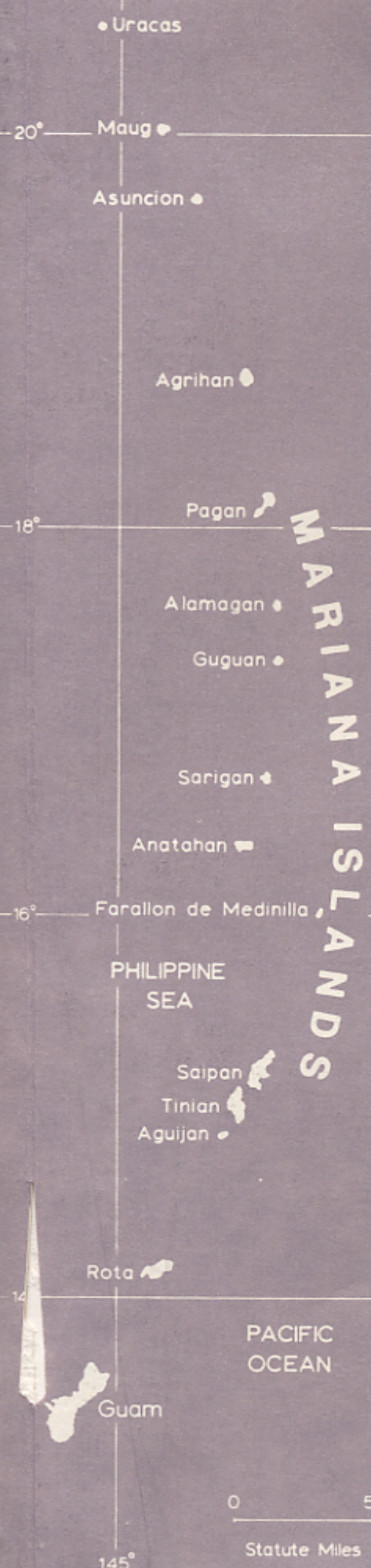

HISTORICAL WATER QUALITY OF PUAG PRODUCTION WATER WELLS

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UNIVERSITY OF GUAM

Water and Energy Research Institute of the Western Pacific

Technical Report No. 57

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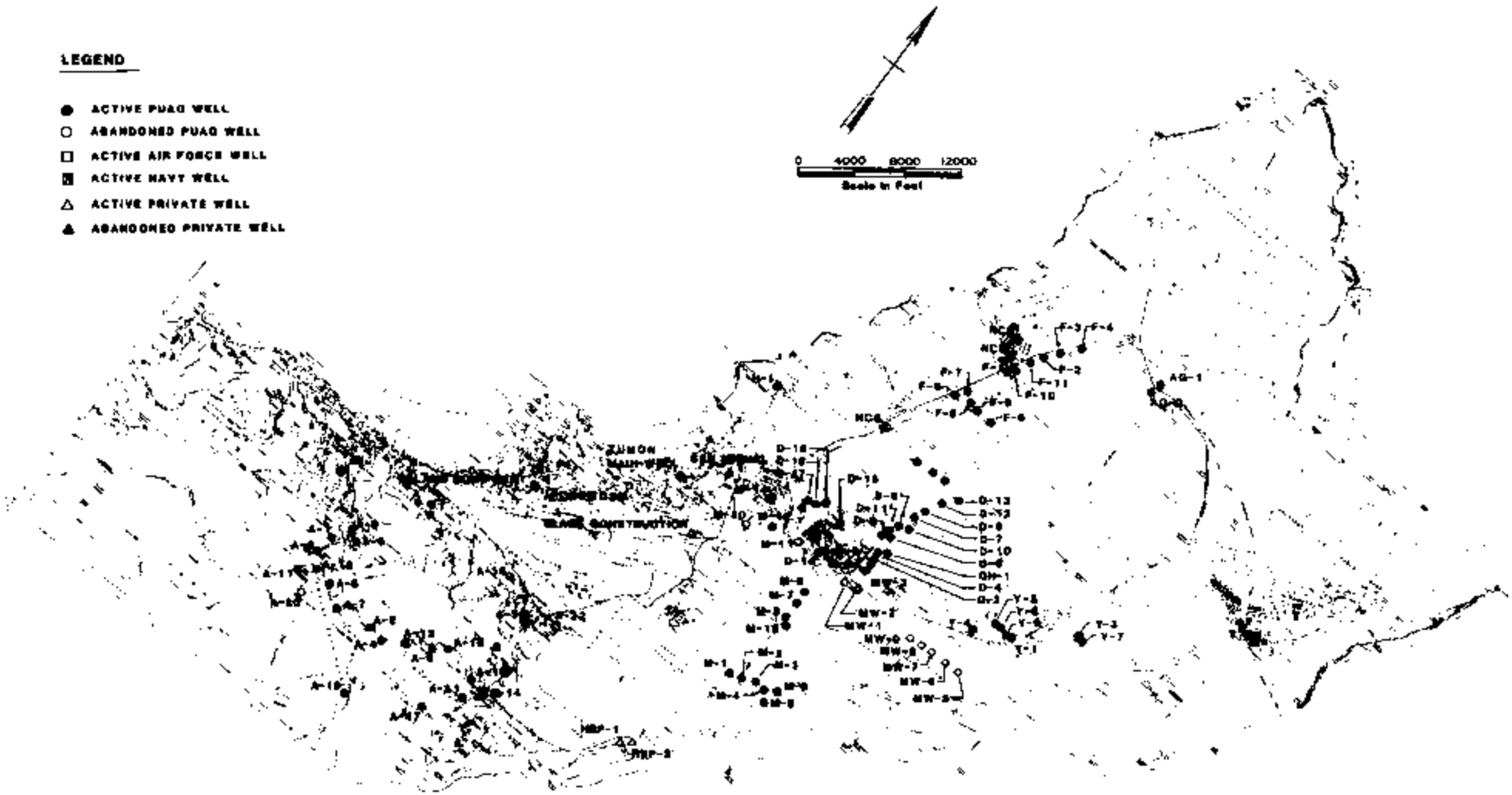


Figure 1. Location of production water wells (adapted from Barrett, Harris and Associate Inc., 1981c).

This historical data report is a potentially valuable management tool. It augments many of the management proposals presented in the NGLS. Statistical analyses contained in the report help provide characterization of individual water wells, grouped water wells by geographical or geological areas and by management zone. This information can be applied in future hydrogeological investigations of the northern Guam aquifer.

Prediction of future water quality trends for individual water wells and, in some cases, grouped water wells can be made based on short-term behavior patterns. As more data are generated in future water quality monitoring by PUAG, it will become possible to assess this new data against base-line data and in relation to short-term patterns. This will enable PUAG or other Government of Guam agencies to easily predict if future water well behavioral patterns are either typical or abnormal.

Scope of Work

WERI was to compile, edit, place in computer storage and statistically analyze the historical water quality data from production water wells, which were generated by the PUAG water laboratory. This historical data report was to be a single source document of water well quality which covered the time period from late 1976 through December 1983. It would assess base-line water quality data and short-term trends for both individual water wells and for combined water well series. It would be a document that could augment other groundwater reports and studies. This would make the report a useful management tool in making decisions in regards to the Northern Guam groundwater aquifer.

Objectives

The following objectives were accomplished by the WERI in the process of making a management-oriented historical report on PUAG production water well data:

1. Compiled a data file on magnetic tape storage at the University of Guam Computer Center. The data files was called ALLWELL. All PUAG water well data from late 1976 through December 1983 were key punched and verified into a master data file. Data from 72 wells were entered into the data file.

2. The master data file was edited and a sorted data file was generated which had "bad data" either corrected or eliminated.

3. Provided information and documentation necessary to convert sorted water well data stored on magnetic tape at the University of Guam Computer Center to the USEPA STORET System.

4. Conducted basic statistical analyses on sorted water well data for individual water wells and grouped water wells.

5. Conducted trend analyses on sorted water well data for individual water wells and grouped water wells.

6. Interpreted trend analyses in order to group water wells based on water quality characteristics.

7. Made recommendations on the application of the historical data report in resolving management problems.

8. Produced a printed compilation of sorted water data for all analyzed production water wells. This compilation of the master data file is Appendix A and is found under a seperate cover.

9. Produced scattergram plots of all water quality parameters for each water well. These plots are found in Appendix B, which is under a seperate cover.

10. Established guidelines for yearly statistical analyses of PUAG production water well data.

Water Quality Parameters

PUAG Monitoring Program

PUAG routinely tests production water wells for up to 12 physical, chemical and bacteriological water quality parameters (Table 1). The physical water quality parameters analyzed by PUAG are temperature, pH, specific electrical conductance, turbidity, color, taste and, in 1982 and 1983, saturation index. Temperature measurements are taken at the well head and the remaining parameters are measured in water samples taken to the water laboratory. The chemical water quality parameters are total hardness, calcium hardness, total alkalinity and chlorides. Total coliform bacteria is the bacteriological water quality parameter.

These water quality parameters were not always monitored on a monthly basis. There was quarterly monitoring of total hardness, calcium hardness and alkalinity in 1981 and most of 1982. Periodically, selected water quality parameters were not measured for either individual wells or the well series. These missed sampling periods have produced common "data gaps" in the base-line water well records. Gaps in the data record interfere with advanced statistical test designs, particularly for programs which analyze long-term trends or time series data. These gaps, if frequent, greatly reduce the accuracy and reliability of data output. Some of these "data gaps" were unavoidable, such as those that occurred after large typhoon storms due to the subsequent power outages and other storm related problems. Other "data gaps" were caused by personnel constraints and problems (physical and economic) with laboratory equipment and off-island arrival of required supplies.

The most consistently monitored water quality parameters are pH, turbidity, chloride and specific conductance. The other water quality parameters have more frequent "data gaps". pH measurements are made on water samples returned to the laboratory. The equilibria in a groundwater aquifer is altered when water is pumped from a well (Hem, 1978). A pH measurement taken in the field at the time of sampling may reasonably represent the equilibria pH in the aquifer. However, if a sample was placed in a sampling bottle and the pH was not determined for many hours or

Table 1. Water quality parameters analyzed from production water wells by PUAC. All parameters are analyzed in accordance with Standard Methods (1980).

Water Quality Parameter	Units	Standard Method
1. Temperature	°C	Standard 20-50°C mercury thermometer (Samples measured at well head)
2. pH	pH	Potentiometric measurement (Fisher 520 Digital meter; Samples measured in laboratory as soon as returned from field)
3. Turbidity	NTU	Nephelometric measurement (Hach 2001 turbidimeter)
4. Color	Colormetric units	Visual comparison with color wheel
5. Taste	Rating Scale	Taste rating (without standards)
6. Total Hardness as $CaCO_3$	mg/ℓ	EDTA titrimetric method
7. Calcium Hardness as $CaCO_3$	mg/ℓ	EDTA titrimetric method
8. Alkalinity as $CaCO_3$	mg/ℓ	Potentiometric titration to end-point pH with 0.02N sulfuric acid, methyl-orange indicator
9. Chlorides	mg/ℓ	Argentometric method, silver nitrate titration
10. Specific Conductance	mhos/cm	Conductivity bridge (Conductivity Bridge Auto 31)
11. Total Coliform Bacteria	counts/100ml	Millipore membrane (samples packed on cold packs for transport from field to laboratory)

days later, the measured pH may not have been related to the original conditions. Accurate measurement of pH in the field should become a standard practice for all groundwater water wells. Specific electrical conductance measurements are also measured in samples returned to the laboratory, but the accuracy of field measurements, with a good meter, can be consistent with those taken in the laboratory, if temperature is held constant. A carefully operated specific conductance meter can produce accuracy and precision measurements that range from ± 2 to ± 5 percent of actual groundwater conditions. Water temperatures measured at the well head do not necessarily represent aquifer temperatures. Friction and mechanical pumping action from submersible pumps can slightly increase water temperatures. Water well temperature increases are generally variable and reflect pump performance more than actual changes in aquifer temperatures. Taste and color are subjective tests which are generally not useful in assessing groundwater quality. Measurements for these tests are almost always zero, which would be anticipated for groundwater samples.

All water quality parameters are analyzed by PUAG in accordance with Standard Methods (1980). The methods used for analyses are presented in Table 1. Chemical parameters are analyzed by various titration methods which are reasonably uncomplicated and provide generally accurate measurements, although the precision can be variable.

The PUAG monitoring program provides data which characterize water well quality. A great deal of care must be used in the interpretation of this water data for both individual wells and water well series. Water well samples are not always indicative of overall water quality in a vertical well section. Many wells can show some degree of vertical water quality stratification. However, it is generally useful to consider the water sample as an average composite of water at that given point in the aquifer. Assuming the degree of water quality stratification is not too great, then evaluation of water quality from wells in a geological or geographical area can provide information on areal variations and patterns of groundwater quality. Since the aquifer is dynamic, subject to slow changes in water quality through time, consideration must be made for time dependent variations in water quality.

Standards

Production well water is classified in the GEPA water quality standards as category G-1 or groundwater resource zone (GEPA, 1984). This zone is defined in the standards as follows:

> "The primary use of groundwater within this zone is for drinking (human consumption) and this use must be protected. Virtually all water of the saturated zone of Guam is included. Specifically it includes all water occurring in the saturated zone below the groundwater table, all vadose water occurring in an unsaturated zone interval extending 100 feet (30.5 m) above any water table, all water of the basal and parabasal freshwater bodies (the freshwater lens), and all water of and below the freshwater/salt-water transition zone beneath the basal water body.

Because any water discharges within this zone will (by definition) be tributary to groundwater bodies which are actual or potential sources of fresh, potable water supply, no pollutant discharges to the groundwater within this zone will be allowed."

There is a set of GEPA water quality standards which apply to this groundwater zone. These standards establish primary drinking water standards and set limits for pollutant discharges which can potentially degrade the groundwater resource.

In relation to those parameters monitored by PUAG, temperature, turbidity, pH, total dissolved solids, chloride and coliform bacteria are specified in the GEPA standards. The GEPA Standards for these parameters are as follows:

Temperature - water temperature shall not be changed more than 1.0°c (1.8°F) from ambient conditions.

Turbidity - turbidity at any point, as measured by nephelometric turbidity units (NTU), shall not exceed 3 NTU over ambient conditions except when due to natural conditions. The previous primary drinking water standard in Guam set a turbidity standard of 1.0 turbidity unit, but did not specify the analysis method.

pH - the pH of fresh and estuarine waters shall be 6.5 - 8.5. Variations of more than 0.5 pH units from ambient shall not be allowed except due to natural causes.

Chloride - the maximum allowable amount of chlorides shall be 250 mg/ℓ.

Total Dissolved Solids - total dissolved solids shall not exceed 500 mg/ℓ or 133% of the ambient condition.

Microbiological requirements - concentrations of total coliform bacteria at any point shall not be increased from natural conditions at any time. The natural condition for aquifer water should be zero total coliform bacteria. The previous primary drinking water standard in Guam set coliform concentrations at 1 coliform bacteria per 100 mℓ sample as arithmetic mean of samples and 4 coliform bacteria per 100 mℓ sample in more than 1 sample when less that 20 samples were examined.

There are also general criteria or water quality requirements which apply to groundwater. These generally accepted aesthetic qualifications require potable water to be free of objectionable color, taste, and odor. There are no standards established for hardness, alkalinity and specific electrical conductance.

All parameters that PUAG analyses can provide information on quality of the potable water resource. However, some of these parameters can be more useful in making an evaluation of the water supply; bacteria, chloride, total hardness, and specific conductance. Although total

dissolved solids (TDS) was not analyzed by PUAG, it could be calculated from specific conductance for comparison with water quality standards.

Parameters

In order to better use this data report, it is important to have a general understanding of the water quality parameters which PUAG analyzes. There are numerous references available which discuss in detail specific water quality parameters as they occur in natural waters. Simplified discussions of pertinent water quality parameters are presented below, which were adapted from, in order of importance, Hem (1970), Johnson Division, UOP Inc. (1975), Standard Methods (1980), ASTM (1979), and Todd (1967).

pH

The pH determination is a reliable method to measure the acidic or alkaline tendency of water. The pH is a measure of the hydrogen ion (H^+) activity in a water. A pH value of 7.0 is considered neutral (temperature dependent), while a value less than 7.0 is acidic and a value greater than 7.0 is alkaline. Guam's aquifer waters are basic because of the presence of bicarbonates and carbonates associated with limestone units. Most groundwaters have a range of pH values from 6.0 to 8.5.

In most natural waters the concentration of hydrogen-ions as measured in mg/ℓ would be very low. Therefore, the activity of these hydrogen-ions are expressed in logarithmic units and pH represents an abbreviation for the negative base-10 log of hydrogen-ion activity in moles per liter. The pH of a water sample can be affected by temperature. Most instruments designed to measure pH can compensate for temperature affects. However, the measured pH value, which uses the water temperature at the time of measurement and not the groundwater temperature, does not necessarily represent the true pH of the groundwater source.

pH measurements are useful in determination of other water quality parameters. Alkalinity concentrations are determined in part by measuring changes in pH during the alkalinity analysis. pH measurements also provide information on carbon dioxide content and the state of equilibria of the water source.

Conductivity

Specific electrical conductance (conductivity) is the ability of a water sample to conduct an electrical current. Conductivity of a solution is measured as specific electrical conductance in a cubic centimeter of sample at a specified temperature. Conductance is the reciprocal of resistance, which is an electrical measure. The unit of conductivity is generally reported as micromhos per centimeter at temperature (t) °C. The occurrence of charged ions in a water sample makes the solution conduct electrical current. An increase in the ion concentration will cause an increase in the conductance of the water sample. Conductivity can then be defined as a measure of the ion concentration of water sample. However, there are a number of factors which can influence conductance. The

variety, amounts and proportions of various constituents, which include dissolved chemicals, suspended matter, as well as temperature, can affect conductance.

Total Dissolved Solids

The total concentration of dissolved minerals in a water sample is total dissolved solids (TDS), or, in more recent nomenclature, total residue. TDS is determined by evaporating a known volume of water and measuring the residue. TDS can also be estimated from specific electrical conductance by a simple mathematical formula: TDS = K * specific conductance, where K is a conversion factor. There are a range of conversion factors that can make a determination of approximate dissolved-solids (TDS) values from conductance measurements. For natural waters this conversion factor usually ranges from 0.55 to 0.75 with the higher values generally applied to waters with higher sulfate concentrations. A reasonally well-defined relationship between conductance and TDS is shown for the range of conductance of 100 to 5000 umhos/cm. The regression line is not exactly a straight-line, but provides a close approximation of TDS. The calculated TDS generally gives a lower value than would be obtained from evaporation analyses. A graph of TDS versus specific conductance is shown in Figure 2.

Alkalinity

Alkalinity in water is its capacity to neutralize acid. Carbonate and bicarbonate ions in water help produce most of the alkalinity. Groundwater in a limestone aquifer can have a considerable alkalinity, even though the pH is below the neutral value of 7. There are 3 major groups of dissolved carbon dioxide species in water which contribute to alkalinity: undissociated carbonic acid, bicarbonate and carbonate ions. The percentages of these groups can be determined from a species-distribution diagram (Figure 3). This diagram is useful in the interpretation of alkalinity chemistry.

Alkalinity is determined by adding a standard acid solution to a water sample and measuring the amount it takes to reach a specific end-point pH. PUAG is using a methyl-orange end point technique which has a final pH between 4.0 and 4.6. If the water sample has a pH value of 8.3 or greater, then the amount a acid required to reach a pH of 8.3 is called phenolphthalein alkalinity. "Methyl-orange alkalinity" is equivalent to "total alkalinity."

Hardness

Hardness is a water characteristic generally related to the amount of calcium and magnesium ions which react with soap. Hardness is commonly demonstrated by the amount of soap needed to produce suds. This reaction occurs when the minerals in the water combine with the soap and form an insoluble scum. The total hardness value is measured in terms of "hardness as $CaCO_3$", while calcium hardness defines the portion of total hardness derived from only calcium carbonate. This makes it possible to determine by calculation the amount of magnesium carbonate (plus other minor carbonate species) present in the water sample. When the total hardness

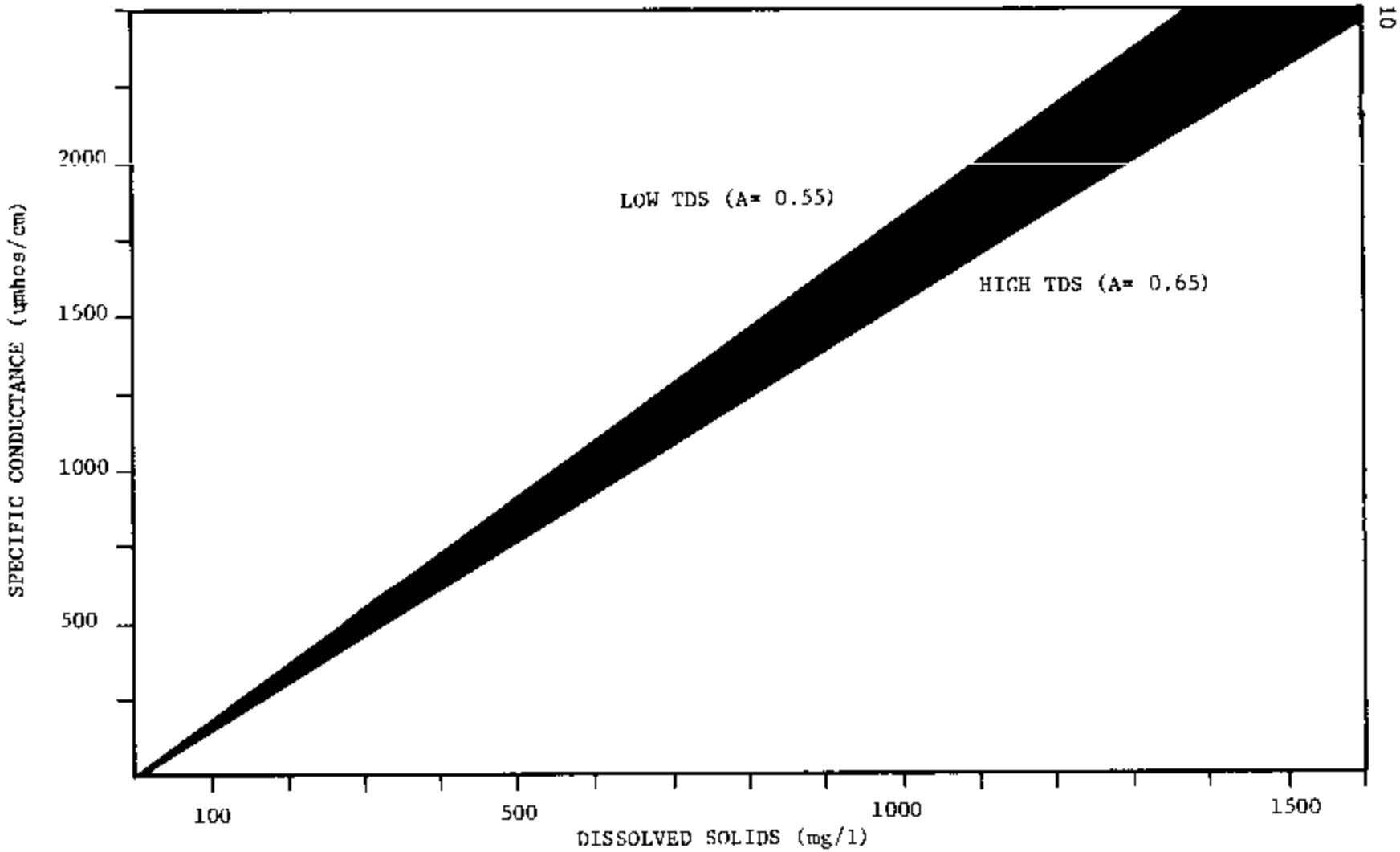


Figure 2. Estimates of total dissolved solids from specific conductance values. The calculated range of low to high TDS values are shown for any given conductance value. The A value is a conversion factor to compute TDS from conductance (K) by the formula KA=S. The center line is (S) the average conversion of specific conductance to TDS.

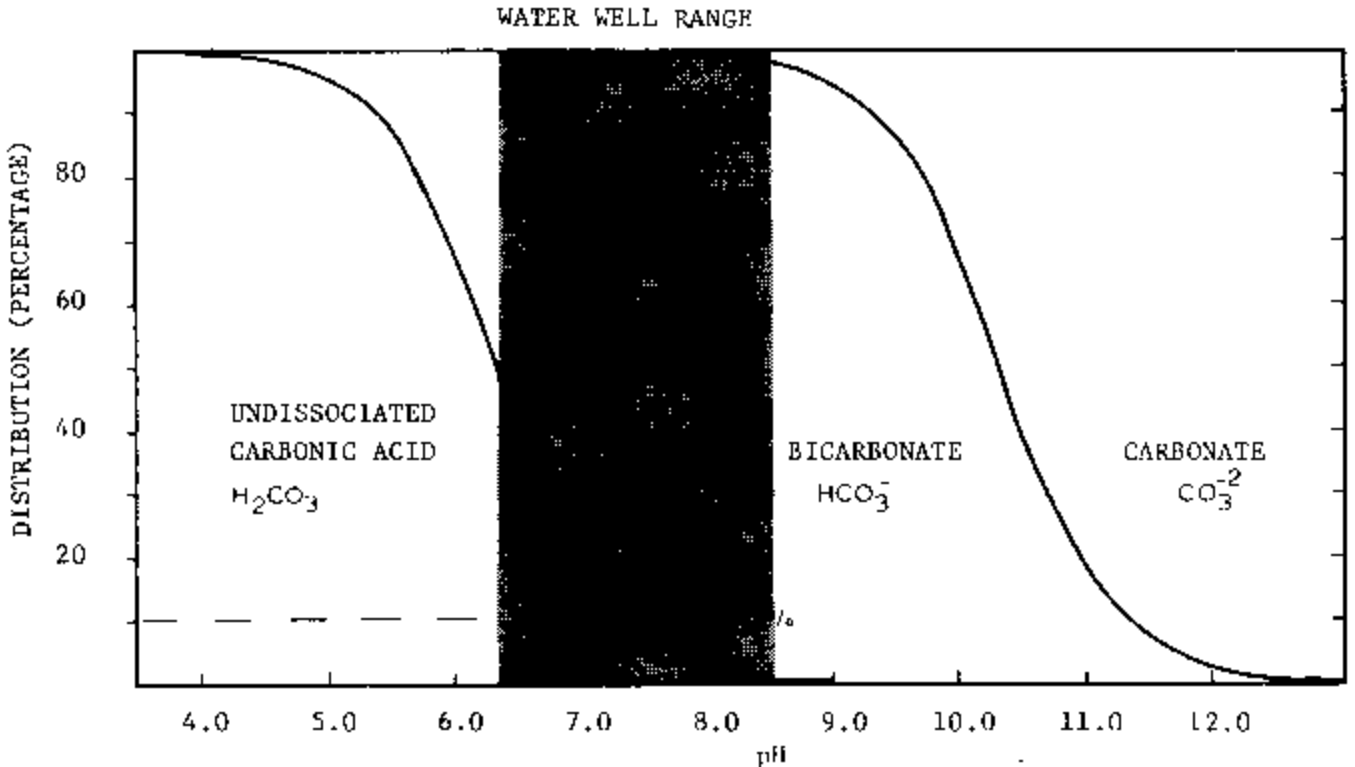


Figure 3. Percentages of total dissolved carbon dioxide species in solution as a function of pH (adapted from Hem, 1978). Production water wells have pH values which range from 6.3 to 8.6 with a grand mean of 7.33 (shaded area). Groundwater has 11 percent undissociated carbonic acid and 89 percent bicarbonate as average percentages of total carbon dioxide species.

value exceeds the total alkalinity value, the excess is termed "noncarbonate hardness." The noncarbonate hardness is caused by other ions that precipitate soap. These include sulfate, chloride and nitrate ions in combination with calcium and magnesium, plus other minor constituents. This noncarbonate hardness cannot be removed from the water by boiling. The "carbonate hardness", which is equal to the alkalinity, includes the portion of calcium and magnesium that combines with the bicarbonate. This carbonate hardness can be removed by boiling the water and forms a precipitate of calcium and magnesium carbonate. Water from a limestone aquifer is classified as being hard to very hard. This water exceeds 120 mg/ℓ $CaCO_3$ hardness and is generally in the range of 200-300 mg/ℓ $CaCO_3$.

Chloride

Chlorine is a member of the halogen group of elements. It is generally found in nature as the negatively charged chloride ion, $Cℓ^-$. This ion can form complexes with positively charged ions found in natural waters, but these complexes are generally weak, unless chloride concentrations are very high. Chloride is most abundant in seawater with a concentration of about 19,000 ppm (parts per million). Chloride can enter an island aquifer by infiltration of salt spray, through the ground or by "upconing" in water wells where pumping is excessive. A continuous or routine record of chloride content in island aquifer water wells provides information on contamination of the aquifer by salt-water intrusion. The chloride standard is set at 250 mg/ℓ. Water containing higher concentrations of chloride is objectionable as potable water and for most irrigation and industrial uses.

Turbidity

Turbidity is a measure of the clarity of a water sample. The amount of suspended matter (clay, silt, very fine organic and inorganic matter, soluble colored organic compounds, microscopic plants and animals) affects turbidity levels. Turbidity is measured by the amount of light scattered and absorbed when a light source is shone through the water sample. The more scatter or absorbtion of light, the higher the turbidity. Correlation of turbidity with the weight concentration of suspended matter is difficult. Turbidity measurements are made with a nephelometer which has horizontal and vertical beams that measure light scatter.

Bacteria

Microbiological examination of water well samples to determine sanitary quality is made by culturing bacteria. Measurements of the presence of total coliform bacteria show the degree of contamination with wastes. Coliform bacteria are wide spread in nature, particularly where man-induced wastes and waste-products accumulate. These bacteria are present in the intestine of warm-blooded animals. Coliform bacteria are indicator organisms to detect the presence of waste-products. It is pathogenic organisms (those harmful to man) which are of concern in potable water supplies. However, it is extremely difficult and dangerous to culture pathogenic organisms. Therefore, the presence of coliform bacteria in a water sample, only suggests the potential for the presence of harmful water-borne disease organisms.

METHODS

PUAG's water quality data were usually taken from a 2-day period within the month for the entire production well series. These monthly data sheets were transcribed onto new data sheets which grouped water quality data by well rather than month. This was done to facilitate encoding of data into a computer file. Transcribed data were verified against the original data sheets and some incorrect data on original data sheets were corrected. Data from 73 production water wells were transcribed and key punched into computer files (Table 2). The maximum record length for any given well was 88 months. Each well was given a sequential number for identification in data files called the WERI well number (Table 2). Table 2 also contains dates when the wells were drilled, beginning dates when PUAG began data analyses, maximum months of data record available for each well and number of months with missing data analyses. There was a file established for each PUAG water well series (A, D, M, F, Y and AG). Data from these files were verified against the encoded data sheets. These corrected well series files were merged into a master data file. This master data file was computer analyzed and edited for "bad data". A sorted master file was produced with "bad data" either corrected or eliminated. Bad data included obviously incorrectly tabulated numbers on PUAG original data sheets or data which were very statistically extreme. Two different computer programs, which were designed to identify extreme data, were used to locate outlying numbers. These outlyers were checked back against the original PUAG data sheets. In some cases, it was possible to correct the tabulated data when the types of errors were typographical (i.e., missing or misplaced decimals). Data which were not correctable were eliminated.

In order to analyze the individual water wells or grouped water wells for either short- or long-term trends, it was necessary to have a full data record with no missing months. Since there were many data gaps in well records, missing data indicators were encoded into the data file. This gave a 12-month record for each year. Missing data were originally encoded as a series of nines and later converted to blanks or periods (which was dependent on the software package used for analyses). This produced a balanced data set, which was required by many of the advanced statistical tests. Months that were not sampled were listed in the data file with a double zero (00) day designation for the date parameter. Pumping data were usually available for these missing months. The edited and sorted master data file was then ready for analyses. This master data file is presented in Appendix A. It includes both sampled and calculated water quality parameters.

Parameter names were given an abbreviated variable name for computer programming and analyses. Computer programs used these variables names to identify outputs. Parameter names with their variable names as used in this report include:

Parameter	Variable
Chloride	CHL
Specific electrical conductance	COND
pH	PH
Total hardness as $CaCO_3$	T HARD
Calcium hardness as $CaCO_3$	C HARD

Table 2. PUAG water wells analyzed with sampling record. The beginning sampling data is when PUAG began data analyses.

PUAG Well	WERI Well No.	Date Drilled	Sampling Began	Maximum Months of Record	Minimum Analysis Months	Missing Months
A- 1	1	1965	22-9-76	74	14	
A- 2	2	1965	22-9-76	80	8	
A- 3	3	1966	22-9-76	77	11	
A- 4	4	1966	22-9-76	79	9	
A- 5	5	1966	22-9-76	75	13	
A- 6	6	1967	22-9-76	80	8	
A- 7	7	1967	22-9-76	80	8	
A- 8	8	1967	22-9-76	80	8	
A- 9	9	1967	22-9-76	79	9	
A-10	10	1967	22-9-76	79	9	
A-11	11	1968	22-9-76	80	8	
A-12	12	1968	22-9-76	81	7	
A-13	13	1973	22-9-76	81	7	
A-14	14	1973	22-9-76	77	11	
A-15	15	1973	22-9-76	81	7	
A-17	16	1973	22-9-76	80	8	
A-18	17	1973	22-9-76	79	9	
A-19	18	1973	22-9-76	76	12	
A-21	19	1974	22-9-76	79	9	
A-22	20	1974	22-9-76	21	1	
A-23	64	1983	24-6-83	4	3	
D- 1	21	1965	20-9-76	81	7	
D- 2	22	1965	20-9-76	80	8	
D- 3	23	1965	20-9-76	80	8	
D- 4	24	1965	20-9-76	81	7	
D- 5	25	1965	20-9-76	81	7	
D- 6	26	1966	20-9-76	81	7	
D- 7	27	1966	20-9-76	81	7	
D- 8	28	1966	20-9-76	80	7	

Table 2. continued.

PUAG Well	WERI Well No.	Date Drilled	Sampling Began	Maximum Months of Record	Minimum Analysis Months	Missing Months
F- 7	53	1975	21-9-76	79	9	
F- 8	54	1975	21-9-76	80	8	
F- 9	55	1979	30-5-79	52	4	
F-10	56	1979	30-5-79	53	3	
F-11	57	1979	30-5-79	53	3	
H- 1	58	1945	21-9-76	80	8	
AG-1	71	?	18-10-76	77	10	
AG-2	72	?	28-12-77	66	7	
GHURA	73	1979	23-1-80	42	6	
Y- 1	59	1966	20-9-76	80	8	
Y- 2	60	1967	20-9-76	78	10	
Y- 3	61	1973	20-9-76	81	7	
Y- 4	62	1974	20-9-76	81	7	
Y- 5	63	1979	29-5-79	50	6	
Y- 6	69	1980	22-7-80	39	3	
Y- 7	70	1982	18-2-83	8	3	

Table 2. continued.

PUAG Well	WERI Well No.	Date Drilled	Sampling Began	Maximum Months of Record	Minimum Analysis	Missing Months
D- 9	29	1968	20-9-76	78	10	
D-10	30	1968	20-9-76	81	7	
D-11	31	1969	20-9-76	80	8	
D-12	32	1971	20-9-76	80	8	
D-13	33	1971	20-9-76	79	9	
D-14	34	1973	20-9-76	80	8	
D-15	35	1974	20-9-76	79	9	
D-16	65	1979	20-9-76	63	25	
D-17	66	1979	24-9-79	46	6	
D-18	67	1980	2-8-81	32	3	
M- 1	36	1965	21-9-76	80	8	
M- 2	37	1968	21-9-76	78	10	
M- 3	38	1967	21-9-76	80	8	
M- 4	39	1967	21-9-76	80	8	
M- 5	40	1969	21-9-76	79	9	
M- 6	41	1969	21-9-76	80	8	
M- 7	42	1969	21-9-76	81	7	
M- 8	43	1970	21-9-76	81	7	
M- 9	44	1970	21-9-76	78	10	
M-12	45	1973	21-9-76	79	9	
M-14	46	1974	21-9-76	80	8	
M-15	68	1982	18-2-83	8	3	
F- 1	47	1969	21-9-76	80	8	
F- 2	48	1971	21-9-76	81	7	
F- 3	49	1972	21-9-76	79	9	
F- 4	50	1975	21-9-76	79	9	
F- 5	51	1975	21-9-76	79	11	
F- 6	52	1975	21-9-76	77	11	

Magnesium hardness	MG HARD
Total or Methyl alkalinity	M ALK
Temperature	TEMP
Turbidity	TURB
Total dissolved solids, lower range	LTDS
Total dissolved solids, average	TDS
Total dissolved solids, upper range	HTDS
Calcium	CALCIUM
Carbonate hardness	CARB
Noncarbonate hardness	NONCARB
Percentage carbonate hardness	P CARB
Percentage noncarbonate hardness	P NONCARB
Total coliform bacteria	BACT
Month	MO
Rainfall for previous month	RAIN
Monthly pumping rate	PUMP

Basic statistical analyses on the sorted master file were conducted for individual water wells and grouped water wells. Basic statistical analyses included mean, mode, standard deviation, range, maximum and minimum values, percent quantiles (95, 75, 50, 25, and 5%), 95% confidence interval, normal distribution of data, kurtosis, skewness and various scattergrams plots. These plots provide a means to visually inspect the data for basic trends and patterns. Plots were made of water quality parameters over time. Chlorides were plotted against previous monthly rainfall, pumping rates and specific electrical conductance. A series of plots of water quality parameter for each production water well is presented in Appendix B. These plots are computer generated scattergrams. There are 17 plots for each well. Appendix B plots are bound seperately in 4 units: 1) water quality plots: A-series; 2) water quality plots: D-series; 3) water quality plots: M-series and AG-series; 4) and water quality plots: F-series and Y-series.

Trend analysis of sorted water well data was conducted for individual water wells and grouped water wells. Advanced statistical analyses programs were used to determine both short-term and long-term trend patterns. These advanced statistical programs included linear, nonlinear and polynominal regressions, analysis of variance, multivariate analysis (factor and discriminant), cluster analysis, and time series. There were many advanced statistical programs which did not produce usable results and were not included in this data report. Other advanced tests provided information which would have been very difficult for a non-technical person to interpet and there was no feasible method to summarize these tests. Therefore, the actual outputs of these statistical programs were not tabulated for the report, but information derived from these tests was utilized in trend discussions.

There are three major software packages available at the University of Guam Computer Center which contain well documented statistical programs: SAS, Statistical Analysis System (SAS Institute Inc., 1982a; 1982b); BMDP, Biomedical Computer programs (Dixon, W. J. (ed), 1981); and SPSS, Statistical Package for the Social Sciences (Nie, N. H., et al., 1975). SAS statistical programs were used primarily in the data analyses. These SAS programs provide a great deal of flexibility in data analyses and

output, with a minimum of programming. An important reason for relying on these major software programs for data analyses was so that future analysis of new PUAG data can utilize the same statistical procedures. This will facilitate in the comparison of new monitoring data against water well data bases.

In addition to the sampled water quality parameters, a set of calculated parameters were derived from specific conductance, hardness and alkalinity parameters. Total dissolved solids (TDS), which included a lower, upper and average value, was calculated from specific conductance measurements. The carbonate and noncarbonate hardness components in water samples were derived from total hardness and total alkalinity data. The noncarbonate hardness component includes contributions by nitrate, sulfate and similar ions. An over estimate of magnesium hardness, since it contained other ions besides magnesium and calcium, was determined for water samples. This value was derived from the calcium hardness and carbonate component. The calcium concentration in a water sample can also be derived from calcium hardness. Percentages were calculated for magnesium hardness, carbonate and noncarbonate components. These carbonate, bicarbonate and noncarbonate parameters can provide information about equilibria characteristics of the groundwater aquifer.

A master data file, which included calculated parameters, was placed on computer magnetic tape. This tape was made for the USEPA STORET system as an addition to the Guam water quality file. The STORET system requires "header" information about each water quality site. This "header" information is presented in Tables 3 and 4. Table 3 presents a number designation for each well, longitude and latitude location of well, physical characteristics of wells and mean monthly water production pumping rates. Table 4 presents location of well by subbasin and management zone as designated in the NGLS.

Table 3. Location, physical characteristics and mean monthly pumping record of each water well.

DESIGNATION		LOCATION				PHYSICAL CHARACTERISTICS				WATER PRODUCTION	
PUAG	WERT	Latitude		Longitude		Elevation	Elevation	Total	Aquifer	Mean Monthly Pumping	
Well	Well No.	Min.	Sec.	Min.	Sec.	Above MSL	Hole Bottom	Depth (FL)	Type	N	$\bar{X}$ ($\times 10^6$)
A- 1	1	27	10	45	24	69	-151	220	Parabasal	76	7.93
A- 2	2	26	38	46	25	110	-51	170	Basal	83	9.03
A- 3	3	26	57	45	22	104	-306	410	Parabasal	83	9.04
A- 4	4	26	34	46	37	141	-289	430	Basal	83	7.38
A- 5	5	27	23	45	29	146	-194	340	Parabasal	83	8.78
A- 6	6	27	22	45	39	153	-153	306	Parabasal	83	9.51
A- 7	7	26	31	45	39	138	-48	186	Parabasal	83	9.27
A- 8	8	26	40	45	44	128	-173	301	Parabasal	83	6.63
A- 9	9	26	54	47	12	186	-51	237	Basal	83	7.05
A-10	10	27	01	47	20	190	-26	216	Basal	83	7.26
A-11	11	26	39	45	13	171	-204	375	Parabasal	84	5.96
A-12	12	26	45	45	28	138	-252	390	Parabasal	83	8.97
A-13	13	26	45	46	56	131	-287	418	Basal	82	7.50
A-14	14	26	53	48	04	208	-52	260	Basal	82	7.39
A-15	15	27	52	47	55	198	-52	250	Basal	83	7.15
A-17	16	26	14	47	36	194	-41	235	Basal	83	7.91
A-18	17	25	55	47	51	195	-55	250	Basal	82	7.70
A-19	18	26	52	46	43	136	-44	180	Parabasal	82	4.69
A-21	19	26	41	47	57	181	-53	234	Parabasal	72	7.73
A-22	20	28	05	48	18	238	-43	281	Basal	22	4.78
A-23	64	27	56	45	07	35	-51	86	Basal	12	7.76
D- 1	21	31	07	50	49	382	-36	418	Basal	85	7.27
D- 2	22	31	08	50	48	382	-35	417	Basal	85	7.85
D- 3	23	31	24	50	47	384	-23	407	Basal	85	6.00
D- 4	24	31	14	50	49	384	-26	410	Basal	85	7.47
D- 5	25	31	00	50	49	378	-34	412	Basal	86	5.96
D- 6	26	31	32	50	49	397	-25	422	Basal	85	7.46
D- 7	27	31	53	50	54	386	-49	435	Basal	85	5.99
D- 8	28	32	03	50	58	414	-36	450	Basal	85	5.72

Table 3. continued.

DESIGNATION		LOCATION				PHYSCIAL CHARACTERISTICS				WATER PRODUCTION	
PUAC	WERI	Latitude		Longitude		Elevation	Elevation	Total	Aquifer	Mean Monthly Pumping	
Well	Well No.	Min.	Sec.	Min.	Sec.	Above MSL	Hole Bottom	Depth (ft)	Type	N	$\bar{X}$ ($x10^6$)
D- 9	29	31	43	50	50	388	-52	440	Basal	85	6.74
D-10	30	31	46	51	00	391	-26	417	Basal	85	7.34
D-11	31	31	35	50	45	393	-37	430	Basal	85	7.18
D-12	32	32	13	51	00	421	-44	465	Basal	85	5.57
D-13	33	32	20	50	57	400	-52	452	Parabasal	85	5.32
D-14	34	30	47	50	18	319	-51	470	Basal	84	6.90
D-15	35	31	17	50	14	363	-89	452	Basal	85	6.40
D-16	65	31	19	49	58	329	-59	388	Basal	34	7.63
D-17	66	31	17	49	44	301	-49	350	Basal	27	5.79
D-18	67	31	17	49	49	310	-50	360	Basal	23	7.76
GHURA	73	31	15	50	50	414	-92	506	Basal	20	6.33
M- 1	36	28	56	50	26	396	-54	450	Parabasal	85	6.77
M- 2	37	29	00	50	32	403	-57	460	Parabasal	85	6.31
M- 3	38	29	07	50	26	422	-53	475	Parabasal	85	9.04
M- 4	39	29	06	50	32	422	-50	472	Parabasal	85	6.47
M- 5	40	29	55	50	50	274	-226	500	Basal	85	7.44
M- 6	41	30	20	50	50	327	-78	405	Basal	85	5.80
M- 7	42	30	07	50	28	289	-51	340	Basal	85	7.77
M- 8	43	29	09	50	55	436	-60	496	Parabasal	85	6.32
M- 9	44	28	58	50	51	449	-51	500	Basal	85	7.05
M-12	45	30	43	49	40	272	-108	380	Basal	85	4.41
M-14	46	31	03	49	25	275	-40	315	Basal	85	7.80
M-15	68	29	55	50	28	294	-50	344	Basal	11	7.01
F- 1	47	34	00	50	40	425	-35	460	Basal	85	5.66
F- 2	48	34	29	50	56	452	-38	490	Basal	85	5.68
F- 3	49	34	39	51	05	456	-36	492	Basal	85	4.87
F- 4	50	34	49	51	12	460	-35	495	Parabasal	85	5.47
F- 5	51	33	23	50	35	392	-33	425	Basal	85	4.43
F- 6	52	33	23	50	20	347	-23	370	Basal	85	5.72

Table 3. continued.

DESIGNATION		LOCATION				PHYSICAL CHARACTERISTICS				WATER PRODUCTION		
PUAC Well	WERI Well No.	Latitude Min.	Sec.	Longitude Min.	Sec.	Elevation Above MSL	Elevation Hole Bottom	Total Depth (ft.)	Aquifer Type	Mean Monthly Pumping N	$\bar{X}$	($\times 10^6$)
F- 7	53	33	36	50	26	367	-21	388	Basal	85	5.57	
F- 8	54	33	24	51	07	438	-18	456	Parabasal	85	6.71	
F- 9	55	33	23	50	46	393	-53	446	Parabasal	33	7.52	
F-10	56	34	07	50	44	436	-47	483	Basal	33	7.52	
F-11	57	34	18	50	51	440	-48	488	Basal	33	6.92	
H- 1	58	32	07	48	36	293	-19	312	Basal	84	6.99	
Y- 1	59	31	39	52	48	415	-35	450	Parabasal	85	7.21	
Y- 2	60	31	39	52	48	415	-52	467	Parabasal	85	6.28	
Y- 3	61	32	03	53	19	415	-50	465	Parabasal	85	5.36	
Y- 4	62	31	19	52	21	398	-47	445	Basal	85	6.35	
Y- 5	63	31	30	52	32	433	-47	480	Parabasal	33	6.89	
Y- 6	69	31	34	52	42	428	-50	480	Parabasal	12	5.70	
Y- 7	70	32	04	53	25	414	-50	464	Parabasal	12	6.07	
AG-1	71	35	07	52	27	470	-27	497	Parabasal	78	5.17	
AG-2	72	35	00	52	16	506	-174	680	Parabasal	39	4.86	

Table 4. Subbasin and management zone location of water wells.

PUAG Well	WERI Well	Management Zone	Name of Zone	Subbasin
A- 1	1	3	Nimitz Hill	AGANA
A- 2	2	32	Agana Swamp	AGANA
A- 3	3	3	Nimitz Hill	AGANA
A- 4	4	33	Sabanan Maagas	AGANA
A- 5	5	3	Nimitz Hill	AGANA
A- 6	6	3	Nimitz Hill	AGANA
A- 7	7	2	Chalan Pago	AGANA
A- 8	8	2	Chalan Pago	AGANA
A- 9	9	33	Sabanan Maagas	AGANA
A-10	10	33	Sabanan Maagas	AGANA
A-11	11	2	Chalan Pago	AGANA
A-12	12	2	Chalan Pago	AGANA
A-13	13	33	Sabanan Maagas	AGANA
A-14	14	33	Sabanan Maagas	AGANA
A-15	15	30	Barrigada	AGANA
A-17	16	33	Sabanan Maagas	AGANA
A-18	17	33	Sabanan Maagas	AGANA
A-19	18	1	Pago Bay	AGANA
A-20		2	Chalan Pago	AGANA
A-21	19	33	Sabanan Maagas	AGANA
A-22	20	30	Barrigada	AGANA
A-23	64	3	Nimitz Hill	AGANA
A-26*		31	Toto	AGANA
A-27*		31	Toto	AGANA
A-28*		33	Sabanan Maagas	AGANA
A-23*		3	Nimitz Hill	AGANA
A-25*		3	Nimitz Hill	AGANA
Ex-1		32	Agana Swamp	AGANA
Ex-9		34	Manaca	AGANA
Ex-4		33	Sabanan Maagas	AGANA

* New wells - insufficient data available for analysis.

Table 4. continued

PUAG Well	WERI Well	Management Zone	Name of Zone	Subbasin
D- 1	21	45	South Dededo	YIGO
D- 2	22	45	South Dededo	YIGO
D- 3	23	45	South Dededo	YIGO
D- 4	24	45	South Dededo	YIGO
D- 5	25	45	South Dededo	YIGO
D- 6	26	45	South Dededo	YIGO
D- 7	27	45	South Dededo	YIGO
D- 8	28	45	South Dededo	YIGO
D- 9	29	45	South Dededo	YIGO
D-10	30	45	South Dededo	YIGO
D-11	31	45	South Dededo	YIGO
D-12	32	44	North Dededo	YIGO
D-13	33	29	Y-Sengsong	YIGO
D-14	34	45	South Dededo	YIGO
D-15	35	45	South Dededo	YIGO
D-16	65	45	South Dededo	YIGO
D-17	66	45	South Dededo	YIGO
D-18	67	45	South Dededo	YIGO
D-19*		44	North Dededo	YIGO
D-20*		44	North Dededo	YIGO
D-21*		44	North Dededo	YIGO

*New wells - insufficient data available for analyses.

Well PUAG	Well WERI	Management Zone	Name of Zone	Subbasin
M- 1	36	36	Taguan	MANGILAO
M- 2	37	8	North Mangilao	MANGILAO
M- 3	38	8	North Mangilao	MANGILAO
M- 4	39	8	North Mangilao	MANGILAO
M- 5	40	8	North Mangilao	YIGO
M- 6	41	45	South Dededo	YIGO
M- 7	42	45	South Dededo	YIGO
M- 8	43	8	North Mangilao	MANGILAO
M- 9	44	36	Taguan	MANGILAO
M-12	45	45	South Dededo	YIGO
M-14	46	45	South Dededo	YIGO
M-15	68	45	South Dededo	YIGO
Ex-1J			North Mangilao	MANGILAO

Table 4. continued.

PUAG Well	WERI Well	Management Zone	Name of Zone	Subbasin
F- 1	47	42	West Finegayan	FINEGAYAN
F- 2	48	42	West Finegayan	FINEGAYAN
F- 3	49	42	West Finegayan	FINEGAYAN
F- 4	50	42	East Finegayan	FINEGAYAN
F- 5	51	43	NCS	FINEGAYAN
F- 6	52	43	NCS	FINEGAYAN
F- 7	53	43	NCS	FINEGAYAN
F- 8	54	43	Callon Tramojo	FINEGAYAN
F- 9	55	43	Callon Tramojo	FINEGAYAN
F-10	56	42	West Finegayan	FINEGAYAN
F-11	57	42	West Finegayan	FINEGAYAN
NCS 1 and 1a		42	West Finegayan	FINEGAYAN
H- 1	58	43	NCS	FINEGAYAN
Y- 1	59	28	West Yigo	YIGO
Y- 2	60	28	West Yigo	YIGO
Y- 3	61	25	East Yigo	YIGO
Y- 4	62	47	Asatdas	YIGO
Y- 5	63	28	West Yigo	YIGO
Y- 6	69	28	West Yigo	YIGO
Y- 7	70	25	East Yigo	YIGO
MW-1		45	South Dededo	YIGO
MW-2		45	South Dededo	YIGO
MW-3		47	Asatdas	YIGO
MW-5		47	Asatdas	YIGO
MW-6		47	Asatdas	YIGO
MW-7		47	Asatdas	YIGO
MW-8		47	Asatdas	YIGO
MW-9		47	Asatdas	YIGO
501		47	Asatdas	YIGO
505		28	West Yigo	YIGO
AG-1	71	16	Central Agafa Gumas	AGAFA GUMAS
AG-2	72	16	Central Agafa Gumas	AGAFA GUMAS
GHURA	73	45	South Dededo	YIGO
Ex-5		45	South Dededo	YIGO

ORGANIZATION OF HISTORICAL DATA

Tabulated historical water well data in this report were divided into 3 sections: basic statistical analyses, regression analyses, and cluster analyses. The basic statistics section provides general water quality characteristics and a measure of distribution of data values for individual and combined wells without an actual assessment of either long- or short-term trends. Presentation of only 2 types of advanced data analyses are made in this report. Regression and cluster analyses provide the simplest to understand results and yet they are still expedient tests that can characterize water quality data. Regression analysis provides information on linear trends in water quality data. Regression analyses can be used to assess if a water quality parameter in a water well was showing increasing, decreasing or, in some cases, cyclic behavior. Cluster analysis could be used to determine grouping of water wells in relation to geographical areas or geological features and management zones as designated in the NGLS. Cluster analysis can also provide information on the short-term trend behavior of wells, particularly in regards to changes in group membership. As a result of the cluster analysis, locations (management zones) can be identified which are producing either good, moderate or poor quality water. Those areas which produce poor quality should be either avoided or carefully examined and evaluated before any development plans are initiated. Those areas with good well water quality can be exploited in future well development plans.

It is important to emphasize that this statistical study was not intended to be a single decisive management report dealing with groundwater quality in the northern aquifer. Statistics and interpretation of short-term trend behavior of wells presented in this report are intended to augment other existing reports and studies. Management decision in regards to future placement of water wells will utimately need to be based on a number of source documents. However, data presented in this report do strongly suggest which areas are proven to contain good, moderate or poor quality groundwater.

The basic statistics section presents for each water quality parameter by water well the general quality (number of data, number of missing data, mean, standard deviation, maximum and minimum values and total range), data distribution (skewness and kurtosis), quantiles (5, 25, 50, 75 and 95 percents, and mode), and test of normal data distribution. Tables 5-43 present general water quality and data distribution statistics for each measured and calculated parameter by water well. The water wells are grouped by PUAG well series (A, D, M, F, Y, AG). Table 44 presents a summary of general statistics for the combined well series. Table 44 provides a general overview of groundwater quality from production water wells. Tables 44-68 present quantile percentages, mode and results of the test of normal data distribution for each parameter by water well. Table 69 presents a summary of data from Tables 44-68 for the combined well series.

The regression section presents for each water quality parameter by water well the results of a linear regression model analysis. The regression model tested for the occurrence of linear changes in water parameters for the data collection period. The F-value, significance level

and R-correlations are presented for each regression analysis. Tables 70-106 present the linear regression data for each water quality parameter by water well. Table 107 presents summary significance levels at $P \leq 0.05$ for water quality parameters by water wells. The trend of graphical and regression data are shown in Table 107. These trends include positive, negative and cyclic patterns in data distribution through time.

The cluster section presents for each water quality parameter and combined parameters the water well group memberships. Cluster analysis provides information on trends in water wells and for geographically or geologically grouped water wells. This type of analysis can also provide insights dealing with short-term behavior of the groundwater aquifer in the vicinity of production water wells. Tables 108-113 present cluster analyses groupings of wells for each parameter. Cluster series were analyzed for 20, 15, 10 and 5 cluster groups. Tables 114-121 present cluster analysis groupings for combined water quality parameters. The parameters used for combined analyses were pH, turbidity, temperature, total and calcium hardness, alkalinity, specific conductance and chlorides. Table 119 presents wells by primary cluster membership in relation to management zones and general water quality. Table 120 identifies water wells which have high mean values for specified water quality parameters. These wells appear in cluster analyses as outlyers. Table 121 presents management zone locations of water wells which have high mean values for specified water quality parameters: chlorides, specific conductance, total and calcium hardness, and alkalinity.

