CHEMICAL AND MINERALOGICAL PROPERTIES OF HIGHLY EROSIVE SOILS ON INSTRUMENTED WATERSHEDS

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CHEMICAL AND MINERALOGICAL PROPERTIES

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INSTRUMENTED WATERSHEDS

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CHAPTER I

INTRODUCTION

For nearly 40 years, federal, state, and local governments, and individuals have been working cooperatively to reduce soil erosion on agricultural and other lands. The program has been successful in protecting millions of acres from accelerated erosion. However, much remains to be done, since sediment is still the largest single pollutant of streams and lakes in the United States. The term sediment here is restricted to the material moved by natural and man-accelerated processes of erosion of soils and geologic material.

Presently, watershed sediment models are needed to develop sediment routing procedures, improve sediment-yield prediction for reservior design, and assess the impact of watershed cultural practices and other changes, including urbanization. The development of such models depends upon an adequate quantity of sediment yield data from various land uses, soil types and areas of different rainfall characteristics. The sediment yield characteristics described herein are to aid in the development of sediment-yield prediction models.

The location of instrumented watershed areas at the

Woodward Experiment Station (USDA) is a unique opportunity to study some of the soil properties related to water runoff, soil removal, and change in chemical and physical characteristics of soil. Therefore it would appear that the study of these soils may be of value for relating runoff, siltation, and nutrient element contents on the productivity of the soil.

CHAPTER II

REVIEW OF LITERATURE

Nutrient element losses in runoff from agricultural lands have received much attention in recent years. From the water quality viewpoint, nutrient concentration and form as well as total quantity lost from diffuse, nonpoint sources are important concerns both for agricultural management and subsequent water users. Viets (1971) studied the quality of water in relation to farm use of fertilizer and concluded that there is no positive evidence for water quality deterioration associated with increased fertilizer use. He therefore rejected the fertilizer restrictions imposed on farmers.

Parr and Bertrand (1960) emphasized the influence of mulches on increased rates of infiltration and decreased rate of runoff, since increased infiltration effectively controls the quantity of N and P lost in surface runoff. Stanford et al. (1970) reported that eutrophication of streams and lakes is often enhanced by nutrient discharges from urban, industrial, and agricultural activities. However, the contribution of runoff from agricultural lands to the P enrichment of surface water has not been well established. Holt et al. (1970) studied the accumulation of phosphate in natural waters and they found low concentrations of dissolved P in runoff water from soils having deep incorporation of fertilizers. They also reported that leaching from forage crop residue resulted in considerable P loss and that more than 70% is in the form of inorganic P, which may be sorbed by sediments. Similar results were obtained by Romken et al. (1973) in relating minimum tillage practices to the N and P composition of runoff. They reported losses of soluble nutrients for two successive simulated rainstorms where tillage treatments were in the order of coulter > till > chisel > double disk > conventional, whereas sediment N and P losses were greatest from conventional tillage system.

A recent study by Ketcheson and Onderdonk (1973) has shown that losses of P fertilizers can be quite large. They broadcast ^{32}P tagged fertilizer on plots with 7% slopes and observed losses of up to 4.7% for one simulated rainfall event and up to 6.8% for a naturally occurring rainfall event. In another study Romkens and Nelson, (1974) reported average soluble orthophosphate concentrations in runoff were proportional to phosphate fertilizer addition rates.

Nutrient and sediment discharges from farm land reduces soil fertility. The receiving streams, ponds, and lakes are enriched with nutrients and with sediments. The degree to which we should control such discharges is now being debated as researchers seek to maintain and improve water quality. Burwell et al. (1975) reported that most of the annual losses of N, P, and K measured in surface runoff from corn cropped plots were associated with sediment losses which occurred during the critical erosion period from corn planting time until two months later. They reported that limited soil cover during this period was a major factor contributing to high seasonal losses of sediment nutrients. They also reported that losses of soluble N, P, and K in runoff water were much less than losses of these nutrients transported by sediment. Other researchers (Harm et al., 1974; Sharpley et al., 1979) reported that due to sorption of P by soil the major proportion of P loading of runoff is sediment bound.

Menzel et al. (1978) studied the variability of annual nutrient and sediment discharges in runoff from Oklahoma cropland and rangeland, and concluded that although nutrient concentration in runoff varies greatly, average annual nutrient concentration seems to be reasonably predictable if runoff volume, sediment discharge, soil characteristics, and fertilization history are considered. Olness et al. (1980) studied fertilizer nutrient losses from rangeland watersheds in central Oklahoma. They monitored four native grassland watersheds for N and P nutrient losses in surface runoff. The watersheds were paired in surface hydrology and grazing management. They fertilized one watershed of each pair with N and P by surface broadcast. Twenty m^2 of each watershed were covered with plastic sheets during fertilization to provide unfertilized check plots. They concluded that fertilization has both positive and negative effects on grassland surface runoff quality. Their reasoning was that initial fertilization increased surface runoff nutrient concentrations, but, over longer time periods it may increase plot cover and decrease runoff volume and soil erosion.

The concentration and amounts of various nutrients in runoff from agricultural areas result from the interaction of many factors. Timmons et al. (1970) reported that these factors include type of crop, cultural and conservation practices, length and steepness of slope, amount and distribution of precipitation, water infiltration and percolation characteristics of the soil, and size of watersheds. They studied the leaching of crop and crop residues as a source of nutrients by surface runoff and concluded that only a fraction of the added N and P is likely to be lost in the surface runoff as a result of leaching of plants or plant residues. They also reported that soluble N and P in leachates from alfalfa (Medicago sativa L.) and bluegrass (Poa pratensis L.) were greatly increased by drying or freezing, two processes which occur naturally in the field.

As soil erosion is a selective process with respect to particle size, selectivity has been observed for P loss in runoff with the result that eroded soil is usually richer in P than the surface soil from which the eroded soil comes.

This has led to the determination of enrichment ratios (ER) for P, calculated as the ratio of the concentration of P in the sediment (eroded soil) to that in the source soil. Enrichment ratio values of 1.3 for total P and 3.3 for 0.002 N H_2SO_4 "extractable" P for a silt loam situated on a 20-25% slope were observed by Rogers (1941). Massey and Jackson (1952) observed ER values between 1.9 and 2.2 for water soluble plus pH 3 extractable P for silt loams in Wisconsin. They also observed that a marked increase in ER can occur with a decrease in the runoff sediment concentration. Massey and Jackson (1952) have reported a negative linear relationship between the logarithms of ER and sediment concentration.

Baker et al. (1975) measured nitrate, P, and sulfate in subsurface drainage water, and reported that annual losses of P, SO_4-S, and NO_3-N were highly variable ranging from 0 to 0.04, 0 to 32, and 0 to 93 kg/ha, respectively, and the elemental loss was very dependent upon the amount of water lost. They concluded that because of low concentrations of P, losses with subsurface drainage water were insignificant compared with losses associated with surface runoff. For SO_4-S and NO_3-N concentrations they concluded that they were inversely related, and tile drainage water with consistently high NO_3-N content relative to surface runoff was responsible for high NO_3-N content in a river draining central Iowa.

Jackson et al. (1973), Benoit (1973), and Hanway and Laflen (1974) concluded that the annual P losses with subsurface drainage were negligible because concentrations were very low. Their reasoning was that because subsoils through which tile drainage water must pass generally are low in P and the clay minerals extract much of the P leached from the surface. They have also reported that NO_3-N content of surface drainage from fertilized row-cropped land (averaging from 0.3 to 5 ppm) is generally less than that in subsurface drainage (9 to 13 ppm). Hanway and Laflen (1974) found an average of 65 ppb in surface drainage relative to 11 ppb in subsurface drainage.

Nitrogen in plant and animal residues and various forms of N fertilizers applied to soil are ultimately changed to the nitrate form of N by natural soil processes in well-drained, aerated soils. Nitrate is highly soluble and when applied as fertilizer, will move readily in the soil. Moe et al. (1967) reported that N losses from fallow and sod plots established on a fragipan soil having a 13% slope ranged from 2 to 15% of the 224 kg/ha applied ammonium nitrate after 12.7 cm of rainfall (simulated rainfall) was applied. In a similar study, Moe et al. (1968) reported that N losses from ammonium nitrate and urea treated plots (448 kg/ha) ranged from 2.4 to 12.7% with ammonium nitrate less susceptible to runoff loss than urea. White et al. (1967) found only 0.15 to 2.3% of broadcast N (applied at the rate of 224 kg/ha as NH_4NO_3) in surface runoff from sandy loam soils with a 5% slope.

Nitrate losses by leaching depends on soil type, management practices, rainfall, and other climatic conditions. Johnston et al. (1065) reported significant levels of of NO_3-N in drainage waters from N fertilized fields.

Studies of rainfall characteristics and the resulting runoff and soil loss from agricultural lands have led to the formulation of empirical relations describing the average soil loss to be expected from a given soil, slope, crop, and management practice. Wischmeier (1959) has shown that from 70 to 95% of the variation in annual soil loss from similar soil, slope, and cover conditions at a given location may be explained by rainstorm characteristics. The empirical soil loss prediction equation (Wischmeier et al., 1958; Wischmeier, 1959) shows that average annual soil loss is dependent on six factors: rainfall, soil erodibility, length of slope, degree of slope, cropping and management treatments, and conservation practices used on the land.

Even with the large amount of data now available, several factors in this equation require refinement. Further study is necessitated in part by variation in rainfall patterns between locations as well as from year to year. The rainulator (Meyer et al., 1958; Rogers et al., 1961) is an effective tool for runoff and erosion investigations because it can be used to produce prescribed storm conditions on different soils, slopes, and management practices.

Wischmeier and Smith (1960) developed the universal soil loss equation for predicting field soil loss as a guide to conservation farm planning, but later Beer et al. (1966), Spraberry et al. (1969), and Williams et al. (1972) reported that the universal soil loss equation can be used to predict sediment yield from watersheds when a delivery ratio is applied. Delivery ratio is the sediment yield at any point along a channel divided by the erosion source above that point. Williams (1975) reported that delivery ratio is not necessary if the rainfall energy factor of the universal equation is replaced by a runoff rate factor. He contended that watershed characteristics such as drainage and stream slope, and watershed shape influence runoff rate and delivery ratio in a similar manner. Wischmeier and Smith (1965) beleive the primary purpose of the soil loss prediction procedure is to provide specific and reliable guides to help select adequate soil and water conservation practices for farm fields. They also recommend that where agricultural lands are a major sediment source, the procedure may be used to compute this phase of sediment production in predicting sediment yield. Williams et al. (1972) reported that the universal soil loss equation has been used very little for predicting sediment yield and they concluded that the application of the universal equation to sediment yield computation is relatively undeveloped.

ratio.

Erosion, transport, deposition, and scour are extremely complicated processes that are not fully understood. Wolman (1977) set sediment yield prediction in the proper technical perspective with respect to difficulty with the following statement:

> Information on the processes of erosion and sedimentation, while sometimes sufficient for gross estimates of yield, remains inadequate for modern environmental management. Little is known about sequential processes involved in the systems of erosion and sedimentations, and practice and theory require attention to unsteady or discontinuous erosion and transportation, as sediments move from source through channel systems with intermittent periods of storage. While climatic and hydrologic variations markedly affect yield, transport, and deposition, thresholds of erosion of cohesive materials and sequences of such effects remain unclear. Impact assessment requires understanding of the highly variable temporal and spatial character of sediment behavior, which is often correlative with pollutant behavior (p. 50).

In brief, Wolman concluded that more information is needed, to know in detail, about sequential microprocesses involved in erosion and sedimentation.

Many examples of erosion and sediment yield can be given. For instance, Trimble (1975) analyzed 10 river basins in the Southern Piedmont of the U. S. with the following observations: 1. gross erosion for the area is 95 mm/100 years, 2 sediment yield to the ocean is 4.5 mm/100 years which results in a sediment delivery ratio of 4.7%. Holman (1968) estimated that in the United States 0.9 billion metric tons of sediment reach the ocean annually.

Gburek et al. (1974) studied the soluble phosphate output of an agricultural watershed in Pennsylvania. They integrated the phosphate concentration with stream flow and concluded that less than 2% of the P applied to the watershed as fertilizer is carried out of the watershed by the stream in soluble form, and they also reported that most of this output is associated with high flows and low concentrations in early spring. Kunishi et al. (1972) studied the phosphate movement from an agricultural watershed during two rainfall periods and concluded that as the suspended material is moved and mixed downstream, phosphate is sorbed from solution. They observed that the amount of available phosphate per unit weight of suspended material carried by the stream was much lower than that of the topsoil.

A 4-year study of the amount of nutrients carried by streams draining farmland in central Ohio, was made by Taylor et al. (1971) who found that essentially all of the phosphate removal occurred during the periods of highest water flow, usually in the late winter and early spring. They reported that N in precipitation averaged 20.3 kg/ha annually for a 2-year period and was one-sixth the average annual N in runoff. Timmons et al. (1968) found N losses in runoff as high as 14.5 kg/ha per year from corn-cropped plots. These losses were affected greatly by the management practices used. They noted that total N loss was much greater from nonfertilized, cultivated fallow and normally fertilized, continuous corn than from land in a 3-year rotation receiving normal annual fertilization. Their results showed that the sediment in the runoff contained most of the N lost. They also showed that leaching of forage crop residues resulted in considerable P loss and that more than 70% was in the form of inorganic P which may be sorbed by sediments.

Since P is relatively immobile in soil, P is lost from agricultural lands primarily sorbed to soil particles transported by runoff. Spomer et al. (1971) reported that soil loss by sheet and rill erosion from a contour-farmed watershed near Treynor, Iowa for one storm in June, 1967 was 101 metric ton/ha. Santon et al. (1971) reported that 6-year annual average soil loss for two contour-farmed watersheds had been 68 and 56 metric tons/ha. Results of investigations conducted by other researchers on the P content of runoff water and sediments are variable and most of them are reported for small plot experiments. Scarseth et al. (1938) reported that plots receiving 345 kg of P/ha over a period of 26 years lost 60% of the added P by erosion.

Thomas et al. (1974) measured nitrate-N and P content of eight streams draining agricultural watersheds in Kentucky from January through May (high rainfall months) in 1971 and 1972. The highest nitrate-N content of the streams for both years was from plots which had received little

N fertilizer. They also concluded that the P content of waters was directly related to the geological formations through which the streams ran. Timmons et al. (1973) found that incorporation of broadcast fertilizer by plowing down and disking resulted in N and P losses in surface runoff about equal to losses from unfertilized plots. Nutrient element losses in surface runoff have also been determined on a watershed basis. Taylor et al. (1971) found that N and P losses from farmland watersheds were significantly greater than those from a woodland watershed at Coschocton, Ohio.

Schuman et al. (1973) measured N losses in surface runoff for four agricultural watersheds near Treynor, Iowa. The 3-year average annual solution N losses were low from all watersheds and ranged from 0.42 to 3.05 kg/ha for the various conservation practices; whereas averaged annual sediment N ranged from 1.21 to 36.59 kg/ha. They also found that 92% of the total N lost in the runoff from contour-planted corn watersheds was associated with the sediment.

Schuman et al. in 1973 reported that level terraces greatly reduced P loss by reducing runoff and erosion. Their watershed study also showed that a reduction of inorganic P in the solution was caused by the sorption of P by additional suspended soil material entering the stream from gully erosion.

Burwell et al. (1974) compared N losses in surface runoff and base flow, from a level-terraced and contour-corn watershed near Treynor, Iowa. They found the average annual N loss (for a 2-year period) from the contour-corn watershed was about six times greater than that from the level-terrace watershed.

In a 2-year period, Schuman and Burwell (1974) found that precipitation contributed an average of 7.26 kg/ha of inorganic N annually. This was four and seven times greater than the average annual surface runoff N from the high and normal fertility watersheds, respectively.

Stoltenberg and White (1953) observed an increase in the proportion of clay-sized material in runoff from surface soil, and that as the rate of runoff decreased from 7 to 0.25 mm/hour, the clay content of eroded material from a soil with a clay content of 16-18% increased from 25 to 60%. They also reported that at least three processes were responsible for higher concentration of nutrient elements in the eroded material than in the surface soil:

> 1 - Selective removal of fines of higher nutrient composition. Due to the greater capacity of runoff for bringing into suspension and transporting the smaller particles, selective removal of fine particles will result if the energy of the runoff is not sufficient to bring the larger particles into suspension. Any decrease in transporting capacity, as caused by a decrease in rate of flow or hydraulic gradient, will result in a further selection of fine particles due to deposition of coarser material.
>
> 2 - Diffusion of soluble forms of nutrients, especially nitrogen and potassium from the soil into runoff water.
>
> 3 - Flotation of low density material, especially organic matter (p. 408).

CHAPTER III

EXPERIMENTAL PROCEDURE

Characteristics of Watersheds

Characteristics of watersheds used in the present study are shown in Table I. The surface and subsurface soil samples were collected from four watersheds which are highly erosive and are located at Southern Great Plains Experiment Station USDA at Woodward, Oklahoma. The major soil types are Woodward loam (coarse-silty, mixed, thermic, typic Argiborolls). These watersheds were in grass and are separated by berms and natural boundaries. The native grass watershed, W-2, is the only watershed with an actively eroding gully.

Runoff from the watersheds is measured with precalibrated flumes equipped with FW-1 water stage recorders. An automatic pumping sampler is installed to collect runoff samples during each runoff event. The runoff samples are composited in proportion to flow to provide a single representative sample of liquid and sediment for chemical analysis for each runoff event and watershed. All samples are refrigerated at 0 to 4 C until analyzed.

The runoff data were collected and analyzed by the USDA

Water Quality Experiment Station at Durant, Oklahoma for study and their data was collected and correlated with data obtained in the Oklahoma State University Soil Chemistry Laboratory and reported in this study.

TABLE I

SUMMARY OF WATERSHED CHARACTERISTICS AT WOODWARD FOR 1977-1980

Watershed	Crop Type	Area (ha)	Slope Percent	Fertilizer Applied (total)
W-1	Native grass	4.8	6	control
W-2	Native grass	5.6	6	9 **
W-3	Native grass* and wheat	2.7	6	60 ***
W-4	Native grass* and wheat	2.9	6	60 ***

*Began cropping with wheat in September, 1978.
**P fertilizer broadcast March, 1980.
***P fertilizer broadcast at a rate of 20 kg/ha elemental P in September of each year, then watershed is disked to incorporate the P.

Climate

Precipitation at Woodward, Oklahoma averages 16 inches in the summer, 6 inches in winter, and 22 inches annually with yearly averages varying from 10 inches to 41 inches. May and June are the months of high rainfall. Temperatures at Woodward are highly variable ranging from -27 F to 114 F. In summary, the climate is harsh, hazardous and highly variable.

Laboratory Procedure

The soil samples were stored in plastic bags and upon arrival at the laboratory they were transferred to paper bags and oven-dried. The samples were then ground in a motor driven mortar and pestle grinding apparatus. The ground soil samples were passed through a 20-mesh sieve and placed into labeled paper cartons for storage purposes. Texture analysis (Bouyoucous, 1926; Day, 1956) was made by the hydrometer method. Fifty grams of oven-dried soil were placed in 250 ml centrifuge bottles with 150 ml deionized water and the pH of the soil was brought to 9.0 by adding 2% $NaHCO_3$ + Na_2CO_3 solution and allowing the samples to soak for several hours (Jackson et al., 1950). To ensure a complete dispersion of soil particles, pH was checked again and additional 2% $NaHCO_3$ + Na_2CO_3 was added to those samples with a pH below 9. The dispersed samples were then transfered to 1000 ml sedimentation cylinders and deionized water was added to bring the soil suspension to the 1000 ml volume. The dispersed soils were vigorously agitated and hydrometer readings made after 40 seconds and at one hour thereafter. The resulting particle-size analysis data were used for textural classification of the soils.

Peech et al. (1947), used a soil-to-water ratio of 1:1 for measuring soil pH. Puri et al. (1938) measured the pH a soil paste containing 1N KCl. Both methods of measuring the soil pH were used in their study. Therefore, 20 gram samples of oven-dried soil and 20 ml of deionized water were mixed and allowed to stand overnight to reach equilibrium. The pH of the soil-water suspensions was measured on a Corning Model 7 pH meter. After the soil-water pH was determined, 20 ml of 1N KCl was added. After several hours equilibrium period, the pH was determined again.

A modification of the Schollenberger (1931) procedure for determining organic matter by the wet combustion method was used. In this method, an oven-dried soil sample was passed through 60-mesh sieve, one-half gram soil was mixed with potassium dichromate-sulfuric acid solution and slowly heated to 160-170 C. Then 100 ml of water added to the cooled mixture and titrated with standard ferrous ammonium sulfate.

The ammonium acetate method recommended by Schollenberger and Simon (1945), and Richard (1954) was used for determining the exchangeable cations in the soil. The determination of exchangeable cations involved the use of 20 grams of soil which was washed with distilled water to eliminate soluble salts, then placed into 250 ml Erlenmeyer flasks with 50 ml neutral 1N ammonium acetate. The soil solution was shaken initially and then allowed to stand overnight before being vacuum filtered through Whatman No. 2 filter paper. Three additional 50 ml portions of ammonium acetate for a total of 200 ml was added and when the entire 200 ml of ammonium acetate solution was leached through the soil sample, the leachates were analyzed on a Perkin Elmer Model 272 Atomic Absorption Spectrophotometer for exchangeable cations. For measuring exchangeable calcium and exchangeable magnesium by atomic absorption 5% $LaCl_3$ (1:5) was added to the ammonium acetate extract to eliminate spectral interference s.

Reed (1980) recommended the following method for determination of cation exchange capacity of soils. According to this method 20 gram samples of oven-dried soil were placed in 200 ml Erlenmeyer flasks with 50 ml 1N $CaCl_2$. The soil-salt mixture was shaken initially and allowed to stand for four hours. The mixture was then filtered through Whatman No. 42 filter paper. Three additional leachings of 50 ml of 1N $CaCl_2$ were followed by three 50 ml washes of deionized water. Finally the soil was leached with three 50 ml 1N $NaNo_3$ and this final leachate was retained for Ca and chloride determinations. The Ca was determined by the EDTA titration method and the chloride was determined by the Mohr titration method. Reed (1980) recommended that cation exchange capacity of soil be calculated as milliequivalents of Ca/100 grams minus milliequivalents of chloride/100 grams in the $NaNO_3$ leachate.

The USDA Salinity Laboratory staff (1954) have developed a procedure for determination of electrical conductivity (EC) and soluble salts in soil. According to this method, 100 ml of distilled water was added to 100 grams of soil and allowed to stand overnight before being vacuum filtering through Whatman (5.5 cm) No. 42 filter paper. The filtrate was then analyzed on a Perkin-Elmer Model 272 Atomic Absorption Spectrophotometer for determination of soluble cations. To eliminate spectral interference 5% $LaCl_3$ (1:5) was added to the filtrate before determination of soluble calcium and magnesium.

Jackson (1956), Kittrick and Hope (1963), and Rich and Barnhisel (1977) have developed procedures for the examination of soil clays by the x-ray diffraction technique. The soil samples used for mechanical analysis were saved and used for this purpose. The separation of clay from the soil involved a 2% sodium carbonate-sodium bicarbonate pretreatment and numerous cycles of sedimentation and siphoning. The siphoned suspensions were passed through a steam turbine supercentrifuge with the fine clay particles of less than 0.2 um collected in 20 liter bottles, while the coarse clay particles larger than 0.2 um collected on plastic sleeves inside the supercentrifuge rotor. Both the fine and coarse clay fractions were Ca saturated and coagulated with excess $CaCl_2$ and then washed with 50 ml portions of 1N $CaCl_2$ and deionized water, respectively. Aliquots of the Ca saturated clays were placed on ceramic tiles and glass slides mounted on a low heat hot plate. The Ca saturated clay slides were dried and x-ray diffraction readings were made. Another aliquot of the Ca saturated clay was treated with 10% ethylene glycol on porous unglazed ceramic tiles mounted in a suction device described by Rich and Barnhisel (1977) and diffraction data collected.

Aliquots of the fine and coarse clays were treated by centrifuging three times with 1N KCl and washing with deionized water to produce the P saturated clay. The glass slides were coated with P saturated clays and allowed to dry on a low heat hot plate before being x-rayed. One set of P saturated slides was heated for four hours at approximately 500 C for identifaction purposes. The heated slides were cooled slowly to prevent curvature and then x-rayed. The Ca saturated, ethylene glycol solvated, P saturated and P saturated heated slides were x-rayed on a General Electric XRD6 instrument with a Ni-filtered Cu radiation generated at 30 KVP and 20 ma. The diffractometer was operated from the lower limit of two degrees 2θ to the upper limit of 30 degrees 2θ.

Total P was determined by a modified perchloric acid method digestion of 2 grams of soil with 72% perchloric acid. Digestion was stopped when the residue turned white. The material was diluted and filtered to obtain a clear filtrate. Color was developed by reducing the molybdenum-phosphate complex with hydrazine sulfate. The intensity of blue color and thus concentration was measured with a Brinkmann Dipping Probe PC 800 Colorimeter.

Available P was determined according to Brays #1 method, and intensity of blue color and thus concentration was measured with a Brinkmann Dipping Probe PC 800 Colorimeter. Total cations were determined by the modified perchloric acid method from the solution obtained as described in the preceeding paragraph. The filtrate was analyzed for total cations on a Perkin-Elmer Model 272 Atomic Absorption Spectrophotometer.

Total N in the soil was determined with asulfuric acid digestion of 1 gram soil and a modified Micro-Kjeldahl procedure as described by Bremner (1965). The digested soil-reagent mixture was distilled and ammonia recovered in 5 ml of boric acid indicator solution. The distillate was then titrated with standardized 0.1013N HCl and the amount of nitrogen in the soil sample was calculated.

CHAPTER IV

RESULTS AND DISCUSSION

Sediment Yield Characteristics From Unit Source Watershed

The data used in this study were from a short period (1977-1981) and are insufficient for developing a dependable model. However, the data do show many interesting features of sediment yield. These include the relative sediment yield of good to excellent rangeland versus poor gullied rangelands, sheet and rill erosion from fair range and cultivated land versus gully erosion from poor rangeland.

Experimental Data and Results

Annual values of precipitation, runoff and sediment yield from the four native grassland watersheds are given in Table II, and Figures 1 and 2.

The 3-year average annual rainfall for the watersheds was 26.53 inches. The average annual runoff and sediment yield were 0.12 inch with 78.84 kg/ha from W-1 and 0.13 inches and 1588.64 kg/ha from W-2, respectively. The sediment yield is probably normal for W-1 with good-to-excellent native grass range characteristics of this

TABLE II

RAINFALL, RUNOFF AND SEDIMENT YIELD FROM RANGELAND WATERSHEDS SOUTHERN PLAINS EXPERIMENT STATION USDA WOODWARD, OKLAHOMA

Watershed	W-1[a]			W-2			W-3			W-4		
Hectare	4.8			5.6			2.7			2.9		
Condition	Good-to-Excellent			Poor			Fair			Fair		
	P[b] (in)	R[c] (in)	S[d] kg/ha	P (in)	R (in)	S kg/ha	P (in)	R (in)	S kg/ha	P (in)	R (in)	S kg/ha
1978	23.04	0.05	183.3	23.04	0.12	3037.1	23.04	0.09	77.3	23.04	0.16	574.3
1979	31.62	0.05	25.9	31.62	0.11	1601.4	31.62	0.22	1296.6	31.62	0.20	733.4
1980	25.05	0.27	29.3	25.05	0.17	127.41	25.05	0.16	20.12	25.05	0.12	20.4
Average	26.56	0.12	79.5	26.56	0.13	1588.64	26.56	0.15	464.67	26.56	0.16	442.7

[a]W = watershed.

[b]P = precipitation.

[c]R = runoff.

[d]S = sediment yield.

Average Soil Loss, 1978-1980

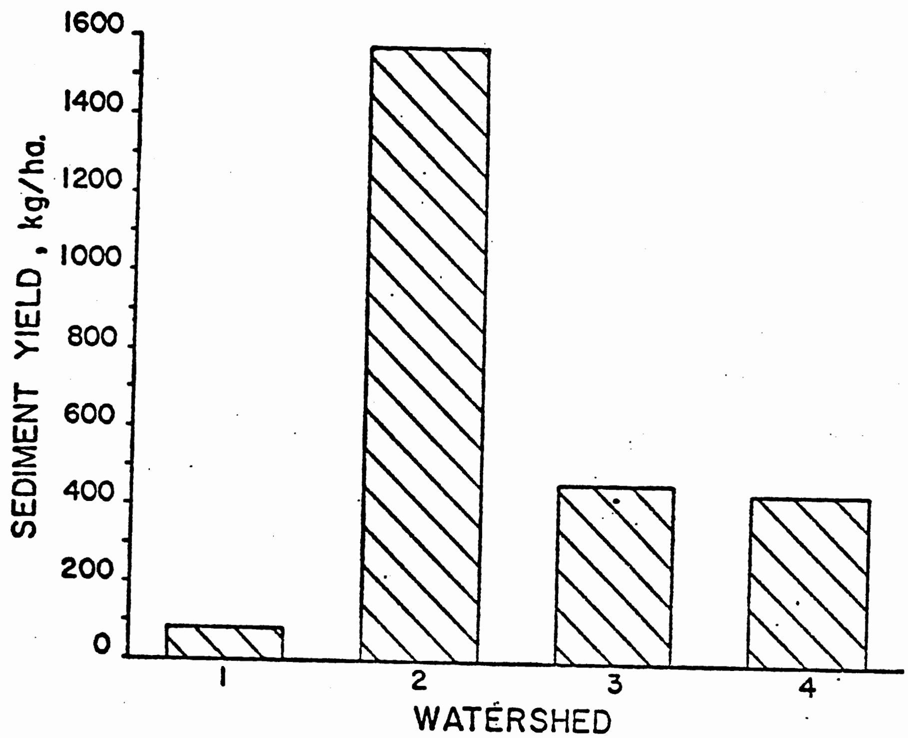

Figure 1. Average Soil Loss, 1978-1980, Southern Plains Exp. Sta. USDA Woodward, Oklahoma

Average Runoff, 1978-1980

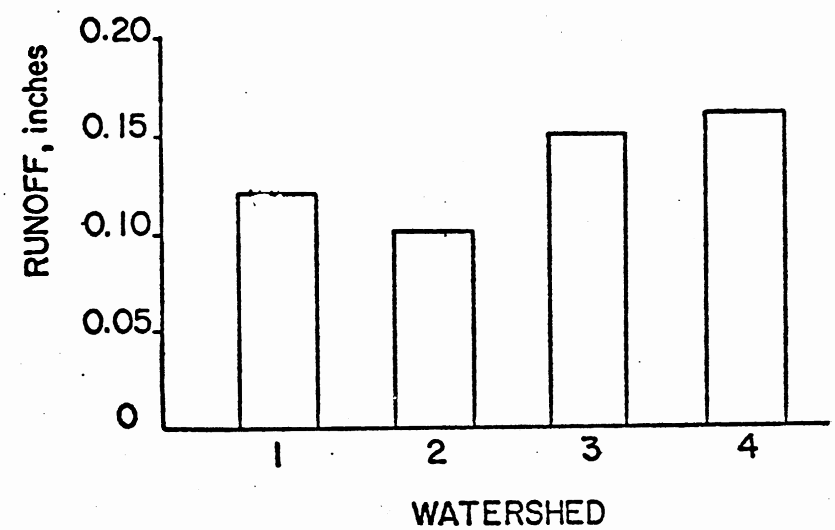

Figure 2. Average Runoff, 1978-1980, Southern Plains Exp. Sta. USDA Woodward, Oklahoma

locality where there are no bare areas or active gullies. This was a loss of 78.84/0.12 = 657 and 1588.64/0.13 = 12220 kg/ha-inch of runoff, respectively. The extensive gully system in watershed 2 is the probable cause for the only high sediment yield from watershed 2 area. Comparison of noneroded watershed 1 with eroded watershed 2 shows almost equal water runoff but 20 times as much sediment yield from the eroded area of W-2 than from noneroded watershed 1 (Figure 1). To determine the magnitude of gully erosion on the eroded watershed 2 an additional gauging site should be established to make it possible to separate out the amount of sediment produced in the nongullied portion of watershed 2.

The major portion of sediment movement from watershed 1 and watershed 2 occurs during the spring. For example, in the spring of 1978 three rainfall events caused 0.57 cm of runoff and 5.02 kg/ha of sediment yield from watershed 1. A larger rainfall event on March 18, 1979 caused only 0.05 cm of runoff but 5.60 kg/ha of sediment yield from watershed 1. Annual values of precipitation runoff and sediment yield from watershed 3 and 4 are given in Table II, and Figures 1 and 2.

Watershed 3 was in native grass and was tilled and cropped to wheat beginning in September, 1978. Fertilizer P was broadcast at a rate of 20 kg P/ha in September of 1978 and each year thereafter and the watershed was disked to incorporate the P.

In spite of high vegetative cover, average annual sediment yield from watershed 3 was six times greater than that of watershed 1 (Figure 1). This high value of sediment yield in watershed 3 can probably be attributed to disturbance of land for application of P-fertilizer and planting the wheat crop. Comparing sediment yield in watershed 3 with that of watershed 2, it can be concluded that erosion in watershed 2 is 3.42 times greater than that of watershed 3. This probably indicates that gully erosion plays a major role in producing high sediment yield in watersheds. This conclusion is also confirmed by study of average runoff in watershed 2 and watershed 3 which were 0.13 inches and 0.15 inches, respectively (Table II), but erosion was much greater from the gullied watershed.

A study of runoff data from watershed 4 (Table II) indicates the same trend as that of watershed 3 for comparison with runoff data in watershed 2. This is because of similarity of these two watersheds with regard to vegetative cover, slope and fertilizer treatment.

One of the interesting results of this work is the small difference which was found in sediment yield from watershed 3 compared to that of watershed 4 (Figure 1). It is likely that differences in soil profiles exert an important influence, particularly the depth of the surface soil and compactness of the subsoil. Nevertheless these results throw some doubt on the rather general belief that cultural practice is an important factor in erosion control.

High gradient of slope (6%) does not allow most of the sands and heavy silt fractions from steeper portions of the watershed to settle out before reaching the measuring station. Therefore sediment yield as herein defined include clay, sand and silt fractions. The sediment data collection described herein is to aid in the development of sediment yield prediction models. The development of such models depends upon an adequate quantity of sediment yield data from various land uses, soil types, and areas of different rainfall characteristics.

Factors Affecting Sediment Yield

Why does the sediment yield from watersheds vary? To answer this question it seems necessary to think in terms of the factors responsible for sediment yield. It is immediately apparent that sediment yield is not the result of any single factor but the resultant of numerous variables within the watershed. Multiple causal factors determine the amount of sediment leaving a watershed or drainage basin. It has already been emphasized that sediment is one of the products of erosion. So those factors which affect erosion in a watershed also affects the sediment yield of a watershed. Rates of runoff in a watershed are not numerically equal to rates of sediment yield from a watershed. This suggests that other factors in addition to erosion play an important part in determining rates of sediment yield.

Causal Factors

Some of the things which seem to have an influence upon sediment yields may be listed in outline form as follows:

A. Soil
   1. Parent material
   2. Texture
   3. Organic content
   4. Chemical constituents
   5. Structure

B. Cover
   1. Permanent vegetation
   2. Annual vegetation
   3. Fallow
   4. Crop residue

C. Precipitation
   1. Intensities
   2. Seasonal occurrence
   3. Amount
   4. Form

D. Channel Types
   1. Scope and size
   2. Slope
   3. Erodibility of bed and bank

E. Runoff

1. Amount

2. Rate

3. Duration

F. Conservation practices and watershed treatment measures. Kind and amount of conservation practices and watershed treatment measures, including tillage methods, terracing, waterways and channel stabilization.

G. Soil Management Practices. Kind and amount of soil cover management practices, including crop rotation, fertility amendments, grazing rate, fire protection etc.

The role of the causal factors, both singly and in various combinations must be understood in order to make well-founded interpretations of the variation in sediment yield of different watersheds. Once the cause and effect relationships are established for a particular soil and climate region, it should be possible to predict sediment yield on the basis of watershed characteristics within that region.

Relation of Erodibility to Soil Texture

Differences in soil erodibility are obvious to most farmers and were noted by scientists and others in the early years of the conservation movement. A close comparison for rate of sediment removal versus silt content of a surface and subsurface soil is shown in Figure 3. A study of Figure 3 indicates that there has been more sediment removed from watersheds 2, 3, and 4 as compared to watershed 1, but the intensity of sediment removal is highest in watershed 2. This, as indicated before, was due to gully erosion which caused the highest sediment yield in the area.

Data shown in Figure 3 also indicates disturbance of land, for fertilizer application in watersheds 3 and 4, caused a higher sediment yield compared to watershed 1 which was not disturbed. This is in spite of the fact they were densely covered with native grass before tillage in 1978. Study of Figures 4 and 5 indicates the same trend of sediment yield with regard to sand and clay content of soil in these watersheds.

In laboratory tests of different soil samples from different soil types, it was concluded that a soil type becomes less erodible with a decrease in silt fraction, regardless of whether the corresponding increase in the sand fraction or the clay fraction. However, the percentages of silt, clay and sand must be considered in relation to existing levels of other physical and chemical properties. Different studies have shown that when this is done, erodibility is often so sensitive to small changes in particle size distribution that conventional textural classifications are much too broad to serve as a reliable guide to the soil's capacity to resist erosion by rainfall.

