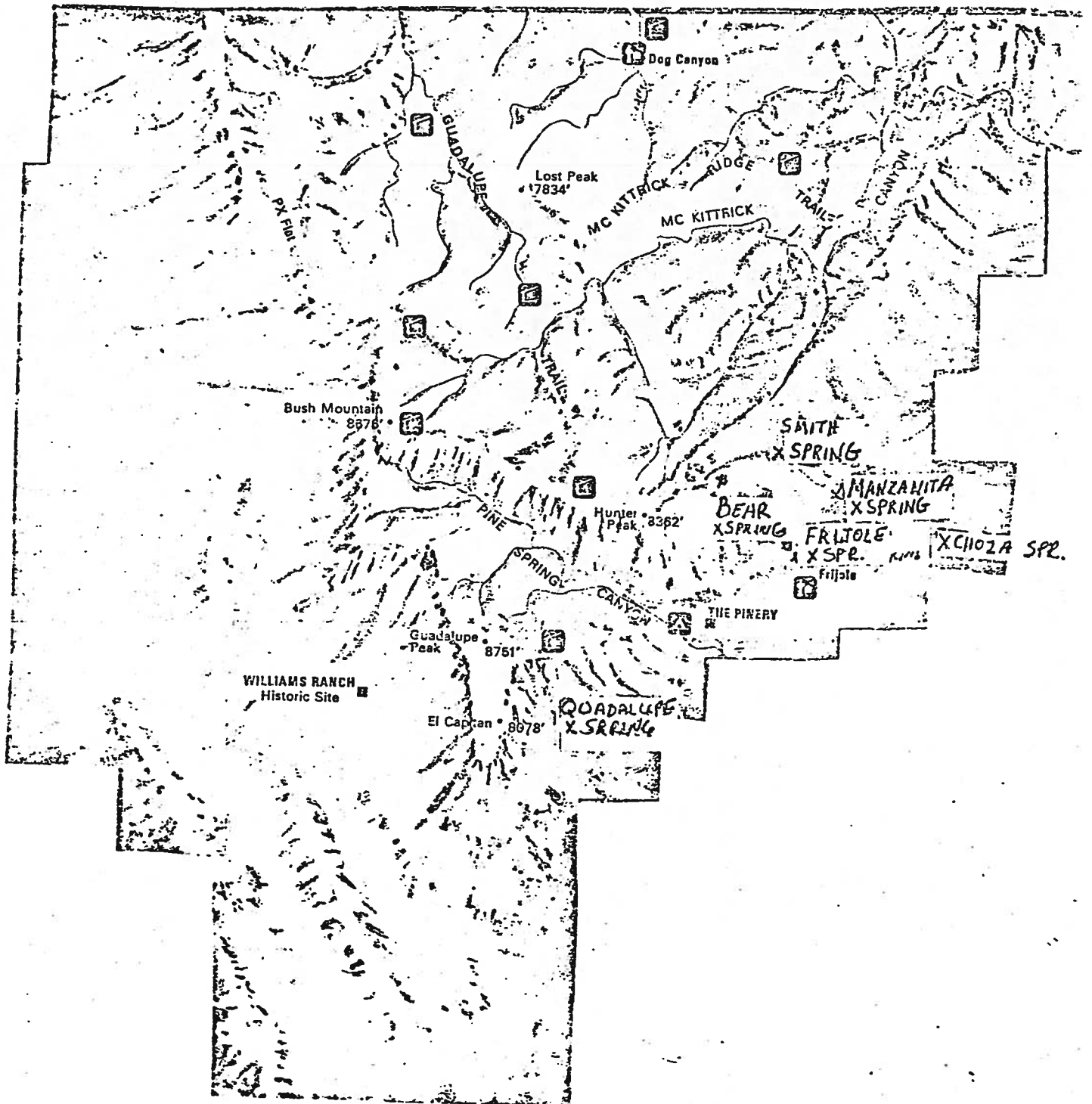
The higher country contains forests of Ponderosa pine, Douglas fir, Timber pine and a few Aspens, this represents a relict of a forest that covered this area thousands of years ago when the climate was cooler and rainfall was greater.

In the canyons, where there is more moisture, are ferns, big tooth maple, choke cherry, walnut, hop horn beam and Texas Madrone.

