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# Biological and Physical Survey of the Conservation Garden Pond, Yuma, Arizona

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## Abstract

The results of research of the Yuma Conservation Garden Pond and the immediate area are to be used for the future development of wildlife habitat and educational programs in the garden. The study includes all biotic and abiotic aspects of the ecosystem. The focus was to lay the groundwork for future, more in-depth, studies. Recommendations are made concerning all aspects of the research and future study and monitoring programs are suggested. Water quality analysis is compared to Colorado River and groundwater samples. Introduction of additional vegetation and control of intrusive plant species are recommended. Problems associated with excessive domestic fowl population and feral cats are addressed. Educational activities suggested include a fish and release program, building of cavity nest boxes, and starting a mounted insect collection.

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# CHAPTER 1 INTRODUCTION

A study was conducted on the Yuma Conservation Garden pond which is part of the Laguna Natural Resource Conservation Districts. Located at the corner of Avenue 2E and 32nd Street in Yuma, Arizona, the garden encompasses a large part of the southwestern corner of the Yuma County Fairgrounds. A member of the Yuma County Fair Board, Frank Deason, began a botanical garden on a section of the land in the early 1950's. With the help of other board members, the conservation garden soon came into existence.

In 1987, management of the area was assumed by the Yuma and Laguna Natural Resource Conservation Districts. In 1992 the NRCD was awarded a grant from the Urban Wildlife Heritage Foundation by authority of the Arizona Game and Fish Department. The grant is to be used to develop the garden into a local educational program and protected wildlife habitat. It is also meant to assist in the High School Aid Program through the use of the garden for educational purposes.

Intermediate Environmental Lab, ENV 285, at Arizona Western College was requested by the Conservation Garden Board to complete one of the requirements of the Urban Wildlife Grant. This requirement was to conduct a thorough investigation of the "Duck Pond". The study was conducted from January to May 1994. It encompassed five main areas of concentration: physical and chemical, plants, terrestrial vertebrates, aquatic organisms, and terrestrial invertebrates. All of the studies were carried out under the supervision of Professor Marie McGee, course instructor.

Currently, the pond serves two purposes. First, it serves as part of the ecosystem protected by and used for education by the Conservation Garden. Secondly, the water is used by the fairgrounds for irrigation, though only minimal amounts of water are taken at a time. The pond is also aerated by an aerating device in the middle of the pond. This is meant to aid in water circulation and prevent stagnation.

According to our studies, the overall fitness of the Yuma Conservation Garden pond seems to be good, with findings that indicate a somewhat balanced ecosystem. The domestic fowl are the only exception. Their numbers continue to grow as more people bring their unwanted fowl to the pond. Ducks at the pond are fed grain by the fairgrounds in addition to table scraps provided by visitors. This study addresses this issue and many more. Also included in this report is a complete list of recommendations based on our findings.

## CHAPTER 2 PHYSICAL AND CHEMICAL SURVEY

### METHODS AND MATERIALS

Site Map

The Global Positioning System (GPS) was used to produce maps of the Conservation Garden Pond, focusing on the immediate area around the pond. The instrument consists of a radio unit and antenna. As the user walks, the "GPS" sends signals to the satellite every few seconds. This information is relayed back to the memory and can then be used to produce a map. When locating specific trees, bushes, etc., the user must type in the object name and stand beside it for approximately 180 seconds. Palm trees and specific flora were mapped around the pond. The perimeter of the pond was also mapped.

Water Level

To monitor water fluctuations, a gauge was placed in the pond. A 3 foot long, 2x4 was fitted with metal brackets on one side. A depth gauge was attached to the opposite side. After rebar was hammered 1.5 feet into the pond bottom, the boarded-gauge was slipped over the remaining 2.5 feet of rebar where it could rest on the pond bottom. In determining the gauge location, I took into consideration ease of reading from the fence (using binoculars) and avoiding avian and human activity. Water depth reading were recorded approximately every two weeks.

Water Analysis

Three water samples were taken to provide a baseline analysis of the pond. A 1 liter sample was used for the comprehensive water chemistry. A 250 ml sample was analyzed for total dissolved solids and electrical conductivity. A 50 ml sample was taken for the heterotrophic plate count. These samples were analyzed by the Bureau of Reclamation. All three samples were taken at the same time, date, and location. Water temperature was measured between March 12 and April 30. No readings were taken April 9. All readings were taken at 0900 hours.

Dissolved Oxygen

Dissolved oxygen readings were taken using a DO meter. I first calibrated the "red line" and zero readings. On April 30, after ensuring no bubbles were present in the probe solution, I made three readings throughout the pond. These readings were taken at 1200 hours. I also noted the depth, location, and time of day.

Water Clarity

The vertical visibility was found by using a standard 20 cm Secci disc (Cole 1975). From the boat, I lowered the

disk into the water until it was no longer visible. I then slowly raised the disc and noticed its depth when it reappeared. Three depth measurements were taken using the precalibrated line from the water's surface down to the disc.

Depth Profile

A depth profile of the pond bottom was determined by using a sounding line while transecting the pond. I picked north and south points directly across from each other to establish points of transection. As an assistant maneuvered the boat across the pond, I dropped a weighted line overboard to measure the distance from the water's surface to the pond bottom. At each measured location the boat was held steady minimizing horizontal drag on the line. The weight was released slowly, not allowing it to sink into the muddy bottom. The line was precalibrated to ensure accuracy.

Soil Analysis

Soil samples of the pond bottom were taken to determine texture and composition. A push tube was forced down into the soil until it encountered an obstruction, or was completely full. The soil sample remained in the tube as it was extracted from the substrate. Three arbitrary samples were taken.

Trash

During every visit, I walked the perimeter and collected trash in and around the pond. The various articles were noted, bagged, and disposed of.

## RESULTS AND DISCUSSION

Site Map

As shown in Figure 1 and Figure 2, the GPS provided a near exact area of the pond and the location of significant plants, vegetation, and landmarks. This information will be beneficial should it become necessary to make physical changes to the pond.

Water Level

Figure 3 reflects water depth fluctuations between March 12 and April 30. The fluctuations are attributed to the addition or use of pond water for irrigation purposes.

Water Analysis

Figure 4 reflects water temperature fluctuations between March 12 and April 30. The constant temperature increase is characteristic of seasonal warming trends. The water analysis, as given in Table 2 through Table 6, reveals a slight increase in total dissolved solids compared to the

incoming canal water. These parameters were compared with baseline data for groundwater (see Appendix 1) and Colorado River water (see Appendix 2), both sampled at Imperial Dam. Selected parameters are compared in Table 1. The increase in the total dissolved solids is expected due to water evaporation and accumulation of these components. The low $NO_3$ value suggests the presence of nitrogen-consuming microorganisms (Reid 1961). The low silica concentration may also suggest silica-consuming diatoms or an unknown reaction between the water and the concrete lined canal. This assumption is based on the fact that the local groundwater silica content is 19 mg/L and the river concentration is 10 mg/L. After flowing through the unlined canal system, it is doubtful any silica would be lost, but instead, should be gained. This decline in silica is not detrimental to the pond system. No selenium, arsenic, or lead were detected in the water analysis. These elements can cause deformities in wildlife.

The heterotrophic plate count revealed bacterial concentrations of 23,000 per 100ml in the aerated end of the pond and 3,000 per 100ml in the west end of the pond. Because the river water at Imperial Dam contains concentrations of coliform and streptococci bacteria, it is possible that these are the same bacteria found in the pond (see Table 1). Fecal matter from ducks and geese may introduce additional bacteria.

The pH of the pond and canal water are in agreement at 8.0 and 8.3 respectively (see Table 1). These values are within the acceptable range (Foley 1993).

Dissolved Oxygen

The high DO values reflect an over-saturation of oxygen. This is probably due to aeration. Oxygen is also produced through photosynthesis of the algae. High concentration of algae could explain the low concentrations of some pond nutrients, as some types of these organisms take up nutrients during "diatom/algae blooms".

Water Clarity

The vertical visibility value (averaged from 3 readings) was found to be 1.8 feet below the water's surface. The water visibility may be diffused due to the relatively high microorganism population and the constant activity of the waterfowl.

Depth Profile

The depth profile revealed a contoured pond bottom. The maximum depth was 4 feet (see Fig. 5).

Soil Analysis

Because of the muddy bottom, the push tube soil samples were only partially successful. The largest sample salvaged was 9 inches in length. The sample revealed slight soil

stratification. The soil is composed of silty clay and sand. Mica flakes from the weathering granite outcrop can be seen throughout the soil horizon. The components of the granite are not believed to adversely affect the pond system.

Trash

Human trash was consistently collected in and around the pond. Flat wood grates, a metal folding chair, pop bottles and cans, cigarette lighters and butts, rubber bands from bundled vegetables, plastic tubing tied with piece of nylon twine, and an automobile car seat, complete with its seat belt, were among the items found.

## CHAPTER 3 PLANT SURVEY

### METHODS AND MATERIALS

On 3-12-94, 3-19-94, and 4-9-94, I surveyed the plants within a 7 meter radius surrounding the pond edge, and the wash to the northwest of the pond. I listed all plant species by common name, location, and included miscellaneous information. I also counted individual plant locations or group locations. We clipped plant samples and placed them in plastic trash bags. A 3x5 white card was placed in the bag with the sample listing the name, location, and date it was collected. The samples were placed in a plant press, dried for two weeks, and mounted on 16.5x11.5 inch herbarium paper. I labeled the mounted samples with the plant's family name, common name, and Latin name. Also included on the label were comments, plant collectors, plant denominator, number, date collected, and location collected. The mounted plants were then laminated for ease of handling.

### RESULTS

A map of the Conservation Garden area, Figure 6, shows plant locations and common names.

Figures 7-a, 7-b, and 7-c are maps showing foliage diversity in the vertical plane. The vegetation ranges from less than 2 meters to over 6 meters in height.

A plant species list of the pond and wash area, Table 7, lists plants by common name and Latin name. The species that were dried and mounted are annotated, and comments are included. Plant taxonomy follows Hickman (1993).

A Reference Collection Portfolio containing 26 plant samples were submitted with our survey to the Conservation Garden Board.

### DISCUSSION

Seventeen species of plants are growing within the perimeter of the pond area. Many other species are growing in the area to the north and northwest. That area was not included in our survey. The most numerous plants are date palms and fan palms. There are 29 fan palm trees, most over 6 meters tall, and 8 date palm trees, two of which are less than 1 meter tall. Two large canopy forming eucalyptus and mesquite trees are located on the west end of the pond. A large thicket of mesquite are located on the north side of the pond. Most of the mesquite located there are shrub type, less than 6 meters tall. However, one mesquite in

this area is over 6 meters tall and should be considered a tree type. This makes a total of three tall trees, not including palm and date trees, in the pond area. Tall trees are very important for providing habitat for birds, insects, and small mammals (Rosenberg et al 1991).