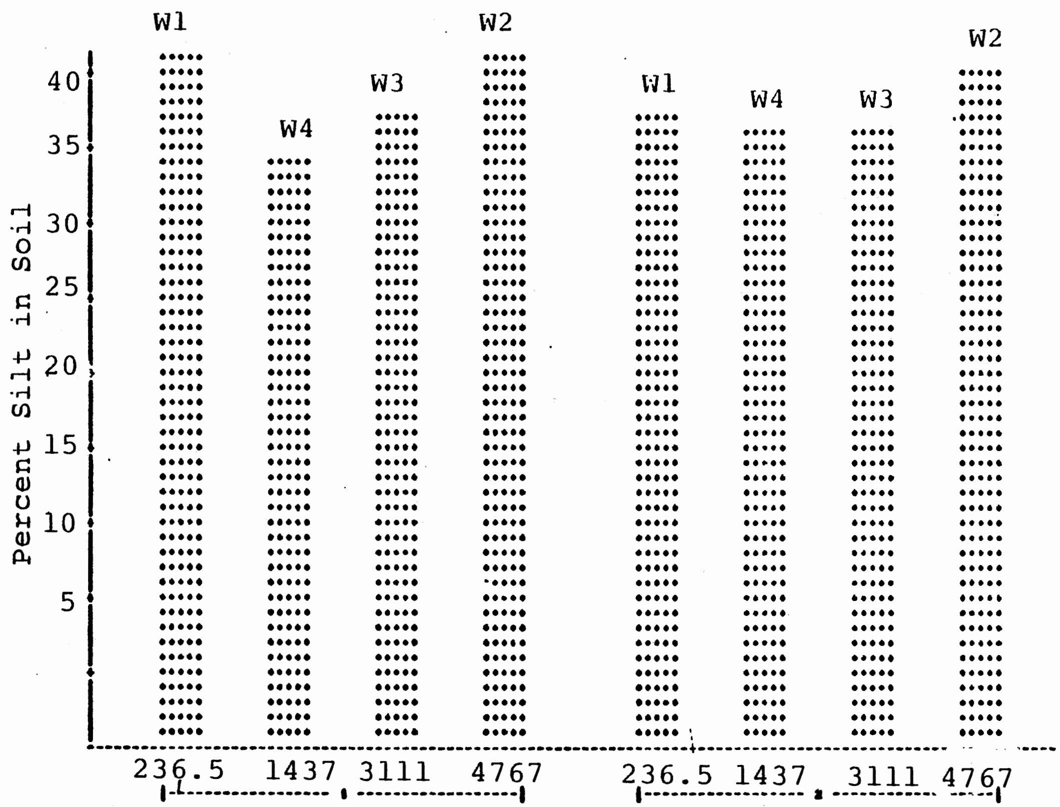

Figure 3. Effect of Percent Silt on Sediment Yield (kg/ha) in 1978-81, Southern Plains Exp. Sta. Woodward, Oklahoma

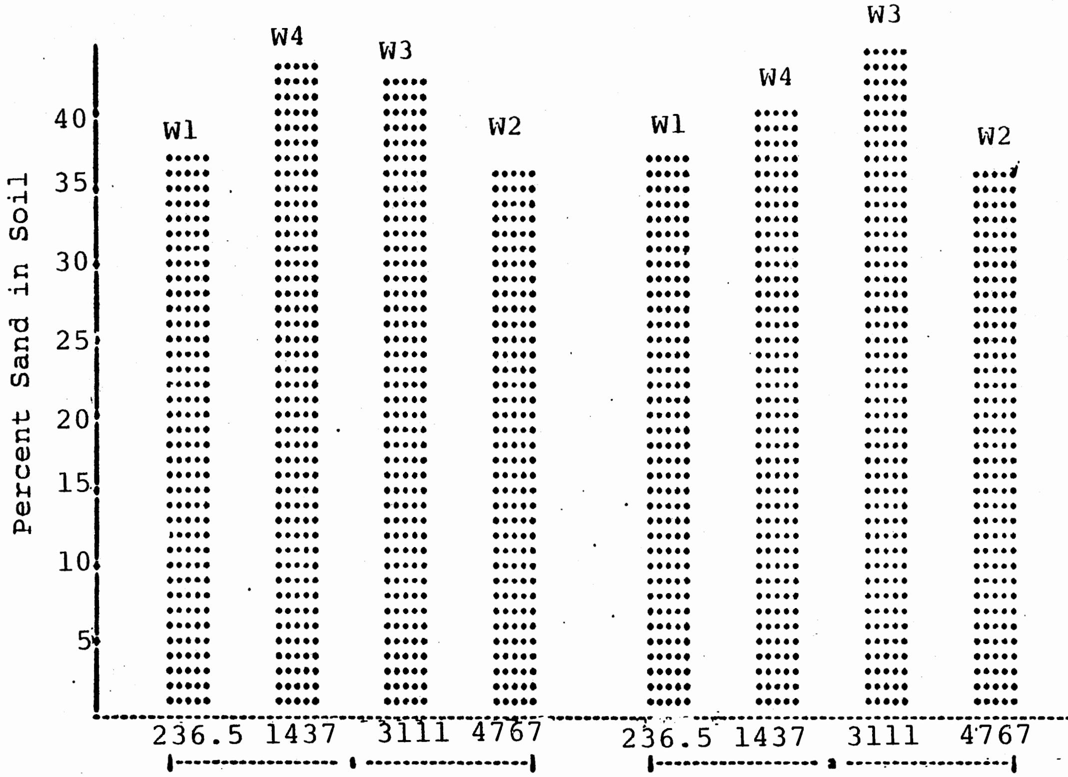

Figure 4. Effect of Percent Sand on Sediment Yield (kg/ha) in 1978-81, Southern Plains Exp. Sta. USDA Woodward, Oklahoma

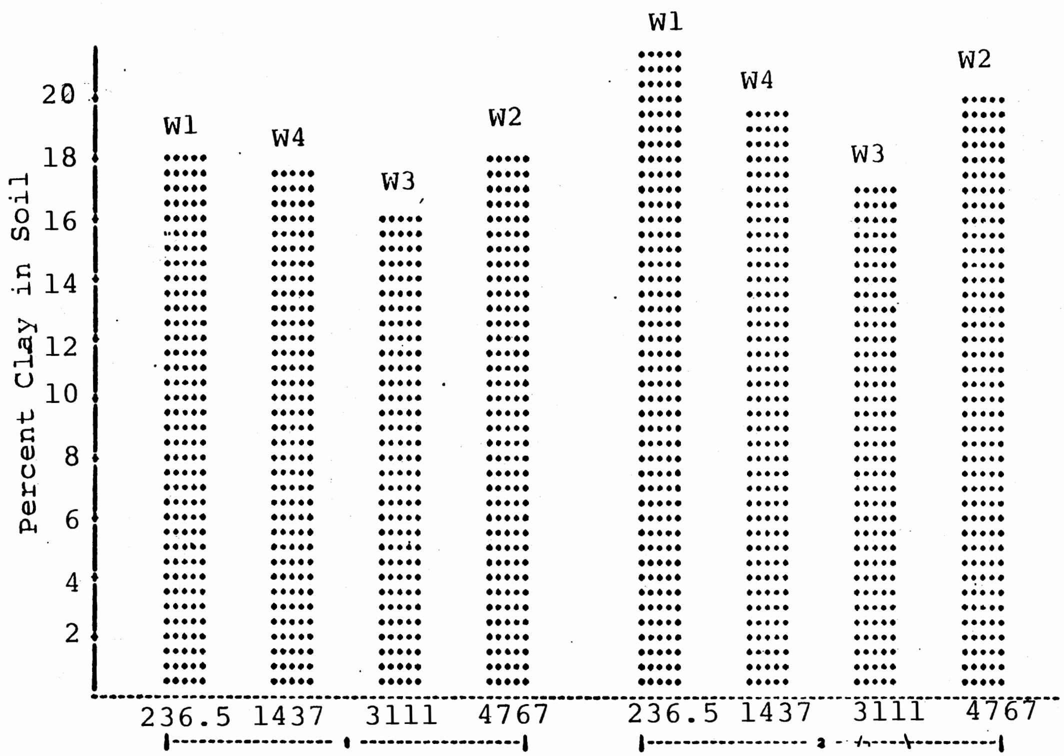

Figure 5. Effect of Percent Clay on Sediment Yield (kg/ha) in 1978-81, Southern Plains Exp. Sta. USDA Woodward, Oklahoma

The conclusion stated above has been reported by other researchers where their data was obtained are under laboratory conditions (Holeman, 1968). Their conclusions are not in agreement with results obtained here under natural conditions; most of which were out of our control. This might be the reason that sediment yield from watershed 1 is low in spite of high silt content of the soil, and sediment yield is highest in watershed 2 in spite of a high silt content.

A study of the data shown in Figure 6 indicates that the relation of soil pH to erodibility depends on silt content. For a high silt content, it appears that higher pH increases erodibility. This only applies for watersheds 3 and 4 in which there was a direct relationship between pH and sediment yield (Figure 7). For watershed 1 this did not prove to be true because in spite of the high silt content, it had the lowest sediment yield. This confirmed the same trend as shown in Figure 5 for watershed 2.

A review of the literature (Holeman, 1968) reveals that erodibility depends on soil structure and silt content and other researchers (Holeman, 1968) have concluded that for a high silt soil, increased pH is related to increased erodibility if the soil structure is fine granular. According to the Soil Survey report for Woodward County the structure of these soils is granular and possibly this fine granular structure might have been a factor in producing high sediment yields in watershed 3 and 4. Moreover the

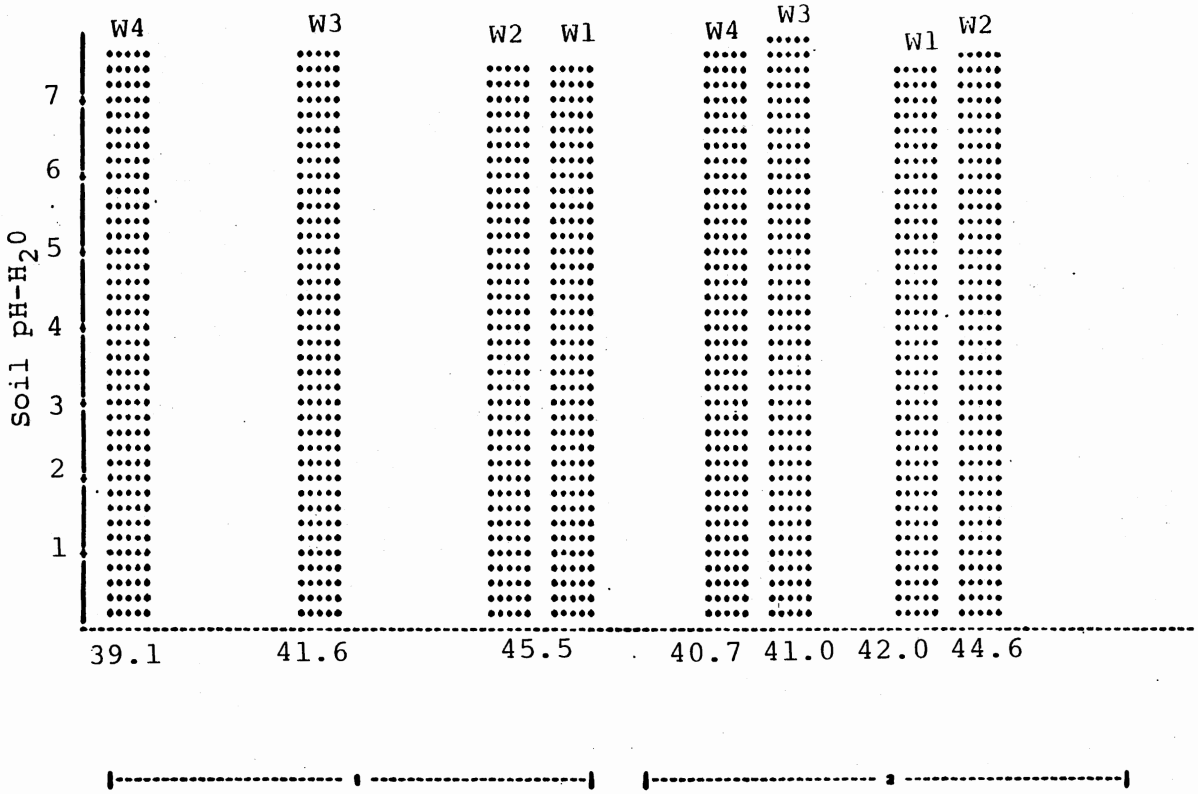

Figure 6. Effect of Silt Content of Soil on pH-H_2O, Southern Plains Exp. Sta. USDA, Woodward, Oklahoma

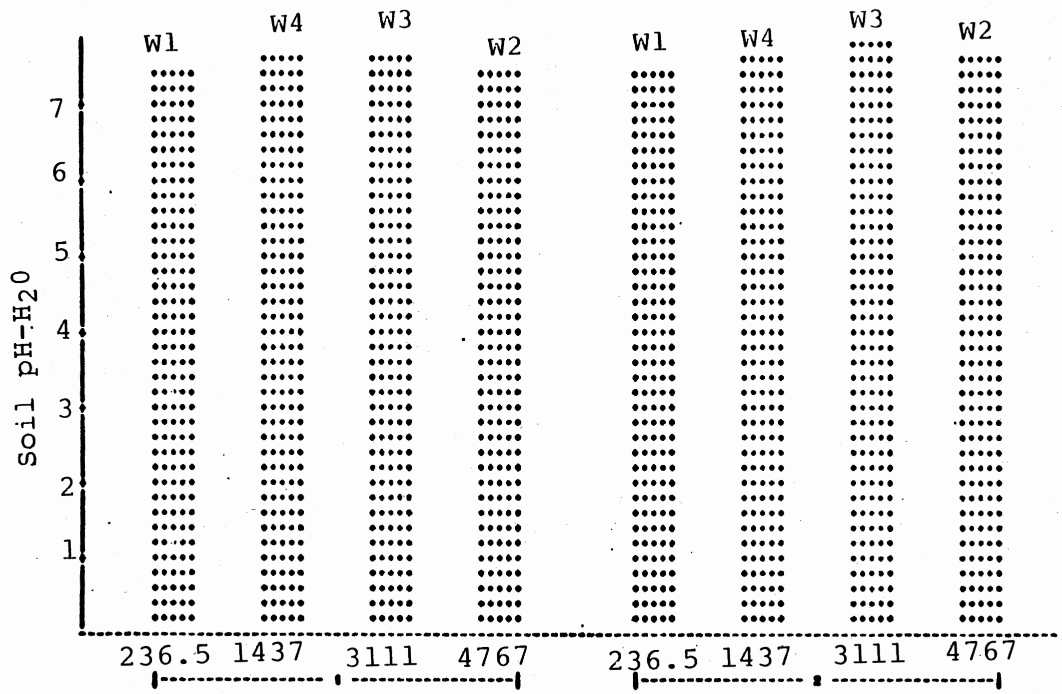

Figure 7. Effect of pH-$H_2$0 on Sediment Yield (kg/ha), Southern Plains Exp. Sta. USDA, Woodward, Oklahoma

disturbance of the soil for the purpose of P application might have enhanced this process also.

Overall, the soil organic matter content ranks next to particle size distribution as an indicator of erodibility. A study of the data shown in Figure 8 indicates that there is a strong inverse relation of erodibility between the soil organic matter content and the amount of runoff. This is true for watershed 3 and 4, but this inverse relation does not hold true for watershed 2 due to gully erosion. In spite of high soil organic matter content still higher amounts of runoff have occurred. The conclusions derived from the data shown in Figure 8 is confirmed by study of Figure 9. Here in Figure 9 the data shows that the same inverse relation holds true for watershed 1 compared to watersheds 3 and 4, but it is not true for watershed 4 compared to watersheds 2 and 3.

The gully erosion in watershed 2 might be one of the reasons for high sediment yield in spite of its higher organic matter content. The soil organic matter content of watershed 3 is higher than that of watershed 4, yet, there is a higher sediment yield in this watershed compared to watershed 4. The reason might be due to the presence of impervious layers in soil (no attempt was made to determine the presence of impermeable layers).

An analysis of the data shown in Figure 10 shows an important but very complex interrelation between soil organic matter and the clay content of the soil in all four

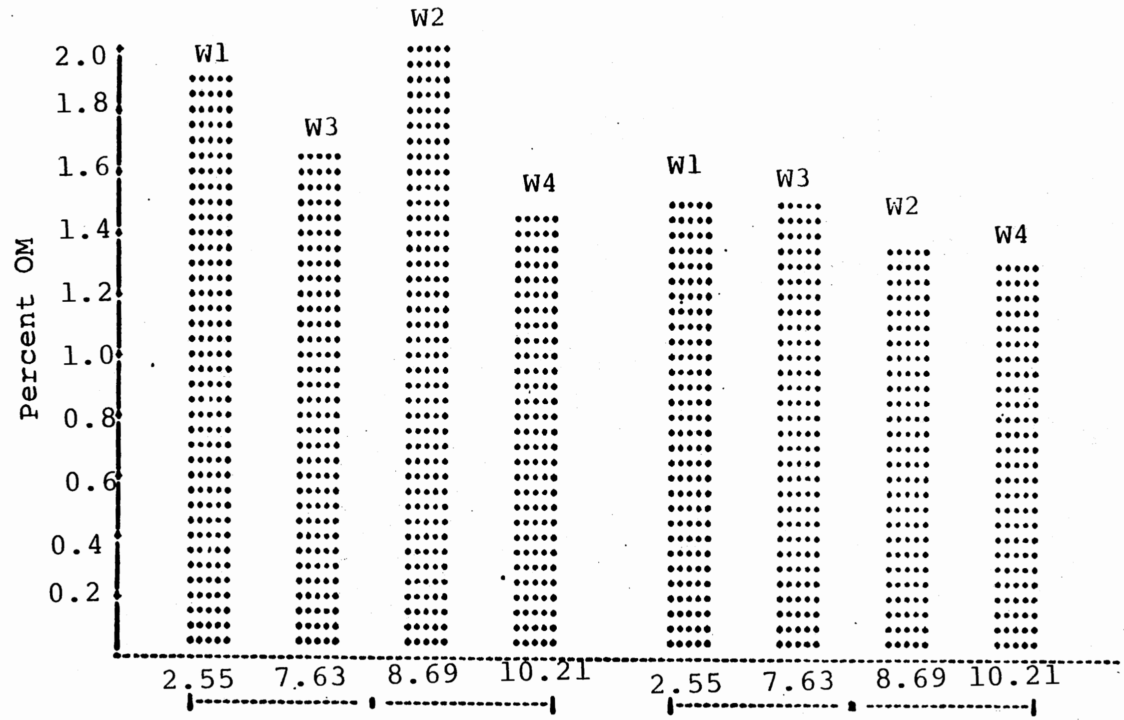

Figure 8. Effect of OM Content of Soil on Surface Runoff (cm), Southern Plains Exp. Sta. USDA Woodward, Oklahoma

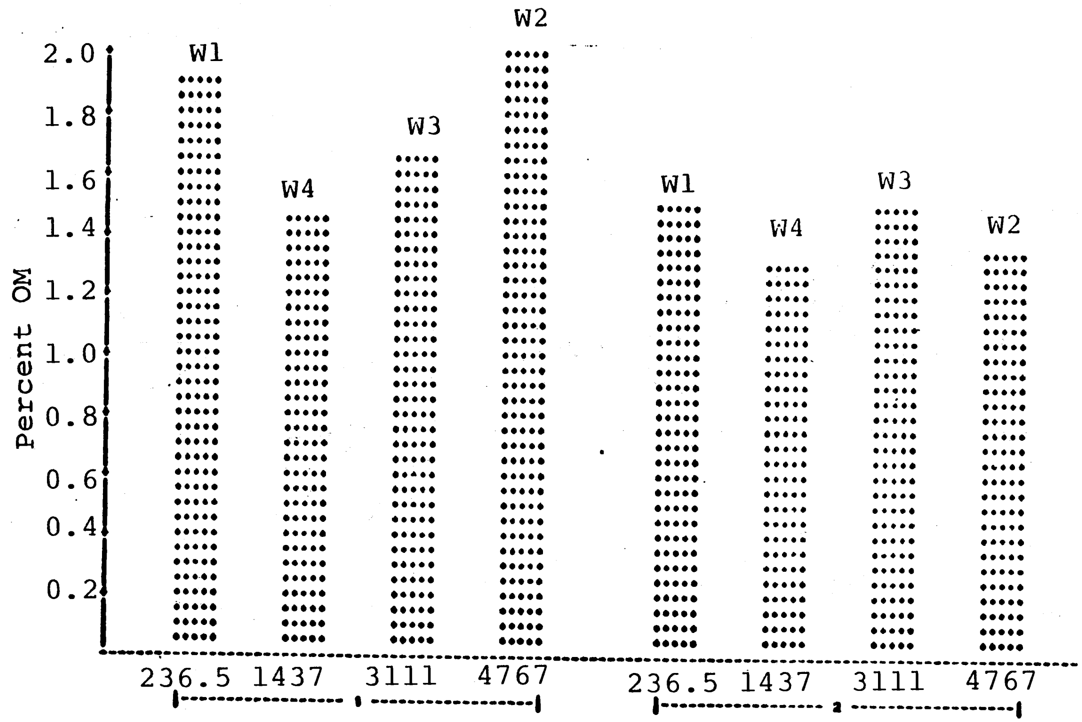

Figure 9. Effect of OM Content of Soil on Sediment Yield (kg/ha), Southern Plains Exp. Sta. USDA Woodward, Oklahoma

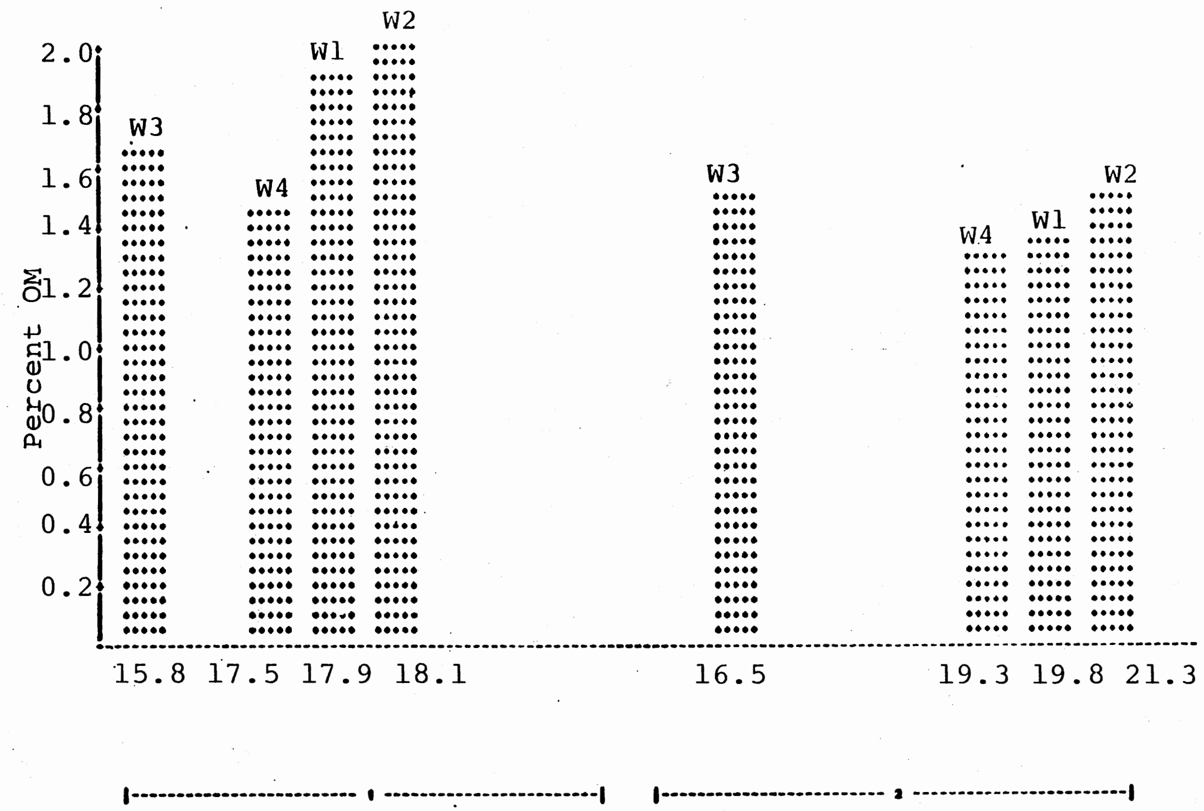

Figure 10. Relation Between OM and Clay Content of Soil, Southern Plains Exp. Sta. USDA Woodward, Oklahoma

watersheds. For instance, watershed 1 with relatively high clay and soil organic matter content produced the lowest sediment yield. Watershed 4 in spite of its high clay content and low organic matter, showed a higher sediment yield, however, in watershed 3 with a lower clay content the sediment yield was essentially the same as that of watershed 4. The reason for high sediment yield in watersheds 3 and 4 might be attributed to high sand content in addition to cultural practices which caused the disturbance of land.

Exchange cations undoubtedly have an important effect on physical properties of these soils, especially on their dispersivity. By study of the data shown in Figure 11 it is noted that the exchangeable Na content of the soils of watershed 4 is higher than that of watershed 1 and this may have caused a higher sediment yield in watershed 4 due to decrease in permeability caused by swelling Na clays which could increase runoff. A study of the data shown in Figure 12 might confirm this conclusion. Comparison of sediment yield from watershed 1 to that of watershed 3 also leads to the same conclusion (Figure 11).

Study of the data shown in Figures 11 and 12 leads to the conclusion that there is negative correlation for sediment yield from watersheds 2 and 4. In spite of high runoff in watershed 4 there was less sediment yield compared to watershed 2. This is further evidence of the importance of gully erosion in sediment yield production.

Data shown in Figures 13 and 14 indicate that

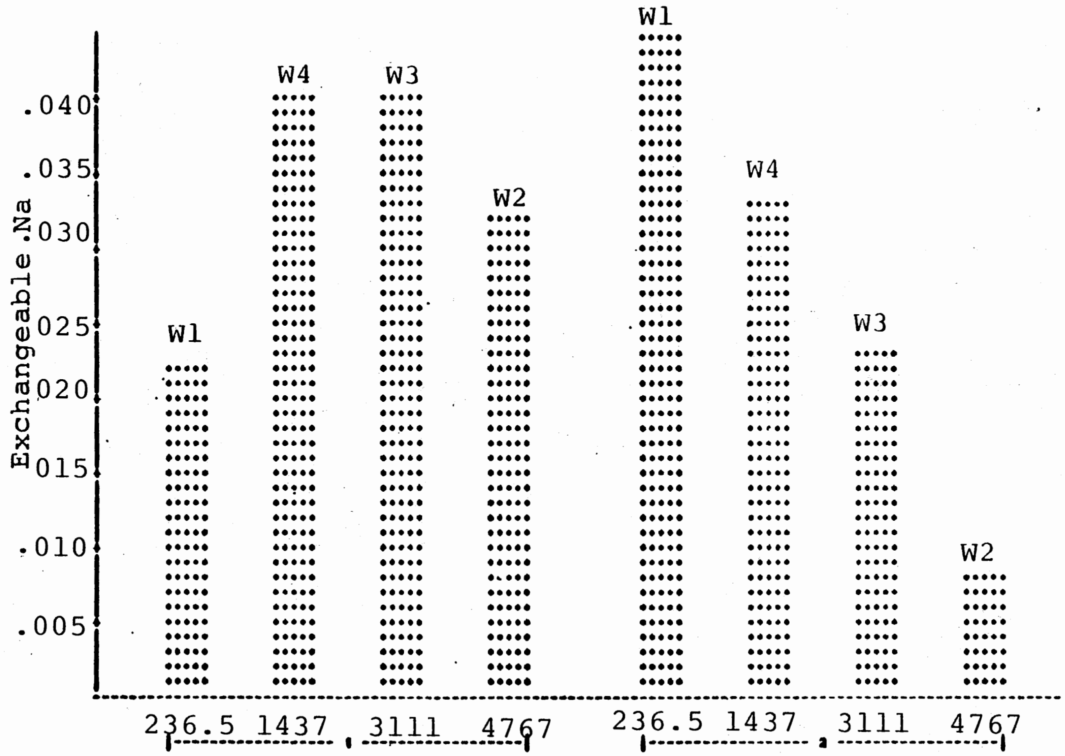

Figure 11. Effect of Exchangeable Na on Sediment Yield (kg/ha), Southern Plains Exp. Sta. USDA Woodward, Oklahoma

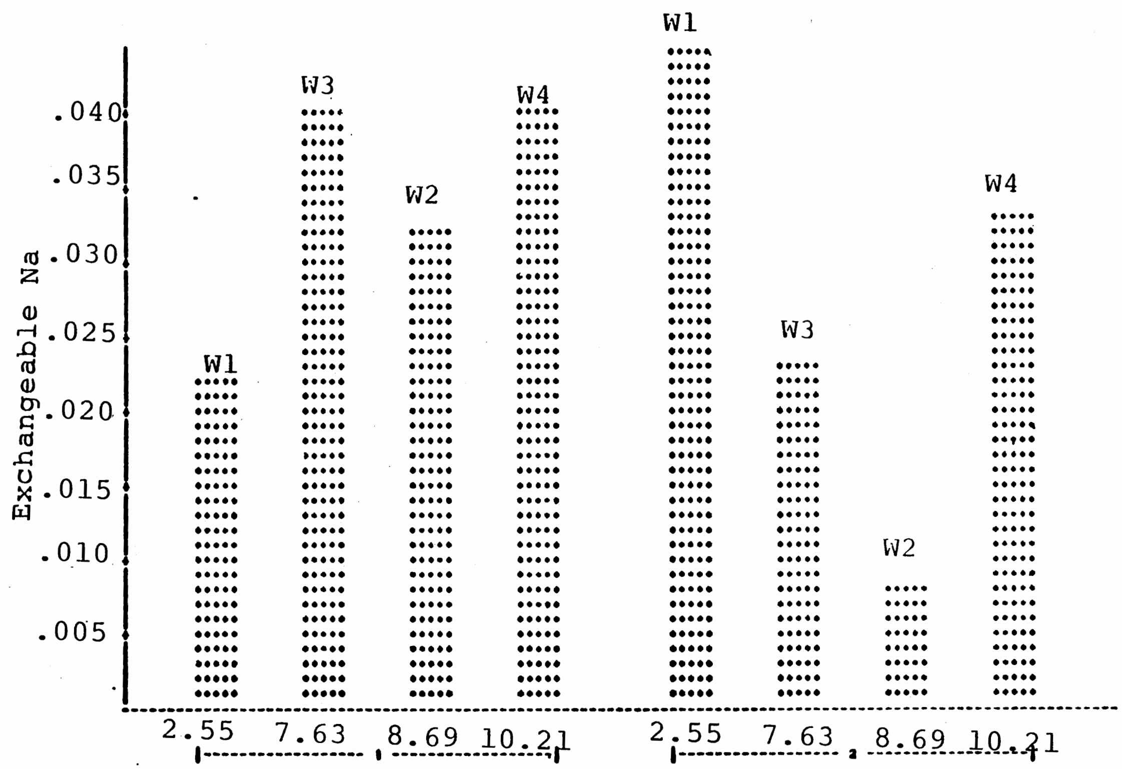

Figure 12. Effect of Exchangeable Na on Surface Runoff (cm), Southern Plains Exp. Sta. USDA Woodward, Oklahoma

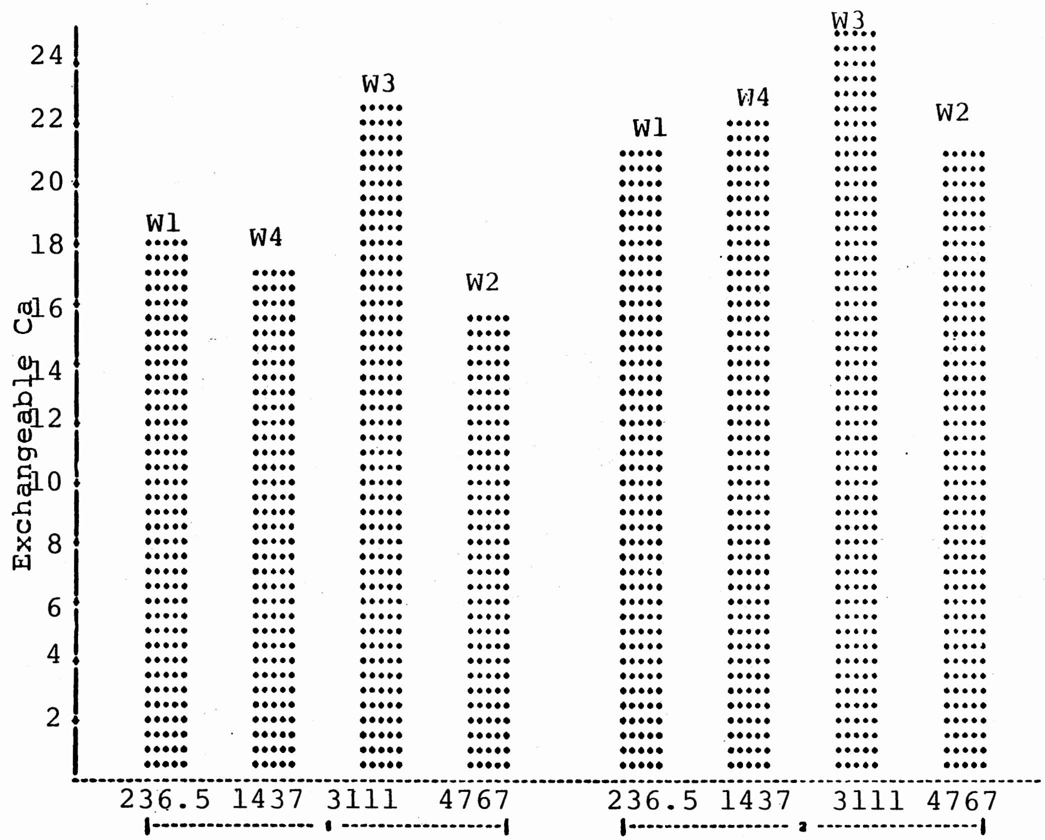

Figure 13. Effect of Exchangeable Ca on Sediment Yield (kg/ha), Southern Plains Exp. Sta. USDA Woodward, Oklahoma

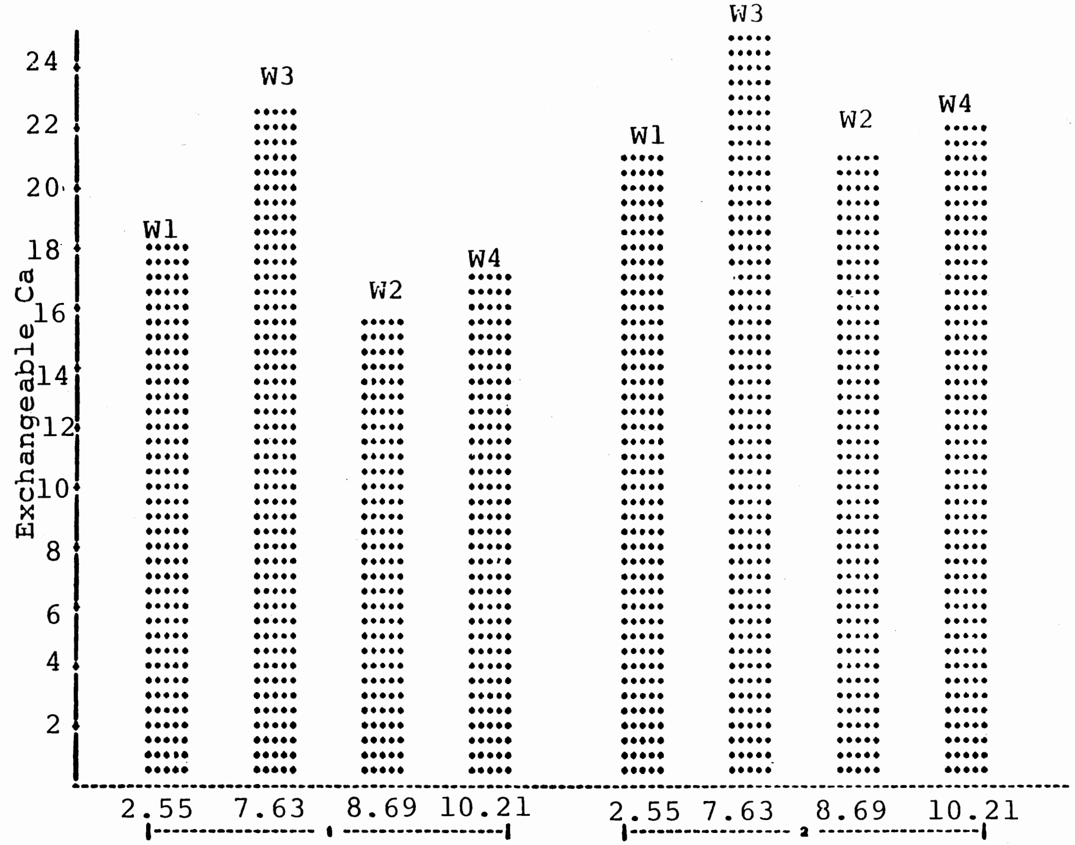

Figure 14. Effect of Exchangeable Ca on Surface Runoff (cm) Southern Plains Exp. Sta. USDA Woodward, Oklahoma

exchangeable Ca in the soils of watershed 4 did not have significant effect in controlling water runoff. As indicated from the data shown in Figure 10 the effect of exchangeable Na was dominant over other cations and may have caused maximum runoff from this watershed. In watershed 1 the effect of exchangeable Ca was dominant since little runoff and sediment yield was produced. Good vegetative cover was another factor in accounting for sedimentation and runoff. This is evident from the data shown in Figures 12, 13, and 14.

Climatological Data

The two general climatological factors of importance in determining water runoff and soil erosion were temperature and precipitation. Other factors such as wind movement, humidity and insolation are of influence only as they affect runoff and soil erosion.

The influence of temperature on runoff and erosion is exerted primarily through its effect on the evaporation of soil water and on freezing. The more rapid the removal of soil water by evaporation or by percolation or by plant transpiration, the lesser the opportunity for water penetration. Undoubtedly percolation and plant use of soil water are together much more important than evaporation, yet evaporation is responsible for considerable water removal during the warmer part of the year with a proportionate increase in absorption.

