November 1972 WRRI Report No. 015

Bioassays of Quality in Water Resources of Major Importance to New Mexico

Technical Completion Report
Project No. A-029-NMEX

BIOASSAYS OF QUALITY IN WATER RESOURCES

OF MAJOR IMPORTANCE TO NEW MEXICO

by

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TECHNICAL COMPLETION REPORT

OWRR: A-029-NMEX

November 1972

The work upon which this publication is based was supported in part by funds provided through the New Mexico Water Resources Research Institute by the United States Department of Interior, Office of Water Resources Research, as authorized under the Water Resources Research Act of 1964, Public Law 88 - 379, under project number A-029-NMEX.

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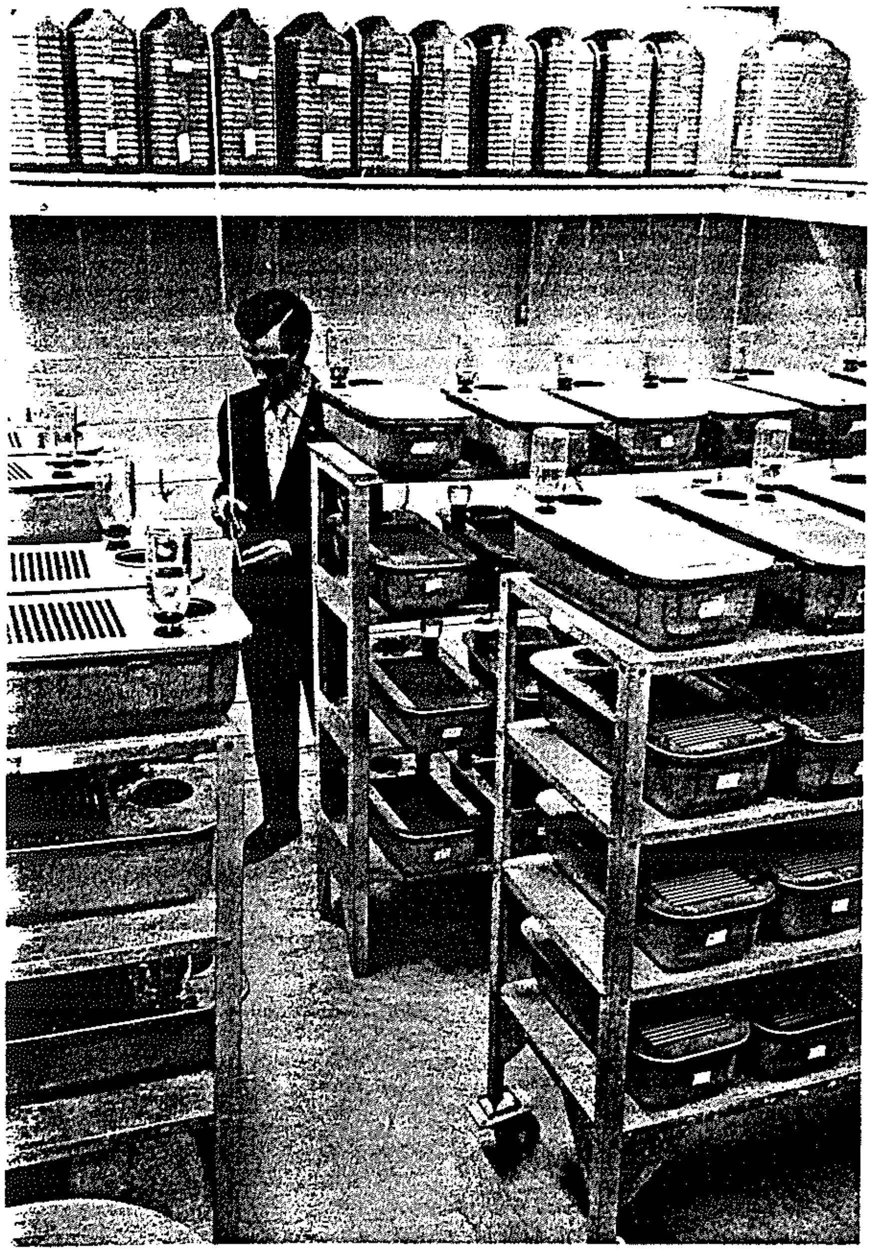

FIGURE 1. G. S. Smith, principal investigator, dispenses drinking water from sample container into drinking bottle for mice in assays of water quality.

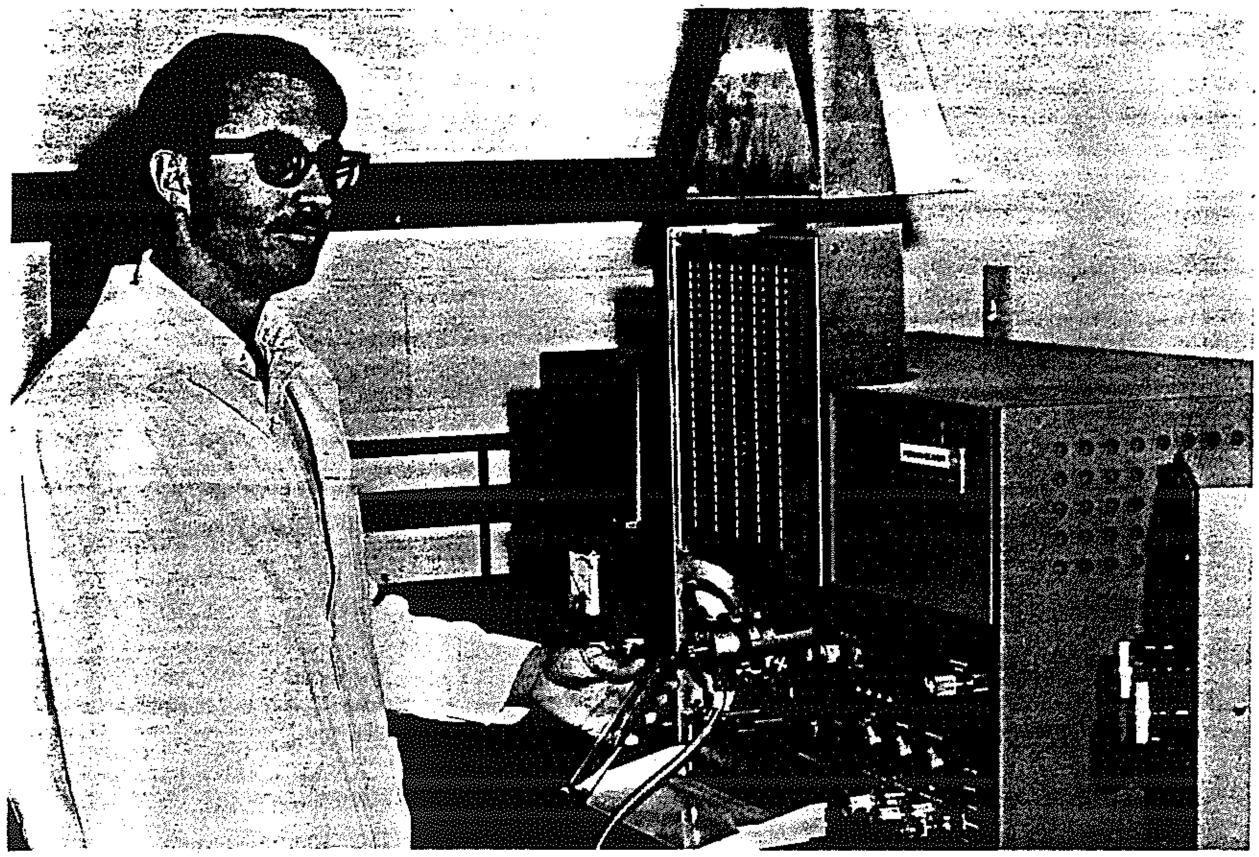

FIGURE 2. John D. Tracy, graduate student, analyses water sample for mineral content using a Perkin-Elmer 403 atomic absorption spectrophotometer.

New Mexico Water Resources Research Institute

Final Report

PROJECT TITLE: Bioassays of quality in water resources of major importance to New Mexico

PROJECT NUMBER: A-029-NMEX

PERSONNEL: (All personnel were from the Department of Animal, Range and Wildlife Sciences, New Mexico State University, Las Cruces, New Mexico.)

Principal Investigator: Mr. G. S. Smith, Ph.D., associate professor; Research Assistants: Mr. John D. Tracy, B.S., graduate assistant, one-half time basis, September, 1970, to January, 1972 (M.S. degree completed December, 1971); Mr. William Humphrey, B.S., graduate assistant, temporary basis, Summer of 1972. Technicians: Mr. Edwin C. Smith, B.S., chemist, August, 1970, to August, 1971; Mr. Stan Good, B.S., technician, October, 1971 to January, 1972; and Miss Patricia Trujillo, B.S., technician, February, 1972, to August, 1972.

Student assistants, undergraduate: Mr. Michael Galyean and Mrs. Gale Cupp, laboratory assistants; Mr. Earl Morgan, Mr. Ken Smith, Miss Yolanda Acosta, Mr. Frank Hayes, Mr. Mike West, Mr. Alfredo Diaz-Gonzales, Mr. Albert Jaquez, Mr. George Lopez, Mr. James Bates and Mr. J. Paul Brown, animal caretakers, part-time basis (services varied in duration from a few weeks to more than one full academic year).

PROJECT OBJECTIVES: 1. To survey major water resources in New Mexico and characterize them in terms of quality for usage by ruminant and non-ruminant animals; 2. To identify water resources with potential hazards to animal health (and humans); and, 3. To derive quantitative relationships from the data by which effects (either harmful or beneficial) from various constituents can be identified in terms of animal performance.

ABSTRACT: Fifty-two samples of water from sources considered representative of several resources that are economically and/or ecologically important to New Mexico were analyzed chemically for major minerals and assayed for quality in terms of mouse growth, mouse reproduction and degradation of fibrous substrates by rumen microorganisms cultured *in vitro*. Chemical constituents measured and evaluated statistically in relation to bioassay data were: electrical conductivity, total dissolved solids, pH, hardness, Ca, Mg, Na, K, Cl, HCO_3, CO_3, and SO_4. Samples were also tested semi-quantitatively for NO_3, Cd, Hg, and Pb. Using waters which varied in mineralization from less than 100 to more than 4700 milligrams of total dissolved solids per liter, mouse growth and reproduction were not significantly affected by water sources ($P > .05$), even though precision was sufficient to detect differences in growth of about 5 percent from the population means. Water sources markedly affected the degradation of fibrous substrates by rumen cultures, especially when purified

cellulose rather than forage (alfalfa hay) was used as the substrate. The results indicate that the mouse is insensitive, in terms of growth and reproduction, to differences in quality of drinking water, at least in regard to the degree of gross mineralization; whereas, cultures of rumen microorganisms respond to changes in apparent quality of water which have been poorly documented and are apparently poorly defined to date. The data suggest that mineralized waters in certain major resources of New Mexico may have greater potential for usage in animal production than would be expected from standards of water quality currently in usage.

PROCEDURES:

<u>Sampling and Storage of Waters</u>

Water samples from municipal supplies, from wells used by sizeable farm, ranch and feedlot enterprises, and from a few surface sources (lakes, ponds and streams) were collected into five-gallon polyethylene cans which had been washed with phosphate detergent ("Alconox", Alconox, Inc., New York, N.Y.), rinsed with tap water, soaked for five days with dilute HCL, rinsed again with tap water, and finally rinsed again with deionized water on the day that samples were collected. Each sample consisted of ten or fifteen gallons. They were collected only a day or two prior to the onset of the growth bioassay trials with the mice. Sub-samples were collected from the polyethylene cans into plastic or glass containers for the descriptive chemical analyses and for use in the rumen culture bioassays. During the mouse trials, the five-gallon cans containing water samples were capped and placed on shelves in the mouse laboratory, with water dispensed by gravity (cans were not sealed from air) into drinking bottles through glass tubes placed into small ports at the tops of the cans and reaching near to the bottom of the cans (see Figure 1).

Chemical Analysis

Sub-samples of water were analyzed for electrical conductivity (a measure of total ionic solids) by direct measurement with a Solu bridge instrument. Total dissolved solids (TDS) were determined by filtering through Whatman 100 filter paper and gravimetric measurement of residues from evaporation of 100-ml aliquots of samples. Chloride, carbonate and bicarbonate were determined directly using chemical procedures described by the A.O.A.C. (1970). Sodium, potassium and sulfate were determined by flame emission spectrophotometry, and calcium and magnesium were determined by atomic absorption spectrophotometry, using a Perkin-Elmer AA spectrophotometer, Model 403 (Perkin-Elmer Corporation, Norwalk, Conn.). Sulfate was precipitated as the barium salt, then dissolved and determined as barium by flame emission spectrophotometry. Nitrate was checked semi-quantitatively using diphenlyamine reagent and the visual color reaction (Hanway et al., 1963). Cadmium, lead and mercury were checked qualitatively by the visual colorimetric tests using the test kits prepared commercially by Koslow Scientific Corporation, North Bergen, N.J.

Mouse growth and reproduction assays

Animals. White mice (*Mus musculus*) were obtained as weanling males and females from the ARS-Sprague colony (ARS-Sprague, Inc., Madison, Wisconsin). Original stock animals were used in a "uniformity trial" at the onset of experimentation to check the variability of animal responses to be expected under the laboratory conditions to be imposed. Offspring from these original stock were used in two bioassay trials, and new stock were purchased from the same supplier for the third major bioassay trial.

Housing, cages. The mice were housed in the New Mexico State University Small Animal Laboratory, a facility of the department of Animal, Range and Wildlife Sciences. The facility is an isolated building which affords forced-air heating and forced-air, evaporative cooling. The skylight ceiling was covered and electrical lighting was scheduled with an automatic timer to provide "day length" (period of light) at eight hours daily throughout the period of experimentation. During periods of extremely low relative humidity (encountered frequently in the Las Cruces area), the walls and floor of the mouse room were hosed once daily with tap water to increase humidity.

The mice were caged in solid, pan-type stainless steel trays measuring 21 inches long, 9 inches wide and 5 inches deep. Feeders were slotted, circular, stainless steel bins suspended from slotted stainless steel cage covers. White pine wood shavings of uniform character and quality were contracted from a lumber company in El Paso, Texas, and delivered fresh every six to eight weeks as needed to be used for bedding in the cages. Shavings in the cages were replaced weekly during the growth trials and twice weekly during the reproduction trials. Cages were placed in racks, four rows high and six cages wide (six cages per row). Prior to usage, and between all trials, the cage equipment was washed thoroughly with phosphate detergent, then rinsed with tap water, dipped in formalin solution (1 pint of 40% formaldehyde per 15 gallons of water) and dried.

Diet. The diet provided throughout all phases of the study was "Wayne Lab Blox F-6", supplied by Allied Mills, Inc., Chicago, Illinois. This high-fat, pelleted diet had been recommended by two nationally-advertised, commercial breeders and suppliers of white mice as being uniform in quality from batch to batch as well as suitable for maintenance, growth and reproduction of mice. The diet supplied was certified as free from estrogenic activity and Salmonella organisms, as well as being free of added antibiotics or chemical preservatives. Batches of diet were purchased in one-ton lots ordered directly from a major supply point and guaranteed to arrive fresh from the manufacturer immediately prior to the onset of bioassay trials upon order. The guaranteed analysis of the diet was: crude protein, minimum 24.0%; crude fat, minimum 6.0%; and crude fiber, maximum 4.5%. The diet was provided to the experimental animals at all times for consumption *ad libitum*.

Drinking fountains. Drinking water was provided in half-pint, glass bottles equipped with "ATCO Ring-Seal Stoppers" (Ancare Corp., Manhasset, Long Island, N.Y.) made of Neoprene, and fitted with "Touch-and-Drink" ball-point drinking tubes made of stainless steal (Ancare Corp.). These fountains were recommended for minimal spillage of drinking water and for minimal contamination of drinking water in the bottles from feed particles and debris. Drinking bottles and fountains were washed and sterilized initially, and then used throughout the three-week growth study and the six-week reproduction trials without further cleaning except periodic rinsing with the drinking waters being assayed. Drinking bottles were checked daily and water was available at all times for *ad libitum* consumption. Water consumption was not measured, but visual checks of water usage were made regularly, and these afforded a semi-quantitative index of water consumption.

Growth trials. Mouse growth was measured in terms of body weight change from weaning (at three weeks of age) to three weeks post-weaning, a 21-day period. Mice were mixed in large containers at weaning time and drawn at random from the containers to be weighed and placed in cages for the growth trials. Generally, five females and one male were placed in each cage, and three or four cages were used as replicates for each of the water sources tested. There were four racks (batteries) of cages in the mouse room, each with four levels (rows) and space for six cages per level. Thus the facility afforded 24 cages per racks, totalling 96 cages for usage in assays. The cages and drinking bottles were numbered to correspond with numbers identifying water sources. In all except the first water assay trial, the cages were placed on the racks in a randomized complete block design, with levels on the racks serving as the criteria for blocking, assuring a treatment at every level on the racks (but not a treatment at every level on every rack), thereby allowing statistical evaluation of position (level) effects on animal response. Since there were four blocks (levels), the experimental design afforded, in general, twenty female and four male individuals for each water source tested. In the first of the water assay trials there were only three replicate cages per water source (15 females and 3 males per source), with one cage on each of three racks, randomly positioned on the racks, thereby confounding effects of cage position (level) with treatment effects due to water sources.

In general, the mice selected for usage in the bioassays weighed 10 to 15 grams at the onset of the growth trials. Weights of females were measured as group weights per cage, and males were weighed individually. The mice were weighed once weekly, but the data presented herein reflect only the initial and the final weights.