Basic Statistical Analyses

This section contains two sets of tables. Each set of tables has a summary table. The first set of tables (5-42) contains basic statistics (number of months of data, number of missing months of data, mean and standard deviation, minimum and maximum values, range, skewness of data curve, and kurtosis of data curve) for each production water well. These tables contain data for both measured and calculated water quality parameters. Most of the parameters in these tables have abbreviated variable names which are as follows:

Parameter	Variables
Specific electrical conductance	CONDUCTANCE
pH	PH
Total hardness as $CaCO_3$	T HARDNESS
Calcium hardness as $CaCO_3$	CA HARDNESS
Total or Methyl Alkalinity	M ALKALINITY
Total Coliform Bacteria	BACTERIA
Total dissolved solids, low range	LOW TDS
Total dissolved solids, average	TDS
Total dissolved solids, high range	HIGH TDS
Carbonate hardness	CARBONATE
Noncarbonate hardness	NONCARBONATE
Magnesium hardness	MG HARDNESS
Magnesium hardness, percent	PERCENT MG
Carbonate hardness, percent	PERCENT CARBONATE
Noncarbonate hardness, percent	PERCENT NONCARB
Number of months of data	No.
Number of months of missing data	No. Missing

The second set of Tables (44-68) contain basic quantile statistics (quantile percentage for 5, 25, 50, 75 and 95 percent levels, mode, and test of normal distribution of data) for each production water well. These tables contain data only for measured water quality parameters. Parameter abbreviations used in these tables are the same as those for Tables 5-42. Summaries of these 2 sets of data tables are in Tables 43 (basic statistics) and 69 (basic quantile statistics) for the total combined well series. Summaries by PUAG well series were purposely not included in this section. Reasons for not including these types of summaries will be discussed in the cluster analysis section.

In order to use tables in this basic statistics section, it is necessary to understand the output results of various test types. The number of months of data is the total record length available for each well. Also shown is the number of months with no data record, which is a portion of the total record length. The mean or arithmetic mean, commonly called the average, is calculated by summing all observations and dividing this sum by total number of observations. The mean is a statistic of location measurement and describes the central tendency of data. However, it does not describe the shape of data or frequency distribution. The mode refers to the most frequently encountered set of data values. It is a measure of where the frequency distribution data curve peaks.

Statistics of dispersion are a measure of data scatter in a frequency distribution from a set of data. These dispersion statistics include range, quartile deviation and standard deviation. The range is the total spread of data points from a minimum to a maximum value and is a measure of the total variation in a data set. Quantile measurements are a division of data in the frequency distribution curve into sections by various percentages. The 95 percent confidence interval, which can be seen in Tables 44-68, is a measure of data spread where 95 percent of the data will lie between the 5 percent and 95 percent data values. Quartile measurements are quantiles which occur at the 25, 50 and 75 percent quarters. Quantile measurements provide a general assessment of the central tendency and dispersion of data values in a data set. The standard deviation is an arithmetic measure of data variance from a mean value.

The normal distribution or probability density function is a measure of the frequency distribution of observations of a variable (Sokal and Rohlf, 1969). In the case of water well data, each parameter from each water well has a series of observations. These data can be plotted as frequency of occurrence for specific values and the resultant curve would be a measure of the density distribution of data. A normal distribution curve will have a balanced symmentry with an equal number of observations to the right and left of a central or mean value. This will also make the mean, median and mode all lie at the same point. In a normal distribution it is improbable to have observations which are more than minus or plus three standard deviations from the mean.

The normal distribution in statistics can be defined in terms of moments. These moments are computed by a frequency function and determine distance away from an arbituary point, usually the mean, in the normal distribution curve. Therefore, moments describe characteristics of the normal distribution in mathematical terms. The mean of the curve is the first moment and it is convenient to use it to calculate the higher moments. The second moment is a measure of the dispersion of data around the mean and is called standard deviation. The third moment is a measure of the deviation from symmentry of the curve about the mean and is termed skewness (Figure 4). Skewness is a measure of deviation of data from a normal distribution. A positive skewness value indicates an excess of distribution of data points to the right of the mean and negative skewness is an excess of data to the left of the mean. The value for skewness in a normal distribution is zero. The fourth moment is a measure of the peakedness, or kurtosis of the distribution curve (Figure 4). This kurtosis moment provides a measure of the grouping of data points in relation to normal distribution. If there are an excess of points around the mean, the distribution curve will have a sharp central peak. This type of curve is called leptokurtic. A flatter curve with a wider distribution of data away from the mean is called platykurtic. A bimodial curve (two peaks) is an extreme platykurtic distribution curve. A normal distribution curve is called mesokurtic. A frequency distribution is generally considered normal if its skewness is 0 and its kurtosis is 3.

There are numerical limits that can be set for skewness and kurtosis:

SKEWNESS VALUE	VERBAL TERM
-4.0 to -0.1	negative skewed

-0.1 to +0.1	almost symmetrical
+0.1 to +4.0	positive skewed
> +4.0	very positive skewed

KURTOSIS VALUE	VERBAL TERM
< +0.9	platykurtic
0.9 to 1.1	mesokurtic
1.1 to 3.0	leptokurtic
> 3.0	extremely leptokurtic

There is only one water quality parameter (pH) which shows a normal distribution of data values for the total data-base (all wells). The remaining parameters deviate from a normal distribution curve. There is an excess of data values on the left side of the normal distribution curve (skewed left) which results in a higher percentage of values in lower parameter concentrations. Tails of these curves trail to the right or toward higher parameter concentration values. Figures 5 to 17 present computer generated bar charts and box plots of normal distribution curves for the water quality parameters: chloride, specific conductance, total hardness, calcium hardness, alkalinity, temperature, turbidity, pH, total dissolved solids, carbonate and noncarbonate hardness, magnesium hardness, and calcium. An explanation of the box plot as given by SAS Institute, Inc. (1982) is:

> The second plot is a box plot or schematic plot. The bottom and top edges of the box are located at the sample 25th and 75th percentiles. The center horizontal line is drawn at the sample median and the central plus sign (+) is at the sample mean. It is possible for all of these statistics to fall on the same printer line. The central vertical lines, called "whiskers," extend from the box as far as the data extend, to a distance of at most 1.5 interquartile ranges. (An interquartile range is the distance between the 25th and 75th sample percentiles). Any value more extreme than this is marked with a 0 if it is within 3 interquartile ranges of the box, or with an * if it is still more extreme.

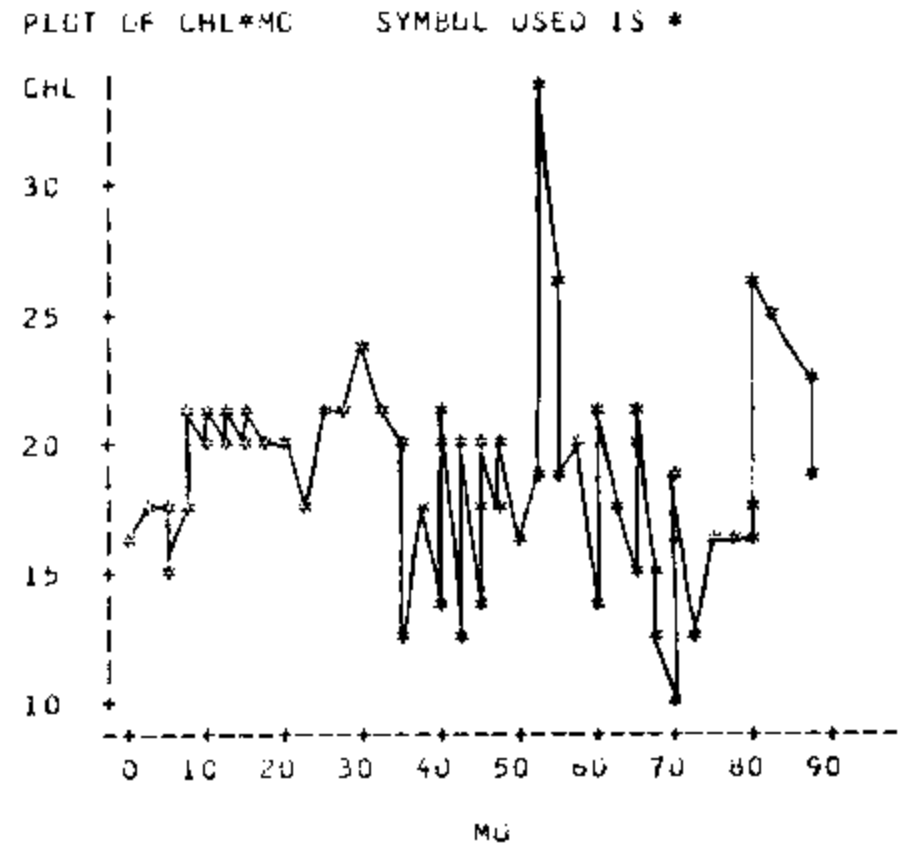
A test of normality was run for water quality parameters for each well. The normality procedure produces a test statistic for the null hypothesis that the input data values are a random sample from a normal distribution (SAS Institute Inc., 1982). The SAS procedure computed a Shapiro-Wilk statistic (W), when the sample size was less than 51 and the usual Kolomogorov D statistic was computed when the sample size was greater than 50. The probability of having a larger test statistic was computed. The PROB>D or PROB<W are tests of the hypothesis that the data came from a normal distribution. There is no sufficient evidence to warrant rejection of the null hypothesis for values of PROB>D which are less than 0.05 for a parameter. When values of PROB>D exceed 0.05, then the data is probably not from a normal distribution. Wells with parameter data that deviate from a normal distribution generally have characteristic behavioral patterns (i.e., skewed or non-uniform cyclic data).

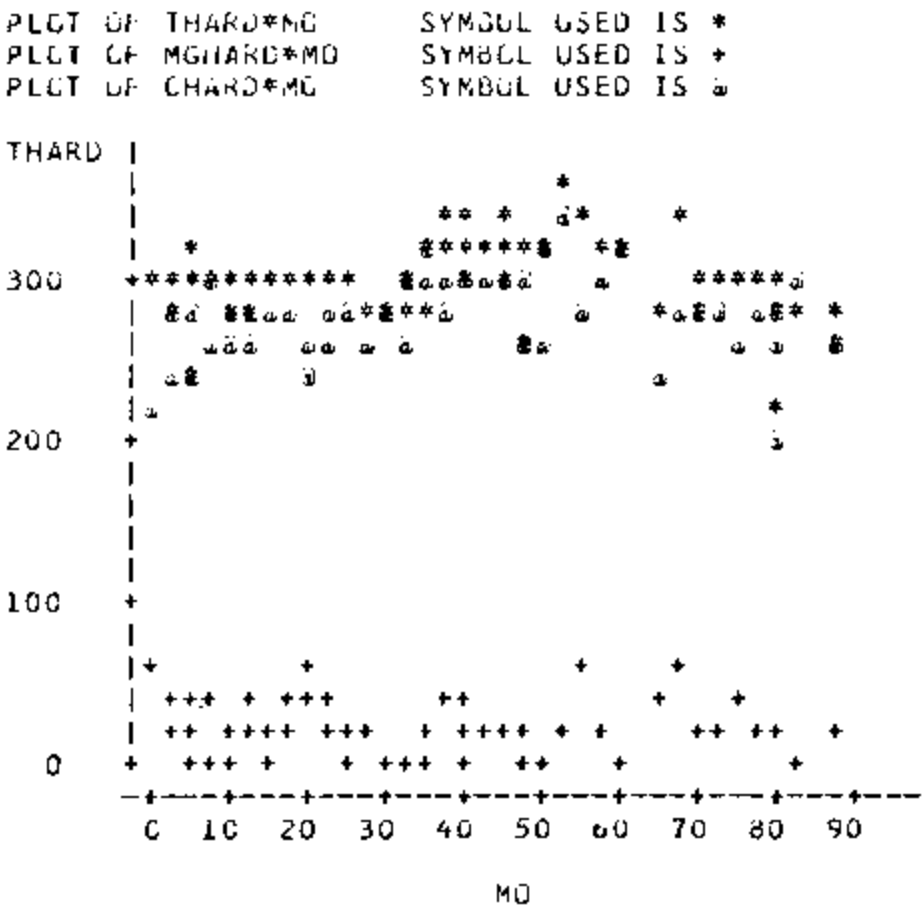
A basic method to assess distribution of water quality data is to plot these data against time. These plots provide a visual determination of general behavioral trends and dispersion characteristics of data values

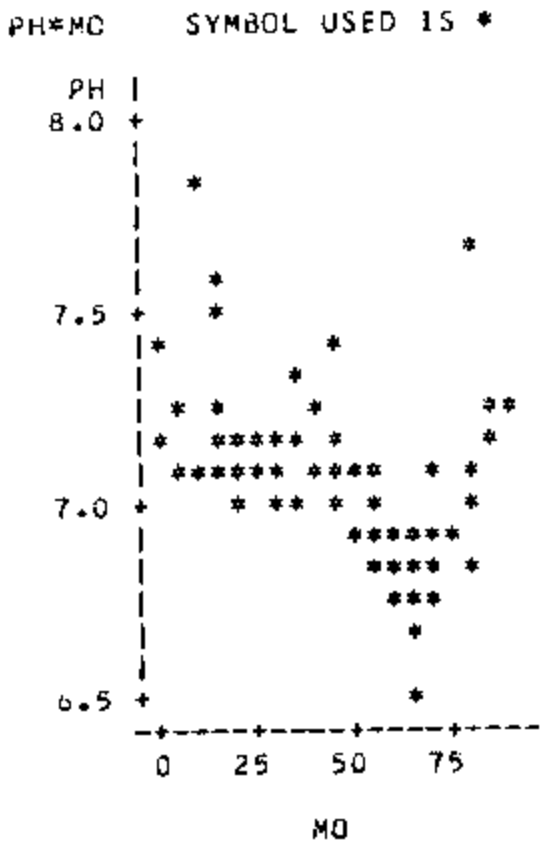
from a data set. Also, plots can be made to compare parameters (i.e., chloride versus specific electrical conductance) which can provide information on the quality of the data. The use of a computer allows the data analyst to make a large number of comparison plots. These computer generated plots are scattergrams. Scattergrams were made for all water quality parameters and other pertinent parameters for each water well. There are 14 of these scattergrams presented for each water well (1022 scattergrams) in Appendix B. The data record of a given parameter plotted against time shows the general trend of data scatter. This makes it possible to quickly estimate parameter behavior for a given well over the monitoring time period. The following list of scattergrams were made for each water well in Appendix B:

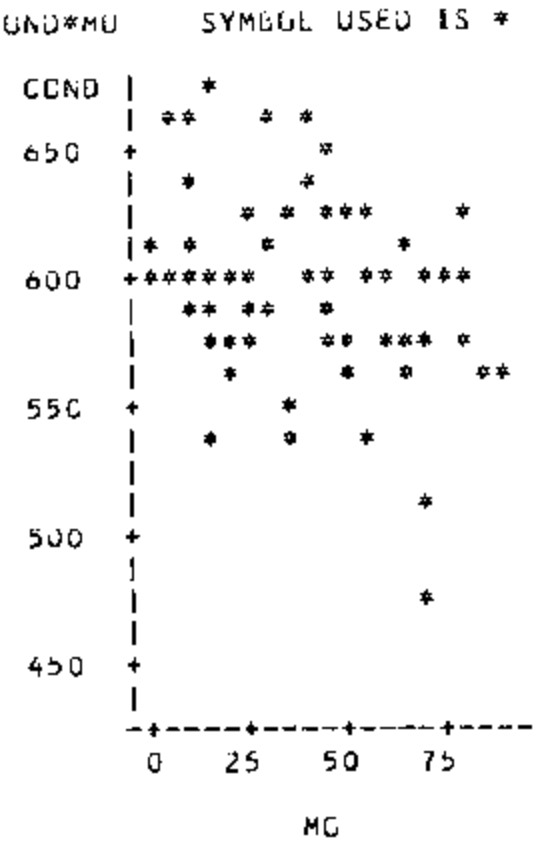
Plot number		Parameter name with units
1.		Chloride, mg/ℓ
2.		Specific electrical conductance, μmhos/cm
3.		pH
4.		Total hardness as $CaCO_3$, mg/ℓ
5.	combined plots of a.	Calcium hardness as $CaCO_3$, mg/ℓ
	b.	Magnesium hardness, mg/ℓ
	c.	Total or methyl alkalinity, mg/ℓ
6.	combined plots of a.	Carbonate hardness, percent
	b.	Noncarbonate hardness, percent
	c.	Magnesium hardness, percent
7.		Temperature, °C
8.		Turbidity, NTU
9.		Total dissolved solids (average), mg/ℓ
10.		Monthly pumping rate, million gallons
11.		Chloride versus conductance
12.		Chloride versus pumping
13.		Turbidity versus pumping
14.		Chloride versus rain, in/month

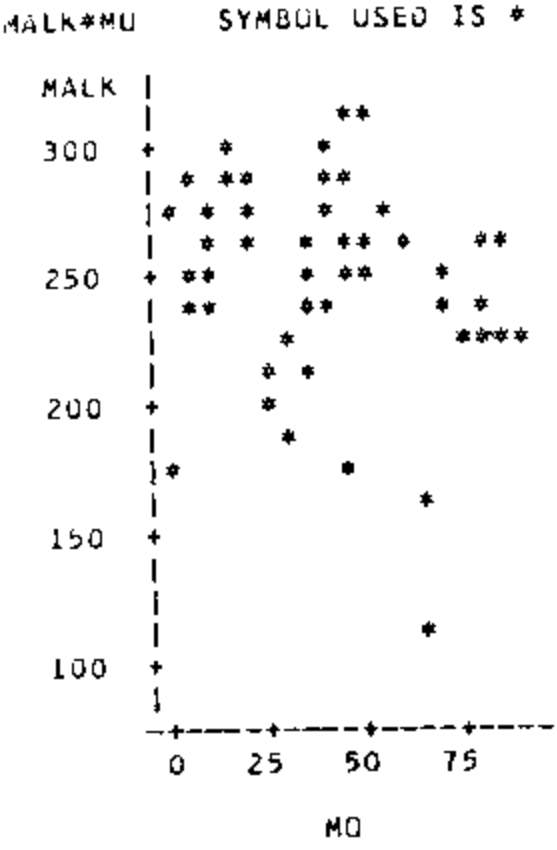
Plots 1 to 9 for each well show the water quality parameters plotted against the monitoring time period. These plots contain corrected data as found in the master data file (Appendix A). Plot 10 for each well shows the available monthly pumping rate (in million gallons) for the monitoring period. Plot 11 shows the chloride concentration versus the specific electrical conductance. Since chloride concentration is related to specific conductance, this plot provides a means to check the accuracy of the chloride data. In order to determine if monthly pumping rates affected chloride concentrations and turbidity levels in water wells, plots were made of chloride and turbidity versus pumping, plots 12 and 13, respectively. Plot 14 shows chloride levels plotted against the monthly rainfall of the previous month period. Examples of scattergram plots as found in Appendix B, except at a smaller scale, for PUAG water well A-1 (WERI 1) are shown on the following 2 pages:

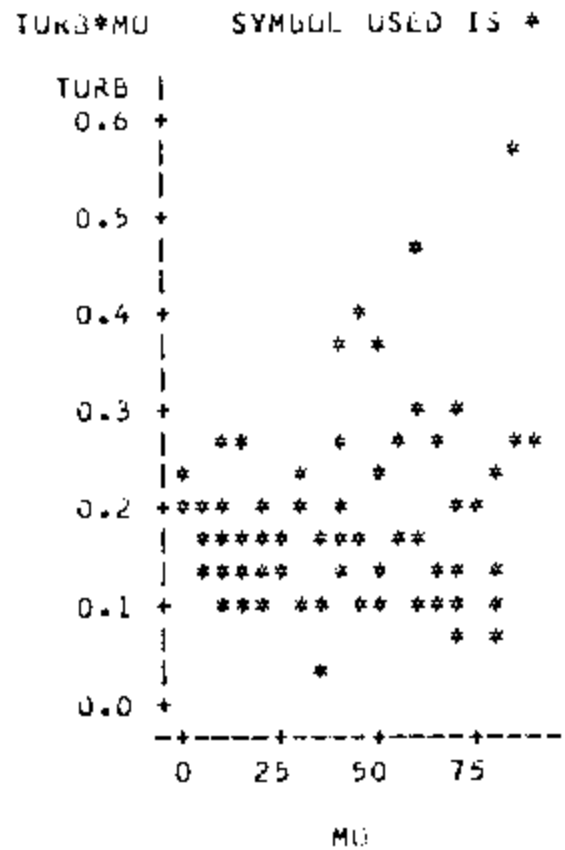

PLOT OF CHL*MO SYMBOL USED IS *
CHL
30
25
20
15
10
0 10 20 30 40 50 60 70 80 90
MO


PLOT OF THARD*MO SYMBOL USED IS *
PLOT OF MGHARD*MO SYMBOL USED IS +
PLOT OF CHARD*MO SYMBOL USED IS a
THARD
300
200
100
0
0 10 20 30 40 50 60 70 80 90
MO


PH*MO SYMBOL USED IS *
PH
8.0
7.5
7.0
6.5
0
25
50
75
MO


COND*MO SYMBOL USED IS *
COND
650
600
550
500
450
0
25
50
75
MO


MALK*MO SYMBOL USED IS *
MALK
300
250
200
150
100
0
25
50
75
MO


TURB*MO SYMBOL USED IS *
TURB
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
25
50
75
MO

Based primarily on plotted data, pumping rates had little affect on chloride concentrations in most water wells. Pumping rates affected chlorides in wells D-8, D-9 and H-1. These wells show a moderate correlation of increased pumping associated with higher chlorides. Generally, for most wells the highest pumping rates correspond with increased chloride concentration, although, the data show a median cluster of values with no apparent trend. There are two wells (F-5 and Y-5) which show a slight negative trend for pumping rate and chloride concentration. Taking a pumping rate at the time of sampling might improve the correlation between pumping and chloride. The establishment of a correlation between pumping rate and chloride concentration could be useful information to apply in well management.

The basic statistical section can be useful as a management and monitoring tool for future water quality monitoring. It provides data-base information necessary for comparative evaluations of future water quality data. It will be possible to make comparisons of new well data against its data-base to ascertain general quality trends: steady-state, increase, decrease, or cyclic behavior.

There are several possible ways to use this basic statistical section in future water quality assessments. If new well data are similar to its data-base mean, within the standard deviation, then there is no water quality change or the well is in a steady-state. These wells do not require more frequent data sampling and analyses than quarterly, as long as data values fall consistently within a standard deviation of the mean. Data values, for any parameter which are more than a standard deviation away from the mean, should be compared to quantile percentages to establish where data values lie in relation to the frequency distribution curve. Values outside the 95 percent confidence interval or beyond the minimum or maximum range should be rechecked at the water laboratory for either calculation or technical errors. If there is verification of these high values, then resampling of water source would be warranted. New water quality data that are outside the data-base range for a well would constitute a major change in that well's water quality. Wells which show this type of major change in water quality need to be sampled on a more frequent basis (monthly). A change in well chloride concentration to a consistant higher value could indicate salt-water intrusion, in which case, pumping rates would need to be evaluated and possibly reduced. Evaluations of sequential new data could be used to generalize about positive or negative trends in parameter concentrations. As an example, if there are 4 sampling periods of parameter data for a well where values are between the 75 and 95 percentiles, then the well shows an increase in parameter concentrations. This could indicate a reduction in water quality, which would require more frequent monitoring (monthly).

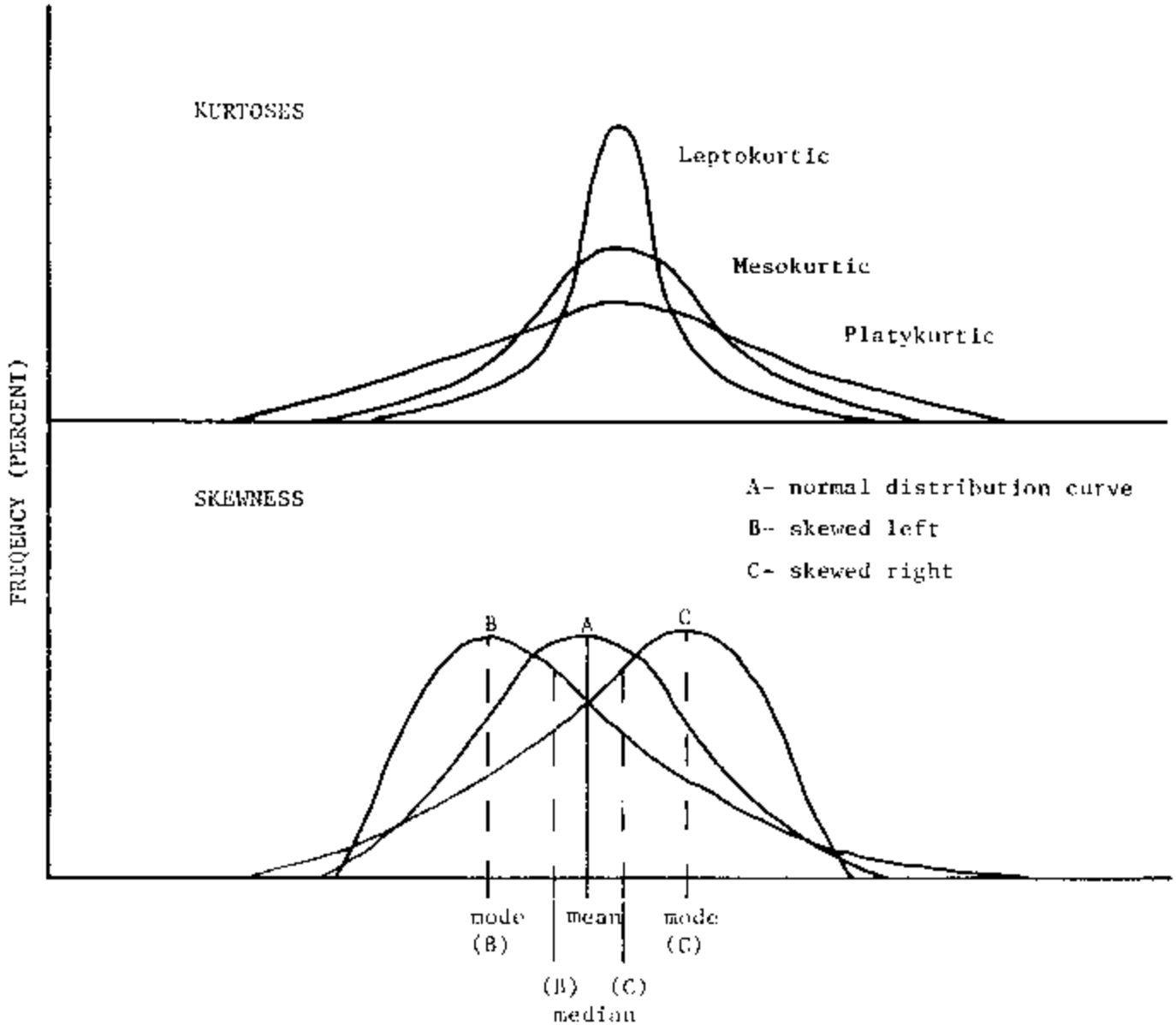


Figure 6. Frequency distribution curves with various kurtoses and skewnesses. The normal distribution curve (A) is symmetrical with mode, median and mean as the same value. The skewed curves have different values for mode, median and mean. The kurtoses curves, which are shown as symmetrical, can also be skewed.

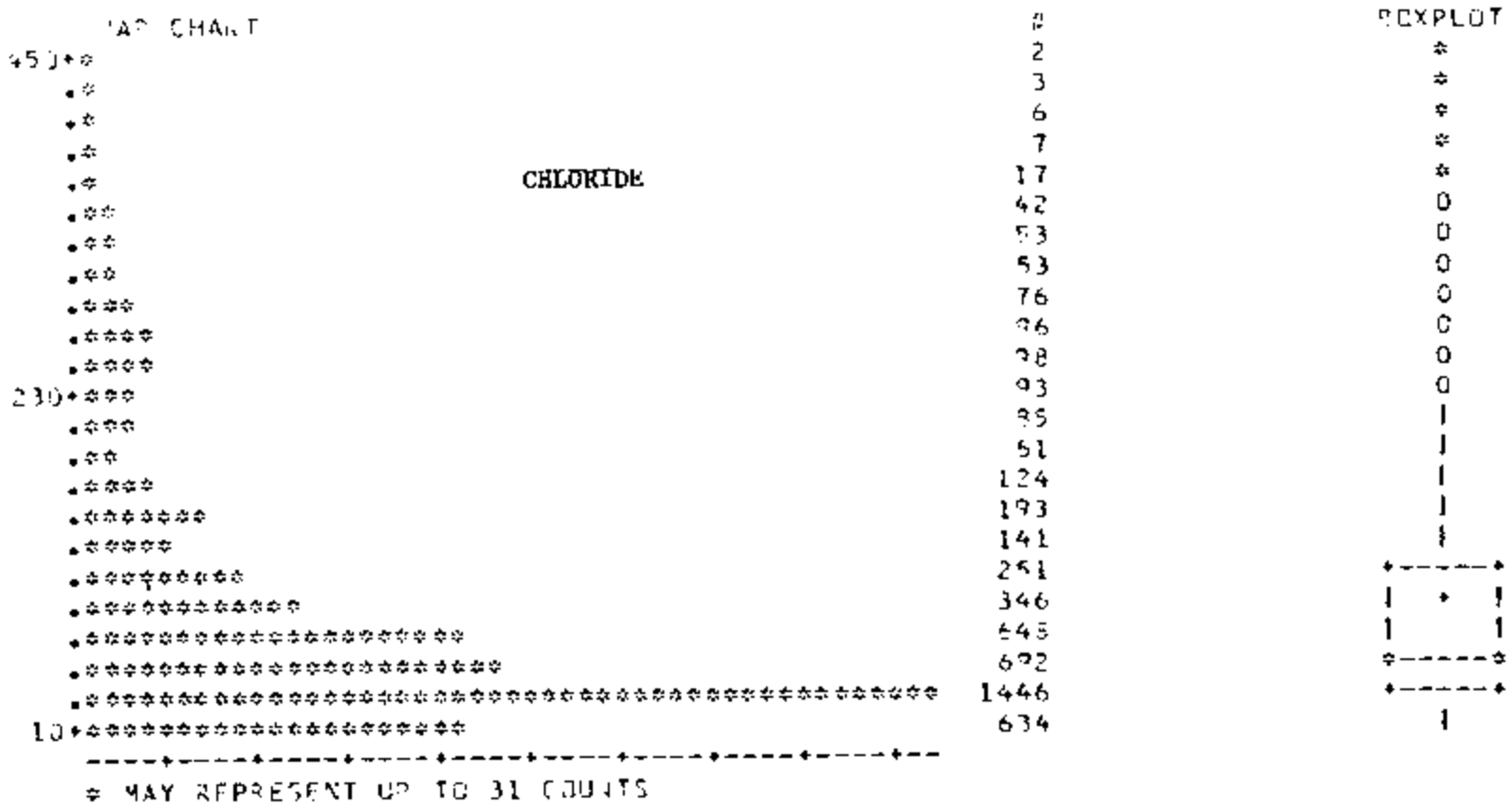


Figure 5. Computer plots of normal distribution of chloride data.

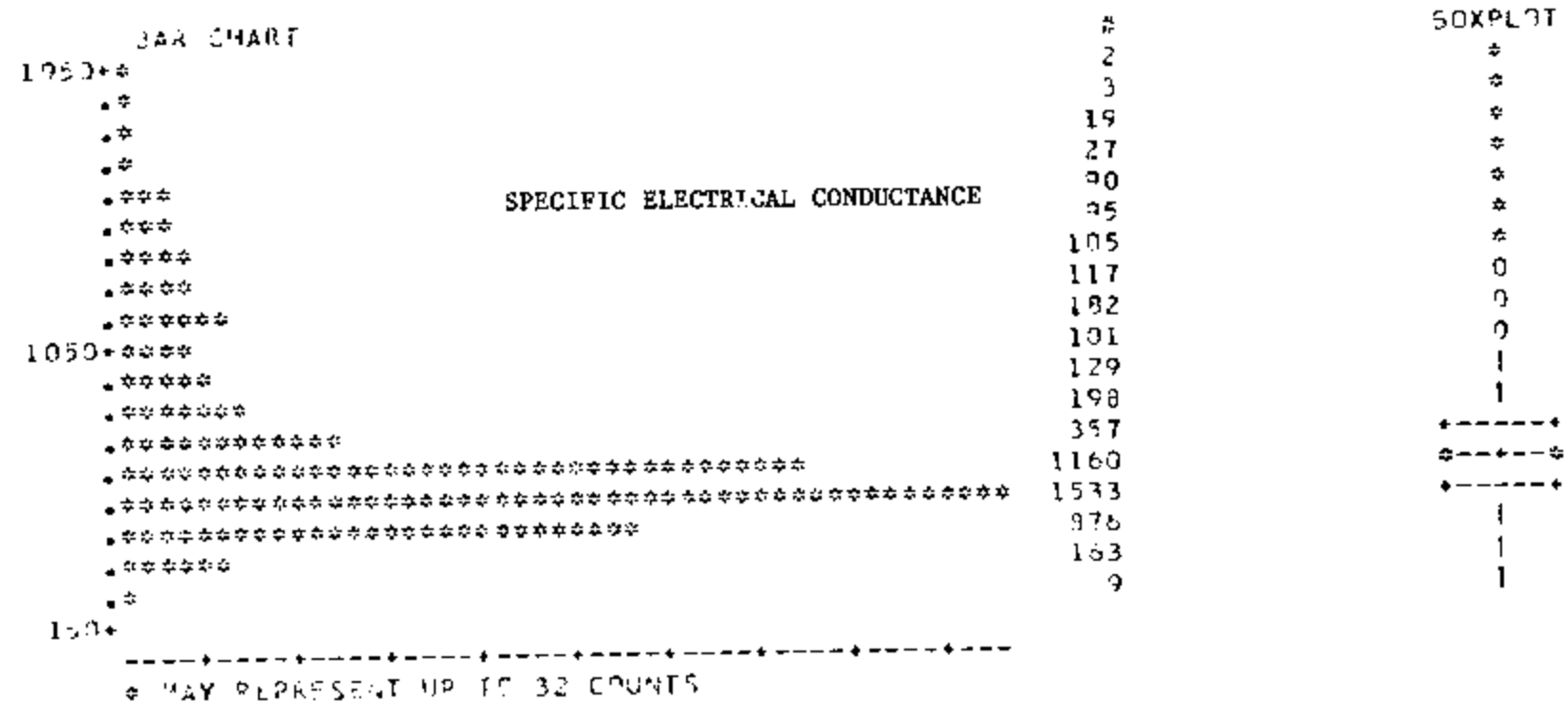


Figure 6. Computer plots of normal distribution of specific electrical conductance.

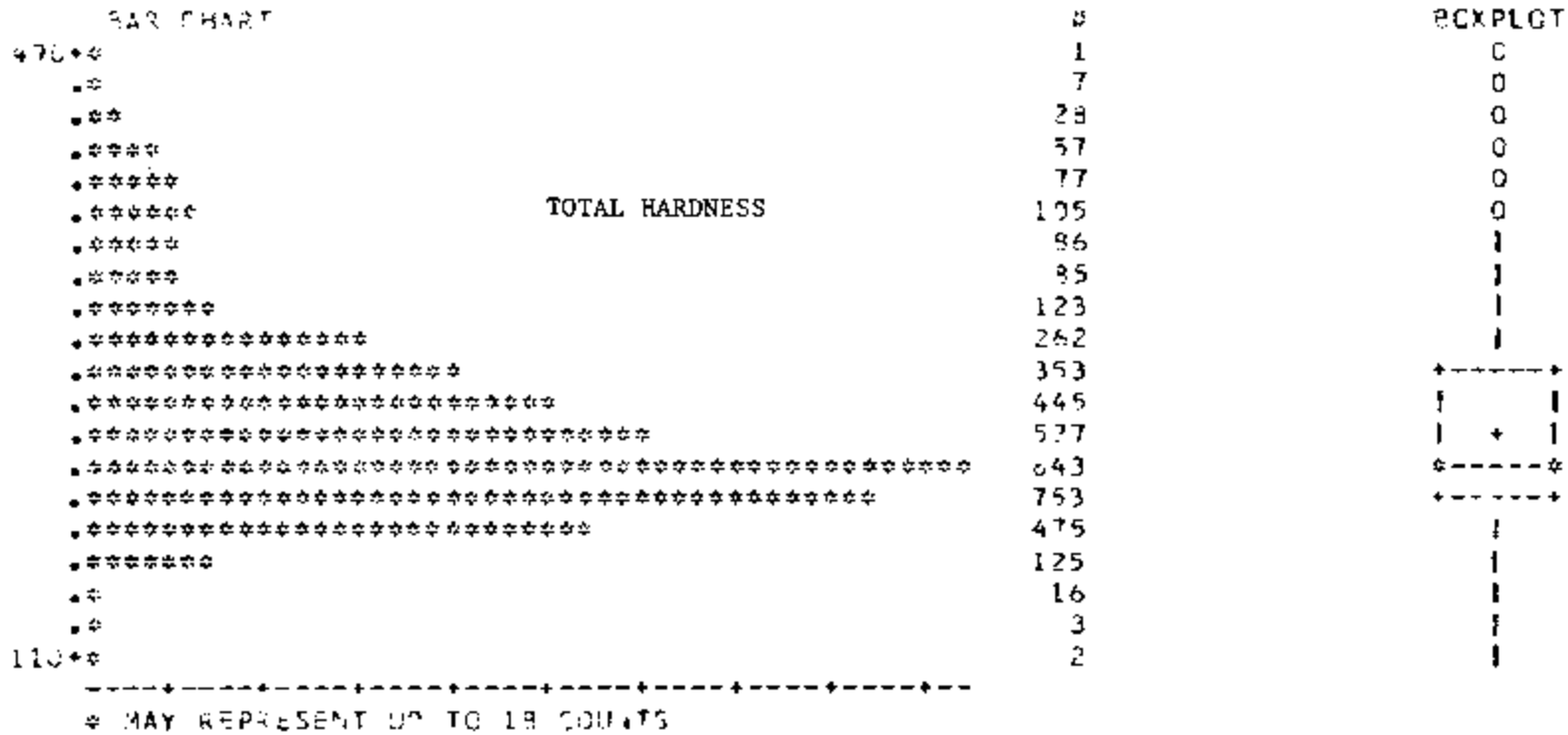


Figure 7. Computer plots of normal distribution of total hardness.

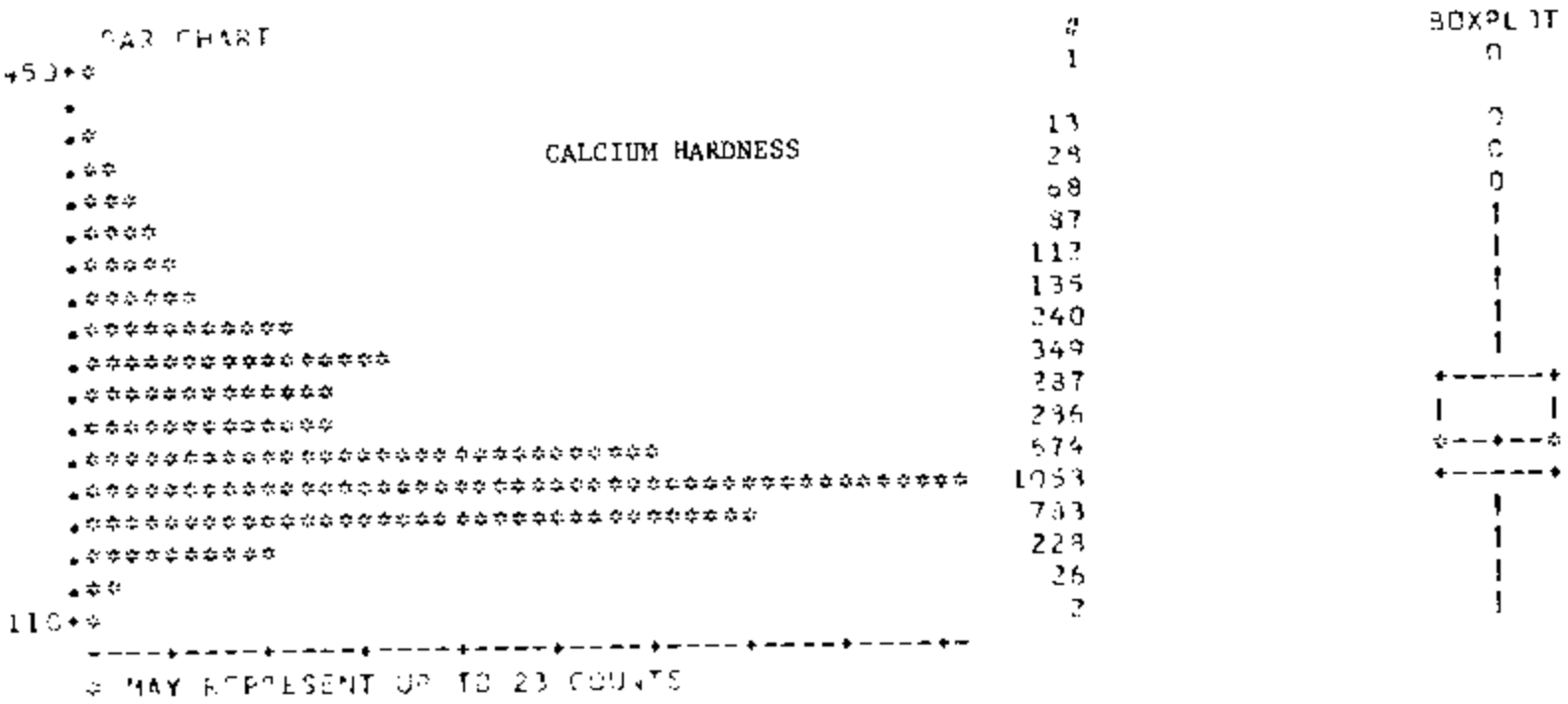


Figure 8. Computer plots of normal distribution of calcium hardness.

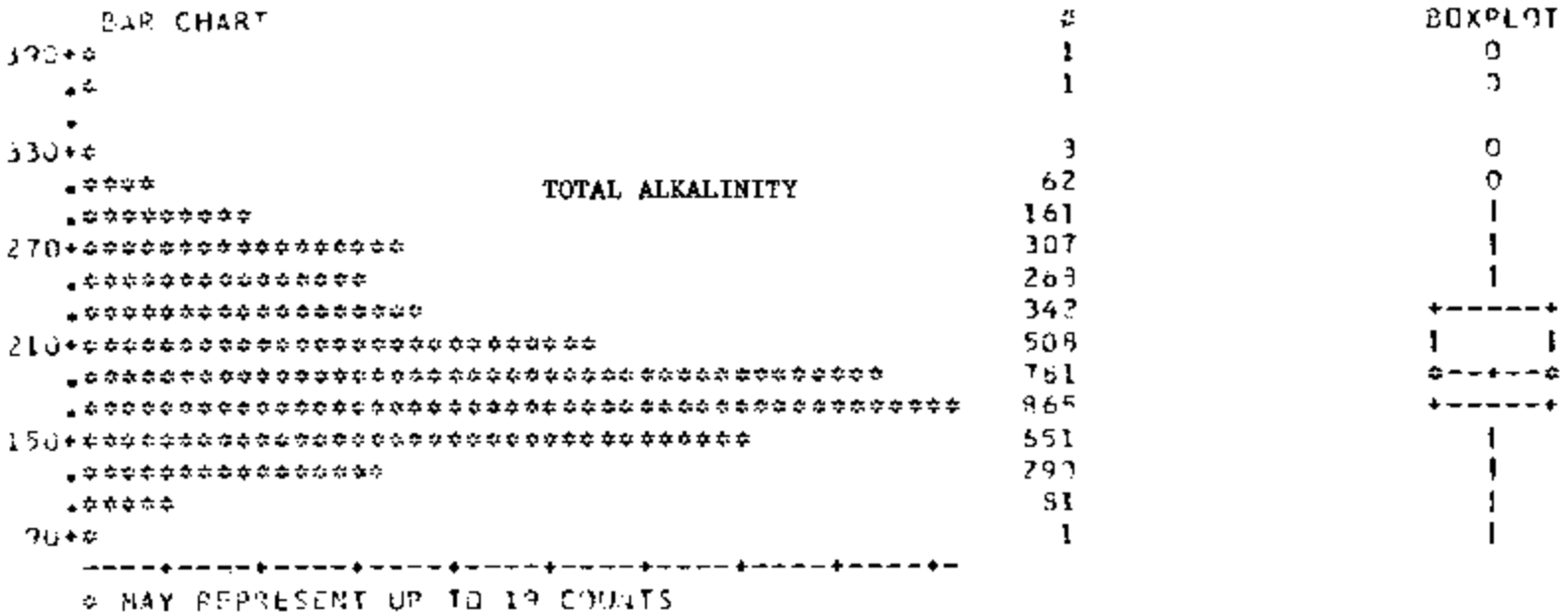


Figure 9. Computer plots of normal distribution of total alkalinity.

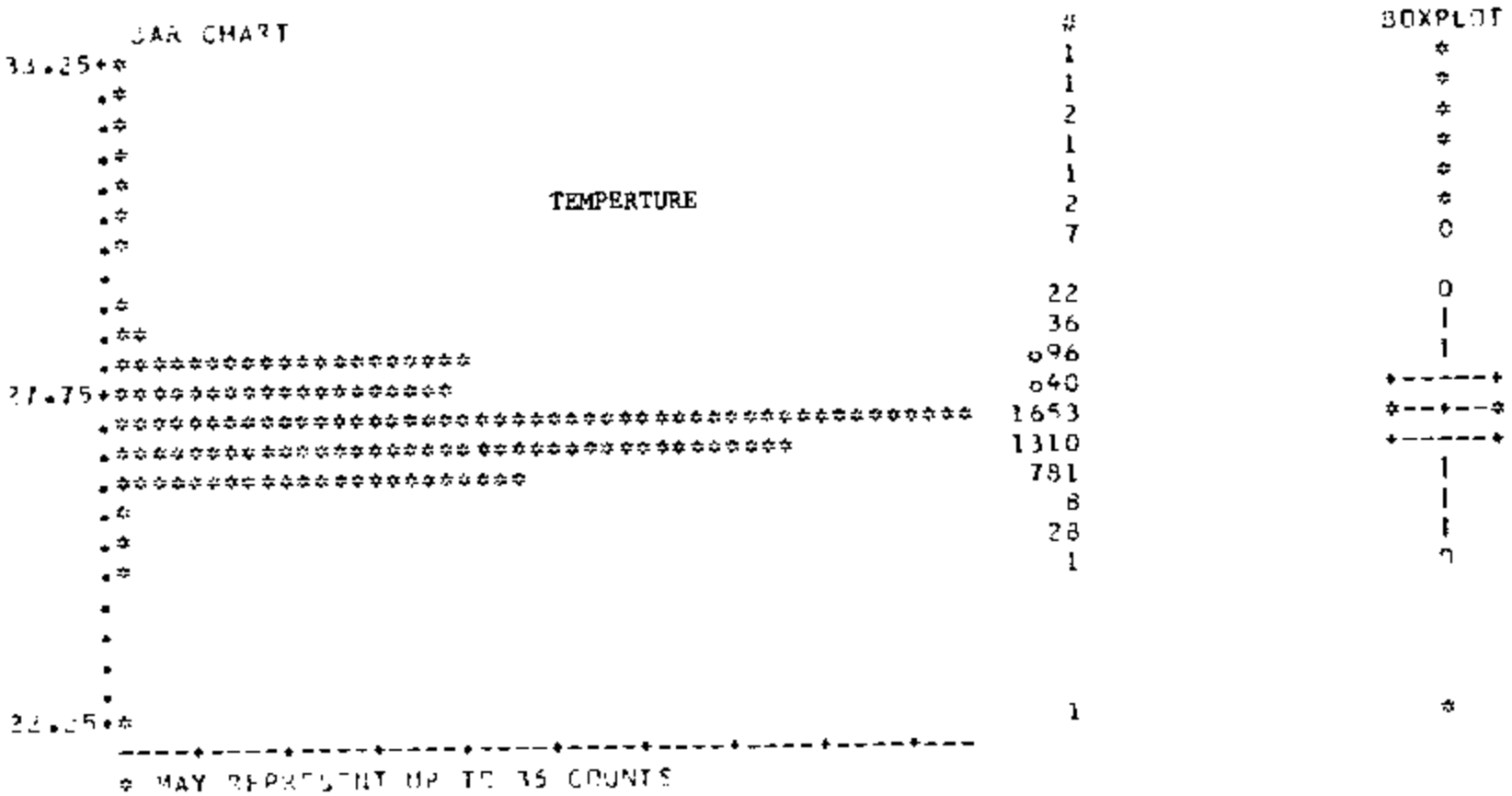


Figure 10. Computer plots of normal distribution of temperature.

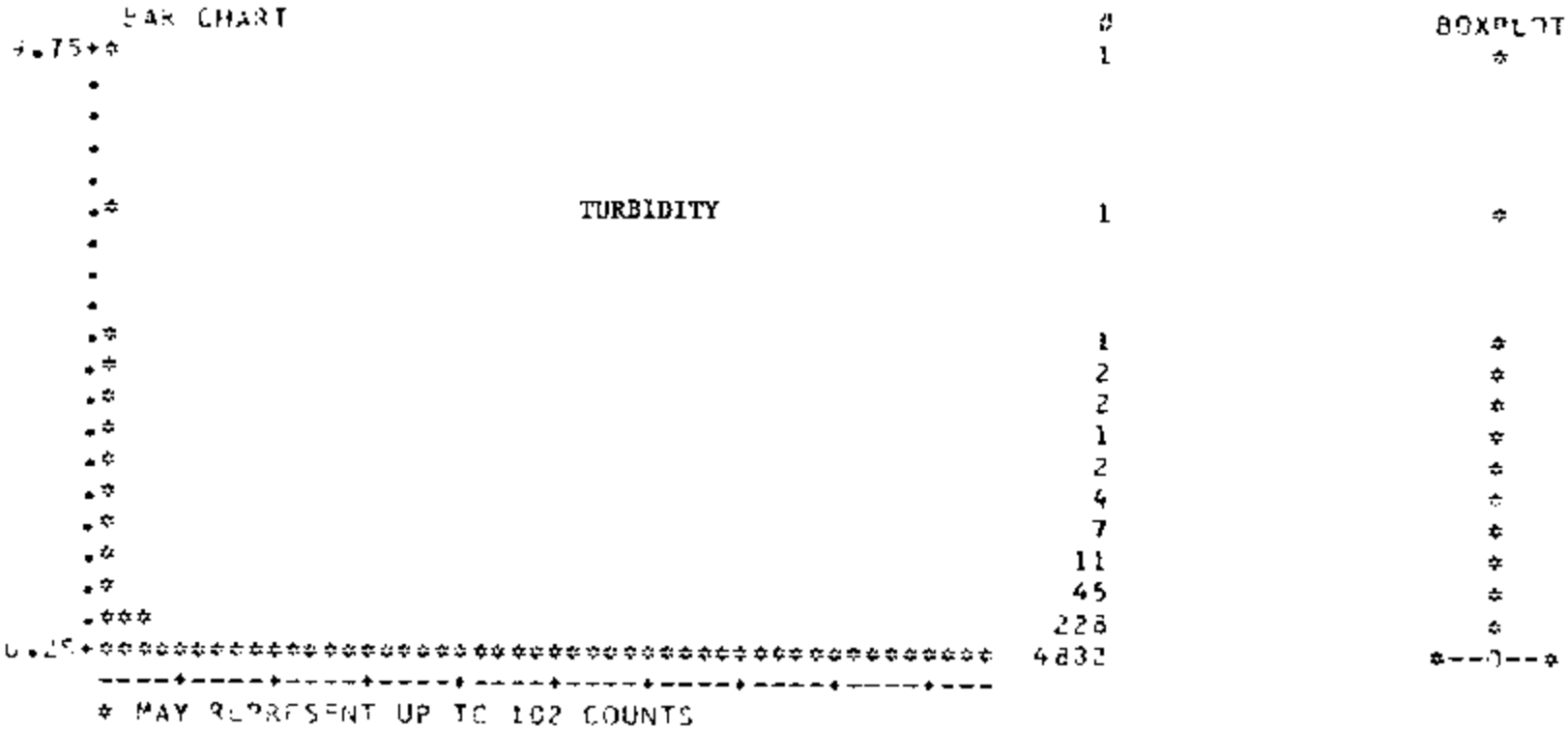


Figure 11. Computer plots of normal distribution of turbidity.

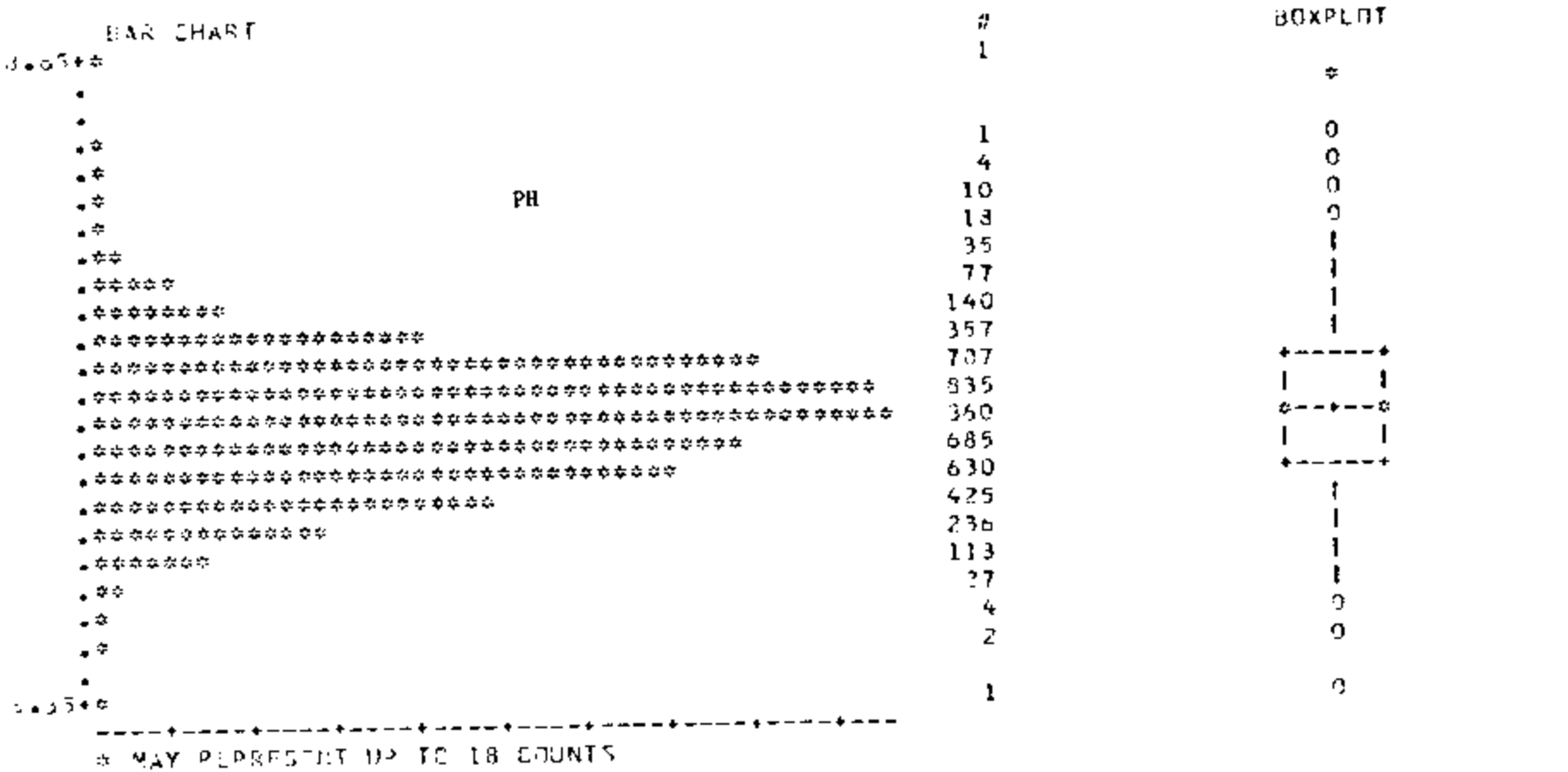


Figure 12. Computer plots of normal distribution of pH.