Unfortunately, the daily temperature has not been recorded for the Woodward Experiment Station since 1979. Therefore correlation between temperature and runoff was not possible. In a broad way the total precipitation is an important factor in determining the water runoff and soil erosion. However, the distribution of rainfall, together with the number and size of the torrential rains is probably of greater importance. Data shown in Table III shows the monthly precipitation and the average monthly precipitation for four years (1978-1981).

TABLE III

PRECIPITATION FOR EACH MONTH DURING THE FOUR YEARS OF EXPERIMENT

Month	1978	1979	1980	1981	Average
January	0.2	1.19	1.39	0.05	0.70
February	1.34	0.2	0.85	0.15	0.63
March	0.3	4.84	2.42	2.37	2.48
April	1.16	1.40	4.72	1.04	2.08
May	7.59	6.43	6.99	3.54	6.13
June	3.34	4.65	2.16	2.38	3.13
July	2.75	6.07	0.28	2.07	2.74
August	1.38	1.31	0.9	3.04	1.65
September	3.40	0.05	0.4	1.48	1.33
October	0.00	4.73	1.64	2.80	2.29
November	0.71	0.5	0.45	4.16	1.45
December	0.34	0.25	2.85	0.24	0.92
Total	22.51	31.62	25.05	23.32	

Nitrogen and Phosphorus Losses in Surface Runoff From Woodward Watershed

The present study provides information on N and P losses in surface runoff from four watersheds at the USDA Southern Great Plains Field Station at Woodward, Oklahoma. This information will be related to conservation management practices, rates of P fertilizer application, and seaonal climate differences. Surface runoff and sediment yield from the watersheds are shown in Table IV. Study of the data in this table indicates that in watersheds 1 and 2 maximum runoff occurred during the first year of nutrient measurements, but in watershed 4, maximum runoff occurred during the second year of nutrient measurements. The coefficients of variation (CV's) for annual runoff were greatest (195%) for the highly eroded watershed 2 and least (153%) for watershed 3 which has a tillage cultural practice (see Appendix C). The coefficients of variation (CV's) for sediment discharges were greatest for watershed 4 (274%) and least for watershed 2 (220%) (see Appendix C). The average of three annual runoffs from different watersheds with different land uses (Table IV) varied from 4.25 cm for the tillage watershed 4 to 0.85 cm for the pasture or range grass watershed 1.

Examination of the data in Figure 15 (runoff vs. sand) shows a complicated relation between runoff and percent sand. Generally speaking there is a positive relationship

TABLE IV

SURFACE RUNOFF AND SEDIMENT YIELD FROM WOODWARD, OKLAHOMA WATERSHEDS

Watershed	Year	Surface Runoff	Sediment Loss
		-------cm------	metric ton/ha
	1978		
1		1.15	0.183
2		3.76	3.0371
3		2.15	0.0773
4		4.07	0.5743
	1979		
1		0.69	0.0251
2		3.59	1.6014
3		3.50	1.2466
4		7.76	0.73344
	1980		
1		0.71	0.02730
2		1.32	0.12741
3		0.84	0.02012
4		0.93	0.02014
	1978-1980 average		
1		0.85	0.078
2		2.89	1.589
3		2.16	0.464
4		4.25	0.442

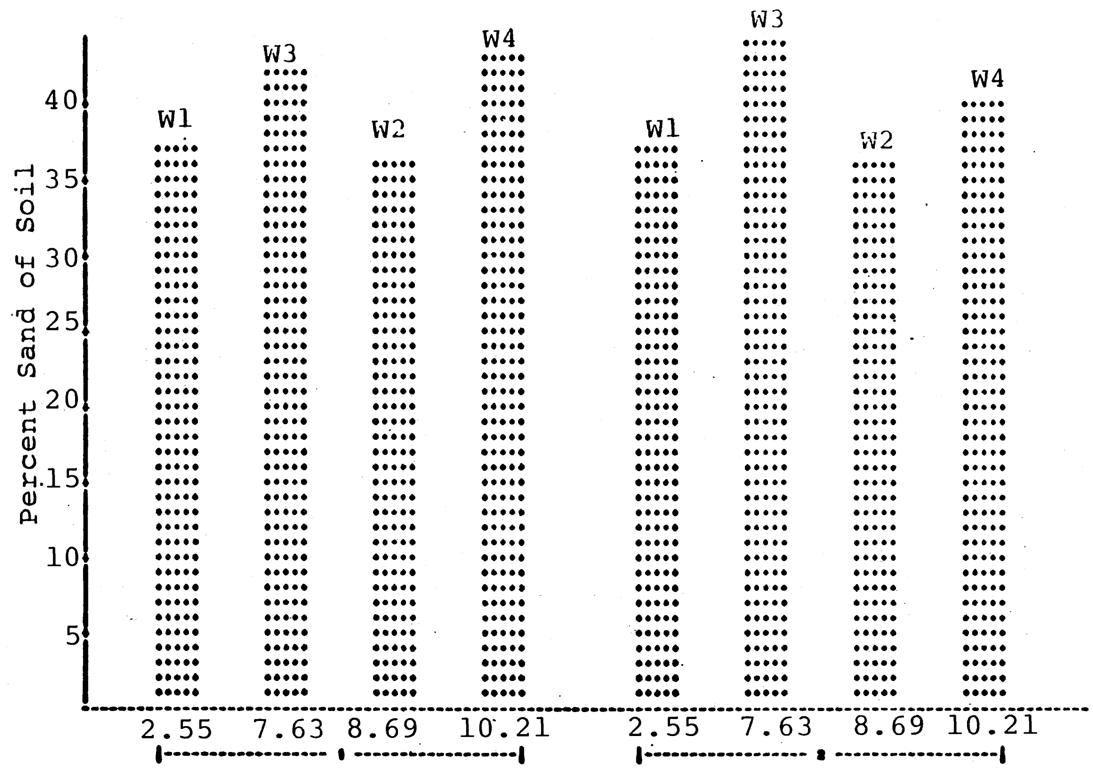

Figure 15. Effect of Percent Sand on Surface Runoff (cm) Southern Plains Exp. Sta. USDA Woodward, Oklahoma

between sand content of soil and surface runoff. In surface soil, as percent sand increases, there is an increase in the amount of surface runoff, except in watershed 2 where in spite of low sand content there was higher surface runoff compared to watersheds 1 and 3 as shown in Figure 15. The reason could possibly be due to active gully erosion in this watershed. In watershed 1 the soil was kept in virgin range with high vegetative cover which resulted in the lowest runoff. Study of Figure 16 (runoff vs. sand, runoff vs. clay) leads to the same conclusion. That is, the conservation practices have completely changed the natural relationship that exists between soil texture and amount of surface runoff.

The averages of three annual sediment yields varied from 1.589 metric ton/ha on the highly eroded watershed 2 to 0.078 metric ton/ha on the least eroded watershed 1 (Table IV). Solution and sediment N losses were also affected by conservation management practices (Table V). The average annual total N (soluble and sediment) losses were 0.2122 kg/ha for watershed 1 with virgin soil, 1.4789 kg/ha for highly eroeded watershed 2, 1.8479 kg/ha for the cultivated watershed 3 and 1.1211 kg/ha for the cultivated watershed 4. Sediment N losses from these watersheds were 84.8%, 94%, 93.6%, and 89% of the total N loss from watersheds 1, 2, 3, and 4, respectively, indicating that soluble N loss in surface runoff is a very small fraction of total N loss (soluble N and sediment N).

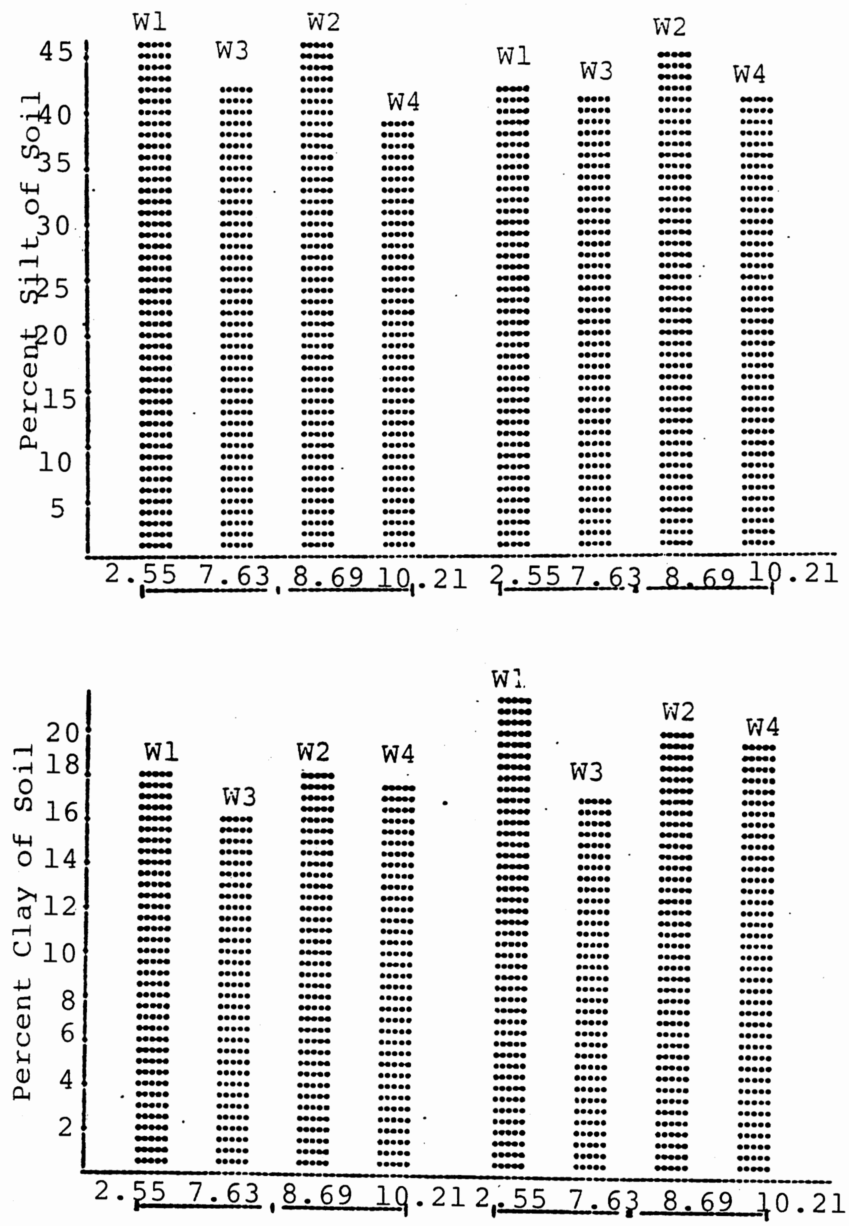

Figure 16. Effect of Silt and Clay Content of Soil on Surface Runoff (cm) Southern Plains Exp. Sta. USDA Woodward, Oklahoma

TABLE V

NITROGEN LOSS IN SURFACE RUNOFF FROM WOODWARD WATERSHED

Watershed Year	Soluble N kg/ha			Sediment-N kg/ha	Total Loss kg/ha
	NO_2-N	NO_3-N	NH_4-N		
1978					
1	0.0019	0.015	0.021	0.34	0.3779
2	0.0043	0.050	0.026	2.44	2.5203
3	0.0035	0.032	0.021	0.46	0.5165
4	0.0036	0.042	0.037	0.75	0.8326
1979					
1	0.0008	0.008	0.012	0.11	0.1308
2	0.0028	0.076	0.044	1.51	1.6328
3	0.0042	0.073	0.136	4.76	4.9732
4	0.0077	0.078	0.102	2.08	2.2677
1980					
1	0.0010	0.023	0.017	0.09	0.1310
2	0.0015	0.040	0.023	0.29	0.3545
3	0.0010	0.046	0.040	0.01	0.0970
4	0.0011	0.055	0.038	0.16	0.2541
1978-1980 Average					
1	0.0012	0.015	0.016	0.18	0.2122
2	0.0029	0.055	0.031	1.39	1.5025
3	0.0029	0.050	0.065	1.73	1.8479
4	0.0041	0.058	0.059	1.00	1.1211

Tillage of watersheds 3 and 4 for fertilizer application probably is one of the causes of higher sediment N loss due to rill and sheet erosion compared to that of watershed 1 which is virgin range, covered with native grass. Gully erosion in watershed 2 caused 94% of the total N loss, in spite of the fact that it was not disturbed for fertilizer application, and fertilizer P was applied by broadcast only.

The average 1978-80 N loss from watershed 2 (Table V) is almost seven times greater than that of watershed 1, indicating the efficiency of nutrient removal by gully erosion. However, from watershed 3 total N removal was 9.6 times greater than that of watershed 1. On the other hand, sediment yield from watershed 2 was five times greater than that of watershed 3. This indicates that total N removal is not directly proportional to the total sediment removal. Examination of Figure 17 [sediment vs. total Kjeldahl nitrogen removal (TKNR)], and Figure 18 (runoff vs. TKNR) confirms the finding mentioned above. The amount of runoff is not directly proportional to the amount of sediment as shown in Figure 18 (sediment vs. runoff). For example, from watershed 4 there was maximum runoff but the least sediment yield compared to those from watershed 2 and watershed 3. The coefficients of variation for sediment N were 233.77 for watershed 3, which is highest, and 146 for watershed 1, which is lowest among all four watersheds. The coefficients of sediment N variation for watersheds 2 and 4

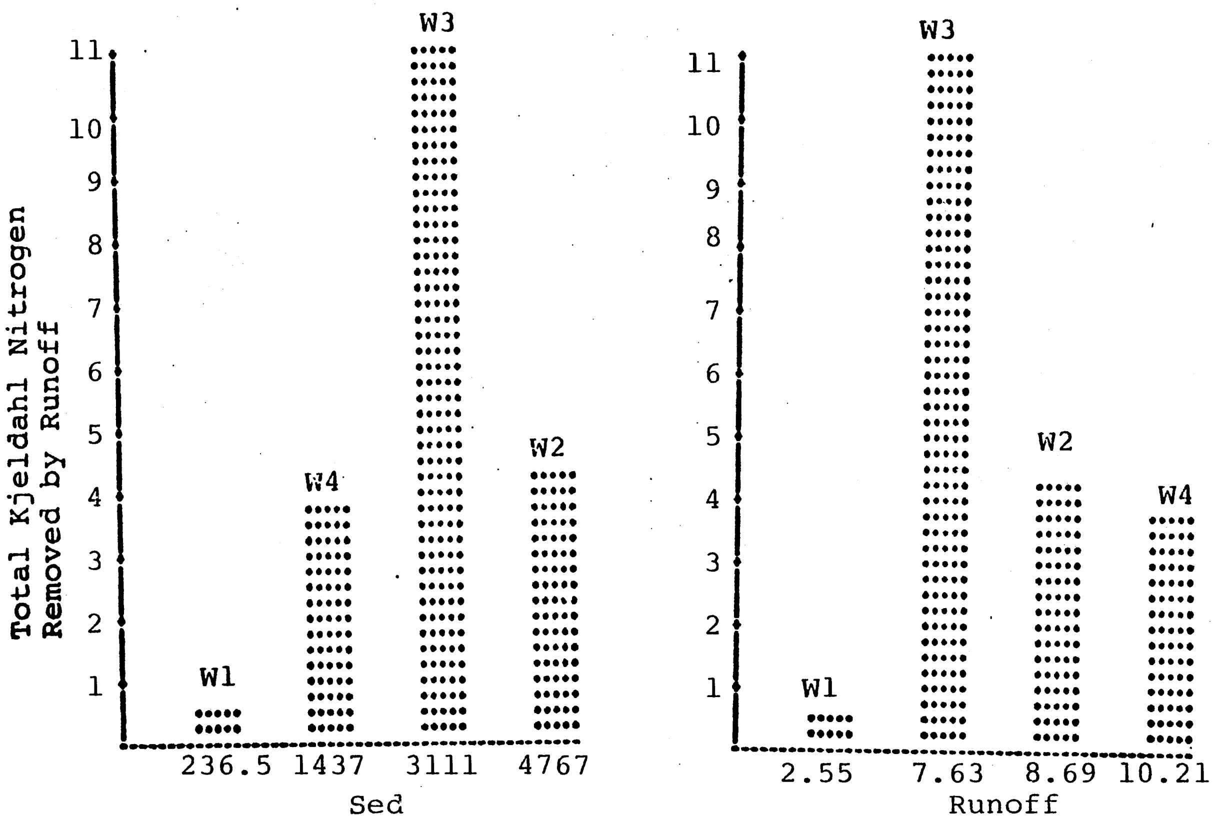

Figure 17. Effect of Sediment Yield (kg/ha) and Surface Runoff (cm) on Total Kjeldahl Nitrogen Removed (TKNR) in Southern Plains Exp. Sta. USDA Woodward, Oklahoma

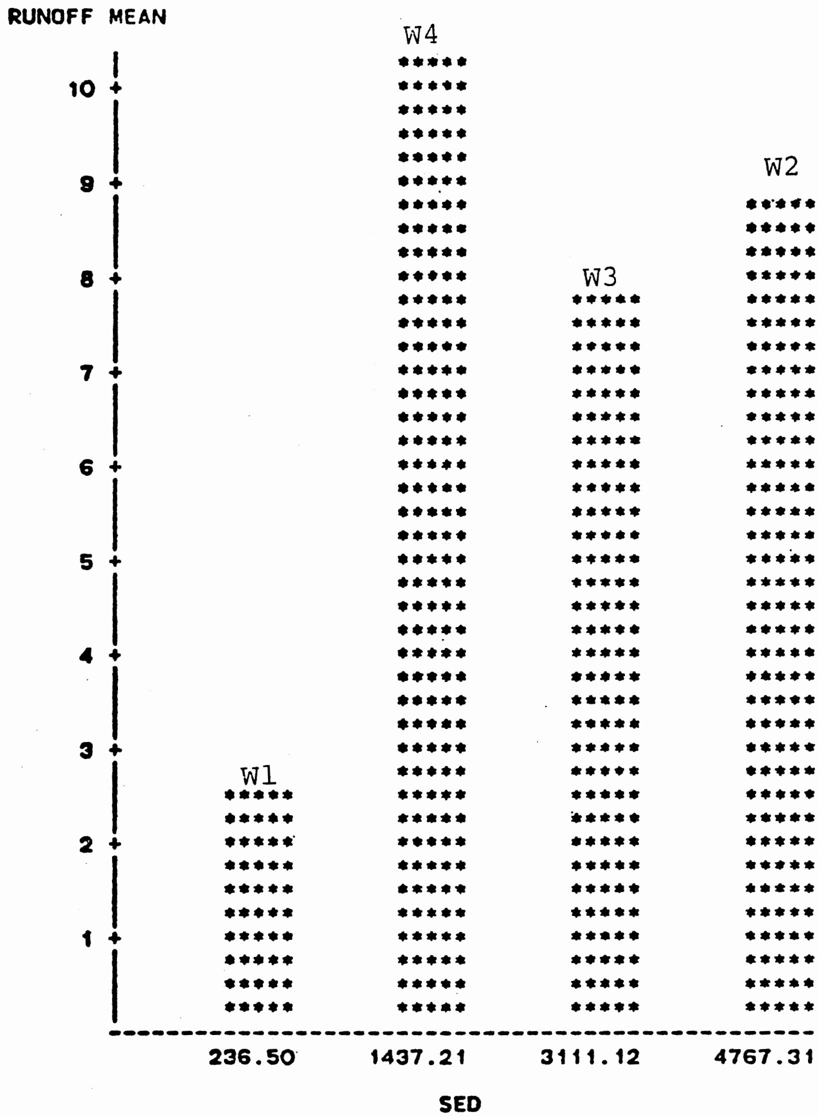

Figure 18. Relation Between Sediment Yield (kg/ha) and Surface Runoff(cm) in Southern Plains Exp. Sta. USDA Woodward, Oklahoma

were almost equal.

The data reported in Table VI represent the weighted concentrations of solution and sediment N in the transporting medium. These values shown in Table VI were obtained by dividing the solution and sediment N losses shown in Table V by the corresponding runoff and sediment yield as shown in Table IV. The annual loss per unit of transporting material of solution and sediment N is expressed as kilograms of N per hectare-centimeters of surface runoff, and kilograms of N per metric ton of sediment yield.

The average annual sediment N losses per unit of sediment for watershed 1 and watershed 2 were 2.30 and 0.87 kg N/metric ton of sediment, respectively. The magnitude of sediment N loss in watershed 1 was almost 2.6 times greater than that of watershed 2 and this was is in spite of the fact that the magnitude of sediment removal in watershed 2 was 20 times greater than that of watershed 1. This might be due to the gully erosion problem as observed for watershed 2 in which there was no uniform sediment removal from over the total area. The average annual sediment N loss per unit of sediment (Table VI) in watershed 3 is almost 1.6 times greater than that of watershed 1, which indicates that disturbance of the surface soil due to cultural practices did increase the amount of sediment N losses. Similar results were found from watershed 4 where N loss was almost equal to that of watesrshed 1. Probably

TABLE VI

LOSS PER UNIT OF TRANSPORTING MATERIAL OF NUTRIENT EXPRESSED ON THE BASIS OF RUNOFF AND SEDIMENT YIELD

Watershed	Soluble Nutrients				Sediment Nutrients	
	NO_2	NO_3	NH_4	P	TKN	TP
	---------kg/ha-cm runoff---------				kg/mt sediment	
			1978			
1	0.0016	0.013	0.018	17.18	1.85	478.08
2	0.0011	0.013	0.007	11.65	0.80	216.06
3	0.0016	0.015	0.009	10.03	5.95	1216.30
4	0.0008	0.010	0.009	9.17	1.28	268.22
			1979			
1	0.0011	0.011	0.017	0.000	4.38	0.40
2	0.0007	0.021	0.012	0.005	0.92	0.43
3	0.0012	0.020	0.038	0.008	3.81	0.69
4	0.0009	0.010	0.013	0.002	2.83	0.59
			1980			
1	0.0014	0.032	0.024	17.88	3.29	358.96
2	0.0011	0.030	0.017	14.09	2.27	513.30
3	0.0011	0.054	0.047	19.99	0.50	1250.50
4	0.0011	0.059	0.040	19.65	7.94	1397.71
			1978-1980 Average			
1	0.0013	0.016	0.019	11.68	2.30	279.14
2	0.001	0.021	0.012	8.58	0.87	243.26
3	0.0013	0.029	0.031	10.00	3.72	822.49
4	0.0009	0.013	0.013	9.60	2.26	555.50

the lower amount of erosion from watersheds 1, 3, and 4 may have resulted in organic matter accumulation, accounting for these small sediment nitrogen differences. The average annual solution N loss per unit of runoff (Table VI) were considered to be low in all watersheds.

Differences in solution N loss per unit of runoff among the three years (Table VI) are not clearly understood but appear to be influenced by climatological differences. The seasonal distribution of precipitation and runoff characteristics varied among the three years. Snowmelt runoff data from these watersheds was not available to measure the effect of snowmelt runoff on soluble nitrogen concentrations.

The influence of P fertilizer application on nutrient losses was evaluated by comparison of watershed 1 which did not receive P fertilizer and watershed 2 which received P fertilizer at a rate of 9 kg P/ha in March, 1980.

Previous studies revealed that runoff and erosion characteristics differed for these two watersheds. Watershed 2 has had more runoff and more sediment yield, but watershed 1 had less runoff and less sediment yield. To evaluate the fertility treatment effect, the runoff and erosion differences for watershed 1 and watershed 2 must be considered. Weighted concentrations of solution P and sediment P in the transporting medium as reported in Table VI were derived by dividing solution and sediment P losses shown in Table VII by the corresponding runoff and sediment

TABLE VII

PHOSPHORUS LOSS IN SURFACE RUNOFF FROM WOODWARD WATERSHEDS

Watershed	Year	Soluble-P kg/ha	Sediment-TP kg/ha	Total Loss kg/ha
	1978			
1		19.76	87.49	107.25
2		43.81	656.20	700.01
3		21.57	94.02	115.59
4		37.32	154.04	191.36
	1979			
1		0.00	0.01	0.01
2		0.02	0.70	0.72
3		0.03	0.89	0.92
4		0.02	0.43	0.45
	1980			
1		12.70	9.80	22.50
2		18.60	65.40	84.00
3		16.79	25.16	41.95
4		18.28	28.15	46.43
	1978-1980 Average			
1		10.82	32.43	43.25
2		20.81	240.76	261.57
3		12.80	40.02	52.82
4		18.54	60.87	79.26

yield shown in Table IV. The annual loss per unit of runoff of solution and sediment P was expressed in kilograms of P per hectare-centimeter of surface runoff and kilograms of N per metric ton of sediment yield.

The average annual sediment P loss per unit of sediment for the control watershed 1, and for the 9 kg P/ha P fertilizer application (watershed 2) were 279.14 and 243.26 kg/metric ton of sediment, respectively as shown in Table VII. These data indicate that there has been little fertility treatment effect (12% decrease) on the amount of P carried by the unit weight of sediment. On the other hand, the average annual solution P loss was 11.68 kg/ha-cm runoff in watershed 1 and 8.85 in watershed 2 after P application, which was a 26% decrease in runoff P. The average annual sediment P loss per unit of sediment was higher on watersheds 3 and 4 than on watersheds 1 and 2. Sediment P loss per unit of sediment for watersheds 3 and 4 were 822.44 and 555.50 kg P/metric ton of sediment, respectively. Higher fertilizer rate application and cultural practices accounts for these sediment P differences of watersheds 3 and 4 compared to those of watersheds 1 and 2.

Study of Variability in Soil Data

Research data show that long-time average soil losses may vary more than 30-fold due to basic soil differences. The following is a report of the Woodward, Oklahoma watershed study and deals primarily with differences among soil variables. The variability in some common parameters is given in Tables VIII and IX. All parameters shown in these tables apply to surface soil and subsoil.

The merits of various soil properties as indicators of erodibility were explored by simple linear regression techniques. Thus the effect of each soil parameter was studied with the level of other runoft parameters allowed to vary freely over their natural ranges. The correlation coefficients (r_1 and r_2) obtained in simple linear regression of sediment yield, surface runoff, total N, total P, and soluble P on various soil properties are shown in Table X.

The correlation coefficient r̲ is a pure number without units or dimensions because the units of the numerator and denominator are both the products of the units in which both soil and runoff variables are measured. Another useful property of r̲ is that it always lies between -1 and +1. Positive values of r̲ indicate a tendency of both variables to increase together and when r̲ is negative, large values of independent variables are associated with small values of dependent variables. When r̲ = 1 the two variables keep in perfect step, any change in one variable is accompanied by a proportionate change in the other. However, it is not easy to make a visual evaluation if the absolute value of r̲ is less than 0.5; even the direction of inclination of dependent and independent variables is elusive if r̲ is

TABLE VIII

VARIABILITY IN SOME PROPERTIES OF SEDIMENT YIELD, RUNOFF, AND SURFACE SOIL OF 4 WATERSHEDS FROM WOODWARD, OKLAHOMA

Surface Soil Variable	Unit	Range in Values		Mean
		Minimum	Maximum	
Sediment Yield	kg/ha	236.50	4767.31	2388.03
Runoff	cm	2.55	10.21	7.27
Total N in Sediment	kg/ha	0.54	11.03	4.87
Soluble P in Runoff	kg/ha	32.46	91.78	63.44
Total P in Sediment	kg/ha	136.00	1607.38	731.60
pH W		7.36	7.67	7.49
pH K		6.62	7.35	6.99
EC	Mmhos/cm	408.84	599.33	525.45
Exchangeable Ca	meq/100 g	15.68	22.40	18.21
Exchangeable Mg	meq/100 g	1.13	1.66	1.49
Exchangeable Ma	meq/100 g	0.02	0.04	0.03
Exchangeable K	meq/100 g	0.34	0.48	0.41
CEC	meq/100 g	12.16	13.47	12.71
Total P in Soil	ppm	130.00	153.56	142.09
Soluble P in Soil	ppm	2.72	5.07	3.63
Percent OM		1.47	1.98	1.76
Total N in Soil	kg/ha	1344.00	1991.11	1635.38
Soluble Ca	meq/100 g	0.37	0.55	0.45
Soluble Mg	meq/100 g	0.09	0.64	0.35
Soluble Na	meq/100 g	0.0006	0.01	0.009
Soluble K	meq/100 g	0.02	0.07	0.04
Total Ca	meq/100 g	22.91	64.63	44.72
Total Mg	meq/100 g	55.86	67.08	59.57
Total Na	meq/100 g	0.57	0.86	0.66
Total K	meq/100 g	6.94	9.17	7.88
Percent Sand		36.40	43.20	39.62
Percent Silt		39.25	45.56	42.99
Percent Clay		15.80	18.10	17.34

TABLE IX

VARIABILITY IN SOME PROPERTIES OF SEDIMENT YIELD, RUNOFF, AND SUBSURFACE SOIL OF 4 WATERSHEDS FROM WOODWARD, OKLAHOMA

Surface Soil Variable	Unit	Range in Values		Mean
		Minimum	Maximum	
Sediment Yield	kg/ha	236.50	4767.31	2388.03
Runoff	cm	2.55	10.21	7.27
Total N in Sediment	kg/ha	0.54	11.03	4.87
Soluble P in Runoff	kg/ha	32.46	91.78	63.94
Total P in Sediment	kg/ha	136.00	1607.38	731.61
pH W		7.40	7.80	7.63
pH K		6.91	7.55	7.16
EC	Mmhos/cm	370.00	434.29	415.37
Exchangeable Ca	meq/100 g	20.89	24.89	22.26
Exchangeable Mg	meq/100 g	0.45	2.01	1.55
Exchangeable Ma	meq/100 g	0.01	0.04	0.27
Exchangeable K	meq/100 g	0.28	0.37	0.33
CEC	meq/100 g	11.94	13.72	13.06
Total P in Soil	ppm	133.78	145.71	138.71
Soluble P in Soil	ppm	0.91	1.60	1.40
Percent OM		1.31	1.50	1.41
Total N in Soil	kg/ha	1254.40	1381.33	1314.93
Soluble Ca	meq/100 g	0.31	0.39	0.36
Soluble Mg	meq/100 g	0.06	0.62	0.29
Soluble Na	meq/100 g	0.01	0.01	0.01
Soluble K	meq/100 g	0.02	0.02	0.02
Total Ca	meq/100 g	45.21	40.36	68.69
Total Mg	meq/100 g	65.62	70.83	67.82
Total Na	meq/100 g	0.57	0.74	0.68
Total K	meq/100 g	6.90	8.86	7.86
Percent Sand		35.60	43.63	38.93
Percent Silt		40.75	44.60	42.09
Percent Clay		16.80	21.36	19.33

TABLE X

COEFFICIENTS OF SIMPLE CORRELATIONS FOR SURFACE SOIL AND SUBSOIL OF 4 WATERSHEDS FROM WOODWARD, OKLAHOMA

Independent Soil Variable	Dependent Variable									
	Sediment Yield		Runoff		Total Sediment N		Soluble P Runoff		Total Sediment P	
	r_1	r_2	r_1	r_2	r_1	r_2	r_1	r_2	r_1	r_2
pH W	0.01	0.52	0.44	0.78	0.80	0.87	0.81	0.98	0.67	0.79
pH K	-0.40	-0.04	-0.18	-.001	0.57	0.82	0.40	0.65	0.46	0.75
EC	0.08	0.30	-0.77	-0.58	-0.15	-.24	-0.41	-0.03	0.01	0.40
Exchangeable Ca	-0.07	0.21	-0.18	0.29	0.76	0.95	0.54	0.86	0.72	0.88
Exchangeable Mg	-0.33	-0.53	-0.04	0.01	-0.92	-0.84	-0.74	-0.65	-0.93	-0.92
Exchangeable Ma	0.38	-0.99	0.86	-0.59	0.73	-0.46	0.90	-0.57	0.62	-0.57
Exchangeable K	0.16	0.13	-0.28	0.02	-0.72	-0.77	-0.69	-0.61	-0.57	-0.69
CEC	-0.26	-0.44	-0.67	-0.32	-0.84	-0.99	-0.92	-0.90	-0.72	-0.97
Total P in Soil	-0.54	0.28	-0.77	0.45	-0.15	0.95	-0.16	0.92	-0.14	0.86
Soluble P in Soil	-0.36	0.74	0.55	0.91	0.12	0.71	0.32	0.89	-0.06	0.68
Percent OM	0.27	-0.16	-0.56	-0.79	-0.34	0.34	-0.49	0.01	-0.14	0.40
Total N in Soil	-0.25	-0.85	-0.89	-0.06	-0.55	-0.44	-0.77	-0.39	-0.41	-0.65
Soluble Ca	-0.16	0.12	-0.78	-0.59	-0.66	-0.42	-0.82	-0.11	-0.51	-0.53
Soluble Mg	-0.08	-0.16	0.60	0.63	0.59	0.44	0.70	0.60	0.41	0.25
Soluble Na	-0.85	-0.68	-0.39	0.21	-0.84	-0.25	-0.80	-0.10	-0.92	-0.44
Soluble K	-0.50	4.72	-0.95	-0.11	-0.63	-0.03	-0.85	-0.03	-0.54	0.22
Total Ca	0.74	0.54	0.12	-0.17	0.80	0.70	0.67	0.48	0.90	0.81
Total Mg	0.25	-0.20	-0.26	-0.54	0.88	0.52	0.67	-0.17	0.89	0.29
Total Na	0.77	0.05	0.14	-0.75	-0.11	-0.15	-0.05	-0.17	0.06	0.29
Total K	0.81	0.70	0.04	-0.17	0.09	0.03	0.06	-0.06	0.28	0.22
Percent Sand	-0.11	-0.02	0.58	0.29	0.57	0.83	0.69	0.78	0.40	0.71
Percent Silt	0.16	0.64	-0.65	-0.02	-0.39	-0.27	-0.57	-0.24	-0.21	-0.09
Percent Clay	-0.11	-0.46	-0.14	-0.51	-0.91	-0.99	-0.78	-0.97	-0.84	-0.94

between -0.3 and +0.3.

Only those variables with correlation coefficients of 90 percent or more are shown in Table XI. The significant variables in Table XII include:

1. Exchangeable Na of subsoil vs. sediment yield.
2. Exchangeable Mg of surface soil vs. total P in sediment yield.
3. Exchangeable Mg of surface soil vs. sediment yield.
4. Cation exchange capacity of subsoil vs. total N of sediment yield.
5. Cation exchange capacity of surface soil and subsoil vs. soluble P in runoff.
6. Cation exchange capacity of subsoil vs. total P of sediment yield.
7. Soluble Na of surface soil vs. total P of sediment yield.
8. Soluble K of surface soil vs. runoff.
9. Total Ca of surface soil vs. total P of sediment yield.
10. pH of subsoil vs. soluble P of runoff.
11. Exchangeable Ca of subsoil vs. total N of sediment yield.
12. Total P of subsoil vs. total N of sediment yield.
13. Soluble P of subsoil vs. runoff.
13. Percent clay of surface soil and subsoil vs. total N of sediment yield.

TABLE IX

COEFFICIENTS OF SIMPLE CORRELATIONS WITH RELATED OSL FOR SURFACE SOIL AND SUBSOIL OF 4 WATERSHEDS FROM WOODWARD, OKLAHOMA

Independent Soil Variable	Dependent Variable									
	Sediment Yield		Runoff		TKNR		Soluble P		Total P	
	r_1	r_2	r_1	r_2	r_1	r_2	r_1	r_2	r_1	r_2
Exchangeable Mg	-0.92								-0.94	
OSL	0.07								0.06	
Exchangeable Ma		-0.99					0.90			
OSL		0.003					0.09			
CEC						-0.99	-0.92	-0.90		-0.97
OSL						0.005	0.07	0.09		0.03
Soluble Na									-0.92	
OSL									0.07	
Soluble K			-0.95							
OSL			0.04							
Total Ca									0.90	
OSL									0.09	
pH W								0.98		
OSL								0.01		
Exchangeable Ca						0.95				
OSL						0.05				
Total P						0.95		0.92		
OSL						0.05		0.08		
Soluble P				0.92						
OSL				0.08						
Percent Clay					-0.91	-0.99		-0.97		-0.94
OSL					0.08	0.01		0.03		0.06

TABLE XII

F VALUES OBTAINED BY ONE-WAY CLASSIFICATION ANALYSIS FOR SURFACE SOIL AND SUBSOIL OF 4 WATERSHEDS FROM WOODWARD, OKLAHOMA

Soil Dependent Variable	Surface Soil		Subsoil	
	F Value	PR > F	F Value	PR > F
pH W	1.95	0.1134	10.64	0.0001
pH K	6.95	0.0003	11.63	0.0001
EC	4.76	0.0029	1.49	0.2272
Exchangeable Ca	6.71	0.0004	3.21	0.0778
Exchangeable Mg	8.24	0.0001	19.92	0.0001
Exchangeable Ma	2.33	0.0646	3.63	0.0110
Exchangeable K	4.13	0.0059	4.22	0.0053
CEC	3.13	0.0212	3.55	0.0121
Total P in Soil	1.96	0.1120	6.78	0.0004
Soluble P in Soil	1.24	0.3327	1.74	0.1559
Percent OM	2.64	0.0417	1.27	0.3167
Total N in Soil	2.23	0.0750	0.44	0.8793
Soluble Ca	3.52	0.0126	3.44	0.0140
Soluble Mg	8.04	0.0001	31.76	0.0001
Soluble Na	1.13	0.3922	1.02	0.4576
Soluble K	1.06	0.4317	1.02	0.4531
Total Ca	3.57	0.0118	3.14	0.0202
Total Mg	3.09	0.0222	1.57	0.2022
Total Na	0.81	0.6034	1.80	0.1420
Total K	4.38	0.0045	3.19	0.0196
Percent Sand	3.75	0.0095	3.98	0.0071
Percent Silt	2.99	0.0256	2.90	0.0280
Percent Clay	2.62	0.0430	5.34	0.0015

14. Percent clay of subsoil vs. soluble P of runoff and total P of sediment yield.

The pH of a soil suspension decreased with increasing concentration of neutral salts. The increase in pH of the soil suspension upon dilution is thus a direct corollary of the observed decrease in pH of the suspension upon addition of neutral salts. The pH values in 1N KCl solution are less influenced by changes in biological and meterological conditions and thus reflect a more intrinsic characteristic of the soil pH than the soil pH values measured in water.