The remainder of the plants can be divided into three growth forms: shrub types, succulent types, and herbaceous types. Two of the plants included in the shrub type could cause some difficulty. Common reed and the tamarisk, which are not native plants, tend to encroach on other plants and take over an area. Tamarisk are usually considered undesirable in this area since they provide limited food or nest sites for birds (Rosenberg et al 1991).

Plants in the pond area are stable and dramatic changes might not be beneficial. Some studies suggest that changing a stable riparian environment would cause more damage than good, in terms of plants and animals recovering from the changes (Anderson & Ohmart, 1988). But small changes would probably not have adverse effects.

Areas on the south and southeast edge of the pond are open with little vegetation, allowing morning sunlight to reach the pond water and fowl. Some open area is beneficial and should be maintained free of vegetation. The hilly area to the north and northwest of the pond, not included in the plant survey, has been planted with numerous, small native trees and cacti. Mesquite, palo verde, and ironwood are a few of the small trees found in this area. These are excellent trees in a desert environment which provide food and nesting sites for many birds. Mesquite is sometimes parasitized by mistletoe, which is an important winter food source for birds. None was noted on the mesquite trees in this area.

The wash area to the northwest of the pond displays a small variety of herbaceous plants, large creosote bushes, desert willows, and Mexican and blue palo verdes. However, cottonwoods and willow trees are missing from the area. They require a large amount of water , but they also additional habitat for the area.

# CHAPTER 4 TERRESTRIAL VERTEBRATE SURVEY

## METHODS AND MATERIALS

Domestic Fowl Population

Birds in this survey considered domestic fowl are ducks, geese, chickens, turkeys, guinea hens, and rock doves. No attempts were made to distinguish between varieties. The gender of ducks and chickens was determined by counting the males that can be positively identified by coloration and plumage. All others are assumed to be females. I was unable to determine the gender of geese conclusively, but pairing indicates that the population gender is probably a 50-50 ratio. Gender of others is unknown (see Table 9).

Count #1 took place on March 12 (see Table 8). We counted from the east end of the pond as a group and remained stationary. Three people counted the birds on land, four others counted the birds in the water. Count #2 occurred on April 9 (see Table 8). Chickens were excluded. This count was taken from a stationary position at the west end of the pond to the center and from the east end of the pond to the center. I then added the numbers to obtain a total population count. The third sample was taken on the same day only 15 minutes later (see Table 8). This count was taken from the north side of the pond in a stationary position at the center and counted in a clockwise direction. Count #3 took place on April 16 (see Table 8). This accounted for ducks, geese, and rock doves only. This count was begun at the west end of the pond and moving in a clockwise direction, ending on the east side. The fifth and final sample took place on April 29 (see Table 8). I counted ducks and geese only. I took this sample beginning at the west end of the pond, moving in a counterclockwise direction, and ending at the east end. The pond was divided into four sections, west end (1), west of center (2), east of center (3), and east end (4). Geese were counted first in sections 1 and 3 and second in sections 2 and 4.

Bird Species Survey (Excluding Domestic Fowl)

I determined the presence of birds through direct observation of the birds themselves and nests. Birds were identified by songs and plumage using field guides (see Table 10). Marie McGee aided in identification of species. Binoculars were used to obtain clear and accurate descriptions. A transect was plotted following the trails around the pond, by the wash area, and through the garden. The transect route was walked for approximately 4 hours on each of the following days: March 12, 19, 26, and April 9, between the hours of 0700 and 1200 hours. Birds were identified and observed to determine breeding behavior.

Mammals and Reptiles

I determined the presence of mammals and reptiles throughout the entire garden and pond area by direct observation, identification of dens, scats, and tracks (see Table 11). A total of 29 Havahart traps, varying in size, were utilized. The traps were placed in areas believed to be travelled by mammals. They were also strategically placed near den openings located on the north side of the pond and around the side of the hill, also on the north side. The traps were baited and left overnight. A variety of baits were used including peanut butter, shelled pecans, sunflower seeds, apple slices, and canned cat food. Any casual observations of mammals or reptiles were recorded throughout the survey.

## RESULTS AND DISCUSSION

Count #5 is probably the most accurate count as the majority of the population was on or near the pond. They remained relatively calm and docile during the sample period. It was observed that the ducks tend to fly from the pond area to the garden area and occasionally into the fairgrounds. The actual number of chickens have declined since the beginning of the study (see Table 8). This decline is reinforced by the absence of 5 chicks and the presence of carcasses. The rock dove population appears to have more than doubled since the beginning of the study; this increase is probably seasonal. The turkey disappeared after count #3. The male duck population is too high, displaying an approximate sex ratio of 2:1. Additional evidence is excessive fighting and injuries of nearly all females, including blindness, pecking scars, bleeding, and general ill health.

Verdin and House Finch were actively breeding. House Sparrow, Lesser Nighthawk, European Starling, Great-tailed Grackles, and Western Kingbirds are believed to be breeding. European Starling and House Sparrow are considered undesirable because they are aggressive, introduced species that compete with natives for nest spots. Road Runners are predators on nestlings and lizards. Great-tailed Grackles, also thought to be nest predators, are increasing greatly in abundance around human residences in the Yuma area (Rosenberg et al 1991). We observed a Verdin mobbing and pursuing a grackle at the garden.

Trapping revealed no specimens. There are 7 feral cats inhabiting the garden. Skunk odor was detected, though the animal was never observed. A small number of rabbits were observed. Failure in trapping was probably due to a variety of factors, including the time of year and cool evening temperatures. Types of rodents that could be present are Round-tailed Ground Squirrels, Woodrats, Kangaroo Rats, and Pocket Mice. It is my belief that the cats and skunks are

heavy predators on the rodent, lizard, and domestic bird populations. Five of the cats are timid but do not appear to be completely feral and could be tamed and adopted if done so quickly.

## CHAPTER 5 AQUATIC ORGANISM SURVEY

### METHODS AND MATERIALS

Observation

Three daytime and two nighttime observations were made. The daytime observations were performed visually and with the aid of binoculars. The nocturnal observations were performed visually and with the aid of an infra-red night scope. All were performed around the entire perimeter of the pond, where access permitted. The hilltop to the north also served as an observation point. The daytime observations were performed 0800 and 1130 hours. Nighttime observations were performed between 2000 and 2230 hours.

Hook and Line

The hook and line method was employed to capture fish and amphibians. Two spinnerbaits (a type of artificial lure), one yellow and blue and the other orange and black, were utilized. The color variation was meant to attract only those predatory game fish, such as the Largemouth Bass (*Micropterus salmodes*). 15 to 20 casts were made at each accessible location, approximately 10 meters apart. The depth ranged from 5-90cm. Baited hooks were employed for bottom feeding fish such as the Flathead Catfish (*Pylodictis olivaris*) and carp (*Cyprinus carpio*). The bait used was chicken liver on a #5 treble hook. An attempt was also made to capture turtles using this method. Fresh bait was applied to the hook as needed.

Seine-Netting

A 0.25 inch mesh seine was employed to take random samples of fish found in the pond. The net is approximately 30 feet in length and 4 feet in height. Two 5 foot poles are on either end, and the bottom is weighted by sinkers. The net was utilized in arching sweeps of 90 degrees and then pulled to the shoreline, closing in on anything trapped within its boundary. This method was used on 2 separate occasions. Six sweeps were made on March 19, one on the west end of the pond and the other 5 on the east end. Two additional sweeps were conducted on April 9 in the northwest section of the pond. Deep mud prohibited seining the center of the pond. All fish captured in these sweeps were identified by species, and where possible, measured and checked for abnormalities.

Aquatic Slide Sampling

Designed to allow growth of microorganisms, slide sampling was employed at various locations throughout the pond. On March 12, three 12 cm by 9 cm microscope slide boxes containing 10 to 12 standard microscope slides were placed in the pond. Slide box #1 was placed at the

northeast corner at a depth of 20 cm. The area was exposed to direct sunlight through most of the day. Box #2 was at the west end of the pond at a depth of 28 cm. It was exposed to direct sunlight for 3-4 hours daily. Box #3 was placed at the south side of the pond at a depth of 28 cm, receiving direct sunlight 6-7 hours daily. All slide boxes were weighted down with pebbles and secured by rubber bands to hold them in place. They remained in the pond for 4 weeks. The results of growth were to be viewed under compound and dissecting microscopes which were used on identifying microscopic organisms (Cole 1975 and Reid 1967).

Plankton Net

A plankton net was pulled behind the boat at a depth of approximately 20-40 cm. We transected the pond from west to east. The samples obtained from the net were then placed in a sample jar for further study under a light microscope.

## RESULTS

Observation

General observation revealed two significant finds. On March 12, 15-20 small fish were observed at the east end of the pond. They ranged in size from 1.5-4 cm, but I was unable to determine species. A second school were noted on the west end of the pond a few minutes later.

A large soft shelled turtle was observer basking on a rock in the middle of the pond. This occurred on May 5. The turtle was quite large at approximately 1 foot in diameter. Species identification could not be made.

Hook and Line

Hook and line results were negative with one exception; on March 12, during a nocturnal sample period, one strike was made at the chicken liver I was using as bait for my hook. The encounter lasted for about 40 seconds until the unidentified organism broke the line. The fishing reel drag was set at light and close observation of the broken end of the line revealed a sharp cut about 13 cm below the weight.

Seine-Netting

The seine-netting method produced positive results in 4 of 8 attempts (see Table 12). Four species of fish were observed and over 135 individuals were captured and released. One fatality occurred. The four fish present are bluegill (*Lepomis macrochirus*), shad (*Dorosoma petenense*), carp (*Cyprinus carpio*), and largemouth bass (*Micropterus salmodes*).

Aquatic Slide Sampling

Submersed microscope slides yielded mixed results. On April 9, the recovery of the slides was attempted. Slide

It was decided to extract a sample of pond bottom at the same area it was originally placed (see Table 14). Slide sample #2 was recovered but was full of pond silt. Microscopic observation of the sample revealed parameciums, daphnia, roundworms, and rotifers, which were the most abundant organism. Slide sample #3 was recovered; however, the slides were missing from the box. The contents of the box itself was used as a sample. It yielded the same microorganisms as sample #2 along with water bears (see Table 13).

Plankton Net

The final sampling method revealed mostly green algae mixed with rotifers and daphnia (see Table 14).

## DISCUSSION

The data gathered in this survey indicates that the pond does support a significant amount of aquatic life. Although the carp and the majority of the microscopic organisms found in the pond can survive in brackish or even stagnant water, the discovery of Threadfin Shad (*Dorosoma petenense*) inhabiting the pond in significant numbers suggests a good dissolved oxygen content. Shad inhabit cleaner, free-flowing bodies of water, not brackish backwaters. The shad, in turn, provide a food source for the largemouth bass which were found in the pond. They may also provide a food source for the herons which spend some time in the garden. Also, most rotifers and water bears are indicator species of highly oxygenated environments (Meglitsch 1972).