Reproduction trials. Water sources were assayed for effects on reproduction by using the same individuals that had been treated with experimental drinking waters during the growth trials. Five females and one male were housed in the same cage for two more weeks following the three-week growth phase (mice reach puberty at about six weeks of age), and then the males were removed from the cages and from the laboratory. Litters were born during the week following removal of males, and for about two weeks subsequently (gestation in mice is 21 days). Four weeks after the removal of males from the breeding cages, all living offspring were counted, and the number of offspring (pups) was used as the criterion for evaluating effects of water sources on reproduction. Initial attempts to weigh the offspring, either individually or collectively, and to use weights as criteria proved futile in view of extreme variation in numbers, ages and sizes of litters. In all but the first trial, in which there were three replicate cages with five females and one male per water source, there were four replicate cages with five females and one male per water source.

Rumen fermentation assays

The effects of water sources on potential digestive function in ruminant animals were estimated in terms of substrate degradation by rumen microorganisms cultured *in vitro*. In general, the procedures were those described by Tilley and Terry (1963), a two-step digestion procedure in which a small amount of substrate is incubated in test tubes with an inoculum of active rumen microorgamisms from the fore-stomach of a cow or sheep plus an excess of buffer solution composed to resemble the saliva of the cow. Following a standard period of incubation, the cultures are centrifuged or filtered to remove soluble material and the residue is treated with activated pepsin to digest the microbial matter in the residue. After subsequent filtration or centrifugation, the insoluble matter--mainly undigested fibrous material from the substrate--is collected, dried and weighed (or determined by loss of weight upon ignition).

In the present experimentation, the standard buffer was prepared in three-fold, four-fold or ten-fold concentration using high-purity, deionized water, and subsequently the water sources under test were used to dilute the consentrated buffer solution back to the proper concentration for the standard fermentations. Thus the water sources were introduced into the "standardized" cultures.

Assays were conducted using a standard sample of alfalfa hay as the substrate to evaluate effects of water sources on the "normal" fermentative activity of rumen microorganisms. Additionally, purified cellulose and urea were used in further tests of water sources since usage of urea is a widespread practice to supplement low-protein, cellulosic feeds and since it had been documented that the microbial flora of animals on such feeds are more sensitive to factors such as might be expected from waters of varying mineral composition. These cultures were expected to provide more sensitive assays of water quality than might be found using the more natural substrate.

Statistical evaluation of data

The data were programmed as dependent variables (mouse growth, mouse reproduction, and rumen assays--*in vitro* dry matter disappearance, "ivDMD") and independent variables (chemical characteristics of water;

initial weights of mice), and ultimately subjected to analyses for simple and standard partial correlations and stepwise multiple linear regressions with computations of residuals, analyses of variance, and t- or F-tests of differences among means (Steel and Torrie, 1960), using APL routines on an IBM 360 computer. In an initial treatment of the data from mouse assays, a M.S. thesis by John Tracy (Tracy, 1971), the mouse growth data were programmed and analyzed as "gains" (final weights minus initial weights); whereas, in the data reflected herein, the data were programmed as initial weights and as final weights, thereby allowing for covariance of differences in final weights as a consequence of differences in initial weights to be reflected if such exist.

The basic statistical analysis was done in accordance with a standard analysis of variance for a randomized complete block design for the experiments. The treatment sum of squares was further partitioned to reflect a possible regression of treatment means on characteristics reflecting the chemical composition of the water sources. This partition was obtained by running a multiple regression analysis on the treatment means and multiplying the resulting sums of squares by the number of blocks to allow including of them in the analysis of variance.

RESULTS:

Sixty-eight samples of water, representing 52 sources under investigation, were characterized chemically in terms of gross mineralization and assayed in terms of effects on mouse growth and reproduction and in terms of effects on rumen microbial cultures. The sources tested represented 19 municipal supplies, one major lake (Elephant Butte reservoir), one intermittant stream which carries the drain from tailings from a major area (creek at Vanadium, N. M.), one hot mineral spring (Geronimo Spring at Truth or Consequences, N. M.), two small surface water impoundments (stock pond at the College Ranch north of Las Cruces, N. M., and stock pond at the Fort Stanton Experimental Range Station, near Capitan, N. M.), and 28 ground wells which supply water for sizeable ranching, farm or feedlot enterprises. A few of the ground walls were less than 200 feet in depth, but most were wells into ground waters below 200 feet. The identification of water sources is provided in Tables 1, 2 and 3 in the Appendix.

Chemical Characterization of Waters

The mouse assays were conducted in three main phases, identified as Trials 1, 2 and 3 in the thesis submitted by Tracy (1971) which was based on the data presented herein, and the same system of identification has been retained in this report. The numbers of water samples tested were 26, 24 and 20 in Trials 1, 2 and 3, respectively. Also, additional experimentation was completed with the waters of Trial 1 (Trial 1-B). The chemical characteristics of the water samples provided as drinking waters (for Trial 1-B as well as Trials 1, 2 and 3) are shown in Tables 1, 2 and 3, respectively. The data shown reflect values for bicarbonate (HCO_3) concentration which are considerably lower than values reported in the literature for some of the ground waters evaluated. This discrepancy is due, apparently, to the fact that the water samples tested in the present study were exposed to contact with air during the period between sampling at the source and sub-sampling in the mouse laboratory. (The 5-gallon cans, which were capped, were not sealed).

In only one of the waters were there detectible levels of lead, cadium or mercury. The sample from the creek at Vanadium (sample number 11 in Trial 3) contained Pb, Cd, and Hg in amounts greater than 0.1 ppm (the lower limit of detection) but the exact concentrations were not determined quantitatively. None of the samples contained nitrate in quantity sufficient to detect (limit of detection at about 1 ppm NO_3).

Outline of Experimentation

Following is a summarization of the overall chronological scheme of experimentation :

I. "Uniformity trial" (Summer and Autumn, 1970)
   A. Growth: 30 cages of females, 10 each and 11 cages of males, 10 each, study variability of weights, initial and final (21 days post-weaning)

   B. Reproduction: 69 cages, 5 females + 1 male each, record offspring born and weaned; study variability among "replicate" cages

II. Assay trial 1-A, first set of (26) waters (Autumn, 1970)
   A. Growth: 3 cages per water soruce; 5 females + 1 male each weights initial and final (21 days post-weaning)

   B. Reproduction: 3 cages per water source; 5 females + 1 male each

III. Assay trial 1-B, first set of (26) waters (Winter, 1970-71)
   A. Growth: 1 cage of 7 females and 1 cage of 7 males per source, individuals selected from litters born to mothers in Trial 1-A and retained on the same respective water sources

IV. Assay trial 2, second set of (24) waters (Spring, 1971)
   A. Growth: 4 cages per water source, 5 females + 1 male each

   B. Reproduction: 4 cages per water source, 5 females + 1 male each

   C. Repeat of reproduction trial, 4 cages per source, 5 females + 1 male each

V. Assay trial 3, third set of (20) waters (Autumn, 1971)
   A. Failure in attempt to breed animals in our colony to produce individuals for assay trial 3 (Summer 1971)

   B. Growth: (weanling mice ordered from ARS-Sprague, Inc., Autumn, 1971), 4 cages per water source, 5 females + 1 male each

   C. Reproduction: 4 cages per water source, 5 females + 1 male each

Mouse growth and reproduction -- "uniformity trial"

Prior to the onset of experimentation with the varied sources of water, a preliminary, "uniformity trial" was conducted with weanling mice purchased from ARS-Sprague, Inc. (Madison, Wisconsin), to determine the variability in mouse growth and reproduction that should be expected among uniform mice under laboratory conditions that would be imposed during water assays, and to establish guidelines as to numbers of individuals (and/or numbers of replicate groups of individuals) that would be required to detect differences in animal response at any given level of differences.

Three hundred female mice were allocated at random to 30 cages, ten females per cage, and 110 males were allocated at random to 11 cages, ten males per cage. Initial weights were recorded individually and final weights were recorded individually after two weeks time. All mice received the same source of drinking water, tap water from the NMSU campus supply. Variability in both initial and final weights were studied, and the regression of final weights on initial weights was computed. The body weights are summarized in Table 4.

For the females, the mean of final weights was 25.0 g. The standard deviation of effects associated with cages was $\pm$ 1.45 g (i.e., $\sqrt{21.030 \div 10}$) and the standard deviation of weights associated with individuals (error) was $\pm$ 0.88 g (i.e., $\sqrt{7.719 \div 10}$). These data show that a coefficient of variability amounting to about 5.8% of the mean (i.e., $\pm$ 1.45 g ÷ 25.0 g) occurred in these uniform mice in association with whatever factors could be attributed to "cage effects".

For males, the mean of final weights was 27.8 g, and the standard deviation of effects associated with cages was $\pm$ 0.97 g (i.e., $\sqrt{9.538/10}$). The standard deviation of weights associated with individuals (error) was $\pm$ 0.89 g (i.e., $\sqrt{7.890/10}$). These data show a coefficient of variability amounting to 3.5% of the mean in association with whatever factors could be attributed to "cage effects".

Since there was variability in the means of initial weights among cages, and since it is expected that part of the variability in final weights was due to the variations in initial weights, the regression of final weight (Y) on initial weight (X) was computed (for the females only) as: $\hat{Y} = 24.58 + 0.573X$. The regression of final weight on initial weight accounted for only 27.86% of the total variability in final weights, but the relationship of Y to X was statistically significant ($P \leq .05$), as indicated by the analysis of variance:

Source	d.f.	M.S.	F
Regression,	1	23.318	8.500*
Deviations from regression	22	2.744.	

The standard error of the estimate for $\hat{Y}$ was $\pm$ 1.657 g, suggesting that the precision that could be expected from similar experiments with similar populations of mice would be about $\pm$ 1.7 g. These relationships suggested that for differences among means due to various water treatments to attain statistical significance ($P \leq .05$), such differences would have to amount to about $\pm$ 10% of the value for overall means of final weights at three weeks post-weaning, if only one replicate of 10 individuals were to be used as the criteria of evaluation.

Following the "uniformity trial" for growth, the females and males from all cages were re-distributed at random into 69 cages with 5 females and 1 male per cage. The males were caged with females for two weeks and then removed. The females were observed daily and the numbers of offspring born were counted as accurately as could be done by daily observation. After four weeks from the time that males were removed from females (i.e., when offspring were approximately three weeks of age) the count was made for all surviving offspring. A total of 1473 pups were born, of which 1330 survived until the time of the final count, i.e., "weaning time". Thus approximately 90% of the offspring born were "weaned". This was considered to be satisfactory performance in terms of survival of offspring born; however, a more important observation was the fact that 9 of the 69 cages (containing 5 females per cage) produced no surviving offspring and the mean $\pm$ standard deviation <u>per cage</u> was 19.3 $\pm$ 11.7 pups. Thus the coefficient of variation, (standard deviation by the mean) amounted to 60% of the mean. This wide variability in numbers of offspring among cages indicated that there would be little liklihood of detecting differences in reproductive responses to various water sources unless the effects of water sources were to be extreme, or unless greater numbers of cages (replicates) were to be used for each source. Yet the data suggested that if three or four cages (replicates) could be used for each source, and if a "normal" population of sources could be used in each trial, then the liklihood of detecting significant differences due to treatments would be sufficiently great to warrant experimentation to detect differences in the range of 15 or 20 percent deviations from the mean for the whole population in any given experiment.

The data from this "uniformity trial" indicated that the variability likely to be encountered in our research facility was somewhat greater than had been anticipated from previous experience of the principal investigation and from reports by commercial breeders of laboratory animals. This fact necessitated some modification of the original plan for the experimentation, whereby the number of replicate cages anticipated per water source was increased from two to three or four, and consequently the number of water sources to be evaluated in any given trial was diminished.

Mouse growth, reproduction -- Trials 1, 2 and 3

The effects of varied water sources on mouse growth, presented in terms of body weight gains (as was done by Tracy, 1971, who studied the data without correction for the covariance of final weights on initial weights) are shown in Tables 5, 6 and 7. Effects of water sources on mouse reproduction are shown in Tables 8, 9 and 10. These data (Tables 5-10) were subjected to analysis of variance whereby the data for locations of replicate cages within water sources were treated as "blocks" in order to account for variations among replicates (cage locations) across all water treatments. The variance thereby associated with treatments was then further partitioned into that which could be attributed to regression of dependent variables (i.e., gains or numbers of offspring) on the composite of independent variables (chemical characteristics of water sources) and to deviations from regression within treatment effects as well as residual variation (error). The analyses of variance by this scheme are summarized in Tables 11, 12 and 13.

The results indicate that neither growth (body weight gains) nor reproduction (number of offspring weaned) was affected significantly ($P \leq .05$) in any of the three trials, except for a significant ($P \leq .05$) regression of body weight gains among females on chemical characteristics of water in Trial 3. (See Table 13.) The nature of this regression relationship is indicated by the data shown in Table 14, which show that body weight gains in females in this trial were negatively related to the Na content of the experimental waters. However, the magnitude of the coefficient for Na, -0.0380, is such that the actual effect on mouse growth--if, in fact, a real cause and effect relationship is involved--is questionable. Even though the relationship of female mouse growth to sodium content of drinking waters in this particular trial are sufficiently consistent to attain statistical significance, the predictive power of the overall equation (containing 10 variables) is low (R^2 = 61.5 of which 53.4 is accountable to initial weights alone). Moreover, the relationship of sodium content and mouse performance in the other two trials is inconsistent with the results of this trial.

Another feature of the data shown in Tables 5 - 13 is the significant effect of "blocks", i.e., the effect of locations (on the racks and in the laboratory room) of cages (replicate treatment groups within water sources) on weight gains of mice in all three trials (see Tables 11, 12 and 13) and on reproduction in the first trial (see Table 11). Although not evident in the data as presented by Tracy (M.S. thesis, 1971) (or as presented in Tables 5 -13 herein) the apparent effect of "blocks" is confounded with variations in the initial weights of experimental groups. Not being aware of this, Tracy (1971) discussed the effect of "blocks" solely in terms of cage locations and concluded that the variability of responses from "replicate" cages was due to variations in environmental effects associated with the different cage locations (positions of replicate cages on the animal racks). But examination of the data in terms of both initial weights and final weights, rather than simply in terms of body weight gains, revealed that the effect of "blocks", identified as being statistically significant in Tables 11, 12 and 13, was present in initial weights, and could be attributed mainly to variations in the initial weights of the experimental animals. This variation was attributable to "blocks" (replicate groups) because bias had been incurred in the allocation of individuals to the replicates while overstressing elimination of bias in allocation of individuals to the various water sources. Such a possibility had been suggested by the data from the "uniformity trial", whereby the regression of final weight on initial weight for various cage groups from a "uniform population" was significant ($P < .05$) (Table 4); although the predictive power of the equation from that study was rather low ($r^2 = 0.13$).

In view of these considerations, the data from Trials 1, 1-B, 2 and 3 were subjected to re-evaluation by multiple (linear) regression analysis in which final weights (rather than weight gains) were treated as the dependent variable and initial weights were introduced as an independent variable in addition to the chemical characteristics of waters which were treated also as independent variables. This procedure increased the precision of the methodology in two ways: first, the usage of body weights rather than weight gains decreased the coefficient of variation in the dependent variable (body weights inherently reflect lesser variability than do weight gains); and second, the usage of initial weights as an independent variable afforded an adjustment of the data by whatever effect of covariance there was between initial and final weights. In this latter approach, however, merely the overall means for water sources were subjected to this analysis and not the individual values for each of the replicates (cages) within each water source. Furthermore, for this re-examination of the data, the variables carbonate and bicarbonate were deleted from the group of chemical characteristics being used as independent variables for the multiple regression analysis, since there was some question regarding the accuracy of the bicarbonate data and since the initial analysis had indicated that the apparent effect of carbonate was unmistakenly skewed.

(It is axiomatic in multiple regression analysis that introduction of additional variables, especially if closely related to some variable already being treated as an independent variable, will automatically reduce the predictive power of the equation but also may skew the magnitude of the coefficients for other variables.)

Results from this subsequent evaluation of the data are summarized in Tables 15-20 which show the extent to which final weights of the mice had been affected by the initial weights. These tables show the final weights which were actually observed and the final weights which would have been expected as a result of variations in initial weights if no other factors were involved. The residuals, i.e., the differences between observed and estimated values, indicate the extent to which other factors (e.g., water sources) may have been expressed.

In Trial 1, variations in the means of initial weights among water sources accounted for 36.76% of the total variation among means for final weights in the females (Table 15) and accounted for 18.76% of the variation among means for final weights in males (Table 16). In Trial 2, variations among the means for initial weights among water sources accounted for only 7.24% of the total variation among means for final weights in females (Table 17) and accounted for only 1.19% of the total variation in final weights for males (Table 18). In Trial 3, variations among means for initial weights among water sources accounted for 53.44% of the total variation among means for final weights for females (Table 19) and for 12.7% of the total variation among means for final weights for males (Table 20).

Mouse Growth, Trial 1-B

Subsequent to Trial 1 (Trial 1-A, as indicated on page 15), the offspring from animals on the treated waters were continued on those same drinking waters until mature and then mated in sets of 5 females and 1 male per cage, with three replicate cages per water source (indicated by the reproduction phase of Trial 1-A, page 15). The offspring from this mating were collected at weaning time (21 days) and composited within their respective water treatment groups. These weanling mice were thereupon used for a subsequent growth trial (Trial 1-B) in which 7 females and 7 males were selected at random from their respective water treatment groups and thereupon continued for three weeks post-weaning on their respective water treatments. Females were caged in one cage (per water source) and males in another. Body weights were recorded individually at the onset and again at the termination of the growth trial. Results from this trial are summarized in Tables 21 and 22.