Study of the data in Figure 19 shows that soil type did not have a significant influence on pH of watershed soils. However, statistical analysis contradicts the observed conclusion indicating that there is significant difference among pH KCl means. This leads to a conclusion that we should not be totally dependent on statistical analysis for interpreting research data. Sometimes practicality of the subject must be considered.

The concentrated superphosphate on these soils has a pH value between 1 and 2 (Burd, 1948) and although this solution does strongly acidify small volumes of soil around the particles on a temporary basis, the long-term effect does not appear to be significant in these soils because of the tendency of phosphate to react with hydrous oxides of aluminum and iron. This reaction releases hydroxyl ions that react with the hydrogen ions present initially.

As the soil moisture content is reduced by evaporation

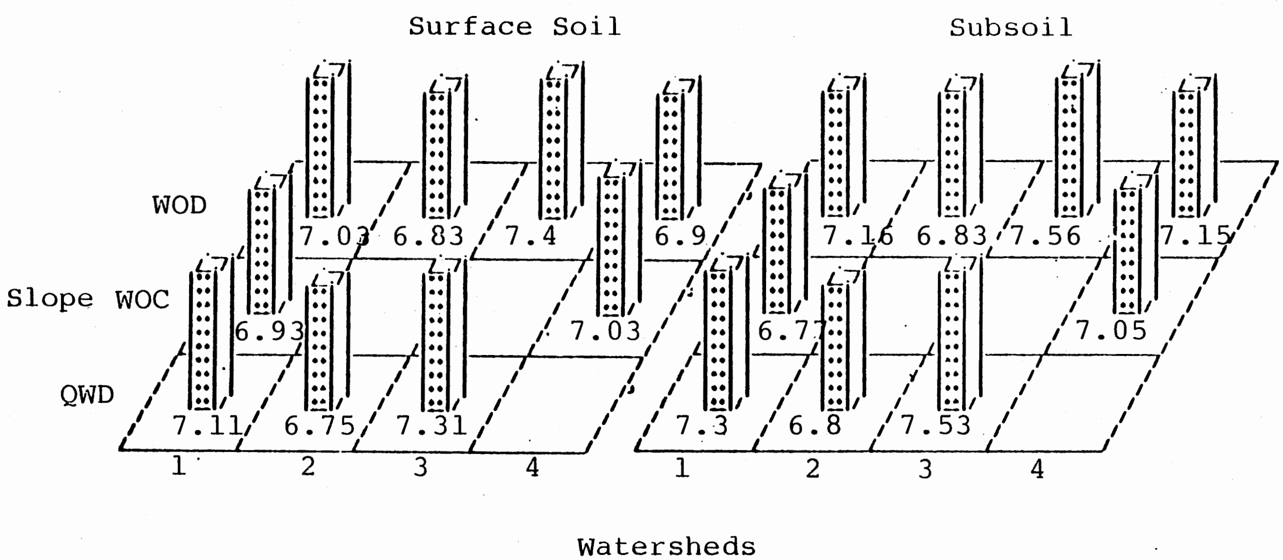

Figure 19. Relation Between Soil Slope and pH-KCl for Woodward, Oklahoma Watersheds

the concentration of soluble salts in the soil solution rises. A comparison of electrical conductivity of surface soil and subsurface soil (Figure 20) indicates that the concentration of soluble salts in the surface soil is higher than that of the subsurface soil. This is in agreement with the conditions of the mineral soils of arid and semiarid regions with low rainfall and restricted drainage (Richard, 1954).

These soils are not saline soils, since their electrical conductivities are less than 4 mmhos/cm and their pH is below 8.5. The pH of these soils probably indicates that there is a small amount of exchangeable Na present. Even upon hydrolysis the pH of the soil is not effected. This conclusion is confirmed by study of Figure 21 and Figure 22 indicating that a very small percentage of cation exchange capacity of these soils is occupied by Na ions.

Study of the data in Figure 23 indicates that the value of exchangeable Ca of some of the soil samples is higher than their cation exchange capacity. This is due to the presence of free calcium carbonate in these samples. The presence of free calcium carbonate in these samples was determined by the carbonate test with HCl.

Particle size distribution of all watershed soils is shown in Table XIII. Some differences in particle size distribution were observed when all the soils were paired for slope, but due to erosion in the area absolute comparisons between particle size distribution of surface

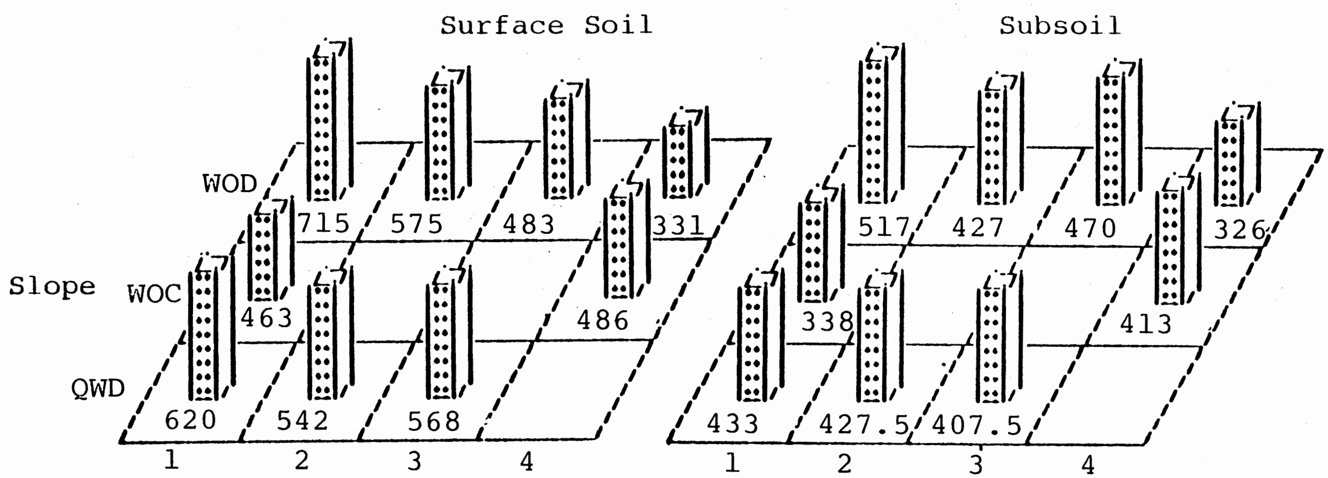

Figure 20. Relation Between Soil Slope and Electrical Conductivity for Woodward, Oklahoma Watersheds

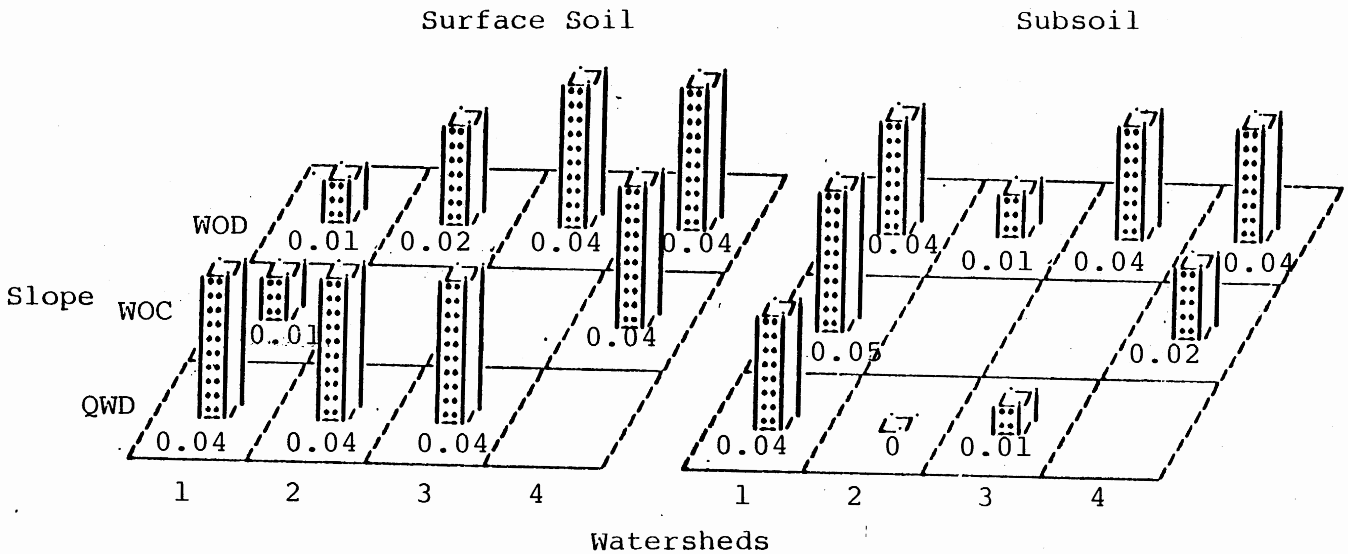

Figure 21. Relation Between Soil Slope and
Exchangeable Sodium for
Woodward, Oklahoma Watersheds

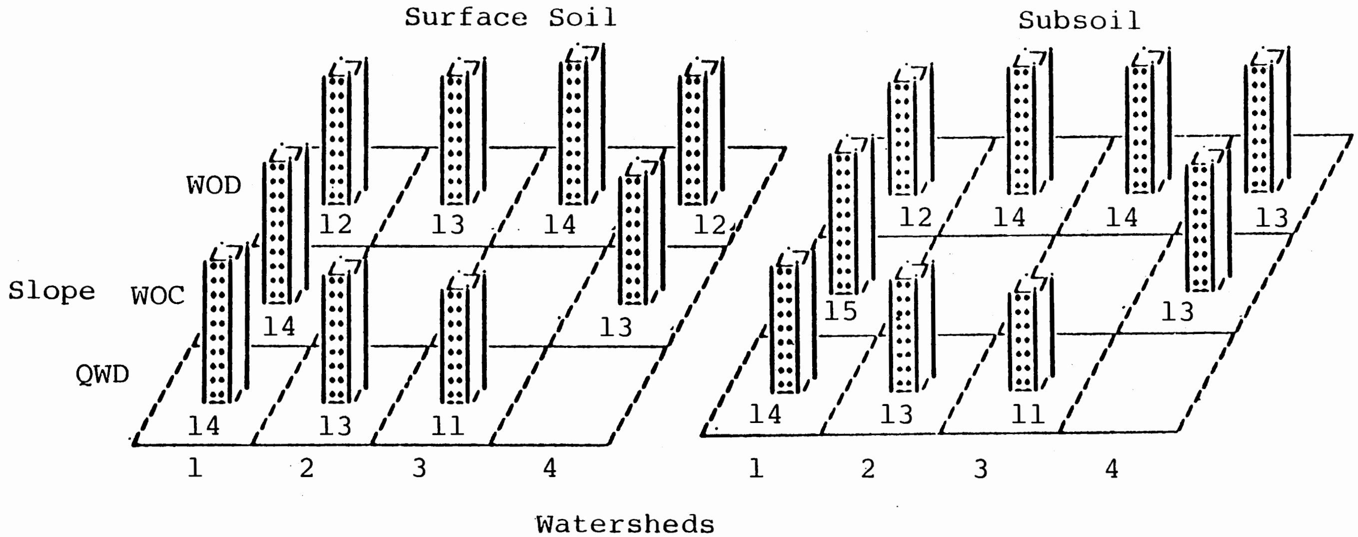

Figure 22. Relation Between Soil Slope and Cation Exchange Capacity for Woodward, Oklahoma Watersheds

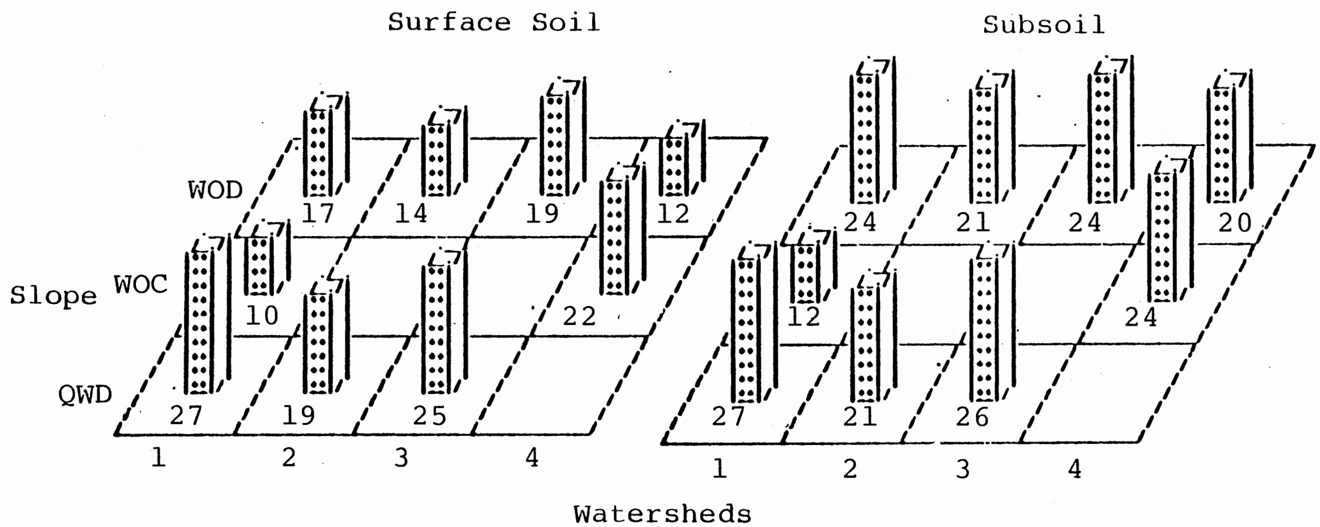

Figure 23. Relation Between Soil Slope and Exchangeable Calcium for Woodward, Oklahoma Watersheds

TABLE XIII

PHYSICAL AND CHEMICAL ANALYSIS DATA ON 4 WATERSHEDS
FROM WOODWARD, OKLAHOMA - PART I

Sample Number	Water-shed	Soil Slope	Depth inches	TKN kg/ha	I Me/100	%Sand	%Silt	%Clay	Textural Class
1	1	WOD	0-9	2016	0.007	35.2	48.0	16.8	Loamy
2	1	WOD	9-13	1344	0.00	43.2	38.0	18.8	Loamy
3	1	WOD	0-9	2016	0.07	35.2	49.0	15.8	Loamy
4	1	WOD	9-13	1568	0.14	37.2	46.0	16.8	Loamy
5	1	WOD	0-9	2240	0.07	40.2	44.0	15.8	Loamy
6	1	WOD	9-13	1344	0.07	43.2	39.0	17.8	Loamy
7	1	WOC	0-10	1344	0.37	35.2	47.0	17.8	Loamy
8	1	WOC	10-14	896	0.07	34.2	44.0	21.8	Loamy
9	1	WOC	0-10	2240	0.07	35.2	47.0	17.8	Loamy
10	1	WOC	10-14	1568	0.22	33.2	43.0	23.8	Loamy
11	1	WOC	0-10	1792	0.07	31.2	49.0	19.8	Loamy
12	1	WOC	10-14	1344	0.37	29.2	47.0	23.8	Loamy
13	1	QWD	0-8	2240	0.07	45.2	38.0	16.8	Loamy

TABLE XIII (Continued)

Sample Number	Water-shed	Soil Slope	Depth inches	TKN kg/ha	I Me/100	%Sand	%Silt	%Clay	Textural Class
14	1	QWD	8-13	1344	0.97	33.2	42.0	24.8	Loamy
15	1	QWD	0-8	1792	0.07	38.2	42.0	19.8	Loamy
16	1	QWD	8-13	1344	0.22	43.2	36.0	20.8	Loamy
17	1	QWD	0-8	2240	0.14	3.2	46.0	20.8	Loamy
18	1	QWD	8-13	1344	0.37	33.2	43.0	23.8	Loamy
19	2	WOD	0-8	1568	0.44	39.2	37.5	23.3	Loamy
20	2	WOD	8-13	1568	0.22	37.2	43.0	19.8	Loamy
21	2	WOD	0-8	1792	0.07	39.2	45.0	15.8	Loamy
22	2	WOD	8-13	896	0.07	35.2	46.0	18.8	Loamy
23	2	WOD	0-8	1792	0.07	31.2	51.0	17.8	Loamy
24	2	WOD	8-13	1120	0.14	33.2	47.0	19.8	Loamy
25	2	QWD	0-17	1792	0.29	39.2	44.0	16.8	Loamy
26	2	QWD	7-14	1568	0.07	35.2	42.0	22.8	Loamy
27	2	QWD	0-7	1568	0.22	33.2	50.0	16.8	Loamy

TABLE XIII (Continued)

Sample Number	Water- shed	Soil Slope	Depth inches	TKN kg/ha	I Me/100	%Sand	%Silt	%Clay	Textural Class
28	2	QWD	7-14	1120	0.07	37.2	45.0	17.8	Loamy
29	3	WOD	0-10	1344	0.14	33.2	50.0	16.8	Loamy
30	3	WOD	10-16	1120	0.07	33.2	47.0	19.8	Loamy
31	3	WOD	0-10	1792	0.07	37.2	45.0	17.8	Loamy
32	3	WOD	10-16	1354	0.00	37.2	45.0	17.8	Loamy
33	3	WOD	0-10	1120	0.22	33.2	47.0	19.8	Loamy
34	3	WOD	10-16	2016	0.59	39.2	45.0	15.8	Loamy
35	3	QWD	0-7	1568	0.07	47.2	38.0	14.8	Loamy
36	3	QWD	7-16	1120	6.52	43.2	40.0	16.8	Loamy
37	3	QWD	0-7	1568	0.29	57.2	30.0	12.8	Sandy Loam
38	3	QWD	7-16	1120	0.07	56.2	29.0	14.8	Sandy Loam
39	3	QWD	0-7	896	0.07	50.4	36.8	12.8	Loamy
40	3	QWD	7-16	896	0.07	53.2	33.0	13.8	Sandy Loam
41	3	QWD	0-7	2240	0.37	39.2	45.0	15.8	Loamy

TABLE XIII (Continued)

Sample Number	Water-shed	Soil Slope	Depth inches	TKN kg/ha	I Me/100	%Sand	%Silt	%Clay	Textural Class
42	3	QWD	7-16	1344	0.29	43.2	38.0	18.8	Loamy
43	4	WOD	0-10	1344	0.14	45.2	37.0	17.8	Loamy
44	4	WOD	10-16	896	0.07	43.2	37.0	19.8	Loamy
45	4	WOD	0-10	1568	0.07	39.2	42.0	18.8	Loamy
46	4	WOD	10-16	2016	0.07	35.2	42.0	22.8	Loamy
47	4	WOD	1-10	896	0.07	47.2	37.5	15.3	Loamy
48	4	WOD	10-16	896	0.37	39.2	41.0	19.8	Loamy
49	4	WOC	0-10	1568	0.00	34.2	43.0	17.8	Loamy
50	4	WOC	10-16	1792	0.37	37.2	44.0	18.8	Loamy
51	4	WOC	0-10	1344	0.07	45.2	38.0	16.8	Loamy
52	4	WOC	10-16	1568	0.07	47.2	37.5	15.3	Loamy
53	4	WOC	0-10	1344	0.07	43.2	38.0	18.8	Loamy
54	4	WOC	10-16	1120	0.07	37.2	43.0	19.8	Loamy

and subsurface soil is not possible. However percent silt was a dominant fraction in all depths.

In some of the soil samples it appears that the cation exchange capacity increases with the amount of clay and organic matter content (see Tables XIV-XVII). However, the correlation coefficient between organic matter and the cation exchange capacity was $r = 0.77$ for surface soil and $r = -0.44$ for subsoil. Correlation coefficients between organic matter and P, K, Ca and Mg were weak and below 60 percent, except for K for which the correlation coefficient was 77 percent. This might be due to an erosion effect or moisture deficiency that hindered the complete decomposition of organic matter in these soils.

Study of the data in Figures 24 and 25 showed that there is no significant difference between organic matter and total N of soil samples in these watersheds, however the trend of their magnitude in soil followed the same pattern. For example, the organic matter content of WOD soils decreased from watersheds 1 to 4 and the same trend was true for total N in the same soils. Almost the same trend was true for subsoil N in WOD soils (see Figure 25). However, the organic matter and total N content of subsoil was less than that of surface soil, which is in agreement with the findings of other researchers.

Study of the data in Figure 26 indicates that there were significant differences among total Ca content of soil samples of different watersheds. This was due to the

TABLE XIV

PHYSICAL AND CHEMICAL ANALYSIS DATA ON 4 WATERSHEDS FROM WOODWARD, OKLAHOMA - SOLUBLE CATIONS

Sample Number	Water-shed	Soil Slope	Depth inches	Soluble Cations meq/100 g soil			
				Ca	Mg	Na	K
1	1	WOD	0-9	0.91	0.10	0.008	0.042
2	1	WOD	9-13	0.44	0.06	0.008	0.025
3	1	WOD	0-9	0.58	0.08	0.004	0.035
4	1	WOD	9-13	0.55	0.06	0.004	0.028
5	1	WOD	0-9	0.46	0.09	0.004	0.030
6	1	WOD	9-13	0.50	0.06	0.008	0.023
7	1	WOC	0-10	0.34	0.12	0.013	0.032
8	1	WOC	10-14	0.25	0.08	0.017	0.015
9	1	WOC	0-10	0.30	0.10	0.004	0.033
10	1	WOC	10-14	0.21	0.07	0.008	0.023
11	1	WOC	0-10	0.40	0.14	0.039	0.034
12	1	WOC	10-14	0.30	0.10	0.013	0.023
13	1	QWD	0-8	0.71	0.07	0.004	0.033
14	1	QWD	8-13	0.33	0.05	0.013	0.010
15	1	QWD	0-8	0.58	0.06	0.008	0.030
16	1	QWD	8-13	0.32	0.05	0.008	0.020
17	1	QWD	0-8	0.63	0.05	0.008	0.030
18	1	QWD	8-13	0.47	0.05	0.013	0.015
19	2	WOD	0-8	0.58	0.11	0.008	0.035
20	2	WOD	8-13	0.31	0.04	0.004	0.015
21	2	WOD	0-8	0.62	0.11	0.004	0.035

TABLE XIV (Continued)

Sample Number	Water-shed	Soil Slope	Depth inches	Soluble Cations meq/100 g soil Ca	Mg	Na	K
22	2	WOD	8-13	0.38	0.05	0.008	0.017
23	2	WOD	0-8	0.40	0.13	0.008	0.047
24	2	WOD	8-13	0.30	0.10	0.013	0.032
25	2	QWD	0-17	0.42	0.05	0.008	0.033
26	2	QWD	7-14	0.34	0.03	0.008	0.020
27	2	QWD	0-7	0.43	0.09	0.008	0.041
28	2	QWD	7-14	0.44	0.08	0.008	0.023
29	3	WOD	0-10	0.28	0.031	0.008	0.030
30	3	WOD	10-16	0.35	0.052	0.013	0.015
31	3	WOD	0-10	0.42	0.114	0.004	0.038
32	3	WOD	10-16	0.41	0.052	0.008	0.025
33	3	WOD	0-10	0.43	0.093	0.008	0.025
34	3	WOD	10-16	0.56	0.060	0.004	0.030
35	3	QWD	0-7	0.34	0.041	0.013	0.028
36	3	QWD	7-16	0.47	0.041	0.017	0.020
37	3	QWD	0-7	0.48	0.031	0.004	0.023
38	3	QWD	7-16	0.34	0.031	0.008	0.015
39	3	QWD	0-7	0.50	0.031	0.004	0.019
40	3	QWD	7-16	0.37	0.020	0.008	0.012
41	3	QWD	0-7	0.28	0.060	0.004	0.035
42	3	QWD	7-16	0.35	0.050	0.008	0.020
43	4	WOD	0-10	0.38	0.083	0.008	0.025

TABLE XIV (Continued)

Sample Number	Water-shed	Soil Slope	Depth inches	Soluble Cations meq/100 g soil Ca	Mg	Na	K
44	4	WOD	10-10	0.30	0.072	0.013	0.010
45	4	WOD	0-10	0.28	0.062	0.013	0.017
46	4	WOD	10-16	0.31	0.072	0.026	0.020
47	4	WOD	1-10	0.14	0.052	0.008	0.016
48	4	WOD	10-16	0.15	0.062	0.008	0.012
49	4	WOD	0-10	0.53	0.083	0.013	0.030
50	4	WOC	10-16	0.33	0.052	0.130	0.015
51	4	WOC	0-10	0.58	0.062	0.008	0.025
52	4	WOC	10-16	0.49	0.072	0.008	0.050
53	4	WOC	0-10	0.33	0.041	0.008	0.017
54	4	WOC	10-16	0.28	0.041	0.008	0.012

TABLE XV

PHYSICAL AND CHEMICAL ANALYSIS DATA ON 4 WATERSHEDS FROM WOODWARD, OKLAHOMA - TOTAL CATIONS

Sample Number	Water-shed	Soil Slope	Depth inches	Total Cations meq/100 g soil			
				Ca	Mg	Na	K
1	1	WOD	0-9	27.50	83.33	0.86	8.20
2	1	WOD	9-13	55.00	95.83	0.86	6.92
3	1	WOD	0-9	17.50	58.33	0.43	7.17
4	1	WOD	9-13	25.00	62.50	0.86	8.20
5	1	WOD	0-9	20.00	75.00	0.86	6.92
6	1	WOD	9-13	60.00	83.33	0.86	7.17
7	1	WOC	0-10	10.00	33.33	0.43	7.94
8	1	WOC	10-14	10.00	33.33	0.43	7.17
9	1	WOC	0-10	12.50	33.33	0.43	8.46
10	1	WOC	10-14	15.00	37.50	0.86	9.23
11	1	WOC	0.10	12.50	41.66	0.86	8.84
12	1	WOC	10-14	15.00	45.83	0.86	10.00
13	1	QWD	0-8	40.00	45.83	0.43	5.84
14	1	QWD	8-13	160.00	137.50	0.86	9.23
15	1	QWD	0-8	72.50	87.50	0.86	7.43
16	1	QWD	8-13	117.50	54.16	0.43	6.28
17	1	QWD	0-8	62.50	62.50	0.43	7.43
18	1	QWD	8-13	70.83	0.65	6.41	27.00
19	2	WOD	0-8	22.50	50.00	0.86	9.23
20	2	WOD	8-13	70.00	62.50	0.86	7.93
21	2	WOD	0-8	17.50	54.16	0.86	8.71

TABLE XV (Continued)

Sample Number	Water-shed	Soil Slope	Depth inches	Total Cations meq/100 g soil Ca	Mg	Na	K
22	2	WOD	8-13	18.75	50.00	0.43	7.43
23	2	WOD	0-8	12.50	54.16	0.86	10.00
24	2	WOD	8-13	15.00	62.50	0.43	10.25
25	2	QWD	0-7	215.00	75.00	0.86	8.20
26	2	QWD	7-14	255.00	95.83	0.86	8.97
27	2	QWD	0-7	12.50	54.16	0.86	9.74
28	2	QWD	7-14	15.00	58.33	0.86	9.74
29	3	WOD	0-10	30.00	66.66	0.43	8.46
30	3	WOD	10-16	57.50	75.00	0.86	9.61
31	3	WOD	0-10	12.50	64.58	0.43	8.46
32	3	WOD	10-16	55.00	75.00	0.86	8.58
33	3	WOD	0-10	25.00	79.16	0.86	9.23
34	3	WOD	10-16	35.00	70.83	0.86	9.23
35	3	QWD	0-7	100.00	66.66	0.43	6.41
36	3	QWD	7-16	117.50	70.83	0.42	7.43
37	3	QWD	0-7	127.50	66.66	0.83	6.41
38	3	QWD	7-16	117.50	66.66	0.83	6.15
39	3	QWD	0-7	95.00	70.83	0.83	7.56
40	3	QWD	7-16	120.00	79.16	0.83	6.53
41	3	QWD	0-7	96.00	55.00	0.43	8.20
42	3	QWD	7-16	130.00	58.33	0.43	7.17
43	4	WOD	0-10	15.00	56.25	0.86	7.17

TABLE XV (Continued)

Sample Number	Water-shed	Soil Slope	Depth inches	Total Cations meq/100 g soil Ca	Mg	Na	K
44	4	WOD	10-16	52.5	75.00	0.43	6.79
45	4	WOD	0-10	20.0	58.33	0.43	7.05
46	4	WOD	10-16	80.0	93.75	0.86	7.17
47	4	WOD	1-10	10.0	37.50	0.43	6.66
48	4	WOD	10-16	10.0	45.83	0.86	4.94
49	4	WOC	0-10	17.0	56.25	0.86	8.46
50	4	WOC	10-16	52.5	70.83	0.43	6.66
51	4	WOC	0-10	22.5	54.16	0.43	6.15
52	4	WOC	10-16	16.25	45.83	0.43	6.15
53	4	WOC	0-10	52.5	66.66	0.43	6.15
54	4	WOC	10-16	60.0	62.50	0.43	6.15

TABLE XVI

PHYSICAL AND CHEMICAL ANALYSIS DATA ON 4 WATERSHEDS FROM WOODWARD, OKLAHOMA - EXCHANGEABLE CATIONS

Sample Number	Water-shed	Soil Slope	Depth inches	Exchangeable Cations meq/100 g soil			
				Ca	Mg	Na	K
1	1	WOD	0-9	19.75	1.25	0.00	0.41
2	1	WOD	9-13	25.50	1.25	0.04	0.28
3	1	WOD	0-9	13.75	1.25	0.00	0.41
4	1	WOD	9-13	21.00	1.25	0.04	0.29
5	1	WOD	0-9	16.00	1.25	0.04	0.34
6	1	WOD	9-13	25.25	1.25	0.04	0.25
7	1	WOC	0-10	9.75	2.50	0.00	0.51
8	1	WOC	10-14	11.50	2.50	0.08	0.43
9	1	WOC	0-10	10.00	2.50	0.00	0.53
10	1	WOC	10-14	11.75	2.91	0.04	0.48
11	1	WOC	0-10	11.00	2.50	0.04	0.58
12	1	WOC	10-14	12.50	3.33	0.04	0.53
13	1	QWD	0-8	26.50	1.25	0.04	0.41
14	1	QWD	8-13	27.25	1.25	0.04	0.20
15	1	QWD	0-8	26.50	0.83	0.04	0.37
16	1	QWD	8-13	26.25	0.83	0.04	0.29
17	1	QWD	0-8	29.99	1.25	0.04	0.46
18	1	QWD	8-13	27.00	1.25	0.04	0.33
19	2	WOD	0-8	13.75	1.66	0.04	0.48
20	2	WOD	8-13	25.00	1.25	0.04	0.30
21	2	WOD	0-8	17.25	1.25	0.04	0.43

TABLE XVI (Continued)

Sample Number	Water-shed	Soil Slope	Depth inches	Exchangeable Cations meq/100 g soil Ca	Mg	Na	K
22	2	WOD	8-13	19.00	1.66	0.00	0.41
23	2	WOD	0-8	10.40	2.08	0.00	0.61
24	2	WOD	8-13	19.75	2.08	0.00	0.51
25	2	QWD	0-17	25.75	0.83	0.04	0.35
26	2	QWD	7-14	28.25	0.83	0.00	0.25
27	2	QWD	0-7	11.25	2.08	0.04	0.53
28	2	QWD	7-14	13.75	1.66	0.00	0.38
29	3	WOD	0-10	22.25	1.25	0.04	0.41
30	3	WOD	10-16	25.25	1.25	0.04	0.33
31	3	WOD	0-10	12.00	2.08	0.04	0.48
32	3	WOD	10-16	24.00	1.25	0.04	0.38
33	3	WOD	0-10	22.75	2.08	0.04	0.43
34	3	WOD	10-16	22.00	1.25	0.04	0.46
35	3	QWD	0-7	25.75	0.83	0.04	0.28
36	3	QWD	7-16	24.25	0.83	0.04	0.24
37	3	QWD	0-7	24.00	0.41	0.04	0.20
38	3	QWD	7-16	27.00	0.83	0.00	0.17
39	3	QWD	0-7	22.75	0.41	0.04	0.17
40	3	QWD	7-16	24.75	0.41	0.00	0.12
41	3	QWD	0-7	27.25	0.83	0.04	0.41
42	3	QWD	7-16	27.00	0.83	0.00	0.29
43	4	WOD	0-10	13.25	1.66	0.04	0.41

TABLE XVI (Continued)

Sample Number	Water-shed	Soil Slope	Depth inches	Exchangeable Cations meq/100 g soil Ca	Mg	Na	K
44	4	WOD	10-10	27.00	2.50	0.04	0.30
45	4	WOD	0-10	7.75	2.08	0.04	0.41
46	4	WOD	10-16	26.25	2.50	0.04	0.25
47	4	WOD	1-10	14.75	2.08	0.04	0.37
48	4	WOD	10-16	8.50	2.50	0.04	0.34
49	4	WOC	0-10	19.00	1.66	0.04	0.46
50	4	WOC	10-10	28.50	1.66	0.04	0.33
51	4	WOC	0-10	21.00	1.25	0.04	0.35
52	4	WOC	10-16	15.27	1.25	0.00	0.51
53	4	WOC	0-10	24.87	1.25	0.04	0.30
54	4	WOC	10-16	27.00	1.66	0.04	0.30

TABLE XVII

PHYSICAL AND CHEMICAL ANALYSIS DATA ON 4 WATERSHEDS FROM WOODWARD, OKLAHOMA - PART II

Sample Number	Water-shed	Soil Slope	Depth inches	$pH-H_2O$	pH-KCl	EC umhos/cm	TP ppm	CEC ME/100	Bray-1 ppm	OM%
1	1	WOD	0-9	7.05	6.80	795	146	13.37	4.00	2.27
2	1	WOD	9-13	7.60	7.20	538	148	11.43	1.20	1.55
3	1	WOD	0-9	7.60	7.20	660	284	12.13	3.20	2.20
4	1	WOD	9-13	7.50	7.10	515	142	14.07	2.00	1.60
5	1	WOD	0-9	7.30	7.10	690	154	11.87	2.80	2.00
6	1	WOD	9-13	7.60	7.20	500	154	11.10	1.40	1.57
7	1	WOC	0-10	7.30	6.90	460	118	13.45	2.40	1.77
8	1	WOC	10-14	7.10	6.80	330	92	13.85	1.20	1.32
9	1	WOC	0-10	7.50	6.90	400	116	13.54	2.20	1.92
10	1	WOC	10-14	7.05	6.80	285	106	16.01	1.20	1.52
11	1	WOC	0-10	7.30	7.00	524	120	14.77	3.00	1.85
12	1	WOC	10-14	7.00	6.70	400	114	16.45	1.20	1.42
13	1	QWD	0-8	7.30	7.10	660	140	13.28	2.80	2.02

TABLE XVII (Continued)

Sample Number	Water-shed	Soil Slope	Depth inches	pH-H_2O	pH-KCl	EC umhos/cm	TP ppm	CEC ME/100	Bray-1 ppm	OM%
14	1	QWD	8-13	7.50	7.20	360	160	12.75	0.00	1.27
15	1	QWD	0-8	7.60	7.30	590	152	13.89	4.80	1.65
16	1	QWD	8-13	7.60	7.40	465	134	13.37	0.00	1.75
17	1	QWD	0-8	7.40	6.95	610	152	14.95	2.20	1.60
18	1	QWD	8-13	7.70	7.30	475	154	14.42	0.00	1.30
19	2	WOD	0-8	7.45	6.70	620	118	13.89	4.20	1.75
20	2	WOD	8-13	7.70	7.30	340	142	12.84	0.20	1.17
21	2	WOD	0-8	7.40	6.70	600	142	12.49	3.04	2.37
22	2	WOD	8-13	7.85	6.70	383	132	13.89	1.60	1.22
23	2	WOD	0-8	7.30	6.20	505	140	13.45	2.80	2.17
24	2	WOD	8-13	7.60	6.80	560	124	14.16	3.80	1.45
25	2	QWD	0-7	7.70	6.90	579	126	12.49	0.00	1.97
26	2	QWD	7-14	7.75	7.05	370	134	11.70	0.00	1.62
27	2	QWD	0-7	7.00	6.60	505	124	13.10	3.20	1.65

TABLE XVII (Continued)

Sample Number	Water-shed	Soil Slope	Depth inches	pH-H_2O	pH-KCl	EC umhos/cm	TP ppm	CEC ME/100	Bray-1 ppm	OM%
28	2	QWD	7-14	7.35	6.70	485	148	13.63	2.20	1.37
29	3	WOD	0-10	7.80	7.41	520	156	13.54	5.20	1.37
30	3	WOD	10-16	7.80	7.60	370	152	13.98	1.60	1.40
31	3	WOD	0-10	7.70	7.40	480	156	13.72	5.20	1.90
32	3	WOD	10-16	7.90	7.70	460	154	13.45	2.40	1.65
33	3	WOD	0-10	7.70	7.40	450	138	13.69	3.40	1.45
34	3	WOD	10-16	7.60	7.40	580	158	13.54	5.40	2.03
35	3	QWD	0-7	7.50	7.05	590	146	10.99	3.80	1.57
36	3	QWD	7-16	7.80	7.50	500	150	10.64	1.00	1.47
37	3	QWD	0-7	7.70	7.45	500	160	8.79	5.60	1.68
38	3	QWD	7-16	7.80	7.50	380	136	9.28	0.80	1.22
39	3	QWD	0-7	7.80	7.45	465	158	10.02	1.60	1.37
40	3	QWD	7-16	7.80	7.60	370	132	9.85	0.00	1.20
41	3	QWD	0-7	7.50	7.30	718	144	13.37	2.00	2.32

TABLE XVII (Continued)