This survey cannot, however, be used as a true representation of the population of fish in the pond. The methods available could not provide access to much of the pond area. The extent of deep, soft bottom made it difficult to maneuver effectively in the pond while utilizing the seine.

We have no explanation for the apparent lack of amphibians.

# CHAPTER 6 TERRESTRIAL INVERTEBRATE SURVEY

## METHODS AND MATERIALS

Insect netting

The primary sampling technique involved the use of a heavy duty insect net. This net was used to capture insects by sweeping it twenty times around bushy trees such as the Creosote bush (*Larrea tridentata*), and Arrow weed (*Pluchea sericea*). After the last sweep was made, the net was gently shaken to force the captured insects to the bottom. Clutching the net directly above the bottom area where the insects collected, the data collector inverted the net over the killing jar and proceeded to place the bottom of the net into the jar. The jar was then sealed with its lid. After a period of 1-3 minutes, depending on the size of the insects, the lid was removed. The sample organisms were taken out and put into sealable plastic bags with a label indicating the sample number, collecting method, and location. This technique was also used to collect diurnal flying insects.

Direct Removal

Another sampling technique used was the direct removal of the insect from plants and rocks using a pair of tweezers. After the insects were collected, they were placed in the killing jar and, subsequently, into labeled plastic bags. This collecting technique was more appropriate for slow moving terrestrial insects.

Small Jar

The third technique coexisted of the use of a small jar to capture small insects flying over areas of the pond in which the use of the bulky net was not effective or appropriate. Once again, the killing jar was utilized to kill the captured insects.

Night Sampling

Two night sampling techniques were used. The first required the use of an ultraviolet light to detect scorpions; the scorpion's exoskeleton glows when exposed to ultraviolet light. The white sheet method was also utilized. It consists of placing a bright light behind a draped white sheet. The insects attracted are then collected.

## RESULTS

There were nine samples taken from plants and one sample taken from a rock. However, no large numbers of

insects were collected. Terrestrial invertebrates found include honey bees, harvester ants, a swarm of midges, American cockroaches, a few moths, a crab spider, daddy long-legs, and black widow spider.

## DISCUSSION

Flowers are the food source for many types of insects. Moreover, insects require warm weather conditions to become fully active due to their lack of an internal temperature regulatory system. Therefore, prevalent windy conditions during the sampling dates, along with a minute number of flowering plants, kept the samples very limited in number. The samples that were collected from the few flowering plants yeilded scarce results due to the strong winds. In addition, the nocturnal sampling took place during a cold night. Once again, a minimal quantity of insects were collected during either of the night sampling events. No scorpions were observed.

In conclusion, it was not possible to determine the actual abundance of the insects found or the total insect population inhabiting the pond since such a small number was collected.

## CHAPTER 7 RECOMMENDATIONS

The following recommendations are intended to be suggestions that may enhance the quality and fitness of the Yuma Conservation Garden for wildlife habitat enhancement and for educational uses. Based on the studies outlined in the above research some recommendations may be implemented without further study. Most recommendations, however, will need to be accompanied by further study to completely assess the ecological impact.

### PHYSICAL AND CHEMICAL

**Continue water quality monitoring.**

Water quality monitoring will signal the Conservation Board in the event of major fluctuations which could be potentially disastrous to the aquatic organisms.

**Initiate monthly cleanup procedures around the pond.**

The high quantity of human generated trash distracts from the beauty of the area and can be potentially lethal to the aquatic organisms. An organized monthly cleanup program would keep this ongoing problem in check and would alleviate, to a lesser extent, damage to wildlife.

**Initiate water quality study.**

An in depth water quality study would be an asset to the future of the Yuma Conservation Garden. The lack of aquatic plants seems to be directly attributed to the turbidity of the pond. A water quality study could addresss this problem with possible positive benefits.

### PLANTS

**Initiate growth of Mesquite and Cottonwoods.**

Mesquite and Cottonwoods planted in the wash area provide several benefits for wildlife. In addition to providing additional ground cover, they provide diverse nesting sites for a wide variety of desert dwelling birds. The flowers and seed pods produced also increase the amount of available food for many types of animals(Rosenberg et al 1991).

**Landscape with native annuals and flowering shrubs with varied flowering periods.**

These plants would be a low maintenance addition to the area. Not only would the available habitat be increased but they would provide an added food source. The flowering plants would act as an insect attractant. Varied flowering

periods would allow a greater variety of birds and insects to take advantage of their resources.

**Remove tamarisk.**

The tamarisk is a very intrusive, non-native plant species. There are only four located around the pond. But if left unchecked they can proliferate rapidly, choking out other native plant species. Young tamarisk are growing in the wash area.

**Maintain some open shoreline.**

Maintaining open shoreline allows sunlight to penetrate the water. This facilitates the proliferation of aquatic plants. It also allows animal access to the pond and sunny areas on shore, and facilitates viewing and access for educational purposes.

**Landscape fence paralleling Hwy 80, particularly the southeast corner.**

Shrubs along the fenceline would act as a noise buffer for the wildlife, and it would provide additional habitat for birds. The southeast corner should be landscaped for aesthetic purposes, promoting greater visitation. However, the view of the pond from outside the fence would be obstructed.

## TERRESTRIAL VERTEBRATES

**Option 1.**
**Maintain population at current level.**

The current population levels of domestic fowl is determined to be excessively high. This large population has certain negative effects on the surrounding wildlife. They discourage the use of the garden by migratory and native birds. The current population levels propagate negative health effects, especially in females. A human health danger exists due to high bacterial levels stemming from the fecal matter of the fowl.

**Option 2.**
**Reduce population.**

Reducing the population would continue to serve as an attraction for visitors and would alleviate some of the negative aspects currently being experienced. It would also increase the use of the garden by migratory and native birds.

**Option 3.**
**Eliminate all domestic fowl.**

The elimination of all domestic fowl would encourage extensive use of the area by migratory and native birds. Water conditions would also be improved, in turn, reducing

the risk to public health. Decreased public attraction would be the main drawback of this option.

**Post "No Dumping" policy and educate the public concerning the reasons.**

The addition of domestic fowl continues to be a problem for the garden. A "No Dumping" policy set forth in a sign would reinforce a commitment to maintaining a stable population. The sign should also educate the general public on the negative effects of dumping animals arbitrarily into the garden.

**Erect cavity nesting boxes for birds and bats throughout the garden.**

Nest cavities are a limited resource. Cavity nesting boxes would allow more birds to take advantage of the garden while protecting themselves from certain species of aggressive birds. This could be considered an excellent project for school groups or children's organizations. Specific plans to build nest boxes are available from Arizona Game and Fish and other organizations.

**Initiate periodic trapping of feral cats.**

Feral cats pose a health risk to the domestic fowl and humans alike. Capture and exportation from the garden would greatly decrease the risks associated with them. Public education is again recommended.

## AQUATIC ORGANISMS

**Stock with more Largemouth bass and initiate a children's fish and release program.**

Initiating a fish and release program would increase the young poeple's awareness of conservation. It could be promoted to educate as well as being a fun event for children. We considered the use of the pond for endangered fish breeding. This idea would be impractical due to the use of the pond water for irrigation by the fairgrounds.

**Undertake further fish population study and monitoring.**

Due to the muddy bottom of the pond, effectiveness of sampling by seining is limited. An electroshocker may be used for more thorough sampling. An increased awareness of the fish population would assist in the education of garden patrons. A continual monitoring program would track changes in the population structure and help indicate problems.

## INSECTS

**Mount an educational insect collection.**

A mounted insect collection would be a welcome addition to the educational programs that currently exist at the garden. This would be an excellent project for school age children. Collecting and identifying can be a real learning tool and can be done throughout the summer.

**Move feed boxes away from public access.**

The feed boxes attract Harvester Ants which inflict a painful sting. The removal of the boxes would decrease this risk substantially.

TABLE 1. Water analysis comparison of Imperial Dam and Yuma Conservation Garden pond.

| Parameter | Pond | Imperial Dam |
|---|---|---|
| Bacteria | 23,000 (east)<br>3,000 (west) | 16,000 |
| pH | 8.01 | 8.30 |
| TDS | 922 ppm | 824 ppm |
| DO ("gauging rock")<br>(west end)<br>(east end) | 14.9 ppm @ 2.5 ft.<br>15.5 ppm @ 1.0 ft.<br>16.3 ppm @ 1.5 ft. | 8.0-9.2 |
| Nitrogen | 0.0 mg/L | 0.8 mg/L |
| Silica | 5.0 mg/L | 10.7 mg/L |

TABLE 2.

**Yuma Desalting Plant Laboratory**
**Chemical Analysis of Water Samples**

USGS Station Number: SITECODE: W0990

DESCRIPTION: DUCK POND (TRACE, NH4, PO4)

LAB NUMBER: 3090.00 SAMPLED BY:

DATE COLLECTED: 03/14/94 TIME COLLECTED: 15:00
DATE RECEIVED: 03/14/94 DATE ANALYSIS COMPLETED: 03/25/94

STATIC WATER LEVEL IN FT.: RESERVOIR SURFACE
DYNAMIC WATER LEVEL IN FT.: ELEVATION IN FT.:

ELECTROCONDUCTIVITY (EC) in microsiemens/cm: 1420
TDS: BY EVAPORATION AT 180 deg. C.: 922
TDS: BY SUMMATION WITH $HCO_3$ CORRECTION ($HCO_3$/2.03):. 877

| | | | |
|---|---|---|---|
| pH: | 8.01 | Field Temp, deg C: | 16.5 |
| Na in mg/L: | 150 | $SiO_2$ in mg/L: | 5.0 |
| K in mg/L: | 6.7 | B in mg/L: | 0.16 |
| Ca in mg/L: | 98.9 | F in mg/L: | Not Tested |
| Mg in mg/L: | 39.2 | $NH_4$ in mg/L: | Trace |
| $CO_3$ in mg/L: | 0.0 | $PO_4$ in mg/L: | Trace |
| $HCO_3$ in mg/L: | 194 | Fe in mg/L: | 0.13 |
| Cl in mg/L: | 131 | Mn in mg/L: | 0.04 |
| $SO_4$ in mg/L: | 350 | Ba in Microgm/L: | 221 |
| $NO_3$ in mg/L: | 0.0 | Sr in Microgm/L: | 1406 |

Cations, mE/L: 14.90
Anions, mE/L: 14.16
% DIFFERENCE: 2.54%

TABLE 3.