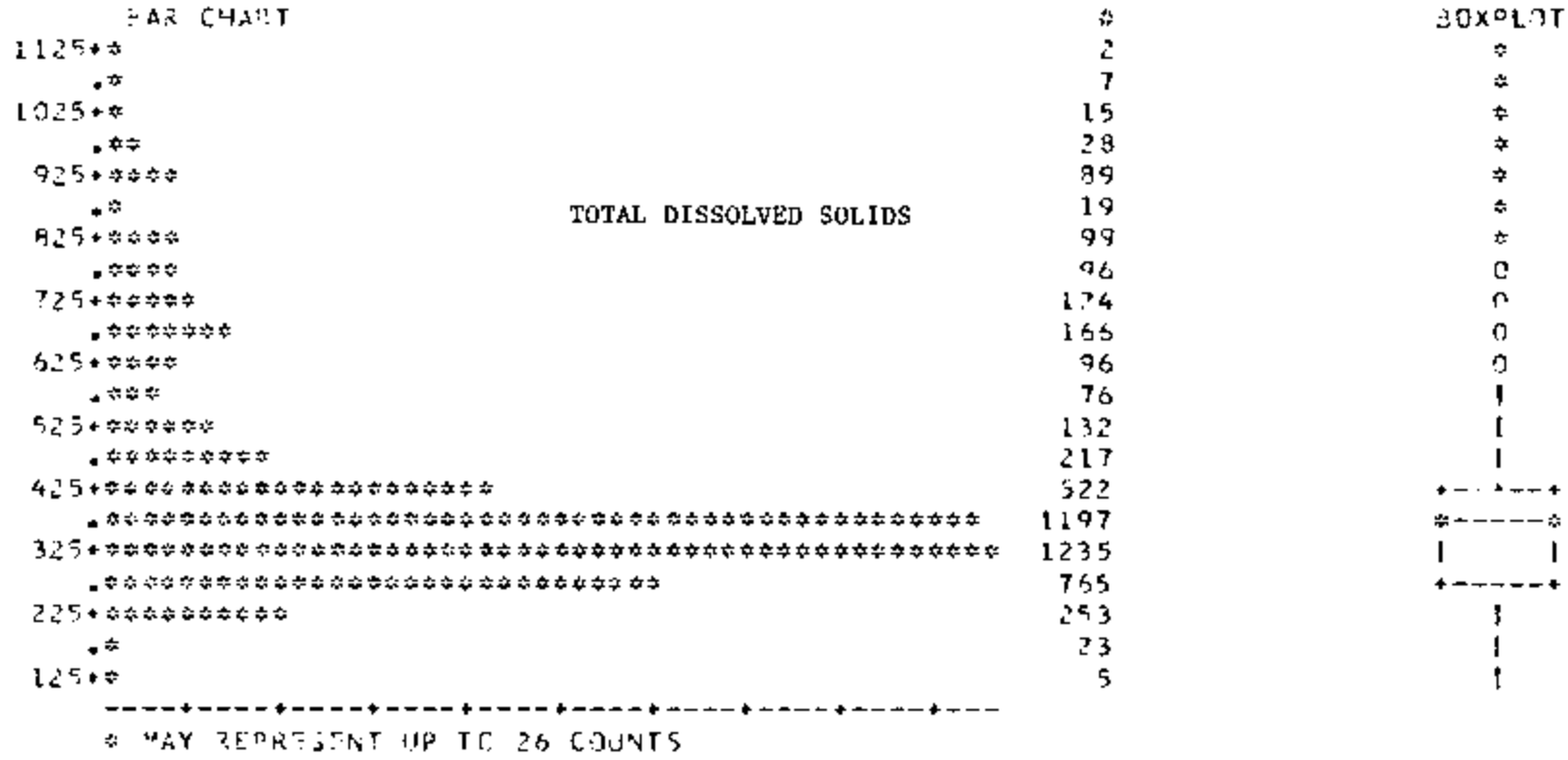


Figure 13. Computer plots of normal distribution of total dissolved solids.

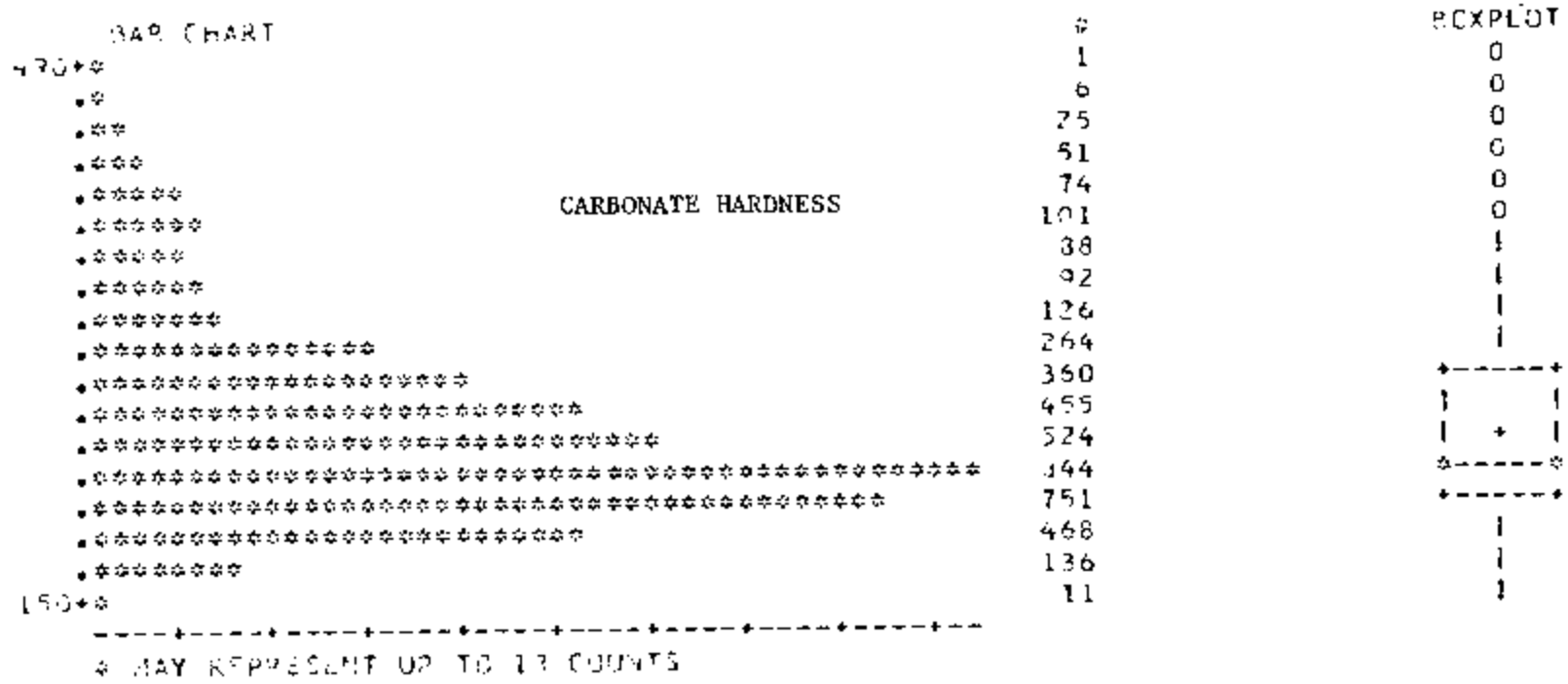
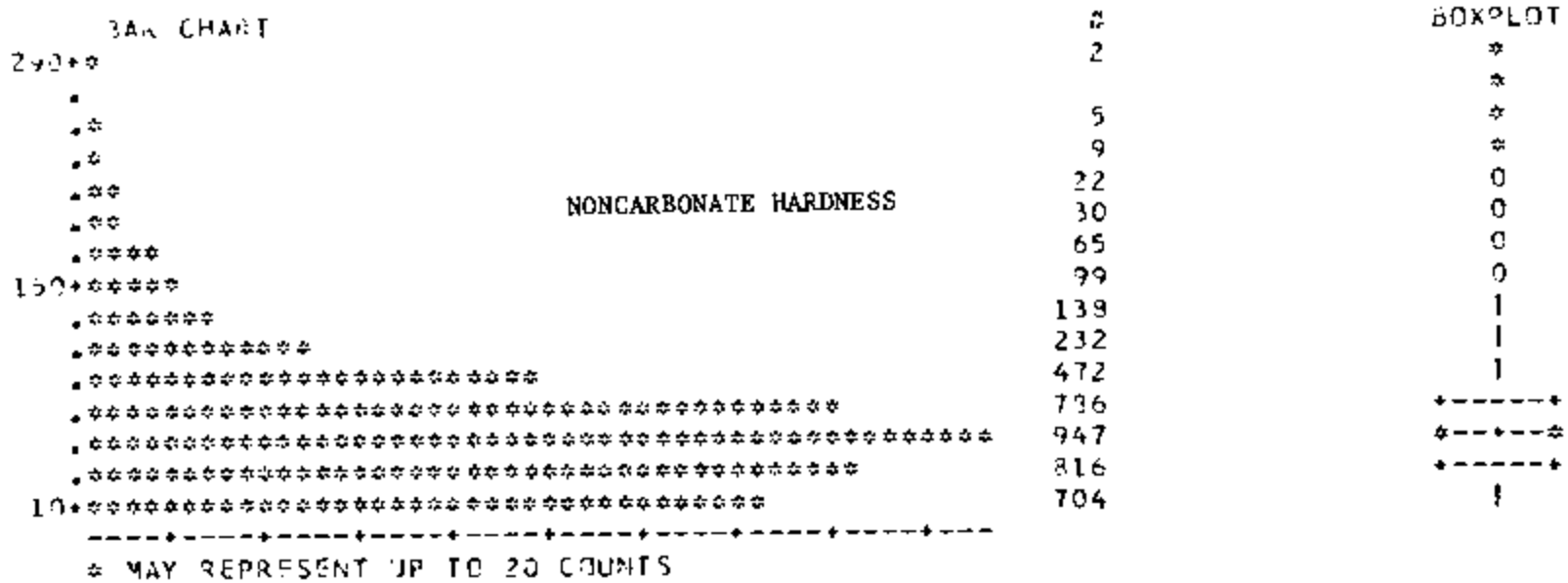


Figure 14. Computer plots of normal distribution of carbonate hardness.



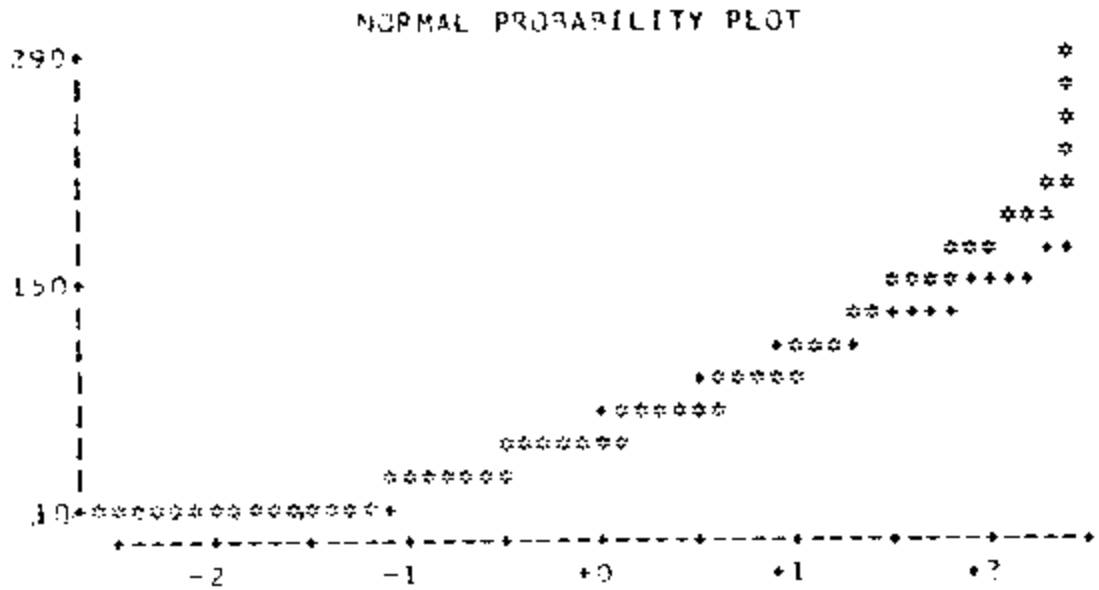


Figure 15. Computer plots of normal distribution of noncarbonate hardness.

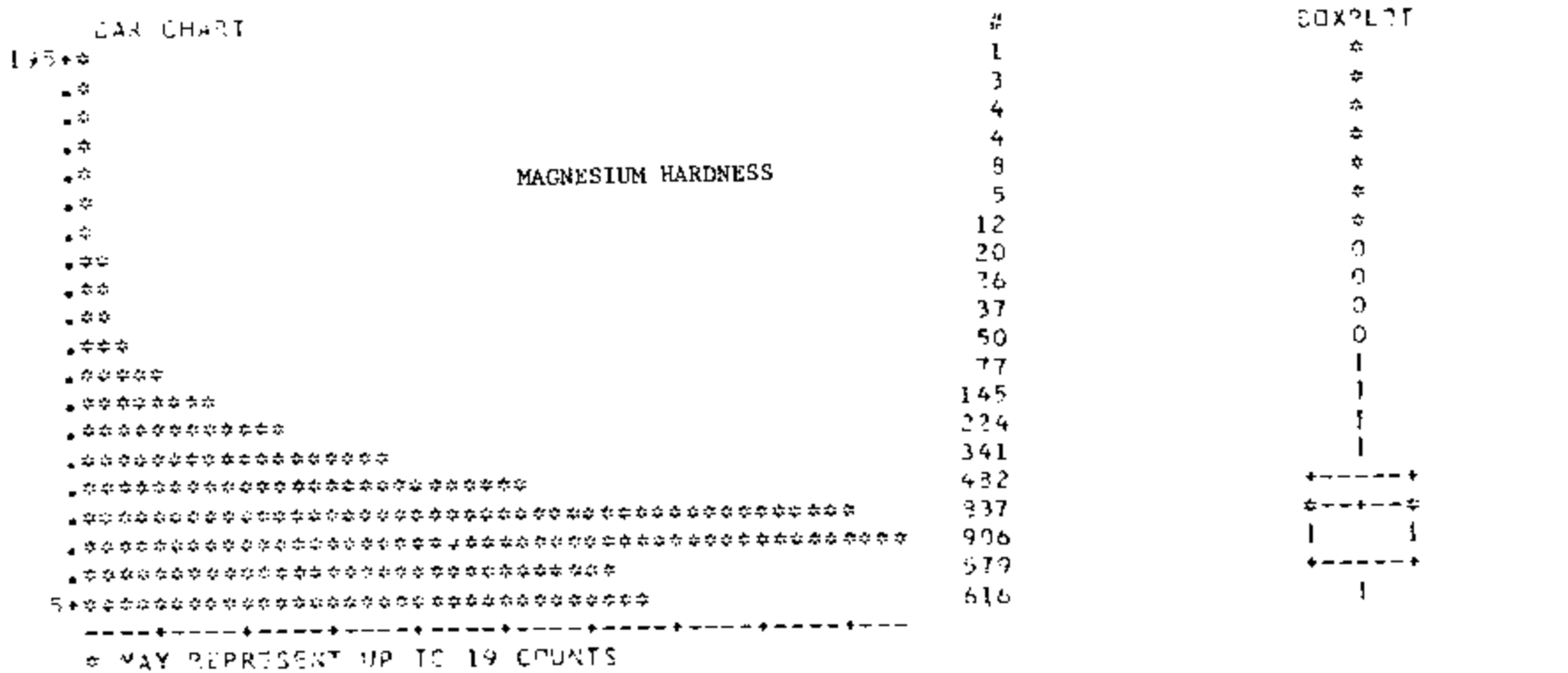


Figure 16. Computer plots of normal distribution of magnesium hardness.

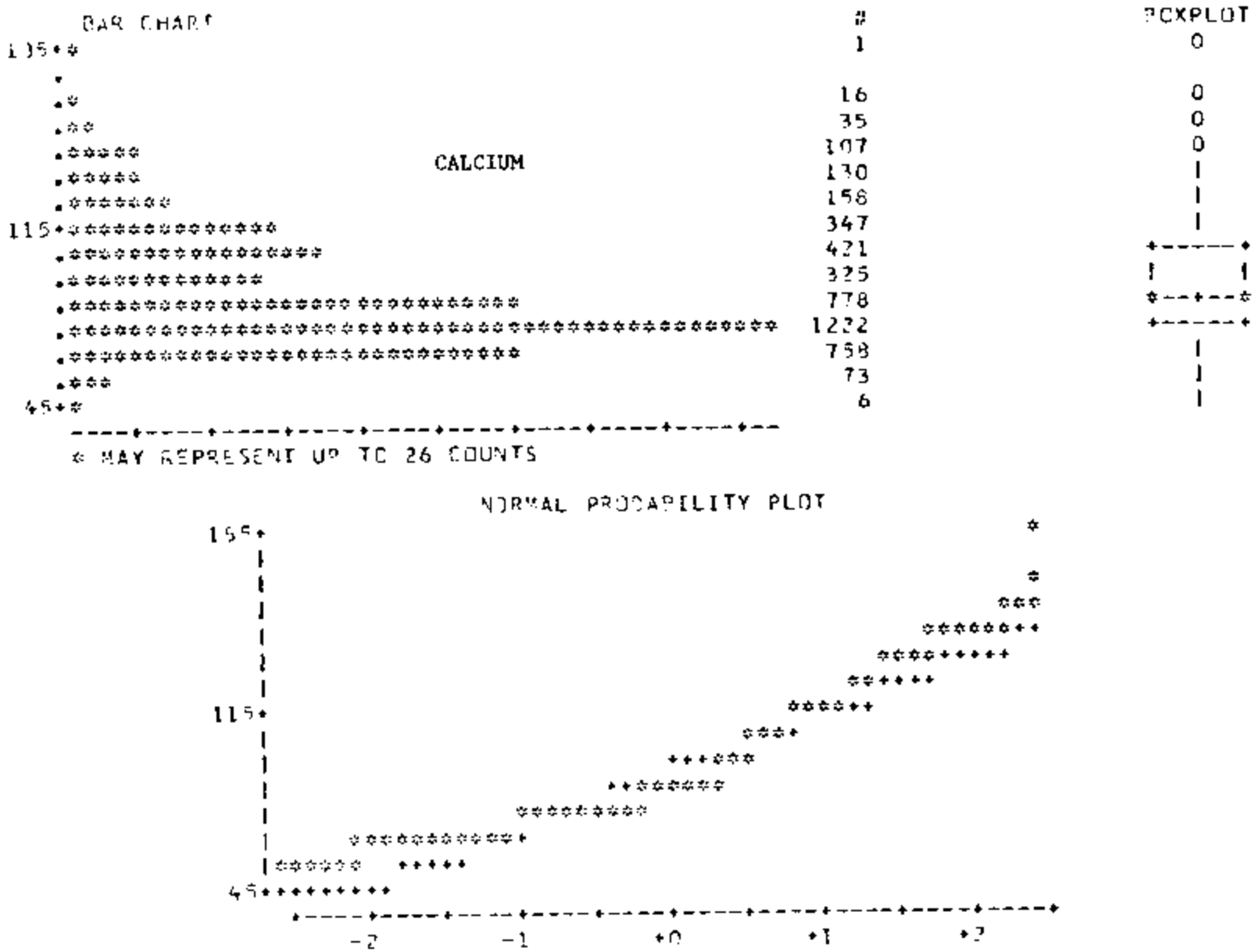


Figure 17. Computer plots of normal distribution of calcium.

Table 5. Basic statistics for water quality parameters from PDAG water wells 1 and 2 from well series A.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 1									
CHLORIDE	73	15	19.00	3.72	10.40	33.70	23.30	0.64	2.71
CONDUCTIVITY	71	17	596.06	35.52	470.00	680.00	210.00	-0.48	1.80
PH	72	16	7.07	0.22	6.54	7.87	1.33	0.91	7.85
TURBIDITY	74	14	0.18	0.09	0.05	0.56	0.51	1.83	4.38
T HARDNESS	62	26	298.82	22.69	219.50	367.20	147.70	-0.17	2.56
CA HARDNESS	62	26	278.13	25.04	199.90	349.90	150.00	-0.31	1.19
M ALKALINITY	63	25	247.88	38.48	110.00	307.00	197.00	-1.03	1.63
TEMPERATURE	73	15	27.46	0.49	26.00	29.00	3.00	0.34	0.99
BACTERIA	50	38	0.42	2.02	0.00	12.00	12.00	5.11	26.23
WATER WELL 2									
CHLORIDE	79	9	21.15	3.89	13.70	30.60	16.90	0.44	0.17
CONDUCTIVITY	78	10	559.81	72.02	380.00	700.00	320.00	-0.82	0.28
PH	79	9	7.15	0.27	6.71	7.85	1.14	0.73	-0.04
TURBIDITY	80	8	0.21	0.20	0.06	1.40	1.34	4.18	19.45
T HARDNESS	67	21	275.40	29.14	205.40	328.60	123.20	-0.80	0.35
CA HARDNESS	68	20	270.07	22.26	199.90	341.30	141.40	-0.42	2.31
M ALKALINITY	67	21	239.86	32.16	155.00	298.00	143.00	-0.48	0.05
TEMPERATURE	80	8	27.39	0.79	22.20	29.00	6.80	-3.64	23.28
BACTERIA	56	32	0.20	1.34	0.00	10.00	10.00	7.38	54.83

Table 5. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 1									
LOW TDS*	71	17	327.8	19.5	258.5	374.0	115.5	-0.5	1.8
TDS	71	17	357.6	21.3	282.0	408.0	126.0	-0.5	1.8
HIGH TDS	71	17	387.4	23.1	305.5	442.0	136.5	-0.5	1.8
CARBONATE	62	26	298.8	23.1	219.5	367.2	147.7	-0.3	2.4
NONCARBONATE	63	25	49.4	40.5	0.0	223.2	223.2	1.6	4.6
MG HARDNESS	62	26	20.7	16.1	0.0	140.2	68.0	1.1	1.0
CALCIUM	62	26	111.5	10.0	80.1	68.0	60.1	-0.3	1.2
PERCENT MG	60	28	7.1	5.2	0.0	23.3	23.3	1.2	1.2
PERCENT CARBONATE	63	25	83.8	12.9	33.0	100.0	67.0	-1.3	2.9
PERCENT NONCARB	61	27	16.8	12.8	0.0	67.0	67.0	1.4	3.0
WATER WELL 2									
LOW TDS*	78	10	307.9	39.6	209.0	385.0	176.0	-0.8	0.3
TDS	78	10	335.9	43.2	228.0	420.0	192.0	-0.8	0.3
HIGH TDS	78	10	363.9	46.8	247.0	455.0	208.0	-0.8	0.3
CARBONATE	68	20	286.4	18.3	235.2	341.3	106.1	0.4	0.9
NONCARBONATE	67	21	40.7	34.6	0.0	135.1	135.1	0.6	-0.6
MG HARDNESS	68	20	16.3	19.3	0.0	78.4	78.4	1.5	2.0
CALCIUM	68	20	108.2	8.9	80.1	136.8	56.7	-0.4	2.1
PERCENT MG	68	23	5.8	6.6	0.0	28.2	28.2	1.5	2.1
PERCENT CARBONATE	68	21	85.9	11.8	53.4	100.0	46.6	-0.6	-0.5
PERCENT NONCARB	64	24	14.8	11.7	0.0	46.6	46.6	0.5	-0.5

Table 6. Basic statistics for water quality parameters from PUM water wells 3 and 4 from well series A.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 3									
CHLORIDE	77	11	19.02	3.48	8.20	28.50	20.30	0.08	1.52
CONDUCTIVITY	77	11	574.48	43.27	450.00	660.00	210.00	-0.54	0.20
PH	77	11	7.13	0.20	6.34	7.60	1.26	-0.34	2.62
TURBIDITY	77	11	0.20	0.19	0.07	1.60	1.53	5.58	37.75
T HARDNESS	66	22	285.76	23.15	245.40	386.80	141.40	1.62	5.02
CA HARDNESS	66	22	265.19	17.83	204.00	337.00	133.00	0.56	4.73
M ALKALINITY	65	23	248.52	30.49	163.00	300.00	137.00	-0.88	0.22
TEMPERATURE	76	12	27.50	0.45	26.50	29.00	2.50	0.45	0.02
BACTERIA	55	33	0.40	1.83	0.00	10.00	10.00	4.80	22.58
WATER WELL 4									
CHLORIDE	75	13	21.72	3.45	15.40	32.10	16.70	0.82	0.80
CONDUCTIVITY	76	12	573.42	55.15	400.00	700.00	300.00	-0.54	1.68
PH	75	13	7.11	0.18	6.67	7.60	0.93	0.30	0.43
TURBIDITY	79	9	0.21	0.19	0.05	1.00	0.95	2.69	7.60
T HARDNESS	64	24	288.89	21.10	251.30	362.90	111.60	0.75	1.09
CA HARDNESS	67	21	269.57	21.73	219.50	337.00	117.50	0.09	1.16
M ALKALINITY	65	23	239.61	31.24	159.00	293.00	134.00	-0.75	0.24
TEMPERATURE	78	10	27.46	0.45	26.00	28.00	2.00	-0.47	0.21
BACTERIA	56	32	0.18	1.34	0.00	10.00	10.00	7.48	56.00

Table 6. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 3									
LOW TDS*	77	11	316.0	23.8	247.5	363.0	115.5	-0.5	0.2
TDS	77	11	344.7	26.0	270.0	396.0	126.0	-0.5	0.2
HIGH TDS	77	11	373.4	28.1	292.5	429.0	136.5	-0.5	0.2
CARBONATE	66	22	287.0	23.5	254.8	386.8	132.0	1.6	4.4
NONCARBONATE	65	23	37.1	33.7	0.0	165.8	165.8	1.2	2.2
MG HARDNESS	66	22	21.8	21.2	0.0	138.6	138.6	3.0	14.0
CALCIUM	66	22	106.3	7.1	81.8	135.1	53.3	2.1	4.7
PERCENT MG	63	25	7.7	6.1	0.0	35.8	35.8	2.1	7.7
PERCENT CARBONATE	65	23	87.4	10.9	57.1	100.0	42.9	-0.9	0.2
PERCENT NONCARB	62	26	13.2	10.8	0.0	42.9	42.9	0.8	0.2
WATER WELL 4									
LOW TDS*	76	12	315.4	30.3	220.0	385.0	165.0	-0.5	1.7
TDS	76	12	344.1	33.1	240.0	420.0	180.0	-0.5	1.7
HIGH TDS	76	12	372.7	35.8	260.0	455.0	195.0	-0.5	1.7
CARBONATE	67	21	288.9	22.3	251.3	362.9	111.6	0.7	0.6
NONCARBONATE	65	23	47.6	32.9	0.0	123.9	123.9	0.3	-0.7
MG HARDNESS	67	21	19.3	17.3	0.0	77.5	77.5	1.5	2.8
CALCIUM	67	21	108.0	8.7	88.0	135.1	47.1	0.1	1.2
PERCENT MG	62	26	7.1	5.5	0.0	25.5	25.5	1.4	2.5
PERCENT CARBONATE	65	23	83.8	11.2	57.1	100.0	42.9	-0.3	-0.6
PERCENT NONCARB	60	28	17.6	10.5	0.0	42.9	42.9	0.3	-0.5

Table 7. Basic statistics for water quality parameters from PUAG water wells 5 and 6 from well series A.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 5									
CHLORIDE	74	14	18.10	3.57	11.90	29.10	17.20	0.63	0.49
CONDUCTIVITY	75	13	567.33	60.68	200.00	660.00	460.00	-3.27	17.45
PH	74	14	7.14	0.16	6.86	7.53	0.67	0.46	-0.26
TURBIDITY	75	13	0.17	0.12	0.06	1.00	0.94	4.58	27.55
T HARDNESS	65	23	287.06	18.38	243.00	357.00	114.00	1.22	3.55
CA HARDNESS	66	22	268.25	15.09	227.40	315.40	88.00	0.08	0.97
M ALKALINITY	65	23	241.40	29.16	161.00	289.00	128.00	-0.71	0.19
TEMPERATURE	75	13	27.78	0.50	26.00	29.00	3.00	-0.64	2.20
BACTERIA	51	37	0.71	2.56	0.00	16.00	16.00	4.95	26.94
WATER WELL 6									
CHLORIDE	79	9	19.84	3.92	11.90	38.90	27.00	1.74	6.73
CONDUCTIVITY	80	8	556.50	45.59	400.00	660.00	260.00	-0.45	1.81
PH	80	8	7.12	0.18	6.77	7.80	1.03	0.95	2.28
TURBIDITY	80	8	0.18	0.16	0.06	1.00	0.94	3.59	14.76
T HARDNESS	68	20	279.86	19.50	228.60	349.90	121.30	0.63	1.87
CA HARDNESS	68	20	261.45	21.70	172.00	311.00	139.00	-0.86	3.70
M ALKALINITY	67	21	235.92	30.21	145.00	284.00	139.00	-0.75	0.43
TEMPERATURE	80	8	27.41	0.50	26.00	29.00	3.00	0.16	0.85
BACTERIA	56	32	24.66	44.09	0.00	243.00	243.00	3.05	11.41

Table 7. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 5									
LOW TDS*	75	13	312.0	33.4	110.0	363.0	253.0	-3.3	17.4
TDS	75	13	340.4	36.4	120.0	396.0	276.0	-3.3	17.4
HIGH TDS	75	13	368.8	39.4	130.0	429.0	299.0	-3.3	17.4
CARBONATE	66	22	287.4	18.7	243.0	357.0	114.0	1.1	3.1
NONCARBONATE	65	23	44.7	29.7	0.0	117.3	117.3	0.5	-0.3
MG HARDNESS	66	22	19.1	14.8	0.0	71.4	71.4	1.3	2.1
CALCIUM	66	22	107.5	6.0	91.0	126.4	35.3	0.1	1.0
PERCENT MG	64	24	6.7	4.6	0.0	20.0	20.0	0.9	0.4
PERCENT CARBONATE	65	23	84.6	10.1	57.9	100.0	42.1	-0.5	-0.3
PERCENT NONCARB	63	25	15.9	9.8	0.0	42.1	42.1	0.5	-0.3
WATER WELL 6									
LOW TDS*	80	8	306.1	25.1	220.0	363.0	143.0	-0.5	1.8
TDS	80	8	333.9	27.4	240.0	396.0	156.0	-0.5	1.8
HIGH TDS	80	8	361.7	29.6	260.0	429.0	169.0	-0.5	1.8
CARBONATE	68	20	281.1	19.4	243.0	349.0	106.9	0.8	1.1
NONCARBONATE	67	21	43.2	29.7	0.0	129.4	129.4	0.4	-0.2
MG HARDNESS	68	20	19.6	16.2	0.0	96.0	96.0	2.3	7.9
CALCIUM	68	20	104.8	8.7	68.9	124.6	55.7	-0.9	3.7
PERCENT MG	66	22	7.1	5.6	0.0	35.8	35.8	2.6	10.4
PERCENT CARBONATE	67	21	84.7	10.4	52.8	100.0	47.2	-0.4	-0.1
PERCENT NONCARB	65	23	15.8	10.2	0.0	47.2	47.2	0.4	-0.0

Table 8. Basic statistics for water quality parameters from PCAC water wells 7 and 8 from well series A.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 7									
CHLORIDE	79	9	22.97	4.88	15.60	45.00	29.40	1.50	4.31
CONDUCTIVITY	79	9	615.19	38.66	520.00	700.00	180.00	-0.03	0.02
PH	77	11	7.07	0.19	6.77	7.80	1.03	1.09	7.74
TURBIDITY	80	8	0.19	0.16	0.05	1.00	0.95	3.49	13.41
T HARDNESS	68	20	310.04	24.24	253.80	393.10	139.30	1.13	2.75
CA HARDNESS	69	19	282.65	27.66	205.60	362.90	157.30	-0.71	1.58
M ALKALINITY	68	20	254.77	33.54	136.00	318.00	182.00	-1.12	2.02
TEMPERATURE	80	8	27.63	0.43	26.40	29.00	2.60	-0.24	0.78
BACTERIA	57	31	0.21	1.46	0.00	11.00	11.00	7.46	56.02
WATER WELL 8									
CHLORIDE	79	9	21.79	11.70	11.80	96.00	84.20	4.24	22.34
CONDUCTIVITY	79	9	601.46	73.71	470.00	980.00	410.00	1.61	3.52
PH	79	9	7.11	0.16	6.75	7.60	0.85	0.46	0.54
TURBIDITY	80	8	0.31	0.19	0.07	1.00	0.93	1.79	3.06
T HARDNESS	68	20	294.79	27.30	202.70	399.60	196.90	0.61	4.01
CA HARDNESS	69	19	275.34	22.62	196.00	328.30	132.30	-0.94	2.53
M ALKALINITY	68	20	247.07	30.25	161.00	299.00	138.00	-0.78	0.32
TEMPERATURE	80	8	27.67	0.56	26.30	30.00	3.70	0.52	3.01
BACTERIA	56	32	0.27	1.75	0.00	13.00	13.00	7.24	53.30

Table 8. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 7									
LOW TDS*	79	9	338.4	21.3	286.0	385.0	99.0	-0.0	0.0
TDS	79	9	369.1	23.2	312.0	420.0	108.0	-0.0	0.0
HIGH TDS	79	9	399.9	25.1	338.0	455.0	117.0	-0.0	0.0
CARBONATE	69	19	309.3	20.6	266.6	393.1	126.5	1.2	3.0
NONCARBONATE	68	20	51.1	36.1	0.0	161.9	161.9	0.7	0.2
MG HARDNESS	69	19	26.6	25.8	0.0	108.7	108.7	1.7	2.9
CALCIUM	69	19	113.3	11.1	82.4	145.5	63.0	-0.7	1.6
PERCENT MG	65	23	9.0	8.0	0.0	34.0	34.0	1.7	2.9
PERCENT CARBONATE	68	20	83.6	11.4	45.7	100.0	54.3	-0.7	0.8
PERCENT NONCARB	64	24	17.4	11.0	0.0	54.3	54.3	0.8	1.0
WATER WELL 8									
LOW TDS*	79	9	330.8	40.5	258.5	484.0	225.5	1.6	3.5
TDS	79	9	360.9	44.2	282.0	528.0	246.0	1.6	3.5
HIGH TDS	79	9	390.9	47.9	305.5	572.0	266.5	1.6	3.5
CARBONATE	69	19	296.7	24.6	261.3	399.6	138.3	1.5	3.8
NONCARBONATE	68	20	47.1	32.8	0.0	129.6	129.6	0.3	-0.7
MG HARDNESS	69	19	21.4	19.7	0.0	108.6	108.6	2.3	7.6
CALCIUM	69	19	110.4	9.1	78.6	131.6	53.0	-0.9	2.5
PERCENT MG	67	21	7.2	6.1	0.0	33.3	33.3	2.0	5.9
PERCENT CARBONATE	68	20	84.8	10.6	57.9	100.0	42.1	-0.3	-0.7
PERCENT NONCARB	66	22	16.1	10.4	0.0	42.1	42.1	0.3	-0.6

Table 9. Basic statistics for water quality parameters from PCAG water wells 9 and 10 from well series A.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 9									
CHLORIDE	78	10	165.13	20.11	137.00	246.10	109.10	1.93	4.39
CONDUCTIVITY	77	11	1064.55	96.32	860.00	1520.00	660.00	1.89	5.87
PH	78	10	7.16	0.23	6.66	7.98	1.32	1.70	1.96
TURBIDITY	79	9	0.32	0.33	0.06	2.30	2.24	3.31	15.44
T HARDNESS	66	22	372.38	29.09	312.40	478.20	165.80	0.84	1.79
CA HARDNESS	67	21	321.24	32.18	210.70	401.80	191.10	-3.07	2.48
M ALKALINITY	66	22	264.63	37.58	162.00	381.00	219.00	0.42	1.29
TEMPERATURE	79	9	27.50	0.44	26.00	28.20	2.20	-0.43	0.27
BACTERIA	55	33	0.13	0.82	0.00	6.00	6.00	7.14	51.91
WATER WELL 10									
CHLORIDE	77	11	200.34	40.76	120.00	314.10	194.10	0.35	0.13
CONDUCTIVITY	78	10	1146.99	143.77	760.00	1400.00	640.00	-0.57	0.02
PH	78	10	7.15	0.23	6.71	7.90	1.19	1.60	2.97
TURBIDITY	79	9	0.23	0.23	0.06	1.30	1.24	2.93	8.87
T HARDNESS	66	22	372.35	33.03	268.50	440.80	172.30	-0.67	1.37
CA HARDNESS	67	21	322.00	33.33	207.80	378.00	170.20	-1.62	3.49
M ALKALINITY	66	22	263.29	31.21	168.00	312.00	144.00	-0.73	0.59
TEMPERATURE	79	9	27.46	0.44	26.50	28.20	1.70	0.06	-1.30
BACTERIA	55	33	0.56	1.99	0.00	10.00	10.00	3.76	13.74

Table 9. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 9									
LOW TDS*	77	11	585.5	53.0	473.0	836.0	363.0	1.1	5.9
TDS	77	11	638.7	57.8	516.0	912.0	396.0	1.1	5.9
HIGH TDS	77	11	692.0	62.6	559.0	988.0	429.0	1.1	5.9
CARBONATE	67	21	372.7	29.2	313.6	478.2	164.6	0.8	1.6
NONCARBONATE	66	22	104.7	43.7	0.0	227.0	227.9	0.1	0.7
MG HARDNESS	67	21	51.4	34.3	0.0	180.6	180.6	1.8	4.5
CALCIUM	67	21	128.8	12.9	84.4	161.0	76.6	-1.1	2.5
PERCENT MG	65	23	14.0	8.3	0.0	46.2	46.2	1.8	4.4
PERCENT CARBONATE	66	22	72.1	10.9	41.5	100.0	58.5	0.0	1.1
PERCENT NONCARB	64	24	28.8	9.9	0.0	58.5	58.5	0.4	1.1
WATER WELL 10									
LOW TDS*	78	10	630.8	79.1	418.0	770.0	352.0	-0.6	0.0
TDS	78	10	688.2	86.3	456.0	840.0	384.0	-0.6	0.0
HIGH TDS	78	10	745.5	93.5	494.0	910.0	416.0	-0.6	0.0
CARBONATE	67	21	373.3	29.0	307.0	440.0	133.0	0.1	-0.3
NONCARBONATE	66	22	105.3	43.1	0.0	181.8	181.8	-0.5	-0.2
MG HARDNESS	67	21	51.3	31.7	0.0	156.8	156.8	1.3	3.2
CALCIUM	67	21	129.1	13.4	83.3	151.5	68.2	-1.6	3.5
PERCENT MG	65	23	14.0	8.2	0.0	43.0	43.0	1.7	4.6
PERCENT CARBONATE	66	22	72.1	10.7	49.8	100.0	50.2	0.6	0.3
PERCENT NONCARB	64	24	28.7	9.6	1.5	50.2	48.7	-0.3	-0.2

Table 10. Basic statistics for water quality parameters from PUAG water wells 11 and 12 from well series A.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 11									
CHLORIDE	79	9	18.70	3.03	10.60	28.40	17.80	0.91	2.42
CONDUCTIVITY	79	9	596.20	59.82	420.00	920.00	500.00	1.41	11.11
PH	79	9	7.10	0.19	6.79	7.73	0.94	0.59	0.78
TURBIDITY	80	8	0.25	0.16	0.08	1.00	0.92	2.54	7.65
T HARDNESS	67	21	299.18	24.75	241.30	397.80	156.60	1.18	3.32
CA HARDNESS	68	20	272.52	28.77	170.70	341.30	170.60	-1.46	3.93
M ALKALINITY	67	21	257.27	32.98	169.00	328.00	159.00	-0.52	0.09
TEMPERATURE	80	8	27.60	0.54	24.90	29.00	4.10	-1.57	7.08
BACTERIA	56	32	1.46	7.46	0.00	53.00	53.00	6.37	43.28
WATER WELL 12									
CHLORIDE	80	8	18.91	5.02	11.90	41.50	29.60	2.40	7.48
CONDUCTIVITY	80	8	608.84	48.60	520.00	900.00	380.00	2.71	15.29
PH	80	8	7.07	0.20	6.78	7.88	1.10	1.34	3.12
TURBIDITY	81	7	0.25	0.22	0.06	1.50	1.44	3.52	15.28
T HARDNESS	68	20	309.18	24.00	263.80	393.10	129.30	0.85	1.37
CA HARDNESS	69	19	290.05	23.06	215.60	358.60	143.00	0.20	2.06
M ALKALINITY	68	20	264.52	37.01	180.00	321.00	141.00	-0.59	-0.15
TEMPERATURE	81	7	27.52	0.51	25.80	28.30	2.50	-1.05	1.09
BACTERIA	57	31	0.77	5.56	0.00	42.00	42.00	7.57	56.73

Table 10. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 11									
LOW TDS*	79	9	327.9	32.9	231.0	506.0	275.0	1.4	11.1
TDS	79	9	357.7	35.9	252.0	552.0	300.0	1.4	11.1
HIGH TDS	79	9	387.5	38.9	273.0	598.0	325.0	1.4	11.1
CARBONATE	68	20	298.7	23.8	266.6	397.8	131.2	1.4	3.8
NONCARBONATE	67	21	40.6	35.2	0.0	167.8	167.8	0.9	1.3
MG HARDNESS	68	20	26.1	27.2	0.0	110.8	110.8	2.1	3.9
CALCIUM	68	20	109.2	11.5	68.4	136.8	68.4	-1.5	3.9
PERCENT MG	64	24	9.1	8.7	0.0	38.9	38.9	2.2	4.2
PERCENT CARBONATE	67	21	86.7	11.1	57.5	100.0	42.5	-0.6	-0.3
PERCENT NONCARB	63	25	14.1	10.9	0.0	42.5	42.5	0.6	-0.2
WATER WELL 12									
LOW TDS*	80	8	334.9	26.7	286.0	495.0	209.0	2.7	15.3
TDS	80	8	365.3	29.2	312.0	540.0	228.0	2.7	15.3
HIGH TDS	80	8	395.7	31.6	338.0	585.0	247.0	2.7	15.3
CARBONATE	69	19	310.7	22.6	270.5	393.1	122.6	1.0	1.9
NONCARBONATE	68	20	42.2	32.4	0.0	129.7	129.7	0.4	-0.5
MG HARDNESS	69	19	20.6	18.4	0.0	105.8	105.8	1.9	6.3
CALCIUM	69	19	116.3	9.2	86.4	143.7	57.3	0.2	2.1
PERCENT MG	65	23	6.9	5.6	0.0	32.9	32.9	2.0	7.1
PERCENT CARBONATE	68	20	86.5	10.4	58.1	100.0	41.9	-0.5	-0.5
PERCENT NONCARB	64	24	14.4	10.1	0.0	41.9	41.9	0.4	-0.4

Table 11. Basic statistics for water quality parameters from PVAG water wells 13 and 14 from well series A.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 13									
CHLORIDE	81	7	312.35	52.19	158.10	442.90	284.80	-0.14	1.47
CONDUCTIVITY	80	8	1440.50	192.48	940.00	1800.00	860.00	-0.47	-0.04
PH	80	8	7.10	0.21	6.51	7.80	1.29	1.07	3.03
TURBIDITY	80	8	0.30	0.21	0.09	1.00	0.91	1.95	3.34
T HARDNESS	69	19	408.35	33.76	325.40	492.60	167.20	-0.12	-0.04
CA HARDNESS	69	19	343.44	37.17	201.80	409.40	207.60	-1.09	2.66
M ALKALINITY	68	20	256.72	32.20	166.00	333.00	167.00	-0.60	0.70
TEMPERATURE	81	7	27.57	0.49	26.00	28.50	2.50	-0.54	0.32
BACTERIA	57	31	22.05	132.37	0.00	998.00	998.00	7.42	55.56
WATER WELL 14									
CHLORIDE	76	12	270.46	34.97	205.40	393.70	188.30	1.16	2.37
CONDUCTIVITY	74	14	1336.55	147.83	1000.00	1600.00	600.00	-0.27	-0.97
PH	75	13	7.11	0.19	6.83	7.80	0.97	1.41	2.52
TURBIDITY	75	13	0.26	0.30	0.06	2.20	2.14	4.16	23.69
T HARDNESS	65	23	399.25	31.84	312.00	475.80	163.80	0.04	0.04
CA HARDNESS	65	23	328.73	39.20	212.20	388.80	176.60	-1.13	1.10
M ALKALINITY	64	24	254.25	40.40	129.00	364.00	235.00	-0.66	1.75
TEMPERATURE	77	11	27.74	0.42	26.50	28.70	2.20	-0.71	0.92
BACTERIA	53	35	0.49	2.77	0.00	20.00	20.00	6.99	49.88

Table 11. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 13									
LOW TDS*	80	8	792.0	105.9	517.0	990.0	473.0	-0.5	-0.0
TDS	80	8	864.3	115.5	564.0	1080.0	516.0	-0.5	-0.0
HIGH TDS	80	8	936.3	125.1	611.0	1170.0	559.0	-0.5	-0.0
CARBONATE	69	19	405.7	34.9	332.8	492.6	159.8	-0.0	-0.3
NONCARBONATE	68	20	140.1	58.5	0.0	241.7	241.7	-0.8	0.6
MG HARDNESS	69	19	62.2	37.8	0.0	170.7	170.7	0.8	1.5
CALCIUM	69	19	137.7	14.9	80.9	164.1	83.2	-1.1	2.7
PERCENT MG	64	24	16.2	8.2	0.0	45.8	45.8	1.2	3.0
PERCENT CARBONATE	68	20	66.1	13.2	40.7	100.0	59.3	1.1	1.5
PERCENT NONCARB	63	25	36.6	9.4	6.0	59.3	53.3	-0.2	0.9
WATER WELL 14									
LOW TDS*	74	14	735.1	81.3	550.0	880.0	330.0	-0.3	-1.0
TDS	74	14	801.9	88.7	600.0	960.0	360.0	-0.3	-1.0
HIGH TDS	74	14	868.8	96.1	650.0	1040.0	390.0	-0.3	-1.0
CARBONATE	65	23	391.2	35.1	293.8	475.8	182.0	-0.1	0.4
NONCARBONATE	64	24	125.3	67.1	0.0	258.0	258.0	-0.5	-0.4
MG HARDNESS	65	23	62.5	43.6	0.0	187.3	187.3	0.9	1.2
CALCIUM	65	23	131.8	15.7	85.1	155.8	70.8	-1.1	1.1
PERCENT MG	57	31	17.7	9.4	2.2	46.9	44.7	1.4	1.8
PERCENT CARBONATE	64	24	68.8	16.3	34.2	100.0	65.8	0.6	0.0
PERCENT NONCARB	56	32	35.7	11.9	0.0	65.8	65.8	-0.2	1.3

Table 12. Basic statistics for water quality parameters from PUAC water wells 15 and 16 from well series A.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 15									
CHLORIDE	81	7	147.90	34.67	105.00	315.60	210.60	2.98	11.32
CONDUCTIVITY	81	7	975.31	133.96	780.00	1600.00	820.00	2.07	7.49
PH	81	7	7.23	0.18	6.79	7.85	1.06	0.95	2.86
TURBIDITY	80	8	0.19	0.20	0.04	1.50	1.46	4.49	24.17
T HARDNESS	69	19	311.08	29.23	262.00	457.00	195.00	1.81	7.87
CA HARDNESS	68	20	268.51	31.27	188.20	371.90	183.70	0.78	3.05
M ALKALINITY	68	20	221.31	29.34	119.00	287.00	168.00	-0.77	1.25
TEMPERATURE	81	7	27.81	0.55	26.60	30.20	3.60	0.87	4.08
BACTERIA	57	31	2.46	18.14	0.00	137.00	137.00	7.55	56.97
WATER WELL 16									
CHLORIDE	78	10	312.78	45.73	200.00	427.40	227.40	0.14	-0.13
CONDUCTIVITY	77	11	1379.74	161.89	1100.00	1700.00	600.00	-0.21	-0.97
PH	80	8	7.33	0.16	6.96	7.90	0.94	1.78	4.81
TURBIDITY	78	10	0.32	0.67	0.06	5.10	5.04	6.11	39.37
T HARDNESS	68	20	316.97	25.43	249.60	382.20	132.60	-0.08	0.45
CA HARDNESS	66	22	254.09	23.73	196.00	313.60	117.60	0.13	0.39
M ALKALINITY	66	22	190.75	27.27	117.00	283.00	166.00	0.52	7.57
TEMPERATURE	79	9	27.88	0.36	26.60	29.00	2.40	-0.55	3.64
BACTERIA	55	33	1.44	7.08	0.00	38.00	38.00	5.08	24.75

Table 12. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 15									
LOW TDS*	81	7	536.7	73.7	429.0	880.0	451.0	2.1	7.5
TDS	81	7	585.2	80.4	468.0	960.0	492.0	2.1	7.5
HIGH TDS	81	7	634.0	87.1	507.0	1040.0	533.0	2.1	7.5
CARBONATE	68	20	310.2	32.0	250.0	457.0	206.1	1.5	5.5
NONCARBONATE	68	20	82.2	45.1	0.0	236.0	236.0	0.7	1.8
MG HARDNESS	68	20	41.7	25.8	0.0	119.5	119.5	0.7	1.3
CALCIUM	68	20	107.6	12.5	75.4	149.1	73.6	0.8	3.0
PERCENT MG	63	25	14.3	6.8	0.0	36.4	36.4	0.7	1.9
PERCENT CARBONATE	68	20	73.9	12.8	35.7	100.0	64.3	-0.1	0.6
PERCENT NONCARB	63	25	28.2	10.8	6.1	64.3	58.3	0.7	1.0
WATER WELL 16									
LOW TDS*	77	11	758.9	89.0	605.0	935.0	330.0	-0.2	-1.0
TDS	77	11	827.8	97.1	660.0	1020.0	360.0	-0.2	-1.0
HIGH TDS	77	11	896.0	105.2	715.0	1105.0	390.0	-0.2	-1.0
CARBONATE	66	22	311.4	30.5	239.1	382.2	143.1	-0.3	-0.0
NONCARBONATE	66	22	115.2	50.1	0.0	234.0	234.0	-0.4	0.7
MG HARDNESS	66	22	57.3	30.2	0.0	166.6	166.6	0.2	2.0
CALCIUM	66	22	101.8	9.5	78.6	125.7	47.1	0.1	0.4
PERCENT MG	61	27	19.4	7.3	1.3	43.6	42.3	0.0	2.4
PERCENT CARBONATE	66	22	64.0	14.1	33.3	100.0	66.7	1.0	1.4
PERCENT NONCARB	61	27	39.0	9.0	13.6	66.7	53.1	0.1	0.6

Table 13. Basic statistics for water quality parameters from USAG water wells 17 and 18 from well series A.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 17									
CHLORIDE	79	9	248.99	36.03	170.10	349.70	179.60	0.14	-0.26
CONDUCTIVITY	79	9	1301.27	141.16	1000.00	1600.00	600.00	0.07	-0.95
PH	79	9	7.13	0.20	6.84	7.74	0.90	1.24	1.45
TURBIDITY	78	10	0.18	0.09	0.08	0.55	0.47	1.95	4.29
T HARDNESS	68	20	393.99	28.65	301.60	461.40	159.60	-0.20	0.67
CA HARDNESS	67	21	330.32	34.57	168.60	385.60	217.00	-2.10	7.18
M ALKALINITY	67	21	257.81	33.93	146.00	312.00	166.00	-1.09	1.40
TEMPERATURE	79	9	27.74	0.46	26.00	28.80	2.80	-0.84	2.06
BACTERIA	55	33	1.25	5.77	0.00	37.00	37.00	5.44	30.67
WATER WELL 18									
CHLORIDE	74	14	242.21	91.97	56.50	402.20	345.70	-0.41	-1.03
CONDUCTIVITY	74	14	1293.99	275.57	760.00	1900.00	1140.00	0.03	-0.79
PH	75	13	7.16	0.28	6.67	8.00	1.33	0.86	0.51
TURBIDITY	74	14	0.24	0.19	0.05	1.10	1.05	2.47	6.98
T HARDNESS	66	22	404.72	38.49	199.90	462.50	262.60	-2.93	12.38
CA HARDNESS	65	23	367.38	37.52	228.80	451.20	222.40	-1.46	3.22
M ALKALINITY	65	23	271.21	37.53	133.00	331.00	198.00	-1.04	1.82
TEMPERATURE	76	12	28.07	0.72	26.60	31.50	4.90	2.12	8.11
BACTERIA	51	37	1.02	4.23	0.00	22.00	22.00	4.73	21.68

Table 13. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 17									
LOW TDS*	79	9	715.7	77.6	550.0	880.0	330.0	0.1	-1.0
TDS	79	9	780.8	84.7	600.0	960.0	360.0	0.1	-1.0
HIGH TDS	79	9	845.8	91.8	650.0	1040.0	390.0	0.1	-1.0
CARBONATE	67	21	389.0	29.8	313.6	447.4	133.8	-0.3	0.0
NONCARBONATE	67	21	124.1	57.7	0.0	279.7	279.7	-0.1	0.8
MG HARDNESS	67	21	58.7	35.4	0.0	196.0	196.0	1.0	3.1
CALCIUM	67	21	132.4	13.9	67.6	154.5	87.0	-2.1	7.2
PERCENT MG	62	26	16.0	8.3	0.0	53.8	53.8	1.9	6.8
PERCENT CARBONATE	67	21	68.8	13.5	34.3	100.0	65.7	0.4	1.0
PERCENT NONCARB	62	26	33.8	10.6	4.9	65.7	60.8	0.4	1.4
WATER WELL 18									
LOW TDS*	74	14	711.7	151.6	418.0	1045.0	627.0	0.0	-0.8
TDS	74	14	776.4	165.3	456.0	1140.0	684.0	0.0	-0.8
HIGH TDS	74	14	841.1	179.1	494.0	1235.0	741.0	0.0	-0.8
CARBONATE	65	23	404.5	30.1	313.6	642.5	148.9	-0.9	0.7
NONCARBONATE	65	23	124.1	61.5	0.0	282.5	282.5	-0.4	0.3
MG HARDNESS	65	23	37.2	34.0	0.0	178.9	178.9	1.9	5.2
CALCIUM	65	23	147.2	15.0	91.7	180.8	89.1	-1.5	3.2
PERCENT MG	60	28	9.8	8.2	0.0	43.9	43.9	2.0	6.0
PERCENT CARBONATE	65	23	69.9	14.4	32.0	100.0	68.0	0.5	0.5
PERCENT NONCARB	60	28	32.6	11.9	0.0	68.0	68.0	-0.2	1.4