Sample Number	Water-shed	Soil Slope	Depth inches	pH-H_2O	pH-KCl	EC umhos/cm	TP ppm	CEC ME/100	Bray-1 ppm	OM%
42	3	QWD	7-16	7.90	7.55	380	138	12.84	0.00	1.55
43	4	WOD	0-10	7.60	7.10	445	130	12.57	5.40	1.42
44	4	WOD	10-10	7.70	7.10	360	136	13.63	0.80	1.45
45	4	WOD	0-10	7.55	7.00	368	148	10.82	4.20	1.46
46	4	WOD	10-16	7.80	7.25	400	152	13.98	0.00	1.35
47	4	WOD	0-10	7.40	6.80	180	106	13.19	5.80	1.32
48	4	WOD	10-16	7.60	7.10	220	120	12.05	1.40	1.02
49	4	WOC	0-10	7.55	7.10	570	138	13.81	5.20	1.87
50	4	WOC	10-16	7.75	7.00	370	148	14.51	1.40	1.28
51	4	WOC	0-10	7.60	6.40	530	144	11.78	8.40	1.45
52	4	WOC	10-16	7.50	7.05	540	142	11.43	5.00	1.67
53	4	WOC	0-10	7.80	7.10	360	136	12.62	1.40	1.27
54	4	WOC	10-16	7.90	7.10	330	138	14.33	0.60	1.10

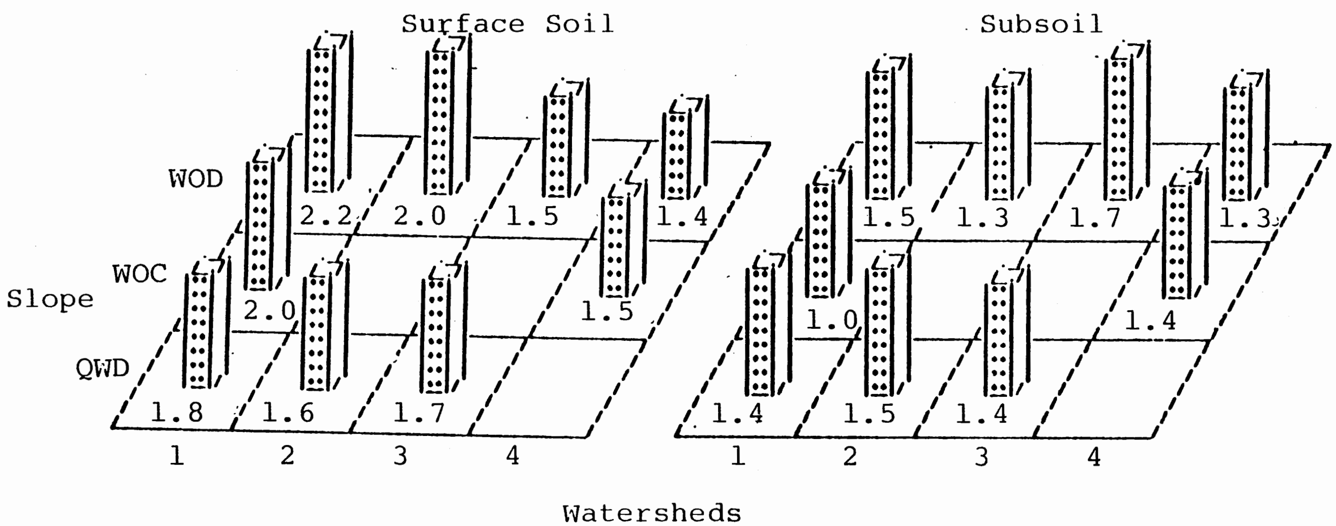

Figure 24. Relation Between Soil Slope and Percent Organic Matter for Woodward, Oklahoma Watersheds

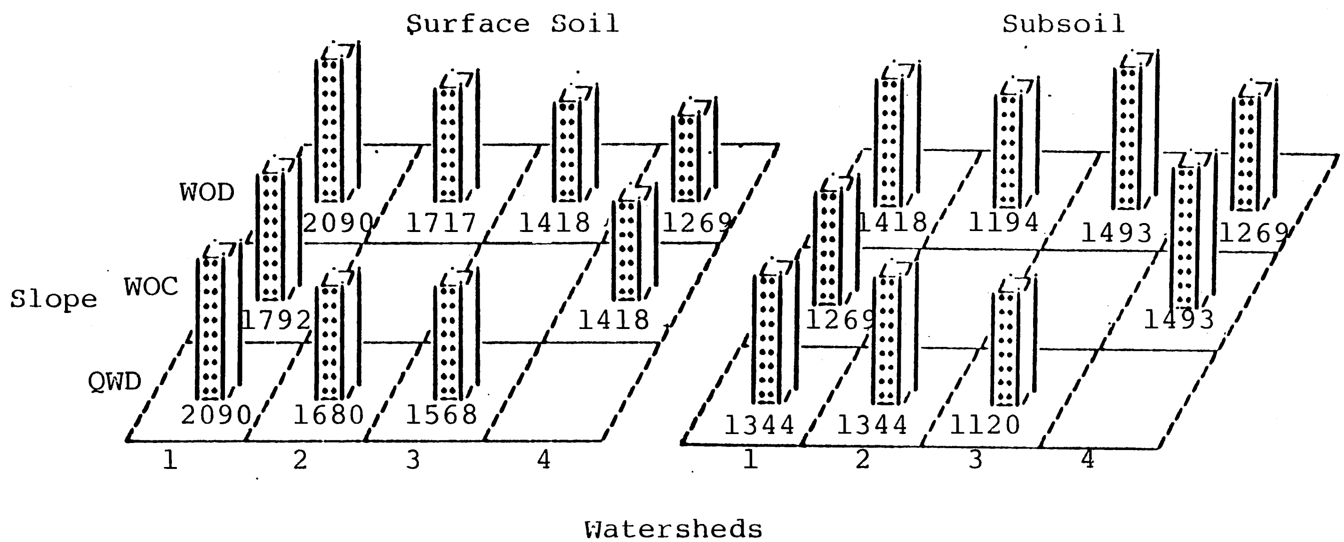

Figure 25. Relation Between Soil Slope and Total Kjeldahl Nitrogen of Soil in Woodward, Oklahoma Watersheds

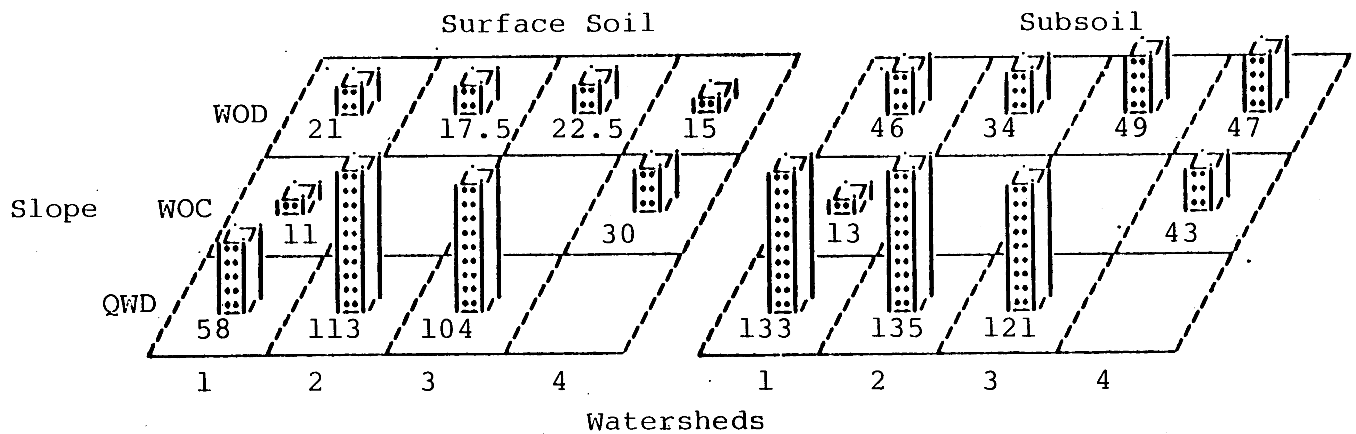

Figure 26. Relation Between Soil Slope and Total Calcium for Woodward, Oklahoma Watersheds

presence of high levels of calcium carbonate in some of the soil samples. The same holds true for subsoil samples. The exchangeable cations in order of abundance are Ca, Mg, K and Na. Due to the presence of free calcium carbonate in these soils, the base saturation is high and in some cases base saturation is 160 percent. This is in agreement with the moderate pH and low Na content of these soils developed under low rainfall.

The parent material might have modified the effect of precipitation. Evidence of clay translocation is illustrated by the distribution of clay between the surface and subsurface soil. Differences in cation exchange capacity values of surface and subsurface soils supports the contention that clay has been translocated. Particle size distribution in all four watersheds indicated lithological discontinuities in soils of both depths and the variation in sand content supports the presence of lithological discontinuities (Table XIII).

Mineralogical Analysis

X-ray diffraction patterns of coarse and fine clays obtained from three different soil types of watershed 1 are shown in Figures 27-32. Analysis of the coarse clay fraction of WOD surface soil (Figure 27) led to the conclusion that it contains randomly mixed layers of vermiculite and montmorillonite as shown by the 16.35 A Ca-saturated, and ethylene glycol solvated peaks. The strong

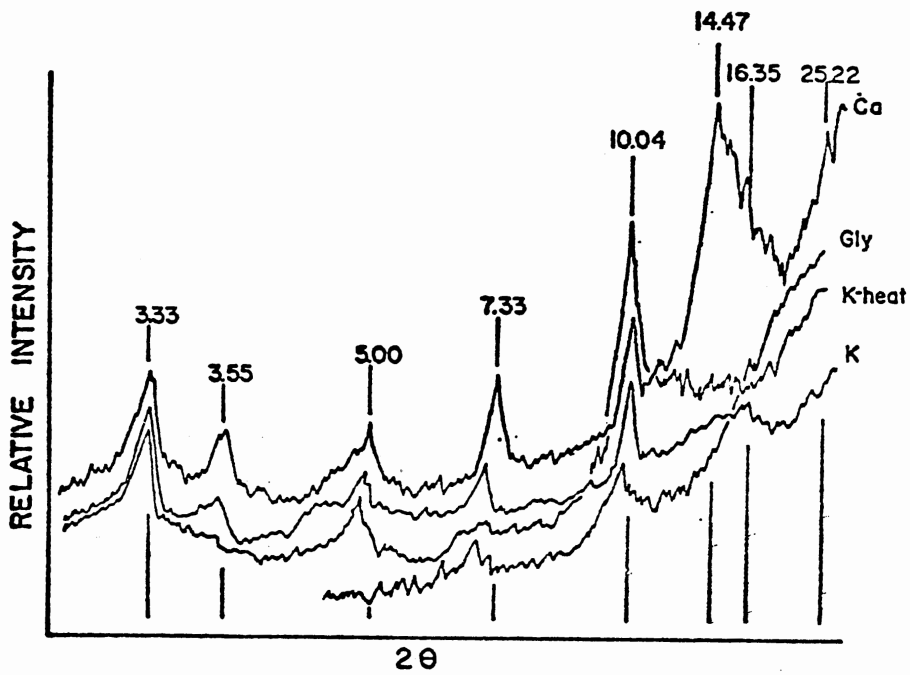

Figure 27. X-ray Diffraction Pattern and d-Spacing in Angstroms for the WOD 0-9" Coarse Clay Fraction, Southern Plains Exp. Sta. USDA Woodward, Oklahoma

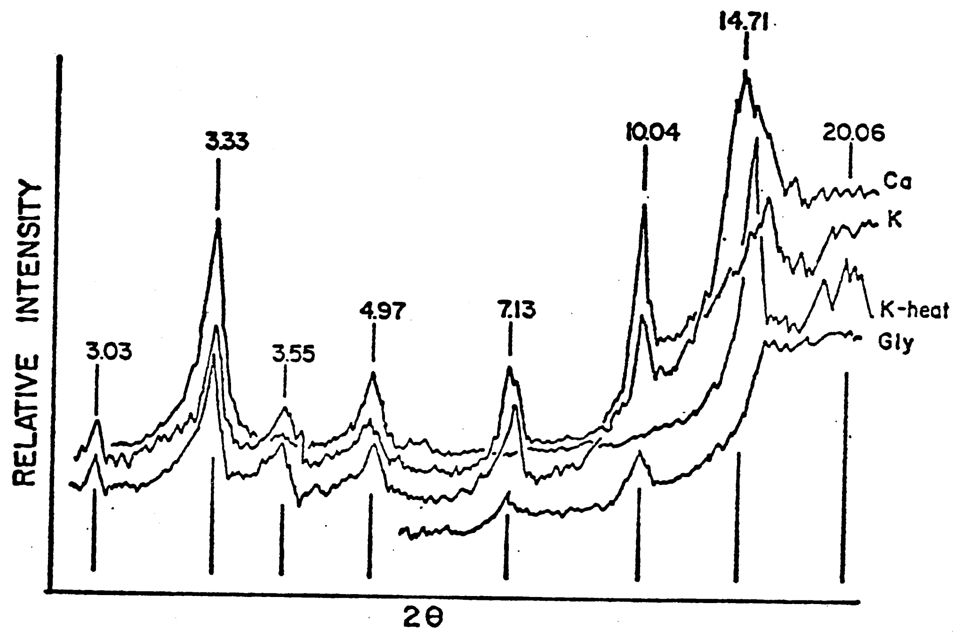

Figure 28. X-ray Diffraction Pattern and d-Spacing in Angstroms for the WOD 9-13" Coarse Clay Fraction, Southern Plains Exp. Sta. USDA Woodward, Oklahoma

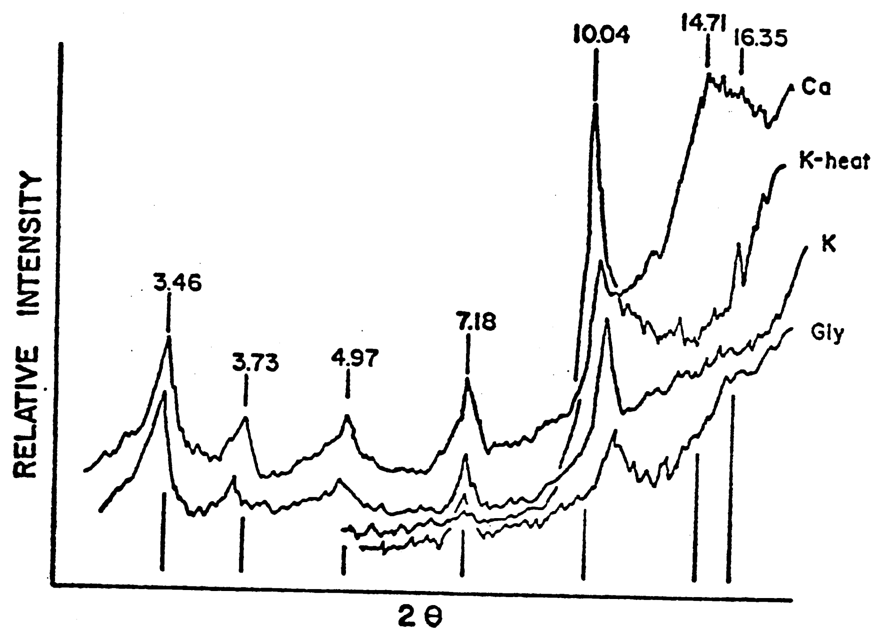

Figure 29. X-ray Diffraction Pattern and d-Spacing in Angstroms for the WOC 0-10" Coarse Clay Fraction, Southern Plains Exp. Sta. USDA Woodward, Oklahoma

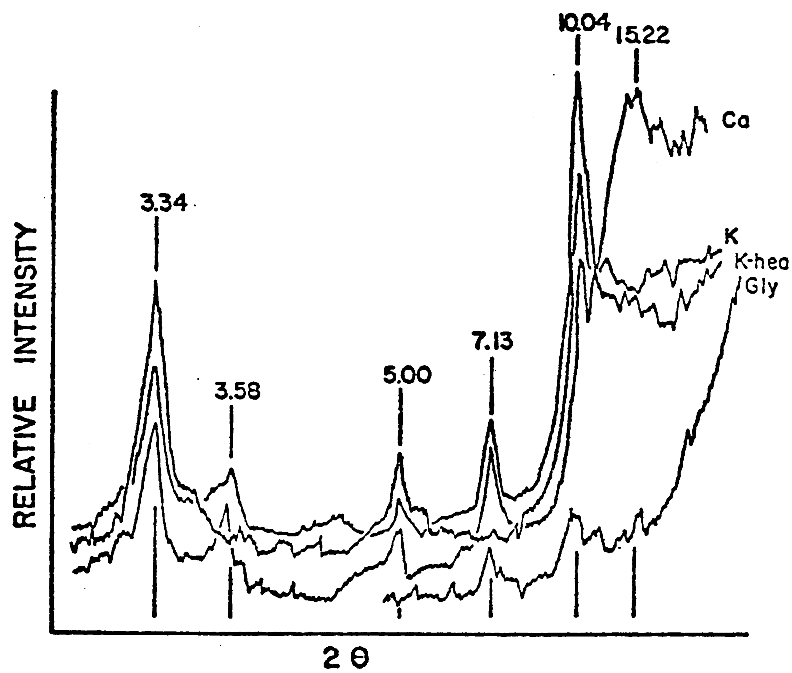

Figure 30. X-ray Diffraction Pattern and d-Spacing in Angstroms for the WOC 10-14" Coarse Clay Fraction, Southern Plains Exp.Sta. USDA Woodward, Oklahoma

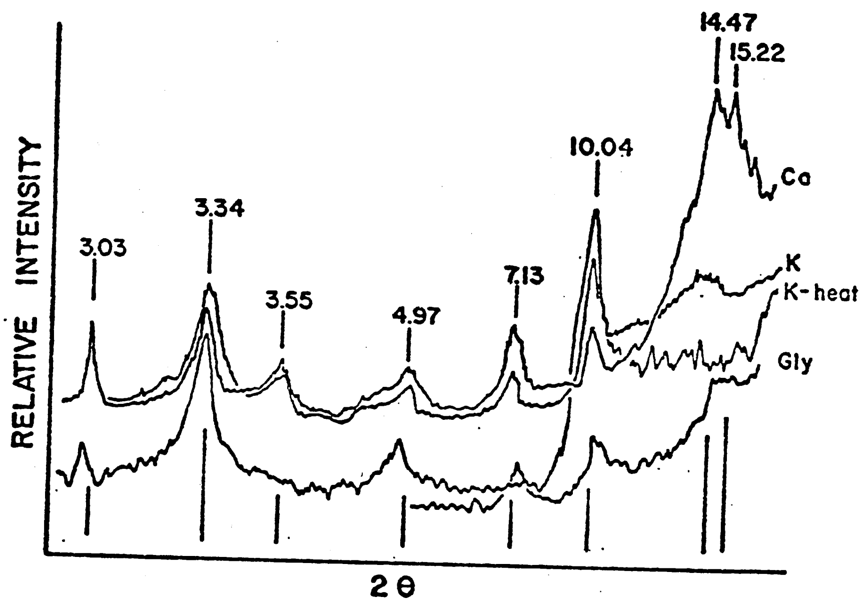

Figure 31. X-ray Diffraction Pattern and d-Spacing in Angstroms for the QWD 0-8" Coarse Clay Fraction, Southern Plains Exp. Sta. USDA Woodward, Oklahoma

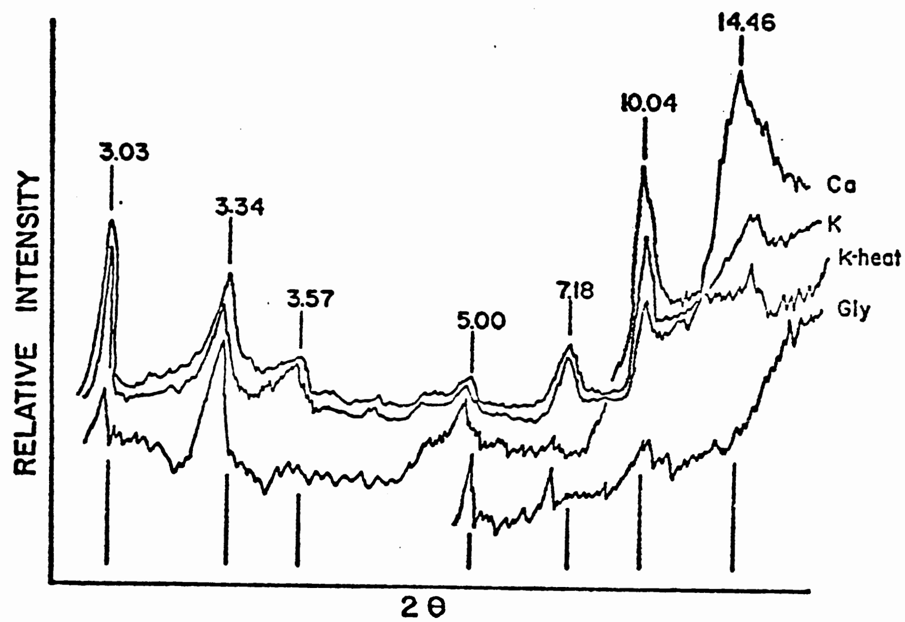

Figure 32. X-ray Diffraction Pattern and d-Spacing in Angstroms for the QWD 8-13" Coarse Clay Fraction, Southern Plains Exp. Sta. USDA Woodward, Oklahoma.

asymetric basal reflections of the 14.47 A peak in the same soil also suggests the presence of this interstratified mineral. Other clay minerals present were illite and kaolinite.

The Ca-saturated coarse clay (Figure 27) produced a very broad shoulder in which shoulder surface identification produced comparable results for electronic noise and actual detection of the clay mineral. The glycolated Ca-saturated sample produced less noise and identification of clay minerals was easier. Collapse of clay minerals with K-saturation resulted in a marked reduction of the shoulder and helped in improving the identification procedure. The heated (550^{o}) K-saturated samples showed a typical 10 A peak associated with micaceous clay minerals. The presence of a shoulder in this sample may be an indication of the presence of excess water in the sample, of poorly crystallized material such as organic matter, hydroxy aluminum polymers, iron oxides, or the presence of salts which may occupy the surface of crystalline minerals. A slight broadening of x-ray diffraction peaks was noticed because the clay fractions were not pretreated to remove iron oxides, carbonates, soluble salts, and organic matter to minimize damage to the interlayer material.

X-ray diffraction patterns of WOD surface soil in all watersheds indicate a uniform clay mineralogy (Table XVIII). Clay mineralogy of the coarse clay was dominated by hydrous mica (illite), vermiculite, montmorillonite, and kaolinite,

TABLE XVIII

X-RAY DIFFRACTION DATA FROM WOODWARD WATERSHED SOILS (001 SPACING)

Sample	Slope	Depth inch	Clay Fraction	Ca-sat 25° C	Ca-sat Gly 25° C	K-sat 25° C	K-sat 550° C	Clay Mineral
3	WOD	0-9	Coarse	10.04 S	10.04 S	10.16 B	10.04 S	Illite
				16.66 W	18.39	14.02 W	14.24 W	Vermiculite
				26.75 B	22.07 B	22.07 W	23.23 W	Montmorillonite
				7.19 S	7.13 B	7.19 S		Kaolinite
				14.72 S	14.72 W	14.02 W		Chlorite
			Fine	22.07 W	24.52 W	12.62 B	19.62 W	Montmorillonite
				19.19 W	18.02 W	16.35 W	16.35 W	Vermiculite
				14.24 W	18.39 B	15.23 W	13.80 W	Chlorite
4	WOD	9-13	Coarse	10.04 S	10.04 S	10.16 S	10.04 S	Illite
				16.35 B	18.39 B	14.02 W	14.24 W	Vermiculite
				19.19 B	22.07 B	22.07 W	23.23 W	Montmorillonite
				7.13 S	7.13 B	7.19 S		Kaolinite
				14.72 W	14.72 W	14.02 W		Chlorite
			Fine	22.07 W	24.52 W	12.62 B	19.62 W	Montmorillonite
				19.19 W	18.02 W	16.35 W	16.35 W	Vermiculite
				14.24 W	18.39 W	15.25 W	13.80 W	Chlorite
9	WOC	0-10	Coarse	10.04 S	10.04 S	10.16 B	10.04 S	Illite
				16.66 W	18.39 B	14.02 W	14.24 W	Vermiculite
				26.75 B	22.07 B	22.07 W	23.23 W	Montmorillonite
				7.19 S	7.13 B	7.19 S		Kaolinite
				14.72 S	14.72 W	14.02 W		Chlorite

TABLE XVIII (Continued)

Sample	Slope	Depth inch	Clay Fraction	Ca-sat 25° C	Ca-sat Gly 25° C	K-sat 25° C	K-sat 550° C	Clay Mineral
			Fine	21.53 W	25.22 W	12.62 B	19.62 W	Montmorillonite
				19.61 W	18.39 W	16.76 W	16.35 W	Vermiculite
				14.24 W	18.02 B	15.49 W	13.80 W	Chlorite
10	WOC	10-14	Coarse	10.04 S	10.04 S	10.15 B	10.04	Illite
				16.35 W	18.39 B	14.24 W	14.24	Vermiculite
				26.75 B	22.07 B	22.07 W	23.23	Montmorillonite
				7.13 S	7.13 B	7.19 S		Kaolinite
				14.47 S	14.72 W	14.02 W		Chlorite
			Fine	21.02 W	24.52	12.62	19.19 W	Montmorillonite
				19.19 W	18.39	16.35	16.35 W	Vermiculite
				14.71 W	18.02	15.23	13.80 W	Chlorite
17	QWD	0-8	Coarse	10.04 S	10.04 S	10.16 B	10.04 S	Illite
				16.66 W	18.39 B	14.02 W	14.24 W	Vermiculite
				26.75 B	22.07 B	22.07 W	23.23 W	Montmorillonite
				7.19 S	7.13 B	7.19 S		Kaolinite
				14.72 S	14.72 W	14.02 W		Chlorite
			Fine	21.53 W	25.22 W	12.62 B	19.62 S	Montmorillonite
				19.61 W	20.39 W	16.76 W	16.35 W	Vermiculite
				14.24 W	18.02 B	15.49 W	13.80 W	Chlorite

TABLE XVIII (Continued)

Sample	Slope	Depth inch	Clay Fraction	Ca-sat 25° C	Ca-sat Gly 25° C	K-sat 25° C	K-sat 550° C	Clay Mineral
18	QWD	8-13	Coarse	10.04 S	10.16 S	10.16 B	10.04 S	Illite
				16.66 W	18.78 B	14.26 W	14.23 W	Vermiculite
				26.75 B	22.63 B	22.07 W	23.23 W	Montmorillonite
				7.19 S	7.13 B	7.19 S		Kaolinite
				14.72 S	14.72 W	14.02 W		Chlorits
			Fine	22.07 W	24.52	12.62 B	19.62 W	Montmorillonite
				19.19 W	18.02	18.76 W	16.35 W	Vermiculite
				14.24 W	18.39	15.44 W	13.80 W	Chlorite
21	WOD	0-8	Coarse	10.04 S	10.04 S	10.16 B	10.04 S	Illite
				16.35 W	18.39 B	14.02 W	14.24 W	Vermiculite
				25.96 B	22.07 B	22.07 W	23.23 W	Montmorillonite
				7.19 S	7.13 B	7.19 S		Kaolinite
				14.72S	14.72 W	14.02 W		Chlorite
			Fine	23.23 W	25.96 W	12.44 B	19.12	Montmorillonite
				20.06 W	18.01 W	16.35 W	16.35	Vermiculite
				14.47 W	18.39 B	15.76 W	13.80	Chlorite
22		8-13	Coarse	10.27 S	10.16 S	10.04 B	10.04	Illite
				16.05 W	18.01 B	13.58 W	14.24	Vermiculite
				25.22 B	21.53 B	22.07 W	23.23	Montmorillonite
					7.19 S	7.18 B	7.07 S	Kaolinite
				14.72 S	14.72 W	14.02 W		Chlorite

TABLE XVIII (Continued)

Sample	Slope	Depth inch	Clay Fraction	Ca-sat 25° C	Ca-sat Gly 25° C	K-sat 25° C	K-sat 550° C	Clay Mineral
			Fine	21.53 W	25.22 W	12.62	19.61	Montmorillonite
				19.61 W	18.39 W	16.76	16.66	Vermiculite
				14.24 W	18.02 B	15.22	13.38	Chlorite
27	QWD	0-7	Coarse	10.04 S	10.04 S	10.16 B	10.04	Illite
				16.66 W	18.39 B	14.02 W	14.24	Vermiculite
				26.75 B	22.07 B	22.07 W	23.23	Montmorillonite
				7.19 S	7.13 B	7.19 S		Kaolinite
				14.72 S	14.72 W	14.02 W		Chlorite
			Fine	21.53 W	25.22 W	12.62	19.62 S	Montmorillonite
				19.61 W	18.39 W	16.76	16.75 W	Vermiculite
				14.24 W	18.02 B	15.44	13.80 W	Chlorite
28		7-14	Coarse	10.27 S	10.16 S	10.04 B	10.04	Illite
				16.05 W	18.01 B	13.58 W	14.24	Vermiculite
				25.22 B	21.53 B	22.07 W	23.23	Montmorillonite
				7.19 S	7.18 B	7.07 S		Kaolinite
				14.72 S	14.72 W	14.02 W		Chlorite
			Fine	23.23 W	25.96 W	12.44 B	19.62	Montmorillonite
				20.06 W	18.01 W	16.35 W	16.35	Vermiculite
				14.47 W	18.39 B	15.76 W	13.80	Chlorite

TABLE XVIII (Continued)

Sample	Slope	Depth inch	Clay Fraction	Ca-sat 25° C	Ca-sat Gly 25° C	K-sat 25° C	K-sat 550° C	Clay Mineral
31	WOD	0-10	Coarse	10.04 S	10.04 S	10.16	10.04	Illite
				16.66 W	18.39 B	14.02	14.24	Vermiculite
				26.75 B	22.07 B	22.07	23.23	Montmorillonite
				7.19 S	7.13 B	7.19		Kaolinite
				14.72 S	14.72 W	14.02		Chlorite
			Fine	22.07 W	24.52 W	12.62 B	19.62 W	Montmorillonite
				19.19 W	18.02 W	16.35 W	16.35 W	Vermiculite
				14.24 W	18.39 B	15.23 W	13.80 W	Chlorite
32		10-16	Coarse	10.04 S	10.04 S	10.16 S	10.04 S	Illite
				16.35 B	18.39 B	14.02 W	14.24 W	Vermiculite
				19.19 B	22.07 B	22.07 W	23.23 W	Montmorillonite
				7.13 S	7.13 B	7.19 S		Kaolinite
				14.72 W	14.72 W	14.02 W		Chlorite
			Fine	22.07 W	24.52 W	12.62 B	19.62 W	Montmorillonite
				19.19 W	18.02 W	16.35 W	16.35 W	Vermiculite
				14.24 W	18.39 W	15.23 W	13.80 W	Chlorite
37	QWD	0-7	Coarse	10.04 S	10.16 S	10.16	10.04	Illite
				16.66 W	20.06 B	14.71	14.24	Vermiculite
				26.75 B	21.02 B	21.53	23.23	Montmorillonite
				7.19 S	7.13 B	7.13		Kaolinite
				14.72 S	14.47 W	14.02		Chlorite

TABLE XVIII (Continued)

Sample	Slope	Depth inch	Clay Fraction	Ca-sat 25° C	Ca-sat Gly 25° C	K-sat 25° C	K-sat 550° C	Clay Mineral
			Fine	21.53 W	24.52 W	12.62 B	19.62 S	Montmorillonite
				20.06 W	21.53 W	16.76 W	16.35 W	Vermiculite
				13.58 W	18.02 B	15.49 W	13.80 W	Chlorite
38		7-16	Coarse	10.04 S	10.04 S	10.16 B	10.04 S	Illite
				16.66 W	18.39 B	14.02 W	14.24 W	Vermiculite
				26.75 B	22.07 B	22.07 W	23.23	Montmorillonite
				7.19 S	7.13 B	7.19 S		Kaolinite
				14.72 S	14.72 W	14.02 W		Chlorite
			Fine	21.53 W	25.22 W	12.62 B	19.62 S	Montmorillonite
				19.61 W	20.06 W	16.76 W	16.35 W	Vermiculite
				14.24 W	18.02 B	17.49 W	13.80 W	Chlorite

while only montmorillonite, vermiculite and chlorite dominated the mineralogy of fine fraction. The presence of chlorite mineral in the coarse and fine clay fractions of the WOD soil type is supported by the persistence of the 14 A peak with K-saturation and 550^{o} heat treatment. The absence of kaolinite in the fine clay fractions of the WOD soil type is supported by the persistence of the 7.15 (chlorite) peak after 550^{o} treatment.

Selected x-ray diffraction patterns of coarse fractions of the WOD soil type showed excellent crystallization of clay minerals which was indicated by a 10 A first order, 5 A second order and 3 A third order spacing for hydrous mica (illite), but the fine clay fractions were shown to be less well crystallized with more diffuse first, and especially, second order spacings. With increasing soil depth, detection of chlorite was observed in the x-ray of the WOD fine clay fraction. The x-ray diffraction pattern of WOC and QWD soil types of Woodward watersheds indicated the same pattern of clay mineralogy showing that all of them might have originated from the same parent material.

CHAPTER V

SUMMARY AND CONCLUSION

The surface and subsurface soil samples were collected from four unit watersheds which are highly erosive and are located at the Southern Great Plains Agricultural Station, USDA, Woodward, Oklahoma. The runoff data were collected and analyzed by the USDA Water Quality Laboratory at Durant, Oklahoma. For this study their data is correlated with data obtained in the Oklahoma State University Soil Chemistry Laboratory.

The sediment yield characteristics of these watersheds were studied. The average annual sediment yield from watershed 1 was 78.84 kg/ha compared to 1588.64 kg/ha from watershed 2. THis was a loss of 657 and 1220 kg/ha-inch of runoff, respectively. The more extensive gully system in watershed 2 was probably the primary cause for the observed differences.

Watershed 3 was in native grass but cropped with wheat beginning in September, 1978. Fertilizer P was broadcast at the rate of 20 kg/ha in September each year and the watershed was disked to incorporate the P. Average annual sediment yield from watershed 3 was six times greater than that of watershed 1 and this can be attributed to disturbance of the land by tillage and the application of P fertilizer.

Sediment yield from watershed 2 was about four times greater than that of watershed 3. A study of runoff data from watershed 4 indicates the same trend as that of watershed 3.

The conclusions and recommendations for this study are:

1. Cultural practices were not an important factor in erosion control.
2. Development of sediment yield prediction models for the Woodward, Oklahoma area needs more sediment yield data from various land uses, soil types, and areas of different rainfall characteristics.
3. To determine the magnitude of gully erosion an additional gauging site must be established to make it possible to separate the amount of sediment produced in nongullied portions of the watershed.
4. Daily temperature should be recorded for the Woodward, Oklahoma watershed for careful correlation between temperature and runoff.

The coefficients of variation for annual runoff were greatest (195%) for highly eroded watershed 2 and were least (153%) for watershed 3. The coefficients of variation for sediment discharge were greatest for watershed 4 (274%) and least for watershed 3 (220%). Generally as percent sand increased there was an increase in the surface runoff except in watershed 2.

Soluble N loss in surface runoff was a very small fraction of total N loss (soluble N and sediment N). This is in agreement with findings of Purwell et al. (1975) who reported that the amount of nutrients transported by sediments were much higher than that transported by water runoff. There was a little fertility treatment effect (12% decrease) on the amount of P carried by unit weight of sediments, however, there was a 26% decrease in runoff P in watershed 2. Higher fertilizer rate application and cultural practice accounted for sediment P differences of watersheds 3 and 4 as compared to those of watersheds 1 and 2.

There were high correlation coefficients (above 90%) between the following variables:

1. Exchangeable Na of subsoil vs. sediment yield.
2. Exchangeable Mg of surface soil vs. total P in sediment yield.
3. Exchangeable Mg of surface soil vs. sediment yield.
4. Cation exchange capacity of subsoil vs. total N of sediment yield.
5. Cation exchange capacity of surface soil and subsoil vs. soluble P in runoff.
6. Cation exchange capacity of subsoil vs. total P of

sediment yield.

7. Soluble Na of surface soil vs. total P of sediment yield.
8. Soluble K of surface soil vs. runoff.
9. Total Ca of surface soil vs. total P of sediment yield.
10. pH of subsoil vs. soluble P of runoff.
11. Exchangeable Ca of subsoil vs. total N of sediment yield.
12. Total P of subsoil vs. total N of sediment yield.
13. Soluble P of subsoil vs. runoff.
14. Percent clay of surface soil and subsoil vs. total N of sediment yield.
15. Percent clay of subsoil vs. soluble P of runoff and total P of sediment yield.

The addition of P fertilizer to these soils did not have any effect on pH, although it might have acidified the small volume of soil around the particles on a temporary basis. The electrical conductivity of surface soil was higher than that of subsoil which is in agreement with the conditions of mineral soils in arid regions. Only a small percentage of cation exchange capacity was occupied with exchangeable Na.

As far as particle size distribution was concerned, percent silt was a dominant fraction in both surface and subsurface soils. The exchangeable cations in order of abundance were Ca, Mg, K, and Na. There was evidence of clay translocation in these soils. X-ray diffraction of these soils substantiates the dominance of illite, vermiculite, montmorilonite, and kaolinite in the coarse clay (0.2-2 uM) and the dominance of montmorilonite, vermiculite, and chlorite in fine clay (<0.2 uM).

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APPENDIX A

TYPICAL SOIL PROFILES

TYPICAL SOIL PROFILE OF THE QUINLAN SERIES

The Quinlan series (Typic Ustochrept, loamy, mixed, thermic, shallow) is made up of somewhat excessively drained, shallow loamy soils that are forming in weakly consolidated calcareous red beds under a cover of grasses. The soils have mainly steep, convex slopes. These soils are members of the Regosol great soil group. They are used primarily as a rangeland.