The data from Trial 1-B show that final body weights were significantly related to initial weights, accounting for about 37% of the variation in final weights for females, and about 19% of the variation in final weights for males. When the regression equations relating final weight to initial weight were used to predict final weights, only one value (Table 21: source 11, males: residual = -4.9*) differed significantly from the value predicted. However, the predictive power of these equations was rather poor both for males and females (r^2 = .1877 and .3756). Variability (coefficients of variation) in the initial weights of the mice in this trial (born to mothers consuming experimental waters) is greater than the variability in initial weights of mice used in other trials. This is illustrated by the following data:

Trial	Coefficients of Variation, %				Regression Coefficients	
	Initial Wts.		Final Wts.			
	Females	Males	Females	Males	Females	Males
"Uniformity Trial"	3.6	4.2	4.9	5.2		
Trial 1-A	8.9	---	4.1	---	.3676	.1876
Trial 1-B	14.8	18.2	5.9	6.7	.3756	.1877
Trial 2	3.6	2.6	3.0	4.3	.0724	.0125
Trial 3	4.4	6.8	8.8	9.1	.5344	.1270.

Undoubtedly, the greater variability in initial weights of the mice in Trial 1-B is due in part to effects of the experimental waters consumed by mothers and/or offspring; however, other factors such as variability in the means of ages for litters and in the numbers of pups per litter from which the experimental subjects were drawn also account for much of the observed variation in initial weights. In any case, it is considered inappropriate to attribute this variation among the means for the water sources to effects of water treatments, per se. Furthermore, the variability in final weights for the mice in Trial 1-B is reduced below the variability in initial weights, and (in the case of females, where the data facilitate comparison) it is of the same order of magnitude as the variability in final weights for the mice which had received the same waters in Trial 1-A, and which had been selected from a more uniform population of weanling mice produced from mothers on a single source of drinking water. The relationship of initial weights and final weights for mice in Trials 1-A and 1-B is remarkably similar: r^2 = .3676 and .3756 for females, and .1876 and .1877 for males.

Relationships of mouse growth to composition of waters

The data from Trials 1 (1-A), 2 and 3 were subjected to multiple linear regression analysis by which equations relating final body weights to initial weights and eight chemical characteristics were computed and used to predict final weights. The chemical characteristics (variables) were: (1) electrical conductivity, EC x 10^6; (2) total dissolved solids, TDS; (3) calcium, Ca; (4) magnesium, Mg; (5) sulfate; (6) chloride, Cl; (7) soldium, Na; and

(8) potassium, K. Other variables (indicated by number in the tables to follow) were: (9) number of pups weaned; (10) initial weights of female mice; (11) final weights of female mice; (12) initial weights of male mice; (13) final weights of male mice; (14) in vitro digestion of dry matter for alfalfa hay, "ivDMD, alfalfa"; and (15) in vitro digestion of dry matter for cellulose, "ivDMD, cellulose".

A summary of means, variance and standard deviations for each of the variables is shown in Table 5 of the Appendix. In Trial 3, no data were included for variables 14 and 15 (in vitro dry matter digestion for alfalfa hay, [14] and for cellulose,[15]), but since the same program for computations was used, the tables of data will show values for these variables based on zeros for the observations.

The results are summarized, by sexes within trials, in Tables 24 -29. An overall summary of the data is shown in Table 30. Chemical characteristics of drinking waters accounted for appreciable amounts of the total variation in body weights in Trials 1 and 2 (R^2 values ranged from about 25 - 30%), but for only about 8% (females) and 15% (males) of the variation in body weights in Trial 3 (Table 30). These relationships are not explainable in terms of overall variability in mineralization of waters; but this may be due in part to the fact that the data in Trial 3 were skewed markedly by one single water source (source 4) which was highly mineralized (33, 087 ppm TDS).

When initial body weights and chemical characteristics of drinking waters (eight variables) were all included in the regression equation, the relationships are sufficiently close that not a single value for predicted body weights differed significantly ($P < .05$) from the values observed, i.e., none of the "residuals" was significant, Tables 24-29. This is in contrast with the data shown in Tables 15-21, in which "residuals" indicated several cases where values predicted from initial weights alone had differed ($P < .05$) from the values actually observed. Thus, the results show that several of the water sources tested yielded mouse growth that was significantly different from what was predicted based on initial body weights alone (i.e., significant residuals, Tables 15-21), and that these differences were largely accountable to the chemical characteristics of the waters (i.e., no significant residuals, Tables 24-29----note, however, that source 4 in Trial 3, Tables 28 and 29, yielded observed values considerably below the predicted values, approaching significance, $P < .10$).

Relationships of mouse reproduction to composition of waters

The regressions of numbers of pups weaned on chemical characteristics of waters are shown in Tables 31, 32 and 33 for Trials 1, 2 and 3, respectively. When only the means for all reps within water sources were analyzed, without regard for the variation among reps within treatments, the variability among treatments (i.e., among water sources) was extensive. This circumstance is reflected by the data as presented in Tables 31, 32 and 33. Coefficients of variation were 33.9%, 15.3% and 65.9% for Trials 1, 2 and 3 respectively. In none of the three trials did the regression equations attain statistical significance (F ratios were 0.25, 1.88 and 1.47, respectively); however, in Trials 2 and 3, the equations did account for appreciable amounts of the total variation in numbers of pups (R^2 = 50.06 and 51.69 in Trials 2 and 3).

A similar relationship exists in the mouse growth data, whereby none of the chemical characteristics (variables 1-8) accounted for sufficient amounts of total variation in final weights as to become statistically significant and consistently so from trial to trial. A single exception exists in the case of female growth in Trial 1, where calcium content of waters was significantly related (negatively) to growth (see Table 24, variable 3 = Ca, $t = -2.13^*$, $P < .05$). But the "failure" of these individual variables to "attain significance" (i.e., failure to account for large portions of the total variance), and similarly the "failure" of the overall regression equations to "attain significance" (i.e., failure to show large F values) is due mainly to the usage of several "independent" variables some of which were not truly independent, i.e., they were highly correlated. For example, EC and TDS (variables 1 and 2) were highly correlated in all three trials (r = .94,.98 and .92 in

Trials 1, 2 and 3). Likewise, TDS and Mg (variables 2 and 4) were highly correlated in all trials (r = .80, .94 and .99). Obviously, the programmed treatment of these dependent variables as if they were independent reduced the "predictive power" of the multiple regression equations and decreased the t values for all variables. All of the simple correlation coefficients are shown in Table 6 of the Appendix, and the data therein serve to indicate other examples where apparent "independent" variables are actually highly correlated and therefore dependent.

This observation is important in the interpretation of the data, because the "stepwise regression" program of computations (APL program) that was employed in all of the computations herein was simply a forward selection process in APL computation by which all variables are included in all of the regression computations, rather than being truly a forward selection, stepwise eliminative, regression computation. This means that the computations cannot be increased in precision by dropping out those variables which contribute little to the overall regression equation, thereby decreasing the degrees of freedom attributable to regression and consequently increasing the value of the F ratio in the analysis of variance. The program used did allow, however, the calculation of standard partial correlation coefficients for any desired grouping of the variables, and these provide evidence that in some cases the elimination of one or more variables (chemical characteristics that were highly correlated with each other) from the computations actually increased the correlation coefficient by notable amounts, and thus would have increased the "predictive power" of the regression equations if those particular variables had been eliminated from the computations of multiple regression equations by a truly stepwise, forward selection, eliminative program. (Such a program is now being developed for usage in APL computations, but was not available at the time these computations were completed).

In a few cases, the standard partial correlation coefficients show increased magnitude when certain variables are eliminated from the calculations, and thereby suggest that mouse growth and reproduction were, in fact, significantly related to chemical characteristics of the waters and could have been predicted with statistically significant regression equations if a stepwise, forward selection, eliminative program had been used in the computations. For example, in Trial 2, body weights of females were related to initial weights and all 8 chemical variables with R^2 = .0562 (whereas initial weights alone yielded R^2 = .2691). Elimination of variable 1 (EC x 10^6) from the computation yielded R^2 = .3944, and elimination of all variables except 2, 3 and 10 (TDS, Ca and initial weights) increased the R^2 value to .4177. A multiple regression equation based on these three variables alone would show that final weights were significantly related ($P < .05$) to both TDS and Ca. In the same trial, numbers of pups weaned (variable 9) correlated with the whole array of variables only to the extent that $R^2 = .187$; whereas correlation with variables 5,6,7 and 8 (sulfate, chloride, Na and K) yielded $R^2 = .516$.

Although these observations do bear some relevance to any detailed interpretation of the data, perhaps the primary observation that can be made from all the data relating to growth and reproduction of mice as affected by the quality of drinking water is that waters which varied in total dissolved solids (TDS) from approximately 1 ppm to almost 5000 ppm affected mouse growth by about 5 to 10 percent of the mean (coefficients of variation ranged from 4.1 to 9.1 percent for males and females, expressed independently, in the various trials), and the effects were not consistently related to any particular variable which characterized the waters chemically.

Relationships of ivDMD to composition of waters

The effects of water sources on *in vitro* dry matter digestibility (ivDMD) are summarized in Tables 34 and 35 for alfalfa hay used as substrate, and in Tables 36 and 37 for cellulose used as substrate. Data are shown for waters of Trials 1 and 2 only; no data are presented herein for the waters of Trial 3. Repeated attempts to obtain usable data for the waters of Trial 3 revealed that the bioassay procedure had "deteriorated" markedly following the earlier bioassay trials. Considerable experimentation was conducted with the procedure before it was recognized that the source of difficulty lay in the usage of plastic (polypropylene) culture tubes (rather than glass, as prescribed by the original procedure--the substitution of plastic for glass tubes was part of an "economy measure" to keep the costs of experimentation within the budget that was provided, which proved to be a costly measure). The plastic culture tubes apparently absorbed sufficient amounts of mercury or mercuric compounds (from the mercuric chloride prescribed in the procedure for killing the cultures at the end of the fermentation phase) during the early trials that they became "toxic" to the cultures in subsequent trials. Routine procedures for cleaning the tubes was inadequate to remove the toxic material, and even after the source of difficulty was recognized special action (prolonged soaking in aqua regia) was required to eliminate the problem. By the time this difficulty was recognized and corrected, the waters from Trial 3 had set in the containers for considerable time, and some of those waters had visible precipitates and/or discoloration due apparently to oxidation of iron or other minerals.

The results shown in Tables 34 and 35 are regarded as valid data which indicate effects of water quality on digestion of alfalfa hay by rumen cultures. Likewise, the data in Table 36 are regarded as valid and unaffected by artifacts of experimentation; but the data shown in Table 37 reflect obvious artifact (toxic material in the plastic of the tubes), and are presented merely to illustrate the problem---the responses noted are not regarded as effects of the water sources being tested.

The data from Tables 34 and 35 show that ivDMD for alfalfa hay varied from about 53% to about 67%, and that chemical composition of waters accounted for 40% and 84.7% of the variation in ivDMD for waters of Trial 1 and Trial 2, respectively. The regression equation relating ivDMD to chemical composition of waters in Trial 1 (Table 34) was not significant ($P < .05$) ($F = 1.42$; d.f.= 8, 17); although variable 2 (TDS) exhibited a $\underline{t}$ value greater than 2.5 ($P < .05$) and accounted for about 13% of the total variation in values for ivDMD. The regression equation relating ivDMD of alfalfa hay to chemical composition of waters in Trial 2 (Table 35) was significant ($P < .01$) ($F = 10.42$; d.f. = 8, 15), and variable 4 (Mg) accounted for 67% of the total variation in values for ivDMD ($\underline{t} = -2.74$; $P < .05$).

These results indicate that ivDMD of a natural substrate (alfalfa hay) was appreciably affected by the quality of the water used for the culture media (coefficients of variability were 3.14% and 5.48% for Trials 1 and 2, respectively), and that either gross mineralization (TDS in Trial 1) or the magnesium content (variable 4, Mg, in Trial 2) could be useful in predicting the response of the rumen microbial cultures to the mineralization of the waters.

The variability of response of rumen cultures to water quality was far greater when cellulose was used as substrate than when alfalfa hay was used. The ivDMD of cellulose varied from 44.2% to 96.5% when the waters of Trial 1 were studied (Table 36) (coefficient of variation was 14.1%), and the chemical composition of the waters accounted for 44.6% of the total variation. Although the regression equation relating ivDMD of cellulose to composition of waters (Table 36) was not significant ($P < .05$) ($F = 1.71$; d.f. = 8, 17), most of the variation in ivDMD was accountable to only 4 of the 8 independent variables in the equation. Elimination of three or four of these "unimportant" variables from the equation would yield F ratios that are considerably greater and statistically significant ($P < .05$), thereby suggesting that ivDMD of cellulose by rumen cultures is, indeed, affected by the mineralization of the waters used for culture media, and that multiple regression equations can be determined which will be useful in predicting rumen culture responses---and perhaps animal responses---to such effects.

DISCUSSION: The objectives of the project were accomplished only in part, and the experimentation was terminated after only two years rather than continued for a third year as originally planned. Thus, a smaller number of water resources was studied than had been anticipated (objective 1); no sources of water were identified as having actual or even potential hazard to human or animal health (objective 2)---with the exception of one source (i.e., water from the creek at Vanadium, New Mexico; Trial 3) which was deliberately included because of potential hazard already suspected, and not because it was regarded as a water resource of major importance; and the quantitative relationships between mouse growth and reproduction or microbial responses to mineralization of waters probably have more limited value in predicting human or animal response to waters of varied quality than had been anticipated (objective 3).

It had been anticipated that a considerably larger number of water samples would be assayed and characterized chemically. Likewise, it had been anticipated that animal responses to water sources would be more widely varied than actually occurred. Moreover, it was anticipated that some sources of major importance might be found with real or potential detrimental effect on animal or microbial functions. Perhaps a more deliberate effort to include samples from suspected or known hazardous sources might have yielded more dramatic results (there are, of course, numerous sources of naturally toxic as well as polluted or contaminated waters in New Mexico); however, the primary effort was directed toward obtaining water samples representative of major resources regarded as economically and/or ecologically important and evaluating these, rather than toward characterization of waters already known or suspected to be hazardous.

The experimentation was terminated after two years, even though the objectives had been only partially attained, because it was felt that another year of the same type of experimentation would add relatively little (in proportion to costs) information additional to that already gained. Rather, it was felt that the information already gained would provide the basis for planning new and more fruitful approaches to further experimentation regarding the characterization of quality in the major resources of New Mexico.

The data from the present study, though limited in scope, indicate that waters representative of several major resources and varied in gross mineralization from "high quality" (i.e., less than 500 ppm TDS) to "medium" or "poor" quality (i.e., 3000 to 5000 ppm TDS) exerted relatively small effects on mouse growth and reproduction (coefficients of variation ranged from about 5% to about 10%, of which variation only about one-tenth to one-third was accountable to the variables which characterized the water sources). The magnitude of responses observed in conjunction with water sources is sufficient to have practical, economic importance to animal production, of course (conceivably, such responses could determine the difference between profit or loss in highly competitive enterprises). The data suggest that a more comprehensive study with greater numbers of water sources and with less disproportionate arrays of water quality, predictive equations can be derived which will relate animal performance to water quality with a high degree of precision. Such a program would require usage of a more refined statistical procedure than was used in the present study, one in which a stepwise, forward-selection, eliminative computer program for multiple regression is used.

Whether the mouse should be the appropriate model for such further research aimed at predicting responses of animals for productive purposes is questionable. From the standpoint of detecting major effects of water components of animal or human health, the mouse likely will remain the model of choice, especially in large-scale, "screening" programs. In the case of the present study, the mouse was selected as the model simply as a matter of necessity, since the scope of experimentation anticipated and the limited laboratory space and limited budget prohibited usage of larger animals, even the rat.

The present study demonstrated that rumen cultures are more sensitive to water quality, from the standpoint of mineralization, than is the mouse growth or reproduction assay. Thus, the usage of microbial cultures as a bioassay procedure for surveys of water quality would appear to offer considerable promise. Rumen cultures obviously would seem to hold more promise for assaying probable effects on ruminant animals than for most other purposes; however, even they could conceivably provide useful information regarding probable effects of water on a wide variety of microbial or biological processes.

PUBLICATIONS:

Tracy, John Driver. 1971. Mouse growth and reproduction in bioassays of water quality from certain natural and municipal water sources in New Mexico. M.S. Thesis, New Mexico State University, Las Cruces, N.M.

Smith, G. S., John D. Tracy, E. C. Smith and A. L. Neumann. 1971. Bioassays of water quality: mice and rumen culture. J. Animal Science 33:310 (abstract).

PUBLICATIONS ANTICIPATED:

One Bulletin from New Mexico Agricultural Experiment Station pertaining to water quality in general and the research completed in particular; and, One Journal Article, concerning bioassays of water quality, intended for Journal of Animal Science.

REFERENCES CITED

A.O.A.C. 1970. Official Methods of Analysis of the Association of Official Analytical Chemists. Assoc. of Official Analytical Chemists, Washington, D.C. 20044.

Hanway, J.J., J.B. Herrick, T.L. Willrich, P.C. Bennett and J.T. McCall. 1963. The Nitrate Problem. Special Report No. 34, Cooperative Extension Service, Iowa State University, Ames, Iowa.