**Yuma Desalting Plant Laboratory**
**Chemical Analysis of Water Samples**

USGS Station Number: SITECODE: W0990

DESCRIPTION: DUCK POND (HPC ONLY) EAST SIDE

23,000 (Bacteria)

LAB NUMBER: 3091.00 SAMPLED BY:

DATE COLLECTED: 03/14/94 TIME COLLECTED: 15:00
DATE RECEIVED: 03/14/94 DATE ANALYSIS COMPLETED: 03/18/94

STATIC WATER LEVEL IN FT.: RESERVOIR SURFACE
DYNAMIC WATER LEVEL IN FT.: ELEVATION IN FT.:

ELECTROCONDUCTIVITY (EC) in microsiemens/cm:
TDS: BY EVAPORATION AT 180 deg. C.:
TDS: BY SUMMATION WITH $HCO_3$ CORRECTION ($HCO_3$/2.03):.

| | |
|---|---|
| pH: | Field Temp, deg C: |
| Na in mg/L: | $SiO_2$ in mg/L: |
| K in mg/L: | B in mg/L: |
| Ca in mg/L: | F in mg/L: |
| Mg in mg/L: | $NH_4$ in mg/L: |
| $CO_3$ in mg/L: | $PO_4$ in mg/L: |
| $HCO_3$ in mg/L: | Fe in mg/L: |
| Cl in mg/L: | Mn in mg/L: |
| $SO_4$ in mg/L: | Ba in Microgm/L: |
| $NO_3$ in mg/L: | Sr in Microgm/L: |

Cations, mE/L:
Anions, mE/L:
% DIFFERENCE: 0 %

TABLE 4.

**Yuma Desalting Plant Laboratory**
**Chemical Analysis of Water Samples**

USGS Station Number: SITECODE: W0990

DESCRIPTION: DUCK POND (HPC ONLY) NORTH SIDE

3,000 (Bacteria)

LAB NUMBER: 3092.00 SAMPLED BY:

DATE COLLECTED: 03/14/94 TIME COLLECTED: 15:00
DATE RECEIVED: 03/14/94 DATE ANALYSIS COMPLETED: 03/18/94

STATIC WATER LEVEL IN FT.: RESERVOIR SURFACE
DYNAMIC WATER LEVEL IN FT.: ELEVATION IN FT.:

ELECTROCONDUCTIVITY (EC) in microsiemens/cm:
TDS: BY EVAPORATION AT 180 deg. C.:
TDS: BY SUMMATION WITH $HCO_3$ CORRECTION ($HCO_3$/2.03):.

pH: Field Temp, deg C:

Na in mg/L: $SiO_2$ in mg/L:

K in mg/L: B in mg/L:

Ca in mg/L: F in mg/L:

Mg in mg/L: $NH_4$ in mg/L:

$CO_3$ in mg/L: $PO_4$ in mg/L:

$HCO_3$ in mg/L: Fe in mg/L:

Cl in mg/L: Mn in mg/L:

$SO_4$ in mg/L: Ba in Microgm/L:

$NO_3$ in mg/L: Sr in Microgm/L:

Cations, mE/L:
Anions, mE/L:
% DIFFERENCE: 0 %

TABLE 5.

**Yuma Desalting Plant Laboratory**
**Chemical Analysis of Water Samples**

USGS Station Number: SITECODE: W0990

DESCRIPTION: GEO - E. DUCK POND

LAB NUMBER: 4394.00 SAMPLED BY: Fred Croxen

DATE COLLECTED: 04/17/94 TIME COLLECTED: 15:24
DATE RECEIVED: 04/20/94 DATE ANALYSIS COMPLETED: 04/27/94

STATIC WATER LEVEL IN FT.: RESERVOIR SURFACE
DYNAMIC WATER LEVEL IN FT.: ELEVATION IN FT.:

ELECTROCONDUCTIVITY (EC) in microsiemens/cm: 1260
TDS: BY EVAPORATION AT 180 deg. C.: 852
TDS: BY SUMMATION WITH $HCO_3$ CORRECTION ($HCO_3$/2.03):. 787

| | | | |
|---|---|---|---|
| pH: | 8.22 | Field Temp, deg C: | |
| Na in mg/L: | 139 | $SiO_2$ in mg/L: | |
| K in mg/L: | 5.7 | B in mg/L: | 0.12 |
| Ca in mg/L: | 82.5 | F in mg/L: | |
| Mg in mg/L: | 36.5 | $NH_4$ in mg/L: | |
| $CO_3$ in mg/L: | | $PO_4$ in mg/L: | |
| $HCO_3$ in mg/L: | 144 | Fe in mg/L: | 0.01 |
| Cl in mg/L: | 128 | Mn in mg/L: | |
| $SO_4$ in mg/L: | 324 | Ba in Microgm/L: | 171 |
| $NO_3$ in mg/L: | | Sr in Microgm/L: | 1263 |

Cations, mE/L: 13.34
Anions, mE/L: 12.72
% DIFFERENCE: 2.41%

TABLE 6.

**Yuma Desalting Plant Laboratory**
**Chemical Analysis of Water Samples**

USGS Station Number: SITECODE: W0990

DESCRIPTION: GEO - N. DUCK POND

LAB NUMBER: 4395.00 SAMPLED BY: Fred Croxen

DATE COLLECTED: 04/17/94 TIME COLLECTED: 15:30
DATE RECEIVED: 04/20/94 DATE ANALYSIS COMPLETED: 04/27/94

STATIC WATER LEVEL IN FT.: RESERVOIR SURFACE
DYNAMIC WATER LEVEL IN FT.: ELEVATION IN FT.:

ELECTROCONDUCTIVITY (EC) in microsiemens/cm: 1260
TDS: BY EVAPORATION AT 180 deg. C.: 848
TDS: BY SUMMATION WITH $HCO_3$ CORRECTION ($HCO_3$/2.03):. 787

| | | | |
|---|---|---|---|
| pH: | 8.32 | Field Temp, deg C: | |
| Na in mg/L: | 139 | $SiO_2$ in mg/L: | |
| K in mg/L: | 5.6 | B in mg/L: | 0.12 |
| Ca in mg/L: | 82.4 | F in mg/L: | |
| Mg in mg/L: | 36.6 | $NH_4$ in mg/L: | |
| $CO_3$ in mg/L: | 0.2 | $PO_4$ in mg/L: | |
| $HCO_3$ in mg/L: | 145 | Fe in mg/L: | 0.01 |
| Cl in mg/L: | 128 | Mn in mg/L: | |
| $SO_4$ in mg/L: | 324 | Ba in Microgm/L: | 192 |
| $NO_3$ in mg/L: | | Sr in Microgm/L: | 1268 |

| | |
|---|---|
| Cations, mE/L: | 13.35 |
| Anions, mE/L: | 12.74 |
| % DIFFERENCE: | 2.32% |

Table 7 - Plants Species List
Species marked with * were pressed & mounted

| Common Name | Latin Name | Comments |
|---|---|---|
| **Tree Types** | | |
| Fan Palm | *Washingtonia filifera* | 29 trees in pond area, most over 6 m. tall. |
| Date Palm | *Phoenix dactylifera* | 6 trees in pond area, 2 are less than 1 m. tall. |
| *Honey mesquite | *Prosopis* hybrid | One large canopy-forming tree at west end of pond and a large thicket of shrub-types north of pond area;corolla is yellow. |
| *Eucalyptus or Silver Dollar Gum | *Eucalyptus polyanthemos* Schauer | One large canopy forming tree at west end of pond. |
| *Blue palo verde | *Cercidium floridum* A. Gray | Small trees growing in wash area, approx. 4-5 m. tall and in mesquite thicket north of pond area; corolla is yellow. |
| *Mexican palo verde | *Parkinsonia aculeata* L. | Small trees growing in wash area, approx. 4-5 m. tall; corolla is yellow with one petal having red spots |
| **Shrub Types** | | |
| *Arrowweed | *Pluchea sericea* (Nutt) Cov. | Growing in numerous locations around pond area. |
| *Common Reed | *Phragmites australis* (Cav.) Steudel | Three large, dense groups growing in pond area. |
| *Tamarisk or salt-cedar | *Tamarix chinensis* Lour. | Six bushy shrubs, one approx. 6 m. tall; corolla is pink |

Table 7

Table 7-cont.

| | | |
|---|---|---|
| *Seep Willow | *Baccharis salicifolia* (Ruiz Lopez & Parvon) Pers. | Corolla is white to off-white |
| *Creosotebush | *Larrea tridentata* (D.C.) Cov. | Growing on north side of pond; corolla is yellow. |
| *Papyrus | *Cyperus alternisolius* | Growing in two locations, east and west of pond |
| Saltbush | *Atriplex canescans* (Pursh) Nutt. | Small plant at west end of pond |
| Cattails | *Typha latifolia* L. | Growing in one location on north side of pond |
| *Fagonia | *Fagonia laevis* Standley | Growing in rocky hills on north side of pond; corolla is purple. |
| *Desert willow | *Chilopsis linearis* Cov. | Growing in wash area; corolla is bell shaped, colored white with pale purple in throat, grouped in clusters. |
| *Range ratany | *Krameria erecta* Schultes | Growing in wash area, 2-3 m. tall; low-branched shrub; corolla is red-purple. |
| *White bursage | *Ambrosia dumosa* (A. Gray) Payne *[Franseria dumosa]* A. Gray | Growing in wash area and north of pond; low shrub. |

**Succulent Types**

| | | |
|---|---|---|
| Yucca | *Yucca* sp. | Large group growing on north side of pond. |

Table 7

Table 7-cont.

| | | |
|---|---|---|
| Prickly pear | *Opuntia* sp. | Growing on north side of pond. |
| Aloe | *Aloe* sp. | Growing on north side of pond. |

**Herbaceous Types**

| | | |
|---|---|---|
| *Sunflower | *Helianthus annuus* L. | Growing in wash area; corolla is yellow with black/brown center. |
| *Yellow sweetclover | *Melilotus officinalis* (L.) Pall. | Growing in was area; corolla is yellow, attracts bees. |
| *Popcorn flower | *Cryptantha angustisolia* (Torr.) Greene | Growing in wash area; corolla is white. |
| *Filaree | *Erodium cicutarium* (L.) L'He'r | Growing in wash area, 0.5 m. tall; beneficial weed, provides food for wildlife; corolla is pink/purple. |
| *Desert-sunflower | *Geraea canescens* A. Gray | Growing in wash area, 2-3 m. tall; corolla is yellow. |
| *Black mustard | *Brassica nigra* L. | Growing in wash area, 2-3 m. tall. |
| *London rocket | *Sisymbrium irio* L. | Growing in wash area; mustard family. |
| *Wire-lettuce | *Stephanomeria pauciflora* (Nutt.) Nelson | Growing in wash area. |

TABLE 8. POPULATION COUNTS FOR DOMESTIC FOWL AND ROCK DOVES

| Count | Ducks | Geese | Chickens | Turkeys | Guinea Hens | Rock Doves |
|---|---|---|---|---|---|---|
| 1 | 100 | 33 | 20 | 1 | 3 | 14 |
| Weather: Clear, windy and warm. | | | | | | |
| 2 | 106 | 32 | 8 | 1 | 3 | 14 |
| Weather: Cold, sunny, scattered cumulus clouds, mild breeze. | | | | | | |
| 3 | 124 | 31 | 13 | 1 | 3 | 14 |
| Weather: Cold, sunny, scattered cumulus clouds, mild breeze. | | | | | | |
| 4 | 111 | 40 | - | 0 | - | 32 |
| Weather: Clear, hot, slight breeze. | | | | | | |
| 5 | 135 | 41 | - | - | - | - |
| Weather: Sunny and warm, cirrocumulus cloud coverage, gentle breeze. | | | | | | |