Table 14. Basic statistics for water quality parameters from PUAG water wells 19 and 20 from well series A.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 19									
CHLORIDE	77	11	263.84	31.85	208.30	380.70	172.40	0.67	1.16
CONDUCTIVITY	77	11	1243.33	122.07	1000.00	1500.00	500.00	0.29	-0.63
PH	75	13	7.29	0.18	6.84	7.90	1.06	0.64	1.83
TURBIDITY	79	9	0.23	0.35	0.07	3.00	2.93	6.95	54.60
T HARDNESS	66	22	321.96	29.67	276.00	433.20	157.20	1.26	2.03
CA HARDNESS	67	21	262.91	22.93	188.00	337.00	149.00	0.42	2.69
M ALKALINITY	67	21	190.81	28.09	131.00	291.00	160.00	0.54	1.55
TEMPERATURE	79	9	27.55	0.50	26.00	78.50	2.50	-0.79	0.38
BACTERIA	56	32	0.32	2.27	0.00	17.00	17.00	7.44	55.59
WATER WELL 20									
CHLORIDE	21	1	95.72	13.65	74.90	115.10	40.20	-0.17	-1.44
CONDUCTIVITY	21	1	779.76	64.62	700.00	1000.00	300.00	2.08	6.14
PH	21	1	7.44	0.30	7.22	8.60	1.38	3.19	11.96
TURBIDITY	21	1	0.36	0.96	0.07	4.50	4.43	4.48	20.27
T HARDNESS	21	1	257.84	9.32	242.90	282.20	39.30	0.87	0.89
CA HARDNESS	21	1	230.60	15.12	199.90	262.40	62.50	-0.15	0.48
M ALKALINITY	21	1	205.54	14.67	181.50	235.00	53.50	-0.11	-0.56
TEMPERATURE	21	1	28.05	0.71	26.80	30.00	3.20	0.95	1.96
BACTERIA	0	22							

Table 14. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 19									
LOW TDS*	77	11	684.1	67.1	550.0	825.0	275.0	0.3	-0.6
TDS	77	11	746.3	73.2	600.0	900.0	300.0	0.3	-0.6
HIGH TDS	77	11	808.5	79.3	650.0	975.0	325.0	0.3	-0.6
CARBONATE	67	21	312.7	37.6	188.0	433.2	245.2	0.1	2.3
NONCARBONATE	67	21	112.3	55.9	0.0	249.2	249.2	-0.6	0.1
MG HARDNESS	67	21	49.8	29.6	0.0	152.4	152.4	0.6	2.6
CALCIUM	67	21	105.8	9.2	75.4	135.1	59.7	0.4	2.7
PERCENT MG	59	29	17.3	6.2	0.0	38.2	38.2	0.5	2.9
PERCENT CARBONATE	67	21	65.5	15.8	42.5	100.0	57.5	1.1	0.4
PERCENT NONCARB	59	29	39.2	9.9	10.0	57.5	47.5	-0.6	0.3
WATER WELL 20									
LOW TDS*	21	1	428.9	35.5	385.0	550.0	165.0	2.1	6.1
TDS	21	1	467.9	38.8	420.0	600.0	180.0	2.1	6.1
HIGH TDS	21	1	506.8	42.0	455.0	650.0	195.0	2.1	6.1
CARBONATE	21	1	257.8	9.3	242.9	282.2	39.3	0.9	0.9
NONCARBONATE	21	1	52.3	15.0	25.2	85.1	59.9	0.2	-0.2
MG HARDNESS	21	1	27.2	14.7	3.8	66.7	62.9	1.1	1.3
CALCIUM	21	1	92.4	6.1	80.1	105.2	25.1	-0.1	0.5
PERCENT MG	21	1	10.5	5.5	1.5	25.0	23.5	1.0	1.1
PERCENT CARBONATE	21	1	79.8	5.6	68.1	89.8	21.8	-0.2	-0.2
PERCENT NONCARB	21	1	20.2	5.6	10.2	31.9	21.8	0.2	-0.2

Table 15. Basic statistics for water quality parameters from PUAC water well 64 from well series A.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 64									
CHLORIDE	4	3	21.40	0.81	20.80	22.60	1.80	1.81	3.48
CONDUCTIVITY	4	3	677.50	51.88	600.00	710.00	110.00	-1.95	3.85
PH	4	3	7.24	0.07	7.19	7.35	0.16	1.70	3.01
TURBIDITY	4	3	0.46	0.50	0.13	1.20	1.07	1.85	3.46
T HARDNESS	4	3	290.12	15.92	271.60	304.90	33.30	-0.34	-3.75
CA HARDNESS	4	3	274.90	14.86	259.60	294.00	34.40	0.62	-0.46
M ALKALINITY	3	4	262.67	13.65	248.00	275.00	27.00	-0.75	
TEMPERATURE	4	3	27.63	0.48	27.00	28.00	1.00	-0.85	-1.29
BACTERIA	4	3	1.75	2.36	0.00	5.00	1.19	1.19	0.44

Table 15. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 64									
LOW TDS*	4	3	372.6	28.5	330.0	390.5	60.5	-1.9	3.8
TDS	4	3	406.5	31.1	360.0	426.0	66.0	-1.9	3.8
HIGH TDS	4	3	440.4	33.7	390.0	461.5	71.5	-1.9	3.8
CARBONATE	4	3	290.1	15.9	271.6	304.9	33.3	-0.3	-3.8
NONCARBONATE	3	4	24.7	29.2	0.0	56.9	56.9	1.1	
MG HARDNESS	4	3	15.2	20.1	3.9	45.3	41.4	2.0	3.8
CALCIUM	4	3	110.2	6.0	104.0	117.8	13.8	0.6	-0.5
PERCENT MG	4	3	5.1	6.6	1.4	14.9	13.5	2.0	3.8
PERCENT CARBONATE	3	4	91.7	9.5	81.3	100.0	18.7	-1.0	
PERCENT NONCARB	3	4	8.3	9.5	0.0	18.7	18.7	1.0	

Table 16. Basic statistics for water quality parameters from PUAG water wells 21 and 22 from well series D.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 21									
CHLORIDE	80	8	57.66	9.23	20.10	75.30	55.20	-0.96	3.60
CONDUCTIVITY	81	7	586.23	59.97	300.00	740.00	440.00	-1.50	6.30
PH	81	7	7.35	0.21	6.85	7.92	1.07	0.33	0.13
TURBIDITY	81	7	0.16	0.10	0.06	0.60	0.54	2.19	5.91
T HARDNESS	69	19	236.14	20.79	187.20	332.80	145.60	1.11	6.31
CA HARDNESS	69	19	195.16	13.20	159.80	237.60	77.80	0.53	2.18
M ALKALINITY	68	20	181.64	25.58	130.00	238.00	108.00	-0.08	-0.65
TEMPERATURE	81	7	26.61	0.55	25.00	28.00	3.00	0.03	0.80
BACTERIA	56	32	0.27	1.87	0.00	14.00	14.00	7.43	55.40
WATER WELL 22									
CHLORIDE	80	8	60.57	9.04	35.90	85.50	49.60	0.60	1.23
CONDUCTIVITY	80	8	585.00	65.51	200.00	760.00	560.00	-2.73	15.11
PH	80	8	7.40	0.17	7.02	7.81	0.79	0.10	0.08
TURBIDITY	80	8	0.22	0.17	0.05	1.00	0.95	2.24	5.99
T HARDNESS	68	20	237.34	21.48	117.40	282.90	165.50	-2.37	13.72
CA HARDNESS	68	20	196.81	13.56	164.60	241.30	76.70	0.12	1.09
M ALKALINITY	67	21	188.21	24.32	114.00	112.00	132.00	-0.75	0.63
TEMPERATURE	80	8	26.62	0.59	25.00	28.00	3.00	0.05	0.80
BACTERIA	56	32	0.11	0.80	0.00	6.00	6.00	7.48	56.00

Table 16. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 21									
LOW TDS*	81	7	322.4	33.0	165.0	407.0	242.0	-1.5	6.3
TDS	81	7	351.7	36.0	180.0	444.0	264.0	-1.5	6.3
HIGH TDS	81	7	381.7	39.0	195.0	481.0	286.0	-1.5	6.3
CARBONATE	69	19	236.3	20.8	187.2	332.8	145.8	1.1	6.3
NONCARBONATE	68	20	54.5	31.3	0.0	120.9	120.9	0.3	-0.7
MG HARDNESS	69	19	41.1	21.1	0.0	124.8	124.8	0.7	2.8
CALCIUM	69	19	78.2	5.3	64.0	95.2	31.2	0.5	2.2
PERCENT MG	69	19	16.9	7.6	0.0	37.5	37.5	-0.2	0.7
PERCENT CARBONATE	68	20	77.4	12.1	51.8	100.0	48.2	-0.1	-0.7
PERCENT NONCARB	68	20	22.6	12.1	0.0	48.2	48.2	0.1	-0.7
WATER WELL 22									
LOW TDS*	80	8	321.7	36.0	110.0	416.0	308.0	-2.7	15.1
TDS	80	8	351.0	39.3	120.0	456.0	336.0	-2.7	15.1
HIGH TDS	80	8	380.2	42.6	130.0	494.0	364.0	-2.7	15.1
CARBONATE	68	20	238.7	16.1	206.0	282.0	76.9	0.4	0.1
NONCARBONATE	67	21	50.5	27.2	0.0	117.3	117.3	0.3	-0.5
MG HARDNESS	68	20	41.9	15.8	0.0	77.6	77.6	-0.3	0.4
CALCIUM	68	20	78.9	5.4	66.0	96.7	30.7	0.1	1.1
PERCENT MG	68	20	17.3	6.0	0.0	31.3	31.3	-0.5	0.9
PERCENT CARBONATE	67	21	79.1	10.8	51.0	100.0	49.0	-0.3	-0.2
PERCENT NONCARB	67	21	20.9	10.8	0.0	49.0	49.0	0.3	-0.2

Table 17. Basic statistics for water quality parameters from PJAC water wells 23 and 24 from well series D.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 23									
CHLORIDE	78	10	37.73	6.24	22.10	65.50	43.40	1.68	6.17
CONDUCTIVITY	79	9	510.82	56.54	300.00	680.00	380.00	-0.60	3.76
PH	79	9	7.35	0.20	6.88	7.90	1.02	0.51	0.49
TURBIDITY	80	8	0.17	0.13	0.05	0.90	0.85	2.97	11.36
T HARDNESS	68	20	225.39	13.87	192.10	261.10	69.00	-0.04	-0.17
CA HARDNESS	69	19	196.40	20.23	119.9	108.9	134.70	-1.80	6.03
M ALKALINITY	68	20	183.51	22.76	125.00	232.00	307.00	-0.57	-0.39
TEMPERATURE	80	8	26.79	0.65	25.40	30.50	5.10	2.30	12.16
BACTERIA	56	32	1.34	3.92	0.00	20.00	20.00	3.45	12.21
WATER WELL 24									
CHLORIDE	80	8	43.54	5.96	33.70	62.30	28.60	1.52	2.44
CONDUCTIVITY	80	8	526.06	60.03	300.00	700.00	400.00	-1.44	5.12
PH	80	8	7.37	0.17	7.00	7.92	0.92	0.35	0.65
TURBIDITY	81	7	0.15	0.09	0.05	0.51	0.46	2.30	5.92
T HARDNESS	67	21	233.42	14.85	199.90	267.80	67.90	0.05	-0.16
CA HARDNESS	70	18	194.44	14.55	137.00	224.60	87.60	-0.63	2.45
M ALKALINITY	69	19	190.23	20.48	129.00	228.00	99.00	-0.44	0.41
TEMPERATURE	81	7	26.69	0.70	25.00	31.00	6.00	2.90	17.88
BACTERIA	57	31	0.75	3.12	0.00	21.00	21.00	5.49	33.26

Table 17. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 23									
LOW TDS*	79	9	281.0	31.1	165.0	374.0	209.0	-0.6	3.8
TDS	79	9	306.5	33.9	180.0	408.0	228.0	-0.6	3.8
HIGH TDS	79	9	332.0	36.8	195.0	442.0	247.0	-0.6	3.8
CARBONATE	69	19	225.1	13.9	192.1	261.1	69.0	-0.0	-0.3
NONCARBONATE	68	20	41.3	23.5	0.0	109.0	109.0	0.3	-0.4
MG HARDNESS	69	19	28.7	15.2	0.0	85.4	85.4	1.1	3.4
CALCIUM	69	19	78.7	7.0	48.1	91.7	43.6	-1.8	6.0
PERCENT MG	68	20	12.9	6.7	0.0	40.0	40.0	1.6	5.6
PERCENT CARBONATE	68	20	81.8	10.2	54.4	100.0	45.6	-0.3	-0.5
PERCENT NONCARB	67	21	18.5	10.0	0.0	45.6	45.6	0.3	-0.4
WATER WELL 24									
LOW TDS*	80	8	289.3	33.0	165.0	385.0	220.0	-1.4	5.1
TDS	80	8	315.6	36.0	180.0	420.0	240.0	-1.4	5.1
HIGH TDS	80	8	341.9	39.0	195.0	455.0	260.0	-1.4	5.1
CARBONATE	70	18	232.0	16.1	184.2	267.8	83.6	-0.2	0.3
NONCARBONATE	69	19	41.4	24.8	0.0	92.1	92.1	0.1	-1.0
MG HARDNESS	70	18	37.6	17.7	0.0	104.0	104.0	0.4	2.2
CALCIUM	70	18	77.9	5.8	54.9	90.0	35.1	-0.6	2.4
PERCENT MG	67	21	16.6	6.4	2.0	43.2	41.2	0.8	3.8
PERCENT CARBONATE	69	19	82.5	10.1	61.5	100.0	38.5	-0.1	-1.0
PERCENT NONCARB	66	22	18.3	9.6	0.0	38.5	38.5	0.1	-1.0

Table 18. Basic statistics for water quality parameters from PUAG water wells 25 and 26 from well series D.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 25									
CHLORIDE	79	9	65.35	8.41	51.00	95.80	44.80	1.68	3.77
CONDUCTIVITY	79	9	575.51	52.31	420.00	680.00	260.00	-0.81	0.75
PH	78	10	7.40	0.15	7.05	7.85	0.80	0.11	0.21
TURBIDITY	81	7	0.17	0.08	0.06	0.45	0.39	1.45	2.32
T HARDNESS	67	21	226.95	15.56	193.60	266.60	73.00	0.25	-0.13
CA HARDNESS	68	20	194.15	13.85	164.80	216.30	51.50	-0.45	-0.16
M ALKALINITY	68	20	175.21	21.66	124.00	240.00	116.00	-0.05	0.67
TEMPERATURE	81	7	26.57	0.56	25.40	28.00	2.60	0.84	0.42
BACTERIA	57	31	8.16	47.95	0.00	347.00	347.00	6.70	46.82
WATER WELL 26									
CHLORIDE	80	8	55.30	8.60	29.10	73.30	44.20	0.23	0.11
CONDUCTIVITY	80	8	537.25	54.43	400.00	680.00	280.00	-0.07	0.42
PH	80	8	7.41	0.17	7.03	7.84	0.81	0.01	0.10
TURBIDITY	81	7	0.19	0.16	0.05	0.89	0.84	2.60	7.55
T HARDNESS	68	20	214.35	18.00	172.30	294.00	121.70	1.22	4.59
CA HARDNESS	69	19	182.25	11.61	156.80	208.00	51.20	0.14	-0.51
M ALKALINITY	68	20	170.37	23.07	126.00	288.00	162.00	1.85	8.94
TEMPERATURE	81	7	26.71	0.62	25.40	30.00	4.60	2.01	8.71
BACTERIA	57	31	0.11	0.67	0.00	5.00	5.00	7.16	52.49

Table 18. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 25									
LOW TDS*	79	9	316.5	28.8	231.0	374.0	143.0	-0.8	0.7
TDS	79	9	345.3	31.4	252.0	408.0	156.0	-0.8	0.7
HIGH TDS	79	9	374.1	34.0	273.0	442.0	169.0	-0.8	0.7
CARBONATE	68	20	226.5	15.7	193.6	266.6	73.0	0.3	-0.2
NONCARBONATE	68	20	49.9	26.3	0.0	106.1	106.1	0.0	-0.6
MG HARDNESS	68	20	32.4	14.4	0.0	64.2	64.2	-0.1	0.3
CALCIUM	68	20	77.8	4.5	66.1	86.7	20.6	-0.4	-0.2
PERCENT MG	66	22	14.5	5.3	0.0	25.9	25.9	-0.2	0.3
PERCENT CARBONATE	68	20	78.3	11.0	56.9	100.0	43.1	0.0	-0.5
PERCENT NONCARB	66	22	22.4	10.4	1.7	43.1	41.4	0.1	-0.5
WATER WELL 26									
LOW TDS*	80	8	295.5	29.9	220.0	374.0	154.0	-0.1	0.4
TDS	80	8	322.3	32.7	240.0	408.0	168.0	-0.1	0.4
HIGH TDS	80	8	349.2	35.4	260.0	442.0	182.0	-0.1	0.4
CARBONATE	69	19	214.1	18.0	172.3	294.0	121.7	1.2	4.5
NONCARBONATE	68	20	44.2	24.4	0.0	125.7	125.7	0.4	0.6
MG HARDNESS	69	19	31.8	15.3	0.0	111.6	111.6	1.9	10.0
CALCIUM	69	19	73.0	4.7	62.8	83.4	20.5	0.1	-0.5
PERCENT MG	68	20	14.8	5.5	3.8	38.0	34.1	0.9	3.7
PERCENT CARBONATE	68	20	79.7	10.2	57.2	100.0	42.8	0.1	-0.7
PERCENT NONCARB	67	21	20.6	10.0	0.0	42.8	42.8	-0.1	-0.7

Table 19. Basic statistics for water quality parameters from PCAG water wells 27 and 28 from well series D.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 27									
CHLORIDE	79	9	54.13	9.60	31.10	83.00	51.90	0.94	1.61
CONDUCTIVITY	79	9	513.86	41.93	400.00	680.00	280.00	0.41	2.66
PH	80	8	7.45	0.17	7.10	8.00	0.90	0.44	0.57
TURBIDITY	81	7	0.22	0.16	0.05	0.97	0.92	2.24	6.28
T HARDNESS	68	20	202.57	16.94	172.30	272.20	99.90	1.14	3.12
CA HARDNESS	69	19	176.62	13.05	131.00	205.80	74.80	-0.64	1.24
M ALKALINITY	68	20	160.97	20.70	112.00	224.00	112.00	0.29	1.03
TEMPERATURE	81	7	26.77	0.45	25.40	28.00	2.60	0.31	1.30
BACTERIA	57	31	0.32	1.35	0.00	9.00	9.00	5.42	32.11
WATER WELL 28									
CHLORIDE	80	8	166.01	39.88	103.70	274.50	170.80	0.95	0.25
CONDUCTIVITY	79	9	819.30	125.25	390.00	1120.00	730.00	-0.29	1.43
PH	80	9	7.50	0.16	7.03	8.00	0.97	-0.04	1.35
TURBIDITY	80	8	0.20	0.14	0.07	1.00	0.93	3.34	14.54
T HARDNESS	68	20	220.035	16.17	176.40	256.80	80.40	-0.04	0.03
CA HARDNESS	69	19	181.10	11.71	159.10	210.00	50.90	0.27	-0.30
M ALKALINITY	68	20	148.99	19.60	103.00	223.00	120.00	0.51	1.96
TEMPERATURE	81	7	26.60	0.51	25.00	28.00	3.00	0.20	1.35
BACTERIA	57	31	0.33	2.00	0.00	15.00	15.00	7.27	53.99

Table 19. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 27									
LOW TDS*	79	9	282.6	23.1	220.0	374.0	154.0	0.4	2.7
TDS	79	9	308.3	25.2	240.0	408.0	168.0	0.4	2.7
HIGH TDS	79	9	334.0	27.3	260.0	442.0	182.0	0.4	2.7
CARBONATE	69	19	202.6	16.7	172.3	272.2	99.9	1.2	3.3
NONCARBONATE	68	20	41.7	22.0	0.0	87.2	87.2	-0.1	-0.8
MG HARDNESS	69	19	25.9	17.9	0.0	100.0	100.0	1.9	5.4
CALCIUM	69	19	70.8	5.2	52.5	82.5	30.0	-0.6	1.2
PERCENT MG	68	20	12.6	7.5	0.0	43.3	43.3	1.5	4.1
PERCENT CARBONATE	68	20	79.7	10.3	57.3	100.0	42.7	0.2	-0.7
PERCENT NONCARB	67	21	20.6	10.0	0.0	42.7	42.7	-0.1	-0.7
WATER WELL 28									
LOW TDS*	79	9	450.6	68.9	214.5	616.0	401.5	-0.3	1.4
TDS	79	9	491.6	75.2	234.0	672.0	438.0	-0.3	1.4
HIGH TDS	79	9	532.5	81.4	253.5	728.0	474.5	-0.3	1.4
CARBONATE	69	19	220.1	16.3	176.4	256.8	80.4	-0.1	0.1
NONCARBONATE	68	20	70.6	24.9	0.0	131.5	131.5	-0.3	1.0
MG HARDNESS	69	19	39.0	14.4	0.0	66.6	66.6	-0.6	0.6
CALCIUM	69	19	72.6	4.7	63.8	84.2	20.4	0.3	-0.3
PERCENT MG	68	20	17.7	5.5	0.0	27.9	27.9	-0.8	1.0
PERCENT CARBONATE	68	20	68.3	10.2	46.4	100.0	53.6	0.6	1.6
PERCENT NONCARB	67	21	32.2	9.5	0.0	53.6	53.6	-0.3	1.2

Table 20. Basic statistics for water quality parameters from PCAG water wells 29 and 30 from well series D.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 29									
CHLORIDE	77	11	119.94	23.23	87.30	209.80	122.50	1.83	4.25
CONDUCTIVITY	77	11	733.96	96.13	390.00	900.00	510.00	-1.43	2.69
PH	77	11	7.42	0.16	7.05	7.89	0.84	0.14	0.19
TURBIDITY	78	10	0.23	0.31	0.06	2.80	2.74	7.43	61.39
T HARDNESS	65	23	243.31	23.05	187.70	299.30	111.60	-0.07	-0.00
CA HARDNESS	66	22	191.85	13.81	164.80	226.80	62.00	0.37	-0.45
M ALKALINITY	66	22	178.67	25.56	120.00	257.00	137.00	0.37	1.32
TEMPERATURE	78	10	26.69	0.53	25.00	28.00	3.00	0.05	1.44
BACTERIA	54	34	1.41	6.11	0.00	42.00	42.00	5.94	38.33
WATER WELL 30									
CHLORIDE	79	9	39.77	6.51	26.30	67.50	41.20	1.77	4.73
CONDUCTIVITY	79	9	493.29	71.19	300.00	840.00	540.00	2.05	11.09
PH	80	8	7.47	0.17	7.10	7.91	0.81	0.18	0.12
TURBIDITY	81	7	0.19	0.26	0.05	1.80	1.75	4.80	24.87
T HARDNESS	68	20	208.04	17.81	180.00	265.40	85.40	1.19	1.70
CA HARDNESS	69	19	182.16	11.16	163.00	224.60	61.60	0.77	1.64
M ALKALINITY	68	20	165.53	21.41	119.00	230.00	111.00	0.38	0.44
TEMPERATURE	81	7	26.69	0.50	25.00	28.00	3.00	-0.00	1.65
BACTERIA	57	31	0.04	0.19	0.00	1.00	1.00	5.19	25.85

Table 20. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 29									
LOW TDS*	77	11	403.7	52.9	214.5	495.0	280.5	-1.4	2.7
TDS	77	11	440.4	57.7	234.0	540.0	306.0	-1.4	2.7
HIGH TDS	77	11	477.1	62.5	253.5	585.0	331.5	-1.4	2.7
CARBONATE	66	22	243.4	22.3	187.7	299.3	111.6	0.1	-0.2
NONCARBONATE	66	22	64.1	32.0	0.0	150.4	150.4	0.1	-0.4
MG HARDNESS	66	22	51.5	23.4	0.0	122.6	122.6	0.1	1.5
CALCIUM	66	22	76.9	5.5	66.1	90.9	24.8	0.4	-0.4
PERCENT MG	65	23	20.9	7.9	0.0	41.0	41.0	-0.6	1.7
PERCENT CARBONATE	66	22	74.2	11.8	45.8	100.0	54.2	0.2	-0.6
PERCENT NONCARB	65	23	26.2	11.4	0.0	54.2	54.2	-0.2	-0.6
WATER WELL 30									
LOW TDS*	79	9	271.3	39.2	165.0	462.0	297.0	2.1	11.1
TDS	79	9	296.0	42.7	180.0	504.0	324.0	2.1	11.1
HIGH TDS	79	9	320.6	46.3	195.0	546.0	351.0	2.1	11.1
CARBONATE	69	19	208.3	17.8	180.0	265.4	85.4	1.1	1.6
NONCARBONATE	68	20	42.4	24.8	0.0	103.4	103.4	0.1	-0.7
MG HARDNESS	69	19	26.1	14.5	0.0	68.5	68.5	0.7	0.9
CALCIUM	69	19	73.0	4.5	65.3	90.0	24.7	0.8	1.6
PERCENT MG	68	20	12.4	5.7	0.0	25.8	25.8	0.1	0.0
PERCENT CARBONATE	68	20	80.0	11.1	61.0	100.0	39.0	0.2	-1.0
PERCENT NONCARB	67	21	20.3	10.9	0.0	39.0	39.0	-0.2	-1.0

Table 21. Basic statistics for water quality parameters from PUAC water wells 31 and 32 from well series D.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 31									
CHLORIDE	79	9	75.38	16.12	33.00	93.30	60.30	-1.09	0.27
CONDUCTIVITY	79	9	599.62	78.63	400.00	800.00	400.00	-0.55	0.28
PH	79	9	7.41	0.18	7.03	7.90	0.87	0.17	0.01
TURBIDITY	80	8	0.19	0.19	0.06	1.40	1.34	4.30	22.63
T HARDNESS	67	21	225.69	15.27	192.10	261.80	69.70	0.13	-0.54
CA HARDNESS	67	21	192.05	12.91	163.00	239.40	76.40	0.65	1.89
M ALKALINITY	67	21	175.99	22.84	119.00	244.00	125.00	0.08	0.86
TEMPERATURE	80	8	26.61	0.52	25.40	28.00	2.60	0.73	0.56
BACTERIA	56	32	0.00	0.00	0.00	0.00	0.00		
WATER WELL 32									
CHLORIDE	78	10	20.22	4.65	12.00	36.00	24.00	0.78	14.14
CONDUCTIVITY	78	10	377.95	42.07	220.00	470.00	250.00	-0.81	2.46
PH	78	10	7.48	0.16	7.06	7.96	0.90	-0.04	0.85
TURBIDITY	79	9	0.15	0.08	0.05	0.42	0.37	1.74	3.37
T HARDNESS	66	22	183.06	25.80	152.80	286.80	134.00	2.24	5.64
CA HARDNESS	67	21	162.49	13.79	121.50	220.50	99.00	0.99	5.09
M ALKALINITY	66	22	144.56	19.12	102.00	216.00	114.00	0.65	2.11
TEMPERATURE	80	8	26.65	0.51	25.00	28.00	3.00	0.02	1.46
BACTERIA	55	33	0.25	0.89	0.00	4.00	4.00	3.61	12.25

Table 21. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 31									
LOW TDS*	79	9	329.8	43.2	220.0	440.0	220.0	-0.5	0.3
TDS	79	9	359.8	47.2	2400.0	480.0	240.0	-0.5	0.3
HIGH TDS	79	9	389.8	51.1	260.0	520.0	260.0	-0.5	0.3
CARBONATE	67	21	225.4	15.4	192.1	261.8	69.7	0.1	-0.5
NONCARBONATE	67	21	49.2	22.6	0.0	111.9	111.9	0.0	0.2
MG HARDNESS	67	21	33.4	15.9	0.0	74.4	74.4	0.2	0.8
CALCIUM	67	21	77.0	5.2	65.3	96.0	30.6	0.6	1.9
PERCENT MG	66	22	14.8	6.2	0.0	29.8	29.8	-0.1	0.8
PERCENT CARBONATE	67	21	78.3	9.7	54.1	100.0	45.9	0.0	0.1
PERCENT NONCARB	66	22	22.0	9.4	0.0	45.9	45.9	0.0	0.1
WATER WELL 32									
LOW TDS*	78	10	207.9	23.1	121.0	258.5	137.5	-0.8	2.5
TDS	78	10	226.8	25.2	132.0	282.0	150.0	-0.8	2.5
HIGH TDS	78	10	245.7	27.3	143.0	305.5	162.5	-0.8	2.5
CARBONATE	67	21	183.2	25.6	152.8	286.8	134.0	2.3	5.8
NONCARBONATE	66	22	39.2	32.0	0.0	145.4	145.4	1.4	2.3
MG HARDNESS	67	21	20.7	25.7	0.0	152.9	152.9	3.5	14.5
CALCIUM	67	21	65.1	5.5	48.7	88.4	39.7	1.0	5.1
PERCENT MG	66	22	10.4	9.6	0.0	55.7	55.7	2.5	9.0
PERCENT CARBONATE	66	22	79.9	13.5	47.0	100.0	53.0	-0.4	-0.3
PERCENT NONCARB	65	23	20.4	13.3	0.0	53.0	53.0	0.4	-0.3

Table 22. Basic statistics for water quality parameters from PCAC water wells 33 and 34 from well series D.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 33									
CHLORIDE	78	10	215.12	90.68	110.00	399.00	289.00	0.70	-1.06
CONDUCTIVITY	78	10	966.67	302.25	500.00	1800.00	1300.00	0.85	-0.32
PH	77	11	7.51	0.16	7.06	8.06	1.00	-0.01	1.55
TURBIDITY	79	9	0.28	0.29	0.06	2.20	2.14	4.10	23.52
T HARDNESS	66	22	235.83	36.25	184.20	329.60	145.40	0.57	-0.67
CA HARDNESS	67	21	187.78	22.28	125.40	278.30	152.90	0.76	3.67
M ALKALINITY	66	22	145.97	19.33	107.00	223.00	116.00	1.05	3.65
TEMPERATURE	79	9	26.65	0.49	25.40	28.00	2.60	0.67	0.93
BACTERIA	55	33	0.00	0.00	0.00	0.00	0.00		
WATER WELL 34									
CHLORIDE	79	9	36.69	6.66	21.80	57.00	32.20	0.67	1.35
CONDUCTIVITY	79	9	542.90	67.44	360.00	850.00	490.00	2.18	9.40
PH	78	10	7.36	0.20	6.94	8.90	1.32	1.12	4.29
TURBIDITY	80	8	0.18	0.19	0.05	1.00	0.95	3.16	10.11
T HARDNESS	67	21	233.77	16.70	203.80	273.90	70.10	0.62	-0.27
CA HARDNESS	68	20	211.23	17.08	146.90	262.10	115.20	-0.76	2.94
M ALKALINITY	67	21	186.29	20.81	130.00	226.00	96.00	-0.37	-0.04
TEMPERATURE	79	9	26.92	0.52	25.00	28.00	3.00	-0.63	2.36
BACTERIA	57	31	0.89	5.47	0.00	41.00	41.00	7.29	54.17

Table 22. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 33									
LOW TDS*	78	10	531.7	166.2	275.0	990.0	715.0	0.9	-0.3
TDS	78	10	580.0	181.3	300.0	1080.0	780.0	0.9	-0.3
HIGH TDS	78	10	628.3	196.5	325.0	1170.0	845.0	0.9	-0.3
CARBONATE	67	21	236.3	36.2	184.2	329.6	145.4	0.6	-0.7
NONCARBONATE	66	22	88.4	46.3	0.0	191.6	191.6	0.3	-0.7
MG HARDNESS	67	21	48.5	29.9	0.0	132.7	132.7	0.4	-0.3
CALCIUM	67	21	75.3	8.9	50.3	111.5	61.3	0.8	3.7
PERCENT MG	66	22	19.9	9.8	0.0	40.3	40.3	-0.3	-0.5
PERCENT CARBONATE	66	22	64.2	14.4	39.0	100.0	61.0	0.3	-0.0
PERCENT NONCARB	65	23	36.4	13.8	0.0	61.0	61.0	-0.2	-0.1
WATER WELL 34									
LOW TDS*	79	9	298.6	37.1	198.0	467.5	269.5	2.2	9.4
TDS	79	9	325.7	40.5	216.0	510.0	294.0	2.2	9.4
HIGH TDS	79	9	352.9	43.8	234.0	552.5	318.5	2.2	9.4
CARBONATE	68	20	233.9	16.9	203.8	273.9	70.1	0.6	-0.3
NONCARBONATE	67	21	46.6	25.8	0.0	95.9	95.9	-0.1	-0.9
MG HARDNESS	68	20	22.7	16.0	0.0	74.3	74.3	0.9	1.2
CALCIUM	68	20	84.7	6.8	58.9	105.1	46.2	-0.8	2.9
PERCENT MG	67	21	9.7	6.5	0.0	31.6	31.6	0.9	1.4
PERCENT CARBONATE	67	21	80.4	10.4	60.3	100.0	39.7	0.2	-0.8
PERCENT NONCARB	66	22	19.9	10.2	0.0	39.7	39.7	-0.2	-0.7

Table 23. Basic statistics for water quality parameters from PUAC water wells 35 and 65 from well series D.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 35									
CHLORIDE	78	10	78.62	18.81	13.40	139.90	126.50	0.34	2.80
CONDUCTIVITY	78	10	655.45	62.67	450.00	800.00	350.00	-0.34	1.02
PH	77	11	7.39	0.18	7.05	7.84	0.79	0.16	-0.47
TURBIDITY	79	9	0.15	0.10	0.05	0.65	0.60	3.01	12.16
T HARDNESS	66	22	246.65	19.00	198.70	282.50	83.80	-0.02	-0.50
CA HARDNESS	67	21	208.37	13.93	160.00	243.00	83.00	-0.35	1.64
M ALKALINITY	66	22	193.60	22.38	132.00	236.00	104.00	-0.57	0.31
TEMPERATURE	79	9	26.66	0.50	25.00	28.00	3.00	-0.09	1.64
BACTERIA	55	33	0.00	0.00	0.00	0.00	0.00		
WATER WELL 65									
CHLORIDE	63	25	65.98	19.75	27.40	105.60	78.20	-0.12	-0.63
CONDUCTIVITY	63	25	610.73	103.68	300.00	780.00	480.00	-0.71	-0.14
PH	62	26	7.31	0.23	0.06	0.90	0.84	2.66	7.51
TURBIDITY	51	37	0.21	0.17	0.06	0.90	0.84	2.66	7.51
T HARDNESS	51	37	241.91	37.36	180.20	363.70	183.50	0.13	0.74
CA HARDNESS	39	49	225.42	18.08	164.60	246.20	81.60	-1.86	3.66
M ALKALINITY	38	50	203.06	23.92	139.00	256.00	117.00	-0.08	0.58
TEMPERATURE	51	37	26.61	0.38	25.40	28.00	2.60	0.24	3.81
BACTERIA	47	41	0.09	0.35	0.00	2.00	2.00	4.49	21.09

Table 23. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 35									
LOW TDS*	78	10	360.5	34.5	247.5	440.0	192.5	-0.3	1.0
TDS	78	10	393.3	37.6	270.0	480.0	210.0	-0.3	1.0
HIGH TDS	78	10	426.0	40.7	292.5	520.0	227.5	-0.3	1.0
CARBONATE	67	21	246.6	16.5	207.8	282.5	74.7	0.1	-0.8
NONCARBONATE	66	22	52.3	29.8	0.0	109.5	109.5	0.1	-1.0
MG HARDNESS	67	21	38.3	17.6	0.0	68.5	68.5	-0.5	-0.2
CALCIUM	67	21	83.5	5.6	64.1	97.4	33.3	-0.3	1.6
PERCENT MG	66	22	15.5	6.4	0.0	27.3	27.3	-0.7	0.4
PERCENT CARBONATE	66	22	79.3	11.3	56.9	100.0	43.1	-0.0	-0.9
PERCENT NONCARB	65	23	21.1	11.1	0.9	43.1	42.3	0.0	-0.9
WATER WELL 65									
LOW TDS*	63	25	335.9	57.0	165.0	429.0	264.0	-0.7	-0.1
TDS	63	25	366.4	62.2	180.0	468.0	288.0	-0.7	-0.1
HIGH TDS	63	25	397.0	67.4	195.0	507.0	312.0	-0.7	-0.1
CARBONATE	39	49	257.3	29.2	164.6	363.7	199.1	-0.0	6.7
NONCARBONATE	38	50	52.6	31.8	0.0	147.7	147.7	0.5	0.8
MG HARDNESS	39	49	31.9	21.1	0.0	133.0	133.0	2.7	13.8
CALCIUM	39	49	90.3	7.2	66.0	98.7	32.7	-1.9	3.9
PERCENT MG	37	51	12.5	5.8	0.0	36.6	36.6	1.7	7.9
PERCENT CARBONATE	38	50	80.3	10.6	59.4	100.0	40.6	0.2	-0.6
PERCENT NONCARB	36	52	20.8	9.7	1.0	40.6	39.6	-0.1	-0.5

Table 24. Basic statistics for water quality parameters from PUAC water wells 66 and 67 from well series D.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 66									
CHLORIDE	46	6	45.30	15.51	15.90	79.40	63.50	0.04	-0.33
CONDUCTIVITY	46	6	583.54	59.39	408.00	700.00	292.00	-0.75	0.36
PH	45	7	7.18	0.17	6.90	7.62	0.72	0.49	-0.14
TURBIDITY	46	6	0.16	0.06	0.06	0.32	0.26	0.59	-0.40
T HARDNESS	35	17	259.81	13.26	229.00	290.40	61.40	0.06	-0.05
CA HARDNESS	35	17	238.02	14.97	179.90	259.20	79.30	-1.94	5.96
M ALKALINITY	34	18	213.32	28.17	102.00	259.00	157.00	-1.60	6.45
TEMPERATURE	46	6	26.69	0.38	26.00	28.00	2.00	0.53	1.75
BACTERIA	45	7	0.09	0.60	0.00	4.00	4.00	6.71	45.00
WATER WELL 67									
CHLORIDE	32	3	67.58	9.98	57.90	96.00	38.10	1.63	1.78
CONDUCTIVITY	32	3	631.25	58.57	400.00	700.00	300.00	-2.00	6.89
PH	32	3	7.18	0.13	6.96	7.45	0.49	0.22	-0.58
TURBIDITY	32	3	0.17	0.10	0.07	0.44	0.37	1.20	0.43
T HARDNESS	21	14	257.23	14.04	218.40	276.50	58.10	-1.00	1.35
CA HARDNESS	21	14	227.28	12.54	195.50	250.90	55.40	-0.58	1.10
M ALKALINITY	20	15	209.70	23.77	176.00	270.00	94.00	0.78	0.48
TEMPERATURE	32	3	26.72	0.24	26.30	27.00	0.70	-0.18	-1.52
BACTERIA	32	3	1.16	5.70	0.00	32.00	32.00	5.46	30.33

Table 24. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 66									
LOW TDS*	46	6	320.9	32.7	224.4	385.0	160.6	-0.7	0.4
TDS	46	6	350.1	35.6	244.8	420.0	175.2	-0.7	0.4
HIGH TDS	46	6	379.3	38.6	265.2	455.0	189.8	-0.7	0.4
CARBONATE	35	17	259.8	13.3	229.0	290.4	61.4	0.1	-0.1
NONCARBONATE	34	18	46.9	29.1	0.0	151.7	151.7	1.2	3.8
MG HARDNESS	35	17	21.8	17.9	0.0	81.2	81.2	2.0	4.4
CALCIUM	35	17	95.4	6.0	72.1	103.9	31.8	-1.9	6.0
PERCENT MG	35	17	8.2	6.5	0.0	31.1	31.1	2.0	4.9
PERCENT CARBONATE	34	18	82.1	11.1	40.2	100.0	59.8	-1.4	5.1
PERCENT NONCARB	34	18	17.9	11.1	0.0	59.8	59.8	1.4	5.1
WATER WELL 67									
LOW TDS*	32	3	347.2	32.2	220.0	385.0	165.0	-2.0	6.9
TDS	32	3	378.7	35.1	240.0	420.0	180.0	-2.0	6.9
HIGH TDS	32	3	410.3	38.1	260.0	455.0	195.0	-2.0	6.9
CARBONATE	21	14	257.6	13.4	222.5	276.5	54.0	-0.9	0.8
NONCARBONATE	20	15	48.0	25.9	4.4	86.1	81.7	-0.1	-1.2
MG HARDNESS	21	14	30.3	16.7	0.0	74.9	74.9	0.5	1.8
CALCIUM	21	14	91.1	5.0	78.4	100.6	22.2	-0.6	1.1
PERCENT MG	21	14	11.6	6.2	0.0	27.7	27.7	0.4	1.8
PERCENT CARBONATE	20	15	81.5	9.6	67.1	98.4	31.2	0.2	-1.2
PERCENT NONCARB	20	15	18.5	9.6	1.6	32.9	31.2	-0.2	-1.2

Table 25. Basic statistics for water quality parameters from PUAC water wells 36 and 37 from well series M.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 36									
CHLORIDE	78	10	156.96	29.46	103.50	238.70	135.20	0.82	0.75
CONDUCTIVITY	78	10	885.90	119.65	560.00	1200.00	640.00	0.08	0.55
PH	78	10	7.49	0.21	6.96	8.10	1.14	-0.09	0.59
TURBIDITY	80	8	0.19	0.19	0.05	1.09	1.04	3.53	12.89
T HARDNESS	66	22	252.63	21.50	196.00	328.00	132.00	0.21	1.59
CA HARDNESS	67	21	172.83	21.73	141.70	237.10	95.40	1.20	0.99
M ALKALINITY	67	21	180.14	26.41	104.50	242.00	137.50	-0.22	0.18
TEMPERATURE	79	9	26.91	0.46	26.00	28.00	2.00	0.57	0.51
BACTERIA	57	31	0.40	1.41	0.00	8.00	8.00	3.89	16.20
WATER WELL 37									
CHLORIDE	79	9	67.99	11.01	31.80	87.40	55.60	-0.88	0.86
CONDUCTIVITY	78	10	616.26	65.09	440.00	900.00	460.00	0.78	4.76
PH	78	10	7.53	0.18	7.09	8.20	1.11	0.44	1.70
TURBIDITY	78	10	0.26	0.22	0.06	1.30	1.24	3.17	11.17
T HARDNESS	67	21	228.16	20.20	184.20	285.10	100.90	0.43	0.19
CA HARDNESS	67	21	165.07	16.18	125.4	220.30	94.9	0.65	1.77
M ALKALINITY	66	22	177.05	22.51	124.00	216.00	92.00	-0.31	-0.45
TEMPERATURE	78	10	26.90	0.45	26.00	28.20	2.20	0.63	1.16
BACTERIA	56	32	0.45	1.62	0.00	8.00	8.00	4.10	16.74

Table 25. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 36									
LOW TDS*	78	10	487.2	65.8	308.0	660.0	352.0	0.1	0.5
TDS	78	10	531.5	71.8	336.0	720.0	384.0	0.1	0.5
HIGH TDS	78	10	575.8	77.8	364.0	780.0	416.0	0.1	0.5
CARBONATE	67	21	248.7	24.8	157.1	283.8	126.7	-1.5	3.5
NONCARBONATE	67	21	70.7	34.1	0.0	169.9	169.9	-0.1	0.1
MG HARDNESS	67	21	75.9	29.5	0.0	121.5	121.5	-1.0	0.4
CALCIUM	67	21	69.3	8.7	56.8	95.0	38.2	1.2	1.0
PERCENT MG	65	23	30.8	9.6	2.0	43.1	41.0	-1.3	1.1
PERCENT CARBONATE	67	21	72.4	12.6	38.1	100.0	61.9	0.3	0.0
PERCENT NONCARB	65	23	28.4	11.8	0.0	61.9	61.9	-0.2	0.1
WATER WELL 37									
LOW TDS*	78	10	339.0	35.8	242.0	495.0	253.0	0.8	4.8
TDS	78	10	369.8	39.1	264.0	540.0	276.0	0.8	4.8
HIGH TDS	78	10	400.6	42.3	286.0	585.0	299.0	0.8	4.8
CARBONATE	67	21	228.2	20.2	184.2	285.1	100.9	0.4	0.2
NONCARBONATE	66	22	51.3	29.1	0.0	119.2	119.2	0.1	-0.9
MG HARDNESS	67	21	63.1	21.2	11.8	111.3	99.5	-0.3	0.2
CALCIUM	67	21	66.2	6.5	50.3	88.3	38.0	0.7	1.8
PERCENT MG	67	21	27.3	7.9	5.6	40.8	35.2	-0.9	0.7
PERCENT CARBONATE	66	22	78.0	11.6	57.2	100.0	42.8	0.0	-1.0
PERCENT NONCARB	66	22	22.0	11.6	0.0	42.8	42.8	-0.0	-1.0

Table 26. Basic statistics for water quality parameters from PVAG water wells 38 and 39 from well series M.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 38									
CHLORIDE	80	8	22.88	4.10	16.10	33.80	17.70	0.47	-0.36
CONDUCTIVITY	80	8	463.25	49.24	330.00	680.00	350.00	1.35	5.16
PH	80	8	7.46	0.20	7.03	8.20	1.17	0.55	2.01
TURBIDITY	79	9	0.17	0.18	0.05	1.50	1.45	5.68	38.60
T HARDNESS	68	20	214.41	19.26	183.00	276.50	93.50	1.14	1.60
CA HARDNESS	68	20	168.35	15.51	117.60	207.40	89.80	0.04	1.01
M ALKALINITY	67	21	175.58	24.56	112.00	226.00	114.00	-0.54	0.28
TEMPERATURE	79	9	26.80	0.43	26.00	28.00	2.00	0.48	0.93
BACTERIA	57	31	17.67	132.17	0.00	998.00	998.00	7.55	56.99
WATER WELL 39									
CHLORIDE	80	8	20.53	4.31	11.90	37.10	25.20	0.64	1.98
CONDUCTIVITY	80	8	444.69	34.45	350.00	540.00	190.00	-0.18	-0.91
PH	80	8	7.51	0.16	7.15	7.91	0.76	0.04	-0.04
TURBIDITY	79	9	0.17	0.12	0.05	0.55	0.50	1.82	2.82
T HARDNESS	68	20	212.18	18.81	168.00	258.00	90.00	0.20	-0.20
CA HARDNESS	68	20	180.33	17.13	137.20	223.40	86.20	-0.07	0.46
M ALKALINITY	67	21	176.24	23.36	128.00	270.00	142.00	0.69	2.73
TEMPERATURE	79	9	26.82	0.43	26.00	28.10	2.10	0.47	1.05
BACTERIA	57	31	0.14	1.06	0.00	8.00	8.00	7.55	57.00

Table 26. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 38									
LOW TDS*	80	8	254.8	27.1	181.5	374.0	192.5	1.3	5.2
TDS	80	8	277.9	29.5	198.0	408.0	210.0	1.3	5.2
HIGH TDS	80	8	301.1	32.0	214.5	442.0	227.5	1.3	5.2
CARBONATE	68	20	214.4	19.3	183.0	276.5	93.5	1.1	1.6
NONCARBONATE	67	21	39.7	28.2	0.0	116.5	116.5	0.6	-0.1
MG HARDNESS	68	20	46.1	16.6	8.3	95.1	86.8	0.5	1.2
CALCIUM	68	20	67.5	6.2	47.1	83.1	36.0	0.0	1.0
PERCENT MG	68	20	21.2	6.7	4.5	41.2	36.6	0.1	0.9
PERCENT CARBONATE	67	21	81.9	12.1	51.4	100.0	48.6	-0.4	-0.5
PERCENT NONCARB	67	21	18.1	12.1	0.0	48.6	48.6	0.4	-0.5
WATER WELL 39									
LOW TDS*	80	8	244.6	18.9	192.5	297.0	104.5	-0.2	0.9
TDS	80	8	266.8	20.7	210.0	324.0	114.0	-0.2	0.9
HIGH TDS	80	8	289.0	22.4	227.5	351.0	123.5	-0.2	0.9
CARBONATE	68	20	212.2	18.8	168.0	258.0	90.0	0.2	-0.2
NONCARBONATE	67	21	37.0	22.5	0.0	80.6	80.6	0.0	-1.1
MG HARDNESS	68	20	31.8	13.0	3.9	66.6	62.7	0.5	0.7
CALCIUM	68	20	72.3	6.9	55.0	89.5	34.5	-0.1	0.5
PERCENT MG	68	20	14.9	5.6	2.0	32.7	30.6	0.5	1.1
PERCENT CARBONATE	67	21	82.9	10.0	62.8	100.0	37.2	0.0	-1.1
PERCENT NONCARB	67	21	17.1	10.0	0.0	37.2	37.2	-0.0	-1.1

Table 27. Basic statistics for water quality parameters from PCAC water wells 40 and 41 from well series M.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 40									
CHLORIDE	79	9	41.53	6.92	28.20	65.50	37.30	0.59	1.16
CONDUCTIVITY	79	9	523.10	55.36	200.00	620.00	420.00	-2.84	14.65
PH	79	9	7.35	0.18	7.01	7.90	0.89	0.15	0.12
TURBIDITY	78	10	0.17	0.19	0.05	1.40	1.35	4.69	25.81
T HARDNESS	67	21	232.34	22.84	199.90	352.80	152.90	2.40	10.70
CA HARDNESS	67	21	192.47	15.24	133.30	224.60	91.30	-1.23	4.04
M ALKALINITY	66	22	185.26	24.71	121.00	229.00	108.00	-0.45	-0.10
TEMPERATURE	78	10	26.86	0.41	26.00	28.00	2.00	0.57	0.08
BACTERIA	54	34	2.81	11.60	0.00	80.00	80.00	5.95	38.59
WATER WELL 41									
CHLORIDE	80	8	55.46	12.56	29.20	81.40	52.20	-0.06	-0.92
CONDUCTIVITY	80	8	564.88	61.31	420.00	800.00	380.00	0.27	1.65
PH	80	8	7.40	0.17	7.07	8.10	1.03	0.76	2.81
TURBIDITY	79	9	0.16	0.13	0.06	1.00	0.94	4.21	23.50
T HARDNESS	68	20	226.90	16.14	196.00	280.80	84.80	1.11	2.05
CA HARDNESS	68	20	198.92	14.83	172.00	250.90	78.90	1.21	2.06
M ALKALINITY	67	21	176.24	20.13	121.00	213.00	92.00	-0.46	-0.16
TEMPERATURE	80	8	26.88	0.58	26.00	30.60	4.60	3.63	21.18
BACTERIA	57	31	2.25	8.29	0.00	49.00	49.00	4.68	22.65

Table 27. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 40									
LOW TDS*	79	9	287.7	30.4	110.0	341.0	231.0	-2.8	14.7
TDS	79	9	313.9	33.2	120.0	372.0	252.0	-2.8	14.7
HIGH TDS	79	9	340.0	36.0	130.0	403.0	273.0	-2.8	14.7
CARBONATE	67	21	232.4	22.8	199.9	352.8	152.9	2.4	10.8
NONCARBONATE	66	22	47.0	31.0	0.0	160.8	160.8	0.9	1.5
MG HARDNESS	67	21	39.9	22.9	0.0	164.6	164.6	2.6	12.7
CALCIUM	67	21	77.1	6.1	53.4	90.0	36.6	-1.2	4.0
PERCENT MG	67	21	16.7	7.8	0.0	46.7	46.7	1.2	3.5
PERCENT CARBONATE	66	22	80.3	11.8	53.7	100.0	46.3	-0.2	-0.7
PERCENT NONCARB	66	22	19.7	11.8	0.0	46.3	46.3	0.2	-0.7
WATER WELL 41									
LOW TDS*	80	8	310.7	33.7	231.0	440.0	209.0	0.3	1.6
TDS	80	8	338.9	36.8	252.0	480.0	228.0	0.3	1.6
HIGH TDS	80	8	367.2	39.9	273.0	520.0	247.0	0.3	1.6
CARBONATE	68	20	226.9	16.1	196.0	280.8	84.8	1.1	2.1
NONCARBONATE	67	21	50.1	24.8	0.0	119.3	119.3	0.4	-0.3
MG HARDNESS	68	20	28.1	11.9	0.0	54.8	54.8	-0.2	-0.2
CALCIUM	68	20	79.7	5.9	68.9	100.6	31.6	1.2	2.1
PERCENT MG	68	20	12.3	4.9	0.0	20.9	20.9	-0.5	-0.2
PERCENT CARBONATE	67	21	78.2	10.1	54.2	100.0	45.8	-0.2	-0.5
PERCENT NONCARB	67	21	21.8	10.1	0.0	45.8	45.8	0.2	-0.5

Table 28. Basic statistics for water quality parameters from POAG water wells 42 and 43 from well series M.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 42									
CHLORIDE	81	7	35.44	6.82	25.40	63.50	38.10	1.78	4.56
CONDUCTIVITY	81	7	508.02	47.55	350.00	700.00	350.00	-0.06	4.80
PH	81	7	7.37	0.21	7.02	8.10	1.08	0.83	1.50
TURBIDITY	80	8	0.17	0.21	0.06	1.90	1.84	7.28	59.25
T HARDNESS	69	19	226.96	22.15	172.30	311.00	138.70	1.09	2.67
CA HARDNESS	69	19	191.58	16.18	149.80	241.90	92.10	-0.39	1.34
M ALKALINITY	68	20	183.81	22.30	130.00	235.00	105.00	-0.40	-0.16
TEMPERATURE	81	7	26.80	0.45	26.00	28.00	2.00	0.43	0.36
BACTERIA	57	31	1.16	3.30	0.00	20.00	20.00	4.05	19.41
WATER WELL 43									
CHLORIDE	81	7	21.28	4.54	13.70	42.30	28.60	1.81	6.44
CONDUCTIVITY	81	7	430.25	41.86	300.00	540.00	240.00	-0.21	0.86
PH	81	7	7.59	0.15	7.28	8.13	0.85	0.49	1.18
TURBIDITY	81	7	0.17	0.16	0.05	0.90	0.85	3.52	13.19
T HARDNESS	69	19	200.53	17.28	156.80	252.50	95.70	0.73	1.67
CA HARDNESS	68	20	153.51	15.93	113.70	209.70	96.00	0.82	2.17
M ALKALINITY	68	20	164.68	20.03	119.00	220.00	101.00	-0.04	-0.07
TEMPERATURE	81	7	26.85	0.51	26.00	29.00	3.00	1.54	4.10
BACTERIA	57	31	17.63	132.17	0.00	998.00	998.00	7.55	57.00

Table 28. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 42									
LOW TDS*	81	7	279.4	26.2	192.5	385.0	192.5	-0.1	4.8
TDS	81	7	304.8	28.5	210.5	420.0	210.0	-0.1	4.8
HIGH TDS	81	7	330.2	30.9	227.5	455.0	227.5	-0.1	4.8
CARBONATE	69	19	227.0	22.1	172.3	311.0	138.7	1.1	2.7
NONCARBONATE	68	20	43.8	26.6	0.0	127.0	127.0	0.5	-0.0
MG HARDNESS	69	19	35.4	20.7	3.7	116.6	112.9	1.5	3.1
CALCIUM	69	19	76.8	6.5	60.0	97.0	36.9	-0.4	1.3
PERCENT MG	69	19	15.1	7.7	1.8	37.5	35.7	1.1	1.2
PERCENT CARBONATE	68	20	81.2	10.6	59.2	100.0	40.8	-0.2	-0.8
PERCENT NONCARB	68	20	18.8	10.6	0.0	40.8	40.8	0.2	-0.8
WATER WELL 43									
LOW TDS*	81	7	236.6	23.0	165.0	297.0	132.0	-0.2	0.9
TDS	81	7	258.1	25.1	180.0	324.0	144.0	-0.2	0.9
HIGH TDS	81	7	279.7	27.2	195.0	351.0	156.0	-0.2	0.9
CARBONATE	68	20	200.5	17.4	156.8	252.5	95.7	0.7	1.6
NONCARBONATE	68	20	36.1	21.2	0.0	92.5	92.5	0.3	-0.5
MG HARDNESS	68	20	46.9	19.0	0.0	120.0	120.0	0.4	2.6
CALCIUM	68	20	61.5	6.4	45.6	84.0	38.5	0.8	2.2
PERCENT MG	68	20	23.1	8.2	0.0	47.6	47.6	-0.3	1.5
PERCENT CARBONATE	68	20	82.3	9.9	57.9	100.0	42.1	-0.2	-0.6
PERCENT NONCARB	68	20	17.7	9.9	0.0	42.1	42.1	0.2	-0.6