Quinlan-Woodward loam, 5 to 12 percent slope (QWD) consists of reddish, shallow and moderately deep, steep loamy soils that occur in an irregular pattern.

The soil profile description of the Quinlan series is as follows:

A_1 0 to 9 inches, red (2.5YR 4/6) loam, dark red (2.5YR 3/6) when moist; weak, medium, granular structure; slightly hard when dry, friable when moist; many roots and pores; calcareous; gradual lower boundary. 7 to 10 inches thick.

AC 9 to 13 inches, a mixture of loam and weathered sandstone; similar in color to the A_1 horizon; calcareous; gradual lower boundary. 4 to 6 inches thick.

C 13 to 65 inches, weakly consolidated, open-grained, highly weathered sandstone that is red (2.5YR 5/6) at a depth of 60 inches; bedded structure; calcareous; seams of calcium carbonate are at various angles in cracks caused by dry weather; when moistened to capacity, the sandstone is friable, but when dry, it is hard; massive (structureless); many roots at a depth of 20 inches but few at 45 inches.

When dry, the A_1 and C horizons are red and reddish brown, hues 5YR and 2.5YR.

TYPICAL SOIL PROFILE OF THE WOODWARD SOIL SERIES

The Woodward soil series (Typic Ustochrepts, coarse-silty, mixed, thermic)is made up of well-drained, moderately deep, reddish soils of the uplands. The soils have formed in weakly consolidated red-bed sediments under native grasses. They have convex slopes that are nearly level to strongly sloping.

The Woodward soils are Regosols that integrate to reddish chestnut soils. Woodward loam, 3 to 5 percent slope (WOC) is a moderately sloping soil. It has about 10 inches of reddish brown loam over a subsoil of granular loam that takes water well. Woodward loam, 5 to 8 percent slope (WOC) is a strongly sloping soil that has about 10 inches of reddish brown loam over a subsoil of granular loam that takes water well.

The typical soil profile of Woodward soils is described as follows:

A_{1P} 0 to 4 inches, reddish brown (5YR 4/4) loam, dark reddish brown (5YR 3/4) when moist; structure has been mostly destroyed by tillage; slightly hard when dry, friable when moist; neutral.

A_{12} 4 to 10 inches, reddish brown (5YR 4/4) loam, dark reddish brown (5YR 3/4) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; slightly calcareous; pH 7.0; many roots and pores and castings of earthworms; gradual lower boundary.

AC 10 to 20 inches, reddish brown (5YR 5/4) loam, reddish brown (5YR 4/4) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; many roots, pores, and castings of earthworms; this horizon has about 5 percent more clay than the horizon above; calcareous; pH 7.5; gradual lower boundary. 8 to 12 inches thick.

C_1 20 to 26 inches, transitional layer of loam that grades to weathered sandstone below.

C_2 26 to 50 inches, red (2.5YR 4/6), highly weathered, loosely cemented, open-grained sandstone; at a depth of 45 inches material is red (2.5YR 5/8); massive (structureless); accumulations of calcium carbonate along bedding planes; very hard when dry, friable when moist; few roots; calcareous; pH 8.0.

Total thickness of the A_1 horizons ranges from 7 to 12 inches. These horizons are thinner at the crest of a slope and thicker at the bottom. Soil on colluvial foot slopes has a deeper profile than the soil just described. In some places the profile has a C_{ca} horizon.

APPENDIX B

RAINFALL DATA

OBS	WATERSHED	DATE	SEDIMENT	RUNOFF	TKNR	SOLP	TOTP
1	1	5- 6-78	0.2	0.00	0.00	0.00	0.28
2	1	5-25-78	0.1	0.00	0.00	0.01	0.33
3	1	5-26-78	0.7	0.01	0.01	0.12	2.76
4	1	5-26-78	2.9	0.04	0.03	0.44	7.88
5	1	5-27-78	117.0	0.52	0.16	1.04	44.72
6	1	6- 4-78	2.7	0.05	0.03	1.00	5.85
7	1	6- 5-78	0.4	0.01	0.00	0.09	9.94
8	1	6-17-78	0.1	0.00	0.00	0.02	0.26
9	1	7-18-78	56.9	0.49	0.11	16.66	38.71
10	1	8- 2-78	0.9	0.01	0.00	0.20	1.47
11	1	9-19-78	1.1	0.01	0.00	0.18	1.29
12	1	9-20-78	0.3	0.01	.	.	.
13	1	3-18-79	5.6	0.05	0.03	0.00	0.00
14	1	3-21-79	10.1	0.12	0.04	0.00	0.00
15	1	5- 9-79	9.7	0.48	0.04	0.00	0.01
16	1	7-23-79	0.3	0.03	0.00	0.00	0.00
17	1	7-24-79	0.2	0.01	0.00	0.00	0.00
18	1	5-27-80	27.3	0.71	0.09	12.70	22.50
19	2	2-23-78	0.8	0.04	0.01	0.68	2.32
20	2	2-24-78	2.3	0.04	0.00	0.60	1.56
21	2	4- 9-78	0.2	0.00	0.00	0.01	0.90
22	2	4-10-78	0.1	0.00	0.00	0.01	0.83
23	2	5- 6-78	14.3	0.01	0.02	0.08	0.00
24	2	5-25-78	35.0	0.03	0.11	0.21	24.66
25	2	5-26-78	248.9	0.38	0.25	3.42	90.44
26	2	5-27-78	1728.0	1.28	1.17	6.40	322.56
27	2	6- 4-78	219.5	0.29	0.16	3.19	53.07
28	2	6- 5-78	32.8	0.12	0.05	1.08	0.01
29	2	6-17-78	1.1	0.00	0.00	0.01	0.41
30	2	7-18-78	711.2	1.32	0.61	23.76	178.20
31	2	8- 2-78	9.4	0.03	0.02	0.54	5.91
32	2	9-19-78	31.8	0.14	0.04	2.94	13.86
33	2	9-20-78	1.7	0.08	0.00	0.88	2.96
34	2	2- 7-79	2.7	0.11	0.02	0.00	0.00
35	2	2-10-79	0.8	0.04	0.00	0.00	0.00
36	2	3-18-79	223.7	0.30	0.22	0.00	0.08
37	2	3-21-79	321.7	0.44	0.21	0.00	0.19
38	2	3-22-79	2.0	0.02	0.00	0.00	0.00
39	2	5- 2-79	1.2	0.01	0.00	0.00	0.00
40	2	5- 9-79	947.8	1.80	0.80	0.01	0.36
41	2	6- 9-79	0.4	0.01	0.00	0.00	0.00
42	2	6-21-79	5.7	0.04	0.02	0.00	0.00
43	2	7-23-79	31.0	0.24	0.06	0.00	0.02
44	2	7-24-79	9.4	0.08	0.03	0.00	0.00
45	2	10-29-79	55.0	0.50	0.15	0.01	0.05

OBS	WATERSHED	DATE	SEDIMENT	RUNOFF	TKNR	SOLP	TOTP
46	2	4-24-80	0.1	0.02	0.01	0.87	3.89
47	2	5- 7-80	0.0	0.00	0.00	0.14	0.60
48	2	5-15-80	0.2	0.02	0.00	0.44	0.89
49	2	5-27-80	127.0	1.28	0.23	17.15	78.72
50	2	5-30-81	0.4	0.01	0.04	1.16	2.70
51	2	6-29-81	0.0	0.00	0.00	0.14	0.41
52	2	7- 3-81	0.0	0.00	0.00	0.06	0.22
53	2	7-29-81	0.0	0.00	0.00	0.03	0.12
54	2	8- 6-81	0.2	0.00	0.00	.	0.43
55	2	8-16-81	0.2	0.00	0.00	0.12	0.71
56	2	8-28-81	0.0	0.00	0.00	.	0.09
57	2	10-16-81	0.6	0.01	0.00	0.31	1.06
58	3	5-26-78	0.3	0.01	0.00	0.04	1.47
59	3	5-26-78	5.2	0.10	0.02	0.70	6.80
60	3	5-27-78	41.2	1.23	0.29	4.92	54.12
61	3	6- 4-78	7.0	0.08	0.02	0.96	7.68
62	3	6- 5-78	4.9	0.10	0.02	0.90	6.80
63	3	6-17-78	0.2	0.00	0.00	0.00	0.15
64	3	7-18-78	16.1	0.54	0.10	12.42	32.94
65	3	8- 2-78	0.7	0.01	0.00	0.15	0.98
66	3	9-19-78	1.5	0.04	0.01	0.68	3.24
67	3	9-20-78	0.2	0.04	0.00	0.80	1.36
68	3	3-18-79	10.0	0.12	0.04	0.00	0.01
69	3	3-21-79	28.8	0.24	0.10	0.00	0.01
70	3	3-22-79	0.6	0.03	0.00	0.00	0.00
71	3	5- 9-79	24.4	1.01	0.14	0.01	0.03
72	3	7-23-79	0.8	0.03	0.01	0.00	0.00
73	3	10-29-79	1232.0	2.07	4.47	0.02	0.84
74	3	4-24-80	0.2	0.01	0.01	1.38	3.54
75	3	5- 7-80	0.1	0.00	0.00	0.23	0.40
76	3	5-27-80	199.0	0.83	.	15.18	38.01
77	3	8-16-81	715.0	0.23	3.50	.	821.00
78	3	8-28-81	499.0	0.25	1.10	7.31	265.00
79	3	10-31-81	160.0	0.25	0.40	21.03	131.00
80	3	11- 1-81	164.0	0.41	0.80	25.05	232.00
81	4	5- 6-78	3.6	0.03	0.01	0.24	4.32
82	4	5-26-78	2.8	0.02	0.01	0.20	3.24
83	4	5-26-78	21.6	0.36	0.09	3.24	22.32
84	4	5-27-78	473.5	1.77	0.23	8.85	56.64
85	4	6- 4-78	19.3	0.27	0.10	2.70	24.03
86	4	6- 5-78	12.0	0.25	0.05	2.00	14.50
87	4	7-18-78	31.2	1.02	0.21	14.28	49.98
88	4	8- 2-78	3.6	0.04	0.01	0.68	3.68
89	4	9-19-78	5.9	0.17	0.03	2.89	10.03
90	4	9-20-78	0.8	0.14	0.01	2.24	3.22

OBS	WATERSHED	DATE	SEDIMENT	RUNOFF	TKNR	SOLP	TOTP
91	4	3-18-79	34.8	0.53	0.16	0.00	0.04
92	4	3-21-79	34.8	0.46	0.15	0.00	0.03
93	4	3-22-79	1.8	0.09	0.01	0.00	0.00
94	4	5- 9-79	49.0	2.12	0.24	0.01	0.06
95	4	6- 9-79	0.2	0.01	0.00	0.00	0.00
96	4	6-21-79	0.3	0.01	0.00	0.00	0.00
97	4	7-23-79	0.8	0.07	0.01	0.00	0.00
98	4	7-24-79	0.7	0.03	0.00	0.00	0.00
99	4	10-29-79	611.0	1.44	1.51	0.01	0.30
100	4	4-24-80	1.8	0.03	0.03	2.55	5.68
101	4	4-25-80	0.2	0.00	0.00	0.49	0.77
102	4	5-15-80	0.4	0.06	0.00	2.60	3.08
103	4	5-20-80	0.0	0.00	0.00	0.13	0.36
104	4	5-27-80	18.0	0.84	0.13	12.51	36.54
105	4	8-28-81	44.9	0.12	0.50	2.25	109.00
106	4	10-16-81	37.2	0.08	0.00	1.96	6.00
107	4	10-31-81	1.7	0.02	0.00	0.56	2.00
108	4	11- 1-81	25.3	0.23	0.20	6.90	39.00

APPENDIX C

RAW SAS DATA

STATISTICAL ANALYSIS SYSTEM

WSHD=1

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
SED	18	13.13888889	29.51635915	0.10000000	117.00000000	6.95707257	236.50000000	871.21545752	224.649
RUNOFF	18	0.14166667	0.23088704	0.00000000	0.71000000	0.05442060	2.55000000	0.05330882	162.979
TKNR	17	0.03176471	0.04653430	0.00000000	0.16000000	0.01128623	0.54000000	0.00216544	146.497
SOLP	17	1.90941176	4.86850012	0.00000000	16.66000000	1.18078472	32.46000000	23.70229338	254.974
TOTP	17	8.00000000	13.97187040	0.00000000	44.72000000	3.38867632	136.00000000	195.21316250	174.648

WSHD=2

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
SED	39	122.23871795	328.26872511	0	1728.0000000	52.56506490	4767.3100000	107760.35589	268.547
RUNOFF	39	0.22282051	0.43562991	0	1.8000000	0.06975661	8.6900000	0.18977	195.507
TKNR	39	0.10846154	0.24073941	0	1.1700000	0.03854916	4.2300000	0.05796	221.958
SOLP	37	1.73648649	4.78459055	0	23.7600000	0.78658184	64.2500000	22.89231	275.533
TOTP	39	20.21102564	60.24972211	0	322.5600000	9.64767677	788.2300000	3630.02901	298.103

WSHD=3

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
SED	23	135.26608696	297.94015649	0.06000000	1232.0000000	62.12481716	3111.1200000	88768.336852	220.262
RUNOFF	23	0.33173913	0.50976512	0.00000000	2.0700000	0.10629337	7.6300000	0.259860	153.664
TKNR	22	0.50136364	1.17184549	0.00000000	4.4700000	0.24983830	11.0300000	1.373222	233.732
SOLP	22	4.17181818	7.41462881	0.00000000	25.0500000	1.58080417	91.7800000	54.976720	177.731
TOTP	23	69.88608696	179.46342136	0.00000000	821.0000000	37.42071015	1607.3800000	32207.119607	256.794

WSHD=4

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
SED	28	51.32892857	140.76197957	0.05000000	611.00000000	26.60151371	1437.2100000	19813.934891	274.235
RUNOFF	28	0.36464286	0.56521043	0.00000000	2.12000000	0.10681473	10.2100000	0.319463	155.004
TKNR	28	0.13178571	0.29353596	0.00000000	1.51000000	0.05547308	3.6900000	0.086163	222.737
SOLP	28	2.40321429	3.76678176	0.00000000	14.28000000	0.71185484	67.2900000	14.188645	156.739
TOTP	28	14.10071429	24.64423153	0.00000000	109.00000000	4.65732199	394.8200000	607.338148	174.773

STATISTICAL ANALYSIS SYSTEM

OBS	WSHD	SED	RUNOFF	TKNR	SOLP	TOTP
1	1	236.50	2.55	0.54	32.46	136.00
2	2	4767.31	8.69	4.23	64.25	788.23
3	3	3111.12	7.63	11.03	91.78	1607.38
4	4	1437.21	10.21	3.69	67.29	394.82

STATISTICAL ANALYSIS SYSTEM

WSHD=1 DEP=1

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
PHW	9	7.36666667	0.18708287	7.0000000	7.6000000	0.06236096	66.300000	0.035000	2.540
PHK	9	7.02777778	0.16029487	6.8000000	7.3000000	0.05343162	63.250000	0.025694	2.281
EC	9	599.33333333	121.53291735	400.0000000	795.0000000	40.51097245	5394.000000	14770.250000	20.278
EXCA	9	18.02777778	7.67854605	9.7500000	29.0000000	2.55951535	162.250000	58.960069	42.593
EXMG	9	1.62000000	0.67377667	0.8300000	2.5000000	0.22459222	14.560000	0.453975	41.591
EXNA	9	0.02222222	0.02108185	0.0000000	0.0400000	0.00702728	0.200000	0.000444	94.868
EXK	9	0.44666667	0.07921490	0.3400000	0.5800000	0.02640497	4.020000	0.006275	17.735
CEC	9	13.47222222	1.02857642	11.8700000	14.9500000	0.34285881	121.250000	1.057969	7.635
TP	9	153.55555556	51.31060103	116.0000000	284.0000000	17.10353368	1382.000000	2632.777778	33.415
AP	9	3.04444444	0.86474145	2.2000000	4.8000000	0.28824715	27.400000	0.747778	28.404
OM	9	1.92000000	0.22912878	1.6000000	2.2700000	0.07637626	17.280000	0.052500	11.934
TKN	9	1991.11111111	305.58650348	1344.0000000	2240.0000000	101.86216783	17920.000000	93383.111111	15.348
SCA	9	0.54555556	0.19378539	0.3000000	0.9100000	0.06459513	4.910000	0.037553	35.521
SMG	9	0.09000000	0.02872281	0.0500000	0.1400000	0.00957427	0.810000	0.000825	31.914
SNA	9	0.01022222	0.01121135	0.0040000	0.0390000	0.00373712	0.092000	0.000126	109.676
SK	9	0.07522222	0.12930466	0.0300000	0.4200000	0.04310155	0.677000	0.016720	171.897
TCA	9	30.55555556	23.00739615	10.0000000	72.5000000	7.66913205	275.000000	529.340278	75.297
TMG	9	57.86777778	20.77673806	33.3300000	87.5000000	6.92557935	520.810000	431.672844	35.904
TNA	9	0.62111111	0.22662990	0.4300000	0.8600000	0.07554330	5.590000	0.051361	36.488
TK	9	7.58666667	0.89305655	5.8900000	8.8400000	0.29768552	68.280000	0.797550	11.771
SAND	9	36.53333333	4.15331193	31.2000000	45.2000000	1.38443731	328.800000	17.250000	11.359
SILT	9	45.55555556	3.64386852	38.0000000	49.0000000	1.21462284	410.000000	13.277778	7.999
CLAY	9	17.91111111	1.83333333	15.8000000	20.8000000	0.61111111	161.200000	3.361111	10.236

WSHD=1 DEP=2

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
PHW	9	7.40000000	0.28284271	7.00000000	7.7000000	0.09428090	66.600000	0.080000	3.822
PHK	9	7.07777778	0.24888641	6.70000000	7.4000000	0.08296214	63.700000	0.061944	3.516
EC	9	429.77777778	89.34732477	285.00000000	538.0000000	29.78244159	3868.000000	7982.944444	20.789
EXCA	9	20.88888889	6.97216689	11.50000000	27.2500000	2.32405563	188.000000	48.611111	33.377
EXMG	9	1.75777778	0.90141247	0.83000000	3.3300000	0.30047082	15.820000	0.812544	51.281
EXNA	9	0.04444444	0.01333333	0.01000000	0.0800000	0.00444444	0.400000	0.000178	30.000
EXK	9	0.34222222	0.11189032	0.20000000	0.5300000	0.03729677	3.080000	0.012519	32.695
CEC	9	13.71666667	1.81996566	11.10000000	16.4500000	0.60665522	123.450000	3.312275	13.268
TP	9	133.77777778	24.19595926	92.00000000	160.0000000	8.06531975	1204.000000	585.444444	18.087
AP	9	0.91111111	0.72877370	0.00000000	2.0000000	0.24292457	8.200000	0.531111	79.987
OM	9	1.47777778	0.16107279	1.27000000	1.7500000	0.05369093	13.300000	0.025944	10.900
TKN	9	1344.00000000	193.98969045	896.00000000	1568.0000000	64.66323015	12096.000000	37632.000000	14.434
SCA	9	0.37444444	0.11886033	0.21000000	0.5500000	0.03962011	3.370000	0.014128	31.743
SMG	9	0.06444444	0.01666667	0.05000000	0.1000000	0.00555556	0.580000	0.000278	25.862
SNA	9	0.01022222	0.00399305	0.00400000	0.0170000	0.00133102	0.092000	0.000016	39.062
SK	9	0.01955556	0.00574698	0.01000000	0.0280000	0.00191566	0.176000	0.000033	29.388
TCA	9	64.44444444	55.71660684	10.00000000	160.0000000	18.57220228	580.000000	3104.340278	86.457
TMG	9	68.97888889	32.94828540	33.33000000	137.5000000	10.98276180	620.810000	1085.589511	47.766
TNA	9	0.74111111	0.18930428	0.43000000	0.8600000	0.06310143	6.670000	0.035836	25.543
TK	9	7.84555556	1.36390167	6.28000000	10.0000000	0.45463389	70.610000	1.860228	17.384
SAND	9	36.64444444	5.31768538	29.20000000	43.2000000	1.77256179	329.800000	28.277778	14.512
SILT	9	42.00000000	3.67423461	36.00000000	47.0000000	1.22474487	378.000000	13.500000	8.748
CLAY	9	21.35555556	2.96273147	16.80000000	24.8000000	0.98757716	192.200000	8.777778	13.873

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

WSHD=2 DEP=1

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
PHW	5	7.36000000	0.25099801	7.0000000	7.7000000	0.11224972	36.8000000	0.063000	3.410
PHK	5	6.62000000	0.25884358	6.2000000	6.9000000	0.11575837	33.1000000	0.067000	3.910
EC	5	561.80000000	53.83957652	505.0000000	620.0000000	24.07779060	2809.0000000	2898.700000	9.583
EXCA	5	15.68000000	6.22691738	10.4000000	25.7500000	2.78476211	78.4000000	38.774500	39.712
EXMG	5	1.58000000	0.54263247	0.8300000	2.0800000	0.24267262	7.9000000	0.294450	34.344
EXNA	5	0.03200000	0.01788854	0.0000000	0.0400000	0.00800000	0.1600000	0.000320	55.902
EXK	5	0.48000000	0.09848858	0.3500000	0.6100000	0.04404543	2.4000000	0.009700	20.518
CEC	5	13.08400000	0.61022947	12.4900000	13.8900000	0.27290291	65.4200000	0.372380	4.664
TP	5	130.00000000	10.48808848	118.0000000	142.0000000	4.69041576	650.0000000	110.000000	8.068
AP	5	2.72000000	1.60374562	0.0000000	4.2000000	0.71721684	13.6000000	2.572000	58.961
OM	5	1.98200000	0.29583779	1.6500000	2.3700000	0.13230268	9.9100000	0.087520	14.926
TKN	5	1702.40000000	122.68985288	1568.0000000	1792.0000000	54.86857024	8512.0000000	15052.800000	7.207
SCA	5	0.49000000	0.10198033	0.4000000	0.6200000	0.04560702	2.4500000	0.010400	20.812
SMG	5	0.09800000	0.03033150	0.0500000	0.1300000	0.01356466	0.4900000	0.000920	30.951
SNA	5	0.00720000	0.00178885	0.0040000	0.0080000	0.00080000	0.0360000	0.000003	24.845
SK	5	0.03820000	0.00576194	0.0330000	0.0470000	0.00257682	0.1910000	0.000033	15.084
TCA	5	56.00000000	88.98033491	12.5000000	215.0000000	39.79321550	280.0000000	7917.500000	158.893
TMG	5	57.49600000	9.94945627	50.0000000	75.0000000	4.44953211	287.4800000	98.991680	17.305
TNA	5	0.86000000	0.00000000	0.8600000	0.8600000	0.00000000	4.3000000	0.000000	0.000
TK	5	9.17600000	0.73649847	8.2000000	10.0000000	0.32937213	45.8800000	0.542430	8.026
SAND	5	36.40000000	3.89871774	31.2000000	39.2000000	1.74355958	182.0000000	15.200000	10.711
SILT	5	45.50000000	5.40832691	37.5000000	51.0000000	2.41867732	227.5000000	29.250000	11.886
CLAY	5	18.10000000	2.99165506	15.8000000	23.3000000	1.33790882	90.5000000	8.950000	16.528

WSHD=2 DEP=2

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
PHW	5	7.62000000	0.19235384	7.30000000	7.8000000	0.08602325	38.1000000	0.037000	2.524
PHK	5	6.91000000	0.26076810	6.70000000	7.3000000	0.11661904	34.5500000	0.068000	3.774
EC	5	427.40000000	92.05324546	340.00000000	560.0000000	41.16746288	2137.0000000	8473.800000	21.538
EXCA	5	21.15000000	5.62527777	13.75000000	28.2500000	2.51570070	105.7500000	31.643750	26.597
EXMG	5	1.49600000	0.47405696	0.83000000	2.0800000	0.21200472	7.4800000	0.224730	31.688
EXNA	5	0.00800000	0.01788854	0.00000000	0.0400000	0.00800000	0.0400000	0.000320	223.607
EXK	5	0.37000000	0.10074721	0.25000000	0.5100000	0.04505552	1.8500000	0.010150	27.229
CEC	5	13.24400000	0.99404728	11.70000000	14.1600000	0.44455146	66.2200000	0.988130	7.506
TP	5	136.00000000	9.27361850	124.00000000	148.0000000	4.14728827	680.0000000	86.000000	6.819
AP	5	1.56000000	1.55820409	0.00000000	3.8000000	0.69685006	7.8000000	2.428000	99.885
OM	5	1.36600000	0.18119051	1.17000000	1.6200000	0.08103086	6.8300000	0.032830	13.264
TKN	5	1254.40000000	300.52753618	896.00000000	1568.0000000	134.40000000	6272.0000000	90316.800000	23.958
SCA	5	0.35400000	0.05727128	0.30000000	0.4400000	0.02561250	1.7700000	0.003280	16.178
SMG	5	0.06000000	0.02915476	0.03000000	0.1000000	0.01303840	0.3000000	0.000850	48.591
SNA	5	0.00820000	0.00319374	0.00400000	0.0130000	0.00142829	0.0410000	0.000010	38.948
SK	5	0.02140000	0.00665582	0.01500000	0.0320000	0.00297658	0.1070000	0.000044	31.102
TCA	5	74.75000000	103.42720870	15.00000000	255.0000000	46.25405388	373.7500000	10697.187500	138.364
TMG	5	65.83200000	17.52866709	50.00000000	95.8300000	7.83905823	329.1600000	307.254170	26.626
TNA	5	0.68800000	0.23552070	0.43000000	0.8600000	0.10532806	3.4400000	0.055470	34.233
TK	5	8.86400000	1.18620403	7.43000000	10.2500000	0.53048657	44.3200000	1.407080	13.382
SAND	5	35.60000000	1.67332005	33.20000000	37.2000000	0.74833148	178.0000000	2.800000	4.700
SILT	5	44.60000000	2.07364414	42.00000000	47.0000000	0.92736185	223.0000000	4.300000	4.649
CLAY	5	19.80000000	1.87082869	17.80000000	22.8000000	0.83666003	99.0000000	3.500000	9.449

STATISTICAL ANALYSIS SYSTEM

WSHD=3 DEP=1

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
PHW	7	7.67142857	0.12535663	7.50000000	7.8000000	0.04738035	53.700000	0.01571	1.634
PHK	7	7.35000000	0.14142136	7.05000000	7.4500000	0.05345225	51.450000	0.02000	1.924
EC	7	531.85714286	94.02557909	450.00000000	718.0000000	35.53832845	3723.000000	8840.80952	17.679
EXCA	7	22.39285714	4.92835576	12.00000000	27.2500000	1.86274339	156.750000	24.28869	22.009
EXMG	7	1.12714286	0.71135351	0.41000000	2.0800000	0.26886635	7.890000	0.50602	63.111
EXNA	7	0.04000000	0.00000000	0.04000000	0.0400000	0.00000000	0.280000	0.00000	0.000
EXK	7	0.34000000	0.12220202	0.17000000	0.4800000	0.04618802	2.380000	0.01493	35.942
CEC	7	12.16000000	2.21767145	8.79000000	14.6900000	0.83820102	85.120000	4.91807	18.237
TP	7	151.14285714	8.39500986	138.00000000	160.0000000	3.17301548	1058.000000	70.47619	5.554
AP	7	3.68571429	1.50017611	1.60000000	5.6000000	0.56712666	25.800000	2.25143	40.711
OM	7	1.66571429	0.34490855	1.37000000	2.3200000	0.13036318	11.660000	0.11896	20.706
TKN	7	1504.00000000	442.63453699	896.00000000	2240.0000000	167.30012951	10528.000000	195925.33333	29.430
SCA	7	0.39000000	0.09073772	0.28000000	0.5000000	0.03429563	2.730000	0.00823	23.266
SMG	7	0.57285714	0.33757539	0.31000000	1.1400000	0.12759150	4.010000	0.11396	58.928
SNA	7	0.00642857	0.00345722	0.00400000	0.0130000	0.00130671	0.045000	0.00001	53.779
SK	7	0.02828571	0.00667618	0.01900000	0.0380000	0.00252336	0.198000	0.00004	23.603
TCA	7	69.42857143	45.52694127	12.50000000	127.5000000	17.20756636	486.000000	2072.70238	65.574
TMG	7	67.07857143	7.21912374	55.00000000	79.1600000	2.72857230	469.550000	52.11575	10.762
TNA	7	0.60571429	0.21938225	0.43000000	0.8600000	0.08291870	4.240000	0.04813	36.219
TK	7	7.81557143	1.07977511	6.41000000	9.2300000	0.40811663	54.730000	1.16591	13.810
SAND	7	42.37142857	9.41660135	32.20000000	57.2000000	3.55914077	296.600000	88.67238	22.224
SILT	7	41.68571429	6.99224060	30.00000000	50.0000000	2.64281053	291.800000	48.89143	16.774
CLAY	7	15.80000000	2.58198890	12.80000000	19.8000000	0.97590007	110.600000	6.66667	16.342

WSHD=3 DEP=2

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
PHW	7	7.80000000	0.10000000	7.60000000	7.9000000	0.03779645	54.6000000	0.01000	1.282
PHK	7	7.55000000	0.09574271	7.40000000	7.7000000	0.03618734	52.8500000	0.00917	1.268
EC	7	434.28571429	82.02786983	370.00000000	580.0000000	31.00362059	3040.0000000	6728.57143	18.888
EXCA	7	24.89285714	1.76101973	22.00000000	27.0000000	0.66560289	174.2500000	3.10119	7.074
EXMG	7	0.95000000	0.31749016	0.41000000	1.2500000	0.12000000	6.6500000	0.10080	33 420
EYNA	7	0.02285714	0.02138090	0.00000000	0.0400000	0.00808122	0.1600000	0.00046	93.541
EXK	7	0.28428571	0.11844227	0.12000000	0.4600000	0.04476697	1.9900000	0.01403	41.663
CEC	7	11.94000000	1.95556471	9 28000000	13.9800000	0.73913398	83.5800000	3.82423	16.378
TP	7	145.71428571	10.16061490	132.00000000	158.0000000	3.84035146	1020.0000000	103.23810	6.973
AP	7	1.60000000	1.87971629	0.00000000	5.4000000	0.71046598	11.2000000	3.53333	117.482
OM	7	1.50142857	0.28127262	1.20000000	2.0200000	0.10631106	10.5100000	0.07911	18.734
TKN	7	1280.00000000	359.19910913	896.00000000	2016.0000000	135.76450199	8960.0000000	129024.00000	28.062
SCA	7	0.39285714	0.07718253	0.34000000	0.5600000	0.02917225	2.7500000	0.00596	19.646
SMG	7	0.43714286	0.13984686	0.20000000	0.6000000	0.05285714	3.0600000	0.01956	31.991
SNA	7	0.00942857	0.00423703	0.00400000	0.0170000	0.00160144	0.0660000	0.00002	44.938
SK	7	0.01957143	0.00629437	0.01200000	0.0300000	0.00237905	0.1370000	0.00004	32.161
TCA	7	90.35714286	39.40781890	35.00000000	130.0000000	14.89475550	632.5000000	1552.97619	43.613
TMG	7	70.83000000	6.80447892	58.33000000	79.1600000	2.57185129	495.8100000	46.30093	9.607
TNA	7	0.72857143	0.20440390	0.43000000	0.8600000	0.07725741	5.1000000	0.04178	28.055
TK	7	7.81428571	1.34146508	6.15000000	9.6100000	0.50702614	54.7000000	1.79953	17.167
SAND	7	43.62857143	8.36375400	33.20000000	56.2000000	3.16120187	305.4000000	69.95238	19.170
SILT	7	41.00000000	4.93288286	33.00000000	47.0000000	1.86445447	287.0000000	24.33333	12.031
CLAY	7	16.80000000	2.16024690	13.80000000	19.8000000	0.81649658	117.6000000	4.66667	12.859

STATISTICAL ANALYSIS SYSTEM

WSHD=4 DEP=1

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
PHW	6	7.56666667	0.13662601	7.40000000	7.8000000	0.05577734	45.4000000	0.018667	1.806
PHK	6	7.00000000	0.12649111	6.80000000	7.1000000	0.05163978	42.0000000	0.016000	1.807
EC	6	408.83333333	140.27176005	180.00000000	570.0000000	57.26570624	2453.0000000	19676.166667	34.310
EXCA	6	16.77000000	6.10421166	7.75000000	24.8700000	2.49203398	100.6200000	37.261400	36.400
EXMG	6	1.66333333	0.37119626	1.25000000	2.0800000	0.15154024	9.9800000	0.137787	22.316
EXNA	6	0.04000000	0.00000000	0.04000000	0.0400000	0.00000000	0.2400000	0.000000	0.000
EXK	6	0.38333333	0.05573748	0.30000000	0.4600000	0.02275473	2.3000000	0.003107	14.540
CEC	6	12.46500000	1.05308594	10.82000000	13.8100000	0.42992054	74.7900000	1.108990	8.448
TP	6	133.66666667	14.93541652	106.00000000	148.0000000	6.09735826	802.0000000	223.066667	11.174
AP	6	5.06666667	2.27918114	1.40000000	8.4000000	0.93047180	30.4000000	5.194667	44.984
OM	6	1.46833333	0.20875025	1.29000000	1.8700000	0.08522193	8.8100000	0.043577	14.217
TKN	6	1344.00000000	245.37970576	896.00000000	1568.0000000	100.17584539	8064.0000000	60211.200000	18.257
SCA	6	0.37333333	0.16268579	0.14000000	0.5800000	0.06641620	2.2400000	0.026467	43.577
SMG	6	0.63833333	0.16750124	0.41000000	0.8300000	0.06838210	3.8300000	0.028057	26.240
SNA	6	0.00966667	0.00258199	0.00800000	0.0130000	0.00105409	0.0580000	0.000007	26.710
SK	6	0.02166667	0.00578504	0.01600000	0.0300000	0.00236173	0.1300000	0.000033	26.700
TCA	6	22.91666667	15.11759161	10.00000000	52.5000000	6.17173215	137.5000000	228.541667	65.968
TMG	6	55.85833333	10.03697846	37.50000000	66.6600000	4.09757930	335.1500000	100.740937	17.969
TNA	6	0.57333333	0.22205105	0.43000000	0.8600000	0.09065196	3.4400000	0.049307	38.730
TK	6	6.94000000	0.86046499	6.15000000	8.4600000	0.35128336	41.6400000	0.740400	12.399
SAND	6	43.20000000	3.34664011	38.20000000	47.2000000	1.36626010	259.2000000	11.200000	7.747
SILT	6	39.25000000	2.56417628	37.00000000	43.0000000	1.04682058	235.5000000	6.575000	6.533
CLAY	6	17.55000000	1.33229126	15.30000000	18.8000000	0.54390563	105.3000000	6.775000	7.591

WSHD=4 DEP=2

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
PHW	6	7.70000000	0.14142136	7.50000000	7.8000000	0.05773503	46.2000000	0.02000	1.837
PHK	6	7.10000000	0.08366600	7.00000000	7.2500000	0.03415650	42.6000000	0.00700	1.178
EC	6	370.00000000	103.92304845	220.00000000	540.0000000	42.42640687	2220.0000000	10800.00000	28.087
EXCA	6	22.08666667	8.21961475	8.50000000	28.5000000	3.35564367	132.5200000	67.56907	37.215
EXMG	6	2.01166667	0.55549677	1.25000000	3.5000000	0.22678061	12.0700000	0.30858	27.614
EXNA	6	0.03333333	0.01632993	0.00000000	0.0400000	0.00666667	0.2000000	0.00027	48.990
EXK	6	0.33833333	0.08975894	0.25000000	0.5100000	0.03664393	2.0300000	0.00806	26.530
CEC	6	13.32166667	1.27694035	11.43000000	14.5100000	0.52130872	79.9300000	1.63058	9.585
TP	6	139.33333333	11.21903145	120.00000000	152.0000000	4.58015041	836.0000000	125.86667	8.052
AP	6	1.53333333	1.77838878	0.00000000	5.0000000	0.72602418	9.2000000	3.16267	115.982
OM	6	1.31166667	0.23659389	1.02000000	1.6700000	0.09658905	7.8700000	0.05598	18.038
TKN	6	1381.33333333	478.68263669	896.00000000	2016.0000000	195.42136810	8288.0000000	229137.06667	34.654
SCA	6	0.31000000	0.10899541	0.15000000	0.4900000	0.04449719	1.8600000	0.01188	35.160
SMG	6	0.61833333	0.12967909	0.41000000	0.7200000	0.05294127	3.7100000	0.01682	20.972
SNA	6	0.01266667	0.00697615	0.00800000	0.0260000	0.00284800	0.0760000	0.00005	55.075
SK	6	0.01816667	0.01570244	0.01000000	0.0500000	0.00641049	0.1090000	0.00025	86.435
TCA	6	45.20833333	26.88420385	10.00000000	80.0000000	10.97543026	271.2500000	722.76042	59.467
TMG	6	65.62333333	18.43609467	45.83000000	93.7500000	7.52650413	393.7400000	339.88959	28.094
TNA	6	0.57333333	0.22205105	0.43000000	0.8600000	0.09065196	3.4400000	0.04931	38.730
TK	6	6.89666667	0.86036426	6.15000000	8.4600000	0.35124224	41.3800000	0.74023	12.475
SAND	6	39.86666667	4.50185147	35.20000000	47.2000000	1.83787317	239.2000000	20.26667	11.292
SILT	6	40.75000000	2.89395923	37.00000000	44.0000000	1.18145391	244.5000000	8.37500	7.102
CLAY	6	19.38333333	2.41695401	15.30000000	22.8000000	0.98671734	116.3000000	5.84167	12.469