TABLE 9. DOMESTIC BIRD POPULATION

| Species | Males | Females | Total | Comments |
|---|---|---|---|---|
| Ducks | 72 | 43 | 115 | Observed mating and laying eggs but not setting. |
| Geese | | | 35 | Observed mating and laying. One pair setting for three weeks then nest was excavated. Predator is unknown. |
| Chickens | 5 | 9 | 14 | Laying and setting eggs. Absence of 5 chicks since count #1 indicates chicks are not reaching maturity. |
| Turkey | | | 1 | |
| Guinea Hen | | | 3 | |
| Rock Dove | | | 32 | |

TABLE 10. BIRD SPECIES LIST (excluding domestic fowl)

| Common Name (No's) | Breeding | Comments |
|---|---|---|
| Great Blue Heron (1) | - | Seen frequently on shore or hill north of pond |
| Egret (1) | - | Unidentified. Seen in flight and in trees west of pond |
| Black-crowned Night Heron (1) | - | Flushed from roost on several occasions in reeds or trees on west end of pond |
| Harris Hawk (2) | - | Seen in flight over farm machinery west of pond and garden |
| American Coot (1) | - | Seen only on first day of study |
| Rock Dove (32) | # | |
| Common Ground Dove (2) | - | Seen in garden area north of pond hill |
| Greater Roadrunner (1) | - | Seen on trails north of pond hill |
| Lesser Nighthawk (4) | + | Seen in far east end of garden carrying nesting materials |
| Costa's Hummingbird (4) | - | Males seen defending feeding territories Unidentified females seen. This species does not form monogamous pairs. |
| Gila Woodpecker (1) | - | Seen on Saguaro cactus north of pond hill |
| Western Kingbird (3) | + | Seen as individuals early in study Later seen far east end of garden with nest material |
| Verdin (7) | * | 3 breeding territories with paired birds Nestlings confirmed in one nest. 1 apparently unpaired male calling from tree-tops. |
| Cactus Wren (0) | 0 | None seen or heard. Several nests were found dilapidated and old |
| Northern Mockingbird (2) | # | Seen in far north side of garden |
| European Starlings (10+) | # | Probably nesting in palm trees |

TABLE 10. BIRD SPECIES LIST cont.

| Common Name (No's) | Breeding | Comments |
|---|---|---|
| Black-throated Sparrow (1) | - | Seen in Palo Verde north of pond hill |
| Great-tailed Grackle (10+) | + | Males displaying to females. This species does not form monogamous pairs. Seen carrying nest material. |
| House Finch (14+) | * | 7 active nests (eggs and/or young) found all in cholla cactus |
| House Sparrow (10+) | + | Seen carrying nest material to palm trees |

KEY TO BREEDING SYMBOLS

(*) Eggs or babies seen in nest
(+) Nest or nest building
(#) Pair seen in suitable breeding environment
(x) Exhibit mating or territorial behavior
(-) Individual(s)
(0) Evidence that species was once present but is no longer here

Numbers in parenthesis after common names of birds indicate the approximate number. The designation 10+ was used for those species that are numerous.

TABLE II. MAMMALS AND REPTILES

| Name | No. | Comments |
|---|---|---|
| Common House Cat | 7 | 1 Lg. (M) orange tabby, 1 Sm. orange tabby, 1 black tabby, 1 black and white long-haired, 1 siamese (possibly lactating), 1 solid black medium-haired, 1 solid black short-haired lactating female. |
| Skunk | - | Identified by smell, never seen. |
| Desert Cottontail | 2 | There are at least two, observed in garden area north of pond. |
| Black-tailed Jackrabbit | 2 | Two observed in southwest area of garden. |
| Unidentified Rodents | - | Presence identified by den holes and scats. |
| Unidentified Lizards | - | Approximately 6 seen primarily in far east area of garden and under creosote bush north end of pond. |

Table 12 - Seining results in the Yuma Conservation Garden Pond

| Date/Time | Location | Pass # | Number and Species | Size |
|---|---|---|---|---|
| **March 19** | | | | |
| 0900 hours | west end | 1 | nil | nil |
| 0920 hours | southeast corner | 2 | nil | nil |
| 0930 hours | southeast corner | 3 | nil | nil |
| 0940 hours | east corner | 4 | nil | nil |
| 0950 hours | northeast corner | 5 | 1 bluegill<br>48 shad<br>2 carp<br>1 largemouth bass | 10 cm.<br>8-10 cm.<br>Approx. 75 cm.<br>Approx. 50 cm. |
| 1010 hours | northeast corner | 6 | 11 bluegill | 8-14 cm. |
| **April 09** | | | | |
| 1000 hours | northeast corner | 1 | 3 shad | 8-10 cm. |
| 1015 hours | northeast corner | 2 | 3 shad | 8-10 cm. |

Table 13. Microscopic Organisms Found in Pond Sediments and Surface Scrapings

Kingdom Protists
- Phylum Chrysophyta - diatoms
  - *Navicula*
- Phylum Ciliophora - ciliated protozoa
  - *Paramecium*
  - various ciliates
  - *Acineta* - suctorian

Kingdom Multicelled Plants
- Division Chlorophyta - Green Algae
  - *Cladophora*
  - *Spirogyra*
  - *Chlorella*
  - *Scenedesmus*

Kingdom Multicelled Animals
- Phylum Platyhelminthes - flatworms
- Phylum Nemotoda - roundworms
- Phylum Rotifera - rotifers or wheel animals
- Phylum Annelida - segmented worms
- Phylum Tardigrada - water bears
- Phylum Arthropoda
  - cladoceran crustaceans - daphnia or water fleas
  - ostracod crustacenas - seed shrimp

Table 14 - Microscopic Organisms found in Yuma Conservation Garden Pond

| Date | Method of Sampling | Location | Type of Species Found |
|---|---|---|---|
| April 09 | Plankton net | 20-'40 cm. in depth throughout the pond | rotifers<br>daphnia<br>various ciliates |