Steel, R.G.D. and J.H. Torrie. 1960. Principles and Proceedures of Statistics. McGraw-Hill Book Company, New York, New York.

Tilley, J.M.A. and R.A. Terry. 1963. A two-stage technique for the *in vitro* digestion of forage crops. J. Brit. Grasslands Soc. 18: 104.

Tracy, John Driver. 1971. Mouse growth and reproduction in bioassays of water quality from certain natural and municipal water sources in New Mexico. M.S. Thesis, New Mexico State University, Las Cruces, N.M.

TABLE 1. CHEMICAL CHARACTERISTICS OF DRINKING WATERS FOR MOUSE GROWTH AND REPRODUCTION BIOASSAYS, TRIAL 1

				Chemical Characteristics[a]							
Source[b]	Category[c]	Ec x 10^6	TDS	Ca	Mg	SO_4	CO_3	HCO_3	Cl	Na	K
1	M	1400	960	12	3	11	11	34.8	118	271	2.3
2	D	900	404	51	12	106	-0-	16.8	58	58	2.7
3	M	400	255	23	9	10	7	21.2	8	40	2.3
4	P	700	395	63	11	84	3	14.6	50	70	2.7
5	D	750	470	46	10	380	0	31.1	58	74	2.7
6	G	1700	1293	95	100	750	0	18.8	24	161	7.8
7	G	900	545	60	66	370	5	22.1	18	49	5.1
8	G	2100	1920	251	48	1120	0	26.2	26	175	10.9
9	S	410	305	35	17	10	0	16.0	3	8	12.1
10	G	2100	1822	100	51	1015	0	11.9	53	171	7.4
11	D	4500	2593	123	30	454	0	30.7	1354	458	52.4
12	S	770	490	61	23	306	5	18.9	35	52	5.1
13	G	1100	715	121	39	370	8	32.2	128	54	4.7
14	G	1700	1090	183	113	465	0	22.3	131	168	13.7
15	G	950	597	77	26	338	0	13.6	62	77	3.5
16	G	1700	987	62	53	116	7	24.4	346	171	30.1
17	M	650	458	67	44	190	4	23.6	12	8	.4
18	M	1600	1280	215	123	412	0	8.4	69	40	1.6
19	G	3200	2552	402	149	856	0	11.2	537	109	3.9
20	G	900	557	103	148	106	4	31.4	38	22	1.6
21	S	342	240	30	6	42	0	22.7	16	3	5.1
22	D	420	267	25	14	10	10	34.0	4	26	1.6
23	G	3000	3110	497	282	1242	0	13.6	18	22	3.9
24	G	3000	3102	506	274	1258	0	14.7	29	33	5.5
25	P	-0-	-0-	-0-	-0-	-0-	0	-0-	-0-	3	-0-
26	M	610	337	56	20	131	6	28.9	49	72	5.5
All Variables $\bar{x}$		1377	1029	126	61	389	2.69	20.9	125	92.2	7.5
All Variables S.D.		1073	923	140	75	404	3.59	8.6	277	101	10.9
Coefficient of Variation %		78	90	111	123	104	134	41.2	222	110	145

[a]Measured in parts per million.

[b]See Appendix, Table 1, for location of each source.

[c]See Appendix, Table 4, for category definitions.

TABLE 2. CHEMICAL CHARACTERISTICS OF DRINKING WATERS FOR MOUSE GROWTH AND REPRODUCTION BIOASSAYS, TRIAL 2

Source[b]	Category[c]	Ec x 10^6	TDS	Chemical Characteristics[a] Ca	Mg	SO_4	CO_3	HCO_3	Cl	Na	K
1	G	5000	4195	640	240	1215	0	20.9	920	200	4.1
2	G	4000	3195	415	163	1236	0	24.1	482	320	3.7
3	D	450	240	31	8	40	4	16.0	7	50	2.2
4	D	2000	1620	285	90	962	0	18.5	47	42	2.1
5	S	850	390	76	15	211	0	19.2	45	76	5.5
6	M	560	320	35	8	106	0	16.8	17	56	8.4
7	G	4600	4790	480	332	1258	0	43.3	114	370	7.8
8	G	5000	4650	570	328	1258	0	42.6	115	370	8
9	D	600	630	38	35	100	2	26.2	22	21	8.4
10	M	560	265	50	28	42	7	30.4	16	12	2.0
11	M	1250	850	120	46	402	1	29.8	18	20	2.0
12	M	650	250	44	30	50	0	23.4	32	35	7.8
13	D	2000	1660	305	86	898	0	27.6	21	22	2.1
14	D	650	695	55	33	150	0	22.3	43	40	10
15	G	950	560	75	15	158	0	32.1	51	90	3.2
16	G	7000	5310	705	178	1247	0	29.3	1131	500	6.4
17	S	380	170	40	10	20	0	18.8	7	18	11.5
18	G	1900	935	20	28	148	0	17.8	35	140	38.0
19	G	1200	650	120	20	222	0	20.2	136	65	5.2
20	G	2300	1670	215	56	898	0	22.3	51	220	16.5
21	M	1450	750	125	42	343	7	22.3	63	40	2.5
22	G	4100	3595	500	156	1236	0	15.0	295	140	16.0
23	M	660	275	120	21	127	0	26.5	50	56	6.5
24	P	-0-	-0-	-0-	-0-	-0-	0	-0-	-0-	-0-	-0-
All Variables $\bar{x}$		2004	1569	211	82	499	188	23.6	155	121	7.5
All Variables S.D.		1897	1705	220	99	522	2.1	8.9	290	138	7.8
Coefficient of Variation %		94.7	109	104	121	105	237	37.7	187	114	104

[a]Measured in parts per million.

[b]See Appendix, Table 2, for location of each source.

[c]See Appendix, Table 4, for category definitions.

TABLE 3. CHEMICAL CHARACTERISTICS OF DRINKING WATERS FOR MOUSE GROWTH AND REPRODUCTION BIOASSAYS, TRIAL 3

				Chemical Characteristics[a]							
Source[b]	Category[c]	Ec x 10^6	TDS	Ca	Mg	SO_4	CO_3	HCO_3	Cl	Na	K
1	M	580	345	180	19	127	0	16.2	56	41	6.7
2	M	400	269	31	7	50	0	13.9	9	60	6.0
3	M	590	370	119	19	32	0	15.2	26	26	4.0
4	M	550	375	105	15	106	0	12.7	25	20	3.7
5	M	1500	1072	230	48	465	0	12.8	120	75	3.3
6	M	520	281	38	12	95	0	14.8	24	42	3.6
7	M	1200	672	106	16	150	0	12.8	275	124	11.0
8	M	540	268	65	13	50	0	11.3	27	9	2.0
9	M	430	255	85	16	50	0	13.8	18	25	4.1
10	M	690	441	120	24	63	0	19.8	58	41	2.8
11	S	10000	33087	202	1600	1263	97	29.6	57	32	5.5
12	M	1010	582	140	25	63	0	18.3	146	65	2.9
13	D	570	363	65	12	116	0	16.8	38	53	3.6
14	G	3300	3312	530	280	1258	0	18.3	105	80	28.8
15	D	420	273	48	16	50	0	19.7	10	44	2.6
16	G	1280	810	195	30	338	0	17.9	162	65	6.6
17	G	950	590	120	22	148	0	21.6	64	91	2.8
18	D	4700	2582	201	26	127	0	19.1	1269	880	68.0
19	S	1050	684	95	20	285	0	13.9	79	115	5.2
20	P	-0-	-0-	-0-	-0-	-0-	0	.5	-0-	-0-	-0-
All Variables $\bar{x}$		15.4	2332	134	111	241	4.85	16	128	94	9
All Variables S.D.		2275	7284	113	355	372	21.7	5.5	277	188	15
Coefficient of Variation %		150	312	84.3	315	154	447	34.4	216	200	167

[a]Measured in parts per million.

[b]See Appendix, Table 3, for location of each source.

[c]See Appendix, Table 4, for category definitions.

TABLE 4. BODY WEIGHTS OF MICE AT ONSET AND AT TERMINAL OF "UNIFORMITY TRIAL", MEANS AND STANDARD DEVIATIONS FOR 10 MICE PER CAGE.

	Females					Males			
Cages	Initial (x)		Final (y)		Cages	Initial (x)		Final (y)	
1	20.0 ±	1.62[a]	23.8 ±	2.59[a]	1	17.5	2.09	27.7	2.95
2	20.0	1.11	25.7	3.12	2	17.9	1.35	28.2	2.32
3	19.9	1.59	24.3	1.58	3	17.8	1.55	28.1	1.66
4	21.2	2.05	25.6	4.30	4	18.4	2.02	28.5	3.19
5	19.4	1.23	24.9	2.75	5	17.9	1.53	28.7	2.39
6	20.2	1.09	21.1	4.60	6	19.8	1.97	30.7	3.00
7	20.9	2.47	25.7	3.47	7	19.2	1.95	30.2	2.64
8	20.3	2.09	24.6	2.49	8	18.8	2.02	27.6	3.58
9	18.5	1.23	24.1	1.54	9	19.2	0.76	29.2	1.74
10	20.1	1.09	26.8	1.82	10	19.4	1.27	30.2	2.54
11	19.6	1.43	26.7	1.91	11	19.3	1.05	32.5	3.32
12	19.7	0.94	27.4	2.48					
13	19.3	1.43	25.0	1.12					
14	19.5	1.12	25.0	2.75					
15	19.6	1.99	26.1	1.33					
16	19.2	0.92	24.5	2.78					
17	19.0	1.74	25.0	2.01					
18	19.9	1.55	25.0	2.28					
19	18.8	1.51	24.4	2.60					
20	18.9	2.05	24.1	2.29					
21	19.6	1.95	24.8	4.46					
22	18.8	2.03	23.1	3.31					
23	19.1	1.80	23.6	3.64					
24	19.5	0.39	24.9	1.61					
25	18.9	1.62	24.8	1.61					
26	19.5	1.76	26.6	1.91					
27	18.8	1.11	26.0	2.07					
28	19.3	1.71	24.6	2.86					
29	18.8	1.82	24.9	2.59					
30	18.8	0.96	25.7	2.82					
$\bar{X} \pm S$	19.5 ±	0.64	25.0 ±	1.23		18.7 ±	0.79	27.8 ±	1.51
	C.V.= ± 3.3%		C.V.= ± 4.9%			C.V.= ± 4.2%		C.V.= ± 5.2%	

Analysis of Variance, final weights

Source	Females d.f.	Females M.S.	Males d.f.	Males M.S.
Total	289	9.009	102	8.053
Cages	29	21.030	10	9.538
Individuals (error)	260	7.719	92	7.890

[a]Means ± standard deviations.

TABLE 5. EFFECTS OF WATER SOURCES ON BODY WEIGHT GAINS OF MICE, TRIAL 1 (5 FEMALES PER REPLICATE; 1 MALE PER REPLICATE).

	Growth[a]							
Source[b]	Females			$\bar{x}$	Males			$\bar{x}$
1	2.8	4.8	5.4	4.3	-1	5	2	2
2	7	2.2	4	4.4	6	3	2	3.7
3	2.6	7	6	5.2	6	2	1	3
4	4.0	3.6	8.9	5.5	3	2	5	3.3
5	3.6	5.8	3.8	4.4	2	3	6	3.7
6	3.8	3.8	5.6	4.4	1	4	2	2.3
7	2.2	5	7.4	4.9	2	1	2	1.7
8	2.4	6.2	3.6	4.1	8	-5	2	1.7
9	1.8	7.4	4.2	4.5	2	2	3	2.3
10	3.2	5.6	2.4	3.7	10	3	7	6.7
11	4.8	4.0	5.4	4.7	0	2	2	1.3
12	3.4	0.2	5.4	3	5	4	2	3.7
13	3.4	2	1.8	2.4	2	2	0	1.3
14	0	4.1	4.6	2.9	3	1	-2	0.7
15	2.6	6	4.4	4.3	5	2	7	4.7
16	7.0	5.4	7.8	6.7	3	3	3	3
17	2.8	3.2	3.4	3.1	2	-3	4	1
18	1.6	4.2	4.0	3.3	3	2	4	3
19	3.6	5.2	1.2	3.3	3	6	3	4
20	2	5.4	6.8	4.7	4	0	7	3.7
21	1.4	5.8	4.5	3.9	2	0	3	1.7
22	4.8	6.2	5.2	5.4	6	0	1	2.3
23	2.4	6.2	4.6	4.4	7	5	3	5
24	3	4	4.6	3.9	1	3	4	2.7
25	6	4.8	2.8	4.5	2	4	3	3
26	4.6	6.2	4.4	5.1	2	0	2	1.3
All Variables $\bar{x}$				4.27				2.79
All Variables S.D.				.94				1.38
Coefficient of Variation %				22				49.5

[a]Measured in grams increase.

[b]See Appendix, Table 1, for location of source.

TABLE 6. EFFECTS OF WATER SOURCES ON BODY WEIGHT GAINS OF MICE, TRIAL 2 (5 FEMALES PER REPLICATE; 1 MALE PER REPLICATE).

	Growth[a]									
Source[b]		Females		$\bar{x}$				Males		$\bar{x}$
1	12.7	10.8	15.7	14.8	13.5	10.5	13.2	13.2	14	12.7
2	11.3	13.6	14.9	18.8	14.6	13.5	11.2	12.1	12	12.2
3	9.9	14.6	16	19.1	14.9	16.6	10.3	16.1	11.6	13.6
4	11.4	15.5	15	20.3	15.6	11.8	8.8	14.1	12.8	11.9
5	10.2	14.9	13.7	15.2	13.5	15.9	9.9	10	11.4	11.8
6	12.8	14.7	17.3	20.3	16.3	13.5	6.4	10	10.6	10.1
7	13	14.7	15.2	19.7	15.6	13.1	10.9	9.6	14.8	12.1
8	11.6	12.4	16.7	18.7	14.8	12.7	6	9.8	11.4	18.6
9	11	16.8	18.2	19.5	16.4	11.6	12.5	14.5	21.1	14.9
10	2	13.8	15.2	15.3	11.6	1.7	10.4	10.1	10.1	8.1
11	10.9	15.7	14.8	22.9	16.1	15.6	9.2	13.1	11.4	12.3
12	10.5	12.8	15.3	17.2	13.9	12.5	11	12.6	8.8	11.2
13	10.6	11.8	17.7	18.6	14.7	11.8	11.5	10	9	10.6
14	10.5	14.9	16.8	16.7	14.7	14.2	11.2	10.7	14.4	12.6
15	11.8	14.3	15.7	20.9	15.7	9.3	9.4	16.1	6.6	10.4
16	12.9	15.7	15.9	21.5	16.5	11.2	11.1	11.7	12.6	11.6
17	8.3	12.7	16.4	19.5	14.2	11.7	8.1	12.9	13.4	11.5
18	11.6	13.9	17.7	19.4	15.6	4.8	11.3	13.4	14.5	11
19	11.5	11	15	19.2	14.2	6.3	8.5	11	11.6	9.4
20	13	15	16.6	17.2	15.4	9.8	13.7	13	12.8	12.3
21	12.9	16.4	17.2	19.7	16.6	12.3	12	10.2	9.6	11
22	11.3	14.3	14.1	17.3	14.2	9.4	11.1	13.1	10.5	11
23	10.1	14.2	13.5	18.3	14	11.8	6.9	12.1	15.9	11.7
24	11.5	10.8	16.1	20.9	14.8	15.8	13.9	14.8	10.8	13.8
All Variables $\bar{x}$					14.9					11.52
All Variables S.D.					1.17					1.57
Coefficient of Variation %					7.8					13.6

[a]Measured in grams increase

[b]See Appendix, Table 2, for location of source.

TABLE 7. EFFECTS OF WATER SOURCES ON BODY WEIGHT GAINS OF MICE, TRIAL 3 (5 FEMALES PER REPLICATE; 1 MALE PER REPLICATE).

	Growth[a]									
Source[b]	Females				$\bar{x}$	Males				$\bar{x}$
1	6.2	7.2	7	7.8	7	3	5	6	8	5.5
2	8.4	6.4	11.6	9.6	9	3	4	12	4	5.8
3	9.2	5.8	12.6	11.2	9.7	9	8	7	11	8.8
4	6	9.2	8.4	12.2	8.9	8	7	4	10	7.2
5	7.4	11.2	6.4	10.4	8.8	12	-1	11	7	7.2
6	6.6	4.4	12.5	7.4	7.7	5	3	11	5	6
7	8	11	13.6	7.8	10.1	6	8	9	7	7.5
8	8.8	9.8	6	12.2	9.2	10	13	7	3	8.2
9	12.2	9.4	7.4	9.8	9.7	8	9	6	3	6.5
10	4.4	7.6	11.4	10.6	8.5	8	7	14	14	10.8
11	2.8	-.4	4.2	4.4	2.8	6	5	2	3	4
12	4.6	6.8	11.6	6.6	7.4	5	14	15	5	9.8
13	6.2	6.8	11	11.4	8.8	10	8	10	10	9.5
14	6.6	11.6	5.8	8.4	8.1	12	14	5	6	9.2
15	8.8	10.8	5.4	9.6	8.6	6	11	5	15	9.2
16	11.8	8	8	13.8	10.4	5	10	7	10	8
17	7.6	9.6	12.8	8.4	9.6	8	10	12	10	10
18	8.8	6	9	13.2	9.2	11	5	7	9	8
19	6.8	10.6	5.4	9.8	8.2	11	12	9	13	11.2
20	9.4	8	4.6	9.6	7.9	12	5	3	9	7.2
All Variables $\bar{x}$					8.49					7.99
All Variables S.D.					1.62					1.88
Coefficient of Variation %					19.1					23.5

[a]Measured in grams increase.