The springs in this area provided water for various groups of people. Spanish conquistadors passed the Guadalupes on their travels from Mexico in the late 1500's where they found the Mescalero Apaches inhabiting the area. Military surveyors mapping a transcontinental route to the California gold fields in 1849 passed along the base of the Guadalupes just south of El Capitan. In 1858 a route was opened through Guadalupe Pass in 1858 and was used for 2 years by the Butterfield Overland Mail Line to carry mail from St. Louis, Missouri, to California. After the Civil War ranchers soon settled the area. In 1878 and 1879 soldiers from near by military posts such as Fort Davis camped at Pine Springs while trying to subdue the remaining Apaches.

The climate in this area is semi-arid with warm summers and mild winters. Although severe and sudden changes in the weather often occur. Strong winds are common in spring and autumn along with electrical storms which are accompanied by heavy downpours and flash flooding in the summer. This weather change was witnessed several times while collecting spring

samples. Variation in temperature between higher and lower elevations and between the eastern and western side of the range is also common.



FRIJOLE SPRINGS

Frijole Springs is located at Frijole Ranger Station and has been used as a domestic water source since 1880. It flows at approximately 11 gallons per minutes. The head of the spring is now enclosed in a man-made structure, and the spring water flows through a cement canal until it returns back underground. Planaria are observed throughout the canal.

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SMITH SPRINGS

Smith Springs is located on the east facing slope of the Guadalupe Escarpment at an elevation 375 feet above Frijole Springs. It is situated in a bolder stream, tree-shaded area and flows from a limestone bedding at a rate of 42 gallons per minute. The water from the spring flows about 25 feet along a riffle channel and plunges over a small travertine fall into a pool approximately 15 feet in diameter and one to two feet in depth. At this point, it is diverted into a catch basin where it is piped downhill to further supply Manzanita pond. Vegetation along Smith Springs consists of:

Chinkapin
✓ Chemcapin Oak

Choke Cherry

Big Tooth Maple

MANZANITA SPRING

At Manzanita Spring there is a man-made earthen pond 100 to 125 feet in diameter in which Mazanita Springs surfaces. This pond is also supplied with water piped from Smith Spring. This is a major watering hole for many of the animals which inhabit the park. The pool has a limestone bottom with silt layers. Green Sunfish (Lepomis cyanellus) and Yellow Belly Sunfish (Lepomis sp) and Blue Gill (Lepomis macrochirus) inhabit the pond along with frogs and tadpoles. Large beds of Chara sp and Potamogeton illinvensic were present.

CHOZA SPRING

Choza Spring is the sight of a small low volume spring located a few hundred feet from Highway U.S. 62-180. It flows from a sand stone strata into a narrow, low gradient brook cut through soft sand-stone deposits. The spring consists of very shallow pools, runs, and riffles. Trees are present but offer no shade. In several shallow ponds, blue gill (Lepomis macrochilus) and yellow sunfish (Lepomis sp) were observed along with frogs (Rana sp) and tadpoles.

Aquatic Vegetation	-	
Algae	-	
	-	<u>Spriogyra sp.</u>
Water Cress	-	<u>Nasturkuim officinale</u>
Stone Worts	-	<u>Chara sp</u>
Maidin Hair Fern	-	<u>Adiantum sp.</u>
Cattail	-	<u>Typha sp.</u> (only Typha found in park)

Willows, alligator juniper, and Texas Madrone are found on the eastern bank.

Odonata sp.	-	(are abundant)
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UPPER PINE SPRING OR BEAR SPRING

Upper Pine Spring is a low-water volume producing spring located about a mile due west and approximately 125 feet above Frijole on the southeast slope of the Guadalupe Escarpment, elevation approximately 5,500 feet. The spring seeps from its source in limestone stratum and trickles through a muddy draw choaked with organic litter. After approximately 150 feet, it collects in a concrete vat.

Aquatic Vegetation

Algae:

Plectonema tomasiniana

Cladphora sp.

Maiden Hair Fern - Adiantum sp.

Trees:

✓ Chimcapin Oak

Choke Cherry

Texas Madrone

Grape Vine

Mexican Blue Oak

Rocky Mountain
Juniper

Ponderosa Pine

GUADALUPE SPRING

Guadalupe Spring is located in Guadalupe Canyon which flows between El Capitan and Guadalupe Peak. It flows from a limestone bedding into a concrete vat at the surface level then down into the canyon. It flows at approximately 5-8 gallons per minute.