Figure 1

# CONSERVATION GARDEN & DUCK POND

## TOPOGRAPHIC MAP

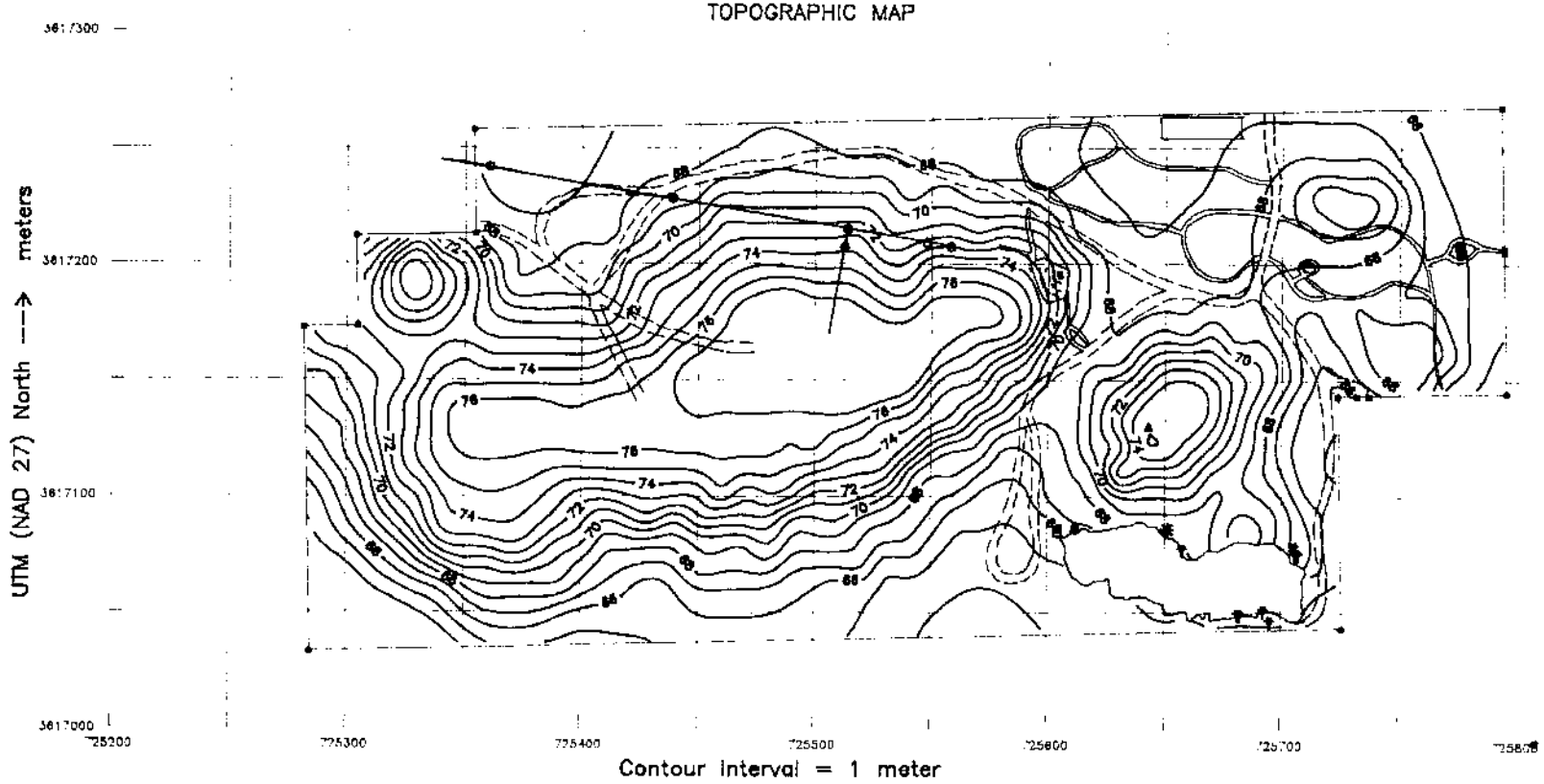


Figure 2. Relief Map of the Yuma Conservation Garden

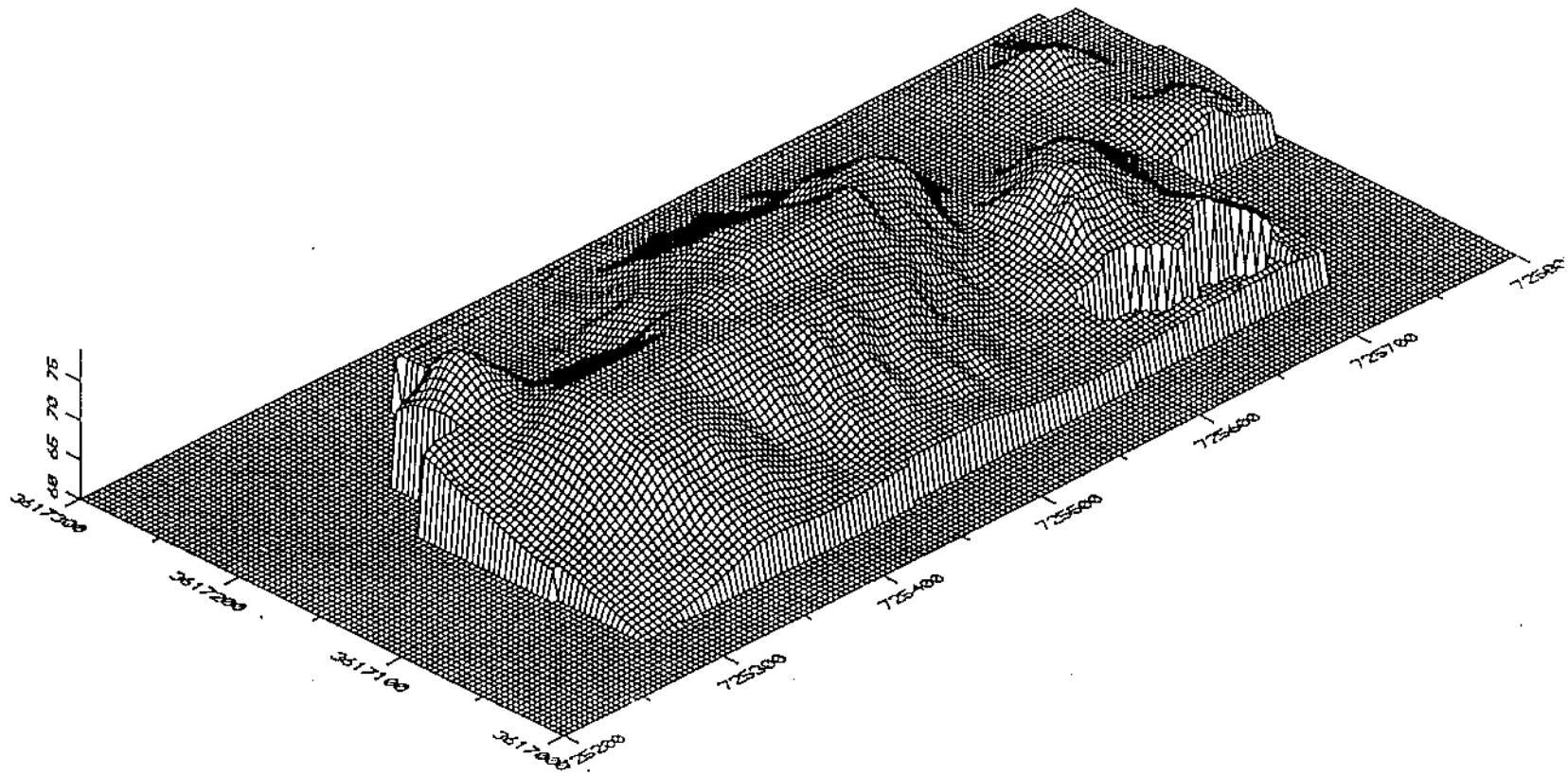


Figure 3 - Yuma Conservation Garden Water Depth Data

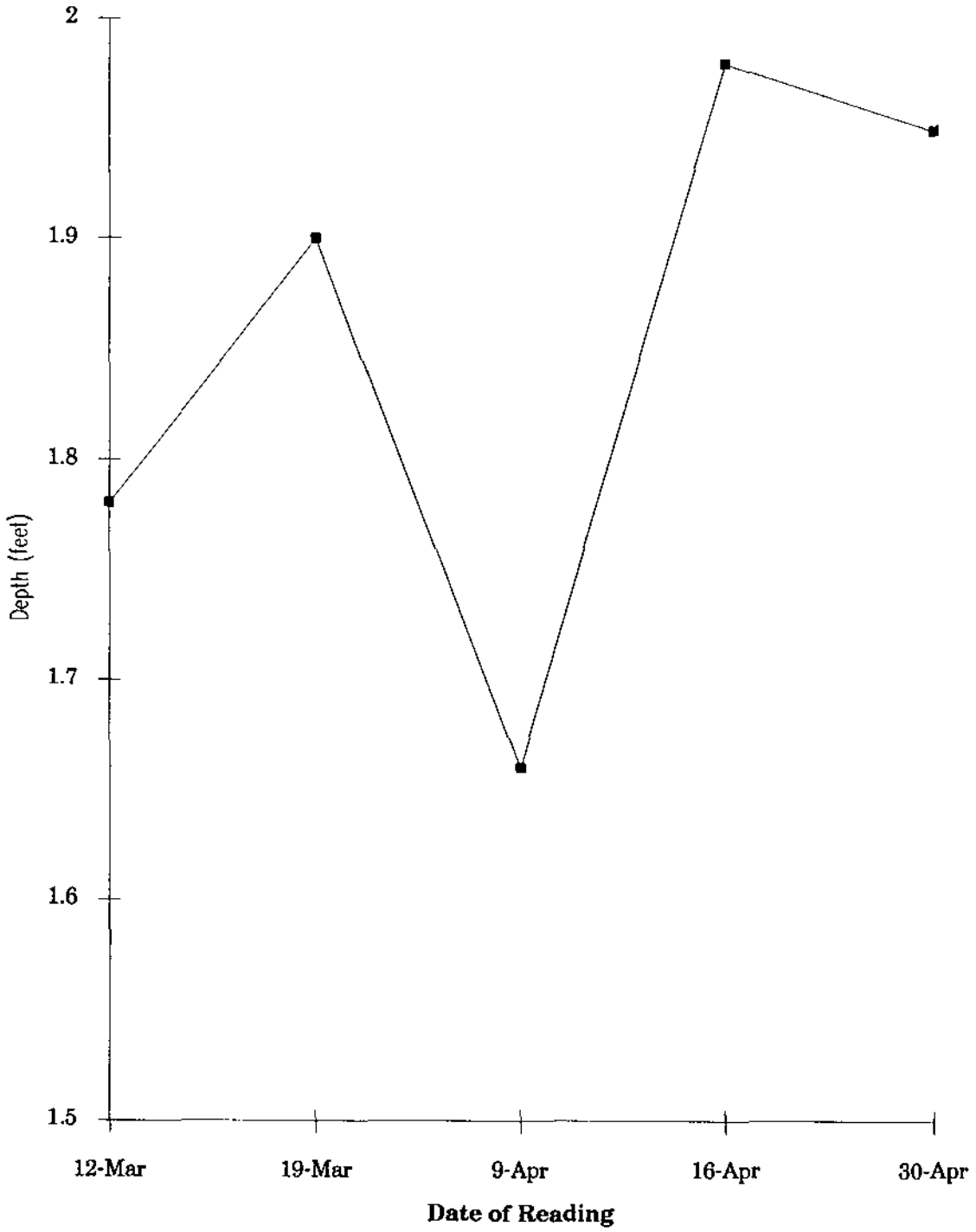


Figure 4 - Yuma Conservation Garden Water Temperature Data

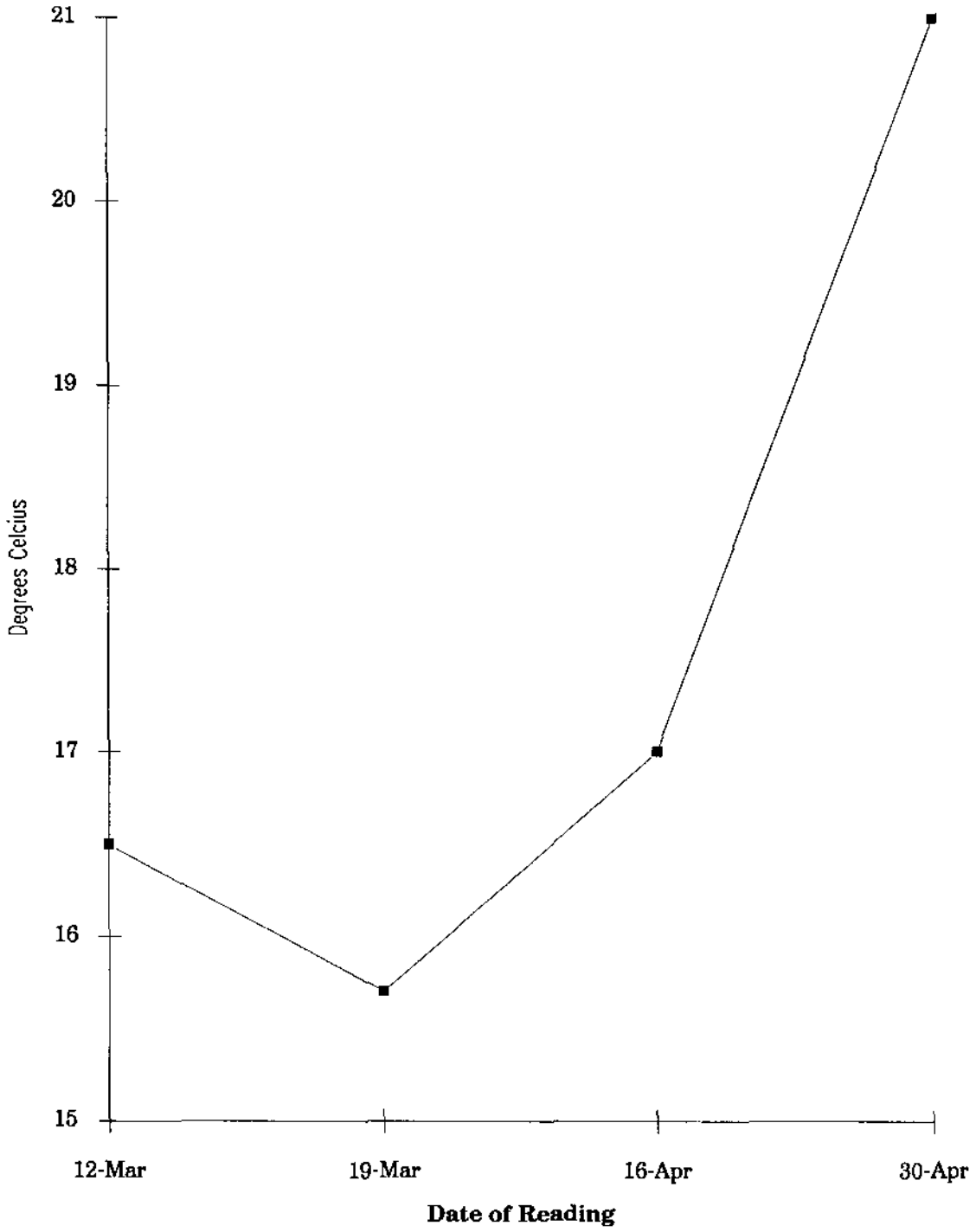