[b]See Appendix, Table 3, for location of each source.

TABLE 8. MOUSE REPRODUCTION AS AFFECTED BY SOURCE OF DRINKING WATER, TRIAL 1

Source[a]	Category[b]	Reproduction: Pups[c]			Reproduction: $\bar{x}$
1	M	24	0	18	14
2	D	0	9	20	9.7
3	M	34	29	31	31.3
4	D	19	14	30	21
5	D	19	25	33	25.7
6	G	26	8	42	25.3
7	G	26	0	21	15.7
8	G	30	28	0	19.3
9	S	21	30	17	22.7
10	G	0	23	34	19
11	D	16	19	22	19
12	S	36	33	39	36
13	G	0	19	15	11.3
14	G	5	32	32	23
15	G	8	8	0	5.3
16	G	16	24	27	22.3
17	M	25	7	30	20.7
18	M	8	12	24	14.7
19	G	0	20	25	15
20	G	29	33	26	29.3
21	S	21	14	11	15.3
22	D	18	10	29	19
23	G	29	0	25	18
24	G	0	28	21	16.3
25	P	15	0	36	17
26	M	29	0	26	18.3
All Variables $\bar{x}$					19.4
All Variables S.D.					6.65
Coefficient of Variation %					34.3

[a]See Appendix, Table 1, for location of source.

[b]See Appendix, Table 4, for definition of category.

[c]Number of offspring weaned.

TABLE 9. MOUSE REPRODUCTION AS AFFECTED BY SOURCE OF DRINKING WATER, TRIAL 2

Source[a]	Category[b]	Reproduction				
		Pups[c]				$\bar{x}$
1	G	39	33	10	21	25.8
2	G	18	23	37	22	25
3	D	35	11	18	30	23.5
4	D	25	30	36	39	32.5
5	S	0	34	18	27	19.8
6	M	18	30	32	22	25.5
7	G	43	39	22	25	32.2
8	G	31	33	32	21	29.2
9	D	49	26	31	35	35.2
10	M	41	45	36	27	37.2
11	M	24	27	10	40	25.2
12	M	32	0	8	32	18
13	D	18	30	33	24	26.2
14	D	26	23	23	34	26.5
15	G	24	32	13	30	24.8
16	G	11	31	11	34	21.8
17	S	25	23	22	20	22.5
18	G	37	36	24	15	28
19	G	34	29	31	10	26
20	G	13	21	48	24	26.5
21	M	32	35	30	31	32
22	G	29	28	2	38	24.2
23	M	17	0	37	28	20.5
24	P	25	24	20	35	26
All Variables $\bar{x}$						26.43
All Variables S.D.						4.74
Coefficient of Variation %						17.9

[a]See Appendix, Table 2, for location of source.

[b]See Appendix, Table 4, for definition of category.

[c]Number of offspring weaned.

TABLE 10. MOUSE REPRODUCTION AS AFFECTED BY SOURCE OF DRINKING WATER, TRIAL 3

		Reproduction				
Source[a]	Category[b]	Pups[c]				$\bar{x}$
1	M	0	0	0	0	0
2	M	0	0	16	0	4
3	M	0	0	0	9	2.2
4	M	0	8	0	22	7.5
5	M	14	7	0	21	10.5
6	M	13	0	0	0	3.2
7	M	0	7	4	0	2.7
8	M	0	21	7	0	7
9	M	0	18	0	10	7
10	M	6	0	10	21	9.2
11	S	0	0	0	10	2.5
12	M	0	11	31	16	14.5
13	D	0	11	27	0	9.5
14	G	6	12	0	10	7
15	D	9	13	0	0	5.5
16	G	8	26	0	0	8.5
17	G	17	0	36	32	21.2
18	D	13	0	15	13	10.2
19	S	0	18	0	15	8.2
20	P	16	23	0	30	17.2
All Variables $\bar{x}$						7.9
All Variables S.D.						5.24
Coefficient of Variation %						66.3

[a]See Appendix, Table 3, for location of each source.

[b]See Appendix, Table 4, for category definitions.

[c]Number of offspring weaned.

TABLE 11. ANALYSIS OF VARIANCE IN DATA FOR MOUSE GROWTH AND REPRODUCTION AS AFFECTED BY SOURCES OF DRINKING WATER, TRIAL I

Source of Variation	D.F.		Male Growth M.S.	Female Growth M.S.	Pups[a] M.S.
Total	78				
Block	2		14.70	17.08**	493.09**
Source of water	25		5.71	2.65	132.64
Regression		10	7.86	2.40	48.15
Deviation		15	4.27	2.82	188.97
Residuals	50		5.53	2.93	118.73

[a]Reproduction as measured by number of pups weaned.
ϕ (p <.10).
** (p <.01).

TABLE 12. ANALYSIS OF VARIANCE IN DATA FOR MOUSE GROWTH AND REPRODUCTION AS AFFECTED BY SOURCES OF DRINKING WATER, TRIAL 2.

Source of Variation	D.F.		Male Growth M.S.	Female Growth M.S.	Pups[a] M.S.
Total	96				
Block	3		23.06*	258.98**	50.34
Source of water	23		9.82	5.46	89.84
Regression		10	10.23	5.23	130.17
Deviation		13	9.51	5.63	58.81
Residuals	69		7.50	2.70	113.94

[a]Reproduction as measured by number of pups weaned.
* (p < .05).
** (p < .01).

TABLE 13. ANALYSIS OF VARIANCE IN DATA FOR MOUSE GROWTH AND REPRODUCTION AS AFFECTED BY SOURCES OF DRINKING WATER, TRIAL 3.

Source of Variation	D.F.		Male Growth M.S.	Female Growth M.S.	Pups[a] M.S.
Total	80				
Block	3		0.34	18.13*	102.83
Source of Water	19		14.04	10.45	109.80
Regression		10	17.85	16.65*	120.99
Deviation		9	9.80	3.56	97.36
Residuals	57		12.06	6.03	85.48

[a]Reproduction as measured by number of pups weaned.

* ($P < .05$)

TABLE 14. REGRESSION COEFFICIENTS, STANDARD ERRORS AND T-STATISTICS OF WATER SAMPLE CONSTITUENTS, TRIAL 3.

Constituents	Regression Coefficient	Standard Error	T-Statistic
Ec x 10^6	-0.0011	0.006	-0.18
TDS	0.0096	0.009	1.04
Ca	-0.0142	0.009	-1.55
Mg	-0.0982	0.055	-1.77
SO_4	0.0018	0.003	0.65
CO_3	-1.6286	1.849	-0.88
HCO_3	0.1052	0.076	1.38
Cl	0.0042	0.011	0.39
Na	-0.0380	0.016	-2.38*
K	0.1952	0.134	1.46

* ($P < .05$)

TABLE 15. REGRESSION OF FEMALE MICE WEIGHTS (FINAL) ON INITIAL WEIGHTS, TRIAL 1.

Water Number	BODY WEIGHTS, g Observed	Estimated	Residual
1	28.2	26.97	1.20
2	25.8	25.33	0.47
3	26.4	25.93	0.47
4	27	26.95	- 0.05
5	26.6	27.46	- 0.86
6	27.2	27.55	- 0.35
7	28.6	26.81	1.79
8	27.1	27.46	- 0.36
9	28.2	27.51	0.69
10	28.5	25.93	2.57
11	27.7	27.51	0.19
12	25.7	26.35	- 0.65
13	26.3	26.07	0.23
14	27.2	28.25	- 1.05
15	22.6	25.28	- 2.68
16	26	27.88	- 1.88
17	25.8	27.14	- 1.34
18	24.7	26.02	- 1.32
19	28.3	27.51	0.79
20	25.9	26.12	- 0.22
21	27.7	26.49	1.21
22	27.7	27.88	- 0.18
23	29.6	26.88	2.74
24	23.7	24.40	- 0.70
25	25.1	25.33	- 0.23
26	26.2	26.81	- 0.61

ANOVA

Source	d.f.	M.S.	F
Regression	1	23.047	13.95**
Error	24	1.652	

S.E. of Estimate = 1.285, $D_{.05}$ = 2.65

$r^2 = .3676$

$\hat{Y} = 20.18 + 0.464 X$

$\bar{x} \pm s = 26.7 \pm 1.58$; cv = $\pm$ 5.9 %

*P < .05

*P < .01

TABLE 16. REGRESSION OF MALE MICE WEIGHTS (FINAL) ON INITIAL WEIGHTS, TRIAL 1.

Water Number	BODY WEIGHTS, g Observed	Estimated	Residual
1	32.8	32.35	0.45
2	31.9	32.15	- 0.25
3	28.3	30.58	- 2.28
4	31.6	32.04	- 0.44
5	30.7	31.70	- 1.00
6	34.2	32.04	2.16
7	33	31.53	1.47
8	34.1	32.28	1.82
9	31.1	31.70	- 0.60
10	32.6	30.89	1.71
11	27.9	32.83	- 4.93
12	29.5	31.33	- 1.83
13	29.2	29.97	- 0.77
14	32	31.67	0.33
15	27.5	29.90	- 2.40
16	33.4	32.79	0.61
17	30.3	32.11	- 1.81
18	32.5	30.58	1.92
19	36.4	32.52	3.88
20	33.1	31.84	1.26
21	33.6	31.57	2.03
22	31.1	32.38	- 1.28
23	30.2	31.02	- 0.82
24	30.9	29.56	1.34
25	31.3	30.21	1.09
26	29.8	31.43	- 1.63

ANOVA

Source	d.f.	M.S.	F
Regression	1	20.84	5.54*
Error	24	3.76	

S. E. of Estimate = 1.939, $D_{.05}$ = 4.00

$r^2 = .1876$

$\hat{Y} = 26.47 + 0.340\ X$

$\bar{x} \pm s = 31.5 \pm 2.11$; c.v. = $\pm$ 6.7 %

*P < .05

ø P < .10

TABLE 17. REGRESSION OF FEMALE MICE WEIGHTS (FINAL) ON INITIAL WEIGHTS, TRIAL 2.

Water Sources	BODY WEIGHTS, g Observed	Estimated	Residual
1	28.2	29.61	- 1.41
2	29.5	29.56	- 0.06
3	29.4	29.65	- 0.25
4	30	29.75	0.25
5	28	29.65	- 1.65
6	31.1	29.56	1.54
7	30.5	29.56	0.94
8	30.2	29.33	0.87
9	31.1	29.61	1.49
10	27.7	28.95	- 1.25
11	29.6	30.16	0.56
12	28.6	29.65	1.05
13	29.7	29.47	0.23
14	29.4	29.65	- 0.25
15	29.7	29.93	- 0.23
16	30.4	29.93	0.47
17	28.6	29.75	- 1.15
18	30.1	29.75	0.35
19	29.6	29.23	0.37
20	30.1	29.65	0.45
21	30.7	29.75	0.95
22	29.3	29.47	- 0.17
23	29.2	29.42	- 0.22
24	29.8	29.47	0.33

ANOVA

Source	d.f.	M.S.	F
Regression	1	1.36	1.72
Error	22	0.79	

S.E. of Estimate = 0.89, $D_{.05}$ = 1.84

$r^2 = .0724$

$\hat{Y} = 36.45 - 0.466 X$

$\bar{x} \pm s = 29.6 \pm 0.90$; c.v. = $\pm$ 3.0%

TABLE 18. REGRESSION OF MALE MICE WEIGHTS (FINAL) ON INITIAL WEIGHTS, TRIAL 2.

	BODY WEIGHTS, g		
Water Source	Observed	Estimated	Residual
1	32.2	---	---
2	30.2	(Not computed; predictive power of regression equation is negligible).	
3	30.8		
4	27.1		
5	29.6		
6	30.6		
7	28.3		
8	29.8		
9	29.7		
10	29.8		
11	29.1		
12	28.2		
13	29.3		
14	28.0		
15	30.3		
16	29.8		
17	29.3		
18	30.2		
19	27.0		
20	30.5		
21	30.2		
22	30.7		
23	29.2		
24	31.8		

ANOVA

Source	d.f.	M.S.	F
Regression	1	0.471	< 1
Error	21	1.76	

$r^2 = .0125$

$\hat{Y} = 24.2 + .302\ X$

$\bar{x} \pm s = 29.65 \pm 1.28$; c.v. = $\pm$ 4.3%

TABLE 19. REGRESSION OF FEMALE MICE WEIGHTS (FINAL) ON INITIAL WEIGHTS, TRIAL 3.

	BODY WEIGHTS, g		
Water Source	Observed	Estimated	Residual
1	22.8	21.98	0.82
2	23.9	22.21	- 1.69
3	22.8	23.14	- 0.34
4	15.2	18.29	- 3.09
5	23	24.52	- 1.52
6	23.3	24.52	- 1.22
7	23.4	22.91	- 0.49
8	22.4	24.06	- 1.66
9	23.9	24.98	- 1.08
10	21.6	23.14	1.54
11	23.8	22.21	1.59
12	24	23.60	0.40
13	24.2	22.21	1.99
14	23.5	22.91	- 0.59
15	23.9	24.06	- 0.16
16	24.9	22.91	1.99
17	24.3	23.14	- 1.16
18	22	22.21	0.21
19	23.3	22.67	- 0.62
20	24.7	25.22	- 0.52

ANOVA

Source	d.f.	M.S.	F
Regression	1	41.94	20.66**
Error	18	2.03	

S.E. of Estimate = 1.425, $D_{.05}$ = 2.99

r^2 = .5344

$\hat{Y}$ = 2.309 X - 10.57

$\bar{x} \pm s$ = 23.05 ± 2.03; c.v. = ± 8.8%

*P < .05

*P < .01

TABLE 20. REGRESSION OF MALE MICE WEIGHTS (FINAL) ON INITIAL WEIGHTS, TRIAL 3.

Water Source	BODY WEIGHTS, g Observed	Estimated	Residual
1	26.8	25.73	- 1.07
2	26.8	27.56	0.76
3	27.8	25.05	- 2.75
4	19	26.07	- 7.07
5	26.8	26.88	- 0.08
6	26.2	25.39	0.81
7	28.2	27.28	1.81
8	27.8	26.07	1.73
9	30.5	27.29	- 3.21
10	24.2	26.61	2.41
11	29	26.74	2.26
12	27.8	27.29	- 0.51
13	26.2	26.61	- 0.41
14	25.2	27.08	- 1.88
15	27.5	27.56	- 0.06
16	25.5	25.73	0.23
17	27	26.20	0.80
18	26.5	27.76	- 1.26
19	23.5	24.85	- 1.35
20	27.2	26.74	0.45

ANOVA

	Source	d.f.	M.S.	F
*	Regression	1	13.97	2.62
	Error	18	5.34	

S.E. of **Estimate** = 2.31, $D_{.05}$ = 4.85

r^2 = .1270

$\hat{Y}$ = 13.90 + 0.676 X

$\bar{x} \pm s = 26.5 \pm 2.41$; c.v. $= \pm 9.19\%$

*P < .05

TABLE 21. EFFECTS OF WATER SOURCES ON BODY WEIGHTS OF MICE, TRIAL 1B.
(7 females and 7 males per water source)

	BODY WEIGHTS[a], g, FEMALES				BODY WEIGHTS[a], g, MALES				ADJUSTMENT FOR COVARIANCE *			
									FEMALE		MALE	
ater Source	Initial	± s	Final	± s	Initial	± s	Final	± s	Estimated	Residual	Estimated	Residual
1	14.7	± 4.8[a]	28.2	± 1.5	17.3	± 3.5	32.8	± 3.8	27.0	1.2	32.4	.4
2	11.1	3.9	25.8	2.5	16.7	3.0	31.9	3.2	25.3	.5	32.1	-.2
3	12.4	1.4	26.4	2.5	12.1	1.7	28.3	3.5	25.9	.5	30.6	-2.3
4	14.6	1.9	27.0	2.9	16.4	1.6	31.6	3.7	26.9	.1	32.0	-.4
5	15.7	1.9	26.6	2.0	15.4	2.8	30.7	4.6	27.5	-.9	31.7	-1.0
6	15.9	1.6	27.2	0.8	16.4	3.1	34.2	1.3	27.6	-.4	32.0	2.2
7	14.3	2.1	28.6	2.9	14.9	0.7	33.0	3.2	26.8	1.8	31.5	1.5
8	15.7	2.8	27.1	3.1	17.1	3.6	34.1	2.9	27.5	-.4	32.3	1.8
9	15.8	1.6	28.2	2.6	15.4	3.0	31.1	2.5	27.5	.7	31.7	-.6
10	12.4	2.0	28.5	2.0	13.0	1.3	32.6	1.8	25.9	2.6	30.9	1.7
11	15.8	2.0	27.7	1.1	18.7	2.1	27.9	1.3	27.5	.2	32.8	-4.9*
12	13.3	1.9	25.7	2.2	14.3	1.4	29.5	1.9	26.3	-.6	31.3	-1.8
13	12.7	1.4	26.3	3.6	10.3	1.7	29.2	1.0	26.0	.3	30.0	-.8
14	17.4	2.7	27.2	1.7	15.3	4.6	32.0	1.3	28.3	1.1	31.7	.3
15	11.0	2.9	22.6	3.9	10.1	3.0	27.5	2.4	25.3	-2.7	29.9	-2.4
16	16.6	2.5	26.0	2.1	18.6	3.3	33.4	2.4	27.9	-1.9	32.8	.6
17	15.0	1.8	25.8	1.6	16.6	2.1	30.3	2.3	27.1	-1.3	32.1	-1.8
18	12.6	2.4	24.7	2.5	12.1	3.2	32.5	3.1	26.0	-1.3	30.6	1.9
19	15.8	3.5	28.3	2.9	17.8	5.0	36.4	3.2	27.5	.8	32.5	3.9
20	12.8	2.0	25.9	1.7	15.8	2.2	33.1	2.8	26.1	-.2	31.8	1.3
21	13.6	1.4	27.7	2.0	15.0	1.4	33.6	1.8	26.5	1.2	31.6	2.0
22	16.6	2.6	27.7	2.1	17.4	2.6	31.1	1.7	27.9	-.2	32.4	-1.3
23	14.6	2.1	29.6	1.7	13.4	1.8	30.2	1.6	26.9	2.7	31.0	-.8
24	9.1	1.2	23.7	1.6	9.1	0.4	30.9	1.8	24.4	-.7	29.6	1.3
25	11.1	1.1	25.1	1.5	11.0	0.8	31.3	1.5	25.3	-.2	30.2	1.1
26	14.3	0.9	26.2	2.4	14.6	1.8	29.8	4.6	26.8	-.6	31.4	-1.6
$\bar{x} \pm s$	14.03	± 2.07	26.68	± 1.58	14.80	± 2.69	31.50	± 2.11	---	---	---	---
c.v.	± 14.8%		± 5.9%		± 18.2%		± 6.7%					

[a]Means ± standard deviation.