Table 29. Basic statistics for water quality parameters from PUAG water wells 44 and 45 from well series M.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 44									
CHLORIDE	77	10	253.43	41.09	181.40	380.70	199.3	1.54	2.34
CONDUCTIVITY	76	11	1152.63	172.29	720.00	1900.00	1180.00	0.59	5.49
PH	78	10	7.55	0.14	7.25	8.20	0.95	1.17	4.38
TURBIDITY	78	10	0.41	0.34	0.14	2.30	2.16	3.29	14.47
T HARDNESS	67	21	276.42	28.46	192.10	348.30	156.20	-0.12	0.98
CA HARDNESS	65	23	185.50	26.52	148.00	293.80	145.80	1.77	3.49
M ALKALINITY	66	22	173.02	23.27	120.00	230.00	110.00	0.07	-0.01
TEMPERATURE	78	10	26.95	0.49	26.00	29.00	3.00	1.15	3.20
BACTERIA	54	34	3.65	24.51	0.00	180.00	180.00	7.29	53.41
WATER WELL 45									
CHLORIDE	78	10	78.58	17.15	30.20	116.60	86.40	-0.43	0.34
CONDUCTIVITY	78	10	685.63	76.21	360.00	820.00	460.00	-1.38	4.25
PH	79	9	7.36	0.16	7.00	7.90	0.90	0.70	1.35
TURBIDITY	79	9	0.32	1.10	0.08	9.60	9.52	8.10	68.54
T HARDNESS	66	22	261.72	19.95	193.80	309.60	115.80	-0.36	1.42
CA HARDNESS	66	21	231.66	23.09	168.60	286.80	118.2	-0.10	0.61
M ALKALINITY	66	22	202.47	30.75	106.00	270.00	164.00	-1.04	2.01
TEMPERATURE	79	9	27.01	0.46	26.00	28.20	2.20	0.33	0.65
BACTERIA	56	32	0.38	1.65	0.00	12.00	12.00	6.67	47.25

Table 29. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 44									
LOW TDS*	76	12	633.9	90.7	396.0	1045.0	649.0	0.6	5.5
TDS	76	12	691.6	98.9	432.0	1140.0	708.0	0.6	5.5
HIGH TDS	76	12	749.2	107.2	468.0	1235.0	767.0	0.6	5.5
CARBONATE	65	23	276.8	28.3	192.1	348.3	156.2	-0.1	1.1
NONCARBONATE	66	22	103.9	34.6	0.0	157.7	157.7	-1.0	1.3
MG HARDNESS	65	23	91.3	33.1	7.9	172.8	164.9	-0.5	0.4
CALCIUM	65	23	74.3	11.4	59.3	117.8	58.4	1.8	3.5
PERCENT MG	65	23	32.6	10.3	2.8	50.6	47.8	-1.2	1.0
PERCENT CARBONATE	66	22	63.1	11.2	48.1	100.0	51.9	1.4	2.8
PERCENT NONCARB	66	22	36.9	11.2	0.0	51.9	51.9	-1.4	2.8
WATER WELL 45									
LOW TDS*	78	10	377.1	41.9	198.0	451.0	253.0	-1.4	4.3
TDS	78	10	411.4	45.7	216.0	492.0	276.0	-1.4	4.3
HIGH TDS	78	10	445.7	49.5	234.0	533.0	299.0	-1.4	4.3
CARBONATE	66	22	262.7	18.0	217.3	309.6	92.3	0.2	0.2
NONCARBONATE	66	22	58.9	33.8	0.0	180.0	180.0	0.9	1.8
MG HARDNESS	66	22	31.1	16.1	0.0	90.1	90.1	0.7	2.1
CALCIUM	66	22	92.8	9.3	67.6	114.9	47.4	-0.1	0.6
PERCENT MG	65	23	12.0	6.0	0.0	34.8	34.8	0.9	2.9
PERCENT CARBONATE	66	22	77.8	12.3	37.1	100.0	62.9	-0.9	1.6
PERCENT NONCARB	65	23	22.5	12.1	0.0	62.9	62.9	1.0	1.7

Table 30. Basic statistics for water quality parameters from PCAC water wells 46 and 68 from well series M.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 46									
CHLORIDE	78	10	38.05	16.28	13.70	89.10	75.40	0.92	0.35
CONDUCTIVITY	79	9	619.49	59.85	350.00	740.00	390.00	-2.01	7.13
PH	80	8	7.22	0.18	6.76	7.70	0.94	0.09	0.08
TURBIDITY	80	8	0.14	0.05	0.05	0.32	0.27	1.03	1.23
T HARDNESS	68	20	281.98	21.57	220.30	337.00	116.70	-0.05	1.06
CA HARDNESS	67	20	253.67	28.07	182.50	311.00	138.5	-0.68	0.81
M ALKALINITY	67	21	230.04	35.73	138.00	292.00	154.00	-0.57	-0.14
TEMPERATURE	80	8	26.89	0.46	26.00	28.00	2.00	0.55	0.53
BACTERIA	56	32	0.61	3.21	0.00	21.00	21.00	5.69	33.25
WATER WELL 68									
CHLORIDE	8	3	33.81	5.71	26.00	42.00	16.00	-0.04	-1.26
CONDUCTIVITY	8	3	540.00	70.71	410.00	650.00	240.00	-0.38	1.24
PH	8	3	7.32	0.14	7.02	7.44	0.42	-1.66	2.75
TURBIDITY	8	3	0.16	0.07	0.09	0.30	0.21	1.48	1.77
T HARDNESS	8	3	230.71	37.38	207.80	321.30	113.50	2.60	7.03
CA HARDNESS	8	3	195.00	7.55	184.20	203.80	19.60	-0.26	-1.44
M ALKALINITY	7	4	191.14	22.73	169.00	222.00	53.00	0.56	-1.68
TEMPERATURE	8	3	26.56	0.29	26.00	27.00	1.00	-0.65	2.12
BACTERIA	8	3	0.00	0.00	0.00	0.00	0.00		

Table 30. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 46									
LOW TDS*	79	9	340.7	32.9	192.5	407.0	214.5	-2.0	7.1
TDS	79	9	371.7	35.9	210.0	444.0	234.0	-2.0	7.1
HIGH TDS	79	9	402.7	38.9	227.5	481.0	253.5	-2.0	7.1
CARBONATE	67	21	282.5	21.0	220.3	337.0	116.7	-0.0	1.3
NONCARBONATE	67	21	53.3	35.8	0.0	167.0	167.0	0.5	0.2
MG HARDNESS	67	21	28.8	21.4	0.0	124.8	124.8	1.9	5.6
CALCIUM	67	21	101.7	11.2	69.1	124.6	55.5	-0.7	0.8
PERCENT MG	67	21	10.2	7.5	0.0	41.1	41.1	1.7	4.3
PERCENT CARBONATE	67	21	81.3	12.4	45.2	100.0	54.8	-0.4	-0.1
PERCENT NONCARB	67	21	18.7	12.4	0.0	54.8	54.8	0.4	-0.1
WATER WELL 68									
LOW TDS*	8	3	297.0	38.9	225.5	357.5	132.0	-0.4	1.2
TDS	8	3	324.0	42.4	246.0	390.0	144.0	-0.4	1.2
HIGH TDS	8	3	351.0	46.0	266.5	422.5	156.0	-0.4	1.2
CARBONATE	8	3	230.7	37.4	207.8	321.3	113.5	2.6	7.0
NONCARBONATE	7	4	42.8	31.9	3.4	99.3	95.9	0.7	0.6
MG HARDNESS	8	3	35.7	36.7	4.0	121.4	117.4	2.2	5.5
CALCIUM	8	3	78.2	3.0	73.8	81.7	7.9	-0.3	-1.4
PERCENT MG	8	3	14.0	10.9	1.9	37.8	35.9	1.7	3.4
PERCENT CARBONATE	7	4	82.6	10.6	69.1	98.5	29.4	0.3	-1.2
PERCENT NONCARB	7	4	17.4	10.6	1.5	30.9	29.4	-0.3	-1.2

Table 31. Basic statistics for water quality parameters from PCAG water wells 47 and 48 from well series F.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 47									
CHLORIDE	79	9	74.80	15.03	54.00	112.10	58.10	0.55	-0.71
CONDUCTIVITY	80	8	564.63	58.70	390.00	720.00	330.00	0.13	0.51
PH	80	8	7.39	0.19	6.94	8.01	1.07	0.17	0.97
TURBIDITY	80	8	0.15	0.11	0.05	0.78	0.73	4.13	19.43
T HARDNESS	68	20	202.63	22.39	133.10	280.80	147.70	0.84	3.81
CA HARDNESS	68	20	178.94	14.02	136.20	220.30	84.10	-0.08	1.05
M ALKALINITY	67	21	152.38	18.14	108.00	182.00	74.00	-0.43	-0.15
TEMPERATURE	80	8	26.76	0.53	25.50	28.00	2.50	0.52	0.18
BACTERIA	36	32	0.38	2.28	0.00	17.00	17.00	7.34	54.47
WATER WELL 48									
CHLORIDE	79	9	109.00	19.99	61.30	179.10	117.80	1.45	3.79
CONDUCTIVITY	80	8	659.63	65.34	380.00	800.00	420.00	-1.12	3.80
PH	80	8	7.46	0.15	7.15	7.97	0.82	0.35	0.45
TURBIDITY	81	7	0.19	0.10	0.06	0.50	0.44	1.56	1.80
T HARDNESS	68	20	201.16	17.64	164.60	259.20	94.60	0.56	0.55
CA HARDNESS	69	19	170.06	15.01	119.80	216.00	96.20	-0.24	1.87
M ALKALINITY	68	20	145.08	16.07	106.00	172.00	66.00	-0.33	-0.59
TEMPERATURE	81	7	26.87	0.82	26.00	33.00	7.00	5.31	38.99
BACTERIA	57	31	0.02	0.13	0.00	1.00	1.00	7.55	57.00

Table 31. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 47									
LOW TDS*	80	8	310.5	32.3	214.5	396.0	181.5	0.1	0.5
TDS	80	8	338.8	35.2	234.0	432.0	198.0	0.1	0.5
HIGH TDS	80	8	367.0	38.2	253.5	468.0	214.5	0.1	0.5
CARBONATE	68	20	203.3	20.9	168.0	280.8	112.8	1.5	3.8
NONCARBONATE	67	21	50.2	26.8	0.0	115.8	115.8	0.5	-0.1
MG HARDNESS	68	20	24.4	15.0	0.0	92.4	92.4	1.6	5.2
CALCIUM	68	20	71.7	5.6	54.6	88.3	33.7	-0.1	1.0
PERCENT MG	68	20	11.6	6.1	0.0	33.0	33.0	0.8	1.3
PERCENT CARBONATE	67	21	76.0	11.3	49.7	100.0	50.3	-0.1	-0.7
PERCENT NONCARB	67	21	24.0	11.3	0.0	50.3	50.3	0.1	-0.7
WATER WELL 48									
LOW TDS*	80	8	362.8	35.9	209.0	440.0	231.0	-1.1	3.8
TDS	80	8	395.8	39.2	228.0	480.0	252.0	-1.1	3.8
HIGH TDS	80	8	428.8	42.5	247.0	520.0	273.0	-1.1	3.8
CARBONATE	69	19	200.7	18.0	164.0	259.2	95.2	0.5	0.6
NONCARBONATE	68	20	55.2	23.5	0.0	99.2	99.2	-0.3	-0.6
MG HARDNESS	69	19	30.7	16.3	0.0	102.8	102.8	1.1	4.6
CALCIUM	69	19	68.2	6.0	48.0	86.6	38.6	-0.2	1.9
PERCENT MG	68	20	15.2	7.2	0.0	46.2	46.2	1.0	4.3
PERCENT CARBONATE	68	20	73.1	10.4	54.1	100.0	45.9	0.5	-0.5
PERCENT NONCARB	67	21	27.4	9.9	4.6	45.9	41.3	-0.4	-0.7

Table 32. Basic statistics for water quality parameters from PUAG water wells 49 and 50 from well series F.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 49									
CHLORIDE	79	9	99.38	22.76	60.20	184.20	124.00	1.94	4.31
CONDUCTIVITY	79	9	630.32	67.25	480.00	840.00	360.00	0.25	0.94
PH	79	9	7.49	0.16	6.95	8.10	1.15	0.31	3.26
TURBIDITY	79	9	0.17	0.09	0.05	0.53	0.48	1.76	4.03
T HARDNESS	67	21	196.69	20.95	129.00	267.80	138.80	0.57	3.28
CA HARDNESS	68	20	168.04	13.16	141.10	220.30	79.20	1.38	3.73
M ALKALINITY	67	21	143.57	16.84	105.00	172.00	67.00	-0.33	-0.56
TEMPERATURE	79	9	26.66	0.47	26.00	28.00	2.00	0.83	0.79
BACTERIA	56	32	0.61	3.62	0.00	27.00	27.00	7.30	54.03
WATER WELL 50									
CHLORIDE	79	9	111.77	36.76	62.40	210.20	147.80	0.85	0.49
CONDUCTIVITY	79	9	668.48	110.00	400.00	880.00	480.00	-0.24	-0.40
PH	79	9	7.51	0.16	7.21	8.10	0.89	0.66	0.84
TURBIDITY	79	9	0.18	0.14	0.07	1.00	0.93	4.11	20.48
T HARDNESS	67	21	202.14	22.06	141.40	272.20	130.80	0.49	1.37
CA HARDNESS	68	20	173.59	13.80	132.50	224.60	92.10	0.46	3.32
M ALKALINITY	67	21	147.71	13.82	106.00	195.00	89.00	0.10	0.24
TEMPERATURE	79	9	26.71	0.58	26.00	28.90	2.90	1.07	1.81
BACTERIA	56	32	1.13	3.51	0.00	18.00	18.00	3.78	14.79

Table 32. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 49									
LOW TDS*	79	9	346.7	37.0	264.0	462.0	198.0	0.3	0.9
TDS	79	9	378.2	40.3	288.0	504.0	216.0	0.3	0.9
HIGH TDS	79	9	409.7	43.7	312.0	546.0	234.0	0.3	0.9
CARBONATE	68	20	197.1	19.2	151.3	267.8	116.5	0.9	2.9
NONCARBONATE	67	21	52.6	24.0	0.0	151.8	151.8	0.8	3.5
MG HARDNESS	68	20	29.1	14.9	0.0	77.0	77.0	0.2	0.7
CALCIUM	68	20	67.3	5.3	56.6	88.3	31.7	1.4	3.7
PERCENT MG	67	21	14.6	6.4	0.0	30.0	30.0	-0.4	0.0
PERCENT CARBONATE	67	21	73.8	10.3	40.9	100.0	59.1	0.1	1.1
PERCENT NONCARB	66	22	26.6	9.8	2.3	59.1	56.8	0.1	1.1
WATER WELL 50									
LOW TDS*	79	9	367.7	60.5	220.0	484.0	264.0	-0.2	-0.4
TDS	79	9	401.1	66.0	240.0	528.0	288.0	-0.2	-0.4
HIGH TDS	79	9	434.5	71.5	260.0	572.0	312.0	-0.2	-0.4
CARBONATE	68	20	202.3	21.1	166.8	272.2	105.4	0.8	1.1
NONCARBONATE	67	21	54.5	26.2	0.0	109.6	109.6	-0.2	-0.3
MG HARDNESS	68	20	26.7	18.4	0.0	101.9	101.9	0.9	2.6
CALCIUM	68	20	69.6	5.5	53.1	90.0	36.9	0.5	3.3
PERCENT MG	67	21	13.9	7.7	0.0	38.8	38.8	0.5	0.9
PERCENT CARBONATE	67	21	73.8	11.2	55.4	100.0	44.6	0.6	-0.0
PERCENT NONCARB	66	22	26.6	10.8	0.0	44.6	44.6	-0.5	0.0

Table 33. Basic statistics for water quality parameters from PUAG water wells 51 and 52 from well series F.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 51									
CHLORIDE	76	12	56.90	11.40	32.80	93.80	61.00	0.76	1.15
CONDUCTIVITY	76	12	520.34	72.17	370.00	860.00	490.00	2.46	10.18
PH	76	12	7.62	0.27	7.08	8.10	1.02	0.26	-1.09
TURBIDITY	77	11	0.29	0.46	0.07	3.90	3.83	6.56	49.48
T HARDNESS	64	24	197.08	25.08	156.80	316.00	159.20	2.06	7.20
CA HARDNESS	65	23	172.11	14.60	129.00	224.60	95.60	0.55	2.48
M ALKALINITY	64	24	148.84	20.12	101.00	195.00	94.00	0.35	-0.12
TEMPERATURE	77	11	26.74	0.57	26.00	30.00	4.00	2.47	13.02
BACTERIA	54	34	0.02	0.14	0.00	1.00	1.00	7.35	54.00
WATER WELL 52									
CHLORIDE	76	12	130.32	37.20	82.70	736.10	153.40	0.93	0.39
CONDUCTIVITY	76	12	727.24	119.46	500.00	980.00	480.00	0.29	-0.62
PH	76	12	7.49	0.14	7.22	8.03	0.81	0.89	2.51
TURBIDITY	77	11	0.16	0.07	0.08	0.56	0.48	2.44	10.00
T HARDNESS	64	24	214.32	22.70	178.50	298.10	119.60	0.96	1.58
CA HARDNESS	65	23	180.37	15.14	139.80	220.30	80.50	0.28	0.24
M ALKALINITY	64	24	149.11	18.87	94.00	205.00	111.00	-0.14	1.12
TEMPERATURE	77	11	26.91	0.50	26.00	28.00	2.00	0.27	-0.26
BACTERIA	52	36	1.67	8.04	0.00	47	47	5.10	25.63

Table 33. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 51									
LOW TDS*	76	12	286.7	39.7	203.5	473.0	269.5	2.5	10.2
TDS	76	12	312.7	43.3	222.0	516.0	294.0	2.5	10.2
HIGH TDS	76	12	338.7	46.9	240.5	559.0	318.5	2.5	10.2
CARBONATE	65	23	196.6	25.1	156.8	316.0	159.2	2.0	7.1
NONCARBONATE	64	24	48.2	29.5	0.0	162.0	162.0	0.8	2.2
MG HARDNESS	65	23	24.5	19.4	0.0	121.6	121.6	2.1	8.8
CALCIUM	65	23	69.0	5.9	51.7	90.0	38.3	0.6	2.5
PERCENT MG	64	24	12.0	7.6	0.0	38.5	38.5	0.9	1.8
PERCENT CARBONATE	64	24	76.4	12.4	48.7	100.0	51.3	0.2	-0.5
PERCENT NONCARB	63	25	24.0	12.2	0.0	51.3	51.3	-0.2	-0.4
WATER WELL 52									
LOW TDS*	76	12	400.0	65.7	275.0	539.0	264.0	0.3	-0.6
TDS	76	12	436.3	71.7	300.0	588.0	288.0	0.3	-0.6
HIGH TDS	76	12	472.7	77.6	325.0	637.0	312.0	0.3	-0.6
CARBONATE	65	23	213.6	23.4	164.0	298.1	134.1	0.8	1.5
NONCARBONATE	64	24	64.2	26.7	0.0	131.1	131.1	-0.1	-0.1
MG HARDNESS	65	23	33.2	15.7	0.0	77.8	77.8	0.2	-0.0
CALCIUM	65	23	72.3	6.1	56.0	88.3	32.3	0.3	0.2
PERCENT MG	64	24	15.4	5.9	2.1	28.3	26.2	-0.2	-0.5
PERCENT CARBONATE	64	24	70.5	10.7	48.9	100.0	51.1	0.6	0.2
PERCENT NONCARB	63	25	30.0	10.1	2.8	51.1	48.2	-0.4	-0.2

Table 34. Basic statistics for water quality parameters from PCAC water wells 53 and 54 from well series F.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 53									
CHLORIDE	78	10	60.70	16.09	40.90	154.20	113.30	3.72	18.27
CONDUCTIVITY	78	10	534.23	48.52	350.00	700.00	350.00	-0.27	7.94
PH	78	10	7.45	0.14	7.10	7.97	0.87	0.43	1.53
TURBIDITY	79	9	0.16	0.17	0.05	1.50	1.45	6.81	53.82
T HARDNESS	66	22	200.19	21.32	156.80	289.40	132.60	1.71	4.88
CA HARDNESS	67	21	178.47	12.43	139.80	224.60	84.80	0.58	4.15
M ALKALINITY	66	22	151.90	17.43	105.00	178.00	73.00	-0.68	-0.05
TEMPERATURE	79	9	26.82	0.56	26.00	29.00	3.00	0.98	1.81
BACTERIA	55	33	0.76	3.84	0.00	26.00	26.00	5.93	36.99
WATER WELL 54									
CHLORIDE	78	10	20.44	3.83	13.60	30.00	16.40	0.65	0.00
CONDUCTIVITY	78	10	402.95	44.32	280.00	500.00	220.00	-0.01	0.31
PH	79	9	7.42	0.15	7.06	7.90	0.84	0.13	0.44
TURBIDITY	80	8	0.17	0.44	0.04	4.00	3.96	8.77	77.86
T HARDNESS	67	21	188.30	21.79	145.00	274.60	129.60	1.15	3.09
CA HARDNESS	68	20	171.16	13.75	148.90	216.00	67.10	0.90	0.93
M ALKALINITY	67	21	151.23	18.72	105.00	194.00	89.00	-0.38	0.23
TEMPERATURE	80	8	26.66	0.42	26.00	28.00	2.00	0.65	0.26
BACTERIA	56	32	1.20	5.96	0.00	43.00	43.00	6.65	46.26

Table 34. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 53									
LOW TDS*	78	10	293.8	26.7	192.5	385.0	92.5	-0.3	2.9
TDS	78	10	320.5	29.1	210.0	420.0	210.0	-0.3	2.9
HIGH TDS	78	10	347.2	31.5	227.5	455.0	227.5	-0.3	2.9
CARBONATE	67	21	200.4	20.7	172.5	289.4	116.9	1.9	5.4
NONCARBONATE	66	22	48.0	24.5	0.0	133.4	133.4	0.7	1.3
MG HARDNESS	67	21	21.9	15.5	0.0	82.1	82.1	1.4	3.1
CALCIUM	67	21	71.5	5.0	56.0	90.0	34.0	0.6	4.1
PERCENT MG	66	22	10.6	6.3	0.0	31.2	31.2	0.7	0.9
PERCENT CARBONATE	66	22	76.6	10.4	53.9	100.0	46.1	-0.1	-0.6
PERCENT NONCARB	65	23	23.8	10.1	0.0	46.1	46.1	0.2	-0.7
WATER WELL 54									
LOW TDS*	78	10	221.6	24.4	154.0	275.0	121.0	-0.0	0.3
TDS	78	10	241.6	26.6	168.0	300.0	132.0	-0.0	0.3
HIGH TDS	78	10	261.9	28.8	182.0	325.0	143.0	-0.0	0.3
CARBONATE	68	20	188.5	21.1	158.2	274.6	116.4	1.3	3.4
NONCARBONATE	67	21	36.8	22.8	0.0	111.6	111.6	0.6	0.5
MG HARDNESS	68	20	17.3	15.3	0.0	103.9	103.9	2.9	14.1
CALCIUM	68	20	68.6	5.5	59.7	86.6	26.9	0.9	0.9
PERCENT MG	67	21	8.6	6.3	0.0	37.8	37.8	1.6	5.3
PERCENT CARBONATE	67	21	81.0	10.6	57.0	100.0	43.0	-0.1	-0.7
PERCENT NONCARB	66	22	19.3	10.4	0.0	43.0	43.0	0.2	-0.6

Table 35. Basic statistics for water quality parameters from PUAG water wells 55 and 56 from well series F.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 55									
CHLORIDE	52	4	63.40	15.75	40.80	113.20	72.90	0.94	0.69
CONDUCTIVITY	52	4	523.63	53.07	420.00	610.00	190.00	0.12	-1.21
PH	52	4	7.42	0.15	7.13	7.76	0.63	0.32	-0.25
TURBIDITY	51	5	0.25	0.62	0.08	4.50	4.42	6.77	47.25
T HARDNESS	40	16	208.38	22.16	160.70	278.50	117.80	0.72	1.77
CA HARDNESS	40	16	179.92	17.22	142.60	229.00	86.40	0.49	1.11
M ALKALINITY	39	17	153.38	16.04	131.00	193.00	62.00	0.80	0.07
TEMPERATURE	52	4	26.56	0.43	26.00	28.00	2.00	0.77	0.99
BACTERIA	52	4	0.00	0.00	0.00	0.00	0.00		
WATER WELL 56									
CHLORIDE	52	4	150.45	35.68	82.60	233.50	150.90	0.19	-0.37
CONDUCTIVITY	53	3	826.98	179.97	460.00	1600.00	1140.00	1.17	5.51
PH	53	3	7.35	0.14	7.06	7.64	0.58	0.08	-0.65
TURBIDITY	53	3	0.27	0.19	0.04	0.95	0.91	1.80	3.62
T HARDNESS	41	15	253.19	27.49	199.90	315.40	115.50	0.02	-0.52
CA HARDNESS	41	15	210.92	20.35	164.60	254.90	90.30	-0.16	-0.21
M ALKALINITY	40	16	179.13	19.39	138.00	229.00	91.00	0.16	-0.06
TEMPERATURE	53	3	26.68	0.98	26.00	32.90	6.90	5.04	31.57
BACTERIA	53	3	0.00	0.00	0.00	0.00	0.00		

Table 35. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 55									
LOW TDS*	52	4	288.0	29.2	231.0	335.5	104.5	0.1	-1.2
TDS	52	4	314.2	31.6	252.0	366.0	114.0	0.1	-1.2
HIGH TDS	52	4	340.4	34.5	273.0	396.5	123.5	0.1	-1.2
CARBONATE	40	16	208.8	21.4	174.7	278.5	103.8	0.9	1.8
NONCARBONATE	39	17	55.9	27.3	0.0	125.5	125.5	-0.4	0.4
MG HARDNESS	40	16	28.9	22.0	0.0	115.5	115.5	1.7	5.1
CALCIUM	40	16	72.1	6.9	57.2	91.8	34.6	0.5	1.1
PERCENT MG	40	16	13.3	8.9	0.0	41.5	41.5	0.9	1.5
PERCENT CARBONATE	39	17	74.1	11.4	54.9	100.0	45.1	1.0	0.3
PERCENT NONCARB	39	17	25.9	11.4	0.0	45.1	45.1	-1.0	0.3
WATER WELL 56									
LOW TDS*	53	3	454.8	99.0	253.0	880.0	627.0	1.2	5.5
TDS	53	3	496.0	108.0	276.0	960.0	684.0	1.2	5.5
HIGH TDS	53	3	537.3	117.0	299.0	1040.0	741.0	1.2	5.5
CARBONATE	41	15	253.3	27.3	203.8	315.4	111.6	0.0	-0.6
NONCARBONATE	40	16	75.4	27.8	6.2	126.4	120.2	-0.3	-0.4
MG HARDNESS	41	15	42.4	20.4	0.0	91.5	91.5	0.3	0.5
CALCIUM	41	15	84.5	8.2	66.0	102.2	36.2	-0.2	-0.2
PERCENT MG	41	15	16.3	7.1	0.0	34.9	34.9	0.2	1.4
PERCENT CARBONATE	40	16	70.9	9.1	56.3	97.4	41.0	0.7	0.4
PERCENT NONCARB	40	16	29.1	9.1	2.6	43.7	41.0	-0.7	0.4

Table 36. Basic statistics for water quality parameters from PUAG water well 57 from well series P.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 57									
CHLORIDE	53	3	100.18	21.13	71.80	160.90	89.10	0.72	0.26
CONDUCTIVITY	53	3	647.74	72.18	500.00	780.00	280.00	-0.08	-0.89
PH	53	3	7.45	0.14	7.11	7.77	0.66	0.17	0.11
TURBIDITY	53	3	0.20	0.13	0.08	0.67	0.59	1.85	3.33
T HARDNESS	41	15	209.24	23.17	163.00	280.80	117.80	0.60	1.27
CA HARDNESS	41	15	177.82	19.43	129.00	250.60	121.60	1.31	5.02
M ALKALINITY	40	16	150.42	15.95	125.00	200.00	75.00	0.81	0.83
TEMPERATURE	52	4	26.67	0.56	26.00	28.00	2.00	0.81	0.42
BACTERIA	53	3	0.02	0.14	0.00	1.00	1.00	7.28	53.00

Table 36. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 57									
LOW TDS*	53	3	356.3	39.7	275.0	429.0	154.0	-0.1	-0.9
TDS	53	3	388.6	43.3	300.0	468.0	168.0	-0.1	-0.9
HIGH TDS	53	3	421.0	46.9	325.0	507.0	182.0	-0.1	-0.9
CARBONATE	41	15	209.7	22.9	163.0	280.8	117.8	0.6	1.4
NONCARBONATE	40	16	59.4	28.5	0.0	139.8	139.8	0.2	0.6
MG HARDNESS	41	15	31.6	15.7	0.0	74.8	74.8	0.4	0.5
CALCIUM	41	15	71.3	7.8	51.7	100.4	48.7	1.3	5.0
PERCENT MG	41	15	14.9	6.9	0.0	36.7	36.7	0.5	1.6
PERCENT CARBONATE	40	16	72.5	11.2	50.2	100.0	49.8	0.5	0.2
PERCENT NONCARB	40	16	27.5	11.2	0.0	49.8	49.8	-0.5	0.2

Table 37. Basic statistics for water quality parameters from PUAG water wells 58 and 59 from well series Y.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 58									
CHLORIDE	80	8	95.40	22.19	45.00	160.90	115.90	0.48	0.92
CONDUCTIVITY	80	8	683.75	75.68	480.00	840.00	360.00	0.06	-0.48
PH	80	8	7.37	0.19	7.02	8.33	1.31	1.57	6.89
TURBIDITY	81	7	0.14	0.08	0.06	0.47	0.41	2.29	6.16
T HARDNESS	67	21	246.17	22.71	213.40	319.70	106.30	0.82	0.22
CA HARDNESS	68	20	204.93	20.84	132.50	262.10	129.60	-0.36	2.57
M ALKALINITY	68	20	183.72	22.45	127.00	228.00	101.00	-0.50	0.36
TEMPERATURE	79	9	26.79	0.47	26.00	28.00	2.00	0.46	0.50
BACTERIA	57	31	1.07	5.62	0.00	41.00	41.00	6.73	47.78
WATER WELL 59									
CHLORIDE	80	8	21.94	6.03	13.90	64.80	50.90	4.83	32.48
CONDUCTIVITY	80	8	481.88	59.51	290.00	790.00	500.00	1.34	9.32
PH	80	8	7.39	0.19	6.93	7.85	0.92	-0.37	0.22
TURBIDITY	80	8	0.14	0.08	0.05	0.40	0.35	1.60	2.67
T HARDNESS	68	20	232.96	16.06	188.20	268.80	80.60	-0.24	0.08
CA HARDNESS	67	21	205.47	12.45	149.90	233.30	83.40	-1.02	4.93
M ALKALINITY	67	21	191.63	25.92	126.00	244.00	118.00	-0.31	-0.43
TEMPERATURE	80	8	27.09	0.76	25.60	32.00	6.40	3.36	21.89
BACTERIA	56	32	0.50	1.69	0.00	8.00	8.00	3.76	13.76

Table 37. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 58									
LOW TDS*	80	8	376.1	41.6	264.0	462.0	198.0	0.1	-0.5
TDS	80	8	410.2	45.4	288.0	504.0	216.0	0.1	-0.5
HIGH TDS	80	8	444.4	49.2	312.0	546.0	234.0	0.1	-0.5
CARBONATE	68	20	244.1	24.0	192.1	319.7	127.6	0.7	0.2
NONCARBONATE	68	20	59.5	28.4	0.	110.8	110.8	-0.3	-0.6
MG HARDNESS	68	20	39.2	22.5	0.0	101.0	101.0	0.3	0.2
CALCIUM	68	20	82.1	8.4	53.1	105.1	51.9	-0.4	2.6
PERCENT MG	65	23	16.4	8.0	0.0	40.9	40.9	0.5	1.3
PERCENT CARBONATE	68	20	76.1	10.8	55.8	100.0	50.1	-0.2	-0.5
PERCENT NONCARB	66	22	17.7	12.1		50.1	50.1	0.2	-0.5
WATER WELL 59									
LOW TDS*	80	8	265.0	32.7	159.5	434.5	275.0	1.3	9.3
TDS	80	8	289.1	35.7	174.0	474.0	300.0	1.3	9.3
HIGH TDS	80	8	313.2	38.7	188.5	513.5	325.0	1.3	9.3
CARBONATE	67	21	232.4	16.0	192.1	268.8	76.7	-0.1	-0.1
NONCARBONATE	67	21	41.5	29.7	0.0	126.5	126.5	0.3	-0.2
MG HARDNESS	67	21	26.9	15.4	0.0	97.6	97.6	1.3	5.7
CALCIUM	67	21	82.4	5.0	60.1	93.5	33.4	-1.0	4.9
PERCENT MG	66	22	11.5	6.0	0.0	39.4	39.4	1.3	6.2
PERCENT CARBONATE	67	21	82.6	12.2	49.9	100.0	50.7	-0.5	0.3
PERCENT NONCARB	65	23	16.8	10.9	0.0	50.7	50.7	0.5	0.4

Table 38. Basic statistics for water quality parameters from PUAG water wells 60 and 61 from well series Y.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 60									
CHLORIDE	78	10	21.51	2.99	15.60	28.50	12.90	0.34	-0.37
CONDUCTIVITY	78	10	483.46	39.14	390.00	600.00	210.00	-0.15	0.82
PH	78	10	7.39	0.21	6.88	7.89	1.01	0.05	0.42
TURBIDITY	78	10	0.16	0.11	0.05	0.90	0.85	4.37	26.33
T HARDNESS	66	22	233.12	15.70	184.20	280.80	96.60	-0.00	1.20
CA HARDNESS	65	23	207.09	11.47	180.00	243.90	63.90	0.30	0.47
M ALKALINITY	66	22	193.73	25.33	112.00	239.00	127.00	-0.65	0.61
TEMPERATURE	78	10	27.01	0.54	25.00	28.10	3.10	-0.72	2.08
BACTERIA	54	34	0.28	1.65	0.00	12.00	12.00	7.01	50.28
WATER WELL 61									
CHLORIDE	81	7	21.02	5.99	12.00	59.60	47.60	3.88	22.43
CONDUCTIVITY	81	7	467.96	45.10	240.00	580.00	340.00	-1.66	7.44
PH	81	7	7.37	0.18	6.95	8.00	1.05	0.70	2.66
TURBIDITY	80	8	0.34	0.37	0.08	2.80	2.72	4.40	25.25
T HARDNESS	69	19	228.44	16.68	199.90	283.00	83.10	0.63	0.32
CA HARDNESS	67	21	205.73	14.01	156.80	244.00	87.20	-0.11	1.97
M ALKALINITY	67	21	187.59	23.20	136.00	241.00	105.00	-0.16	-0.18
TEMPERATURE	80	8	27.19	0.82	25.00	32.00	7.00	2.37	14.55
BACTERIA	56	32	19.46	57.32	0.00	400.00	400.00	5.70	36.63

Table 38. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 60									
LOW TDS*	78	10	265.9	21.5	214.5	330.0	115.5	-0.2	0.8
TDS	78	10	290.1	23.5	234.0	360.0	126.0	-0.2	0.8
HIGH TDS	78	10	314.2	25.4	253.5	390.0	136.5	-0.2	0.8
CARBONATE	65	23	232.6	15.8	184.2	280.8	96.6	0.1	1.1
NONCARBONATE	66	22	38.9	26.0	0.0	115.4	115.4	0.5	0.2
MG HARDNESS	65	23	25.7	12.9	0.0	71.4	71.4	0.2	1.6
CALCIUM	65	23	83.0	4.6	72.1	97.8	25.6	0.3	0.5
PERCENT MG	64	24	11.0	4.9	0.0	25.4	25.4	-0.2	0.7
PERCENT CARBONATE	66	22	83.5	11.0	49.3	100.0	50.7	-0.5	-0.3
PERCENT NONCARB	65	23	16.8	10.9	0.0	50.7	50.7	0.5	0.4
WATER WELL 61									
LOW TDS*	81	7	257.4	24.8	132.0	319.0	187.0	-1.7	7.4
TDS	81	7	280.8	27.1	144.0	348.0	204.0	-1.7	7.4
HIGH TDS	81	7	304.2	29.3	156.0	377.0	221.0	-1.7	7.4
CARBONATE	67	21	228.9	16.7	199.9	283.0	83.1	0.6	0.4
NONCARBONATE	67	21	41.5	27.3	0.0	99.2	99.2	0.2	-0.9
MG HARDNESS	67	21	23.2	14.9	0.0	78.4	78.4	1.1	2.5
CALCIUM	67	21	82.5	5.6	62.8	97.8	34.9	-0.1	2.0
PERCENT MG	67	21	9.9	5.9	0.0	33.3	33.3	0.9	2.7
PERCENT CARBONATE	67	21	82.3	11.2	59.3	100.0	40.7	-0.1	-1.0
PERCENT NONCARB	67	21	17.7	11.2	0.0	40.7	40.7	0.1	-1.0

Table 39. Basic statistics for water quality parameters from PUAG water wells 62 and 63 from well series Y.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 62									
CHLORIDE	81	7	23.12	4.18	17.40	38.00	20.60	1.75	3.71
CONDUCTIVITY	81	7	488.77	58.12	340.00	800.00	460.00	1.77	10.07
PH	81	7	7.38	0.18	6.96	8.01	1.05	0.46	1.14
TURBIDITY	80	8	0.22	0.32	0.05	2.50	2.45	5.54	34.84
T HARDNESS	69	19	234.28	16.71	203.80	263.50	59.70	0.06	-1.29
CA HARDNESS	67	21	201.47	13.97	164.60	237.10	72.50	-0.16	-0.08
M ALKALINITY	67	21	193.50	22.08	134.00	234.00	100.00	-0.60	0.11
TEMPERATURE	80	8	26.98	0.51	25.60	28.20	2.60	-0.22	0.50
BACTERIA	56	32	1.32	5.98	0.00	38.00	38.00	5.12	27.90
WATER WELL 63									
CHLORIDE	50	6	34.21	8.45	16.00	59.70	43.70	0.00	1.33
CONDUCTIVITY	50	6	483.60	52.44	300.00	600.00	300.00	-0.70	2.09
PH	50	6	7.36	0.19	6.98	7.76	0.78	0.00	-0.57
TURBIDITY	50	6	0.47	1.08	0.05	7.00	6.95	4.96	27.87
T HARDNESS	39	17	224.98	15.86	190.10	257.00	66.90	-0.18	-0.05
CA HARDNESS	39	17	200.14	16.05	156.80	246.20	89.40	0.53	2.13
M ALKALINITY	38	18	176.95	21.38	114.00	220.00	106.00	-0.22	0.82
TEMPERATURE	50	6	26.72	0.48	26.00	28.00	2.00	0.71	1.36
BACTERIA	49	7	0.55	3.58	0.00	25.00	25.00	6.93	48.34

Table 39. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 62									
LOW TDS*	81	7	268.8	32.0	187.0	440.0	253.0	1.8	10.1
TDS	81	7	293.3	34.9	204.0	480.0	276.0	1.8	10.1
HIGH TDS	81	7	317.7	37.8	221.0	520.0	299.0	1.8	10.1
CARBONATE	67	21	233.9	16.8	203.8	263.5	59.7	0.1	-1.3
NONCARBONATE	67	21	40.7	24.4	0.0	92.6	92.6	0.2	-1.0
MG HARDNESS	67	21	32.7	13.9	3.9	72.7	68.8	0.0	0.0
CALCIUM	67	21	80.7	5.6	66.0	95.0	29.1	-0.2	-0.1
PERCENT MG	67	21	13.7	5.5	1.8	29.3	27.5	-0.0	0.2
PERCENT CARBONATE	67	21	82.9	10.0	61.0	100.0	39.0	-0.2	-0.8
PERCENT NONCARB	67	21	17.1	10.0	0.0	39.0	39.0	0.2	-0.8
WATER WELL 63									
LOW TDS*	50	6	266.0	28.8	165.0	330.0	165.0	-0.7	2.1
TDS	50	6	290.2	31.5	180.0	360.0	180.0	-0.7	2.1
HIGH TDS	50	6	314.3	34.1	195.0	390.0	195.0	-0.7	2.1
CARBONATE	39	17	225.9	16.3	190.1	257.0	66.9	-0.3	-0.2
NONCARBONATE	38	18	47.8	21.5	0.0	83.5	83.5	-0.0	-0.6
MG HARDNESS	39	17	25.7	12.9	0.0	52.3	52.3	0.2	-0.1
CALCIUM	39	17	80.2	6.4	62.8	98.7	35.8	0.5	2.1
PERCENT MG	39	17	11.3	5.4	0.0	24.5	24.5	0.2	0.2
PERCENT CARBONATE	38	18	78.9	9.2	58.2	100.0	41.8	0.0	-0.3
PERCENT NONCARB	38	18	21.1	9.2	0.0	41.8	41.8	-0.0	-0.3

Table 40. Basic statistics for water quality parameters from PUAG water wells 69 and 70 from well series Y.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 69									
CHLORIDE	39	3	23.03	9.92	14.10	66.50	52.40	2.96	10.26
CONDUCTIVITY	39	3	492.31	64.34	330.00	700.00	370.00	0.82	2.98
PH	39	3	7.26	0.16	6.99	7.67	0.68	0.54	0.30
TURBIDITY	39	3	0.17	0.23	0.06	1.50	1.44	5.49	32.45
T HARDNESS	27	15	236.64	13.50	201.80	267.80	66.00	-0.40	1.34
CA HARDNESS	27	15	211.62	16.93	177.10	278.30	101.20	2.06	9.34
M ALKALINITY	26	16	188.77	20.18	129.00	224.00	95.00	-0.65	2.04
TEMPERATURE	38	4	26.84	0.35	26.00	27.80	1.80	0.40	1.38
BACTERIA	39	3	0.00	0.00	0.00	0.00	0.00		
WATER WELL 70									
CHLORIDE	8	3	24.44	3.76	19.20	31.70	11.80	0.83	1.00
CONDUCTIVITY	8	3	512.50	89.88	440.00	700.00	260.00	1.43	2.07
PH	8	3	7.30	0.15	7.07	7.52	0.45	-0.45	-0.78
TURBIDITY	8	3	0.13	0.04	0.10	0.21	0.11	1.46	1.92
T HARDNESS	8	3	230.69	8.59	219.50	246.90	27.40	0.96	0.84
CA HARDNESS	8	3	204.27	9.97	180.30	211.70	31.40	-2.52	6.71
M ALKALINITY	7	4	195.86	33.49	148.00	244.00	96.00	0.01	-0.99
TEMPERATURE	8	3	26.97	0.45	26.50	28.00	1.50	2.02	5.13
BACTERIA	8	3	0.00	0.00	0.00	0.00	0.00		

Table 40. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 69									
LOW TDS*	39	3	270.8	35.4	181.5	385.0	203.5	0.8	3.0
TDS	39	3	295.4	38.6	198.0	420.0	222.0	0.8	3.0
HIGH TDS	39	3	320.0	41.8	214.5	455.0	240.5	0.8	3.0
CARBONATE	27	15	237.7	15.5	201.8	278.3	76.5	0.3	1.7
NONCARBONATE	26	16	47.3	21.9	6.8	95.6	88.8	0.1	-0.3
MG HARDNESS	27	15	26.0	15.5	0.0	09.7	90.7	2.7	11.9
CALCIUM	27	15	84.8	6.8	71.0	111.5	40.6	2.1	9.3
PERCENT MG	27	15	10.8	5.7	0.0	33.9	33.9	2.3	10.2
PERCENT CARBONATE	26	16	80.1	9.0	57.4	97.0	39.6	-0.2	0.4
PERCENT NONCARB	26	16	19.9	9.0	3.0	42.6	39.6	0.2	0.4
WATER WELL 70									
LOW TDS*	8	3	281.9	49.4	242.0	385.0	143.0	1.4	2.1
TDS	8	3	307.5	53.9	264.0	420.0	156.0	1.4	2.1
HIGH TDS	8	3	333.1	58.4	286.0	455.0	169.0	1.4	2.1
CARBONATE	8	3	230.1	8.6	219.5	246.9	27.4	1.0	0.8
NONCARBONATE	7	4	37.1	34.7	0.0	77.0	77.0	0.2	-2.5
MG HARDNESS	8	3	26.4	12.8	11.7	47.1	35.4	0.5	-1.1
CALCIUM	8	3	81.9	4.0	72.3	84.8	12.6	-2.5	6.7
PERCENT MG	8	3	11.4	5.3	5.3	20.7	15.4	0.7	-0.5
PERCENT CARBONATE	7	4	84.7	14.7	65.8	100.0	34.2	-0.2	-2.4
PERCENT NONCARB	7	4	15.8	14.7	0.0	34.2	34.2	0.2	-2.4

Table 41. Basic statistics for water quality parameters from PUAG water wells 71 and 72 from well series AG.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 71									
CHLORIDE	77	10	38.76	7.95	27.80	68.50	40.70	1.75	3.20
CONDUCTIVITY	77	10	471.95	50.99	300.00	600.00	300.00	-0.82	1.70
PH	75	12	7.42	0.19	7.01	8.10	1.09	0.68	2.13
TURBIDITY	76	11	0.15	0.10	0.05	0.51	0.46	2.45	6.51
T HARDNESS	65	22	203.34	20.20	133.10	267.80	134.70	-0.07	2.36
CA HARDNESS	65	22	187.78	16.91	168.60	292.60	124.00	4.06	23.11
M ALKALINITY	64	23	164.13	19.45	115.00	197.00	82.00	-0.49	-0.37
TEMPERATURE	76	11	26.81	0.50	26.00	28.00	2.00	0.64	0.22
BACTERIA	56	31	1.38	9.35	0.00	70.00	70.00	7.45	55.70
WATER WELL 72									
CHLORIDE	66	7	18.50	4.78	13.40	38.80	25.40	2.43	7.64
CONDUCTIVITY	66	7	393.26	44.22	290.00	500.00	210.00	0.41	0.65
PH	66	7	7.40	0.18	6.96	7.96	1.00	-0.10	0.98
TURBIDITY	63	10	0.17	0.08	-.07	-.53	0.46	1.77	4.32
T HARDNESS	55	18	189.24	21.51	112.30	250.60	138.30	0.14	3.59
CA HARDNESS	51	22	174.18	14.98	152.90	236.70	83.80	2.20	6.61
M ALKALINITY	51	22	151.46	22.54	117.00	245.00	128.00	1.29	4.43
TEMPERATURE	63	10	26.66	0.51	26.00	28.00	2.00	0.97	0.92
BACTERIA	55	18	0.04	0.19	0.00	1.00	1.00	5.09	24.85

Table 41. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 71									
LOW TDS*	77	10	259.6	28.0	165.0	330.0	165.0	-0.8	1.7
TDS	77	10	283.2	30.6	180.0	360.0	180.0	-0.8	1.7
HIGH TDS	77	10	306.8	33.1	195.0	390.0	195.0	-0.8	1.7
CARBONATE	65	22	205.8	20.9	172.5	292.6	120.1	1.5	4.1
NONCARBONATE	64	23	39.7	24.8	0.0	105.8	105.8	0.3	-0.3
MG HARDNESS	65	22	18.0	14.9	0.0	77.7	77.7	1.4	2.9
CALCIUM	65	22	75.3	6.8	67.6	117.3	49.7	4.1	23.1
PERCENT MG	65	22	8.4	6.2	0.0	29.0	29.0	0.9	0.7
PERCENT CARBONATE	64	23	81.1	11.1	53.3	100.0	46.7	-0.1	-0.7
PERCENT NONCARB	64	23	18.9	11.1	0.0	46.7	46.7	0.1	-0.7
WATER WELL 72									
LOW TDS*	66	7	216.3	24.3	159.5	275.0	115.5	0.4	0.6
TDS	66	7	236.0	26.5	174.0	300.0	126.0	0.4	0.6
HIGH TDS	66	7	255.0	28.7	188.5	325.0	136.5	0.4	0.6
CARBONATE	51	22	192.8	19.6	164.6	250.6	86.0	1.3	1.4
NONCARBONATE	51	22	39.2	24.1	0.0	101.6	101.6	0.3	0.0
MG HARDNESS	51	22	18.6	14.9	0.0	69.2	69.2	1.3	2.8
CALCIUM	51	22	69.8	6.0	61.3	94.9	33.6	2.2	6.6
PERCENT MG	50	23	9.4	6.5	0.0	27.6	27.6	0.7	0.8
PERCENT CARBONATE	51	22	79.9	11.3	57.7	100.0	42.3	0.2	-0.9
PERCENT NONCARB	50	23	20.5	11.0	0.0	42.3	42.3	-0.2	-0.8

Table 42. Basic statistics for water quality parameters from PUAG water well 73 from well series AG.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 73									
CHLORIDE	42	6	68.45	14.78	46.00	119.40	73.40	1.22	2.52
CONDUCTIVITY	42	6	561.90	51.86	450.00	640.00	190.00	-0.74	-0.61
PH	42	6	7.33	0.17	7.04	7.85	0.81	0.74	0.70
TURBIDITY	41	7	0.29	0.61	0.01	4.00	3.99	5.83	35.73
T HARDNESS	30	18	231.67	14.99	190.10	266.20	76.10	-0.21	1.83
CA HARDNESS	30	18	191.97	19.13	156.60	246.20	89.60	1.11	2.49
M ALKALINITY	29	19	177.16	24.79	114.00	214.00	100.00	-0.76	0.92
TEMPERATURE	41	7	26.75	0.50	25.60	29.00	3.40	2.04	10.06
BACTERIA	40	8	0.05	0.22	0.00	1.00	1.00	4.29	17.29

Table 42. continued.

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
WATER WELL 73									
LOW TDS*	42	6	309.0	28.5	247.5	352.0	104.5	-0.7	-0.6
TDS	42	6	337.1	31.1	270.0	384.0	114.0	-0.7	-0.6
HIGH TDS	42	6	365.2	33.7	292.5	416.0	123.5	-0.7	-0.6
CARBONATE	30	18	232.5	15.1	190.1	266.2	76.1	-0.3	1.8
NONCARBONATE	29	19	54.0	27.1	6.3	124.6	118.3	0.5	0.4
MG HARDNESS	30	18	40.6	16.8	0.0	74.8	74.8	-0.3	0.2
CALCIUM	30	18	76.9	7.7	62.8	98.7	35.9	1.1	2.5
PERCENT MG	30	18	17.4	6.9	0.0	28.6	28.6	-0.5	0.3
PERCENT CARBONATE	29	19	76.9	11.3	48.9	97.1	48.3	-0.5	0.4
PERCENT NONCARB	29	19	23.1	11.3	2.9	51.1	48.3	0.5	0.4

Table 43. Summary statistics of water quality parameters for combined well series.

Parameter	No.	No. Missing	% Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
CHLORIDE	5167	636	11	84.8	83.7	8.2	442.9	434.7	1.64	2.00
CONDUCTIVITY	5166	638	11	677	278	200	1900	1700	1.68	2.28
PH	5168	636	11	7.33	0.23	6.34	8.60	2.26	0.08	0.27
TURBIDITY	5187	617	11	0.21	0.30	0.01	9.6	9.59	13.58	303.89
T HARDNESS	4373	1431	25	254.8	60.5	112.3	492.6	380.3	1.14	1.02
CA HARDNESS	4377	1427	25	219.8	55.4	113.7	451.2	337.5	1.06	0.50
M ALKALINITY	4327	1477	25	194.5	45.9	94.0	381.0	287.0	0.59	-0.30
TEMPERATURE	5191	613	11	27.0	0.7	22.2	33.0	10.8	0.81	4.68

Variable	No.	No. Missing	Mean	Standard Deviation	Minimum Value	Maximum Value	Total Range	Skewness	Kurtosis
LOW TDS*	5166	638	372.3	152.9	110.0	1045.0	935.0	1.7	2.3
TDS	5166	638	406.2	166.8	120.0	1140.0	1020.0	1.7	2.3
HIGH TDS	5166	638	440.0	180.7	130.0	1235.0	1105.0	1.7	2.3
CARBONATE	4377	1427	254.8	59.6	151.3	492.6	341.3	1.1	1.0
NONCARBONATE	4327	1477	58.8	42.1	0.0	282.5	282.5	1.1	1.9
MG HARDNESS	4377	1427	34.9	26.0	0.0	196.0	196.0	1.5	3.9
CALCIUM	4377	1427	88.1	22.2	45.6	180.8	135.3	1.1	0.5
PERCENT MG	4267	1537	13.9	8.7	0.0	55.7	55.7	0.9	1.1
PERCENT CARBONATE	4377	1477	77.7	12.9	32.0	100.0	68.0	-0.2	-0.4
PERCENT NONCARB	4217	1587	22.9	12.5	0.0	68.0	68.0	0.2	-0.3

Table 44. Basic quantile statistics for A-1, A-2 and A-3 water wells.

Parameter	Quantiles 95%	75%	50%	25%	5%	Mode	Prob>D
WATER WELL 1: A-1							
CHLORIDE	25.9	21.5	19.4	16.95	12.04	21.8	0.01
SPECIFIC COND	660	620	600	580	540	600	0.01
T. HARDNESS	333.63	312.88	295.95	286.65	264.13	290.1	0.01
CA. HARDNESS	312.19	295.63	278.3	262.6	239.1	278.3	0.15
M. ALKALINITY	300.6	276	253	227	173.6	289	0.15
TEMPERATURE	28.09	28	27.4	27	27	27	0.01
TURBIDITY	0.37	0.21	0.15	0.11	0.09	0.1	0.01
WATER WELL 2: A-2							
CHLORIDE	28.5	23.3	21.1	18.1	14.1	17.9	0.01
SPECIFIC COND	642	600	580	520	409.5	600	0.01
T. HARDNESS	316.18	294.6	278.3	268.6	211.7	274.4	0.01
CA. HARDNESS	296.26	283.85	269.3	261.38	230.91	254.8	0.04
M. ALKALINITY	289.7	259	242	221	176	221	0.15
TEMPERATURE	28	28	27.4	27	26.70	28	0.01
TURBIDITY	0.59	0.21	0.15	0.12	0.08	0.2	0.01
WATER WELL 3: A-3							
CHLORIDE	25.81	20.35	19.4	17.4	13.04	19.9	0.01
SPECIFIC COND	640	600	580	550	499	600	0.02
T. HARDNESS	317.22	298.45	278.35	271.9	256.63	274.4	0.01
CA. HARDNESS	294.15	272.63	265.6	254.8	243	250.9	0.01
M. ALKALINITY	285.1	272	254	229	184.1	260	0.01
TEMPERATURE	28	28	27.5	27	27	28	0.01
TURBIDITY	0.414	0.22	0.15	0.12	0.09	0.14	0.01

Table 45. Basic quantile statistics for A-4, A-5 and A-6 water wells.

Parameter	Quantiles 95%	75%	50%	25%	5%	Mode	Prob>|0|
WATER WELL 4: A-4							
CHLORIDE	28.5	23.3	21.5	19.7	16.08	19.9	0.01
SPECIFIC COND	683	600	580	552.5	458.5	600	0.01
T. HARDNESS	317.83	303.85	284	272.3	259.35	266.6	0.01
CA. HARDNESS	306.14	282.9	269.7	258.7	223.98	258.7	0.15
M. ALKALINITY	284	262	242	220	170.8	235	0.01
TEMPERATURE	28	28	27.45	27.15	26.86	28	0.01
TURBIDITY	0.84	0.2	0.15	0.11	0.07	0.1	0.01
WATER WELL 5: A-5							
CHLORIDE	23.98	19.9	17.9	15.24	13.33	19.9	0.15
SPECIFIC COND	622	600	580	560	476	600	0.01
T. HARDNESS	318.24	295.3	285.6	274.4	262.6	274.4	0.07
CA. HARDNESS	291	276.93	267.15	258.7	243	266.6	0.15
M. ALKALINITY	281.1	265.5	243	223.5	180.9	250	0.15
TEMPERATURE	28.58	28	28	27.5	27	28	0.01
TURBIDITY	0.38	0.18	0.14	0.11	0.08	0.15	0.01
WATER WELL 6: A-6							
CHLORIDE	26.2	21.8	19.7	17.5	14.8	21.9	0.01
SPECIFIC COND	640	580	560	540	480.2	560	0.01
T. HARDNESS	311.5	293.48	279.25	265.7	257.55	270.5	0.04
CA. HARDNESS	301.09	275	260.2	250.38	235.36	254.8	0.02
M. ALKALINITY	279.2	255	241	218	176	242	0.13
TEMPERATURE	28	28	27.2	27	27	27	0.01
TURBIDITY	0.4	0.2	0.14	0.1	0.08	0.1	0.01

Table 46. Basic quantile statistics for A-7, A-8 and A-9 water wells.