Figure 5. Depth Profile of the Yuma Conservation Garden Pond

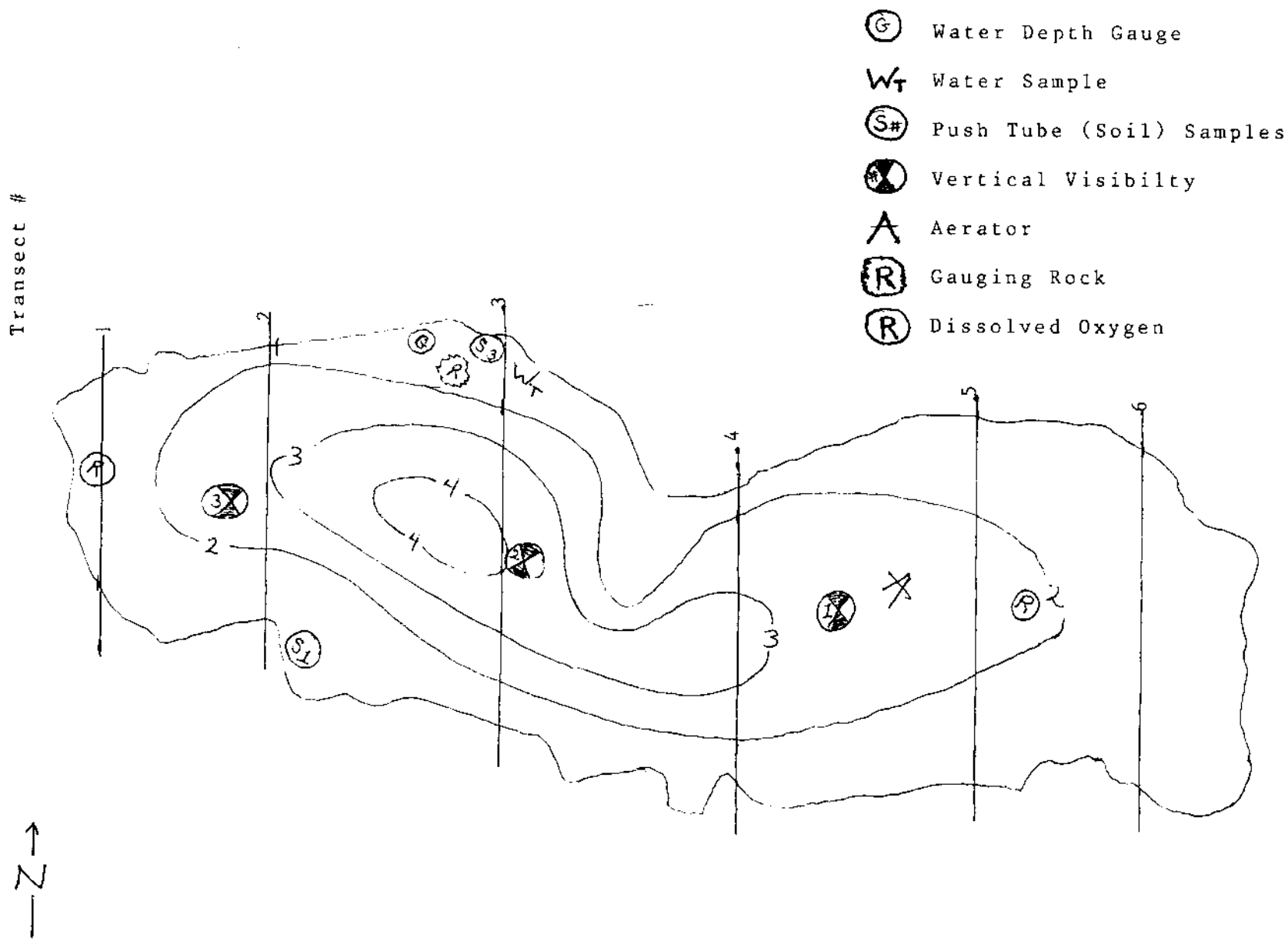


Figure 6 Map of Plant Locations at Yuma Conservation Garden Pond

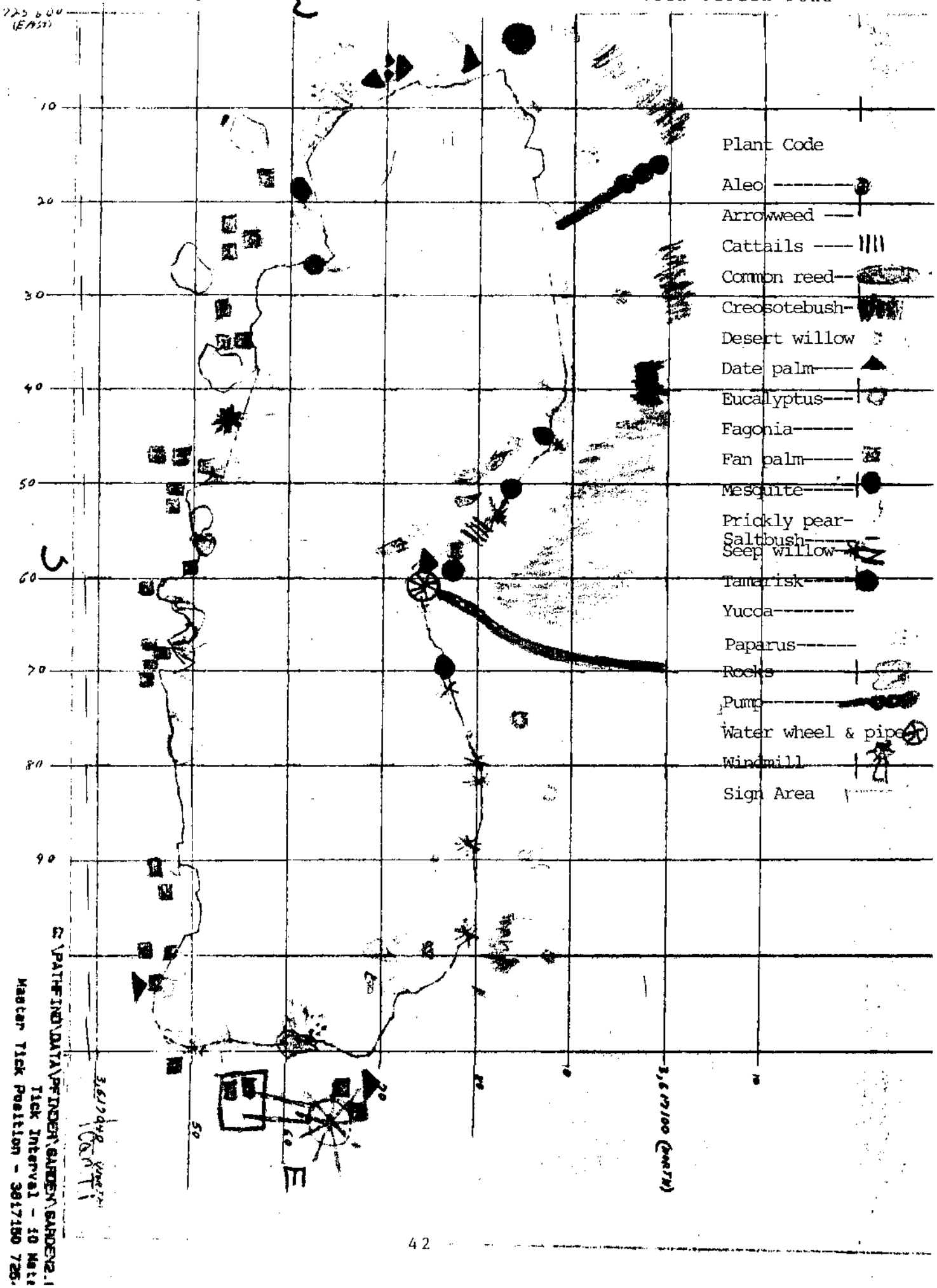
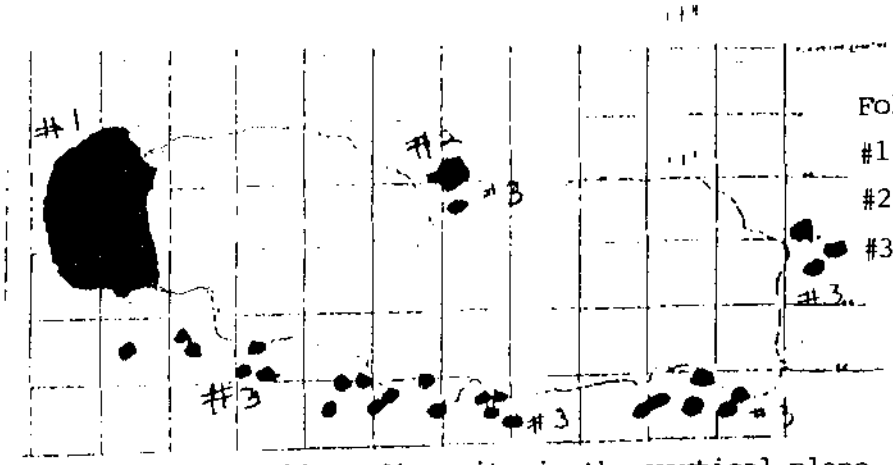


Figure 7. Foliage Height Diversity of Yuma Conservation Garden




Foliage over 6 meters tall

#1 - Eucalyptus & mesquite

#2 - Mesquite

#3 - Fan & Date palms (27 locations)