[b]Estimate of final weight by regression on initial weight.

*$P < .05$; S.E. of estimate: Females = 1.68, Males = 2.07; $D_{.05}$:Females = 3.47, Males = 4.27

TABLE 22. ANALYSIS OF VARIANCE: REGRESSION OF FINAL WEIGHTS ON INITIAL WEIGHTS, TRIAL 1-B.

ANOVA

Source	d.f.	M.S., Females	M.S., Males
Regression	1	23.54**	20.84ø
Error	24	2.84	4.30

For Females, $Y = 20.1 + .469\ X$; S.E. of Estimate = 1.68; $r^2 = .3756$

For Males, $Y = 26.5 + .340\ X$; S.E. of Estimate = 2.07; $r^2 = .1877$

ø $P < .10$

** $P < .01$

TABLE 24. REGRESSION OF FEMALE MOUSE WEIGHTS ON INITIAL WEIGHTS AND CHEMICAL ANALYSIS OF DRINKING WATER, TRIAL 1. VARIABLES ARE: 1 = EC, 2 = TDS, 3 = CA, 4 = MG, 5 = SULFATE, 6 = CL, 7 = NA, 8 = K, AND 10 = INITIAL WEIGHT.

STEPWISE REGRESSION

VAR.	*COEFF.*	*ST. ERROR*	*T-VALUE*	*VARIATION*	
1.000000000E1	6.157600000E¯1	1.389500000E¯1	4.430000000E0	3.676000000E1	**
2.000000000E0	4.260000000E¯3	2.420000000E¯3	1.760000000E0	4.270000000E0	
8.000000000E0	¯5.730000000E¯2	4.997000000E¯2	¯1.150000000E0	2.850000000E0	
3.000000000E0	¯1.765000000E¯2	8.300000000E¯3	¯2.130000000E0	8.860000000E0	*
7.000000000E0	¯1.279000000E¯2	9.400000000E¯3	¯1.360000000E0	6.160000000E0	
5.000000000E0	¯1.720000000E¯3	2.050000000E¯3	¯8.400000000E¯1	1.750000000E0	
4.000000000E0	¯7.340000000E¯3	1.282000000E¯2	¯5.700000000E¯1	6.500000000E¯1	
6.000000000E0	¯1.270000000E¯3	4.930000000E¯3	¯2.600000000E¯1	1.200000000E¯1	
1.000000000E0	5.300000000E¯4	3.180000000E¯3	1.700000000E¯1	7.000000000E¯2	

INTERCEPT 18.03518

REGRESSION

DEGREES OF FREEDOM	9
SUM OF SQUARES	38.55054
MEAN SQUARE	4.28339

ERROR

DEGREES OF FREEDOM	16
SUM OF SQUARES	24.1433
MEAN SQUARE	1.50896

S.E. OF ESTIMATE	1.2284
F-VALUE	2.84*
MULTIPLE R-SQUARED	61.49

RESIDUALS

NO.	*OBSERVED*	*ESTIMATED*	*RESIDUAL*
1	28.2	27.9144	0.2856
2	25.8	24.92578	0.87422
3	26.4	25.82529	0.57471
4	27	26.62706	0.37294
5	26.6	27.38794	¯0.78794
6	27.2	27.99617	¯0.79617
7	28.6	26.51688	2.08312
8	27.1	27.38929	¯0.28929
9	28.2	27.72075	0.47925
10	28.5	27.97999	0.52001
11	27.7	27.43204	0.26796
12	25.7	25.946	¯0.246
13	26.3	25.30222	0.99778
14	27.2	26.33256	0.86744
15	22.6	24.45886	¯1.85886
16	26	27.32426	¯1.32426
17	25.8	27.55704	¯1.75704
18	24.7	25.99594	¯1.29594
19	28.3	28.36688	¯0.06688
20	25.9	25.99152	¯0.09152
21	27.7	26.61585	1.08415
22	27.7	28.62542	¯0.92542
23	29.6	28.23398	1.36602
24	23.7	24.56244	¯0.86244
25	25.1	24.83169	0.26831
26	26.2	25.93975	0.26025

* $P \leq .05$
** $P \leq .01$

TABLE 25. REGRESSION OF MALE MOUSE WEIGHTS ON INITIAL WEIGHTS AND CHEMICAL ANALYSIS OF DRINKING WATER. TRIAL 1. VARIABLES ARE: 1 = EC, 2 = TDS, 3 = CA, 4 = MG, 5 = SULFATE, 6 = CL, 7 = NA, 8 = K, and 12 = INITIAL WEIGHT.

STEPWISE REGRESSION

VAR.	*COEFF.*	*ST. ERROR*	*T-VALUE*	*VARIATION*
1.200000000E1	5.542100000E¯1	1.784500000E¯1	3.110000000E0	1.876000000E1 **
8.000000000E0	¯6.345000000E¯2	7.701000000E¯2	¯8.200000000E¯1	1.346000000E1
5.000000000E0	9.000000000E¯4	3.310000000E¯3	2.700000000E¯1	1.365000000E1
6.000000000E0	¯3.580000000E¯3	7.920000000E¯3	¯4.500000000E¯1	5.300000000E¯1
1.000000000E0	1.660000000E¯3	5.090000000E¯3	3.300000000E¯1	5.500000000E¯1
7.000000000E0	¯2.770000000E¯3	1.393000000E¯2	¯2.000000000E¯1	1.300000000E¯1
2.000000000E0	¯8.700000000E¯4	3.800000000E¯3	¯2.300000000E¯1	1.800000000E¯1
4.000000000E0	¯1.030000000E¯3	2.039000000E¯2	¯5.000000000E¯2	1.000000000E¯2
3.000000000E0	2.300000000E¯4	1.270000000E¯2	2.000000000E¯2	0.000000000E0

INTERCEPT 22.76371

REGRESSION

DEGREES OF FREEDOM	9
SUM OF SQUARES	52.50509
MEAN SQUARE	5.8339

ERROR

DEGREES OF FREEDOM	16
SUM OF SQUARES	58.57491
MEAN SQUARE	3.66093

S.E. OF ESTIMATE	1.91336
F-VALUE	1.59
MULTIPLE R-SQUARED	47.27

RESIDUALS

NO.	*OBSERVED*	*ESTIMATED*	*RESIDUAL*
1	32.8	32.53282	0.26718
2	31.9	32.71835	¯0.81835
3	28.3	29.63208	¯1.33208
4	31.6	32.20673	¯0.60673
5	30.7	31.89455	¯1.19455
6	34.2	33.12016	1.07984
7	33	31.79814	1.20186
8	34.1	33.80704	0.29296
9	31.1	30.91329	0.18671
10	32.6	31.62448	0.97552
11	27.9	29.31066	¯1.41066
12	29.5	31.21513	¯1.71513
13	29.2	29.09229	0.10771
14	32	31.65984	0.34016
15	27.5	29.05838	¯1.55838
16	33.4	31.47904	1.92096
17	30.3	32.69062	¯2.39062
18	32.5	30.84829	1.65171
19	36.4	33.96094	2.43906
20	33.1	32.30207	0.79793
21	33.6	31.08565	2.51435
22	31.1	32.68501	¯1.58501
23	30.2	33.03683	¯2.83683
24	30.9	30.51403	0.38597
25	31.3	28.8517	2.4483
26	29.8	30.9619	¯1.1619

** $P \leq .01$

TABLE 26. REGRESSION OF FEMALE MOUSE WEIGHTS ON INITIAL WEIGHTS AND CHEMICAL ANALYSIS OF DRINKING WATER, TRIAL 2. VARIABLES ARE: 1 = EC, 2 = TDS, 3 - CA, 4 = MG, 5 = SULFATE, 6 = CL, 7 = NA, 8 = K, AND 10 = INITIAL WEIGHT.

STEPWISE REGRESSION

VAR.	*COEFF.*	*ST. ERROR*	*T-VALUE*	*VARIATION*
1.000000000E1	¯2.997500000E¯1	4.182400000E¯1	¯7.200000000E¯1	7.240000000E0
7.000000000E0	¯6.300000000E¯4	4.730000000E¯3	¯1.300000000E¯1	5.350000000E0
6.000000000E0	¯2.310000000E¯3	2.040000000E¯3	¯1.140000000E0	1.230000000E1
2.000000000E0	1.730000000E¯3	1.330000000E¯3	1.300000000E0	4.800000000E¯1
4.000000000E0	¯1.217000000E¯2	9.520000000E¯3	¯1.280000000E0	5.780000000E0
3.000000000E0	¯7.350000000E¯3	8.140000000E¯3	¯9.000000000E¯1	3.270000000E0
8.000000000E0	¯2.957000000E¯2	3.690000000E¯2	¯8.000000000E¯1	3.010000000E0
1.000000000E0	2.500000000E¯4	1.190000000E¯3	2.100000000E¯1	2.000000000E¯1
5.000000000E0	6.000000000E¯5	1.570000000E¯3	4.000000000E¯2	1.000000000E¯2

INTERCEPT 33.97604

REGRESSION

DEGREES OF FREEDOM	9
SUM OF SQUARES	7.03813
MEAN SQUARE	0.78201

ERROR

DEGREES OF FREEDOM	14
SUM OF SQUARES	11.67145
MEAN SQUARE	0.83367

S.E. OF ESTIMATE	0.91306
F-VALUE	0.94
MULTIPLE R-SQUARED	37.62

RESIDUALS

NO.	*OBSERVED*	*ESTIMATED*	*RESIDUAL*
1	28.2	28.13206	0.06794
2	29.5	29.66816	¯0.16816
3	29.4	29.69119	¯0.29119
4	30	29.62566	0.37434
5	28	29.44251	¯1.44251
6	31.1	29.5611	1.5389
7	30.5	30.737	¯0.237
8	30.2	29.82465	0.37535
9	31.1	29.79558	1.30442
10	27.7	28.93843	¯1.23843
11	29.6	30.17824	¯0.57824
12	28.6	29.18197	¯0.58197
13	29.7	29.48547	0.21453
14	29.4	29.74462	¯0.34462
15	29.7	29.97185	¯0.27185
16	30.4	30.30105	0.09895
17	28.6	29.26623	¯0.66623
18	30.1	29.97837	0.12163
19	29.6	29.13072	0.46928
20	30.1	30.10474	¯0.00474
21	30.7	29.67784	1.02216
22	29.3	29.96633	¯0.66633
23	29.2	28.61639	0.58361
24	29.8	29.47986	0.32014

TABLE 27. REGRESSION OF MALE MOUSE WEIGHTS ON INITIAL WEIGHTS AND CHEMICAL ANALYSIS OF DRINKING WATER, TRIAL 2. VARIABLES ARE: 1 = EC, 2 = TDS, 3 = CA, 4 = MG, 5 = SULFATE, 6 = CL, 7 = NA, 8 = K AND 12 = INITIAL WEIGHT.

STEPWISE REGRESSION

VAR.	*COEFF.*	*ST. ERROR*	*T-VALUE*	*VARIATION*
8	0.00893	0.05473	0.16	1.56
12	0.66054	0.68114	0.97	0.88
6	0.00571	0.00323	1.77	0.6
1	¯0.00275	0.00178	¯1.54	1.28
2	0.0027	0.00199	1.36	9.67
5	0.00359	0.0023	1.56	6.3
3	¯0.0103	0.0114	¯0.9	9.5
7	0.00214	0.007	0.31	0.48
4	¯0.00425	0.01409	¯0.3	0.45

INTERCEPT 18.38877

REGRESSION

DEGREES OF FREEDOM	9
SUM OF SQUARES	11.48345
MEAN SQUARE	1.27594

ERROR

DEGREES OF FREEDOM	14
SUM OF SQUARES	25.91655
MEAN SQUARE	1.85118

S.E. OF ESTIMATE	1.36058
F-VALUE	0.69
MULTIPLE R-SQUARED	30.7

RESIDUALS

NO.	*OBSERVED*	*ESTIMATED*	*RESIDUAL*
1	30.7	30.322	0.378
2	30.2	30.84471	¯0.64471
3	32.2	29.97626	2.22374
4	30.2	29.93024	0.26976
5	29.8	29.37449	0.42551
6	28.2	29.88062	¯1.68062
7	30.3	30.36161	¯0.06161
8	28	27.85069	0.14931
9	30.6	30.52516	0.07484
10	27.1	29.76664	¯2.66664
11	30.8	29.57593	1.22407
12	28.3	28.49821	¯0.19821
13	29.7	29.95643	¯0.25643
14	29.8	30.09036	¯0.29036
15	29.1	29.92963	¯0.82963
16	29.6	29.34201	0.25799
17	29.8	29.62339	0.17661
18	29.3	28.82171	0.47829
19	27	28.9082	¯1.9082
20	30.5	30.27577	0.22423
21	29.3	28.74401	0.55599
22	29.2	29.59214	¯0.39214
23	30.1	29.1973	0.9027
24	31.8	30.21246	1.58754

TABLE 28. REGRESSION OF FEMALE MOUSE WEIGHTS ON INITIAL WEIGHTS AND CHEMICAL ANALYSIS OF DRINKING WATER, TRIAL 3. VARIABLES ARE: 1 = EC, 2 = TDS, 3 = CA, 4 = MG, 5 = SULFATE, 6 = CL, 7 = NA, 8 = K, AND 10 = INITIAL WEIGHT.

STEPWISE REGRESSION

VAR.	*COEFF.*	*ST. ERROR*	*T-VALUE*	*VARIATION*
1.000000000E1	2.452060000E0	7.619500000E¯1	3.220000000E0	5.344000000E1 **
5.000000000E0	5.770000000E¯3	6.850000000E¯3	8.400000000E¯1	4.140000000E0
3.000000000E0	6.050000000E¯3	1.550000000E¯2	3.900000000E¯1	6.300000000E¯1
7.000000000E0	1.621000000E¯2	2.978000000E¯2	5.400000000E¯1	4.900000000E¯1
8.000000000E0	¯4.936000000E¯2	2.781800000E¯1	¯1.800000000E¯1	2.700000000E¯1
6.000000000E0	3.120000000E¯3	1.729000000E¯2	1.800000000E¯1	2.600000000E¯1
1.000000000E0	¯4.150000000E¯3	6.080000000E¯3	¯6.800000000E¯1	8.000000000E¯2
2.000000000E0	1.060000000E¯3	3.230000000E¯3	3.300000000E¯1	2.240000000E0
4.000000000E0	¯7.100000000E¯4	7.664000000E¯2	¯1.000000000E¯2	0.000000000E0

INTERCEPT ¯12.4808

REGRESSION

DEGREES OF FREEDOM	9
SUM OF SQUARES	48.30411
MEAN SQUARE	5.36712

ERROR

DEGREES OF FREEDOM	10
SUM OF SQUARES	30.18539
MEAN SQUARE	3.01854

S.E. OF ESTIMATE	1.73730
E-VALUE	1.78
MULTIPLE R-SQUARED	61.54

RESIDUALS

NO.	*OBSERVED*	*ESTIMATED*	*RESIDUAL*
1	22.8	22.37046	0.42954
2	23.9	22.13986	1.76014
3	22.8	22.46042	0.33958
4	15.2	17.74223	¯2.54223
5	23	25.17418	¯2.17418
6	23.3	24.27884	¯0.97884
7	23.4	22.62832	0.77168
8	22.4	23.14802	¯0.74802
9	23.9	24.81807	¯0.91807
10	21.6	22.70446	¯1.10446
11	23.8	23.79812	0.00188
12	24	22.79539	1.20461
13	24.2	22.21301	1.98699
14	23.5	23.37338	0.12662
15	23.9	24.03093	¯0.13093
16	24.9	22.96596	1.93404
17	24.3	23.10499	1.19501
18	22	22.36943	¯0.36943
19	23.3	23.25783	0.04217
20	24.7	25.5261	¯0.8261

** $P \leq .01$

TABLE 29. REGRESSION OF MALE MOUSE WEIGHTS ON INITIAL WEIGHTS AND CHEMICAL ANALYSIS OF DRINKING WATER, TRIAL 3. VARIABLES ARE: 1 = EC, 2 = TDS, 3 = CA, 4 = MG, 5 = SULFATE, 6 = CL, 7 = NA, 8 = K AND 12 = INITIAL WEIGHT.