Parameter	Quantiles 95%	75%	50%	25%	5%	Mode	Prob>D
WATER WELL 7: A-7							
CHLORIDE	31.1	25.1	21.8	19.9	16	21.8	0.01
SPECIFIC COND	680	640	620	600	540	600	0.01
T. HARDNESS	354.3	325.1	305.35	294.23	283.67	297.9	0.01
CA. HARDNESS	312.4	303.05	286.2	272.2	215.5	278.3	0.01
M. ALKALINTIY	301	276	260.5	236.25	181.15	267	0.01
TEMPERATURE	28	28	27.6	27.5	27	28	0.01
TURBIDITY	0.59	0.20	0.15	0.11	0.08	0.1	0.01
WATER WELL 8: A-8							
CHLORIDE	44.80	22	18.8	16	14	17.9	0.01
SPECIFIC COND	800	620	580	560	520	580	0.01
T. HARDNESS	342.06	310.85	292.05	278.3	260.15	278.3	0.05
CA. HARDNESS	307.95	290.2	278.3	265.8	226.25	270.5	0.03
M. ALKALINITY	288	270	250	230	183.95	270	0.15
TEMPERATURE	28.50	28	27.75	27.33	27	28	0.01
TURBIDITY	0.78	0.35	0.25	0.2	0.15	0.2	0.01
WATER WELL 9: A-9							
CHLORIDE	215.4	168.98	161.05	152.9	143.57	164.8	0.01
SPECIFIC COND	1164	1110	1100	1000	898	1100	0.01
T. HARDNESS	415.55	393.28	365.95	352	329.8	356.7	0.08
CA. HARDNESS	362.76	341.1	321.4	310.4	244.6	313.6	0.01
M. ALKALINITY	311.6	288	271.5	242.5	194	279	0.01
TEMPERATURE	28	28	27.5	27.1	27	26	0.01
TURBDITY	0.98	0.35	0.2	0.14	0.08	0.15	0.01

Table 47. Basic quantile statistics for A-10, A-11 and A-12 water wells.

Parameter	Quantiles 95%	75%	50%	25%	5%	Mode	Prob>D
WATER WELL 10: A-10							
CHLORIDE	285.68	226.5	203.7	174.7	138.35	140	0.15
SPECIFIC COND	1362	1245	1170	1095	895	1200	0.01
T. HARDNESS	423.92	395.75	372.4	356.98	302.47	364.6	0.04
CA. HARDNESS	363.8	341.3	329.3	309.7	227.76	333.2	0.01
M. ALKALINITY	311.3	283	266.5	241.75	201.12	234	0.04
TEMPERATURE	28	28	27.4	27	27	28	0.01
TURBIDITY	0.99	0.21	0.15	0.12	0.08	0.15	0.01
WATER WELL 11: A-11							
CHLORIDE	25.9	19.9	17.9	17.2	15	17.9	0.01
SPECIFIC COND	660	620	600	570	500	600	0.01
T. HARDNESS	342.98	313.6	294	282.2	267.16	282.2	0.10
CA. HARDNESS	306.7	291.15	274.4	262.6	198.33	266.6	0.01
M. ALKALINITY	305.6	280	261	234	192	234	0.15
TEMPERATURE	28.2	28	27.6	27.4	27	28	0.01
TURBIDITY	0.63	0.3	0.20	0.15	0.11	0.15	0.01
WATER WELL 12: A-12							
CHLORIDE	31.41	19.9	17.9	16	13.7	17.9	0.01
SPECIFIC COND	679.5	640	600	580	540.5	600	0.01
T. HARDNESS	355.80	323.95	304.65	294	274.54	297.9	0.15
CA. HARDNESS	341.3	302.7	290.1	278.3	254.8	278.3	0.15
M. ALKALINITY	312	289.5	267.9	242.5	194.25	266	0.05
TEMPERATURE	28	28	27.6	27.1	26.6	28	0.01
TURBIDITY	0.82	0.28	0.19	0.15	0.09	0.15	0.01

Table 48. Basic quantile statistics for A-13, A-14 and A-15 water wells.

Parameter	Quantiles 95%	75%	50%	25%	5%	Mode	Prob>D
WATER WELL 13: A-13							
CHLORIDE	423.84	336.2	315.6	295.25	212.78	285.9	0.01
SPECIFIC COND	1747.5	1537.5	1490	1362.5	1120	1500	0.01
T. HARDNESS	464.15	432.6	403.8	384.2	343.4	384.2	0.15
CA. HARDNESS	403.95	364.05	346.1	329.3	272.05	333.2	0.02
M. ALKALINITY	306	275	262	239.18	188.6	266	0.03
TEMPERATURE	28.29	28	27.5	27.2	27	28	0.01
TURBIDITY	0.87	0.35	0.22	0.18	0.11	0.2	0.01
WATER WELL 14: A-14							
CHLORIDE	352.98	281.9	269.5	247.93	219	277.9	0.01
SPECIFIC COND	1520	1485	1360	1215	1100	1500	0.01
T. HARDNESS	453.6	423.55	395.9	377.65	349.47	376.3	0.15
CA. HARDNESS	376.42	358.95	333.2	317.5	241.2	321.4	0.01
M. ALKALINITY	311.5	275	262.75	232.75	187.25	274	0.10
TEMPERATURE	28.5	28	27.8	27.55	26.98	28	0.01
TURBIDITY	0.73	0.28	0.16	0.11	0.08	0.1	0.01
WATER WELL 15: A-15							
CHLORIDE	200.97	152.2	142.9	128.95	112.21	139	0.01
SPECIFIC COND	1190	1000	980	900	801	1000	0.01
T. HARDNESS	350.85	326.8	309	292.5	269.25	301.8	0.15
CA. HARDNESS	333.68	280.8	268.65	250.9	215.64	258.7	0.01
M. ALKALINITY	263.55	239	226	204.5	166.8	239	0.02
TEMPERATURE	28.8	28	28	27.5	27	28	0.01
TURBIDITY	0.53	0.19	0.14	0.1	0.07	0.1	0.01

Table 49. Basic quantile statistics for A-17, A-18 and A-19 water wells.

Parameter	Quantiles 95%	75%	50%	25%	5%	Mode	Prob>0
WATER WELL 16: A-17							
CHLORIDE	400.31	342.53	314.75	275.4	239.76	357.3	0.15
SPECIFIC COND	1605	1500	1400	1240	1119	1500	0.01
T. HARDNESS	355.67	332.45	317.35	301.8	271	321.4	0.15
CA. HARDNESS	300.44	266.9	254.3	238.13	216.97	235.2	0.15
M. ALKALINITY	225.02	207.25	188.55	174.5	148.4	188	0.15
TEMPERATURE	28.4	28	28	27.8	27	28	0.01
TURBIDITY	0.63	0.29	0.18	0.17	0.08	0.15	0.01
WATER WELL 17: A-18							
CHLORIDE	303	274	252.1	216.2	192.2	268	0.15
SPECIFIC COND	1500	1400	1300	1200	1100	1300	0.05
T. HARDNESS	440.8	415.58	392	377.35	348.41	380.2	0.15
CA. HARDNESS	369.98	353.6	337	317.5	264.74	317.5	0.01
M. ALKALINITY	302.6	280	265	240	189.4	240	0.01
TEMPERATURE	28.5	28	27.8	27.5	27	28	0.01
TURBIDITY	0.431	0.21	0.15	0.12	0.08	0.15	0.01
WATER WELL 18: A-19							
CHLORIDE	368.1	319.1	271	177.48	84.73	224.3	0.01
SPECIFIC COND	1712.5	1500	1300	1137.5	835	1300	0.15
T. HARDNESS	442.3	423.4	413.4	396.43	318.75	423.4	0.01
CA. HARDNESS	410.85	388.1	374.4	354.7	275.57	372.4	0.01
M. ALKALINITY	325.1	294.5	280	246.7	199.6	286	0.05
TEMPERATURE	29.44	28	28	27.8	27	28	0.01
TURBIDITY	0.68	0.28	0.17	0.12	0.09	0.1	0.01

Table 50. Basic quantile statistics for A-21, A-22 and A-23 water wells.

Parameter	Quantiles 95%	75%	50%	25%	5%	Mode	Prob>0
WATER WELL 19: A-21							
CHLORIDE	314.49	286.65	258.5	240.35	215.53	287.7	0.15
SPECIFIC COND	1500	1330	1200	1155	1078	1200	0.01
T. HARDNESS	378.38	343.33	310.85	298.8	288.12	301.8	0.01
CA. HARDNESS	312.78	274.4	260	250.9	229.56	250.9	0.11
M. ALKALINITY	235.6	204	192	173	142	190	0.13
TEMPERATURE	28	28	27.6	27.2	26.5	28	0.01
TURBIDITY	0.5	0.21	0.15	0.11	0.08	0.1	0.01
WATER WELL 20: A-22							
CHLORIDE	114.82	109.6	96	82.85	74.93	101.2	0.09
SPECIFIC COND	986	800	780	740	702	740	0.01
T. HARDNESS	281.03	263.2	254.8	251.45	243.43	254.8	0.36
CA. HARDNESS	261.26	237.55	232.8	221	200.09	227.4	0.65
M. ALKALINITY	233.8	215.75	208	191.3	181.65	208	0.45
TEMPERATURE	29.9	28.15	28	27.65	26.82	28	0.03
TURBIDITY	4.11	0.17	0.12	0.1	0.07	0.01	0.01
WATER WELL 64: A-23							
CHLORIDE	22.6	22.23	21.1	20.88	20.8	21.1	0.08
SPECIFIC COND	710	707.5	700	625	600	700	0.07
T. HARDNESS	304.9	304.13	292	274.25	271.6	271.6	0.40
CA. HARDNESS	294	290.08	273	261.63	259.6	259.6	0.81
M. ALKALINITY	275	275	265	248	248	248	0.70
TEMPERATURE	28	28	27.75	27.13	27	28	0.30
TURBIDITY	1.2	0.98	0.25	0.14	0.13	0.13	0.07

Table 51. Basic quantile statistics for D-1, D-2 and D-3 water wells.

Parameter	Quantiles 95%	75%	50%	25%	5%	Mode	Prob>D
WATER WELL 21: D-1							
CHLORIDE	75.1	62.8	58.2	53.55	40.22	63.5	0.01
SPECIFIC COND	678	620	600	560	491	600	0.01
T. HARDNESS	264.15	247.25	235.2	226.15	196.95	235.2	0.01
CA. HARDNESS	219.95	203	193.6	187.15	172.25	188.2	0.03
M. ALKALINITY	219.1	199	186.1	164.25	137.6	145	0.11
TEMPERATURE	27.59	27	26.5	26.3	26	26.5	0.01
TURBIDITY	0.42	0.2	0.15	0.1	0.07	0.15	0.01
WATER WELL 22: D-2							
CHLORIDE	82.87	64.33	60.25	54.73	48.53	63.5	0.01
SPECIFIC COND	659	620	600	560	480.5	600	0.01
T. HARDNESS	268.21	248.28	237.35	227.33	211.7	231.3	0.01
CA. HARDNESS	219.56	205.4	198.05	186.7	171.38	184.2	0.15
M. ALKALINITY	220.6	204	191	177	143.8	220	0.15
TEMPERATURE	27.80	27	26.5	26.4	26	26.5	0.01
TURBIDITY	0.60	0.25	0.15	0.10	0.06	0.09	0.01
WATER WELL 23: D-3							
CHLORIDE	40.43	39.7	37.45	34.58	29	37.7	0.01
SPECIFIC COND	580	540	520	500	430	500	0.01
T. HARDNESS	244.43	236.68	226.8	215.6	201.66	215.6	0.15
CA. HARDNESS	219.3	207.1	199.7	188.2	168.6	188.2	0.03
M. ALKALINITY	217.65	197.75	188.85	170.25	130.45	193	0.06
TEMPERATURE	27.99	27	26.8	26.5	26	27	0.01
TURBIDITY	0.50	0.19	0.13	0.1	0.07	0.1	0.01

Table 52. Basic quantile statistics for D-4, D-5 and D-6 water wells.

Parameter	Quantiles 95%	75%	50%	25%	5%	Mode	Prob>D
WATER WELL 24: D-4							
CHLORIDE	59,46	45.7	42	39.48	36,63	43.7	0.01
SPECIFIC COND	600	560	540	500	410.5	540	0.01
T. HARDNESS	261,1	241.9	233.3	223.4	206,48	227.4	0.15
CA. HARDNESS	219.71	203.8	192.85	184.2	173,52	184.2	0.15
M. ALKALINITY	222.5	204,5	190	179.5	153	187	0.15
TEMPERATURE	27.68	27	26.6	26.4	26	27	0.01
TURBIDITY	0.38	0.18	0.12	0.1	0.07	0,1	0.01
WATER WELL 25: D-5							
CHLORIDE	85.5	67.6	63.5	60.1	55.9	67.5	0.01
SPECIFIC COND	660	610	580	560	470	600	0.01
T. HARDNESS	257.24	239,1	227.4	215.6	202.04	219.5	0.02
CA. HARDNESS	209,73	203	196	187.78	172.5	184,7	0.13
M. ALKALINITY	209,3	187.75	174.75	161	130.45	182	0.15
TEMPERATURE	27.96	27	26.5	26.05	26	26	0.01
TURBIDITY	0.32	0.2	0.15	0.11	0.09	0.1	0.01
WATER WELL 26: D-6							
CHLORIDE	70.10	61.0	53.6	49.4	43.80	55.6	0.01
SPECIFIC COND	620	580	540	500	440.5	520	0.14
T. HARDNESS	243.06	224.38	214.5	202.1	191.71	203.8	0.02
CA. HARDNESS	203.4	190.75	181.3	172.75	164.6	180.3	0.15
M. ALKALINITY	201.1	181.5	170	156.25	136.8	176	0.04
TEMPERATURE	27.97	27	26.5	26.35	26	27	0.01
TURBIDITY	0.60	0.21	0.14	0.1	0.07	0.1	0.01

Table 53. Basic quantile statistics for D-7, D-8 and D-9 water wells.

Parameter	Quantiles 95%	75%	50%	25%	5%	Mode	Prob>D
WATER WELL 27: D-7							
CHLORIDE	75.1	57.2	51.6	49	41.5	51.6	0.01
SPECIFIC COND	580	540	500	500	440	500	0.01
T. HARDNESS	233.45	211.7	199.8	191.58	178.16	196	0.01
CA. HARDNESS	196.55	185.8	178.9	168.3	154.85	164.6	0.15
M. ALKALINITY	195.2	173	160	147.25	127.3	166	0.15
TEMPERATURE	27.44	27	26.7	26.5	26	27	0.01
TURBIDITY	0.58	0.27	0.16	0.13	0.06	0.15	0.01
WATER WELL 28: D-8							
CHLORIDE	255.91	198.7	155.15	137	119.17	137	0.01
SPECIFIC COND	1040	900	800	740	620	800	0.15
T. HARDNESS	248.31	233	219	120.28	193.23	215.6	0.15
CA. HARDNESS	202.1	189.55	180.3	172.5	162.35	172.5	0.15
M. ALKALINITY	176	161.75	148	136	114.45	136	0.15
TEMPERATURE	27.68	27	26.5	26.3	26	27	0.01
TURBIDITY	0.54	0.23	0.15	0.11	0.08	0.15	0.01
WATER WELL 29: D-9							
CHLORIDE	165.82	128.05	113.5	104.05	95.23	104.5	0.01
SPECIFIC COND	862	800	760	700	498	800	0.01
T. HARDNESS	282.79	261.55	240.6	227.1	201.2	239.1	0.15
CA. HARDNESS	217.37	203	189.3	180.3	170.43	184.2	0.01
M. ALKALINITY	224.4	193.25	178.1	162.75	131.9	153	0.15
TEMPERATURE	27.72	27	26.6	26.5	26	26.5	0.01
TURBIDITY	0.441	0.25	0.18	0.1	0.07	0.25	0.01

Table 54. Basic quantile statistics for D-10, D-11 and D-12 water wells.

Parameter	Quantiles 95%	75%	50%	25%	5%	Mode	Prob>|D|
WATER WELL 30: D-10							
CHLORIDE	54.5	41.4	39	35.7	33	37.7	0.01
SPECIFIC COND	560	500	490	470	400	500	0.01
T. HARDNESS	249.98	218.55	203.8	196	185.43	199.9	0.01
CA. HARDNESS	199.8	188.75	181.3	172.5	165.7	168.6	0.15
M. ALKALINITY	200.55	180.75	164	148.25	129.9	164	0.09
TEMPERATURE	27.69	27	26.6	26.45	26	26.5	0.01
TURBIDITY	0.55	0.19	0.12	0.09	0.05	0.1	0.01
WATER WELL 31: D-11							
CHLORIDE	93.3	88.6	81.4	64.4	38.9	89.3	0.01
SPECIFIC COND	700	660	610	550	440	680	0.04
T. HARDNESS	250.72	237.1	222.6	215.6	203.8	219.5	0.15
CA. HARDNESS	214.66	197.8	192.1	184.2	171.6	184.2	0.14
M. ALKALINITY	209	192	178	162	132.4	184	0.15
TEMPERATURE	27.69	27	26.5	26.23	26	26.5	0.01
TURBIDITY	0.43	0.20	0.14	0.1	0.07	0.1	0.01
WATER WELL 32: D-12							
CHLORIDE	27.9	23.3	19.7	16.7	13.5	21.8	0.04
SPECIFIC COND	450.5	400	385	350	300	400	0.01
T. HARDNESS	243.93	185.8	176.4	168.6	156.87	172.5	0.01
CA. HARDNESS	190	168.6	160.7	155.2	145	156.8	0.02
M. ALKALINITY	174.85	156	144	130.75	113.05	150	0.15
TEMPERATURE	27.5	27	26.5	26.4	26	27	0.01
TURBIDITY	0.36	0.18	0.12	0.1	0.06	0.1	0.01

Table 55. Basic quantile statistics for D-13, D-14 and D-15 water wells.

Parameter	Quantiles 95%	75%	50%	25%	5%	Mode	Prob>D
WATER WELL 33: D-13							
CHLORIDE	377.21	314.68	172.1	145.63	116.6	161.6	0.01
SPECIFIC COND	1505	1210	860	735	639	720	0.01
T. HARDNESS	299.6	265.55	227.4	205.6	190.56	203.8	0.01
CA. HARDNESS	222.7	201.2	188	170.7	158.76	180.3	0.03
M. ALKALINITY	170.25	157	144.95	133.75	114.05	142	0.15
TEMPERATURE	27.7	27	26.5	26.3	26	27	0.01
TURBIDITY	0.80	0.33	0.2	0.12	0.08	0.25	0.01
WATER WELL 34: D-14							
CHLORIDE	49.3	39.7	35.9	33.3	25.1	37.7	0.02
SPECIFIC COND	650	560	540	500	470	540	0.01
T. HARDNESS	268.88	243.0	231.3	219.5	211.82	223.4	0.04
CA. HARDNESS	232.36	222.6	212.6	203.8	178.16	207.8	0.11
M. ALKALINITY	219.6	202	185	172	144.4	200	0.15
TEMPERATURE	27.9	27.1	27	26.5	26	27	0.01
TURBIDITY	0.06	0.16	0.12	0.09	0.06	0.15	0.01
WATER WELL 35: D-15							
CHLORIDE	122	91.38	73.5	68.68	54.05	73.5	0.01
SPECIFIC COND	761	700	660	620	559	680	0.14
T. HARDNESS	280.07	261.35	243.5	231.3	216.97	247	0.03
CA. HARDNESS	233.18	216.3	209.7	199.9	189.64	196	0.15
M. ALKALINITY	225	209.25	194.5	179	146.4	176	0.15
TEMPERATURE	27.5	27	26.6	26.4	26	27	0.01
TURBIDITY	0.28	0.18	0.11	0.09	0.07	0.1	0.01

Table 56. Basic quantile statistics for D-16, D-17 and D-18 water wells.

Parameter	Quantiles 95%	75%	50%	25%	5%	Mode	Prob>|C|
WATER WELL 65: D-16							
CHLORIDE	100.16	79.4	66	50.5	34.96	66	0.02
SPECIFIC COND	740	690	640	500	444	660	0.01
T. HARDNESS	279.24	265.4	253.8	199.2	184.12	276.5	0.01
CA. HARDNESS	246	237.6	228.8	219.5	176.7	228.8	0.01
M. ALKALINITY	249.35	219.5	199	189.75	161.23	198	0.88
TEMPERATURE	27	27	26.5	26.5	26	26.5	0.01
TURBIDITY	0.68	0.24	0.15	0.13	0.08	0.15	0.01
WATER WELL 66: D-17							
CHLORIDE	72.63	56.25	45.6	35.08	16.6	15.9	0.43
SPECIFIC COND	660	620	600	540	486.75	600	0.01
T. HARDNESS	284.4	270.4	261.1	250	235.88	247	0.92
CA. HARDNESS	259.04	244	241.3	235.2	202.38	243	0.01
M. ALKALINITY	256.75	229.5	212	200.5	166.5	192	0.01
TEMPERATURE	27.20	27	26.65	26.5	26	27	0.01
TURBIDITY	0.27	0.20	0.15	0.10	0.07	0.1	0.04
WATER WELL 67: D-18							
CHLORIDE	90.93	68.5	63.7	61.23	57.97	68.5	0.01
SPECIFIC COND	700	660	640	600	504	640	0.01
T. HARDNESS	276.29	269.1	262.1	247	220.62	247	0.10
CA. HARDNESS	250.43	234.1	229	221.	196.85	229	0.64
M. ALKALINITY	268.9	229.75	205	188	176.4	188	0.30
TEMPERATURE	27	27	26.8	26.5	26.37	27	0.01
TURBIDITY	0.41	0.24	0.13	0.09	0.06	0.1	0.01

Table 57. Basic quantile statistics for M-1, M-2 and M-3 water wells.

Parameter	Quantiles 95%	75%	50%	25%	5%	Mode	Prob>D
WATER WELL 36: M-1							
CHLORIDE	223.11	170	153	140.1	115.01	115.1	0.01
SPECIFIC COND	1100.5	960	890	800	706.5	900	0.01
T. HARDNESS	282.2	267.8	250.9	243	215.6	247	0.10
CA. HARDNESS	224.6	181.4	168.5	156.8	148.04	152.9	0.01
M. ALKALINITY	223.2	201	180.5	163	133.6	210	0.15
TEMPERATURE	28	27	26.9	26.6	26	27	0.01
TURBIDITY	0.72	0.19	0.15	0.1	0.07	0.1	0.01
WATER WELL 37: M-2							
CHLORIDE	81.4	77.4	72.1	60.1	51.9	75.4	0.01
SPECIFIC COND	700	642.5	620	600	499.5	600	0.01
T. HARDNESS	264.36	241.9	221.2	214.2	196.76	215.6	0.01
CA. HARDNESS	198.34	168.6	164.8	155.2	136.42	160.7	0.01
M. ALKALINITY	210.65	197.75	178.75	161	134.7	161	0.15
TEMPERATURE	28	27	26.9	26.6	26	27	0.01
TURBIDITY	0.83	0.28	0.2	0.15	0.09	0.2	0.01
WATER WELL 38: M-3							
CHLORIDE	31.1	25.78	23.15	19.63	16.74	23.8	0.01
SPECIFIC COND	579	480	450	440	400	450	0.01
T. HARDNESS	255.98	226.6	212.55	199.9	191	199.9	0.01
CA. HARDNESS	196.9	176.98	167.5	156.8	146.08	164.6	0.15
M. ALKALINITY	215.8	192	180	160	121.4	160	0.03
TEMPERATURE	27.7	27	26.8	26.5	26	27	0.01
TURBIDITY	0.35	0.19	0.13	0.1	0.06	0.1	0.01

Table 58. Basic quantile statistics for M-4, M-5 and M-6 water wells.

Parameter	Quantiles 95%	75%	50%	25%	5%	Mode	Prob>|T|
WATER WELL 39: M-4							
CHLORIDE	28.47	22	20.35	17.93	13.6	21.8	0.01
SPECIFIC COND	500	467.5	450	422.5	385.25	450	0.01
T. HARDNESS	248.62	228.8	208.75	197.93	183.71	203.8	0.01
CA. HARDNESS	212.62	190.1	183.3	169.13	149.49	184.2	0.15
M. ALKALINITY	209.4	192	177	161	136	160	0.15
TEMPERATURE	27.7	27	26.8	26.5	26	27	0.01
TURBIDITY	0.50	0.21	0.13	0.1	0.08	0.1	0.01
WATER WELL 40: M-5							
CHLORIDE	54.7	45	41.7	37.2	31.2	43.7	0.15
SPECIFIC COND	600	550	540	500	450	540	0.01
T. HARDNESS	271.28	241.9	231.1	215.6	206.48	215.6	0.01
CA. HARDNESS	215.84	200	193.6	184.2	163.28	184.2	0.01
M. ALKALINITY	223.3	202.5	188.5	167	139.05	167	0.15
TEMPERATURE	27.61	27	26.8	26.5	26.40	27	0.01
TURBIDITY	0.45	0.15	0.12	0.1	0.06	0.1	0.01
WATER WELL 41: M-6							
CHLORIDE	75.34	65.5	57.1	44.48	36.02	69.5	0.04
SPECIFIC COND	649.5	600	580	520	451	600	0.01
T. HARDNESS	259.13	235.35	223.4	216.08	206.59	233.4	0.01
CA. HARDNESS	242.15	206.73	196	188.2	180.3	196	0.06
M. ALKALINITY	205.2	192	177.7	161	136.4	198	0.15
TEMPERATURE	27.90	27	26.85	26.5	26.4	27	0.01
TURBIDITY	0.4	0.18	0.13	0.1	0.08	0.15	0.01

Table 59. Basic quantile statistics for M-7, M-8 and M-9 water wells.

Parameter	Quantiles 95%	75%	50%	25%	5%	Mode	Prob>D
WATER WELL 42: M-7							
CHLORIDE	49.66	37.6	35.1	31.25	27.04	35.7	0.01
SPECIFIC COND	560	540	500	490	440	500	0.01
T. HARDNESS	271.4	237.75	223.4	211.15	202.4	215.6	0.01
CA. HARDNESS	214	200	194.4	184.2	158.4	188.2	0.02
M. ALKALINITY	214.65	202	184.25	167	134.9	165	0.15
TEMPERATURE	27.77	27	26.8	26.5	26	27	0.01
TURBIDITY	0.35	0.18	0.13	0.1	0.07	0.1	0.01
WATER WELL 43: M-8							
CHLORIDE	29.57	23.3	20	19.25	15.6	19.9	0.01
SPECIFIC COND	500	450	430	400	350	450	0.01
T. HARDNESS	239.75	209.7	199.9	188.2	174.25	188.2	0.02
CA. HARDNESS	188.96	159.05	152.9	143.6	130.57	145	0.01
M. ALKALINITY	194	178.75	163	150.25	129.7	156	0.15
TEMPERATURE	27.99	27	26.8	26.5	26.02	27	0.01
TURBIDITY	0.53	0.16	0.12	0.09	0.06	0.09	0.01
WATER WELL 44: M-9							
CHLORIDE	363.37	266.2	243.3	224.35	210.06	230.3	0.01
SPECIFIC COND	1400	1200	1170	1100	817	1200	0.01
T. HARDNESS	325.24	299.6	270.7	257.6	236.04	266.6	0.15
CA. HARDNESS	258.52	191.95	180.3	168.55	153.59	180.3	0.01
M. ALKALINITY	217.9	187.25	172.35	157	131.4	185	0.15
TEMPERATURE	28	27	27	26.6	26.29	27	0.01
TURBIDITY	0.99	0.5	0.3	0.21	0.14	0.25	0.01

Table 60. Basic quantile statistics for M-12, M-14 and M-15 water wells.

Parameter	Quantiles 95%	75%	50%	25%	5%	Mode	Prob>D
WATER WELL 45: M-12							
CHLORIDE	105.86	91.48	79	70	42.48	93.3	0.15
SPECIFIC COND	810.5	720	700	640	520	700	0.01
T. HARDNESS	295.68	274.98	262.35	250.9	229.68	254.8	0.13
CA. HARDNESS	274.36	243	231.3	218.5	190.1	223.4	0.15
M. ALKALINITY	238.65	220.75	205.5	188.5	127.1	201	0.01
TEMPERATURE	28	27.1	27	26.7	26	27	0.01
TURBIDITY	0.31	0.2	0.14	0.11	0.08	0.1	0.01
WATER WELL 46: M-14							
CHLORIDE	70.03	50.6	33.7	26.15	17.5	35.7	0.01
SPECIFIC COND	700	660	630	600	520	600	0.01
T. HARDNESS	320.32	299.08	278.3	270.5	245.95	270.5	0.06
CA. HARDNESS	293.8	271.3	254.8	240.6	195.04	247	0.03
M. ALKALINITY	279.6	255	235	208	158.4	224	0.02
TEMPERATURE	27.90	27	26.9	26.6	26	27	0.01
TURBIDITY	0.24	0.16	0.13	0.1	0.08	0.1	0.01
WATER WELL 68: M-15							
CHLORIDE	42	38.7	34.9	28.03	26	26	0.70
SPECIFIC COND	650	590	540	505	410	540	0.84
T. HARDNESS	321.3	279.33	218.4	211.03	207.8	215.6	0.01
CA. HARDNESS	203.8	207.83	196	187.18	184.2	196	0.43
M. ALKALINITY	222	220	185	170	169	169	0.18
TEMPERATURE	27	26.75	26.55	26.5	26	26.5	0.36
TURBIDITY	0.3	0.20	0.14	0.11	0.09	0.12	0.08

Table 61. Basic quantile statistics for F-1, F-2 and F-3 water wells.

Parameter	Quantiles 95%	75%	50%	25%	5%	Mode	Prob>D
WATER WELL 47: F-1							
CHLORIDE	101.2	87.3	72	62	56	85.4	0.01
SPECIFIC COND	660	600	560	522.5	480	540	0.01
T. HARDNESS	237.93	214.2	199.9	188.2	173.45	188.2	0.10
CA. HARDNESS	198.7	188.28	179.6	168.6	160.32	168.6	0.15
M. ALKALINITY	181.6	165	152	140	116	140	0.15
TEMPERATURE	28	27	26.7	26.4	26	27	0.01
TURBIDITY	0.33	0.15	0.12	0.1	0.07	0.1	0.01
WATER WELL 48: F-2							
CHLORIDE	158.3	115	107.2	96.7	89.9	107.2	0.01
SPECIFIC COND	759	700	660	630	522	640	0.01
T. HARDNESS	228.78	215.55	196	188.2	173.45	196	0.01
CA. HARDNESS	191.95	180.95	168.6	160.7	145.8	164.6	0.15
M. ALKALINITY	168.55	158	146.15	133.25	114.8	143	0.15
TEMPERATURE	27.95	27	26.8	26.5	26	27	0.01
TURBIDITY	0.45	0.21	0.15	0.12	0.09	0.1	0.01
WATER WELL 49: F-3							
CHLORIDE	165.8	102.1	94	90	73.2	91.3	0.01
SPECIFIC COND	780	660	640	600	500	640	0.01
T. HARDNESS	224.2	207.8	196	184.2	158.88	184.2	0.01
CA. HARDNESS	195.34	172.45	166.4	160.7	152.02	160.7	0.01
M. ALKALINITY	169.6	155	146	131	112.2	155	0.15
TEMPERATURE	27.5	27	26.5	26.3	26	27	0.01
TURBIDITY	0.35	0.2	0.15	0.11	0.07	0.15	0.01

Table 62. Basic quantile statistics for F-4, F-5 and F-6 water wells.

Parameter	Quantiles 95%	75%	50%	25%	5%	Mode	Prob>D
WATER WELL 50: F-4							
CHLORIDE	199.4	134.5	105.2	78.8	64	113.2	0.01
SPECIFIC COND	860	750	660	580	460	580	0.15
T. HARDNESS	235.22	215.6	199.9	187.2	170.64	203.8	0.15
CA. HARDNESS	195.73	179.8	172.75	165.15	150.31	164.6	0.01
M. ALKALINITY	177.2	156	146.2	138	115.4	144	0.15
TEMPERATURE	28	27	26.6	26.2	26	27	0.01
TURBIDITY	0.35	0.22	0.14	0.11	0.09	0.1	0.01
WATER WELL 51: F-5							
CHLORIDE	80.71	62.83	55.6	50	40.51	59.6	0.15
SPECIFIC COND	606	550	500.5	472.5	447.75	500	0.01
T. HARDNESS	239.18	206.73	192.1	180.3	168.68	176.4	0.01
CA. HARDNESS	199.54	180.2	172.5	163.8	149.17	164.6	0.02
M. ALKALINITY	174.75	163.75	151	135	112.25	158	0.15
TEMPERATURE	27.5	27	26.7	26.45	26	27	0.01
TURBIDITY	0.74	0.3	0.19	0.12	0.08	0.1	0.01
WATER WELL 52: F-6							
CHLORIDE	212.85	152.68	121.1	98.78	84.8	93.3	0.03
SPECIFIC COND	963	815	700	640	538.5	800	0.01
T. HARDNESS	252.3	230.78	211.7	196	184.2	196	0.13
CA. HARDNESS	210.53	190.9	180.3	168.6	160.7	172.5	0.15
M. ALKALINITY	176	160.75	149.4	139.25	114.5	145	0.15
TEMPERATURE	28	27.2	27	26.5	26	27	0.01
TURBIDITY	0.27	0.2	0.15	0.11	0.09	0.15	0.01

Table 63. Basic quantile statistics for F-7, F-8 and F-9 water wells.

Parameter	Quantiles 95%	75%	50%	25%	5%	Mode	Prob>D
WATER WELL 53: F-7							
CHLORIDE	80.56	63.5	57.5	52.3	46.11	63.5	0.01
SPECIFIC COND	600	562.5	535	500	450	520	0.01
T. HARDNESS	249.37	209.7	195.75	187.1	178.5	188.2	0.01
CA. HARDNESS	200.92	184	179.8	172.5	162.26	180.3	0.01
M. ALKALINITY	176	164.75	154	141	115.7	160	0.05
TEMPERATURE	28	27	26.7	26.5	26	27	0.01
TURBIDITY	0.3	0.17	0.13	0.1	0.06	0.1	0.01
WATER WELL 54: F-8							
CHLORIDE	28.21	22.2	19.9	17.85	15.42	19.9	0.01
SPECIFIC COND	480.95	430	400	370	329.5	400	0.01
T. HARDNESS	221.76	199.9	185.8	172.5	158.56	172.5	0.15
CA. HARDNESS	195.77	178.9	168.9	160.7	153.67	160.7	0.02
M. ALKALINITY	183.4	163	152	140	113	145	0.15
TEMPERATURE	27.5	27	26.5	26.4	26	26.5	0.01
TURBIDITY	0.25	0.14	0.1	0.09	0.06	0.1	0.01
WATER WELL 55: F-9							
CHLORIDE	96.26	75.05	60.25	50	45.66	50	0.01
SPECIFIC COND	600	580	500	480	440	500	0.01
T. HARDNESS	250.27	218.3	207.7	195.63	174.83	195.5	0.34
CA. HARDNESS	213.7	185.9	177.15	172.25	146.07	176.4	0.27
M. ALKALINITY	192	163	151	141	133	151	0.02
TEMPERATURE	27.18	27	26.5	26.3	26	27	0.01
TURBIDITY	0.63	0.18	0.13	0.1	0.09	0.1	0.01

Table 64. Basic quantile statistics for F-10 and F-11 water wells.

Parameter	Quantiles 95%	75%	50%	25%	5%	Mode	Prob>D
WATER WELL 56: F-10							
CHLORIDE	219.13	180.2	143.35	127.1	89.94	126.8	0.10
SPECIFIC COND	1026	930	820	700	530	800	0.15
T. HARDNESS	300.15	272.2	253.9	232.15	204.36	231.3	0.86
CA. HARDNESS	245.66	225.6	212.2	197.85	171.64	203.8	0.96
M. ALKALINITY	205.9	197	176.5	165.5	142.5	162	0.53
TEMPERATURE	27.65	27	26.5	26.2	26	27	0.01
TURBIDITY	0.75	0.35	0.2	0.15	0.07	0.2	0.01
WATER WELL 57: F-11							
CHLORIDE	144	113.75	99.3	82.5	73.4	74	0.01
SPECIFIC COND	759	720	640	600	520	600	0.14
T. HARDNESS	253.38	226.1	207.4	195.75	169.38	207.4	0.55
CA. HARDNESS	222.68	182.7	176.4	168.3	153.45	160.7	0.01
M. ALKALINITY	178.55	165.25	148	138.25	128.15	145	0.08
TEMPERATURE	28	27	26.5	26.23	26	27	0.01
TURBIDITY	0.51	0.25	0.15	0.11	0.09	0.1	0.01

Table 65. Basic quantile statistics for H-1 and Y-1 water wells.

Parameter	Quantiles 95%	75%	50%	25%	5%	Mode	Prob>D
WATER WELL 58: H-1							
CHLORIDE	147.89	107.15	97.95	78.25	61.15	77.4	0.07
SPECIFIC COND	809.5	740	680	620	570.5	700	0.04
T. HARDNESS	285.72	263.7	239.1	227.4	218.9	239.1	0.01
CA. HARDNESS	236.00	219.13	206.8	192.1	175.88	192.1	0.06
M. ALKALINITY	218.2	197	186	170	133.45	167	0.15
TEMPERATURE	27.8	27	26.8	26.5	26	27	0.01
TURBIDITY	0.32	0.16	0.12	0.1	0.07	0.1	0.01
WATER WELL 59: Y-1							
CHLORIDE	29.83	22.75	21.7	19.5	16	21.8	0.01
SPECIFIC COND	579	500	490	450	400	500	0.01
T. HARDNESS	258.12	245.25	231.3	221.35	202.47	227.4	0.15
CA. HARDNESS	227.24	214	206.8	199.3	188.96	199.9	0.15
M. ALKALINITY	230	213	194	172	146.8	210	0.15
TEMPERATURE	28	27.4	27	26.73	26	27	0.01
TURBIDITY	0.35	0.18	0.11	0.09	0.06	0.1	0.01
WATER WELL 60: Y-2							
CHLORIDE	26.21	23.33	21.5	19.7	16	21.8	0.01
SPECIFIC COND	541	500	490	460	400	500	0.01
T. HARDNESS	257.70	244.28	231.3	221.65	211.7	231.3	0.15
CA. HARDNESS	224.6	215.8	207.8	196	190.1	196	0.15
M. ALKALINITY	232	213	196.5	177.5	144.5	219	0.14
TEMPERATURE	28	27.33	27	26.8	26	27	0.01
TURBIDITY	0.34	0.16	0.13	0.1	0.07	0.1	0.01

Table 66. Basic quantile statistics for Y-3, Y-4 and Y-5 water wells.

Parameter	Quantiles 95%	75%	50%	25%	5%	Mode	Prob>D
WATER WELL 61: Y-3							
CHLORIDE	25.9	21.9	19.9	18.1	14.01	21.8	0.01
SPECIFIC COND	520	500	470	450	400	500	0.01
T. HARDNESS	255.9	242.15	224.6	215.6	204	215.6	0.03
CA. HARDNESS	230.7	214.2	207.4	196	188.08	196	0.12
M. ALKALINITY	220	206	188.1	174	146.8	182	0.15
TEMPERATURE	28	27.5	27	26.93	26	27	0.01
TURBIDITY	0.93	0.35	0.22	0.18	0.12	0.2	0.01
WATER WELL 62: Y-4							
CHLORIDE	33.51	24.25	21.9	21.15	18.01	21.8	0.01
SPECIFIC COND	578	505	500	450	402	500	0.01
T. HARDNESS	261.95	250.1	235.2	218.4	211.65	211.7	0.04
CA. HARDNESS	222.88	212.2	203.8	192	177.42	188.2	0.15
M. ALKALINITY	229.4	208	198	180	147.6	200	0.05
TEMPERATURE	27.99	27.2	27	26.8	26	27	0.01
TURBIDITY	0.55	0.2	0.14	0.1	0.07	0.1	0.01
WATER WELL 63: Y-5							
CHLORIDE	49.04	37.78	34.95	32.08	17.2	33.7	0.02
SPECIFIC COND	569	505	500	450	400	500	0.09
T. HARDNESS	254.9	233.3	227.9	214	194.4	207.8	0.43
CA. HARDNESS	235.4	207.4	198.7	191.4	178.5	191.4	0.11
M. ALKALINITY	213.35	192.75	174.5	163.25	149.15	152	0.50
TEMPERATURE	28	27	26.6	26.5	26	27	0.01
TURBIDITY	2.36	0.3	0.15	0.1	0.09	0.1	0.01

Table 67. Basic quantile statistics for Y-6 and Y-7 water wells.

Parameter	Quantiles 95%	75%	50%	25%	5%	Mode	Prob>D
WATER WELL 69: Y-6							
CHLORIDE	50	24	20	18	14.1	14.1	0.01
SPECIFIC COND	640	520	490	460	400	500	0.01
T. HARDNESS	262.64	243	238	228.8	205.12	228.8	0.57
CA. HARDNESS	256.39	218.4	211.7	203.8	182.3	211.7	0.01
M. ALKALINITY	223.3	199.25	188.5	178.75	139.85	182	0.24
TEMPERATURE	27.61	27	26.9	26.5	26.19	27	0.01
TURBIDITY	0.32	0.17	0.12	0.09	0.07	0.09	0.01
WATER WELL 70: Y-7							
CHLORIDE	31.7	26.15	24.7	21.03	19.9	25.4	0.51
SPECIFIC COND	700	555	485	447.5	440	440	0.05
T. HARDNESS	246.9	237.15	228.15	225.6	219.5	227.4	0.45
CA. HARDNESS	211.7	209.08	207.75	204.25	180.3	207.8	0.01
M. ALKALINITY	244	224	199	177	148	148	0.91
TEMPERATURE	28	27	26.9	26.73	26.5	26.9	0.02
TURBIDITY	0.21	0.15	0.12	0.1	0.1	0.1	0.04

Table 68. Basic quantile statistics for AG-1, AG-2 and GHURA water wells.

Parameter	Quantiles 95%	75%	50%	25%	5%	Mode	Prob>D
WATER WELL 71: AG-1							
CHLORIDE	59.6	41.05	37.1	33.7	30.02	31.8	0.01
SPECIFIC COND	542	500	480	450	360	500	0.01
T. HARDNESS	235.65	216.1	203	191.1	175.14	192.1	0.04
CA. HARDNESS	211.42	192.55	184.2	180.3	172.5	180.3	0.01
M. ALKALINITY	191.75	180.75	164.5	149	126.25	148	0.15
TEMPERATURE	28	27	26.75	26.43	26	27	0.01
TURBIDITY	0.46	0.16	0.12	0.1	0.06	0.1	0.01
WATER WELL 72: AG-2							
CHLORIDE	30.23	19.9	17.9	15.88	13.7	15.9	0.01
SPECIFIC COND	493	410	400	367.5	323.5	400	0.01
T. HARDNESS	240.36	197.8	188.2	176.4	162.72	176.4	0.01
CA. HARDNESS	213.62	179.8	171.2	164.6	156.8	164.6	0.01
M. ALKALINITY	179	165	151	134	119.2	136	0.15
TEMPERATURE	27.98	27	26.5	26.4	26	26.5	0.01
TURBIDITY	0.35	0.2	0.15	0.11	0.08	0.15	0.01
WATER WELL 73: GHURA							
CHLORIDE	95.97	72.1	66.5	61.55	46.48	65.5	0.01
SPECIFIC COND	620	600	580	520	460	600	0.01
T. HARDNESS	264.72	237.83	233.3	222.78	201.1	233.3	0.15
CA. HARDNESS	243.89	197.72	192.6	181.35	162.1	194.4	0.01
M. ALKALINITY	212.85	199.5	177	165.5	116.5	163	0.06
TEMPERATURE	27.39	27	26.6	26.5	26.01	26.5	0.01
TURBIDITY	0.86	0.24	0.15	0.1	0.07	0.1	0.01

Table 69. Summary quantiles and test of normal distribution for water quality parameters from combined well series.

Parameter	Quantiles 95%	75%	50%	25%	5%	Mode	Prob>D
CHLORIDE	279.8	109.0	54.3	23.3	16.3	21.8	0.01
CONDUCTANCE	1336	710	600	500	400	600	0.01
pH	7.70	7.50	7.35	7.17	6.95	7.38	0.01
T. HARDNESS	391.1	283.8	239.1	212.1	184.0	215.6	0.01
CA. HARDNESS	337.0	256.0	200.0	180.3	156.8	164.6	0.01
M. ALKALINITY	281.0	223.0	186.0	161.0	132.0	172.0	0.01
TEMPERATURE	28.0	27.5	27.0	26.5	26.0	27.0	0.01
TURBIDITY	0.50	0.21	0.15	0.10	0.08	0.1	0.01

Regression Analyses

A series of regression programs were run to assess linear changes in water quality data throughout the sample period for each well. The SAS regression programs fit a least squares estimate to linear regression models (SAS Institute Inc., 1982). The data presented in this regression section are from a GLM (General Linear Models) procedure. This is an extremely versatile procedure that can do many different analyses which include simple and multiple regression, analysis of variance for unbalanced data, analysis of covariance, response-surface models, weighted regression, polynomial regression, partial correlation, and multivariate analysis of variance. The assumptions and description of tests are well documented in the SAS users' manual (SAS Institute Inc., 1982).

The regression section presents significance levels and R-correlations of linear regressions for each measured water quality parameter by well. The F-value, PROB>F, R-squared and adjusted R-squared values are presented in Tables 70-106 with a summary in Table 107. The F-value tests the hypothesis that all parameters are zero except for the intercept. The PROB>F is the significance probability, which is a measure of the probability of getting a greater F statistic than that observed for a true hypothesis. The R-squared is a measure between 0 and 1 and indicates the fit of the data in a regression line. This is a coefficient of determination which indicates the portion of total variation that attributes to fit rather than left to residual error. Values of R-squared that are closer to 1 indicate a better fit, while values nearer zero show wider data scatter. The adjusted R-square version of R-squared takes into account the degrees of freedom (number of data used minus 1). It also provided a measure of data fit to the linear regression line.

This regression section can be used to determine linear trends in water quality parameters for production water wells. Many water quality parameters which were showing significant trends (either positive or negative) had poor data correlations or low R-squared values. This showed that monthly data values were widely scattered on a time series basis, but generally that there was a longer-term trend imposed on the data. This type of well behavior was usually associated with a cyclic trend and the data scatter indicated the magnitude of cycles.

Polynomial regressions were run to determine the types of cycles occurring in the water quality data. The polynomial regressions were difficult to interpet and provided peculiar results. For those water quality parameters showing cyclic trends, there was a great deal of similarity in the cyclic behavior for a particular parameter for the entire well series. For example, monthly changes in pH values followed similar increases or decreases for all monitored wells. This was not an anticipated characteristic of the groundwater aquifer, but more probably reflected an analysis artifact. Total hardness, calcium hardness and total alkalinity also show all well-wide large cyclic trends, but not to the same extent as pH. These larger cyclic trends were determined to be primarily an artifact of laboratory analysis techniques and reflect laboratory technician trends. However, the shorter-term cyclic behavior and longer-term trends seen in well data are probably characteristic of well waters.

Table 70. Significance levels of linear regressions of water quality parameters for A-1 and A-2 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 1: A-1	Variable	F value	Prob >P	R square	Adj R-square
	Chloride	1.361	0.2484	0.0242	0.0064
	pH	5.687	0.0206	0.0937	0.0772
	Conductance	4.943	0.0303	0.0825	0.0658
	T. Hardness	0.043	0.8366	0.0008	-0.0174
	Ca. Hardness	0.352	0.5557	0.0064	-0.0117
	M.Alkalinity	3.170	0.0805	0.0545	0.0373
	Temperature	2.908	0.0938	0.0502	0.0330
	Turbidity	0.204	0.6534	0.0037	-0.0144
Well 2: A-2					
	Chloride	2.670	0.1074	0.0419	0.0262
	pH	1.986	0.1638	0.0315	0.0157
	Conductance	0.191	0.6636	0.0031	-0.0132
	T. Hardness	0.403	0.5279	0.0066	-0.0097
	Ca. Hardness	10.678	0.0018	0.1490	0.1350
	M.Alkalinity	0.701	0.4056	0.0114	-0.0048
	Temperature	2.496	0.1193	0.0393	0.0236
	Turbidity	0.067	0.7960	0.0011	-0.0153

A summary of water quality parameter trends at the $P<0.05$ level are shown for all wells in Table 107. Based on linear regression models, polynomial regressions and scattergrams, three types of water quality trends (which occurred in wells with both significant linear regressions and apparent cyclic patterns) were determined: positive or increase, negative or decrease, and cyclic. These trend patterns are shown in Table 107.

A statistically significant increase in chloride concentrations occurs in 17 wells (24%) with an additional 20 wells (27%) that have a positive cyclic pattern. These are 51 percent of the production water wells with an increase in chloride concentration over time. Saltwater intrusion is the primary factor which causes an increase in chlorides. Over-pumping can cause an increase in saltwater intrusion. Therefore, at least half of the production water wells have pumping rates high enough to affect chlorides. There were 9 wells (12%) that had negative chloride trends. These wells were from the D, M and F-series and they had significant decreases in chloride concentrations within the last few years. These wells are classified as both basal and parabasal wells. There are no obvious reasons which account for this decrease in chlorides. A negative regression trend for pH occurred in 88% of the wells with 2 wells showing cyclic behavior. Total hardness showed all three types of trends: increased hardness in 22% of the wells, decreased hardness in 8% of the wells, and cyclic behavior in 36% of the wells. Sixty percent of the wells showed a positive or positive-cyclic behavior for calcium hardness with only 4% showing a decrease in calcium hardness. Total alkalinity showed primarily a cyclic behavior, with 85% of the wells being cyclic. There were 34% of the wells with a negative trend for water temperature, as taken at well heads. These changes are probably representative of either sampling artifact or from the actual pumping process and not an aquifer characteristic. Turbidity increased in 15% of the wells and decreased in 2 wells (3%). Many of the turbidity measurements are recorded in PUAC data sheets at a level at or below the readability of the nephelometer. Therefore, some of these turbidity trends may not actually be significant. Large increases in turbidity generally do not represent changes in suspended matters in aquifer water, but reflect changes caused by the pumping process or deterioration in the well (ie. rust).

In the A-series wells two wells (A-9 and A-13) show an increase or positive cycle for chlorides, total and calcium hardness and alkalinity. Well A-9 also shows an increase in turbidity, while A-13 shows an increase in specific conductance. Cyclic chloride behavior occurs for wells A-10, A-15, A-17, A-19 and A-21. A positive trend was imposed over the cyclic behavior for wells A-10 and A-19. Well A-10 shows cyclic behavior for chloride that roughly corresponds to 1-year cycles with a longer-term trend for an increase in chloride over the full sample period. The well fluctuates as much as 150 mg/ℓ chloride between yearly cycles.

Almost all of the D-series wells, with larger data-bases, show trend behavior. There are 11 wells (60%) which show significant positive chloride trends with mostly cyclic behavior. There are 3 wells (D-6, D-7, and D-10) which show significant decreases in chlorides. Well D-18 has a shorter data-base and shows some improvement in chlorides. These decreased trends were caused by high initial chloride concentrations at the beginning

of water production. These initial chlorides were variable with a few very high values. Well D-18 appeared to stabilize, at least in relation to chloride, after having had higher initial chloride concentrations that were caused by drilling operations. It took about a 2 year period for well D-18 to stabilize. Wells D-6, D-7 and D-10 appear to be in a flow line with higher quality water in D-10, which is near the basal and parabasal boundary, and lower quality in D-7, which is a basal well.

The Y-series has 3 wells (Y-1, Y-2, and Y-4) which show significant increases in chlorides. These wells are in the lower end of the Yigo trough, as designated by the NGLS. This Yigo trough was supposed to be an area where a larger amount of groundwater exists (over 4 feet of head) that could be pumped at a higher rates (over 500 gpm) than the current average rate of 200 gpm. However, if wells in this area already show chloride increases at current pumping rates, then caution must be used in future well placement and pumping within the Yigo trough. These Y-series wells must be monitored on a more frequent basis (monthly).

In the F-series wells, there is a positive trend in chlorides for well F-1 to F-8 and a negative trend for wells F-9, F-10 and F-11. Wells F-8 and F-9 are both parabasal wells. The difference in chloride behavior between these wells could be related to drilling depth; well F-8 is deeper by almost 100 feet compared with well F-9. Wells F-10 and F-11 are basal wells which had decreases in chloride content beginning in mid-1981. These wells show a large chloride range over time with an indication of recent chloride increase. Although there is large variability in parameter values over time, there is no distinct cyclic trend. These wells were drilled in 1979 and the higher initial chloride may reflect the period of time (about 2 years) necessary for wells to stabilize. These wells warrant further monthly monitoring for at least chlorides.