Vegetation:

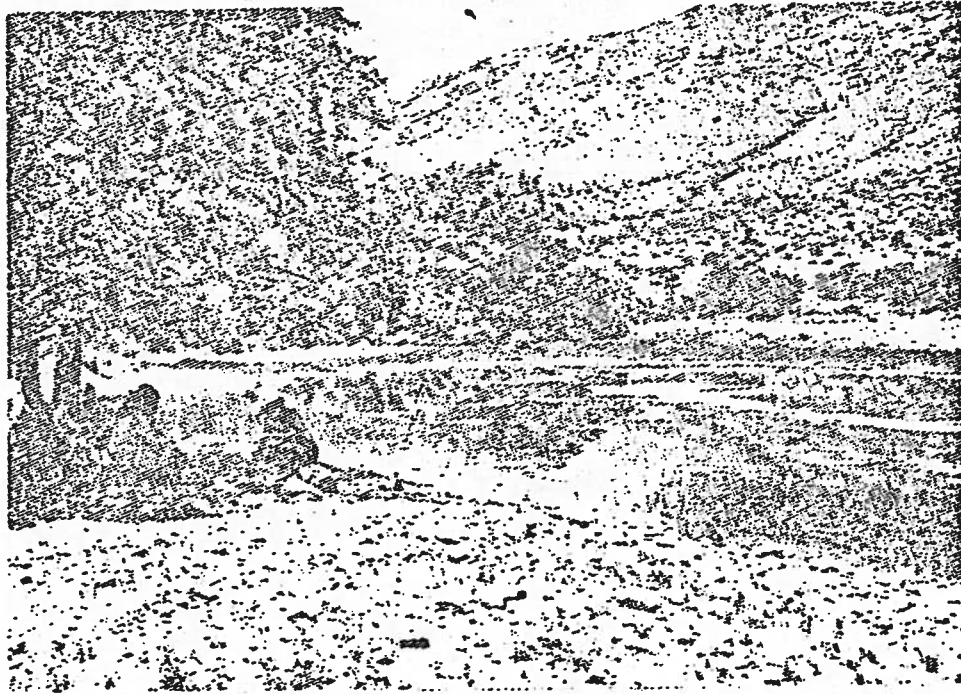
Stone Wort - Chara sp

Horse Tail Fern - Equisitum sp

Trees:

Oak - Lithocarpus sp

Cottonwood - Populus deltoides



MANZANITA POND + SPRING



CHOZA SPRING



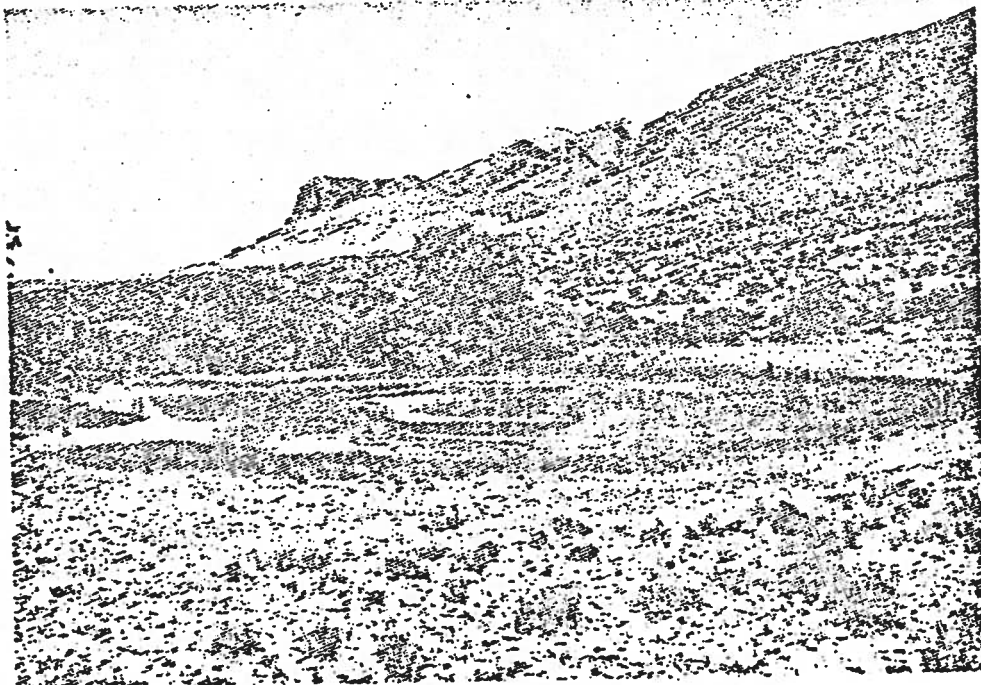
Upper Pine on Bear Spring



SMITH Spring



SMITH SPRING



MANZANITA SPRING

WATER QUALITY SUMMARY

Manzanita, Smith, and Choza Springs showed the highest D.O. levels. Higher D.O. levels which occurred in Manzanita Springs are attributed to the pond it flows into from its underground source. Photosynthesis from algae and macrophytes are primary reasons for higher D.O. levels in this pond. Smith Springs also forms a pond where photosynthetic activity occurs along with the natural oxidation that occurs as spring water flows down the rocks through the canyon. Choza Springs D.O. levels are elevated by a rich growth of algae which occurs the entire length of the spring.

The highest conductivity readings were found at Guadalupe Springs as were the highest sulfate levels. These readings correspond with the geological formations which compose El Capitan. As stated earlier in this report, El Capitan is an extensive fossil reef built by limestone secreting algae and other organisms along with deposits of mineral salts.

The temperature levels in Frijole Spring were relatively constant due to the fact it was sampled in an enclosed structure at the site where it emerged from the ground. All other spring temperatures were relatively similar, fluctuating with the time and the month sampled.

Clarity of the six springs sampled is shown in the turbidity table as none being greater than 5 JTU.

Low levels of T-PO₄, O-PO₄, NH₃-N, VSS, and TSS found in this study show no pollution throughout the spring area what trace amounts that were shown in the tables are results of the decomposition of detritus in the springs. Frijole Spring had the highest nitrate level but was low enough to be of little significance. Higher levels of nitrate nitrogen occurred in springs having the most aquatic vegetation.

The nitrate nitrogen levels found in this study were much lower than the ones found by O.T. Lind in his 1971 paper, "Limnological Analysis of McKittrick^{ck}-Creek and Springs". Dr. Lind found the nitrate levels to be 20 mg/l in Manzanita Spring, 50 mg/l in Choza Spring, and 50 mg/l in Upper Pine Spring. The differences in the nitrate levels may be due to different sampling sites in the two studies. The samples taken in this study were all close to the point where the spring emerged from the ground. Dr. Lind's samples were probably further along the springs course, and there was more time for detritus decomposition. At the time this study was performed, all the springs except Choza did not travel far before returning back underground. This is the primary reason for the sampling sites chosen.

The pH values in all springs were relatively constant in each individual spring, however, there were changes in response to temperature changes.

Total hardness as CaCO_3 were relatively the same in the five streams that were tested for hardness. The highest being Guadalupe Springs (390 mg/l which correlates with the geologic formation where it originates) and the lowest being Choza Spring at 250 mg/l. Choza Spring was also at a lower elevation than the other 5 springs. Choza Spring passes through different formations at this lower elevation.

Fecal coliform bacteria were not found in any of the six springs samples. This is another indicator that these springs are free from contamination both from above-ground sources as well as underground water table contamination.

The six springs sampled showed only trace amounts of heavy metals in water. Bear and Guadalupe Springs showed higher amounts of lead but these levels are still only trace amounts and are probably due to similar geological formations.