STEPWISE REGRESSION

VAR.	*COEFF.*	*ST. ERROR*	*T-VALUE*	*VARIATION*
12	0.50717	0.6558	0.77	12.7
2	¯0.00296	0.00506	¯0.59	3.82
5	¯0.00334	0.01106	¯0.3	4.7
4	0.0726	0.12475	0.58	2.19
3	¯0.00228	0.02453	¯0.09	0.2
8	¯0.198	0.42187	¯0.47	0.27
6	0.01723	0.02906	0.59	3.83
1	¯0.00123	0.01012	¯0.12	0.11
7	0.00246	0.04789	0.05	0.02

INTERCEPT 18.13873

REGRESSION
DEGREES OF FREEDOM 9
SUM OF SQUARES 30.61572
MEAN SQUARE 3.40175

ERROR
DEGREES OF FREEDOM 10
SUM OF SQUARES 79.40178
MEAN SQUARE 7.94018

S.E. OF ESTIMATE 2.81783
F-VALUE 0.43
MULTIPLE R-SQUARED 27.83

RESIDUALS

NO.	*OBSERVED*	*ESTIMATED*	*RESIDUAL*
1	26.8	25.56527	1.23473
2	26.8	26.4819	0.3181
3	27.8	25.40914	2.39086
4	19	25.72591	¯6.72591
5	26.8	25.86883	0.93117
6	26.2	25.56244	0.63756
7	29.2	28.00326	1.19674
8	27.8	26.53216	1.26784
9	30.5	27.25908	3.24092
10	24.2	27.3258	¯3.1258
11	29	28.98006	0.01994
12	27.8	28.60542	¯0.80542
13	26.2	26.30771	¯0.10771
14	25.2	25.39676	¯0.19676
15	27.5	27.71126	¯0.21126
16	25.5	25.29488	0.20512
17	27	26.05889	0.94111
18	26.5	26.69607	¯0.19607
19	23.5	23.94014	¯0.44014
20	27.2	27.77502	¯0.57502

TABLE 30. VARIATION IN MOUSE GROWTH (BODY WEIGHTS THREE WEEKS POST-WEANING) ACCOUNTABLE TO REGRESSION ON CHEMICAL CHARACTERISTICS OF DRINKING WATER AND INITIAL WEIGHT.

Items		Trial 1	Trial 2	Trial 3
Variability in TDS, Coefficients of Variation,%:		90	109	312
Variability in mouse weights, C.V., %:	Females	5.9	3.0	8.8
	Males	6.7	4.3	9.1
Variation accountable to initial weights plus chemical characteristics, R^2 x 100:	Females	61.5*[b]	37.6*[b]	61.5*[b]
	Males	47.3*[b]	30.7*[b]	27.8*[b]
Variation accountable to initial weights alone, R^2 x 100:	Females	36.8**[a]	7.2	53.4*[a]
	Males	18.8*[a]	1.2	12.7
Difference, Variation accountable to chemical characteristics, R^2 x 100:	Females	24.7*[b]	30.4*[b]	8.1*[b]
	Males	28.5*[b]	29.5*[b]	15.1*[b]

*P < .05

**P < .01

[a] Significance verified, Tables 15-20.

[b] Significance indicated if variance is re-distributed among reduced number of variables as suggested by standard partial (multiple) correlations (see discussion page 30-32).

TABLE 31. REGRESSION OF PUPS WEANED ON CHEMICAL ANALYSIS OF DRINKING WATER, TRIAL 1. VARIABLES ARE: 1 = EC, 2 = TDS, 3 = CA, 4 = MG, 5 = SULFATE, 6 = CL, 7 = NA, AND 8 = K.

STEPWISE REGRESSION

VAR.	*COEFF.*	*ST. ERROR*	*T-VALUE*	*VARIATION*
3	-0.03592	0.15039	-0.24	3.05
4	0.11979	0.23499	0.51	1.99
8	0.69615	0.9084	0.77	0.73
6	0.01863	0.09091	0.2	3.08
1	-0.02905	0.05842	-0.5	0.35
5	0.01362	0.03777	0.36	0.53
7	0.04885	0.16536	0.3	0.29
2	0.01254	0.0445	0.28	0.42

INTERCEPT 65.38613

REGRESSION	
DEGREES OF FREEDOM	8
SUM OF SQUARES	1025.31629
MEAN SQUARE	128.16454
ERROR	
DEGREES OF FREEDOM	17
SUM OF SQUARES	8784.83756
MEAN SQUARE	516.75515
S.E. OF ESTIMATE	22.73225
F-VALUE	0.25
MULTIPLE R-SQUARED	10.45

RESIDUALS

NO.	*OBSERVED*	*ESTIMATED*	*RESIDUAL*
1	47	53.86654	-6.86654
2	29	51.14838	-22.14838
3	94	61.05529	32.94471
4	63	56.43242	6.56758
5	77	60.78674	16.21326
6	76	64.73441	11.26559
7	47	63.14321	-16.14321
8	58	57.06174	0.93826
9	68	67.08508	0.91492
10	57	58.05687	-1.05687
11	57	56.60299	0.39701
12	108	60.63487	47.36513
13	34	56.05438	-22.05438
14	69	63.1469	5.8531
15	16	57.57816	-41.57816
16	67	69.82962	-2.82962
17	62	59.18946	2.81054
18	44	51.93045	-7.93045
19	45	37.53347	7.46653
20	88	52.61483	35.38517
21	46	62.66817	-16.66817
22	57	59.90621	-2.90621
23	54	54.1987	- 0.1987
25	51	65.53267	-14.53267
26	55	62.31768	-7.31768
24	49	54.87077	- 5.89077

TABLE 32. REGRESSION OF PUPS WEANED ON CHEMICAL ANALYSIS OF DRINKING WATER, TRIAL 2. VARIABLES ARE: 1 = EC, 2 = TDS, 3 = CA, 4 = MG, 5 = SULFATE, 6 = CL, 7 = NA, AND 8 = K.

STEPWISE REGRESSION

VAR.	COEFF.	ST. ERROR	T-VALUE	VARIATION
8	¯0.49569	0.67144	¯0.74	10.68
5	¯0.00529	0.02864	¯0.18	6.25
7	0.14842	0.08619	1.72	18.19
4	0.28702	0.17447	1.65	3.51
2	¯0.01556	0.02457	¯0.63	2.02
6	0.05975	0.03773	1.58	7.1
1	¯0.01598	0.02167	¯0.74	2.31
3	¯0.00423	0.14136	¯0.03	0

INTERCEPT 140.21218

REGRESSION

DEGREES OF FREEDOM	8
SUM OF SQUARES	4321.0461
MEAN SQUARE	540.13076

ERROR

DEGREES OF FREEDOM	15
SUM OF SQUARES	4310.91223
MEAN SQUARE	287.39415

S.E. OF ESTIMATE	16.9527
F-VALUE	1.88
MULTIPLE R-SQUARED	50.06

RESIDUALS

NO.	OBSERVED	ESTIMATED	RESIDUAL
1	143	137.40899	5.59101
2	127	139.5268	¯12.5268
3	147	137.9894	9.0106
4	130	110.58074	19.41926
5	124	134.6717	¯10.6717
6	146	133.03535	12.96465
7	137	136.62978	0.37022
8	131	130.85011	0.14989
9	151	130.44386	20.55614
10	118	136.48917	¯18.48917
11	122	120.63196	1.36804
12	152	137.33654	14.66346
13	77	104.54221	¯27.54221
14	105	131.00454	¯26.00454
15	151	134.76735	16.23265
16	125	125.85628	¯0.85628
17	142	131.47966	10.52034
18	96	106.50632	¯10.50632
19	126	130.17755	¯4.17755
20	126	115.40569	10.59431
21	130	123.79344	6.20656
22	90	85.34791	4.65209
23	133	138.31249	¯5.31249
24	124	140.21218	¯16.21218

TABLE 33. REGRESSION OF PUPS WEANED ON CHEMICAL ANALYSIS OF DRINKING WATER, TRIAL 3. VARIABLES ARE: 1 = EC, 2 = TDS, 3 = CA, 4 = MG, 5 = SULFATE, 6 = CL, 7 = NA, AND 8 = K.

STEPWISE REGRESSION

VAR.	*COEFF.*	*ST. ERROR*	*T-VALUE*	*VARIATION*	
4	1.63943	0.73165	2.24	6.1	*
1	¯0.02626	0.06634	¯0.4	1.21	
8	¯7.87255	2.68922	¯2.93	12.44	**
7	0.64317	0.31508	2.04	0.83	*
2	¯0.0723	0.03049	¯2.37	24.86	*
6	0.18553	0.17577	1.06	6.07	
5	0.01296	0.07467	0.17	0.14	
3	¯0.01591	0.16566	¯0.1	0.04	

INTERCEPT 40.67462

REGRESSION

DEGREES OF FREEDOM	8
SUM OF SQUARES	4286.91704
MEAN SQUARE	535.86463

ERROR

DEGREES OF FREEDOM	11
SUM OF SQUARES	4007.28296
MEAN SQUARE	364.29845

S.E. OF ESTIMATE	19.0866
F-VALUE	1.47
MULTIPLE R-SQUARED	51.69

RESIDUALS

NO.	*OBSERVED*	*ESTIMATED*	*RESIDUAL*
1	1	14.44755	¯13.44755
2	16	15.37913	0.62087
3	9	18.15912	¯9.15912
4	30	11.78961	18.21039
5	42	49.36875	¯7.36875
6	13	30.1299	¯17.1299
7	11	31.24556	¯20.24556
8	28	23.09916	4.90084
9	28	23.61594	4.38406
10	38	44.01486	¯6.01486
11	10	10.10669	¯0.10669
12	58	57.71493	0.28507
13	38	32.40349	5.59651
14	28	25.69792	2.30208
15	22	45.71069	¯23.71069
16	34	18.86897	15.13103
17	85	57.5103	27.4897
18	41	37.75424	3.24576
19	33	46.30855	¯13.30855
20	69	40.67462	28.32538

* P ≤.05, ** P ≤.01

TABLE 34. REGRESSION OF IN VITRO DRY MATTER DIGESTION, ALFALFA HAY, ON CHEMICAL ANALYSIS OF WATER, TRIAL 1. VARIABLES ARE: 1 = EC, 2 = TDS, 3 = CA, 4 = MG, 5 = SULFATE, 6 = CL, 7 = NA, AND 8 = K.

STEPWISE REGRESSION

VAR.	*COEFF.*	*ST. ERROR*	*T-VALUE*	*VARIATION*
5.000000000E0	¯3.180000000E¯3	3.140000000E¯3	¯1.010000000E0	5.410000000E0
8.000000000E0	1.265400000E¯1	7.543000000E¯2	1.680000000E0	3.280000000E0
6.000000000E0	4.390000000E¯3	7.550000000E¯3	5.800000000E¯1	6.630000000E0
2.000000000E0	9.240000000E¯3	3.700000000E¯3	2.500000000E0	6.690000000E0
1.000000000E0	¯8.940000000E¯3	4.850000000E¯3	¯1.840000000E0	1.332000000E1
7.000000000E0	8.990000000E¯3	1.373000000E¯2	6.500000000E¯1	4.740000000E0
3.000000000E0	¯7.800000000E¯4	1.249000000E¯2	¯6.000000000E¯2	1.000000000E¯2
4.000000000E0	4.900000000E¯4	1.951000000E¯2	3.000000000E¯2	0.000000000E0

INTERCEPT 65.81336

REGRESSION
DEGREES OF FREEDOM 8
SUM OF SQUARES 40.5235
MEAN SQUARE 5.06544

ERROR
DEGREES OF FREEDOM 17
SUM OF SQUARES 60.57689
MEAN SQUARE 3.56335

S.E. OF ESTIMATE 1.88768
F-VALUE 1.42
MULTIPLE R-SQUARED 40.08

RESIDUALS

NO.	*OBSERVED*	*ESTIMATED*	*RESIDUAL*
1	64.7	65.36739	¯0.66739
2	66	62.24684	3.75316
3	65.6	65.23345	0.36655
4	66.4	64.08426	2.31574
5	63.9	63.47344	0.42656
6	62.5	62.69146	¯0.19146
7	63.7	62.77714	0.92286
8	64.8	64.11152	0.68848
9	65.2	66.53096	¯1.33096
10	62.2	63.29847	¯1.09847
11	65.1	64.70407	0.39593
12	62.4	63.71421	¯1.31421
13	61.9	62.97593	¯1.07593
14	62.4	62.93908	¯0.53908
15	63.3	63.12159	0.17841
16	66.8	66.20688	0.59312
17	64.1	63.77678	0.32322
18	61.1	62.78253	¯1.68253
19	60.8	61.65068	¯0.85068
20	61	63.08664	¯2.08664
21	62.8	65.56166	¯2.76166
22	67	64.93445	2.06555
23	64.4	64.29739	0.10261
24	66.1	64.51136	1.58864
25	68	65.84032	2.15968
26	62.3	64.58149	¯2.28149

TABLE 35. REGRESSION OF IN VITRO DRY MATTER DIGESTION, ALFALFA HAY, ON CHEMICAL ANALYSIS OF WATERS, TRIAL 2. VARIABLES ARE: 1 = EC, 2 = TDS, 3 = CA, 4 = MG, 5 = SULFATE, 6 = CL, 7 = NA, AND 8 = K.

STEPWISE REGRESSION

VAR.	*COEFF.*	*ST. ERROR*	*T-VALUE*	*VARIATION*
4	¯0.04475	0.01633	¯2.74	67.56
8	0.10964	0.06283	1.75	5.03
7	¯0.01143	0.00806	¯1.42	5.65
5	¯0.00532	0.00268	¯1.98	0.97
2	0.00412	0.0023	1.79	2.02
6	¯0.00443	0.00353	¯1.26	2.84
1	¯0.00142	0.00203	¯0.7	0.2
3	0.00909	0.01323	0.69	0.48

INTERCEPT	62.02373
REGRESSION	
DEGREES OF FREEDOM	8
SUM OF SQUARES	209.77519
MEAN SQUARE	26.2219
ERROR	
DEGREES OF FREEDOM	15
SUM OF SQUARES	37.74314
MEAN SQUARE	2.51621
S.E. OF ESTIMATE	1.58626
F-VALUE	10.42*
MULTIPLE R-SQUARED	84.75

RESIDUALS

NO.	*OBSERVED*	*ESTIMATED*	*RESIDUAL*
1	54.3	54.9068	¯0.6068
2	55.2	54.02212	1.17788
3	60.4	61.72283	¯1.32283
4	58.2	58.84763	¯0.64763
5	60.3	60.85504	¯0.55504
6	60.7	62.14849	¯1.44849
7	53.5	54.16503	¯0.66503
8	54.2	54.03371	0.16629
9	63.4	62.59845	0.80155
10	60.4	61.3093	¯0.9093
11	59.1	60.55605	¯1.45605
12	64.4	61.23497	3.16503
13	60.6	60.0575	0.5425
14	62.8	62.63846	0.16154
15	63.4	61.21197	2.18803
16	55.6	55.74065	¯0.14065
17	61.4	63.01801	¯1.61801
18	63.8	63.72937	0.07063
19	59.1	61.23615	¯2.13615
20	58.7	59.37862	¯0.67862
21	60.4	59.96945	0.43055
22	62	60.8505	1.1495
23	62.3	61.5452	0.7548
24	63.6	62.02373	1.57627

* $P \leq .05$

TABLE 36. REGRESSION OF IN VITRO DRY MATTER DIGESTION OF CELLULOSE ON CHEMICAL ANALYSIS OF WATER, TRIAL 1. VARIABLES ARE: 1 = EC, 2 = TDS, 3 = CA, 4 = MG, 5 = SULFATE, 6 = CL, 7 = NA, AND 8 = K.

STEPWISE REGRESSION

VAR.	*COEFF.*	*ST. ERROR*	*T-VALUE*	*VARIATION*
1	0.04727	0.02714	1.74	8.34
8	¯0.70537	0.42201	¯1.67	4.12
2	¯0.04783	0.02067	¯2.31	13.95
6	¯0.03682	0.04223	¯0.87	16.04
4	0.08779	0.10917	0.8	1.07
3	¯0.01787	0.06987	¯0.26	0.48
5	0.00696	0.01755	0.4	0.3
7	0.02465	0.07682	0.32	0.34

INTERCEPT 68.7778

REGRESSION	
DEGREES OF FREEDOM	8
SUM OF SQUARES	1529.41378
MEAN SQUARE	191.17672
ERROR	
DEGREES OF FREEDOM	17
SUM OF SQUARES	1895.94507
MEAN SQUARE	111.52618
S.E. OF ESTIMATE	10.5606
F-VALUE	1.71
MULTIPLE R-SQUARED	44.65

RESIDUALS

NO.	*OBSERVED*	*ESTIMATED*	*RESIDUAL*
1	88.9	89.87995	¯0.97995
2	91.3	90.26861	1.03139
3	62.4	75.00757	¯12.60757
4	91.2	81.37985	9.82015
5	86.4	82.23641	4.16359
6	96.5	97.18007	¯0.68007
7	87.1	89.50002	¯2.40002
8	83	79.40652	3.59348
9	58.8	66.05919	¯7.25919
10	85.4	87.70029	¯2.30029
11	83.8	85.54873	¯1.74873
12	72.4	81.195	¯8.795
13	89.6	83.71827	5.88173
14	84.9	96.54659	¯11.64659
15	90.1	85.53709	4.56291
16	91.3	76.52804	14.77196
17	89.9	81.49834	8.40166
18	90.4	90.33088	0.06912
19	85.7	90.0045	¯4.3045
20	90.8	85.80675	4.99325
21	44.2	69.6358	¯25.4358
22	82.8	76.07815	6.72185
23	80.4	83.49005	¯3.09005
24	87.9	81.85852	6.04148
25	82.8	68.85176	13.94824
26	76.5	79.25305	¯2.75305

TABLE 37. REGRESSION OF IN VITRO DRY MATTER DIGESTION OF CELLULOSE ON CHEMICAL ANALYSIS OF WATERS, TRIAL 2. VARIABLES ARE: 1 = EC, 2 = TDS, 3 = CA, 4 = MG, 5 = SULFATE, 6 = CL, 7 = NA, AND 8 = K.