Table 71. Significance levels of linear regressions of water quality parameters for A-3 and A-4 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 3: A-3	Variable	F value	Prob >P	R square	Adj R-square
	Chloride	1.672	0.2010	0.0276	0.0111
	pH	3.488	0.0668	0.0558	0.0398
	Conductance	0.000	0.9844	0.0000	-0.0169
	T. Hardness	0.905	0.3454	0.0151	-0.0016
	Ca. Hardness	2.572	0.1141	0.0418	0.0255
	M.Alkalinity	0.817	0.3697	0.0137	-0.0031
	Temperature	9.563	0.0030	0.1395	0.1249
	Turbidity	0.144	0.7058	0.0024	-0.0145

Well 4: A-4					
	Chloride	1.913	0.1722	0.0330	0.0158
	pH	7.107	0.0100	0.1126	0.0968
	Conductance	0.125	0.7252	0.0022	-0.0156
	T. Hardness	2.934	0.0922	0.0498	0.0328
	Ca. Hardness	0.707	0.4041	0.0125	-0.0052
	M.Alkalinity	0.852	0.3600	0.0150	-0.0026
	Temperature	5.651	0.0209	0.0917	0.0754
	Turbidity	0.330	0.5682	0.0059	-0.0119

Table 72. Significance levels of linear regressions of water quality parameters for A-5 and A-6 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 5: A-5	Variable	F value	Prob >P	R square	Adj R-square
	Chloride	0.380	0.5400	0.0063	-0.0103
	pH	8.500	0.0050	0.1241	0.1095
	Conductance	0.089	0.7664	0.0015	-0.0152
	T. Hardness	4.074	0.0480	0.0636	0.0480
	Ca. Hardness	2.490	0.1198	0.0398	0.0238
	M. Alkalinity	1.842	0.1798	0.0298	0.0136
	Temperature	4.456	0.0390	0.0691	0.0536
	Turbidity	0.022	0.8816	0.0004	-0.0163
Well 6: A-6					
	Chloride	2.688	0.1061	0.0409	0.0257
	pH	14.118	0.0004	0.1831	0.1701
	Conductance	4.411	0.0397	0.0654	0.0506
	T. Hardness	8.740	0.0044	0.1218	0.1079
	Ca. Hardness	9.012	0.0038	0.1251	0.1113
	M.Alkalinity	6.655	0.0122	0.0955	0.0812
	Temperature	7.191	0.0093	0.1025	0.0882
	Turbidity	0.206	0.6512	0.0033	-0.0126

Table 73. Significance levels of linear regressions of water quality parameters for A-7 and A-8 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 7: A-7	Variable	F value	Prob >P	R square	Adj R-square
	Chloride	3.214	0.0767	0.0497	0.0344
	pH	9.357	0.0033	0.1311	0.1171
	Conductance	0.640	0.4266	0.0102	-0.0057
	T. Hardness	5.625	0.0208	0.0832	0.0684
	Ca. Hardness	7.888	0.0066	0.1129	0.0986
	M.Alkalinity	2.337	0.1315	0.0363	0.0208
	Temperature	1.565	0.2156	0.0246	0.0089
	Turbidity	0.019	0.8908	0.0003	-0.0158
Well 8: A-8					
	Chloride	0.416	0.5215	0.0065	-0.0091
	pH	8.712	0.0044	0.1198	0.1061
	T. Hardness	2.420	0.1247	0.0364	0.0214
	Ca. Hardness	13.183	0.0006	0.1708	0.1578
	M.Alkalinity	2.567	0.1140	0.0386	0.0235
	Temperature	0.123	0.7270	0.0019	-0.0137
	Turbidity	3.242	0.0765	0.0482	0.0333

Table 74. Significance levels of linear regressions of water quality parameters for A-9 and A-10 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 9: A-9	Variable	F value	Prob >P	R square	Adj R-square
	Chloride	7.198	0.0094	0.1055	0.0909
	pH	4.707	0.0339	0.0716	0.0564
	Conductance	2.544	0.1159	0.0400	0.0243
	T. Hardness	10.143	0.0023	0.1426	0.1285
	Ca. Hardness	11.108	0.0015	0.1540	0.1402
	M.Alkalinity	2.415	0.1254	0.0381	0.0223
	Temperature	7.128	0.0097	0.1046	0.0899
	Turbidity	6.925	0.0107	0.1020	0.0872
Well 10: A-10					
	Chloride	6.803	0.0114	0.1003	0.0856
	pH	5.683	0.0203	0.0852	0.0702
	Conductance	0.278	0.5998	0.0045	-0.0118
	T. Hardness	1.284	0.2616	0.0206	0.0046
	Ca. Hardness	16.178	0.0002	0.2096	0.1967
	M.Alkalinity	2.045	0.1578	0.0324	0.0166
	Temperature	15.920	0.0002	0.2070	0.1940
	Turbidity	1.056	0.3082	0.0170	0.0009

Table 75. Significance levels of linear regressions of water quality parameters for A-11 and A-12 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 11: A-11	Variable	F value	Prob >F	R square	Adj R-square
	Chloride	0.386	0.5366	0.0063	-0.0100
	pH	14.334	0.004	0.1903	0.1770
	Conductance	1.306	0.2575	0.0210	0.0049
	T. Hardness	8.176	0.0058	0.1182	0.1037
	Ca. Hardness	6.734	0.0118	0.0994	0.0847
	M.Alkalinity	1.020	0.3166	0.0164	0.0003
	Temperature	0.923	0.3406	0.0149	-0.0012
	Turbidity	0.827	0.3668	0.0134	-0.0028
Well 12: A-12					
	Chloride	0.263	0.6099	0.0042	-0.0118
	pH	4.252	0.0434	0.0642	0.0491
	Conductance	1.163	0.2850	0.0184	0.0026
	T. Hardness	2.118	0.1506	0.0330	0.0174
	Ca. Hardness	20.265	0.0001	0.2463	0.2342
	M. Alkalinity	0.991	0.3234	0.0157	-0.0001
	Temperature	4.612	0.0357	0.0692	0.0542
	Turbidity	1.238	0.2701	0.0196	0.0038

Table 76. Significance levels of linear regressions of water quality parameters for A-13 and A-14 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 13: A-13	Variable	F value	Prob >F	R square	Adj R-square
	Chloride	16.445	0.0001	0.2180	0.2047
	pH	5.453	0.0230	0.0846	0.0691
	Conductance	12.145	0.0009	0.1707	0.1566
	T. Hardness	8.964	0.0040	0.1319	0.1172
	Ca. Hardness	10.135	0.0023	0.1466	0.1321
	M.Alkalinity	3.112	0.0829	0.0501	0.0340
	Temperature	6.013	0.0172	0.0925	0.0771
	Turbidity	0.661	0.4195	0.0111	-0.0057
Well 14: A-14					
	Chloride	1.009	0.3199	0.0194	0.0002
	pH	3.824	0.0560	0.0698	0.0515
	Conductance	3.590	0.0638	0.0658	0.0474
	T. Hardness	2.430	0.1252	0.0455	0.0268
	Ca. Hardness	0.301	0.5856	0.0059	-0.0136
	M.Alkalinity	5.583	0.0220	0.0987	0.0810
	Temperature	2.430	0.1252	0.0455	0.0268
	Turbidity	0.004	0.9495	0.0001	-0.0195

Table 77. Significance levels of linear regressions of water quality parameters for A-15 and A-16 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 15: A-15	Variable	F value	Prob >F	R square	Adj R-square
	Chloride	0.037	0.8473	0.0006	-0.0163
	pH	6.990	0.0105	0.0159	0.0908
	Conductance	0.087	0.7694	0.0015	-0.0155
	T. Hardness	8.033	0.0063	0.1198	0.0149
	Ca. Hardness	6.049	0.0169	0.0930	0.0776
	M.Alkalinity	9.194	0.0026	0.1439	0.1294
	Temperature	2.447	0.1231	0.0398	0.0235
	Turbidity	1.331	0.2533	0.0221	0.0055

Well 16: A-16					
	Chloride	0.515	0.4759	0.0095	-0.0089
	pH	4.771	0.0333	0.0812	0.0642
	Conductance	2.364	0.1300	0.0419	0.0242
	T. Hardness	0.466	0.4977	0.0086	-0.0098
	Ca. Hardness	4.313	0.0426	0.0740	0.0568
	M.Alkalinity	0.330	0.5678	0.0061	-0.0123
	Temperature	1.573	0.2151	0.0283	0.0103
	Turbidity	0.114	0.7365	0.0021	-0.0164

Table 78. Significance levels of linear regressions of water quality parameters for A-18 and A-19 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 17: A-18	Variable	F value	Prob >P	R square	Adj R-square
	Chloride	0.051	0.8220	0.0009	-0.0163
	pH	2.379	0.1284	0.0394	0.0228
	Conductance	3.275	0.0755	0.0534	0.0371
	T. Hardness	7.668	0.0075	0.1168	0.1015
	Ca. Hardness	7.850	0.0069	0.1192	0.1040
	M.Alkalinity	1.722	0.1946	0.0288	0.0121
	Temperature	0.644	0.4255	0.0110	-0.0061
	Turbidity	0.548	0.4620	0.0094	-0.0077
Well 18: A-19					
	Chloride	37.173	0.0001	0.4033	0.3924
	pH	6.309	0.0150	0.1029	0.0866
	Conductance	0.981	0.3263	0.0175	-0.0003
	T. Hardness	6.756	0.0120	0.1094	0.0932
	Ca. Hardness	1.334	0.2530	0.0237	0.0059
	M.Alkalinity	5.710	0.0203	0.0940	0.0776
	Temperature	0.816	0.3703	0.0146	-0.0033
	Turbidity	9.187	0.0037	0.1431	0.1275

Table 79. Significance levels of linear regressions of water quality parameters for A-21 and A-22 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 19: A-21	Variable	F value	Prob >F	R square	Adj R-square
	Chloride	1.102	0.2985	0.0196	0.0018
	pH	6.626	0.0128	0.1075	0.0913
	Conductance	2.239	0.1402	0.0391	0.0217
	T. Hardness	6.930	0.0110	0.1119	0.0958
	Ca. Hardness	1.706	0.1969	0.0301	0.0125
	M.Alkalinity	2.232	0.1409	0.0390	0.0215
	Temperature	1.391	0.2433	0.0247	0.0069
	Turbidity	2.164	0.1470	0.0379	0.0204
Well 20: A-22					
	Chloride	2.156	0.1584	0.1019	0.0546
	pH	0.227	0.6388	0.0118	-0.0402
	Conductance	1.578	0.2243	0.0767	0.0281
	T. Hardness	1.388	0.2533	0.0681	0.0190
	Ca. Hardness	6.365	0.0207	0.2509	0.2115
	M.Alkalinity	3.373	0.0820	0.1508	0.1061
	Temperature	0.023	0.8823	0.0012	-0.0514
	Turbidity	0.021	0.8860	0.0011	-0.0515

Table 80. Significance levels of linear regressions of water quality parameters for D-1 and D-2 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 21: D-1	Variable	F value	Prob >P	R square	Adj R-square
	Chloride	0.891	0.3486	0.0135	-0.0016
	pH	19.839	0.0001	0.2338	0.2221
	Conductance	2.357	0.1295	0.0350	0.0202
	T. Hardness	1.300	0.2583	0.0196	0.0045
	Ca. Hardness	2.091	0.1530	0.0312	0.0163
	M.Alkalinity	0.512	0.4766	0.0078	-0.0074
	Temperature	2.928	0.0918	0.0431	0.0284
	Turbidity	2.706	0.1048	0.0400	0.0252
Well 22: D-2					
	Chloride	2.347	0.1304	0.0348	0.0200
	pH	9.597	0.0029	0.1286	0.1152
	Conductance	0.495	0.4844	0.0076	0.0077
	T. Hardness	0.856	0.3582	0.0130	-0.0022
	Ca. Hardness	10.954	0.0015	0.1442	0.1311
	M.Alkalinity	0.015	0.9038	0.0002	-0.0152
	Temperature	3.575	0.0631	0.0521	0.0375
	Turbidity	15.859	0.0002	0.1961	0.1838

Table 81. Significance levels of linear regressions of water quality parameters for D-3 and D-4 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 23: D-3	Variable	F value	Prob >F	R square	Adj R-square
	Chloride	0.353	0.5545	0.0055	-0.0101
	pH	23.328	0.0001	0.2671	0.2557
	Conductance	0.003	0.9579	0.0000	-0.0156
	T. Hardness	24.869	0.0001	0.2798	0.2686
	Ca. Hardness	5.073	0.0277	0.0734	0.0590
	M.Alkalinity	1.518	0.2224	0.0232	0.0079
	Temperature	0.126	0.7237	0.0020	-0.0136
	Turbidity	1.073	0.3041	0.0165	0.0011
Well 24: D-4					
	Chloride	3.757	0.0570	0.0554	0.0407
	pH	39.277	0.0001	0.3803	0.3705
	Conductance	0.110	0.7409	0.0017	-0.0139
	T. Hardness	6.403	0.0139	0.0909	0.0767
	Ca. Hardness	3.200	0.0784	0.0476	0.0327
	M.Alkalinity	0.679	0.4129	0.0105	-0.0050
	Temperature	0.072	0.7895	0.0011	-0.0145
	Turbidity	0.003	0.9549	0.0001	-0.0156

Table 82. Significance levels of linear regressions of water quality parameters for D-5 and D-6 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 25: D-5	Variable	F value	Prob >P	R square	Adj R-square
	Chloride	0.561	0.4567	0.0087	-0.0068
	pH	16.674	0.0001	0.2067	0.1943
	Conductance	0.428	0.5155	0.0066	-0.0089
	T. Hardness	15.617	0.0002	0.1962	0.1836
	Ca. Hardness	9.830	0.0026	0.1331	0.1196
	M.Alkalinity	3.592	0.0626	0.0531	0.0383
	Temperature	2.678	0.1066	0.0402	0.0252
	Turbidity	2.793	0.0996	0.0418	0.0268
Well 26: D-6					
	Chloride	42.818	0.0001	0.3971	0.3879
	pH	36.713	0.0001	0.3609	0.3511
	Conductance	3.381	0.0705	0.0494	0.0348
	T. Hardness	3.518	0.0652	0.0513	0.0368
	Ca. Hardness	19.691	0.0001	0.2325	0.2207
	M.Alkalinity	4.946	0.0296	0.0707	0.0564
	Temperature	0.065	0.7998	0.0010	-0.0144
	Turbidity	4.457	0.0386	0.0642	0.0498

Table 83. Significance levels of linear regressions of water quality parameters for D-7 and D-8 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 27: D-7	Variable	F value	Prob >F	R square	Adj R-square
	Chloride	13.476	0.0005	0.1739	0.1610
	pH	54.954	0.0001	0.4620	0.4536
	Conductance	2.650	0.1085	0.0398	0.0248
	T. Hardness	9.720	0.0027	0.1319	0.1183
	Ca. Hardness	17.861	0.0001	0.2182	0.2060
	M.Alkalinity	0.019	0.8901	0.0003	-0.0153
	Temperature	0.335	0.5649	0.0052	-0.0103
	Turbidity	5.542	0.0216	0.0797	0.0653
Well 28: D-8					
	Chloride	3.677	0.0596	0.0535	0.0390
	pH	20.794	0.0001	0.2424	0.2307
	Conductance	2.693	0.1056	0.0398	0.0250
	T. Hardness	15.003	0.0003	0.1875	0.1750
	Ca. Hardness	6.618	0.0124	0.0924	0.0784
	M.Alkalinity	0.121	0.7295	0.0019	-0.0135
	Temperature	5.708	0.0198	0.0807	0.0666
	Turbidity	2.902	0.0933	0.0427	0.0280

Table 84. Significance levels of linear regressions of water quality parameters for D-9 and D-10 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 29: D-9	Variable	F value	Prob >F	R square	Adj R-square
	Chloride	0.204	0.6533	0.0032	-0.0126
	pH	43.110	0.0001	0.4063	0.3969
	Conductance	1.612	0.2089	0.0249	0.0095
	T. Hardness	7.87	0.0089	0.1037	0.0894
	Ca. Hardness	11.162	0.0014	0.1505	0.1370
	M.Alkalinity	7.150	0.0095	0.1019	0.0877
	Temperature	5.334	0.0242	0.0781	0.0634
	Turbidity	0.0007	0.9334	0.0001	-0.0158
Well 30: D-10					
	Chloride	14.865	0.0003	0.1885	0.1758
	pH	36.486	0.0001	0.3631	0.3531
	Conductance	0.020	0.8874	0.0003	-0.0153
	T. Hardness	2.938	0.0193	0.0439	0.0290
	Ca. Hardness	10.445	0.0019	0.1403	0.1269
	M.Alkalinity	1.223	0.2699	0.0190	0.0037
	Temperature	6.370	0.0141	0.0905	0.0763
	Turbidity	3.392	0.0701	0.0503	0.0355

Table 85. Significance levels of linear regressions of water quality parameters for D-11 and D-12 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 31: D-11	Variable	F value	Prob >F	R square	Adj R-square
	Chloride	12.590	0.0007	0.1644	0.1513
	pH	18.584	0.0001	0.2250	0.2129
	Conductance	3.994	0.0499	0.0587	0.0440
	T. Hardness	13.543	0.0005	0.1747	0.1618
	Ca. Hardness	5.107	0.0272	0.0739	0.0594
	M.Alkalinity	6.135	0.0159	0.0875	0.0732
	Temperature	3.603	0.0622	0.0533	0.0385
	Turbidity	1.196	0.2782	0.0183	0.0030
Well 32: D-12					
	Chloride	0.147	0.7027	0.0023	-0.0135
	pH	31.193	0.0001	0.3312	0.3205
	Conductance	0.065	0.7989	0.0010	-0.0148
	T. Hardness	6.635	0.0124	0.0953	0.0809
	Ca. Hardness	0.026	0.6516	0.0033	-0.0126
	M.Alkalinity	0.0000	0.09931	0.0000	-0.0159
	Temperature	1.834	0.1805	0.0283	0.0129
	Turbidity	2.447	0.1228	0.0374	0.0221

Table 86. Significance levels of linear regressions of water quality parameters for D-13 and D-14 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 33: D-13	Variable	F value	Prob >F	R square	Adj R-square
	Chloride	0.0004	0.9491	0.0001	-0.0161
	pH	36.570	0.0001	0.3710	0.3609
	Conductance	0.505	0.4801	0.0081	-0.0079
	T. Hardness	1.318	0.2553	0.0208	0.0050
	Ca. Hardness	10.071	0.0023	0.1397	0.1259
	M.Alkalinity	0.381	0.5396	0.0061	-0.0099
	Temperature	0.000	0.9910	0.0000	-0.0161
	Turbidity	11.358	0.0013	0.1548	0.1412
Well 34: D-14					
	Chloride	5.818	0.0188	0.0845	0.0700
	pH	3.836	0.0546	0.0574	0.0424
	Conductance	4.515	0.0375	0.0669	0.0521
	T. Hardness	8.032	0.0062	0.1131	0.0990
	Ca. Hardness	6.371	0.0141	0.0918	0.0774
	M.Alkalinity	1.054	0.3085	0.0165	0.008
	Temperature	1.457	0.2320	0.0226	0.0071
	Turbidity	4.065	0.0480	0.0606	0.0457

Table 87. Significance levels of linear regressions of water quality parameters for D-15 and M-1 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 35: D-15	Variable	F value	Prob >F	R square	Adj R-square
	Chloride	0.070	0.7916	0.0011	-0.0150
	pH	24.548	0.0001	0.2836	0.2721
	Conductance	0.865	0.3559	0.0138	-0.0021
	T. Hardness	3.651	0.0607	0.0556	0.0404
	Ca. Hardness	24.478	0.0001	0.2831	0.2715
	M.Alkalinity	0.255	0.6156	0.0041	-0.0120
	Temperature	1.405	0.2404	0.0222	0.0064
	Turbidity	0.668	0.4169	0.0107	-0.0053

Well 36: M-1					
	Chloride	4.862	0.0312	0.0738	0.0586
	pH	15.787	0.0002	0.2056	0.1926
	Conductance	16.766	0.0001	0.2156	0.2027
	T. Hardness	0.139	0.7109	0.0023	-0.0141
	Ca. Hardness	1.638	0.2055	0.0261	0.0102
	M.Alkalinity	0.915	0.3425	0.0148	-0.0014
	Temperature	11.568	0.0012	0.1594	0.1456
	Turbidity	0.013	0.9082	0.0002	-0.0162

Table 88. Significance levels of linear regressions of water quality parameters for M-2 and M-3 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 37: M-2	Variable	F value	Prob >F	R square	Adj R-square
	Chloride	29.594	0.0001	0.3267	0.3156
	pH	17.104	0.0001	0.2190	0.2062
	Conductance	6.028	0.0169	0.0899	0.0750
	T. Hardness	0.183	0.6707	0.0030	-0.0134
	Ca. Hardness	7.839	0.0068	0.1139	0.0994
	M.Alkalinity	1.726	0.1939	0.0275	0.0116
	Temperature	4.603	0.0359	0.0702	0.0549
	Turbidity	0.114	0.7370	0.0019	-0.0145

Well 38: M-3					
	Chloride	11.259	.0013	0.1496	0.1363
	pH	10.329	0.0021	0.1390	0.1255
	Conductance	0.008	0.9283	0.0001	-0.0155
	T. Hardness	5.672	0.0202	0.0814	0.0671
	Ca. Hardness	11.936	0.0010	0.1572	0.1440
	M.Alkalinity	3.877	0.0533	0.0571	0.0424
	Temperature	5.035	0.0283	0.0729	0.0584
	Turbidity	5.376	0.0236	0.0775	0.0631

Table 89. Significance levels of linear regressions of water quality parameters for M-4 and M-5 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 39: M-4	Variable	F value	Prob >F	R square	Adj R-square
	Chloride	3.371	0.0710	0.0500	0.0352
	pH	23.292	0.0001	0.2668	0.2554
	Conductance	1.044	0.3107	0.0161	0.0007
	T. Hardness	21.411	0.0001	0.2507	0.2390
	Ca. Hardness	16.733	0.0001	0.2073	0.1949
	M.Alkalinity	6.247	0.0150	0.0889	0.0747
	Temperature	2.450	0.1224	0.0369	0.0218
	Turbidity	0.701	0.4054	0.0108	-0.0046

Well 40: M-5					
	Chloride	0.263	0.6100	0.0042	-0.0117
	pH	18.439	0.0001	0.2264	0.2141
	Conductance	1.294	0.2597	0.0201	0.0046
	T. Hardness	9.111	0.0037	0.1263	0.1125
	Ca. Hardness	4.648	0.0349	0.0687	0.0539
	M.Alkalinity	2.235	0.1399	0.0343	0.0189
	Temperature	9.480	0.0031	0.1308	0.1170
	Turbidity	1.522	0.2219	0.0236	0.0081

Table 90. Significance levels of linear regressions of water quality parameters for M-6 and M-7 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 41: M-6	Variable	F value	Prob >F	R square	Adj R-square
	Chloride	12.182	0.0009	0.1599	0.1458
	pH	5.083	0.0276	0.0736	0.0591
	Conductance	2.204	0.1426	0.0333	0.0182
	T. Hardness	1.445	0.2338	0.0221	0.0068
	Ca. Hardness	2.594	0.1122	0.0389	0.0239
	M.Alkalinity	1.021	0.3160	0.0157	0.0003
	Temperature	0.102	0.7508	0.00016	-0.0140
	Turbidity	3.021	0.0870	0.0451	0.0302
Well 42: M-7					
	Chloride	0.116	0.7350	0.0018	-0.0136
	pH	12.430	0.0008	0.1605	0.1476
	Conductance	0.044	0.8337	0.0007	-0.0147
	T. Hardness	5.391	0.0234	0.0766	0.0624
	Ca. Hardness	3.324	0.0729	0.0487	0.0340
	M.Alkalinity	0.959	0.3312	0.0145	-0.0006
	Temperature	5.408	0.0232	0.0768	0.0626
	Turbidity	0.126	0.7242	0.0019	-0.0134

Table 91. Significance levels of linear regressions of water quality parameters for M-8 and M-9 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 43: M-8	Variable	F value	Prob >P	R square	Adj R-square
	Chloride	0.056	0.8132	0.0009	-0.0145
	pH	10.798	0.0016	0.1425	0.1293
	Conductance	2.413	0.1252	0.0358	0.0210
	T. Hardness	0.844	0.3616	0.0128	-0.0024
	Ca. Hardness	0.295	0.5891	0.0045	-0.0108
	M.Alkalinity	0.000	0.9973	0.0000	-0.0154
	Temperature	2.363	0.1291	0.0351	0.0202
	Turbidity	4.774	0.0325	0.0684	0.0541
Well 44: M-9					
	Chloride	4.094	0.0475	0.0639	0.0483
	pH	34.486	0.0001	0.3650	0.3544
	Conductance	0.619	0.4345	0.0102	-0.0063
	T. Hardness	9.451	0.0032	0.1361	0.1217
	Ca. Hardness	2.824	0.0981	0.0450	0.0290
	M.Alkalinity	0.951	0.3335	0.0156	-0.0008
	Temperature	0.935	0.3374	0.0153	-0.0011
	Turbidity	0.112	0.7392	0.0019	-0.0148

Table 92. Significance levels of linear regressions of water quality parameters for M-12 and M-14 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 45: M-12	Variable	F value	Prob >F	R square	Adj R-square
	Chloride	2.365	0.1292	0.0367	0.0212
	pH	11.844	0.0010	0.1604	0.1469
	Conductance	1.750	0.1907	0.0275	0.0118
	T. Hardness	0.941	0.3358	0.0150	-0.0009
	Ca. Hardness	1.382	0.2442	0.0218	0.0060
	M.Alkalinity	09.58	0.3314	0.0152	-0.0007
	Temperature	4.132	0.0464	0.0625	0.0474
	Turbidity	1.124	0.2931	0.0178	0.0020
Well 46: M-14					
	Chloride	1.863	0.1773	0.0296	0.0137
	pH	10.266	0.0022	0.1441	0.1300
	Conductance	2.067	0.1557	0.0328	0.0169
	T. Hardness	2.797	0.0996	0.0438	0.0282
	Ca. Hardness	3.708	0.0588	0.0573	0.0419
	M.Alkalinity	3.469	0.0674	0.0538	0.0383
	Temperature	4.842	0.0316	0.0735	0.0583
	Turbidity	4.950	0.0298	0.0751	0.0599

Table 93. Significance levels of linear regressions of water quality parameters for F-1 and F-2 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 47: F-1	Variable	F value	Prob >F	R square	Adj R-square
	Chloride	0.108	0.7436	0.0017	-0.0137
	pH	41.400	0.0001	0.3891	0.3797
	Conductance	0.130	0.7197	0.0020	-0.0134
	T. Hardness	3.058	0.0851	0.0449	0.0302
	Ca. Hardness	15.323	0.0002	0.1908	0.1783
	M.Alkalinity	2.062	0.1558	0.0307	0.0158
	Temperature	3.139	0.0811	0.0461	0.0314
	Turbidity	0.039	0.8448	0.0006	-0.0148
Well 48: F-2					
	Chloride	0.171	0.6807	0.0026	-0.0127
	pH	45.425	0.0001	0.4119	0.4028
	Conductance	3.695	0.0590	0.0538	0.0392
	T. Hardness	4.009	0.0494	0.0581	0.0436
	Ca. Hardness	7.274	0.0089	0.1006	0.0868
	M.Alkalinity	1.563	0.2157	0.0235	0.0085
	Temperature	0.000	0.9985	0.0000	-0.0154
	Turbidity	0.288	0.5934	0.0044	-0.0109

Table 94. Significance levels of linear regressions of water quality parameters for F-3 and F-4 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 49: F-3	Variable	F value	Prob >F	R square	Adj R-square
	Chloride	3.243	0.0765	0.0490	0.0339
	pH	50.196	0.0001	0.4432	0.4344
	Conductance	0.013	0.9104	0.0002	-0.0157
	T. Hardness	1.092	0.3000	0.0170	0.0014
	Ca. Hardness	5.176	0.0263	0.0759	0.0613
	M.Alkalinity	0.464	0.4980	0.0073	-0.0084
	Temperature	0.808	0.3722	0.0127	-0.0030
	Turbidity	0.989	0.3237	0.0155	-0.0002

Well 50: F-4					
	Chloride	1.273	0.2636	0.0198	0.0042
	pH	38.278	0.0001	0.3780	0.3681
	Conductance	0.244	0.6229	0.0039	-0.0119
	T. Hardness	0.967	0.3292	0.0151	-0.0005
	Ca. Hardness	7.630	0.0075	0.1080	0.0939
	M.Alkalinity	0.050	0.8229	0.0008	-0.0151
	Temperature	0.061	0.8057	0.0010	-0.0149
	Turbidity	0.793	0.3765	0.0124	-0.0032

Table 95. Significance levels of linear regressions of water quality parameters for F-5 and F-6 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 51: F-5	Variable	F value	Prob >F	R square	Adj R-square
	Chloride	4.667	0.0347	0.0711	0.0558
	pH	6.488	0.0134	0.0961	0.0813
	Conductance	2.603	0.1118	0.0409	0.0252
	T. Hardness	7.110	0.0098	0.1044	0.0897
	Ca. Hardness	2.297	0.1348	0.0363	0.0205
	M.Alkalinity	1.796	0.1852	0.0286	0.0127
	Temperature	0.031	0.8613	0.0005	-0.0159
	Turbidity	1.176	0.2824	0.0189	0.0028
Well 52: F-6					
	Chloride	14.151	0.0004	0.1883	0.1750
	pH	36.722	0.0001	0.3758	0.3655
	Conductance	8.051	0.0062	0.1166	0.1021
	T. Hardness	18.409	0.0001	0.2318	0.2192
	Ca. Hardness	13.942	0.0004	0.1860	0.1727
	M.Alkalinity	0.565	0.4551	0.0092	-0.0071
	Temperature	3.084	0.0841	0.0481	0.0325
	Turbidity	5.463	0.0227	0.0822	0.0671

Table 96. Significance levels of linear regressions of water quality parameters for F-7 and F-8 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 53: F-7	Variable	F value	Prob >F	R square	Adj R-square
	Chloride	14.690	0.0003	0.1891	0.1762
	pH	30.440	0.0001	0.3258	0.3151
	Conductance	4.395	0.0401	0.0652	0.0504
	T. Hardness	7.318	0.0088	0.1041	0.0899
	Ca. Hardness	3.788	0.0561	0.0567	0.0417
	M.Alkalinity	1.516	0.2228	0.0235	0.0080
	Temperature	4.619	0.0355	0.0683	0.0535
	Turbidity	0.095	0.7584	0.0015	-0.0143

Well 54: F-8					
	Chloride	19.888	0.0001	0.2430	0.2308
	pH	25.278	0.0001	0.2896	0.2782
	Conductance	43.049	0.0001	0.4098	0.4003
	T. Hardness	54.578	0.0001	0.4682	0.4596
	Ca. Hardness	46.308	0.0001	0.4276	0.4183
	M.Alkalinity	9.120	0.0037	0.1282	0.1142
	Temperature	0.205	0.6523	0.0033	-0.0128
	Turbidity	0.000	0.9908	0.0000	-0.0161

Table 97. Significance levels of linear regressions of water quality parameters for F-9 and F-10 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 55: F-9	Variable	F value	Prob >P	R square	Adj R-square
	Chloride	21.331	0.0001	0.3721	0.3546
	pH	12.842	0.0010	0.2629	0.2425
	Conductance	16.232	0.0003	0.3108	0.2916
	T. Hardness	0.520	0.4753	0.0142	-0.0131
	Ca. Hardness	1.987	0.1672	0.0523	0.0260
	M.Alkalinity	1.681	0.2031	0.0446	0.0181
	Temperature	5.587	0.0236	0.1343	0.1103
	Turbidity	0.833	0.3674	0.0226	-0.0045

Well 56: F-10					
	Chloride	12.136	0.0013	0.2470	0.2266
	pH	22.829	0.0001	0.3816	0.3649
	Conductance	4.091	0.0504	0.0996	0.0752
	T. Hardness	9.195	0.0044	0.1991	0.1774
	Ca. Hardness	8.181	0.0069	0.1811	0.1589
	M.Alkalinity	0.141	0.7093	0.0038	0.0231
	Temperature	1.194	0.2815	0.0313	0.0051
	Turbidity	1.388	0.2462	0.0362	0.0101

Table 98. Significance levels of linear regressions of water quality parameters for F-11 and H-1 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 57: F-11	Variable	F value	Prob >F	R square	Adj R-square
	Chloride	88.030	0.0001	0.6985	0.6906
	pH	19.120	0.0001	0.3347	0.3172
	Conductance	17.715	0.0002	0.3180	0.3000
	T. Hardness	11.808	0.0014	0.2371	0.2170
	Ca. Hardness	8.447	0.0061	0.1819	0.1603
	M.Alkalinity	1.589	0.2152	0.0401	0.0149
	Temperature	1.269	0.2671	0.0323	0.0068
	Turbidity	1.613	0.2117	0.0407	0.0155
Well 58: H-1					
	Chloride	31.280	0.0001	0.3390	0.3281
	pH	6.235	0.0152	0.0927	0.0779
	Conductance	3.132	0.0818	0.0488	0.0332
	T. Hardness	12.308	0.0009	0.1679	0.1543
	Ca. Hardness	20.928	0.0001	0.2554	0.2432
	M.Alkalinity	6.304	0.0147	0.0937	0.0788
	Temperature	1.751	0.01907	0.0279	0.0120
	Turbidity	2.864	0.0957	0.0449	0.0292

Table 99. Significance levels of linear regressions of water quality parameters for Y-1 and Y-2 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 59: Y-1	Variable	F value	Prob >P	R square	Adj R-square
	Chloride	11.487	0.0012	0.1542	0.1408
	pH	23.387	0.0001	0.2707	0.2592
	Conductance	0.517	0.4747	0.0081	-0.0076
	T. Hardness	5.408	0.0233	0.0791	0.0644
	Ca. Hardness	5.043	0.0282	0.0741	0.0594
	M.Alkalinity	0.041	0.8406	0.0006	-0.0152
	Temperature	2.257	0.1380	0.0346	0.0193
	Turbidity	2.2746	0.1024	0.0418	0.0266
Well 60: Y-2					
	Chloride	9.739	0.0027	0.1358	0.1218
	pH	10.476	0.0019	0.1445	0.1307
	Conductance	0.967	0.3292	0.0154	-0.0005
	T. Hardness	17.905	0.0001	0.2241	0.2116
	Ca. Hardness	17.788	0.0001	0.2229	0.2104
	M.Alkalinity	0.753	0.3889	0.0120	-0.0039
	Temperature	3.557	0.0640	0.0543	0.0390
	Turbidity	1.276	0.2630	0.0202	0.0044

Table 100. Significance levels of linear regressions of water quality parameters for Y-3 and Y-4 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 61: Y-3	Variable	F value	Prob >P	R square	Adj R-square
	Chloride	2.522	0.1172	0.0379	0.0229
	pH	21.475	0.0001	0.2512	0.2395
	Conductance	0.499	0.4827	0.0077	-0.0078
	T. Hardness	17.827	0.0001	0.2179	0.2056
	Ca. Hardness	3.569	0.0634	0.0528	0.0380
	M.Alkalinity	0.006	0.9366	0.0001	-0.0155
	Temperature	0.363	0.5492	0.0056	-0.0099
	Turbidity	0.753	0.3889	0.0116	-0.0038
Well 62: Y-4					
	Chloride	9.81	0.0026	0.1334	0.1199
	pH	21.220	0.0001	0.2490	0.2373
	Conductance	2.935	0.0915	0.0439	0.0289
	T. Hardness	33.405	0.0001	0.3429	0.3327
	Ca. Hardness	13.527	0.0005	0.1745	0.1616
	M.Alkalinity	1.771	0.1879	0.0269	0.0117
	Temperature	4.278	0.0427	0.0626	0.0480
	Turbidity	0.541	0.4648	0.0084	-0.0071

Table 101. Significance levels of linear regressions of water quality parameters for Y-5 and A-23 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 63: Y-5	Variable	F value	Prob >P	R square	Adj R-square
	Chloride	0.027	0.8701	0.0008	-0.0270
	pH	15.823	0.0003	0.3053	0.2860
	Conductance	2.443	0.1268	0.0636	0.0375
	T. Hardness	2.319	0.1366	0.0605	0.0344
	Ca. Hardness	2.844	0.1003	0.0732	0.0475
	M.Alkalinity	5.488	0.0248	0.1323	0.1082
	Temperature	11.652	0.0016	0.2445	0.2235
	Turbidity	0.958	0.3341	0.0259	-0.0011
Well 64: A-23					
	Chloride	0.389	0.6451	0.2800	-0.4401
	pH	2.008	0.3912	0.6676	0.3352
	Conductance	1.043	0.4932	0.5106	0.0212
	T. Hardness	0.000	0.9894	0.0003	-0.9994
	Ca. Hardmess	1.829	0.4053	0.6465	0.2930
	M.Alkalinity	0.002	0.9736	0.0017	-0.9965
	Temperature	0.037	0.8790	0.0357	-0.9286
	Turbidity	225.333	0.0423	0.9956	0.9912

Table 102. Significance levels of linear regressions of water quality parameters for D-16 and D-17 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 65: D-16	Variable	F value	Prob >P	R square	Adj R-square
	Chloride	0.009	0.9251	0.0003	-0.0291
	pH	17.717	0.0002	0.3426	0.3232
	Conductance	3.669	0.0639	0.0974	0.0708
	T. Hardness	0.167	0.6854	0.0049	-0.0244
	Ca. Hardness	1.548	0.2220	0.0438	0.0154
	M.Alkalinity	1.452	0.2366	0.0409	0.0127
	Temperature	0.754	0.3912	0.0217	-0.0071
	Turbidity	0.404	0.5292	0.0117	-0.0173
Well 66: D-17					
	Chloride	4.637	0.0392	0.1301	0.1021
	pH	8.777	0.0058	0.2207	0.1955
	Conductance	4.423	0.0437	0.1247	0.0966
	T. Hardness	0.431	0.5161	0.0137	-0.0181
	Ca. Hardness	2.605	0.1166	0.0775	0.0478
	M.Alkalinity	4.572	0.0405	0.1285	0.1004
	Temperature	0.118	0.7335	0.0038	-0.0283
	Turbidity	0.784	0.3828	0.0247	-0.0068

Table 103. Significance levels of linear regressions of water quality parameters for D-18 and M-15 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 67: D-18	Variable	F value	Prob >P	R square	Adj R-square
	Chloride	11.003	0.0038	0.3794	0.3449
	pH	8.247	0.0101	0.3142	0.2761
	Conductance	0.249	0.6237	0.0137	-0.0411
	T. Hardness	4.581	0.0463	0.2029	0.1586
	Ca. Hardness	1.183	0.2911	0.0617	0.0095
	M.Alkalinity	1.174	0.2928	0.0612	0.0091
	Temperature	7.644	0.0128	0.2981	0.2591
	Turbidity	6.280	0.0220	0.2586	0.2175
Well 68: M-15					
	Chloride	0.278	0.6205	0.0527	-0.1368
	pH	2.194	0.1987	0.3049	0.1659
	Conductance	0.068	0.8043	0.0135	-0.1838
	T. Hardness	2.416	0.1808	0.3258	0.1909
	Ca. Hardness	2.652	0.1644	0.3466	0.2159
	M.Alkalinity	1.586	0.2635	0.2408	0.0890
	Temperature	0.565	0.4862	0.1015	-0.0782
	Turbidity	0.187	0.6836	0.0360	-0.1568

Table 104. Significance levels of linear regressions of water quality parameters for Y-6 and Y-7 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 69: Y-6	Variable	F value	Prob >F	R square	Adj R-square
	Chloride	0.519	0.4787	0.0221	-0.0205
	pH	2.827	0.1062	0.1094	0.0707
	Conductance	0.000	0.9835	0.0000	-0.0435
	T. Hardness	11.089	0.0029	0.3253	0.2960
	Ca. Hardness	0.010	0.9203	0.0004	-0.0430
	M.Alkalinity	0.160	0.6928	0.0069	0.0363
	Temperature	0.003	0.9557	0.0001	-0.0433
	Turbidity	4.799	0.0389	0.1726	0.1366
Well 70: Y-7					
	Chloride	0.000	0.9910	0.0000	-0.2000
	pH	4.551	0.0860	0.4765	0.3718
	Conductance	0.638	0.4608	0.1131	-0.0643
	T. Hardness	1.027	0.3573	0.1704	0.0045
	Ca. Hardness	0.926	0.3802	0.1562	-0.0125
	M.Alkalinity	2.685	0.1622	0.3494	0.2193
	Temperature	0.879	0.3916	-0.1495	-0.0207
	Turbidity	0.229	0.6526	0.0438	-0.1475

Table 105. Significance levels of linear regressions of water quality parameters for AG-1 and AG-2 water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 71: AG-1	Variable	F value	Prob >F	R square	Adj R-square
	Chloride	0.506	0.4797	0.0085	-0.0083
	pH	14.183	0.0004	0.1938	0.1801
	Conductance	0.024	0.8784	0.0004	-0.0165
	T. Hardness	0.025	0.8743	0.0004	-0.0165
	Ca. Hardness	0.513	0.4769	0.0086	-0.0082
	M.Alkalinity	0.030	0.8641	0.0005	-0.0164
	Temperature	4.524	0.0376	0.0712	0.0555
	Turbidity	0.758	0.3876	0.0127	-0.0041
Well 72: AG-2					
	Chloride	2.581	0.1150	0.0531	0.0326
	pH	6.830	0.0121	0.1293	0.1103
	Conductance	0.154	0.6964	0.0033	-0.0183
	T. Hardness	0.262	0.6114	0.0057	-0.0160
	Ca. Hardness	0.531	0.4697	0.0114	-0.0101
	M.Alkalinity	0.799	0.3761	0.0171	-0.0043
	Temperature	11.904	0.0012	0.2056	0.1883
	Turbidity	0.052	0.8203	0.0011	-0.0206

Table 106. Significance levels of linear regressions of water quality parameters for GHURA water wells. The R-correlations and adjusted R-correlations are given for each regression.

Well 73: GHURA	Variable	F value	Prob >P	R square	Adj R-square
	Chloride	1.154	0.2930	0.0441	0.0059
	pH	6.758	0.0154	0.2128	0.1813
	Conductance	3.332	0.0799	0.1176	0.0823
	T. Hardness	1.606	0.2167	0.0604	0.0228
	Ca. Hardness	0.375	0.5461	0.0148	-0.0246
	M.Alkalinity	0.658	0.4250	0.0256	-0.0133
	Temperature	0.163	0.6895	0.0065	-0.0332
	Turbidity	1.923	0.1778	0.0714	0.0343

Table 107. Summary of linear regression analysis of water quality parameters for each water well. Those parameters which have a significant regression at $P \leq .05$ are shown. The trend of the regression or graphed data is indicated: P - positive or increase; N - negative or decrease; C- cyclic or non-linear trend.

Well	Chloride	Conductance	pH	T.Hardness	Ca.Hardness	M.Alkalinity	Temp.	Turbidity
A- 1		.03 N	.02 N			C		
A- 2					.01 P	C		
A- 3						C	.01 N	
A- 4			.01 N			C	.02 N	
A- 5			.01 N	.05 P		C	.04 N	
A- 6		.04 P	.01 N	.01 P	.01 C	.01 P	.01 N	
A- 7			.01 N	.02 C	.01 P	C		
A- 8			.01 N		.01 P	C		
A- 9	.01 P		.03 N	.01 P	.01 P	C	.01 N	.01 P
A-10	.01 C		.02 N		.01 P	C	.01 N	
A-11			.01 N	.01 C	.01 P	C		
A-12			.04 N	C	.01 P	C	.04 N	
A-13	.01 P	.01 P	.02 N	.01 C	.01 P	C	.01 N	
A-14				C		.01 P		
A-15	C		.01 N	.01 P	.02 P	.01 P		
A-17	C		.03 N		.04 P			
A-18			N	.01 C	.01 P	C		
A-19	.01 C	C	.01 N	.01 N		.02 C		.01 P
A-21	C		.01 N	.01 N		C		
A-22					.02 P			
A-23	too few data							
D- 1			.01 N			C		
D- 2	C		.01 N		.01 P	C		.01 P
D- 3			.01 N	.01 P	.03 P	C		
D- 4			.01 N	.01 C		C		
D- 5	C		.01 N	.01 P	.01 P	C		

Table 107. continued.

Well	Chloride	Conductance	pH	T.Hardness	Ca.Hardness	M.Alkalinity	Temp.	Turbidity
D- 6	.01 N		.01 N		.01 P	.03 C		.04 C
D- 7	.01 N		.01 N	.01 P	.01 P	C		.02 C
D- 8	C	C	.01 N	.01 P	.01 C	C	.02 N	
D- 9	C		.01 N	.01 P	.01 C	.01 C	.02 N	
D-10	.01 N		.01 N	.01 C	.01 C	C	.01 N	
D-11	.01 C	.05 N	.01 N	.01 P	.03 C	.02 C		
D-12	C		.01 N	.01 P		C		
D-13	C	C	.01 N	C	.01 C	C		.01 P
D-14	.02 P	.04 P	.05 N	.01 C	.01 C	C		.05 P
D-15	C		.01 N		.01 P	C		
D-16	P	P	.01 N	P	P	P		
D-17	.04 C	.04 C	.01 N			.04 C		
D-18	.01 N		.01 C	.04 N	N		.01 P	.02 P
M- 1	.03 C	.01 C	.01 N	C		C	.01 N	
M- 2	.01 N	.02 N	.01 N		.01 C	C	.04 N	
M- 3	.01 N		.01 N	.02 C	.01 P	.05 C	.03 N	.02 N
M- 4			.01 N	.01 P	.01 P	.01 C		
M- 5			.01 N	.01 C	.03 C	C	.01 N	
M- 6	.01 C		.03 N			C		
M- 7			.01 N	.02 P		C	.02 N	
M- 8			.01 N	C		C		.03 P
M- 9	C		.01 N	.01 P		C		
M-12	C		.01 N			C	.05 N	
M-14	C		.01 N			C	.03 N	.03 P
M-15	too few data							
F- 1	C	C	.01 N		.01 P	C		
F- 2	C		.01 N	.05 C	.01 C	C		
F- 3	C		.01 N		.03 C	C		
F- 4	C	C	.01 N	C	.01 C	C		

Table 107. continued.

Well	Chloride		Conductance		pH		T.Hardness		Ca.Hardness		M.Alkalinity		Temp.		Turbidity	
F- 5	.04	C			.01	N	.01	P		P		C				
F- 6	.01	C	.01	C	.01	N	.01	C	.01	C					.03	P
F- 7	.01	P	.04	P	.01	N	.01	C		C		C	.04	N		
F- 8	.01	P	.01	P	.01	N	.01	C	.01	C	.01	C				
F- 9	.01	N	.01	N	.01	N							.02	N		
F-10	.01	N	.05	N	.01	N	.01	N	.01	N						
F-11	.01	N	.01	N	.01	N	.01	N	.01	N						
H- 1	.01	C			.02	N	.01	C			.01	C	.02	N		
AG-1		C			.01	N		C		C		C	.04	N		
AG-2					.01	N		C		C		C	.01	N		
GHURA		P			.01	N										
Y- 1	.01	P			.01	N	.02	C		C		C				
Y- 2	.01	P			.01	N	.01	C	.01	C		C				
Y- 3					.01	N	.01	C		C		C				
Y- 4	.01	P			.01	N	.01	C	.01	C		C	.04	N		
Y- 5					.01	N					.03	P	.01	N		
Y- 6						C	.01	N							.04	N
Y- 7	too few data															

Cluster Analyses

The cluster analysis program generates a specified number of groups of water quality data. The entire date file, which can include all or specific water quality parameters, is analyzed by the cluster program and each value is placed into a discrete group. Membership in a cluster was determined by the distance away from an initial seed value in the beginning of the analysis and a cluster mean value at the end of analysis. This produced a prescribed set of mathematically distinct clusters. These clusters did not necessarily correspond to individual wells. There are clusters which do not have any well memberships. Wells with widely scattered data will belong to more clusters than wells with small variances in data. However, there is usually a primary cluster which describes individual well memberships for specific or grouped water quality parameters. The cluster program can generate clusters that do not have any primary well memberships. These clusters generally contain outlier data. The mean water quality values for specific water quality parameters or a combined series of parameters can be assessed against cluster mean values to determine well membership.

Tables 108 to 113 present the primary well membership by cluster with 4 different cluster criteria analyses (cluster = 20, 15, 10, 5) for water quality parameters chloride, specific conductance, total and calcium hardness, alkalinity and pH. These tables show which wells associate by a specific water quality parameter. Those clusters of particular interest are those with high mean values, which are indicative of poorer water quality. Wells in these higher value clusters are potential problem wells, in terms of water quality. These wells or "outlier clusters" correspond to the tail of a total-data normal distribution curve. Group membership for clusters equal to 20, 15 and 10 are basically similar. A 5 cluster analysis defines water quality well membership in the broadest categories: very good, good, moderate, and poor.

A more comprehensive type of cluster analysis uses all water quality parameters in conjunction to produce groups. This type of cluster analysis can also assess which parameters have the greatest weight in group or cluster determinations. Parameters which are major contributions to clusters, in order of importance, are chloride, specific conductance, total hardness, calcium hardness and alkalinity. The parameters pH, temperature and turbidity are least important in group determination. Tables 114 to 117 present the mean and standard deviations of parameters in clusters for 4 different cluster criteria schemes (clusters = 20, 15, 10 and 5). Well memberships in these clusters are shown in Table 118. Primary and secondary cluster memberships for each well are shown for cluster analyses with 20 clusters. Only primary cluster memberships are shown for cluster analyses with 15, 10 and 5 clusters. The percent data membership in a cluster is shown for each well. This percentage membership provides a measure of the data scatter and can show major changes in data trends. Wells with high percentage primary data memberships in a cluster are indicative of stable wells, as related to overall water quality. Those wells which have lower primary percentages and common secondary memberships have increasing, decreasing, or cyclic water quality behavioral patterns. Wells with more secondary memberships were usually showing positive or cyclic trends in specific water quality parameters. Wells that associate

by primary membership, based on the 20 cluster analyses of combined water quality parameters, are shown in Table 119. This cluster set provides the best way to group wells in relation to management zones and general water quality. There are 12 wells (cluster 8) which have very good overall water quality with consistently low parameter concentrations and show almost no significant behavior trends. There is a majority of wells (43 wells or 60%) which also have overall very good water quality (cluster 4, 16, 2) with a few higher parameter concentrations. These wells have common significant behavioral trends. Wells in cluster 2 exhibit primarily cyclic trends, while clusters 4 and 16 show a mixture of positive, negative and cyclic trends. There are 9 wells which have good general water quality with periodic moderate to poor water quality. These wells show mostly cyclic trends with a larger variance in data (water quality is more erratic from month to month). There are 3 A-series wells which have moderate overall water quality with periodic poor water quality and exceedances of the chloride standard. These wells have shown decreased water quality over time. They are in the Pago Bay and Sabanan Maagas management zones. There are 6 wells (M-9, A-13, A-14, A-17, A-18, A-21) with poor overall water quality and high to very high parameter concentrations. These wells have mean chlorides which exceed the chloride standard for potable water. These wells should be removed from the distribution system. They are located in the Sabanan Maagas and Taguan management zones.

In order to determine which water quality parameters contributed to the moderate and poor overall quality in grouped wells, specific parameter cluster analyses were used to determine well memberships in "outlier clusters". These outlier wells, which have higher parameter concentrations, are shown in Table 120. These wells fall along the tail of a total-data normal distribution curve. Outlier wells are identified by management zone in Table 121. Management zones or portions of management zones listed in this table should have low priority for future well development.

Water wells can be grouped by geographical locations and assessed in relation to water quality (Figure). This type of grouping can potentially characterize regional aquifer quality, assuming the geographical grouping places water wells in a similar geological unit with essentially uniform hydrogeologic features. One possible set of geographical groups for water wells based on proximity of wells and general geological units is as follows:

Group	Water Wells	
1	M-series:	1, 2, 3, 4, 8, and 9
2	M-series:	5, 6, 7, 10, 12, 14, 15 with D-series: 14, 15, 16, 17, and 18
3	D-series:	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, and CHURA
4	F-series:	5, 6, 7, 8, and 9
5	F-series:	1, 2, 3, 4, 10, and 11
6	AG-series:	1 and 2
7	A-series:	9, 10, 13, 14, 15, 17, 18, 19, 21, 22, and 28
8	A-series:	2, 7, 8, 11, 12, and 20
9	A-series:	1, 3, 4, 6, 23, and 25
10	Y-series:	1, 2, 4, 5, 6, 7

In order to determine if these geographical groups of water wells correspond to water quality, comparisons were made of primarily group membership from both separate parameter and combined parameter cluster analyses. Taking group 1 (M-series) water wells with a 20 cluster analysis for combined parameter, the geographical membership did not correspond with the water quality membership. The other geographical groups also showed generally poor correlation with water quality. Other combinations of geographical groups were also analyzed and found to have poor correlation with water quality. Therefore, geographical grouping of water wells is not a reasonable scheme for regional characterization of the groundwater aquifer. As a result, statistical data were not presented in this report using the PUAG well series geographical location scheme.

An analysis of variance test made between basal and parabasal water wells as mapped in the NGLS, showed no significant difference in water quality. There are both high and low water quality basal and parabasal wells.

Table 119 presents the primary cluster membership of water wells from cluster analysis (N=20) of combined water quality parameters. This grouping of water wells shows that the water quality relationships are not, for the most part, a geographical clusters which could reflect underlying geology. Some of the water well clusters relate to parabasal conditions (See Table 119, cluster 4) which indicate a correlation with the volcanic basement (Figure 18). Table 119 shows that there is a zone along central eastern Guam, which encompasses management zones Pago Bay, Sabanan Maagas, Manaca, Barrigada, Asbeco and Taguan. This zone has poor quality groundwater with higher chloride concentrations (Figure 18). There is apparent salt water intrusion along this zone. Based on the results of new wells drilled in the Toto management zone and previous results from the Agana Swamp management zone, this salt water intrusion zone extends across central Guam. This roughly corresponds to the basal portion of the argillaceous member of the mariana limestone. Drilling operations should be either avoided or done with great care within this region of the Toto and Agana Swamp management zones.

There are management zones or portions of management zones which produce poor water quality for selected parameters (chlorides, specific conductance, total and calcium hardness) from production wells (Figure 19):

1. Sabanan Maagas (entire zone)
2. Barrigada (area around A-15, A-22)
3. Pago Bay (entire zone)
4. Chalan Pago (portions)
5. Taguan (at M-9)
6. Nimitz (area around A-1 and A-23)
7. South Dededo (area around D-8)
8. Y-Sengsong (area around D-13 and new D wells in line with ocean)

Although there are no data from the Manaca management zone, it probably also has poor water quality from salt water intrusion. A saltwater intrusion zone is known to extend into the Barrigada zone, which implicates the manaca management zone as also having saltwater intrusion. A consideration of groundwater quality does not appear to be a major

criteria in the establishment of maragement zones in the NCLS. There are some management zones which produce very good to poor quality well water (i.e. Dededo South). Clumped distribution of water wells in some management zones and none in others made it unfeasible to analyze water quality by these zones. In terms of groundwater quality, management zone boundaries, as well as the number of zones, should be re-evaluated.