Figure 7-A Foliage diversity in the vertical plane
Foliage over 6 meters tall

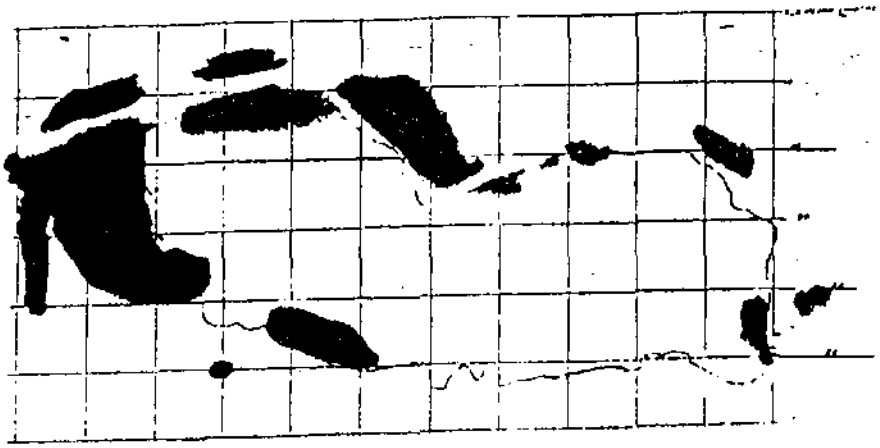


Figure 7-B Foliage diversity in the vertical plane
Foliage 2-6 meters tall

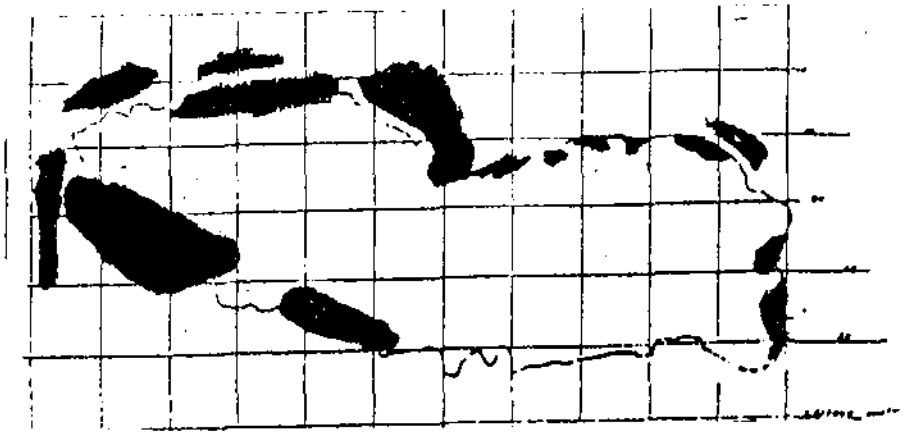


Figure 7-C Foliage diversity in the vertical plane
Foliage less than 2 meters tall

# COLORADO RIVER CHEMICAL ANALYSES
## GROUND-WATER STATUS REPORT - 1993

| COLORADO RIVER AT IMPERIAL DAM | Na ppm | K ppm | Ca ppm | Mg ppm | Cl ppm | HCO3 ppm | SO4 ppm | NO3 ppm | SiO2 ppm | B ppm | F ppm | Fe ppm | Mn ppm | Ba ppm | Sr ppm | TDS ppm | EC mmhos/cm | pH | SAR* | TEMP Deg C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLE DATE | | | | | | | | | | | | | | | | | | | | |
| 01/04/93 | 169 | 5.1 | 106 | 39 | 158 | 222 | 370 | 0.9 | 12.7 | 0.19 | 0.3 | 0.00 | 0.00 | 0.13 | 1.42 | 1030 | 1490 | 8.3 | 3.6 | 22.0 |
| 01/19/93 | 176 | 5.0 | 89 | 36 | 174 | 216 | 375 | 1.0 | 11.5 | 0.20 | 0.4 | 0.00 | 0.00 | 0.11 | 1.35 | 992 | 1490 | 8.31 | 4.0 | |
| 02/01/93 | 176 | 4.9 | 88 | 34 | 166 | 219 | 333 | 0.6 | 13.2 | 0.19 | 0.4 | 0.00 | 0.00 | 0.11 | 1.25 | 1000 | 1470 | 8.37 | 4.0 | |
| 02/16/93 | 158 | 5.1 | 90 | 33 | 148 | 204 | 305 | 0.8 | 13.2 | 0.18 | 0.4 | 0.00 | 0.00 | 0.10 | 1.17 | 874 | 1340 | 8.2 | 3.6 | |
| 03/01/93 | 110 | 4.5 | 66 | 25 | 99 | 168 | 223 | 1.4 | 13.4 | 0.12 | 0.4 | 0.02 | 0.00 | 0.08 | 0.89 | 620 | 973 | 8.2 | 2.9 | |
| 03/15/93 | 81 | 4.5 | 56 | 21 | 71 | 151 | 176 | 1.0 | 13.7 | 0.08 | 0.4 | 0.03 | 0.00 | 0.08 | 0.73 | 510 | 812 | 8.1 | 2.3 | |
| 04/05/93 | 110 | 4.8 | 72 | 27 | 95 | 167 | 211 | 0.8 | 13.5 | 0.11 | 0.4 | 0.02 | 0.00 | 0.10 | 0.91 | 632 | 960 | 8.2 | 2.8 | |
| 04/19/93 | 123 | 4.7 | 82 | 32 | 114 | 174 | 303 | 0.9 | 6.0 | 0.12 | 0.4 | 0.01 | 0.00 | 0.12 | 1.13 | 798 | 1180 | 8.3 | 2.9 | |
| 05/03/93 | 129 | 4.8 | 87 | 34 | 120 | 174 | 304 | 1.3 | 7.0 | 0.13 | 0.5 | 0.01 | 0.00 | 0.13 | 1.18 | 794 | 1210 | 8.2 | 3.0 | |
| 05/17/93 | 133 | 5.0 | 88 | 34 | 121 | 181 | 319 | 1.0 | 10.0 | 0.14 | 0.4 | 0.00 | 0.00 | 0.13 | 1.20 | 820 | 1240 | 8.3 | 3.1 | |
| 06/07/93 | 126 | 5.1 | 87 | 34 | 113 | 173 | 315 | 0.9 | 10.6 | 0.13 | 0.3 | 0.00 | 0.00 | 0.12 | 1.21 | 780 | 1200 | 8.3 | 2.9 | |
| 06/21/93 | 129 | 4.9 | 86 | 34 | 117 | 177 | 297 | 0.9 | 9.6 | 0.13 | 0.3 | 0.00 | 0.00 | 0.12 | 1.20 | 820 | 1230 | 8.4 | 3.0 | |
| 07/06/93 | 123 | 4.9 | 86 | 33 | 113 | 173 | 301 | 1.0 | 7.1 | 0.10 | 0.3 | 0.00 | 0.00 | 0.13 | 1.17 | 814 | 1200 | 8.3 | 2.9 | |
| 07/19/93 | 130 | 5.1 | 86 | 33 | 116 | 173 | 297 | 0.0 | 10.3 | 0.13 | 0.4 | 0.00 | 0.00 | 0.12 | 1.21 | 822 | 1230 | 8.4 | 3.0 | |
| 08/02/93 | 137 | 5.0 | 88 | 35 | 118 | 175 | 306 | 0.7 | 9.0 | 0.13 | 0.4 | 0.00 | 0.00 | 0.13 | 1.24 | 816 | 1240 | 8.3 | 3.1 | |
| 08/16/93 | 130 | 4.8 | 87 | 34 | 116 | 172 | 297 | 0.7 | 9.4 | 0.14 | 0.4 | 0.00 | 0.00 | 0.13 | 1.21 | 836 | 1240 | 8.3 | 3.0 | |
| 09/07/93 | 136 | 4.9 | 87 | 35 | 125 | 168 | 309 | 0.6 | 10.1 | 0.14 | 0.4 | 0.00 | 0.00 | 0.13 | 1.23 | 824 | 1260 | 8.3 | 3.1 | 25.0 |
| 09/22/93 | 138 | 5.0 | 88 | 35 | 127 | 173 | 305 | 0.6 | 11.0 | 0.14 | 0.4 | 0.01 | 0.00 | 0.14 | 1.25 | 840 | 1250 | 8.3 | 3.1 | |
| 10/04/93 | 141 | 5.2 | 90 | 36 | 127 | 173 | 317 | 0.7 | 10.6 | 0.15 | 0.4 | 0.00 | 0.00 | 0.14 | 1.28 | 820 | 1230 | 8.3 | 3.2 | |
| 10/18/93 | 134 | 4.8 | 86 | 34 | 120 | 172 | 303 | 0.7 | 10.3 | 0.14 | 0.4 | 0.00 | 0.00 | 0.13 | 1.25 | 834 | 1250 | 8.3 | 3.1 | |
| 11/01/93 | 132 | 5.0 | 86 | 34 | 126 | 172 | 305 | 0.8 | 10.2 | 0.15 | 0.4 | 0.00 | 0.00 | 0.13 | 1.25 | 856 | 1250 | 8.2 | 3.1 | |
| 11/15/93 | 147 | 4.6 | 96 | 36 | 129 | 184 | 318 | 0.8 | 11.8 | 0.14 | 0.4 | 0.02 | 0.00 | 0.14 | 1.29 | 870 | 1300 | 8.3 | 3.2 | 26.0 |
| 12/06/93 | 144 | 5.1 | 90 | 35 | 133 | 173 | 323 | 0.8 | 10.7 | 0.15 | 0.4 | 0.00 | 0.00 | 0.13 | 1.28 | 876 | 1300 | 8.2 | 3.3 | 22.0 |
| 12/20/93 | 148 | 5.0 | 96 | 36 | 141 | 178 | 331 | 0.7 | 10.7 | 0.15 | 0.4 | 0.00 | 0.00 | 0.16 | 1.33 | 898 | 1350 | 8.4 | 3.3 | |
| COLORADO RIVER STATISTICS - 1993 | | | | | | | | | | | | | | | | | | | | |
| AVERAGE | 136 | 4.9 | 86 | 33 | 124 | 180 | 302 | 0.8 | 10.7 | 0.14 | 0.4 | 0.01 | 0.00 | 0.12 | 1.19 | 824 | 1237 | 8.3 | 3.1 | 23.8 |
| MAXIMUM | 176 | 5.2 | 106 | 39 | 174 | 222 | 375 | 1.4 | 13.7 | 0.20 | 0.5 | 0.03 | 0.00 | 0.16 | 1.42 | 1030 | 1490 | 8.4 | 4.0 | 26.0 |
| MINIMUM | 81 | 4.5 | 56 | 21 | 71 | 151 | 176 | 0.0 | 6.0 | 0.08 | 0.3 | 0.00 | 0.00 | 0.08 | 0.73 | 510 | 812 | 8.1 | 2.3 | 22.0 |
| STANDARD DEVIATION | 21 | 0.2 | 10 | 4 | 22 | 17 | 43 | 0.3 | 2.0 | 0.03 | 0.0 | 0.01 | 0.00 | 0.02 | 0.15 | 111 | 151 | 0.1 | 0.4 | 1.8 |
| NUMBER OF SAMPLES | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 4 |

*SAR = Sodium Adsorption Ratio

Appendix 2 - Colorado River Above Imperial Dam - Water Quality Analysis

| Date | Bacteria | | pH | Solids Residue | Water Temp. | Dissolved Oxygen | % Saturation | Nitrogen | Silica |
|---|---|---|---|---|---|---|---|---|---|
| | Colifom | Streptococci | | | | | | | |
| January 28 | 3,000/100ml | '14,000/100ml | 8.3 | 785ppm | 12.0 C | 10.6ppm | 98 | 0.210ppm | 9.4ppm |
| March 24 | 4,000/100ml | '12,000/100ml | 8.1 | 788ppm | 18.5 C | 9.2ppm | 98 | 0.230ppm | 8.9ppm |
| May 19 | 14,000/100ml | ,28,000/100ml | 8.2 | 790ppm | 26.0 C | 8.0ppm | 99 | 0.210ppm | 8.6ppm |

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