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

OBS	WSHD	DEP	PHW	PHK	EC	EXCA	EXMG	EXNA	EXK	CEC	TP	AP	OM
1	1	1	7.36667	7.02778	599.333	18.0278	1.62000	0.0222222	0.446667	13.4722	153.556	3.04444	1.92000
2	1	2	7.40000	7.07778	429.778	20.8889	1.75778	0.0444444	0.342222	13.7167	133.778	0.91111	1.47778
3	2	1	7.36000	6.62000	561.800	15.6800	1.58000	0.0320000	0.480000	13.0840	130.000	2.72000	1.98200
4	2	2	7.62000	6.91000	427.400	21.1500	1.49600	0.0080000	0.370000	13.2440	136.000	1.56000	1.36600
5	3	1	7.67143	7.35000	531.857	22.3929	1.12714	0.0400000	0.340000	12.1600	151.143	3.68571	1.66571
6	3	2	7.80000	7.55000	434.286	24.8929	0.95000	0.0228571	0.284286	11.9400	145.714	1.60000	1.50143
7	4	1	7.56667	7.00000	408.833	16.7700	1.66333	0.0400000	0.383333	12.4650	133.667	5.06667	1.46833
8	4	2	7.70000	7.10000	370.000	22.0867	2.01167	0.0333333	0.338333	13.3217	139.333	1.53333	1.31167

OBS	TKN	SCA	SMG	SNA	SK	TCA	TMG	TNA	TK	SAND	SILT	CLAY
1	1991.11	0.545556	0.090000	0.0102222	0.0752222	30.5556	57.8678	0.621111	7.58667	36.5333	45.5556	17.9111
2	1344.00	0.374444	0.064444	0.0102222	0.0195556	64.4444	68.9789	0.741111	7.84556	36.6444	42.0000	21.3556
3	1702.40	0.490000	0.098000	0.0072000	0.0382000	56.0000	57.4960	0.860000	9.17600	36.4000	45.5000	18.1000
4	1254.40	0.354000	0.060000	0.0082000	0.0214000	74.7500	65.8320	0.688000	8.86400	35.6000	44.6000	19.8000
5	1504.00	0.390000	0.572857	0.0064286	0.0282857	69.4286	67.0786	0.605714	7.81857	42.3714	41.6857	15.8000
6	1280.00	0.392857	0.437143	0.0094286	0.0195714	90.3571	70.8300	0.728571	7.81429	43.6286	41.0000	16.8000
7	1344.00	0.373333	0.638333	0.0096667	0.0216667	22.9167	55.8583	0.573333	6.94000	43.2000	39.2500	17.5500
8	1381.33	0.310000	0.618333	0.0126667	0.0181667	45.2083	65.6233	0.573333	6.89667	39.8667	40.7500	19.3833

STATISTICAL ANALYSIS SYSTEM

DEP=1

VARIABLE	N	MEAN	STD DEV	SUM	MINIMUM	MAXIMUM
CLAY	4	17.34027778	1.05189790	69.36111111	15.80000000	18.10000000

CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / N = 4

	SED	RUNOFF	TKNR	SOLP	TOTP	PHW	PHK	EC	EXCA	EXMG	EXNA	EXK	CEC
SED	1.00000	0.55877	0.51068	0.59187	0.62210	0.01574	-0.40137	0.08799	-0.07068	-0.33335	0.38380	0.16760	-0.26029
	0.0000	0.4412	0.4893	0.4081	0.3779	0.9843	0.5986	0.9120	0.9293	0.6666	0.6162	0.8324	0.7397
RUNOFF	0.55877	1.00000	0.41557	0.69667	0.34642	0.44949	-0.18309	-0.77598	-0.18621	-0.04302	0.86260	-0.28341	-0.67490
	0.4412	0.0000	0.5844	0.3033	0.6536	0.5505	0.8169	0.2240	0.8138	0.9570	0.1374	0.7166	0.3251
TKNR	0.51068	0.41557	1.00000	0.94172	0.97929	0.80744	0.57592	-0.15198	0.76596	-0.92659	0.73447	-0.72524	-0.84547
	0.4893	0.5844	0.0000	0.0583	0.0207	0.1926	0.4241	0.8480	0.2340	0.0734	0.2655	0.2748	0.1545
SOLP	0.59187	0.69667	0.94172	1.00000	0.89567	0.81510	0.40124	-0.41943	0.54226	-0.74625	0.90378	-0.69146	-0.92435
	0.4081	0.3033	0.0583	0.0000	0.1043	0.1849	0.5988	0.5806	0.4577	0.2537	0.0962	0.3085	0.0756
TOTP	0.62210	0.34642	0.97929	0.89567	1.00000	0.67216	0.46629	0.01848	0.72488	-0.93329	0.62272	-0.57997	-0.72813
	0.3779	0.6536	0.0207	0.1043	0.0000	0.3278	0.5337	0.9815	0.2751	0.0667	0.3773	0.4200	0.2719
PHW	0.01574	0.44949	0.80744	0.81510	0.67216	1.00000	0.79469	-0.56809	0.73635	-0.69848	0.83792	-0.97986	-0.95685
	0.9843	0.5505	0.1926	0.1849	0.3278	0.0000	0.2053	0.4319	0.2636	0.3015	0.1621	0.0201	0.0432
PHK	-0.40137	-0.18309	0.57592	0.40124	0.46629	0.79469	1.00000	-0.12874	0.91740	-0.70529	0.33458	-0.88987	-0.58969
	0.5986	0.8169	0.4241	0.5988	0.5337	0.2053	0.0000	0.8713	0.0826	0.2947	0.6654	0.1101	0.4103
EC	0.08799	-0.77598	-0.15198	-0.41943	0.01848	-0.56809	-0.12874	1.00000	0.12255	-0.15658	-0.76749	0.50922	0.64716
	0.9120	0.2240	0.8480	0.5806	0.9815	0.4319	0.8713	0.0000	0.8775	0.8434	0.2325	0.4908	0.3528
EXCA	-0.07068	-0.18621	0.76596	0.54226	0.72488	0.73635	0.91740	0.12255	1.00000	-0.91686	0.31745	-0.79015	-0.57974
	0.9293	0.8138	0.2340	0.4577	0.2751	0.2636	0.0826	0.8775	0.0000	0.0831	0.6825	0.2099	0.4203
EXMG	-0.33335	-0.04302	-0.92659	-0.74625	-0.93329	-0.69848	-0.70529	-0.15658	-0.91686	1.00000	-0.44881	0.67636	0.64785
	0.6666	0.9570	0.0734	0.2537	0.0667	0.3015	0.2947	0.8434	0.0831	0.0000	0.5512	0.3236	0.3521
EXNA	0.38380	0.86260	0.73447	0.90378	0.62272	0.83792	0.33458	-0.76749	0.31745	-0.44881	1.00000	-0.72125	-0.95510
	0.6162	0.1374	0.2655	0.0962	0.3773	0.1621	0.6654	0.2325	0.6825	0.5512	0.0000	0.2788	0.0449
EXK	0.16760	-0.28341	-0.72524	-0.69146	-0.57997	-0.97986	-0.88987	0.50922	-0.79015	0.67636	-0.72125	1.00000	0.88026
	0.8324	0.7166	0.2748	0.3085	0.4200	0.0201	0.1101	0.4908	0.2099	0.3236	0.2788	0.0000	0.1197
CEC	-0.26029	-0.67490	-0.84547	-0.92435	-0.72813	-0.95685	-0.58969	0.64716	-0.57974	0.64785	-0.95510	0.88026	1.00000
	0.7397	0.3251	0.1545	0.0756	0.2719	0.0432	0.4103	0.3528	0.4203	0.3521	0.0449	0.1197	0.0000
TP	-0.54740	-0.77767	0.14995	-0.16104	0.14082	0.20892	0.75279	0.48833	0.74186	-0.48465	-0.35283	-0.36998	0.06111
	0.4526	0.2223	0.8500	0.8390	0.8592	0.7911	0.2472	0.5117	0.2581	0.5153	0.6472	0.6300	0.9389
AP	-0.36220	0.55234	0.12830	0.32315	-0.06883	0.64860	0.37491	-0.94703	0.06247	0.09112	0.67135	-0.65078	-0.63270
	0.6378	0.4477	0.8717	0.6769	0.9312	0.3514	0.6251	0.0530	0.9375	0.9089	0.3287	0.3492	0.3673

STATISTICAL ANALYSIS SYSTEM

DEP=1

VARIABLE	N	MEAN	STD DEV	SUM	MINIMUM	MAXIMUM
SED	4	2388.03500000	1976.27363825	9552.14000000	236.50000000	4767.31000000
RUNOFF	4	7.27000000	3.32004016	29.08000000	2.55000000	10.21000000
TKNR	4	4.87250000	4.41574739	19.49000000	0.54000000	11.03000000
SOLP	4	63.94500000	24.34046357	255.78000000	32.46000000	91.78000000
TOTP	4	731.60750000	642.48416154	2926.43000000	136.00000000	1607.38000000
PHW	4	7.49119048	0.15373088	29.96476190	7.36000000	7.67142857
PHK	4	6.99944444	0.29870296	27.99777778	6.62000000	7.35000000
EC	4	525.45595238	82.50367209	2101.82380952	408.83333333	599.33333333
EXCA	4	18.21765873	2.94413339	72.87063492	15.68000000	22.39285714
EXMG	4	1.49761905	0.24931744	5.99047619	1.12714286	1.66333333
EXNA	4	0.03355556	0.00844444	0.13422222	0.02222222	0.04000000
EXK	4	0.41250000	0.06279744	1.65000000	0.34000000	0.48000000
CEC	4	12.79530556	0.59281126	51.18122222	12.16000000	13.47222222
TP	4	142.09126984	11.87961915	568.36507937	130.00000000	153.55555556
AP	4	3.62920635	1.03892380	14.51682540	2.72000000	5.06666667
OM	4	1.75901190	0.23723359	7.03604762	1.46833333	1.98200000
TKN	4	1635.37777778	278.80657130	6541.51111111	1344.00000000	1991.11111111
SCA	4	0.44972222	0.08207382	1.79888889	0.37333333	0.54555556
SMG	4	0.34979762	0.29659470	1.39919048	0.09000000	0.63833333
SNA	4	0.00837937	0.00184840	0.03351746	0.00642857	0.01022222
SK	4	0.04084365	0.02390491	0.16337460	0.02166667	0.07522222
TCA	4	44.72519841	21.70843634	178.90079365	22.91666667	69.42857143
TMG	4	59.57517063	5.07786188	238.30068254	55.85833333	67.07857143
TNA	4	0.66503968	0.13148993	2.66015873	0.57333333	0.86000000
TK	4	7.88030952	0.94039593	31.52123810	6.94000000	9.17600000
SAND	4	39.62619048	3.66435611	158.50476190	36.40000000	43.20000000
SILT	4	42.99781746	3.08602722	171.99126984	39.25000000	45.55555556

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

DEP=1

CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / N = 4

	SED	RUNOFF	TKNR	SOLP	TOTP	PHW	PHK	EC	EXCA	EXMG	EXNA	EXK	CEC
OM	0.27949	-0.56347	-0.34095	-0.49471	-0.14668	-0.80482	-0.53116	0.90773	-0.26973	0.13789	-0.77304	0.80089	0.77894
	0.7205	0.4365	0.6590	0.5053	0.8533	0.1952	0.4688	0.0923	0.7303	0.8621	0.2270	0.1991	0.2211
TKN	-0.25642	-0.89589	-0.55468	-0.77663	-0.41871	-0.76807	-0.24643	0.89637	-0.14795	0.23710	-0.97129	0.66067	0.88710
	0.7436	0.1041	0.4453	0.2234	0.5813	0.2319	0.7536	0.1036	0.8520	0.7629	0.0287	0.3393	0.1129
SCA	-0.16627	-0.78440	-0.66083	-0.82142	-0.51440	-0.89156	-0.45612	0.84031	-0.35753	0.39932	-0.97438	0.81172	0.95691
	0.8337	0.2156	0.3392	0.1786	0.4856	0.1084	0.5439	0.1597	0.6425	0.6007	0.0256	0.1883	0.0431
SMG	-0.08712	0.60840	0.59038	0.70538	0.41747	0.93112	0.62660	-0.82504	0.45881	-0.39381	0.88278	-0.90307	-0.92056
	0.9129	0.3916	0.4096	0.2946	0.5825	0.0689	0.3734	0.1750	0.5412	0.6062	0.1172	0.0969	0.0794
SNA	-0.85827	-0.39601	-0.84785	-0.80295	-0.92806	-0.38618	-0.11074	-0.15155	-0.45116	0.76992	-0.49816	0.25054	0.52358
	0.1417	0.6040	0.1521	0.1971	0.0719	0.6138	0.8893	0.8485	0.5488	0.2301	0.5018	0.7495	0.4764
SK	-0.50169	-0.95307	-0.63755	-0.85755	-0.54617	-0.69343	-0.11371	0.77742	-0.11599	0.30560	-0.97430	0.54756	0.86610
	0.4983	0.0469	0.3625	0.1425	0.4538	0.3066	0.8863	0.2226	0.8840	0.6944	0.0257	0.4524	0.1339
TCA	0.74520	0.12796	0.80690	0.67137	0.90955	0.30881	0.20399	0.38422	0.56740	-0.83583	0.29404	-0.21468	-0.38406
	0.2548	0.8720	0.1931	0.3286	0.0905	0.6912	0.7860	0.6158	0.4326	0.1642	0.7060	0.7853	0.6159
TMG	0.25531	-0.06169	0.88201	0.67301	0.89118	0.66496	0.74035	0.22262	0.94336	-0.99421	0.36526	-0.66302	-0.58637
	0.7447	0.9383	0.1180	0.3270	0.1088	0.3350	0.2596	0.7774	0.0566	0.0058	0.6347	0.3370	0.4136
TNA	0.77308	0.14753	-0.11011	-0.05369	0.06366	-0.62203	-0.81532	0.43495	-0.51778	0.17760	-0.23378	0.75226	0.40424
	0.2269	0.8525	0.8899	0.9463	0.9363	0.3780	0.1847	0.5650	0.4822	0.8224	0.7662	0.2477	0.5958
TK	0.81859	0.04688	0.09404	0.06956	0.28185	-0.49692	-0.61959	0.57855	-0.25630	-0.08835	-0.21597	0.61710	0.31397
	0.1814	0.9531	0.9060	0.9304	0.7181	0.5031	0.3804	0.4214	0.7437	0.9116	0.7840	0.3829	0.6860
SAND	-0.11206	0.58942	0.57991	0.69050	0.40494	0.93073	0.63980	-0.82137	0.46539	-0.39007	0.87034	-0.90783	-0.91295
	0.8879	0.4106	0.4201	0.3095	0.5951	0.0693	0.3602	0.1786	0.5346	0.6099	0.1297	0.0922	0.0871
SILT	0.16752	-0.65101	-0.39961	-0.57168	-0.21328	-0.81934	-0.48420	0.92767	-0.25271	0.16644	-0.83767	0.79246	0.82453
	0.8325	0.3490	0.6004	0.4283	0.7867	0.1807	0.5158	0.0723	0.7473	0.8336	0.1623	0.2075	0.1755
CLAY	-0.11765	-0.14827	-0.91093	-0.78001	-0.84664	-0.89160	-0.86136	0.13622	-0.94404	0.93780	-0.60890	0.88983	0.80985
	0.8823	0.8517	0.0891	0.2200	0.1534	0.1084	0.1386	0.8638	0.0560	0.0622	0.3911	0.1102	0.1902

	TP	AP	OM	TKN	SCA	SMG	SNA	SK	TCA	TMG	TNA	TK	SAND
SED	-0.54740	-0.36220	0.27949	-0.25642	-0.16627	-0.08712	-0.85827	-0.50169	0.74520	0.25531	0.77308	0.81859	-0.11206
	0.4526	0.6378	0.7205	0.7436	0.8337	0.9129	0.1417	0.4983	0.2548	0.7447	0.2269	0.1814	0.8879
RUNOFF	-0.77767	0.55234	-0.56347	-0.89589	-0.78440	0.60840	-0.39601	-0.95307	0.12796	-0.06169	0.14753	0.04688	0.58942
	0.2223	0.4477	0.4365	0.1041	0.2156	0.3916	0.6040	0.0469	0.8720	0.9383	0.8525	0.9531	0.4106
TKNR	0.14995	0.12830	-0.34095	-0.55468	-0.66083	0.59038	-0.84785	-0.63755	0.80690	0.88201	-0.11011	0.09404	0.57991
	0.8500	0.8717	0.6590	0.4453	0.3392	0.4096	0.1521	0.3625	0.1931	0.1180	0.8899	0.9060	0.4201

STATISTICAL ANALYSIS SYSTEM

DEP=1

CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / N = 4

	TP	AP	OM	TKN	SCA	SMG	SNA	SK	TCA	TMG	TNA	TK	SAND
SOLP	-0.16104	0.32315	-0.49471	-0.77663	-0.82142	0.70538	-0.80295	-0.85755	0.67137	0.67301	-0.05369	0.06956	0.69050
	0.8390	0.6769	0.5053	0.2234	0.1786	0.2946	0.1971	0.1425	0.3286	0.3270	0.9463	0.9304	0.3095
TOTP	0.14082	-0.06883	-0.14668	-0.41871	-0.51440	0.41747	-0.92806	-0.54617	0.90955	0.89118	0.06366	0.28185	0.40494
	0.8592	0.9312	0.8533	0.5813	0.4856	0.5825	0.0719	0.4538	0.0905	0.1088	0.9363	0.7181	0.5951
PHW	0.20892	0.64860	-0.80482	-0.76807	-0.89156	0.93112	-0.38618	-0.69343	0.30881	0.66496	-0.62203	-0.49692	0.93073
	0.7911	0.3514	0.1952	0.2319	0.1084	0.0689	0.6138	0.3066	0.6912	0.3350	0.3780	0.5031	0.0693
PHK	0.75279	0.37491	-0.53116	-0.24643	-0.45612	0.62660	-0.11074	-0.11371	0.20399	0.74035	-0.81532	-0.61959	0.63980
	0.2472	0.6251	0.4688	0.7536	0.5439	0.3734	0.8893	0.8863	0.7960	0.2596	0.1847	0.3804	0.3602
EC	0.48833	-0.94703	0.90773	0.89637	0.84031	-0.82504	-0.15155	0.77742	0.38422	0.22262	0.43495	0.57855	-0.82137
	0.5117	0.0530	0.0923	0.1036	0.1597	0.1750	0.8485	0.2226	0.6158	0.7774	0.5650	0.4214	0.1786
EXCA	0.74186	0.06247	-0.26973	-0.14795	-0.35753	0.45881	-0.45116	-0.11599	0.56740	0.94336	-0.51778	-0.25630	0.46539
	0.2581	0.9375	0.7303	0.8520	0.6425	0.5412	0.5488	0.8840	0.4326	0.0566	0.4822	0.7437	0.5346
EXMG	-0.48465	0.09112	0.13789	0.23710	0.39932	-0.39381	0.76992	0.30560	-0.83583	-0.99421	0.17760	-0.08835	-0.39007
	0.5153	0.9089	0.8621	0.7629	0.6007	0.6062	0.2301	0.6944	0.1642	0.0058	0.8224	0.9116	0.6099
EXNA	-0.35283	0.67135	-0.77304	-0.97129	-0.97438	0.88278	-0.49816	-0.97430	0.29404	0.36526	-0.23378	-0.21597	0.87034
	0.6472	0.3287	0.2270	0.0287	0.0256	0.1172	0.5018	0.0257	0.7060	0.6347	0.7662	0.7840	0.1297
EXK	-0.36998	-0.65078	0.80089	0.66067	0.81172	-0.90307	0.25054	0.54756	-0.21468	-0.66302	0.75226	0.61710	-0.90783
	0.6300	0.3492	0.1991	0.3393	0.1883	0.0969	0.7495	0.4524	0.7853	0.3370	0.2477	0.3829	0.0922
CEC	0.06111	-0.63270	0.77894	0.88710	0.95691	-0.92056	0.52358	0.86610	-0.38406	-0.58637	0.40424	0.31397	-0.91295
	0.9389	0.3673	0.2211	0.1129	0.0431	0.0794	0.4764	0.1339	0.6159	0.4136	0.5958	0.6860	0.0871
TP	1.00000	-0.19575	0.08841	0.45244	0.24227	-0.03242	0.10363	0.55171	0.13915	0.57425	-0.55555	-0.34530	-0.01297
	0.0000	0.8042	0.9116	0.5476	0.7577	0.9676	0.8964	0.4483	0.8609	0.4258	0.4444	0.6547	0.9870
AP	-0.19575	1.00000	-0.97375	-0.80005	-0.80468	0.87430	0.30114	-0.61707	-0.47174	-0.12827	-0.69969	-0.80569	0.87858
	0.8042	0.0000	0.0263	0.2000	0.1953	0.1257	0.6989	0.3829	0.5283	0.8717	0.3003	0.1943	0.1214
OM	0.08841	-0.97375	1.00000	0.85255	0.89341	-0.96005	-0.12048	0.68717	0.27622	-0.09910	0.73299	0.77806	-0.96332
	0.9116	0.0263	0.0000	0.1475	0.1066	0.0399	0.8795	0.3128	0.7238	0.9009	0.2670	0.2219	0.0367
TKN	0.45244	-0.80005	0.85255	1.00000	0.97446	-0.89759	0.29606	0.96476	-0.06476	-0.15292	0.29055	0.33624	-0.88695
	0.5476	0.2000	0.1475	0.0000	0.0255	0.1024	0.7039	0.0352	0.9352	0.8471	0.7094	0.6638	0.1130
SCA	0.24227	-0.80468	0.89341	0.97446	1.00000	-0.96404	0.32360	0.91796	-0.13343	-0.32918	0.43833	0.42999	-0.95683
	0.7577	0.1953	0.1066	0.0255	0.0000	0.0360	0.6764	0.0820	0.8666	0.6708	0.5617	0.5700	0.0432
SMG	-0.03242	0.87430	-0.96005	-0.89759	-0.96404	1.00000	-0.14928	-0.78044	0.00311	0.34712	-0.66131	-0.63944	0.99966
	0.9676	0.1257	0.0399	0.1024	0.0360	0.0000	0.8507	0.2196	0.9969	0.6529	0.3387	0.3606	0.0003
SNA	0.10363	0.30114	-0.12048	0.29606	0.32360	-0.14928	1.00000	0.50004	-0.96093	-0.71443	-0.42956	-0.60584	-0.13040
	0.8964	0.6989	0.8795	0.7039	0.6764	0.8507	0.0000	0.5000	0.0391	0.2856	0.5704	0.3942	0.8696

STATISTICAL ANALYSIS SYSTEM

DEP=1

CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / N = 4

	TP	AP	OM	TKN	SCA	SMG	SNA	SK	TCA	TMG	TNA	TK	SAND
SK	0.55171 0.4483	-0.61707 0.3829	0.68717 0.3128	0.96476 0.0352	0.91796 0.0820	-0.78044 0.2196	0.50004 0.5000	1.00000 0.0000	-0.26268 0.7373	-0.20911 0.7909	0.05070 0.9493	0.07840 0.9216	-0.76415 0.2359
TCA	0.13915 0.8609	-0.47174 0.5283	0.27622 0.7238	-0.06476 0.9352	-0.13343 0.8666	0.00311 0.9969	-0.96093 0.0391	-0.26268 0.7373	1.00000 0.0000	0.80790 0.1921	0.39179 0.6082	0.61641 0.3836	-0.01120 0.9888
TMG	0.57425 0.4258	-0.12827 0.8717	-0.09910 0.9009	-0.15292 0.8471	-0.32918 0.6708	0.34712 0.6529	-0.71443 0.2856	-0.20911 0.7909	0.80790 0.1921	1.00000 0.0000	-0.21699 0.7830	0.05858 0.9414	0.34582 0.6542
TNA	-0.55555 0.4444	-0.69969 0.3003	0.73299 0.2670	0.29055 0.7094	0.43833 0.5617	-0.66131 0.3387	-0.42956 0.5704	0.05070 0.9493	0.39179 0.6082	-0.21699 0.7830	1.00000 0.0000	0.95807 0.0419	-0.68055 0.3195
TK	-0.34530 0.6547	-0.80569 0.1943	0.77806 0.2219	0.33624 0.6638	0.42999 0.5700	-0.63944 0.3606	-0.60584 0.3942	0.07840 0.9216	0.61641 0.3836	0.05858 0.9414	0.95807 0.0419	1.00000 0.0000	-0.65796 0.3420
SAND	-0.01297 0.9870	0.87858 0.1214	-0.96332 0.0367	-0.88695 0.1130	-0.95683 0.0432	0.99966 0.0003	-0.13040 0.8696	-0.76415 0.2359	-0.01120 0.9888	0.34582 0.6542	-0.68055 0.3195	-0.65796 0.3420	1.00000 0.0000
SILT	0.16920 0.8308	-0.95984 0.0402	0.99327 0.0067	0.90732 0.0927	0.93513 0.0649	-0.97185 0.0282	-0.02936 0.9706	0.76663 0.2334	0.20545 0.7946	-0.11667 0.8833	0.65471 0.3453	0.70020 0.2998	-0.97213 0.0279
CLAY	-0.48541 0.5146	-0.24710 0.7529	0.45957 0.5404	0.44922 0.5508	0.62268 0.3773	-0.66526 0.3347	0.58816 0.4118	0.43662 0.5634	-0.61523 0.3848	-0.92929 0.0707	0.47039 0.5296	0.24081 0.7592	-0.66549 0.3345

	SILT	CLAY
SED	0.16752 0.8325	-0.11765 0.8823
RUNOFF	-0.65101 0.3490	-0.14827 0.8517
TKNR	-0.39961 0.6004	-0.91093 0.0891
SOLP	-0.57168 0.4283	-0.78001 0.2200
TOTP	-0.21328 0.7867	-0.84664 0.1534
PHW	-0.81934 0.1807	-0.89160 0.1084
PHK	-0.48420 0.5158	-0.86136 0.1386
EC	0.92767 0.0723	0.13622 0.8638

• STATISTICAL ANALYSIS SYSTEM
DEP=1

CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / N = 4

	SILT	CLAY
EXCA	-0.25271	-0.94404
	0.7473	0.0560
EXMG	0.16644	0.93780
	0.8336	0.0622
EXNA	-0.83767	-0.60890
	0.1623	0.3911
EXK	0.79246	0.88983
	0.2075	0.1102
CEC	0.82453	0.80985
	0.1755	0.1902
TP	0.16920	-0.48541
	0.8308	0.5146
AP	-0.95984	-0.24710
	0.0402	0.7529
OM	0.99327	0.45957
	0.0067	0.5404
TKN	0.90732	0.44922
	0.0927	0.5508
SCA	0.93513	0.62268
	0.0649	0.3773
SMG	-0.97185	-0.66526
	0.0282	0.3347
SNA	-0.02936	0.58816
	0.9706	0.4118
SK	0.76663	0.43662
	0.2334	0.5634
TCA	0.20545	-0.61523
	0.7946	0.3848
TMG	-0.11667	-0.92929
	0.8833	0.0707
TNA	0.65471	0.47039
	0.3453	0.5296
TK	0.70020	0.24081
	0.2998	0.7592

STATISTICAL ANALYSIS SYSTEM
DEP=1

CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / N = 4

	SILT	CLAY
SAND	-0.97213 0.0279	-0.66549 0.3345
SILT	1.00000 0.0000	0.47194 0.5281
CLAY	0.47194 0.5281	1.00000 0.0000

STATISTICAL ANALYSIS SYSTEM

DEP=2

VARIABLE	N	MEAN	STD DEV	SUM	MINIMUM	MAXIMUM
SED	4	2388.03500000	1976.27363825	9552.14000000	236.50000000	4767.31000000
RUNOFF	4	7.27000000	3.32004016	29.08000000	2.55000000	10.21000000
TKNR	4	4.87250000	4.41574739	19.49000000	0.54000000	11.03000000
SOLP	4	63.94500000	24.34046357	255.78000000	32.46000000	91.78000000
TOTP	4	731.60750000	642.48416154	2926.43000000	136.00000000	1607.38000000
PHW	4	7.63000000	0.17009801	30.52000000	7.40000000	7.80000000
PHK	4	7.15944444	0.27383648	28.63777778	6.91000000	7.55000000
EC	4	415.36587302	30.37842458	1661.46349206	370.00000000	434.28571429
EXCA	4	22.25460317	1.83247650	89.01841270	20.88888889	24.89285714
EXMG	4	1.55386111	0.45429949	6.21544444	0.95000000	2.01166667
EXNA	4	0.02715873	0.01551862	0.10863492	0.00800000	0.04444444
EXK	4	0.33371032	0.03584019	1.33484127	0.28428571	0.37000000
CEC	4	13.05558333	0.77197982	52.22233333	11.94000000	13.71666667
TP	4	138.70634921	5.19998159	554.82539683	133.77777778	145.71428571
AP	4	1.40111111	0.32781356	5.60444444	0.91111111	1.60000000
OM	4	1.41421825	0.09034615	5.65687302	1.31166667	1.50142857
TKN	4	1314.93333333	58.13333333	5259.73333333	1254.40000000	1381.33333333
SCA	4	0.35782540	0.03561516	1.43130159	0.31000000	0.39285714
SMG	4	0.29498016	0.27876507	1.17992063	0.06000000	0.61833333
SNA	4	0.01012937	0.00188504	0.04051746	0.00820000	0.01266667
SK	4	0.01967341	0.00132611	0.07869365	0.01816667	0.02140000
TCA	4	68.68998016	18.93499486	274.75992063	45.20833333	90.35714286
TMG	4	67.81605556	2.52854040	271.26422222	65.62333333	70.83000000
TNA	4	0.68275397	0.07638759	2.73101587	0.57333333	0.74111111
TK	4	7.85512698	0.80378906	31.42050794	6.89666667	8.86400000
SAND	4	38.93492063	3.61784859	155.73968254	35.60000000	43.62857143
SILT	4	42.08750000	1.75991240	168.35000000	40.75000000	44.60000000

STATISTICAL ANALYSIS SYSTEM
DEP=2

VARIABLE	N	MEAN	STD DEV	SUM	MINIMUM	MAXIMUM
CLAY	4	19.33472222	1.89098128	77.33888889	16.80000000	21.35555556

CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / N = 4

	SED	RUNOFF	TKNR	SOLP	TOTP	PHW	PHK	EC	EXCA	EXMG	EXNA	EXK	CEC
SED	1.00000	0.55877	0.51068	0.59187	0.62210	0.52299	-0.04857	0.30227	0.21884	-0.53772	-0.99727	0.13128	-0.44434
	0.0000	0.4412	0.4893	0.4081	0.3779	0.4770	0.9514	0.6977	0.7812	0.4623	0.0027	0.8687	0.5557
RUNOFF	0.55877	1.00000	0.41557	0.69667	0.34642	0.78999	-0.00107	-0.58664	0.29223	0.01854	-0.59643	0.02004	-0.32151
	0.4412	0.0000	0.5844	0.3033	0.6536	0.2100	0.9989	0.4134	0.7078	0.9815	0.4036	0.9800	0.6785
TKNR	0.51068	0.41557	1.00000	0.94172	0.97929	0.87289	0.82403	0.24842	0.95036	-0.84841	-0.46877	-0.77929	-0.99437
	0.4893	0.5844	0.0000	0.0583	0.0207	0.1271	0.1760	0.7516	0.0496	0.1516	0.5312	0.2207	0.0056
SOLP	0.59187	0.69667	0.94172	1.00000	0.89567	0.98259	0.65851	-0.03390	0.86344	-0.65459	-0.57286	-0.61794	-0.90328
	0.4081	0.3033	0.0583	0.0000	0.1043	0.0174	0.3415	0.9661	0.1366	0.3454	0.4271	0.3821	0.0967
TOTP	0.62210	0.34642	0.97929	0.89567	1.00000	0.79831	0.75136	0.40896	0.88277	-0.92248	-0.57594	-0.69277	-0.97428
	0.3779	0.6536	0.0207	0.1043	0.0000	0.2017	0.2486	0.5910	0.1172	0.0775	0.4241	0.3072	0.0257
PHW	0.52299	0.78999	0.87289	0.98259	0.79831	1.00000	0.59763	-0.21896	0.81479	-0.50440	-0.51561	-0.56860	-0.82490
	0.4770	0.2100	0.1271	0.0174	0.2017	0.0000	0.4024	0.7810	0.1852	0.4956	0.4844	0.4314	0.1751
PHK	-0.04857	-0.00107	0.82403	0.65851	0.75136	0.59763	1.00000	0.23670	0.94821	-0.71079	0.10356	-0.99600	-0.87120
	0.9514	0.9989	0.1760	0.3415	0.2486	0.4024	0.0000	0.7633	0.0518	0.2892	0.8964	0.0040	0.1288
EC	0.30227	-0.58664	0.24842	-0.03390	0.40896	-0.21896	0.23670	1.00000	0.14705	-0.72341	-0.24248	-0.17924	-0.30393
	0.6977	0.4134	0.7516	0.9661	0.5910	0.7810	0.7633	0.0000	0.8529	0.2766	0.7575	0.8208	0.6961
EXCA	0.21884	0.29223	0.95036	0.86344	0.88277	0.81479	0.94821	0.14705	1.00000	-0.75460	-0.17383	-0.92820	-0.96582
	0.7812	0.7078	0.0496	0.1366	0.1172	0.1852	0.0518	0.8529	0.0000	0.2454	0.8262	0.0718	0.0342
EXMG	-0.53772	0.01854	-0.84841	-0.65459	-0.92248	-0.50440	-0.71079	-0.72341	-0.75460	1.00000	0.47554	0.64688	0.87382
	0.4623	0.9815	0.1516	0.3454	0.0775	0.4956	0.2892	0.2766	0.2454	0.0000	0.5245	0.3531	0.1262
EXNA	-0.99727	-0.59643	-0.46877	-0.57286	-0.57594	-0.51561	0.10356	-0.24248	-0.17383	0.47554	1.00000	-0.18398	0.39675
	0.0027	0.4036	0.5312	0.4271	0.4241	0.4844	0.8964	0.7575	0.8262	0.5245	0.0000	0.8160	0.6033
EXK	0.13128	0.02004	-0.77929	-0.61794	-0.69277	-0.56860	-0.99600	-0.17924	-0.92820	0.64688	-0.18398	1.00000	0.82926
	0.8687	0.9800	0.2207	0.3821	0.3072	0.4314	0.0040	0.8208	0.0718	0.3531	0.8160	0.0000	0.1707
CEC	-0.44434	-0.32151	-0.99437	-0.90328	-0.97428	-0.82490	-0.87120	-0.30393	-0.96582	0.87382	0.39675	0.82926	1.00000
	0.5557	0.6785	0.0056	0.0967	0.0257	0.1751	0.1288	0.6961	0.0342	0.1262	0.6033	0.1707	0.0000
TP	0.28012	0.45926	0.95088	0.82574	0.86887	0.90290	0.88423	0.00115	0.98312	-0.67633	-0.24626	-0.86501	-0.94822
	0.7189	0.5407	0.0491	0.0743	0.1311	0.0971	0.1158	0.9988	0.0169	0.3237	0.7537	0.1350	0.0518
AP	0.74626	0.91844	0.71135	0.89627	0.68133	0.92167	0.26067	-0.24720	0.55279	-0.37755	-0.75701	-0.21629	-0.63315
	0.2537	0.0816	0.2886	0.1037	0.3187	0.0783	0.7393	0.7528	0.4472	0.6224	0.2430	0.7837	0.3668

STATISTICAL ANALYSIS SYSTEM
DEP=2

CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / N = 4

	SED	RUNOFF	TKNR	SOLP	TOTP	PHW	PHK	EC	EXCA	EXMG	EXNA	EXK	CEC
OM	-0.16971 0.8303	-0.70964 0.2904	0.34581 0.6542	0.01040 0.9896	0.40386 0.5961	-0.14076 0.8592	0.63317 0.3668	0.80621 0.1938	0.43039 0.5696	-0.68106 0.3189	0.24110 0.7589	-0.61697 0.3830	-0.43800 0.5620
TKN	-0.85579 0.1442	-0.06997 0.9300	-0.49429 0.5057	-0.39668 0.6033	-0.65771 0.3423	-0.24846 0.7515	-0.10186 0.8981	-0.75175 0.2482	-0.23826 0.7617	0.76894 0.2311	0.82117 0.1788	0.01347 0.9865	0.47870 0.5213
SCA	0.12288 0.8771	-0.59727 0.4027	0.42967 0.5703	0.11178 0.8882	0.53421 0.4658	-0.06474 0.9353	0.55102 0.4490	0.93226 0.0677	0.41873 0.5813	-0.81250 0.1875	-0.05152 0.9485	-0.50919 0.4908	-0.50363 0.4964
SMG	-0.16199 0.8380	0.63255 0.3675	0.44485 0.5552	0.60059 0.3994	0.25982 0.7402	0.71827 0.2817	0.49667 0.5033	-0.71362 0.2864	0.58412 0.4159	0.07573 0.9243	0.14655 0.8534	-0.53452 0.4655	-0.41703 0.5830
SNA	-0.68983 0.3102	0.21461 0.7854	-0.25942 0.7406	-0.10557 0.8944	-0.44940 0.5506	0.05865 0.9414	0.03174 0.9683	-0.87457 0.1254	-0.02611 0.9739	0.66768 0.3323	0.65236 0.3476	-0.11278 0.8872	0.26452 0.7355
SK	0.72759 0.2724	-0.11042 0.8896	0.03160 0.9684	-0.03761 0.9624	0.22930 0.7707	-0.16694 0.8331	-0.34085 0.6591	0.70750 0.2925	-0.24173 0.7583	-0.41616 0.5838	-0.71239 0.2876	0.41890 0.5811	-0.01294 0.9871
TCA	0.54824 0.4518	-0.17281 0.8272	0.70039 0.2996	0.47740 0.5226	0.81531 0.1847	0.30588 0.6941	0.55886 0.4411	0.86167 0.1383	0.57843 0.4216	-0.97070 0.0293	-0.48516 0.5148	-0.48906 0.5109	-0.73165 0.2684
TMG	-0.19733 0.8027	-0.54269 0.4573	0.51910 0.4809	0.21307 0.7869	0.52796 0.4720	0.08623 0.9138	0.82197 0.1780	0.64824 0.3518	0.64194 0.3581	-0.71730 0.2827	0.26851 0.7315	-0.81363 0.1864	-0.60637 0.3936
TNA	0.05320 0.9468	-0.75339 0.2466	0.15348 0.8465	-0.16609 0.8339	0.28877 0.7112	-0.34236 0.6576	0.29201 0.7080	0.96745 0.0326	0.12802 0.8720	-0.63553 0.3645	0.00999 0.9900	-0.25365 0.7464	-0.22984 0.7702
TK	0.69306 0.3069	-0.16923 0.8308	0.02584 0.9742	-0.06361 0.9364	0.22582 0.7742	-0.19973 0.8003	-0.31780 0.6822	0.74688 0.2531	-0.23720 0.7628	-0.43310 0.5669	-0.67440 0.3256	0.39477 0.6052	-0.01381 0.9862
SAND	-0.02325 0.9768	0.29151 0.7085	0.83181 0.1682	0.77547 0.2245	0.71304 0.2870	0.77095 0.2291	0.94098 0.0590	-0.08070 0.9193	0.95724 0.0428	-0.54390 0.4561	0.05856 0.9414	-0.94653 0.0535	-0.85106 0.1489
SILT	0.63748 0.3625	-0.01957 0.9804	-0.27236 0.7276	-0.24296 0.7570	-0.09067 0.9093	-0.31568 0.6843	-0.66732 0.3327	0.43068 0.5693	-0.54784 0.4522	-0.04954 0.9505	-0.64966 0.3503	0.72928 0.2707	0.31229 0.6877
CLAY	-0.45667 0.5433	-0.51221 0.4878	-0.98678 0.0132	-0.96954 0.0305	-0.93654 0.0635	-0.92952 0.0705	-0.82006 0.1799	-0.08958 0.9104	-0.95899 0.0410	0.75199 0.2480	0.42279 0.5772	0.78491 0.2151	0.97370 0.0263