MANZANITA SPRINGS

Field Data:

Date	<u>6-26-75</u>	<u>7-18-75</u>	<u>10-1-75</u>
Time	1400	0930	1135
D.O. (mg/l)	14.7	4.1	8.7
Water Temp (°F)	78	64	58
pH	8.3	8.0	7.8
Turbidity (JTU)	<5	<5	0
Chloride (mg/l)	5	15	3
Conductivity (micro ohms)	310	500	190

Lab Data:

Chloride (mg/l)	3	6	4
Sulfate (mg/l)	10	11	11
T-PO ₄ (mg/l)	0.03	0.18	<.03
O-PO ₄ (mg/l)	<.03	<.03	<.03
Ammonia Nitrogen (mg/l)	<.1	0.1	<.1
Nitrate Nitrogen (mg/l)	<.02	<.02	<.02
TSS (mg/l)	<10	10	<10
VSS	<10	7	<10
pH	8.0	7.9	8.4
Conductivity	366	558	474
TOC	4	21	3
Fecal Coliform (#100 ml)			0
Hardness CaCO ₃ (mg/l)		200	
Total Hardness (mg/l)		310	

FRIJOLE SPRING

Field Data:

Date	6-26-75	7-18-75	10-1-75
Time	0940	1115	1115
D.O. (mg/l)	-	5.9	6.0
Water Temp. (°F)	62	64	63
pH	7.4	7.6	7.1
Turbidity (JTU)	<5	<5	<5
Chloride (mg/l)	10	5	3
Conductivity (micro ohms)	470	490	230
Flow (cfs)	11 gpm	-	-

Lab Data:

Chloride (mg/l)	4	4	4
Sulfate (mg/l)	14	14	13
T-PO ₄ (mg/l)	<.03	<.03	<.03
O-PO ₄ (mg/l)	<.03	<.03	<.03
NH ₃ -N (mg/l)	<.1	<.1	<.1
NO ₃ -N (mg/l)	0.59	0.60	0.57
TSS (mg/l)	<10	<10	<10
VSS (mg/l)	<10	<10	<10
pH (mg/l)	8.0	7.6	7.9
Conductivity (micro ohms)	546	546	540
TOC (mg/l)	<1	3	<1
Fecal Coliform (#100 ml)		0	
Hardness CaCO ₃ (mg/l)		210	
Total Hardness (mg/l)		300	

SMITH SPRING

Field Data:

Date	<u>6-26-75</u>	<u>7-18-75</u>	<u>10-1-75</u>
Time	1500	1030	1230
D.O. (mg/l)	7.7	7.3	8.1
Water Temp. (°F)	62	60	59
pH	--	7.3	7.8
Turbidity (JTU)	5	5	0.
Chloride (mg/l)	5	10	3
Conductivity (micro ohms)	480	480	235
Flow (cfs)	35 gpm		

Lab Data:

Chloride (mg/l)	8	2	2
Sulfate (mg/l)	<5	6	<5
T-PO ₄ (mg/l)	<.03	0.03	<.03
O-PO ₄ (mg/l)	<.03	<.03	<.03
NH ₃ -N (mg/l)	<.1	<.1	<.1
NO ₃ -N (mg/l)	0.36	0.43	0.41
TSS (mg/l)	<10	<10	<10
VSS (mg/l)	<10	<10	<10
pH (mg/l)	8.0	8.2	8.3
Conductivity (micro ohms)	519	546	540
TOC (mg/l)	1	<1	4
Fecal Coliform (#100 ml)			0
Hardness CaCO ₃ (mg/l)		240	
Total Hardness (mg/l)		310	

GUADALUPE SPRING

Field Data:

Date	<u>6-26-75</u>	<u>7-18-75</u>	<u>10-1-75</u>
Time	1035	1530	1630
D.O. (mg/l)	6.9	5.5	7.4
Water Temp. (°F)	69	62	59
pH	7.5	7.6	7.9
Turbidity (JTU)	<5	5	0
Chloride (mg/l)	15	10	3
Conductivity (micro ohms)	670	680	215
Flow (cfs)	7 gpm		

Lab Data:

Chloride (mg/l)	8	7	3
Sulfate (mg/l)	140	142	6
T-PO ₄ (mg/l)	<.03	0.17	<.03
O-PO ₄ (mg/l)	<.03	<.03	<.03
NH ₃ -N (mg/l)	<.1	<.1	<.1
NO ₃ -N (mg/l)	1.3	1.3	0.60
TSS (mg/l)	<10	15	<10
VSS (mg/l)	<10	5	<10
pH (mg/l)	8.0	7.8	8.4
Conductivity (micro ohms)	812	800	525
TOC (mg/l)	<1	4	<1
Fecal Coliform (#100 ml)			
Hardness CaCO ₃ (mg/l)	320		
Total Hardness (mg/l)	390		