STEPWISE REGRESSION

VAR.	*COEFF.*	*ST. ERROR*	*T-VALUE*	*VARIATION*
5	0.05726	0.03576	1.6	41.93
2	¯0.0309	0.03068	¯1.01	3.43
8	¯0.39646	0.83838	¯0.47	1.7
7	0.0431	0.10762	0.4	0.93
4	0.16534	0.21785	0.76	0.97
1	0.00878	0.02706	0.32	1.07
6	0.00696	0.04712	0.15	0.08
3	0.00115	0.17651	0.01	0

INTERCEPT 13.39851

REGRESSION
DEGREES OF FREEDOM 8
SUM OF SQUARES 6751.79851
MEAN SQUARE 843.97481

ERROR
DEGREES OF FREEDOM 15
SUM OF SQUARES 6721.15983
MEAN SQUARE 448.07732

S.E. OF ESTIMATE 21.16784
F-VALUE 1.88
MULTIPLE R-SQUARED 50.11

RESIDUALS

NO.	*OBSERVED*	*ESTIMATED*	*RESIDUAL*
1	52	51.04573	0.95427
2	55	63.66416	¯8.66416
3	1	14.91351	¯13.91351
4	51	52.49295	¯1.49295
5	1	24.86769	¯23.86769
6	1	15.06093	¯14.06093
7	53	46.88626	6.11374
8	52	54.09577	¯2.09577
9	1	8.48196	¯7.48196
10	12	17.05412	¯5.05412
11	57	29.06286	27.93714
12	5	17.89305	¯12.89305
13	55	45.911	9.089
14	1	9.79482	¯8.79482
15	1	19.06885	¯18.06885
16	47	39.29306	7.70694
17	1	10.59169	¯9.59169
18	20	5.52672	14.47328
19	22	21.69124	0.30876
20	54	46.20629	7.79371
21	20	31.05093	¯11.05093
22	22	37.18529	¯15.18529
23	48	21.76262	26.23738
24	65	13.39851	51.60149

APPENDIX

TABLE 1. LOCATION OF WATER SOURCES, TRIAL 1 (SAMPLED OCTOBER 1 AND 2, 1970)

1. Lordsburg Municipal
2. M & M Hog Farm, Animas
3. Deming Municipal
4. WB Hog Farm, Animas
5. M & M Hog Farm (Secondary Source), Animas
6. Jornada Experimental Range West Well
7. Jornada Experimental Range Headquarters
8. New Mexico State University College Ranch North Well
9. New Mexico State University College Ranch Stock Pond
10. New Mexico State University College Ranch Northwest Well
11. Geronimo Springs, Truth or Consequences
12. Elephant Butte Reservoir, Truth or Consequences
13. Clyde Simpson Feedlot, Las Cruces
14. Morrow and Mundy Feedlot, Hatch
15. Price Black Dairy, Arrey
16. Wholesome Dairy, Anthony
17. Alamogordo Municipal
18. Tularosa Municipal
19. New Mexico State University Fort Stanton Ranch Mesa Well
20. New Mexico State University Fort Stanton Ranch Bonita Well
21. New Mexico State University Fort Stanton Ranch Stock Tank
22. Porter Feedlot, Deming
23. Harvey Ranch, Site #2, Carrizozo
24. Harvey Ranch, Site #1, Carrizozo
25. New Mexico State University campus tap water, deionized
26. New Mexico State University campus tap water

APPENDIX

TABLE 2. LOCATION OF WATER SOURCES, TRIAL 2 (SAMPLED JANUARY 1 AND 2, 1971)

1. Bill Danley Well #2, Tularosa
2. Osie Danley, Tularosa
3. Porter Feedlot, Deming
4. New Mexico State University Experimental Station, Artesia
5. Elephant Butte Reservoir, Truth or Consequences
6. Albuquerque Municipal
7. George Fernandez Well 1, Springer
8. George Fernandez Well 2, Springer
9. Clovis Feedyards, Clovis
10. Carlsbad Municipal
11. Artesia Municipal
12. Clovis Municipal
13. Seven Rivers Cattle Company, Seven Rivers
14. Bogle and Bogle Feedyards, Clovis
15. Price Black Dairy, Arrey
16. Tracy Farms, Carlsbad
17. New Mexico State University College Ranch Stock Pond
18. Wholesome Dairy, Anthony
19. Simpson Feedlot, Las Cruces
20. New Mexico State University College Ranch Northwest Well
21. Roswell Municipal
22. Bill Danley Well #1, Tularosa
23. New Mexico State University campus
24. New Mexico State University campus, deionized

APPENDIX

TABLE 3. LOCATION OF WATER SOURCES, TRIAL 3 (SAMPLED SEPTEMBER 17 AND 18, 1971)

a	b	
15	1.	Porter Feedlot, Deming
9	2.	Silver City Municipal
19	3.	Elephant Butte Reservoir, Truth or Consequences
11	4.	Creek at Vanadium
20	5.	New Mexico State University, Deionized
14	6.	Les Bates Ranch, Carlsbad
13	7.	Brownfield Ranch, Las Cruces
12	8.	Lovington Municipal
10	9.	Hobbs Municipal
1	10.	New Mexico State University, Municipal
17	11.	Price Black Dairy, Arrey
18	12.	Geronimo Springs, Truth or Consequences
7	13.	Truth or Consequences Municipal
2	14.	Albuquerque Municipal
4	15.	Farmington Municipal
16	16.	Simpson Feedlot, Las Cruces
3	17.	Aztec Municipal
6	18.	Socorro Municipal
5	19.	Carrizozo Municipal
20	20.	Santa Fe Municipal

[a] Sample number used in Table 3 (page 44) for chemical analysis, Table 7 (page 48), Table 10 (page 51) and Table 33 (page 72).

[b] Sample number used in Table 19 (page 54), Table 20 (page 60), Table 28 (page 67) and Table 29 (page 68).

APPENDIX

TABLE 4. CATEGORY INDEX FOR WATER SOURCES

The category of a water source was dependent upon the water source.

D. Deep Ground Water (Source greater than 200 feet deep)

G. Shallow Ground Water

M. Municipal Water

S. Surface Water

P. Deionized

TABLE 5. MEANS, VARIANCE AND STANDARD DEVIATIONS FOR VARIABLES IN TRIALS 1, 2, AND 3. VARIABLES ARE: 1 = EC; 2 = TDS; 3 = CA; 4 = MG; 5 = SULFATE; 6 = CL; 7 = NA; 8 = K; 9 = PUPS WEANED; 10 = INITIAL WT., FEMALES; 11 = FINAL WT., FEMALES; 12 = INITIAL WT., MALES; 13 = FINAL WT., MALES; 14 = ivDMD, ALFALFA; 15 = ivDMD, CELLULOSE.

VAR.	MEAN	VARIANCE	ST.DEV.
1.000000000E0	1.377000000E3	1.152184400E6	1.073398530E3
2.000000000E0	1.028615380E3	8.514876061E5	9.227608600E2
3.000000000E0	1.255384600E2	1.975353846E4	1.405472800E2
4.000000000E0	6.061538000E1	5.637846150E3	7.508559000E1
5.000000000E0	3.904615400E2	1.623047385E5	4.028706200E2
6.000000000E0	1.247692300E2	7.652242462E4	2.766268700E2
7.000000000E0	9.211538000E1	1.026698615E4	1.013261400E2
8.000000000E0	7.484620000E0	1.202941500E2	1.096787000E1
9.000000000E0	5.838462000E1	3.924061500E2	1.980924000E1
1.000000000E1	1.402692000E1	4.282050000E0	2.069310000E0
1.100000000E1	2.668462000E1	2.507750000E0	1.583590000E0
1.200000000E1	1.480000000E1	7.211200000E0	2.685370000E0
1.300000000E1	3.150000000E1	4.443200000E0	2.107890000E0
1.400000000E1	6.401923000E1	4.044020000E0	2.010970000E0
1.500000000E1	8.286538000E1	1.370143500E2	1.170531000E1
1.000000000E0	2.004583330E3	3.598878080E6	1.897070920E3
2.000000000E0	1.569375000E3	2.907641984E6	1.705180920E3
3.000000000E0	2.110000000E2	4.867121739E4	2.206155400E2
4.000000000E0	8.200000000E1	9.801478260E3	9.900242000E1
5.000000000E0	5.136250000E2	2.584611141E5	5.083907100E2
6.000000000E0	1.552500000E2	8.408436957E4	2.899730500E2
7.000000000E0	1.209583300E2	1.902230254E4	1.379213600E2
8.000000000E0	7.475000000E0	6.074717000E1	7.794050000E0
9.000000000E0	1.272083300E2	3.753025400E2	1.937273000E1
1.000000000E1	1.470417000E1	2.717200000E¯1	5.212700000E¯1
1.100000000E1	2.960417000E1	8.134600000E¯1	9.019200000E¯1
1.200000000E1	1.817083000E1	2.247600000E¯1	4.740900000E¯1
1.300000000E1	2.965000000E1	1.626090000E0	1.275180000E0
1.400000000E1	5.990833000E1	1.076167000E1	3.280500000E0
1.500000000E1	2.904167000E1	5.857808000E2	2.420291000E1
1.000000000E0	1.514000000E3	5.176888421E6	2.275277660E3
2.000000000E0	2.331550000E3	5.306106194E7	7.284302430E3
3.000000000E0	1.337500000E2	1.273051316E4	1.128295800E2
4.000000000E0	1.110000000E2	1.263245263E5	3.554216200E2
5.000000000E0	2.418000000E2	1.341801684E5	3.663061100E2
6.000000000E0	1.284000000E2	7.652004211E4	2.766225600E2
7.000000000E0	9.440000000E1	3.525298947E4	1.877577900E2
8.000000000E0	8.660000000E0	2.302330500E2	1.517343000E1
9.000000000E0	3.170000000E1	4.365368400E2	2.089346000E1
1.000000000E1	1.456000000E1	4.141100000E¯1	6.435100000E¯1
1.100000000E1	2.304500000E1	4.131030000E0	2.032490000E0
1.200000000E1	1.867500000E1	1.607240000E0	1.267770000E0
1.300000000E1	2.652500000E1	5.790390000E0	2.406320000E0
1.400000000E1	0.000000000E0	0.000000000E0	0.000000000E0
1.500000000E1	0.000000000E0	0.000000000E0	0.000000000E0

TABLE 6. SIMPLE CORRELATION COEFFICIENTS, TRIALS 1, 2 AND 3. VARIABLES ARE: 1 = EC, 2 = TDS, 3 = CA, 4 = MG, 5 = SULFATE, 6 = CL, 7 = NA, 8 = K, 9 = PUPS WEANED, 10 = INITIAL WEIGHTS, FEMALES; 11 = FINAL WEIGHTS, FEMALES; 12 = INITIAL WEIGHTS, MALES; 13 = FINAL WEIGHTS, MALES; 14 = ivDMD, ALFALFA; AND 15 = ivDMD, CELLULOSE.

I	J	R(I,J)	J	R(I,J)	J	R(I,J)
1	2	0.93947	2	0.98238	2	0.92223
1	3	0.70971	3	0.96805	3	0.4545
1	4	0.61899	4	0.87194	4	0.30891
1	5	0.72011	5	0.91183	5	0.77481
1	6	0.7053	6	0.7979	6	0.34648
1	7	0.65111	7	0.90788	7	0.32863
1	8	0.60191	8	0.09394	8	0.40481
1	9	-0.14762	9	-0.15044	9	-0.17852
1	10	0.12819	10	-0.07564	10	-0.18505
1	11	0.22303	11	0.16521	11	0.0593
1	12	0.16589	12	-0.07526	12	0.21147
1	13	0.1004	13	-0.01992	13	0.18135
1	14	-0.13918	14	-0.77921	14	1
1	15	0.28877	15	0.52342	15	1
2	3	0.87487	3	0.9697	3	0.2374
2	4	0.80086	4	0.93708	4	0.99483
2	5	0.8709	5	0.92858	5	0.71888
2	6	0.4436	6	0.72168	6	0.00642
2	7	0.41716	7	0.89295	7	-0.01163
2	8	0.36066	8	0.0514	8	0.04044
2	9	-0.15426	9	-0.12933	9	-0.238
2	10	0.00287	10	-0.02225	10	-0.14465
2	11	0.20832	11	0.18373	11	0.08602
2	12	-0.01297	12	-0.07572	12	0.09316
2	13	0.15546	13	0.01031	13	0.22778
2	14	-0.12594	14	-0.80179	14	1
2	15	0.23853	15	0.53257	15	1
3	4	0.93303	4	0.8859	4	0.29017
3	5	0.8386	5	0.94379	5	0.77801
3	6	0.11848	6	0.77882	6	0.22413
3	7	-0.01472	7	0.81714	7	0.18995
3	8	0.00837	8	-0.06688	8	0.45782
3	9	-0.17474	9	-0.14945	9	-0.0694
3	10	-0.12254	10	-0.0014	10	-0.1473
3	11	0.05228	11	0.08306	11	-0.00142
3	12	-0.21532	12	-0.02124	12	0.1238
3	13	0.18396	13	0.00794	13	-0.10421
3	14	-0.17877	14	-0.79659	14	1
3	15	0.17773	15	0.57392	15	1
4	5	0.77885	5	0.86693	5	0.76655
4	6	-0.00108	6	0.51383	6	-0.05614
4	7	-0.09693	7	0.79955	7	-0.07436
4	8	-0.03425	8	-0.01445	8	0.00746
4	9	-0.11231	9	-0.03693	9	-0.2469
4	10	-0.12788	10	0.10076	10	-0.13379
4	11	0.05024	11	0.14398	11	0.09502
4	12	-0.274	12	-0.05919	12	0.08521
4	13	0.16142	13	-0.01584	13	0.21822
4	14	-0.15553	14	-0.82194	14	1
4	15	0.21597	15	0.5292	15	1
5	6	0.08251	6	0.61205	6	-0.02003
5	7	0.17344	7	0.77235	7	-0.03837
5	8	0.07488	8	-0.01592	8	0.19383
5	9	-0.11432	9	-0.24473	9	-0.17603
5	10	-0.07965	10	-0.02492	10	-0.11567
5	11	0.14415	11	0.16701	11	0.11762
5	12	-0.1998	12	0.04281	12	0.08374
5	13	0.20618	13	0.06804	13	0.01881
5	14	-0.23262	14	-0.79333	14	1
5	15	0.25175	15	0.64752	15	1
6	7	0.77787	7	0.68034	7	0.98609
6	8	0.84986	8	-0.06635	8	0.92866
6	9	-0.07691	9	0.02068	9	0.09876
6	10	0.28539	10	-0.16028	10	-0.13369
6	11	0.16578	11	-0.05613	11	-0.07849
6	12	0.40807	12	-0.18913	12	0.36094
6	13	-0.12233	13	0.06547	13	0.02957
6	14	-0.00162	14	-0.56827	14	1
6	15	0.11269	15	0.32862	15	1
7	8	0.77725	8	0.15625	8	0.93398
7	9	-0.02172	9	0.01642	9	0.11655
7	10	0.37592	10	-0.07668	10	-0.14047
7	11	0.25221	11	0.25117	11	-0.07563
7	12	0.46544	12	-0.16146	12	0.33918
7	13	-0.00159	13	-0.02196	13	-0.00546
7	14	0.00888	14	-0.75661	14	1
7	15	0.26251	15	0.44131	15	1
8	9	0.06693	9	-0.32682	9	-0.00192
8	10	0.38159	10	-0.08955	10	-0.17934
8	11	0.16189	11	0.15068	11	-0.08745
8	12	0.41425	12	-0.12881	12	0.37522
8	13	-0.1545	13	-0.12472	13	-0.02897
8	14	0.15309	14	0.23607	14	1
8	15	0.01163	15	-0.17171	15	1
9	10	0.30624	10	-0.17661	10	0.21553
9	11	0.15882	11	0.07012	11	0.14881
9	12	0.2304	12	-0.23884	12	0.15608
9	13	-0.02069	13	0.09759	13	-0.09657
9	14	-0.04136	14	-0.09375	14	1
9	15	-0.22472	15	-0.26096	15	1
10	11	0.60631	11	-0.26915	11	0.73101
10	12	0.77144	12	0.09728	12	0.12709
10	13	0.2985	13	-0.47062	13	0.68624
10	14	-0.05136	14	-0.04909	14	1
10	15	-0.01497	15	-0.00139	15	1
11	12	0.52392	12	-0.01496	12	0.14201
11	13	0.36501	13	0.11209	13	0.7284
11	14	-0.06509	14	-0.07848	14	1
11	15	-0.24519	15	0.15873	15	1
12	13	0.43318	13	0.10896	13	0.35631
12	14	0.08614	14	-0.00906	14	1
12	15	0.07653	15	0.17062	15	1
13	14	-0.22166	14	-0.0238	14	1
13	15	0.12378	15	0.30591	15	1
14	15	-0.02685	15	-0.56836	15	1