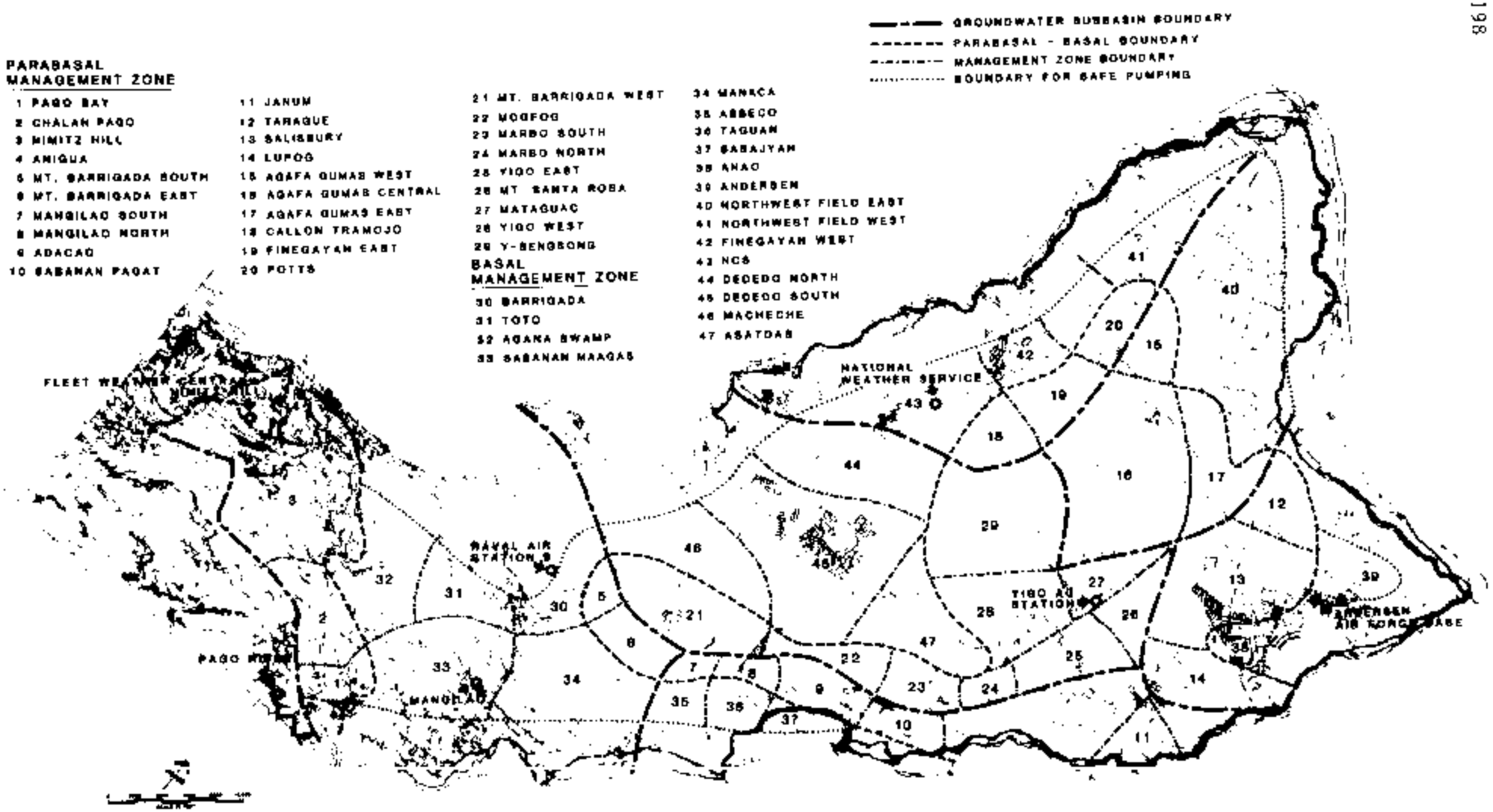
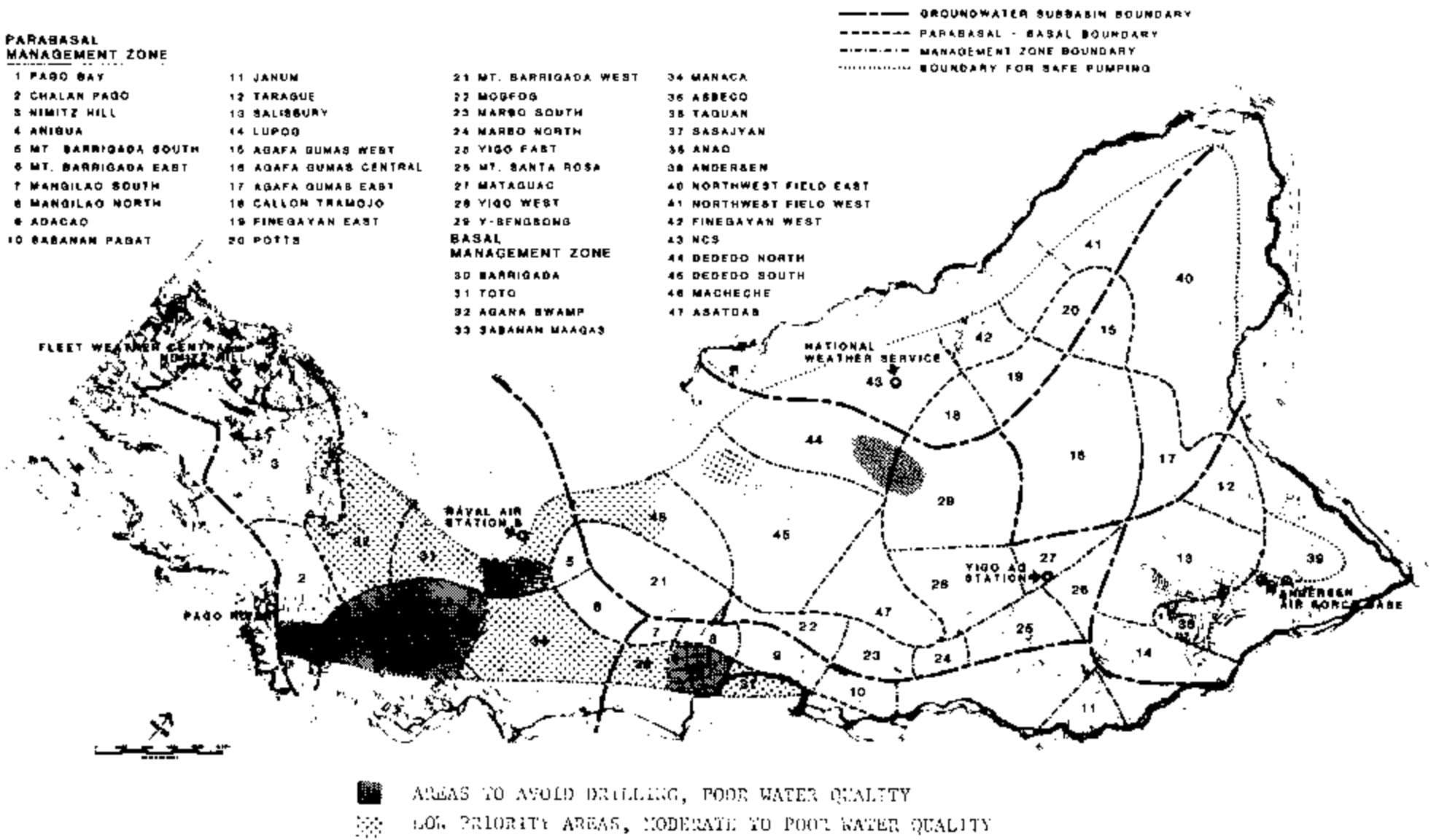


Figure 18. Groundwater management zones, production water wells and volcanic basement (adapted from Barrett, Harris, and Associate Inc., 1981a and 1981c).



AREAS TO AVOID DRILLING, POOR WATER QUALITY

LOW PRIORITY AREAS, MODERATE TO POOR WATER QUALITY

Figure 19. Management zones of poor water quality.

Table 108. Cluster analysis of water quality parameters: Chloride.

Cluster (no=20)	Cluster Mean	Cluster Standard Dev.	Members	Well Membership (By Well Mean)
1	18.6	2.5	1207	1-8,11,12,32,38,39,43,54,59-62,64,72
2	30.7	5.8	917	23,30,40,42,46,63,68-71
3	52.9	7.0	864	21,22,24,26,27,41,51,53,63,66
4	73.3	6.3	543	25,31,35,37,45,47,65,67,73
5	96.3	5.9	342	20,48,49,57,58
6	118.2	6.6	234	29,50,52
7	144.3	6.3	204	15,56
8	163.0	5.2	140	9,36
9	184.1	6.4	81	28
10	210.2	6.4	96	10,33
11	232.5	6.4	111	18
12	253.9	6.5	99	17,44
13	277.0	7.2	114	14,19
14	298.8	6.5	63	13
15	322.7	6.7	64	16
16*	344.3	6.0	47	
17*	366.1	7.5	25	
18*	390.3	6.2	7	
19*	419.3	6.2	7	
20*	442.9	0.0	2	

Cluster (no=15)				
1	19.9	3.3	1539	1-8,11,12,32,38,39,43,54,59,60-62,64,72,69-70
2	38.0	6.1	890	23,24,30,34,66,40,42,46,68,63,66,71
3	62.8	7.8	971	21,22 25,26,27,31,65,67,37,41,47,51,53,55,73
4	91.9	7.8	458	20,35,45,48,49,57,58
5	119.0	8.2	275	29,50,52
6	150.4	7.9	266	15,36,56
7	177.4	8.6	128	9,28
8	212.5	8.5	128	10,33
9	240.5	7.9	138	17,18

Table 108. continued

Cluster (no=15)	Cluster Mean	Cluster Standard Dev.	Members	Well Membership (By Well Mean)
10	269.2	8.0	132	14,19,44
11	298.1	9.8	106	13,16
12*	331.2	8.8	77	
13*	361.8	10.6	46	
14*	404.1	11.8	9	
15*	432.7	9.3	5	
Cluster (no=10)				
1	22.9	6.4	1998	1-8,11,12,23,32,38,39,43,46,54,59-64,68-72
2	56.8	11.3	1401	21,22,25-27,30,31,40-42,47,51,53,55,65-67,73
3	99.8	13.4	662	20,29,35,45,48-50,52,57,58
4	152.0	13.2	394	9,15,28,36,56
5	205.1	14.2	181	10,33
6	247.7	12.3	203	17-19,44
7	288.1	12.3	162	13,14,16
8*	334.1	12.9	110	
9*	373.5	11.5	27	
10*	427.6	14.5	10	
Cluster (no=5)				
1	33.1	15.7	3065	1-8,11,12,21-23,24-27,3-32,34,37-43,46,47,51,53-55,59-73
2	103.8	28.7	1378	9,15,20,28,29,35,36,45,48-50,52,56-58
3	218.6	32.0	475	10,14,17-19,33,44
4	309.7	26.8	272	13,16
5*	394.5	23.8	28	

* These clusters contain observations, that are outlyers (either uncommonly high or low values) and do not represent mean well values.

Table 109. Cluster analysis of water quality parameters: Specific Conductance.

Cluster (no=20)	Cluster Mean	Cluster Standard Dev.	Members	Well Membership (By Well Mean)
1*	220	25	6	
2*	330	21	68	
3	397	17	292	32,54,72
4	464	19	682	30,38,39,43,59,60-63,69,71
5	530	24	1232	2-6,21-27,34,40-43,47,51,53,55,66,68,70
6	607	21	99	1,7,8,11,12,31,37,46,49,65,73
7	692	26	522	29,35,45,48,50,57,58,64,67
8	789	21	217	20,52
9	880	27	146	28,36,56
10	983	23	129	9,15,33
11*	1047	20	6	
12	1119	20	1198	10,44
13	1212	22	119	19
14	1303	11	90	14,17,18
15	1397	18	101	16
16	1498	14	99	13
17*	1603	18	29	
18*	1708	19	16	
19*	1798	5	4	
20*	1900	0	2	

Cluster (no=15)				
1*	276	38	22	
2	400	30	463	32,39,43,54,72
3	500	29	1493	2-6,21-27,30,34,36,40-42,47,51,53,55,59-63,68-71
4	603	31	100	1,7,8,11,12,31,35,37,46,48-50,57,64-67,73
5	735	46	597	20,29,45,52,58
6	894	37	185	28,36,56
7	1042	49	194	9,15,33
8	1163	37	198	10,44

Table 109. continued

Cluster (no=15)	Cluster Mean	Cluster Standard Dev.	Members	Well Membership (By Well Mean)
9	1289	26	118	14,17-19
10	1395	17	100	16
11	1497	15	101	13
12*	1603	16	29	
13*	1700	0	15	
14*	1777	26	7	
15*	1900	0	2	
Cluster (no=10)				
1*	306	38	48	
2	466	45	1605	30,32,38,39,43,54,59-63,69,71,72
3	593	37	1967	1-8,11,12,21-27,31,34,35,37,40-42,46-51,53,55,57,64-68,70,73
4	744	55	652	20,28,29,45,52,56,58
5	954	50	241	15,33,36
6	1149	49	299	9,10,44
7	1345	51	197	14,16-19
8	1515	45	130	13
9*	1715	44	25	
10*	1900	0	1	
Cluster (no=5)				
1	420	44	803	30,32,38,39,43,54,59-63,69,71,72
2	593	80	3379	1-8,11,12,20-29,31,34,35,37,40-42,45-53,55-58,64-68,70,73
3	1024	125	612	9,10,15,33,36,44
4	1389	89	320	13,14,16-19
5*	1667	80	52	

* These clusters contain observations, that are outlyers (either uncommonly high or low values) and do not represent mean well values.

Table 110. Cluster analysis of water quality parameters: Total Hardness.

Cluster (no=20)	Cluster Mean	Cluster Standard Dev.	Members	Well Membership (By Well Mean)
1*	114.9	3.6	2	
2*	136.3	6.6	5	
3*	160.8	4.8	37	
4	179.3	5.1	243	32,54,72
5	197.1	5.1	580	27,43,47-51,53,71
6	217.4	5.9	896	26,28,30,38,39,52,55,57,63
7	237.8	5.9	738	21-25,29,31,33,34,37,40-42,59-62,65,68-70,73
8	259.8	6.5	492	20,35,36,45,56,58,66,67
9	280.6	6.0	418	2-6,44,46
10	301.9	4.5	164	1,7,8,11,12,64
11	323.0	5.9	335	15,16
12	347.3	6.6	102	19
13	367.3	4.7	73	9,10,17
14	383.4	4.3	72	18
15	399.1	5.2	87	14
16	418.3	4.5	64	13
17*	432.6	3.2	28	
18*	444.7	4.6	27	
19*	462.4	5.0	7	
20*	482.2	9.1	3	
Cluster (no=15)				
1*	125.0	9.6	5	
2*	159.3	6.0	36	
3	182.3	6.3	360	37,54,72
4	203.7	6.8	773	26,27,30,38,39,43,47-53,55,57,71
5	226.8	7.6	1069	21-25,28,31,33,34,37,40-42,59-63,68-70,73
6	251.9	7.3	628	20,29,35,36,45,56,58,65-67
7	277.3	6.9	519	2-6,44,46
8	301.6	6.5	366	1,7,8,11,12,64

Table 110. continued

Cluster (no=15)	Cluster Mean	Cluster Standard Dev.	Members	Well Membership (By Well Mean)
9	323.8	6.3	156	15,16
10	347.8	6.4	100	19
11	368.8	5.6	86	9,10,17
12	390.4	6.6	118	14,18
13	415.2	7.6	98	13
14*	441.7	8.6	54	
15*	476.8	10.0	5	
Cluster (no=10)				
1*	134.3	13.1	9	
2	182.6	9.0	475	32,49,51,54,72
3	215.3	11.1	1521	25-28,30,31,37-39,41-43,47,48,50,52,53,55,57,59-63,71
4	253.4	12.8	1129	2,21-24,29,33-36,40,44,45,56,58,65-70,73
5	296.7	12.5	698	1,2,3-8,11,12,15,46,64
6	343.8	13.4	219	16,19
7	387.4	10.8	183	9,10,14,17
8	420.0	7.9	95	13,18
9*	445.2	7.5	39	
10*	476.8	9.9	5	
Cluster (no=5)				
1*	163.6	11.9	89	
2	212.5	17.3	2164	25-28,30-32,37-39,41-43,47-55,57,59-63,71,72
3	275.0	22.5	1579	1-8,11,12,15,21-24,29,33-36,40,44-46,56,58,64-70,73
4	364.7	25.5	412	9,10,13,14,16,19
5	430.8	16.0	129	

* These clusters contain observations, that are out yers (either uncommonly high or low values) and do not represent mean well values.

Table 111. Cluster analysis of water quality parameters: Calcuim Hardness.

Cluster (no=20)	Cluster Mean	Cluster Standard Dev.	Members	Well Membership (By Well Mean)
1*	120.6	3.9	8	
2*	137.9	4.8	41	
3	155.6	4.7	286	32,43
4	170.2	4.5	672	27,36-38,47-51,53,54,57,71,72
5	185.7	4.2	801	26,28-31,33,39,40,42,44,55,58,73
6	200.7	4.6	695	21-25,41,59-63,68-70
7	216.2	4.7	381	34,52,56
8	233.8	4.6	192	45,-65-67
9	249.5	4.4	216	16,20,35,46
10	264.5	4.1	270	2,3,5,6,15,19
11	278.6	4.1	217	1,4,7,8,11,64
12	292.5	4.5	169	12
13	311.5	5.6	137	9,10
14	333.4	5.5	113	14,17
15	351.5	5.0	73	13
16	366.7	4.5	57	18
17*	383.1	4.6	29	
18*	399.2	3.1	14	
19*	410.8	4.1	5	
20*	451.2	0	1	
Cluster (no=15)				
1*	123.6	5.4	12	
2	144.7	5.5	100	43
3	165.0	5.8	725	36-38,42,48-51,54,55,72
4	184.7	5.7	1041	21-31,33,39,40,42,44,47,52,53,57,68,71,73
5	205.0	6.8	885	34,35,41,56,58-63,69
6	231.0	8.0	360	20,45,65-67,70
7	257.9	6.7	385	3,6,15,16,19,46
8	279.6	6.6	353	1,2,4,5,7,8,11,64

Table 111. continued

Cluster (no=15)	Cluster Mean	Cluster Standard Dev.	Members	Well Membership (By Well Mean)
9	302.7	6.9	183	12
10	325.5	6.3	109	9,10,14,17
11	344.8	6.1	101	13
12	365.8	6.1	81	18
13*	389.5	6.7	33	
14*	408.0	5.2	8	
15*	451.2	0.	1	
Cluster (no=10)				
1	137.0	8.1	61	43
2	166.1	7.8	947	32,36-38,47-55,57,72
3	193.8	9.5	1598	21-31,33-35,39-42,44,56,58-63,69-71,73
4	229.9	12.3	615	16,20,45,46,65,66-68
5	270.6	10.6	619	1-8,11,15,19,64
6	306.0	10.6	266	9,10,12
7	344.8	10.8	187	13,14,17
8	376.0	8.0	65	18
9*	402.8	5.9	18	
10	451.2	0	1	
Cluster (no=5)				
1	159.8	9.5	693	32,36-38,43,47-55,57,72
2	196.2	16.1	2321	16,20-31,33-35,39-42,44-46,56,58-63,69-71,73
3	272.7	21.2	1059	1-12,15,19,45,46,64
4	349.8	18.9	287	13,14,17,18
5*	406.3	12.9	17	

* These clusters contain observations, that are outlyers (either uncommonly high or low values) and do not represent mean well values.

Table 112. Cluster analysis of water quality parameters: Methyl Alkalinity.

Cluster (no=20)	Cluster Mean	Cluster Standard Dev.	Members	Well Membership (By Well Mean)
1*	103.8	3.3	14	
2*	116.0	3.6	86	
3*	130.9	3.7	216	
4	144.2	3.9	406	32,33,48-52,57
5	157.9	4.0	525	27,43,47,53-55,71,72
6	171.4	4.1	599	25-26,36-39,41,44,56,63,73
7	185	4.0	569	16,19,21-24,28-31,34,35,40,42,58,59,61,69
8	199.1	4.0	473	45,60,62,65,68,70
9	213.4	4.1	322	20,66,67
10	227.7	3.9	224	15,46
11	240.5	3.7	200	1-6,8
12	253.9	3.8	174	7,11,13,14,17
13	266.8	3.5	216	18
14	278.6	3.5	196	9,10,12,64
15*	290.0	3.1	83	
16*	301.8	3.3	53	
17*	312.8	2.9	25	
18*	327.3	3.8	7	
19*	364.0	0	1	
20*	381.0	0	1	
Cluster (no=15)				
1*	105.3	3.7	20	
2*	121.3	5.7	152	
3	141.3	6.0	550	32,33,48-52,57
4	160.9	5.6	778	27,43,47,53-55,71,72
5	180.4	5.8	839	16,19,21-26,28-31,34-42,44,56,58,59,61,63,69,73
6	199.0	5.2	609	45,60,62,65,68,70
7	217.7	5.4	379	20,66,67
8	237.3	5.4	307	1-6,8,15,46

Table 112. continued

Cluster (no=15)	Cluster Mean	Cluster Standard Dev.	Members	Well Membership (By Well Mean)
9	257.4	5.7	269	7,11,13,14,17
10	274.8	5.1	248	9,10,12,64
11	292.5	5.4	124	18
12*	309.6	4.0	42	
13*	326.5	4.1	8	
14*	364.0	0	1	
15*	381.0	0	1	
Cluster (no=10)				
1*	109.6	4.5	46	
2*	129.5	6.5	308	
3	153.5	7.8	948	27,32,33,43,47-55,57,71,72
4	179.4	8.0	1151	16,19,21-26,28-31,34-42,44,56,58,59,61,63,69,73
5	206.9	8.9	823	20,45,60,62,65-68,70
6	239.9	9.1	483	1-6,8,15,46
7	271.2	8.3	419	7,9-14,17,64
8	298.4	7.9	135	18
9*	323.2	6.0	12	
10*	372.5	12.0	2	
Cluster (no=5)				
1	132.5	10.5	555	32,33,48-52,57
2	174.5	16.0	2240	16,19,21-31,34-42,44,53-56,58,59,61,63,69-73
3	229.9	17.9	1070	1-6,8,15,20,45,46,60,62,65-68
4	282.8	10.5	459	7,10-14,17,18,64
5*	359.3	24.3	3	

* These clusters contain observations that are outlyers (either uncommonly high or low values) and do not represent mean well values.

Table 113. Cluster analysis of water quality parameters: pH.

Cluster (no=20)	Cluster Mean	Cluster Standard Dev.	Members	Well Membership (By Well Mean)
1*	6.34	0	1	
2*	6.53	0.02	2	
3*	6.67	0.01	4	
4*	6.75	0.01	19	
5*	6.82	0.02	65	
6*	6.90	0.02	137	
7*	6.98	0.03	259	
8	7.07	0.03	443	1,4,6-8,11-14
9	7.16	0.03	578	2,3,5,9,10,17,18,66,67
10	7.25	0.03	695	15,19,46,64,69,70
11	7.35	0.03	780	16,21,23-25,34,40,42,45,47,56,58-63,65,68,73
12	7.44	0.03	760	20,22,26-32,35,36,38,41,48,52-55,57,71,72
13	7.53	0.03	681	33,37,39,44,49,50
14	7.61	0.03	442	43,51
15*	7.74	0.04	182	
16*	7.87	0.03	73	
17*	7.99	0.03	25	
18*	8.11	0.05	19	
19*	8.30	0.05	2	
20*	8.60	0	1	
Cluster (no=15)				
1*	6.34	0	1	
2*	6.53	0.02	2	
3*	6.74	0.04	23	
4*	6.87	0.04	176	
5*	6.99	0.03	356	
6	7.11	0.04	750	1-8,10-14,17,66,67
7	7.24	0.04	893	9,15,18,19,46,64,69,70
8	7.37	0.04	1123	16,20-27,29-32,34-36,38,40-42,45,47-49,52-63,65,68,71-73

Table 113. continued

Cluster (no=15)	Cluster Mean	Cluster Standard Dev.	Members	Well Membership (By Well Mean)
9	7.50	0.04	1037	28,33,37,39,44,50,51
10	7.62	0.04	549	43
11*	7.77	0.04	168	
12*	7.92	0.05	61	
13*	8.07	0.05	21	
14*	8.24	0.06	5	
15*	8.60	0	1	
Cluster (no=10)				
1*	6.46	0.11	3	
2*	6.78	0.04	60	
3*	6.95	0.06	465	
4	7.15	0.06	1262	1-15,17-19,46,64,67,69,70
5	7.35	0.06	1719	16,20-27,29-32,34-36,38,40-42,45-49,52-63,65,68,71-73
6	7.54	0.06	1319	28,33,37,39,44,50,51
7	7.76	0.07	285	43
8*	8.01	0.07	49	
9*	8.23	0.06	5	
10*	8.60	0	1	
Cluster (no=5)				
1*	6.67	0.11	16	
2	7.07	0.11	1638	1-15,17-19,46,64,67,69,70
3	7.42	0.11	3078	16,20-42,44,45,47-63,65,68,71-73
4	7.76	0.12	430	43
5*	8.30	0.16	6	

* These clusters contain observations that are outlyers (either uncommonly high or low values) and do not represent mean well values.

Table 114. Cluster analysis of water quality parameters: Combined data with 20 clusters.

MEAN

Cluster (no=20)	Members	Chl	Cond	pH	T. Hard	Ca.Hard	M. Alk	Temp	Turb
1	62	26.6	319	7.47	224.54	196.52	182.90	26.9	0.23
2	1055	71.2	628	7.38	228.70	194.29	174.69	26.8	0.18
3	38	326.5	1652	7.25	420.71	356.24	260.49	27.7	0.29
4	716	27.4	427	7.45	204.36	178.74	167.53	26.8	0.19
5	109	159.4	924	7.16	360.67	314.28	262.66	27.7	0.75
6	155	178.0	950	7.40	261.77	201.85	177.08	26.9	0.27
7	105	298.0	1453	7.15	407.52	344.76	257.00	27.7	0.24
8	820	24.1	584	7.12	294.30	273.21	251.73	27.4	0.20
9	64	305.0	1524	7.30	321.74	260.18	189.35	27.6	0.34
10	82	312.9	1350	7.32	314.82	234.85	172.20	27.5	0.28
11	124	191.0	1098	7.19	363.88	314.87	252.37	27.6	0.27
12	427	122.0	765	7.42	237.35	194.75	170.19	26.8	0.23
13	66	220.9	1310	7.15	397.69	342.71	274.85	27.5	0.23
14	71	266.4	1195	7.43	299.92	229.93	178.02	27.3	0.30
15	73	214.7	1136	7.38	289.18	215.08	192.58	27.3	0.24
16	1192	44.3	514	7.40	222.43	192.42	176.75	26.8	0.20
17	15	195.3	1850	7.44	267.70	169.81	158.50	26.9	0.16
18	17	254.3	1378	7.10	316.21	330.08	255.03	27.4	0.26
19	9	357.3	1808	7.10	450.90	380.86	255.27	28.0	0.39
20	71	250.6	1203	7.13	400.76	345.04	261.06	27.6	0.23

Table 114. continued

STANDARD DEVIATION

Cluster (no=20)	Chl	Cond	pH	T. Hard	Ca. Hard	M. Alk	Temp	Turb
1	12.3	43	0.19	36.14	37.16	33.91	0.5	0.25
2	25.9	37	0.20	28.43	26.30	30.13	0.6	0.18
3	38.8	56	0.25	23.80	35.42	31.57	0.6	0.38
4	13.9	34	0.19	24.36	24.55	26.94	0.6	0.35
5	59.0	59	0.20	36.86	32.42	32.84	0.7	0.33
6	42.2	50	0.22	30.05	34.35	28.17	0.7	0.20
7	40.1	52	0.21	26.21	31.85	35.09	0.4	0.18
8	13.8	42	0.18	23.78	27.49	28.08	0.6	0.18
9	55.5	45	0.25	21.76	26.31	26.96	0.5	0.56
10	47.9	54	0.23	34.73	35.06	31.43	0.6	0.21
11	40.1	34	0.22	31.69	34.51	38.44	0.5	0.47
12	34.1	45	0.19	28.78	27.13	31.17	0.7	0.53
13	35.3	32	0.20	27.63	34.26	32.52	0.6	0.19
14	40.3	46	0.19	33.83	37.14	32.67	0.6	0.31
15	32.6	47	0.26	35.96	43.13	35.29	0.6	0.21
16	21.3	27	0.20	23.87	20.72	26.51	0.6	0.27
17	29.2	71	0.08	16.06	11.52	18.21	0.3	0.09
18	21.4	48	0.19	52.28	40.07	32.55	0.5	0.30
19	17.7	55	0.20	29.61	44.09	40.81	0.5	0.29
20	44.2	37	0.21	27.78	29.76	34.77	0.4	0.19

Table 115. Cluster analysis of water quality parameters: combined data with 15 clusters.

MEAN

Cluster (no=15)	Members	Chl	Cond	pH	T. Hard	Ca.Hard	M. Alk	Temp	Turb
1	135	238.5	1239	7.13	396.51	337.84	266.63	27.6	0.25
2	66	25.7	331	7.44	233.15	216.11	197.11	26.9	0.23
3	120	292.9	1450	7.14	407.78	347.84	259.99	27.7	0.24
4	72	313.2	1543	7.32	337.71	266.40	198.52	27.6	0.33
5	980	25.9	581	7.14	289.92	267.09	244.78	27.6	0.20
6	7	205.0	1850	7.46	248.80	162.58	152.14	26.7	0.26
7	34	337.1	1701	7.21	434.13	371.85	258.24	27.9	0.31
8	1425	33.0	461	7.42	212.59	184.93	171.78	26.8	0.20
9	1503	72.5	613	7.41	223.64	189.78	171.38	26.8	0.18
10	165	190.2	1057	7.18	367.45	321.83	261.85	27.5	0.22
11	167	228.5	1115	7.39	292.72	223.10	186.48	27.3	0.28
12	368	132.6	823	7.43	242.33	194.35	172.37	26.9	0.24
13	110	155.3	839	7.24	344.04	300.01	240.76	27.0	0.22
14	23	248.7	1377	7.14	326.75	322.40	261.13	27.5	0.25
15	96	305.7	1339	7.34	313.55	237.19	174.18	27.4	0.30

Table 115. continued

STANDARD DEVIATION

Cluster (no=15)	Chl	Cond	pH	T. Hard	Ca Hard	M Alk	Temp	Turb
1	49.7	40	7.13	28.43	32.55	35.36	0.5	0.28
2	11.8	51	7.20	38.41	44.20	38.36	0.6	0.24
3	43.0	52	7.22	25.76	31.99	35.85	0.4	0.18
4	51.9	52	7.24	40.90	34.29	39.99	0.6	0.54
5	14.2	46	7.18	25.17	26.56	32.47	0.6	0.17
6	26.5	71	7.08	40.01	11.39	21.96	0.6	0.11
7	23.8	69	7.23	22.89	30.50	32.48	0.5	0.41
8	17.1	44	7.19	25.08	22.84	26.25	0.6	0.34
9	28.2	56	7.19	25.48	21.79	27.78	0.6	0.17
10	49.1	61	7.21	33.83	34.86	34.17	0.5	0.21
11	48.1	67	7.23	35.57	42.09	34.60	0.6	0.43
12	39.2	68	7.20	26.01	26.15	29.69	0.7	0.58
13	56.1	65	7.20	40.54	33.29	31.95	0.7	0.18
14	36.0	50	7.21	53.47	39.40	29.53	0.6	0.27
15	51.0	58	7.23	34.32	37.32	29.36	0.6	0.24

Table 116. Cluster analysis of water quality parameters: combined data with 10 clusters.

MEAN

Cluster (no=10)	Members	Chl	Cond	pH	T. Hard	Ca Hard	M Alk	Temp	Turb
1	30	340.1	1729	7.20	430.38	368.33	248.38	27.89	0.28
2	158	304.4	1390	7.30	330.12	255.97	186.84	27.51	0.31
3	744	121.2	766	7.42	240.43	198.49	173.00	26.87	0.22
4	307	202.5	1066	7.31	311.50	252.07	210.08	27.35	0.25
5	314	25.0	375	7.45	204.23	181.58	166.76	26.82	0.20
6	2221	47.4	522	7.41	218.10	187.36	172.70	26.82	0.20
7	224	237.0	1217	7.17	388.22	334.23	262.67	27.61	0.25
8	15	193.9	1850	7.44	241.38	168.70	160.92	26.95	0.17
9	1129	34.9	602	7.16	285.68	261.28	239.86	27.24	0.19
10	129	297.8	1507	7.16	397.86	338.78	256.68	27.72	0.26

STANDARD DEVIATION

Cluster (no=10)	Chl	Cond	pH	T. Hard	Ca Hard	M Alk	Temp	Turb
1	24.1	52	0.20	29.05	38.79	35.03	0.47	0.24
2	46.9	72	0.23	45.92	46.71	37.95	0.55	0.40
3	41.9	77	0.20	38.46	35.00	34.64	0.72	0.42
4	52.8	77	0.25	46.05	58.00	47.87	0.64	0.35
5	15.2	37	0.18	32.59	32.09	32.22	0.63	0.42
6	25.0	58	0.20	23.90	21.29	26.48	0.55	0.26
7	50.7	77	0.27	33.97	35.24	37.24	0.49	0.25
8	31.0	71	0.06	38.43	41.00	20.07	0.38	0.09
9	24.5	44	0.20	27.47	30.78	34.33	0.68	0.15
10	52.07	64	0.25	42.48	39.92	40.03	0.57	0.35

Table 117. Cluster analysis of water quality parameters: combined data with 5 clusters.

MEAN

Cluster (no=5)	Members	Chl	Cond	pH	T. Hard	Ca Hard	M Alk	Temp	Turb
1	388	280.7	1355	7.23	358.28	291.40	222.69	27.55	0.27
2	87	324.8	1640	7.26	402.21	342.12	253.28	27.73	0.28
3	541	188.4	1013	7.29	319.59	264.78	220.02	27.31	0.24
4	3255	57.5	600	7.33	242.84	212.09	192.64	26.96	0.20
5	1000	29.1	430	7.45	211.45	184.78	171.59	26.83	0.21

STANDARD DEVIATION

Cluster (no=5)	Chl	Cond	pH	T. Hard	Ca Hard	M Alk	Temp	Turb
1	49.8	104	0.24	55.68	61.62	52.41	0.54	0.31
2	54.9	94	0.26	54.15	53.48	44.79	0.59	0.30
3	52.8	112	0.25	60.25	66.94	50.51	0.69	4.31
4	36.8	80	0.23	39.05	41.58	43.71	0.65	0.27
5	15.7	47	0.19	28.47	27.57	28.31	0.60	0.36

Table 118. Primary and secondary well membership in clusters from combined water quality parameter analysis. The cutoff point for inclusion in secondary membership for clusters 15, 10 and 5 is about 10% data membership.

Well WER1/PUAG	Cluster Number	Primary Cluster [No. (%)]	Secondary Cluster Membership [No. (%)]
1/A- 1	20	8(87)	2(9),9(1)
	15	5(93)	
	10	9(99)	
	5	4(97)	
2/A- 2	20	8(68)	1(1),2(11),4(9),9(1),13(1),16(3)
	15	5(82)	
	10	9(80)	6(10)
	5	4(84)	5(14)
3/A- 3	20	8(94)	2(2),9(1),13(1),16(1)
	15	5(97)	
	10	9(95)	
	5	4(96)	
4/A- 4	20	8(80)	1(1),2(10),5(1),9(1),16(5)
	15	5(89)	
	10	9(90)	
	5	4(90)	
5/A- 5	20	8(90)	1(1),2(2),4(1),5(1),16(4)
	15	5(90)	
	10	9(90)	
	5	4(94)	
6/A- 6	20	8(87)	1(1),2(1),4(1),5(10,16(9)
	15	5(94)	
	10	9(82)	6(13)
	5	4(95)	
7/A- 7	20	8(89)	2(10),5(1)
	15	5(89)	
	10	9(98)	
	5	4(98)	
8/A- 8	20	8(81)	2(6),5(6),9(1),12(1),16(4)
	15	5(89)	
	10	9(88)	
	5	4(94)	

Table 118. continued.

Well WERI/PUAG	Cluster Number	Primary Cluster [No. (%)]	Secondary Cluster Membership [No. (%)]
9/A- 9	20	11(59)	5(26),6(5),7(1),13(2),19(1),20(2)
	15	10(71)	11(10)
	10	4(65)	7(24)
	5	3(85)	
10/A-10	20	11(28)	5(16),6(2),7(1),10(1),12(2),13(6),14(1), 15(2),18(2),20(25)
	15	1(43)	10(30,15(10)
	10	7(65)	4(24)
	5	3(63)	1(33)
11/A-11	20	8(87)	2(27),4(1),5(1),9(1),16(1)
	15	5(90)	
	10	9(94)	
	5	4(94)	
12/A-12	20	8(93)	2(2),5(2),9(2)
	15	5(94)	
	10	9(96)	
	5	4(96)	
13/A-13	20	7(45)	3(18),5(2),9(1),10(2),11(10),13(2),15(3), 18(2),19(5),20(5)
	15	3(47)	7(18),10(32)
	10	10(49)	1(14),2(13),7(17)
	5	1(50)	2(30),3(20)
14/A-14	20	7(29)	3(6),8(1),9(5),11(15),13(13),15(2),18(3) 20(16)
	15	3(39)	1(22),10(14)
	10	7(37)	2(18),4(10),10(33)
	5	1(69)	2(10),3(21)
15/A-15	20	6(32)	5(30),8(1),9(2),10(1),11(13),12(12),15(6)
	15	10(27)	11(18),12(23),13(27)
	10	4(54)	3(40)
	5	3(89)	
16/A-17	20	9(38)	3(2),7(1),10(27),11(1),14(15),15(6),18(1)
	15	4(39)	11(22),15(38)
	10	2(55)	4(20),10(17)
	5	1(72)	3(16)
17/A-18	20	7(27)	3(2),5(1),9(1),10(4),11(17),13(15),15(5), 20(17)
	15	1(37)	3(27),10(16)

Table 118. continued.

Well WERI/PGAC	Cluster Number	Primary Cluster [No. (%)]	Secondary Cluster Membership [No. (%)]
17/A-18	10	7(51)	2(16),4(10),10(23)
	5	1(72)	3(21)
18/A-19	20	13(19)	3(14),5(11),6(3),7(14),9(1),11(2),12(2), 14(1),18(1),19(5),20(16)
	15	1(25)	3(20),7(16),10(17)
	10	7(38)	1(14),3(10),8(12),10(23)
	5	3(37)	1(32),2(29)
19/A-21	20	10(30)	6(1),7(1),9(8),11(5),14(24),15(19),16(1), 18(1),20(5)
	15	11(43)	4(10),15(33)
	10	4(40)	2(37),7(21)
	5	1(67)	3(29)
20/A-22	20	12(90)	2(5),6(5)
	15	12(76)	9(14)
	10	3(95)	
	5	4(86)	
64/A-23	20	8(75)	4(25)
	15	5(75)	8(25)
	10	9(100)	
	5	4(100)	
21/D- 1	20	2(68)	1(1),4(1),8(2),12(1),16(25)
	15	9(85)	8(9)
	10	6(70)	9(25)
	5	4(98)	
22/D- 2	20	2(71)	1(1),4(5),8(3),12(3),16(22)
	15	9(90)	
	10	6(66)	9(29)
	5	4(97)	
23/D- 3	20	16(70)	1(3),2(6),4(13),8(4),12(3)
	15	8(59)	9(29)
	10	6(93)	
	5	4(79)	5(21)
24/D- 4	20	16(72)	1(5),2(15),4(4),8(4)
	15	9(52)	5(11),8(32)
	10	6(91)	
	5	4(86)	5(14)

Table 118. continued.

Well WERI/PUAC	Cluster Number	Primary Cluster [No. (%)]	Secondary Cluster Membership [No. (%)]
25/D- 5	20	2(57)	4(2),6(2),8(3),16(28)
	15	9(80)	8(15)
	10	6(80)	9(18)
	5	4(81)	
26/D- 6	20	16(62)	2(25),4(7),6(1),8(4)
	15	9(59)	5(11),8(30)
	10	6(91)	
	5	4(82)	5(18)
27/D- 7	20	16(81)	2(4),4(13),8(3)
	15	8(59)	9(35)
	10	6(98)	
	5	4(78)	5(22)
28/D- 8	20	12(50)	2(9),4(4),5(4),6(29),15(3)
	15	12(63)	9(19)
	10	3(79)	4(12)
	5	4(59)	3(40)
29/D- 9	20	12(73)	2(16),4(1),5(1),6(5),16(5)
	15	12(49)	9(34)
	10	3(88)	
	5	4(91)	
30/D-10	20	16(64)	1(2),2(1),4(28),12(4)
	15	8(79)	
	10	6(89)	
	5	4(51)	5(49)
31/D-11	20	2(59)	4(6),8(5),12(2),16(27)
	15	9(83)	8(14)
	10	6(55)	3(32),9(13)
	5	4(90)	5(10)
32/D-12	20	4(84)	1(14),2(1),17(1)
	15	8(81)	2(16)
	10	5(84)	
	5	5(100)	
33/D-13	20	12(45)	2(4),4(3),6(13),9(6),10(14),14(9),15(1), 16(3),17(1)
	15	12(34)	9(23),11(9),15(15)
	10	3(60)	2(22),4(11)
	5	4(46)	1(22),3(22)

Table 118. continued.

Well WER!/PUAG	Cluster Number	Primary Cluster [No. (%)]	Secondary Cluster Membership [No. (%)]
34/D-14	20	16(65)	1(1),2(19),4(1),8(9),10(1),12(3),14(1)
	15	9(41)	5(19),8(34)
	10	6(81)	
	5	4(88)	5(12)
35/D-15	20	2(73)	12(16),14(1),16(9)
	15	9(81)	12(10)
	10	9(41)	3(39),6(20)
	5	4(99)	
65/D-16	20	2(55)	4(10),8(3),12(15),16(16),17(1)
	15	9(54)	2(9),5(9),8(21)
	10	9(44)	3(22),6(28)
	5	4(84)	5(16)
66/D-17	20	2(46)	4(1),8(33)16(20)
	15	5(49)	8(12),9(39)
	10	9(78)	6(18)
	5	4(96)	
67/D-18	20	2(85)	4(3),8(6),16(6)
	15	9(84)	5(13)
	10	9(78)	
	5	4(97)	
36/M- 1	20	6(40)	2(5),4(1),5(6),11(1),12(35),15(9)
	15	12(68)	11(13)
	10	3(68)	4(21)
	5	3(64)	4(32)
37/M- 2	20	2(76)	4(1),6(1),8(5),12(3),16(14)
	15	9(85)	
	10	6(65)	3(18),13(17)
	5	4(96)	
38/M- 3	20	4(63)	1(1),2(6),16(29)
	15	8(92)	
	10	6(90)	
	5	5(81)	4(19)
39/M- 4	20	4(80)	1(2),16(18)
	15	8(96)	
	10	6(82)	5(18)
	5	5(94)	

Table 118. continued.

Well WERI/PUAG	Cluster Number	Primary Cluster [No. (%)]	Secondary Cluster Membership [No. (%)]
40/M- 5	20	16(79)	1(1),2(10),4(6),8(4)
	15	9(47)	5(11),8(41)
	10	6(94)	
	5	4(82)	5(18)
41/M- 6	20	2(49)	4(6),8(7),16(38)
	15	9(63)	5(14),8(23)
	10	6(86)	9(14)
	5	4(89)	5(11)
42/M- 7	20	16(79)	1(1),2(2),4(11),8(5),12(1)
	15	8(68)	5(11),9(20)
	10	6(88)	
	5	4(77)	5(23)
43/M- 8	20	4(91)	1(3),2(1),16(5)
	15	8(96)	
	10	6(69)	5(31)
	5	5(93)	
44/M- 9	20	14(32)	4(1),6(15),10(10),11(1),12(4),13(3),15(29), 17(3),18(3)
	15	11(58)	12(9),15(17)
	10	4(62)	2(17)
	5	3(48)	1(45)
45/M-12	20	2(55)	1(1),8(5),12(37),15(1),16(1)
	15	9(66)	5(10),12(17)
	10	3(58)	9(36)
	5	4(95)	
46/M-14	20	8(52)	1(4),2(41),12(3)
	15	5(77)	9(23)
	10	9(86)	
	5	4(97)	
68/M-15	20	16(44)	2(33),4(11),8(11)
	15	9(500	5(12),8(38)
	10	6(75)	9(20)
	5	4(88)	5(12)
47/F- 1	20	16(48)	2(42),4(5),8(5)
	15	9(79)	8(15)
	10	6(80)	9(13)
	5	4(94)	

Table 118. continued.

Well WERI/PUAG	Cluster Number	Primary Cluster [No. (%)]	Secondary Cluster Membership [No. (%)]
48/F- 2	20	2(65)	8(4),12(29),16(1),17(1)
	15	9(83)	12(13)
	10	3(52)	6(44)
	5	4(99)	
49/F- 3	20	2(67)	4(1),12(15),16(16),17(1)
	15	9(84)	8(10)
	10	6(64)	3(25)
	5	4(96)	
50/F- 4	20	2(68)	4(11),5(2),6(2),16(14),17(2)
	15	9(56)	8(10),12(20),13(14)
	10	3(57)	6(41)
	5	4(85)	
51/F- 5	20	16(54)	2(12),4(28),8(3),12(1),17(1)
	15	8(62)	9(32)
	10	6(95)	
	5	4(66)	5(33)
52/F- 6	20	12(37)	2(37),4(1),5(6),6(11),16(6),17(1)
	15	9(59)	12(28),13(9)
	10	3(64)	6(28)
	5	4(78)	3(20)
53/F- 7	20	16(63)	2(22),4(6),8(6),12(1),17(1)
	15	9(52)	5(9),8(38)
	10	6(90)	
	5	4(87)	5(13)
54/F- 8	20	4(86)	1(6),2(1),16(5),17(1)
	15	8(95)	
	10	5(62)	6(37)
	5	5(96)	
55/F- 9	20	16(53)	2(29),4(16),8(2)
	15	8(56)	9(42)
	10	6(98)	
	5	4(74)	5(26)
56/F-10	20	12(38)	2(12),5(8),6(35),9(2),16(5)
	15	12(37)	9(27),11(14),13(12)
	10	3(64)	4(21),6(11)
	5	4(49)	3(47)

Table 118. continued.

Well WERI/PUAG	Cluster Number	Primary Cluster [No. (%)]	Secondary Cluster Membership [No. (%)]
57/F-11	20	2(49)	8(4),12(34),16(13)
	15	9(85)	12(12)
	10	3(47)	6(41),9(12)
	5	4(100)	
58/H- 1	20	2(57)	8(1),12(39),16(3)
	15	9(69)	12(26)
	10	3(55)	6(30),9(15)
	5	4(98)	
59/Y- 1	20	16(62)	1(2),2(4),4(32)
	15	8(83)	5(9)
	10	6(88)	5(10)
	5	4(52)	5(49)
60/Y- 2	20	16(71)	2(1),4(28)
	15	8(87)	5(10)
	10	6(91)	
	5	4(52)	5(48)
61/Y- 3	20	16(59)	1(1),2(1),4(39)
	15	8(95)	
	10	6(92)	
	5	5(67)	4(33)
62/Y- 4	20	16(60)	1(2),2(4),4(33),12(1)
	15	8(81)	5(9)
	10	6(93)	
	5	4(52)	5(48)
63/Y- 5	20	16(63)	1(2),2(4),4(29),8(2)
	15	8(80)	9(10)
	10	6(92)	
	5	4(54)	5(46)
69/Y- 6	20	16(56)	1(3),2(13),4(28)
	15	8(74)	9(15)
	10	6(82)	5(10)
	5	5(53)	4(47)
70/Y- 7	20	4(50)	2(12),16(38)
	15	8(63)	9(25),5(12)
	10	6(88)	3(12)
	5	4(50)	5(50)

Table 118. continued.

Well WER1/PUAG	Cluster Number	Primary Cluster [No. (%)]	Secondary Cluster Membership [No. (%)]
71/AG-1	20	16(51)	2(1),4(48)
	15	8(92)	2(16)
	10	6(88)	5(10)
	5	5(54)	4(46)
72/AG-2	20	4(79)	1(15),14(1),16(5)
	15	8(81)	
	10	5(73)	6(25)
	5	5(96)	
73/GEURA	20	2(56)	4(5),8(2),16(33)
	15	9(71)	8(21)
	10	6(76)	9(24)
	5	4(86)	5(14)

Table 119. Primary cluster membership of water wells based on cluster analysis of combined water quality parameters with management zones and general potable water quality from these zones. The data is from the 20 cluster analysis and only the mean chloride values are shown, ranked from lowest to highest. The primary membership is based on all the analyzed water quality parameters (see Table 114 and 118).

Cluster	Mean Chloride	Wells by Primary Membership	Management zone	General water quality
8	24.1	A-1 to A-8,A-11,A-12,A-23,M-14	3,32,33,2,45	Very good generally water quality of all parameters is very good with few higher values.
1	26.6			
4	27.4	D-12,M-3,M-4,M-8,F-8,Y-7,AC-2	44,8,43,25,16	
16	44.3	D-3,D-4,D-6,D-7,D-10,M-5,M-7,M-15,F-1, F-5,F-7,F-9,Y-1 to Y-6,AC-1	45,42,43,25,47,28,16	
2	71.2	D-1,D-2,D-5,D-11,D-15,D-16 to D-18,M-2, M-6,M-12,F-2 to F-4,F-11,H-1,CHURA	45,8,42,43	
12	122.0	A-22,D-8,D-9,D-13,D-14,F-6,F-10	30,45,29,43,42	Good generally good water quality with occassional high values.
5	159.4			
6	178.0	A-15,M-1	30,36	
11	191.0	A-9,A-10	33	Moderate periodic high (poor) water quality values.
17	195.3			
15	214.7			
13	220.9	A-19	1	
20	250.6			Poor water quality generally with high to very high values. Exceeds chloride standard (250 mg/l) for potable water.
18	254.3			
14	286.4	M-9	36	
7	298.0	A-13,A-14,A-18	33	
9	305.0	A-17	33	
10	312.9	A-21	33	
3	326.5			
19	357.3			

Table 120. Clusters of water wells which have high mean value for specified water quality parameters. These wells are shown in the cluster analysis as outlyers.

CHLORIDE		SPECIFIC CONDUCTANCE		TOTAL HARDNESS		CALCIUM HARDNESS		METHYL ALKALINITY	
Wells (clusters = 20)	Mean	Wells	Mean	Wells	Mean	Wells	Mean	Wells	Mean
28	184.1	9,15,33	985	1,7,8,11,12,64	301.9	12	292.5	1-6,8	240.5
10,33	210.2	10,44	1120	15,16	323.0	9,10	311.5	7,11,13,14,17	253.9
18	232.5	19	1210	19	347.3	14,17	333.4	18	266.8
17,44	253.9*	14,17,18	1305	9,10,17	367.3	13	351.5	9,10,12,64	278.6
14,19	277.0*	16	1400	18	383.4	18	366.7		
13	298.8*	13	1500	14	399.1				
16	322.7*			13	418.3				
(clusters = 15)									
9,28	177.4	9,15,33	1040	15,16	323.8	12	302.7	1-6,8,15,46	237.3
10,33	212.5	10,44	1165	19	347.8	9,10,14,17	325.5	7,11,13,14,17	257.4
17,18	240.5	14,17-19	1290	9,10,17	368.6	13	344.8	9,10,12,64	274.8
14,19,44	269.2*	16	1395	14,18	390.4	18	365.8	18	292.5
13,16	298.1*	13	1500	13	415.7				
(clusters = 10)									
10,3	205.1	15,33,36	955	16,19	343.8	9,10,12	306.0	1-6,8,15,46	239.9
17,18,19,44	247.7	9,10,44	1150	9,10,14,17	387.4	13,14,17	344.8	7,9-14,17,64	271.2
13,14,16	288.1*	14,16-19	1345	13,18	420.0	18	376.0	18	298.4
		13	1515						
(clusters = 5)									
10,14,17-19,33,34	218.6	9,10,15,33,34	1025	9,10,13,14,	364.7	13,14,17,18 16-19	349.8 364.7	7,10-14,17, 18,64	282.8
13,16	309.7*	13,14,16-19	1390						

* exceeds chloride standard of 250 mg/l.

Table 121. Management zone locations of water wells which have high mean values for specified water quality parameters.

Parameter	Water Wells	Managment Zone
Chloride	10(A-10),13(A-13),14(A-14),16(A-17),17(A-18),19(A-21)	Sabanan Maagas
	18(A-19)	Pago Bay
	28(D-8)	South Dededo
	33(D-13)	Y-Sengsong
	44(M-9)	Taguan
Specific Conductance	9(A-9),10(A-10),13(A-13),14(A-14),16(A-17),17(A-18),	Sabanan Maagas
	19(A-21)	Sabanan Maagas
	18(A-19)	Pago Bay
	15(A-15)	Barrigada
	33(D-13)	Y-Sengsong
	44(M-9)	Taguan
Total Hardness	1(A-1),64(A-23)	Nimitz
	9(A-9),10(A-10),13(A-13),14(A-14),16(A-17),17(A-18),	Sabanan Maagas
	19(A-21)	Sabanan Maagas
	18(A-19)	Pago Bay
	15(A-15)	Barrigada
	7(A-7),8(A-8),11(A-11),12(A-12)	Chalan Pago
Calcium Hardness	9(A-9),10(A-10),13(A-13),14(A-14),17(A-18)	Sabanan Maagas
	12(A-12)	Chalan Pago
	18(A-19)	Pago Bay
Alkalinity	1(A-1),3(A-3),5(A-5),6(A-6),64(A-23)	Nimitz
	4(A-4),9(A-9),10(A-10),13(A-13),14(A-14),17(A-18)	Sabanan Maagas
	2(A-2)	Agana Swamp
	7(A-7),8(A-8),11(A-11),12(A-12)	Chalan Pago
	18(A-19)	Pago Bay
	15(A-15)	Barrigada
	46(M-14)	South Dededo

RECOMMENDATIONS

1. A change should be made in test procedures for water quality parameters pH and specific electrical conductance. These parameters should be analyzed at the well site as soon after sampling as possible.

2. Total dissolved solids (TDS) or total filtrable residue analysis should be added to water quality sampling sets. This would make it possible to determine carbon dioxide content which can be done nomographically with pH, temperature, total alkalinity and total mineral content (TDS) data. Additionally, the bicarbonate, carbonate, hydroxide and calcium carbonate saturation content of well water can be determined nomographically or by calculation.

3. The pumping rate at the time of water quality sampling should be measured and included on the water quality data sheet.

4. Periodic (semi-annual) water quality tests for nitrate and nitrite-nitrogen, total phosphorsus, sulfate and iron should be conducted. These tests should be done for all production water wells. This data would be useful in the characterization of groundwater quality.

5. Quarterly sampling of water wells for water quality data will not produce enough information to assess or predict well behavior. The frequency of data analyses for water wells should be on a monthly basis. However, if there are financial or personnel constraints which inhibit more frequent water well sampling for the entire well series, then selected wells should be monitored on a monthly basis and the remainder on a quarterly schedule. A selection of those wells showing positive, cyclic and negative chloride trends should be monitored on a monthly basis. This would provide the minimal amount of information necessary to evaluate the groundwater aquifer behavior. A selection of wells from the following list should be included in a monthly monitoring schedule:

Chloride behavior Trends

Well series	Positive	Cyclic	Negative
A-series	A-9,A-13	A-10,A-19	none
D-series	D-14,D-16,GHURA	D-11,D-17	D-6,D-7,D-10,D-18
M-series	M-1,M-6	M-9,M-12,M-14	M-2,M-3
F-series	F-7,F-8	F-5,F-6	F-9,F-10,F-11
Y-series	Y-1,Y-2,Y-4	none	none
AG-series	AG-1	none	none

At least one well from each series and from each trend group (if applicable) should be monitored on a monthly basis. This amounts to a minimum of 13 wells (18%) that would have more frequent monitoring. It would probably be best to monitor all three of the positive trend Y-series wells.

6. There is a need to conduct more water quality and hydrogeological research in the region of the Yigo trough. More hydrogeological information will be needed in this region to better delineate the volcanic basement and configuration of the trough. More water quality information will be needed to determine causes for increased chlorides in 3 Y-series production wells.

7. Records for the Air Force MW series water wells should be obtained and, if availabled, analyzed for water quality trends.

8. Since there is some Layne International water well quality data available for production wells prior to 1976, this data should be tabulated and evaluated against the PUAG historical data-base.

9. More detailed and useable monthly water production records should be maintained for water wells.

10. Management zone boundaries in relation to groundwater quality should be re-evaluated and the number of management zones reduced to more realistically assess groundwater regions.

11. On a once a year basis, GEPA or an independent water quality laboratory should collect and analyze a duplicate set of water well samples in conjunction with the PUAG routine monitoring sampling set to determine the reliability of PUAG data.

12. The guidelines outlined in the NGLS management reports should be used for placement of water wells. Some recent water wells were drilled in low priority zones as designated by the NGLS. Several of these wells have poor water quality.

13. The following management zones or portions of management zones should be given low priority in future exploratory drilling for water wells:

1.	Sabanan Maagas	(entire zone)
2.	Pago Bay	(entire zone)
3.	Agana Swamp	(entire zone)
4.	Toto	(entire zone)
5.	Manaca	(entire zone)
6.	Asbeco	(entire zone)
7.	Taguan	(entire zone)
8.	Sasajyan	(entire zone)
9.	Barrigada	(most of zone)
10.	Chalan Pago	(portions)
11.	Nimitz	(area around A-1 and A-23)
12.	South Dededo	(area around D-8)
13.	Y-Sengsong	(area around D-13)
14.	Dededo North	(in D-13 flow line with ocean)

YEARLY GUIDELINES

The following guidelines apply to yearly statisticaly analyses of PUAG production water well data if well sampling continues only on a quarterly basis.

1. Only basic statistics should be done for each water quality parameter analyzed by water well. These basic statistics should include:

    1. mean
    2. standard deviation
    3. number of analysis months
    4. minimum and maximum values

2. Calculated parameters should be generated from measured water quality parameters and analyzed for basic statistics.

3. A yearly supplement of the basic statistical data should be made and kept with the historical data report.

The following guidelines apply to yearly statistical analyses of monthly PUAG production water well data.

1. Statistics should be done for each calculated and measured water quality parameter analyzed by well. The basic and advanced statistics should include:

    1. number of analysis months
    2. number of missing months (should be $\geq$10 months)
    3. mean
    4. standard deviation
    5. minimum and maximum values
    6. 95 percent confidence limits
    7. deviation of new yearly mean from historical mean
    8. t-test of new yearly mean and historical mean to ascertain if means are from the same data distribution (population of data).
    9. linear regression of data to determine yearly trend or lack of trend.
    10. cluster analysis with a 20 cluster criteria for separate and combined water quality parameters. This would determine change in water well membership in relation to basic water quality behavior.

2. New water quality data should be keypunched onto a sorted master data file to maintain an updated water quality record for each production water well.

3. If better pumping records become available, then analysis should be made of relationships between pumping rate and chloride concentration.

4. A yearly supplement of statistics and water well trends should be made and kept with the historical data report.

5. After 5-years of monthly data analyses for water wells have been gathered for some or all wells, then a new historical data-base should be tabulated, analyzed and evaluated. SAS procedures should be used for data analyses. When a larger monthly data-base becomes available for water wells, it will be possible to determine long-term trends by applying time-series analysis. This time-series information will make it possible to predict water well quality behavior which will greatly enhance well management. Additionally, a longer water well data-base will make it possible to better characterize the groundwater aquifer which will help in the location of future water well sites.

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