CHOZA SPRINGS

Field Data:

Date	<u>6-26-75</u>	<u>7-18-75</u>	<u>10-1-75</u>
Time	1615	1130	1800
D.O. (mg/l)	6.8	7.2	8.2
Water Temp. (°F)	62	72	60
pH	7.1	8.5	7.2
Turbidity (JTU)	<5	5	0
Chloride (mg/l)	5	15	5
Conductivity (micro ohms)	490	440	270
Flow (cfs)			

Lab Data:

Chloride (mg/l)	30	6	4
Sulfate (mg/l)	13	12	12
T-PO ₄ (mg/l)	<.03	0.04	<.03
O-PO ₄ (mg/l)	<.03	<.03	<.03
NH ₃ -N (mg/l)	<.1	<.1	<.1
NO ₃ -N (mg/l)	0.59	0.32	0.59
TSS (mg/l)	<10	<10	<10
VSS (mg/l)	<10	<10	<10
pH (mg/l)	7.8	8.3	8.0
Conductivity (micro ohms)	549	486	552
TOC (mg/l)	1	2	1
Fecal Coliform (#100 ml)		0	
Hardness CaCO ₃ (mg/l)		200	
Total Hardness (mg/l)		250	

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UPPER PINE SPRING (BEAR SPRING)

Field Data:

Date	<u>6-26-75</u>	<u>10-1-75</u>
Time	1210	1630
D.O.	6.2	7.4
Water Temp.	70	59
pH	7.5	7.9
Turbidity	<5	0
Chloride	10	3
Conductivity	460	215

Lab Data:

Chloride	4	3
Sulfate	7	6
T-PO ₄	0.03	<0.03
O-PO ₄	<.03	<.03
NH ₃ -N	<.1	<.1
Nitrate Nitrogen	0.56	0.60
Chlorophyll A	<.004	
TSS	14	<10
USS	8	<10
pH	8.3	8.4
Conductivity	528	525
Fecal Coliform		0
T.O.C.	9	<1

METALS (ug/L)
(IN WATER)

	<u>Manzanita</u>	<u>Frijole</u>	<u>Smith</u>	<u>Guadalupe</u>	<u>Choza</u>	<u>Upper Pine or Bear</u>
Arsenic	<10	<10		<10		<10
Borium	<500	<500		<500		<500
Boron						
Cadmium	<10	<10		<10		<10
Copper	<50	<50		<50		<50
Chromium	<100	<100		<100		<100
Iron	120	<100		200		200
Lead	<50	<50		<50		<50
Manganese	<50	<50		<50		<50
Mercury	<0.5	<0.5		<.5		<.5
Nickel	<100	<100		<100		<100
Selenium	<1	<1		3		<1
Silver	<20	<20		<20		<20
Zinc	<100	<100		100		100

FIELD AND LAB PROCEDURES

Field Measurements

Parameter

Temperature	-	Hand Mercury Thermometer
Dissolved Oxygen	-	Azide modification of Winkler Titratim
pH	-	Sargent Welch PBX pH Meter
Conductivity	-	Beckman Conductivity Meter
Hardness	-	Hach Titration Method

Laboratory Analyses

Samples were collected in polyethylene containers and stored on ice until time of shipment to the Texas State Department of Health Laboratories in Austin. Heavy metal samples were collected in glass containers and stored on ice until time of shipment to laboratory. Bacteriological samples were collected in sterilized glass bottles provided by the Texas State Health Department and stored on ice until vacuum filtered and incubated by the Millipore membrane filter method. All laboratory analyses were conducted by the Water Chemistry and Sanitary Bacteriology

Laboratories of Texas State Department of Health as described in "Standard Methods for the Examination of Water and Wastewater", 13th Edition. The specific method utilized for each parameter is outlined in the following table:

TSS	-	Gooch crucibles and glass fiber discs
VSS	-	Gooch crucibles and glass fiber discs
NH ₃ -N	-	Distillation and nesslerization
NO ₃ -N	-	Brucine method
T-PO ₄	-	Ascorbic acid method
Sulphates	-	Turbidimetric method
Chlorides	-	Argentometric method
Chlorophyll <u>a</u>	-	Trichromatic method

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Guadalupe Mountain National Park

Owen L. Lind

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