	TP	AP	OM	TKN	SCA	SMG	SNA	SK	TCA	TMG	TNA	TK	SAND
SED	0.28012 0.7199	0.74626 0.2537	-0.16971 0.8303	-0.85579 0.1442	0.12288 0.8771	-0.16199 0.8380	-0.68983 0.3102	0.72759 0.2724	0.54824 0.4518	-0.19733 0.8027	0.05320 0.9468	0.69306 0.3069	-0.02325 0.9768
RUNOFF	0.45926 0.5407	0.91844 0.0816	-0.70964 0.2904	-0.06997 0.9300	-0.59727 0.4027	0.63255 0.3675	0.21461 0.7854	-0.11042 0.8896	-0.17281 0.8272	-0.54269 0.4573	-0.75339 0.2466	-0.16923 0.8308	0.29151 0.7085
TKNR	0.95088 0.0491	0.71135 0.2886	0.34581 0.6542	-0.49429 0.5057	0.42967 0.5703	0.44485 0.5552	-0.25942 0.7406	0.03160 0.9684	0.70039 0.2996	0.51910 0.4809	0.15348 0.8465	0.02584 0.9742	0.83181 0.1682

STATISTICAL ANALYSIS SYSTEM

DEP=2

CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / N = 4

	TP	AP	OM	TKN	SCA	SMG	SNA	SK	TCA	TMG	TNA	TK	SAND
SOLP	0.92574	0.89627	0.01040	-0.39668	0.11178	0.60059	-0.10557	-0.03761	0.47740	0.21307	-0.16609	-0.06361	0.77547
	0.0743	0.1037	0.9896	0.6033	0.8882	0.3994	0.8944	0.9624	0.5226	0.7869	0.8339	0.9364	0.2245
TOTP	0.86887	0.68133	0.40386	-0.65771	0.53421	0.25982	-0.44940	0.22930	0.81531	0.52796	0.28877	0.22582	0.71304
	0.1311	0.3187	0.5961	0.3423	0.4658	0.7402	0.5506	0.7707	0.1847	0.4720	0.7112	0.7742	0.2870
PHW	0.90290	0.92167	-0.14076	-0.24846	-0.06474	0.71827	0.05865	-0.16694	0.30588	0.08623	-0.34236	-0.19973	0.77095
	0.0971	0.0783	0.8592	0.7515	0.9353	0.2817	0.9414	0.8331	0.6941	0.9138	0.6576	0.8003	0.2291
PHK	0.88423	0.26067	0.63317	-0.10186	0.55102	0.49667	0.03174	-0.34085	0.55886	0.82197	0.29201	-0.31780	0.94098
	0.1158	0.7393	0.3668	0.8981	0.4490	0.5033	0.9683	0.6591	0.4411	0.1780	0.7080	0.6822	0.0590
EC	0.00115	-0.24720	0.80621	-0.75175	0.93226	-0.71362	-0.87457	0.70750	0.86167	0.64824	0.96745	0.74688	-0.08070
	0.9988	0.7528	0.1938	0.2482	0.0677	0.2864	0.1254	0.2925	0.1383	0.3518	0.0326	0.2531	0.9193
EXCA	0.98312	0.55279	0.43039	-0.23826	0.41873	0.58412	-0.02611	-0.24173	0.57843	0.64194	0.12802	-0.23720	0.95724
	0.0169	0.4472	0.5696	0.7617	0.5813	0.4159	0.9739	0.7583	0.4216	0.3581	0.8720	0.7628	0.0428
EXMG	-0.67633	-0.37755	-0.68106	0.76894	-0.81250	0.07573	0.66768	-0.41616	-0.97070	-0.71730	-0.63553	-0.43310	-0.54390
	0.3237	0.6224	0.3189	0.2311	0.1875	0.9243	0.3323	0.5838	0.0293	0.2827	0.3645	0.5669	0.4561
EXNA	-0.24626	-0.75701	0.24110	0.82117	-0.05152	0.14655	0.65236	-0.71239	-0.48516	0.26851	0.00999	-0.67440	0.05856
	0.7537	0.2430	0.7589	0.1788	0.9485	0.8534	0.3476	0.2876	0.5148	0.7315	0.9900	0.3256	0.9414
EXK	-0.86501	-0.21629	-0.61697	0.01347	-0.50919	-0.53452	-0.11278	0.41890	-0.48906	-0.81363	-0.25365	0.39477	-0.94653
	0.1350	0.7837	0.3830	0.9865	0.4908	0.4655	0.8872	0.5811	0.5109	0.1864	0.7464	0.6052	0.0535
CEC	-0.94822	-0.63315	-0.43800	0.47870	-0.50363	-0.41703	0.26452	-0.01294	-0.73165	-0.60637	-0.22984	-0.01381	-0.85106
	0.0518	0.3668	0.5620	0.5213	0.4964	0.5830	0.7355	0.9871	0.2684	0.3936	0.7702	0.9862	0.1489
TP	1.00000	0.67692	0.25834	-0.20136	0.25911	0.68323	0.04909	-0.27801	0.47952	0.49145	-0.04140	-0.28474	0.95310
	0.0000	0.3231	0.7417	0.7986	0.7409	0.3168	0.9509	0.7220	0.5205	0.5086	0.9586	0.7153	0.0469
AP	0.67692	1.00000	-0.39415	-0.38532	-0.23147	0.53495	-0.08412	0.08632	0.22811	-0.23144	-0.44084	0.03812	0.46352
	0.3231	0.0000	0.6059	0.6147	0.7685	0.4651	0.9159	0.9137	0.7719	0.7686	0.5592	0.9619	0.5365
OM	0.25834	-0.39415	1.00000	-0.32302	0.95311	-0.31877	-0.43527	0.15269	0.72789	0.95908	0.90191	0.20874	0.33552
	0.7417	0.6059	0.0000	0.6770	0.0469	0.6812	0.5647	0.8473	0.2721	0.0409	0.0981	0.7913	0.6645
TKN	-0.20136	-0.38532	-0.32302	1.00000	-0.59324	0.49423	0.95041	-0.88392	-0.84982	-0.21993	-0.56203	-0.88146	0.05262
	0.7986	0.6147	0.6770	0.0000	0.4068	0.5058	0.0496	0.1161	0.1502	0.7801	0.4380	0.1185	0.9474
SCA	0.25911	-0.23147	0.95311	-0.59324	1.00000	-0.45045	-0.68008	0.42293	0.88394	0.87860	0.95421	0.47030	0.24462
	0.7409	0.7685	0.0469	0.4068	0.0000	0.5495	0.3199	0.5771	0.1161	0.1214	0.0458	0.5297	0.7554
SMG	0.68323	0.53495	-0.31877	0.49423	-0.45045	1.00000	0.73125	-0.79372	-0.31309	-0.03897	-0.68178	-0.81907	0.75365
	0.3168	0.4651	0.6812	0.5058	0.5495	0.0000	0.2688	0.2063	0.6869	0.9610	0.3182	0.1809	0.2464
SNA	0.04909	-0.08412	-0.43527	0.95041	-0.68008	0.73125	1.00000	-0.94593	-0.81108	-0.26154	-0.72791	-0.95713	0.25888
	0.9509	0.9159	0.5647	0.0496	0.3199	0.2688	0.0000	0.0541	0.1889	0.7385	0.2721	0.0429	0.7411

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

DEP=2

CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / N = 4

	TP	AP	OM	TKN	SCA	SMG	SNA	SK	TCA	TMG	TNA	TK	SAND
SK	-0.27801	0.08632	0.15269	-0.88392	0.42293	-0.79372	-0.94593	1.00000	0.58589	-0.05629	0.53432	0.99801	-0.51210
	0.7220	0.9137	0.8473	0.1161	0.5771	0.2063	0.0541	0.0000	0.4141	0.9437	0.4657	0.0020	0.4879
TCA	0.47952	0.22811	0.72789	-0.84982	0.88394	-0.31309	-0.81108	0.58589	1.00000	0.69505	0.77114	0.60833	0.33737
	0.5205	0.7719	0.2721	0.1502	0.1161	0.6869	0.1889	0.4141	0.0000	0.3050	0.2289	0.3917	0.6626
TMG	0.49145	-0.23144	0.95908	-0.21993	0.87860	-0.03897	-0.26154	-0.05629	0.69505	1.00000	0.75153	-0.00562	0.58507
	0.5086	0.7686	0.0409	0.7801	0.1214	0.9610	0.7385	0.9437	0.3050	0.0000	0.2485	0.9944	0.4149
TNA	-0.04140	-0.44084	0.90191	-0.56203	0.95421	-0.68178	-0.72791	0.53432	0.77114	0.75153	1.00000	0.58490	-0.04591
	0.9586	0.5592	0.0981	0.4380	0.0458	0.3182	0.2721	0.4657	0.2289	0.2485	0.0000	0.4151	0.9541
TK	-0.28474	0.03812	0.20874	-0.88146	0.47030	-0.81907	-0.95713	0.99801	0.60833	-0.00562	0.58490	1.00000	-0.50749
	0.7153	0.9619	0.7913	0.1185	0.5297	0.1809	0.0429	0.0020	0.3917	0.9944	0.4151	0.0000	0.4925
SAND	0.95310	0.46352	0.33552	0.05262	0.24462	0.75365	0.25888	-0.51210	0.33737	0.58507	-0.04591	-0.50749	1.00000
	0.0469	0.5365	0.6645	0.9474	0.7554	0.2464	0.7411	0.4879	0.6626	0.4149	0.9541	0.4925	0.0000
SILT	-0.54010	0.02828	-0.17691	-0.66938	0.07873	-0.78631	-0.75229	0.92474	0.23448	-0.40686	0.25935	0.91003	-0.76064
	0.4599	0.9717	0.8231	0.3306	0.9213	0.2137	0.2477	0.0753	0.7655	0.5931	0.7406	0.0900	0.2394
CLAY	-0.98144	-0.76034	-0.23419	0.37099	-0.29358	-0.58165	0.11124	0.09975	-0.57553	-0.44055	-0.00250	0.11119	-0.87859
	0.0186	0.2397	0.7658	0.6290	0.7064	0.4184	0.8888	0.9002	0.4245	0.5595	0.9975	0.8888	0.1214

	SILT	CLAY
SED	0.63748	-0.45667
	0.3625	0.5433
RUNOFF	-0.01957	-0.51221
	0.9804	0.4878
TKNR	-0.27236	-0.98678
	0.7276	0.0132
SOLP	-0.24296	-0.96954
	0.7570	0.0305
TOTP	-0.09067	-0.93654
	0.9093	0.0635
PHW	-0.31568	-0.92952
	0.6843	0.0705
PHK	-0.66732	-0.82006
	0.3327	0.1799
EC	0.43068	-0.08858
	0.8693	0.9104

STATISTICAL ANALYSIS SYSTEM

DEP=2

CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / N = 4

	SILT	CLAY
EXCA	-0.54784 0.4522	-0.95899 0.0410
EXMG	-0.04954 0.9505	0.75199 0.2480
EXNA	-0.64966 0.3503	0.42279 0.5772
EXK	0.72928 0.2707	0.78491 0.2151
CEC	0.31229 0.6877	0.97370 0.0263
TP	-0.54010 0.4599	-0.98144 0.0186
AP	0.02828 0.9717	-0.76034 0.2397
OM	-0.17691 0.8231	-0.23419 0.7658
TKN	-0.66938 0.3306	0.37099 0.6290
SCA	0.07873 0.9213	-0.29358 0.7064
SMG	-0.78631 0.2137	-0.58165 0.4184
SNA	-0.75229 0.2477	0.11124 0.8888
SK	0.92474 0.0753	0.09975 0.9002
TCA	0.23448 0.7655	-0.57553 0.4245
TMG	-0.40686 0.5931	-0.44055 0.5595
TNA	0.25935 0.7406	-0.00250 0.9975
TK	0.91003 0.0900	0.11119 0.8888

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M
DEP=2

CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / N = 4

	SILT	CLAY
SAND	-0.76064 0.2394	-0.87859 0.1214
SILT	1.00000 0.0000	0.36896 0.6310
CLAY	0.36896 0.6310	1.00000 0.0000

STATISTICAL ANALYSIS SYSTEM

DEP=1

GENERAL LINEAR MODELS PROCEDURE

LEAST SQUARES MEANS

STYPS	WSHD	PHW LSMEAN	I/J	1	2	3	4	5	6	7	8	9
QWD	1	7.43333333	1	.	0.6357	0.2018	0.6715	0.2123	0.4000	0.6715	0.0682	0.6715
QWD	2	7.35000000	2	0.6357	.	0.1109	0.9243	0.1187	0.7758	0.9243	0.0397	0.3971
QWD	3	7.62500000	3	0.2018	0.1109	.	0 0910	0.9547	0.0375	0.0910	0.4636	0.3989
WOC	1	7.36666667	4	0.6715	0.9243	0.0910	.	0.1018	0.6715	1.0000	0.0291	0.4000
WOC	4	7.63333333	5	0.2123	0.1187	0.9547	0.1018	.	0.0449	0.1018	0.5261	0.4000
WOD	1	7.30000000	6	0.4000	0.7758	0.0375	0.6715	0.0449	.	0.6715	0.0118	0.2123
WOD	2	7.36666667	7	0.6715	0.9243	0.0910	1.0000	0.1018	0.6715	.	0.0291	0.4000
WOD	3	7.73333333	8	0.0682	0.0397	0.4636	0.0291	0.5261	0.0118	0.0291	.	0.1487
WOD	4	7.50000000	9	0.6715	0.3971	0.3989	0.4000	0.4000	0.2123	0.4000	0.1487	.

STYPS	WSHD	PHK LSMEAN	I/J	1	2	3	4	5	6	7	8	9
QWD	1	7.11666667	1	.	0.0333	0.1586	0.2140	0.5655	0.5655	0.0007	0.0619	0.3058
QWD	2	6.75000000	2	0.0333	.	0.0015	0.2643	0.0919	0.0919	0.1901	0.0007	0.1501
QWD	3	7.31250000	3	0.1586	0.0015	.	0.0107	0.0504	0.0504	0.0001	0.5193	0.0182
WOC	1	6.93333333	4	0.2140	0.2643	0.0107	.	0.4913	0.4913	0.0116	0.0042	0.8175
WOC	4	7.03333333	5	0.5655	0.0919	0.0504	0.4913	.	1.0000	0.0025	0.0190	0.6451
WOD	1	7.03333333	6	0.5655	0.0919	0.0504	0.4913	1.0000	.	0.0025	0.0190	0.6451
WOD	2	6.53333333	7	0.0007	0.1901	0.0001	0.0116	0.0025	0.0025	.	0.0001	0.0070
WOD	3	7.40000000	8	0.0619	0.0007	0.5193	0.0042	0.0190	0.0190	0.0001	.	0.0070
WOD	4	6.96666667	9	0.3058	0.1901	0.0182	0.8175	0.6451	0.6451	0.0070	0.0070	.

STYPS	WSHD	EC LSMEAN	I/J	1	2	3	4	5	6	7	8	9
QWD	1	620.000000	1	.	0.3351	0.4425	0.0388	0.0746	0.1942	0.5310	0.0682	0.0007
QWD	2	542.000000	2	0.3351	.	0.7294	0.3291	0.4913	0.0414	0.6802	0.4660	0.0153
QWD	3	568.250000	3	0.4425	0.7294	.	0.1276	0.2316	0.0389	0.9195	0.2138	0.0020
WOC	1	463.000000	4	0.0388	0.3291	0.1276	.	0.7408	0.0022	0.1293	0.7762	0.0773
WOC	4	486.666667	5	0.0746	0.4913	0.2316	0.7408	.	0.0045	0.2259	0.9628	0.0403
WOD	1	715.000000	6	0.1942	0.0414	0.0389	0.0022	0.0045	.	0.0623	0.0041	0.0001
WOD	2	575.000000	7	0.5310	0.6802	0.9195	0.1293	0.2259	0.0623	.	0.2096	0.0028
WOD	3	483.333333	8	0.0682	0.4660	0.2138	0.7762	0.9628	0.0041	0.2096	.	0.0443
WOD	4	331.000000	9	0.0007	0.0153	0.0020	0.0773	0.0403	0.0001	0.0028	0.0443	.

STYPS	WSHD	EXCA LSMEAN	I/J	1	2	3	4	5	6	7	8	9
QWD	1	27.3333333	1	.	0.0251	0.4386	0.0001	0.0944	0.0036	0.0006	0.0190	0.0002
QWD	2	18.5000000	2	0.0251	.	0.0768	0.0349	0.3990	0.5869	0.2100	0.8915	0.0853
QWD	3	24.9375000	3	0.4386	0.0768	.	0.0001	0.2876	0.0121	0.0017	0.0653	0.0004
WOC	1	10.2500000	4	0.0001	0.0349	0.0001	.	0.0025	0.0691	0.2867	0.0145	0.6125
WOC	4	21.6233333	5	0.0944	0.3990	0.2876	0.0025	.	0.1305	0.0263	0.4278	0.0077
WOD	1	16.5000000	6	0.0036	0.5869	0.0121	0.0691	0.1305	.	0.4146	0.4495	0.1734
WOD	2	13.8000000	7	0.0006	0.2100	0.0017	0.2867	0.0263	0.4146	.	0.1252	0.5675
WOD	3	19.0000000	8	0.0190	0.8915	0.0653	0.0145	0.4278	0.4495	0.1252	.	0.0419

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M
DEP=1

GENERAL LINEAR MODELS PROCEDURE

LEAST SQUARES MEANS

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

STYPS	WSHD	EXCA LSMEAN	I/J	1	2	3	4	5	6	7	8	9
WOD	4	11.8166667	9	0.0002	0.0853	0.0004	0.6125	0.0077	0.1734	0.5675	0.0419	.

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

STYPS	WSHD	EXMG LSMEAN	I/J	1	2	3	4	5	6	7	8	9
QWD	1	1.11000000	1	.	0.2841	0.0772	0.0001	0.3353	0.6225	0.0632	0.0232	0.0082
QWD	2	1.45500000	2	0.2841	.	0.0114	0.0036	0.8293	0.5201	0.5134	0.2796	0.1380
QWD	3	0.62000000	3	0.0772	0.0114	.	0.0001	0.0089	0.0269	0.0009	0.0003	0.0001
WOC	1	2.50000000	4	0.0001	0.0036	0.0001	.	0.0009	0.0003	0.0078	0.0226	0.0604
WOC	4	1.38666667	5	0.3353	0.8293	0.0089	0.0009	.	0.6307	0.3353	0.1533	0.0632
WOD	1	1.25000000	6	0.6225	0.5201	0.0269	0.0003	0.6307	.	0.1564	0.0632	0.0238
WOD	2	1.66333333	7	0.0632	0.5134	0.0009	0.0078	0.3353	0.1564	.	0.6225	0.3353
WOD	3	1.80333333	8	0.0232	0.2796	0.0003	0.0226	0.1533	0.0632	0.6225	.	0.6307
WOD	4	1.94000000	9	0.0082	0.1380	0.0001	0.0604	0.0632	0.0238	0.3353	0.6307	.

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

STYPS	WSHD	EXNA LSMEAN	I/J	1	2	3	4	5	6	7	8	9
QWD	1	0.04000000	1	.	1.0000	1.0000	0.0248	1.0000	0.0248	0.2365	1.0000	1.0000
QWD	2	0.04000000	2	1.0000	.	1.0000	0.0419	1.0000	0.0419	0.2678	1.0000	1.0000
QWD	3	0.04000000	3	1.0000	1.0000	.	0.0174	1.0000	0.0174	0.2069	1.0000	1.0000
WOC	1	0.01333333	4	0.0248	0.0419	0.0174	.	0.0248	1.0000	0.2365	0.0248	0.0248
WOC	4	0.04000000	5	1.0000	1.0000	1.0000	0.0248	.	0.0248	0.2365	1.0000	1.0000
WOD	1	0.01333333	6	0.0248	0.0419	0.0174	1.0000	0.0248	.	0.2365	0.0248	0.0248
WOD	2	0.02666667	7	0.2365	0.2878	0.2069	0.2365	0.2365	0.2365	.	0.2365	0.2365
WOD	3	0.04000000	8	1.0000	1.0000	1.0000	0.0248	1.0000	0.0248	0.2365	.	1.0000
WOD	4	0.04000000	9	1.0000	1.0000	1.0000	0.0248	1.0000	0.0248	0.2365	1.0000	.

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

STYPS	WSHD	EXK LSMEAN	I/J	1	2	3	4	5	6	7	8	9
QWD	1	0.41333333	1	.	0.6923	0.0155	0.0467	0.4744	0.6583	0.1330	0.6583	0.7819
QWD	2	0.44000000	2	0.6923	.	0.0123	0.1489	0.3051	0.4317	0.3280	1.0000	0.5217
QWD	3	0.26500000	3	0.0155	0.0123	.	0.0001	0.0746	0.0417	0.0004	0.0055	0.0290
WOC	1	0.54000000	4	0.0467	0.1489	0.0001	.	0.0103	0.0187	0.5810	0.1090	0.0265
WOC	4	0.37000000	5	0.4744	0.3051	0.0746	0.0103	.	0.7819	0.0333	0.2532	0.6583
WOD	1	0.38666667	6	0.6583	0.4317	0.0417	0.0187	0.7819	.	0.0581	0.3804	0.8680
WOD	2	0.50666667	7	0.1330	0.3280	0.0004	0.5810	0.0333	0.0581	.	0.2757	0.0801
WOD	3	0.44000000	8	0.6583	1.0000	0.0055	0.1090	0.2532	0.3804	0.2757	.	0.4744
WOD	4	0.39666667	9	0.7819	0.5217	0.0290	0.0265	0.6583	0.8680	0.0801	0.4744	.

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

DEP=1

GENERAL LINEAR MODELS PROCEDURE

LEAST SQUARES MEANS

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

STYPS	WSHD	CEC LSMEAN	I/J	1	2	3	4	5	6	7	8	9
QWD	1	14.0400000	1	.	0.2349	0.0012	0.8961	0.1675	0.0976	0.4106	0.9508	0.0565
QWD	2	12.7950000	2	0.2349	.	0.0517	0.2814	0.9547	0.7423	0.6402	0.2561	0.5600
QWD	3	10.7925000	3	0.0012	0.0517	.	0.0017	0.0341	0.0652	0.0089	0.0014	0.1157
WOC	1	13.9200000	4	0.8961	0.2814	0.0017	.	0.2080	0.1237	0.4868	0.9450	0.0728
WOC	4	12.7366667	5	0.1675	0.9547	0.0341	0.2080	.	0.7609	0.5586	0.1858	0.5562
WOD	1	12.4566667	6	0.0976	0.7423	0.0652	0.1237	0.7609	.	0.3774	0.1093	0.7747
WOD	2	13.2766667	7	0.4106	0.6402	0.0089	0.4868	0.5586	0.3774	.	0.4456	0.2474
WOD	3	13.9833333	8	0.9508	0.2561	0.0014	0.9450	0.1858	0.1093	0.4456	.	0.0638
WOD	4	12.1933333	9	0.0565	0.5600	0.1157	0.0728	0.5562	0.7747	0.2474	0.0638	.

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

STYPS	WSHD	TP LSMEAN	I/J	1	2	3	4	5	6	7	8	9
QWD	1	148.000000	1	.	0.3749	0.8521	0.2011	0.7060	0.0537	0.5247	0.9305	0.3880
QWD	2	125.000000	2	0.3749	.	0.2750	0.7850	0.5777	0.0130	0.7455	0.3358	0.9068
QWD	3	152.000000	3	0.8521	0.2750	.	0.1253	0.5567	0.0588	0.3891	0.9257	0.2713
WOC	1	118.000000	4	0.2011	0.7850	0.1253	.	0.3579	0.0033	0.5063	0.1740	0.6635
WOC	4	139.333333	5	0.7060	0.5777	0.5567	0.3579	.	0.0249	0.7937	0.6428	0.6223
WOD	1	194.666667	6	0.0537	0.0130	0.0588	0.0033	0.0249	.	0.0143	0.0637	0.0086
WOD	2	133.333333	7	0.5247	0.7455	0.3891	0.5063	0.7937	0.0143	.	0.4705	0.8162
WOD	3	150.000000	8	0.9305	0.3358	0.9257	0.1740	0.6428	0.0637	0.4705	.	0.3434
WOD	4	128.000000	9	0.3880	0.9068	0.2713	0.6635	0.6223	0.0086	0.8162	0.3434	.

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

STYPS	WSHD	AP LSMEAN	I/J	1	2	3	4	5	6	7	8	9
QWD	1	3.26666667	1	.	0.2811	0.9895	0.5913	0.2127	0.9609	0.8831	0.4656	0.1810
QWD	2	1.60000000	2	0.2811	.	0.2614	0.5416	0.0360	0.2629	0.2293	0.0923	0.0300
QWD	3	3.25000000	3	0.9895	0.2614	.	0.5750	0.1801	0.9478	0.8648	0.4284	0.1507
WOC	1	2.53333333	4	0.5913	0.5416	0.5750	.	0.0825	0.5584	0.4955	0.2127	0.0685
WOC	4	5.00000000	5	0.2127	0.0360	0.1801	0.0825	.	0.2300	0.2680	0.5913	0.9219
WOD	1	3.33333333	6	0.9609	0.2629	0.9478	0.5584	0.2300	.	0.9219	0.4955	0.1964
WOD	2	3.46666667	7	0.8831	0.2293	0.8648	0.4955	0.2680	0.9219	.	0.5584	0.2300
WOD	3	4.26666667	8	0.4656	0.0923	0.4284	0.2127	0.5913	0.4955	0.5584	.	0.5264
WOD	4	5.13333333	9	0.1810	0.0300	0.1507	0.0685	0.9219	0.1964	0.2300	0.5264	.

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

STYPS	WSHD	OM LSMEAN	I/J	1	2	3	4	5	6	7	8	9
QWD	1	1.75666667	1	.	0.8281	0.9160	0.6826	0.3231	0.0812	0.1338	0.4083	0.1169
QWD	2	1.81000000	2	0.8281	.	0.7478	0.8813	0.2737	0.1693	0.2518	0.3413	0.1076
QWD	3	1.73500000	3	0.9160	0.7478	.	0.5882	0.3405	0.0519	0.0910	0.4352	0.1155
WOC	1	1.84666667	4	0.6826	0.8813	0.5882	.	0.1694	0.1694	0.2634	0.2230	0.0539
WOC	4	1.53666667	5	0.3231	0.2737	0.3405	0.1694	.	0.0103	0.0186	0.8674	0.5359
WOD	1	2.15666667	6	0.0812	0.1693	0.0519	0.1694	0.0103	.	0.7849	0.0148	0.0026
WOD	2	2.09666667	7	0.1338	0.2518	0.0910	0.2634	0.0186	0.7849	.	0.0265	0.0048
WOD	3	1.57333333	8	0.4083	0.3413	0.4352	0.2230	0.8674	0.0148	0.0265	.	0.4339

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

DEP=1

GENERAL LINEAR MODELS PROCEDURE

LEAST SQUARES MEANS

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

STYPS	WSHD	OM LSMEAN	I/J	1	2	3	4	5	6	7	8	9
WOD	4	1.40000000	9	0.1169	0.1076	0.1155	0.0539	0.5359	0.0026	0.0048	0.4339	.

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

STYPS	WSHD	TKN LSMEAN	I/J	1	2	3	4	5	6	7	8	9
QWD	1	2090.66667	1	.	0.1973	0.0567	0.2907	0.0248	1.0000	0.1904	0.0248	0.0078
QWD	2	1680.00000	2	0.1973	.	0.7048	0.7193	0.4054	0.1973	0.9045	0.4054	0.1973
QWD	3	1568.00000	3	0.0567	0.7048	.	0.3942	0.5678	0.0567	0.5678	0.5678	0.2597
WOC	1	1792.00000	4	0.2907	0.7193	0.3942	.	0.1904	0.2907	0.7886	0.1904	0.0729
WOC	4	1418.66667	5	0.0248	0.4054	0.5678	0.1904	.	0.0248	0.2907	1.0000	0.5929
WOD	1	2090.66667	6	1.0000	0.1973	0.0567	0.2907	0.0248	.	0.1904	0.0248	0.0078
WOD	2	1717.33333	7	0.1904	0.9045	0.5678	0.7886	0.2907	0.1904	.	0.2907	0.1198
WOD	3	1418.66667	8	0.0248	0.4054	0.5678	0.1904	1.0000	0.0248	0.2907	.	0.5929
WOD	4	1269.33333	9	0.0078	0.1973	0.2597	0.0729	0.5929	0.0078	0.1198	0.5929	.

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

STYPS	WSHD	SCA LSMEAN	I/J	1	2	3	4	5	6	7	8	9
QWD	1	0.64000000	1	.	0.0668	0.0180	0.0081	0.1219	0.9203	0.2935	0.0156	0.0013
QWD	2	0.42500000	2	0.0668	.	0.8137	0.4863	0.6238	0.0561	0.3386	0.6662	0.1679
QWD	3	0.40000000	3	0.0180	0.8137	.	0.5701	0.3970	0.0143	0.1653	0.8031	0.1653
WOC	1	0.34666667	4	0.0081	0.4863	0.5701	.	0.1929	0.0065	0.0744	0.7643	0.4276
WOC	4	0.48000000	5	0.1219	0.6238	0.3970	0.1929	.	0.1017	0.5951	0.3083	0.0441
WOD	1	0.65000000	6	0.9203	0.0561	0.0143	0.0065	0.1017	.	0.2520	0.0125	0.0011
WOD	2	0.53333333	7	0.2935	0.3386	0.1653	0.0744	0.5951	0.2520	.	0.1294	0.0145
WOD	3	0.37666667	8	0.0156	0.6662	0.8031	0.7643	0.3083	0.0125	0.1294	.	0.2791
WOD	4	0.26666667	9	0.0013	0.1679	0.1653	0.4276	0.0441	0.0011	0.0145	0.2791	.

PROB > |T| HO: LSMEAN(I)=LSMEAN(J)

STYPS	WSHD	SMG LSMEAN	I/J	1	2	3	4	5	6	7	8	9
QWD	1	0.06000000	1	.	0.9516	0.0197	0.6843	0.0012	0.8386	0.7009	0.0001	0.0007
QWD	2	0.07000000	2	0.9516	.	0.0418	0.7616	0.0033	0.9033	0.7770	0.0003	0.0020
QWD	3	0.40750000	3	0.0197	0.0418	.	0.0484	0.1350	0.0311	0.0462	0.0108	0.0831
WOC	1	0.12000000	4	0.6843	0.7616	0.0484	.	0.0029	0.8386	0.9819	0.0002	0.0017
WOC	4	0.62000000	5	0.0012	0.0033	0.1350	0.0029	.	0.0018	0.0028	0.2480	0.8035
WOD	1	0.09000000	6	0.8386	0.9033	0.0311	0.8386	0.0018	.	0.8563	0.0001	0.0010
WOD	2	0.11666667	7	0.7009	0.7770	0.0462	0.9819	0.0028	0.8563	.	0.0002	0.0016
WOD	3	0.79333333	8	0.0001	0.0003	0.0108	0.0002	0.2480	0.0001	0.0002	.	0.3590
WOD	4	0.65666667	9	0.0007	0.0020	0.0831	0.0017	0.8035	0.0010	0.0016	0.3590	.

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

DEP=1

GENERAL LINEAR MODELS PROCEDURE

LEAST SQUARES MEANS

STYPS	WSHD	SNA LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	0.00666667	1	.	0.8288	0.9356	0.0404	0.5877	0.8090	1.0000	1.0000	0.5877
QWD	2	0.00800000	2	0.8288	.	0.7649	0.0962	0.7870	0.6660	0.8288	0.8288	0.7870
QWD	3	0.00625000	3	0.9356	0.7649	.	0.0251	0.5101	0.8589	0.9356	0.9356	0.5101
WOC	1	0.01866667	4	0.0404	0.0962	0.0251	.	0.1150	0.0246	0.0404	0.0404	0.1150
WOC	4	0.00966667	5	0.5877	0.7870	0.5101	0.1150	.	0.4356	0.5877	0.5877	1.0000
WOD	1	0.00533333	6	0.8090	0.6660	0.8589	0.0246	0.4356	.	0.8090	0.8090	0.4356
WOD	2	0.00666667	7	1.0000	0.8288	0.9356	0.0404	0.5877	0.8090	.	1.0000	0.5877
WOD	3	0.00666667	8	1.0000	0.8288	0.9356	0.0404	0.5877	0.8090	1.0000	.	0.5877
WOD	4	0.00966667	9	0.5877	0.7870	0.5101	0.1150	1.0000	0.4356	0.5877	0.5877	.

STYPS	WSHD	SK LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	0.03100000	1	.	0.9309	0.9346	0.9742	0.9100	0.0463	0.8972	1.0000	0.8506
QWD	2	0.03700000	2	0.9309	.	0.8700	0.9539	0.8511	0.0844	0.9769	0.9309	0.7987
QWD	3	0.02525000	3	0.9346	0.8700	.	0.9072	0.9690	0.0291	0.8258	0.9346	0.9049
WOC	1	0.03300000	4	0.9742	0.9539	0.9072	.	0.8844	0.0493	0.9228	0.9742	0.8254
WOC	4	0.02400000	5	0.9100	0.8511	0.9690	0.8844	.	0.0368	0.8087	0.9100	0.9399
WOD	1	0.16166667	6	0.0463	0.0844	0.0291	0.0493	0.0368	.	0.0597	0.0463	0.0315
WOD	2	0.03900000	7	0.8972	0.9769	0.8258	0.9228	0.8087	0.0597	.	0.8972	0.7510
WOD	3	0.03100000	8	1.0000	0.9309	0.9346	0.9742	0.9100	0.0463	0.8972	.	0.8506
WOD	4	0.01933333	9	0.8506	0.7987	0.9049	0.8254	0.9399	0.0315	0.7510	0.8506	.

STYPS	WSHD	TCA LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	58.333333	1	.	0.1053	0.1058	0.1257	0.3566	0.2232	0.1771	0.2335	0.1533
QWD	2	113.750000	2	0.1053	.	0.7706	0.0056	0.0200	0.0110	0.0083	0.0116	0.0071
QWD	3	104.625000	3	0.1058	0.7706	.	0.0031	0.0142	0.0069	0.0049	0.0073	0.0040
WOC	1	11.666667	4	0.1257	0.0056	0.0031	.	0.5179	0.7348	0.8432	0.7137	0.9100
WOC	4	30.833333	5	0.3566	0.0200	0.0142	0.5179	.	0.7561	0.6519	0.7776	0.5926
WOD	1	21.666667	6	0.2232	0.0110	0.0069	0.7348	0.7561	.	0.8876	0.9774	0.8212
WOD	2	17.500000	7	0.1771	0.0083	0.0049	0.8432	0.6519	0.8876	.	0.8653	0.9324
WOD	3	22.500000	8	0.2335	0.0116	0.0073	0.7137	0.7776	0.9774	0.8653	.	0.7993
WOD	4	15.000000	9	0.1533	0.0071	0.0040	0.9100	0.5926	0.8212	0.9324	0.7993	.

STYPS	WSHD	TMG LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	65.2766667	1	.	0.9456	0.9543	0.0045	0.4960	0.4503	0.1816	0.5960	0.1790
QWD	2	64.5800000	2	0.9456	.	0.9829	0.0111	0.5875	0.4574	0.2559	0.5877	0.2528
QWD	3	64.7875000	3	0.9543	0.9829	.	0.0031	0.5022	0.3889	0.1706	0.5333	0.1679
WOC	1	36.1066667	4	0.0045	0.0111	0.0031	.	0.0202	0.0008	0.0805	0.0014	0.0818
WOC	4	59.0233333	5	0.4960	0.5875	0.5022	0.0202	.	0.1597	0.4962	0.2328	0.4908
WOD	1	72.2200000	6	0.4503	0.4574	0.3889	0.0008	0.1597	.	0.0444	0.8192	0.0436
WOD	2	52.7733333	7	0.1816	0.2559	0.1706	0.0805	0.4962	0.0444	.	0.0696	0.9930
WOD	3	70.1333333	8	0.5960	0.5877	0.5333	0.0014	0.2328	0.8192	0.0696	.	0.0684

STATISTICAL ANALYSIS SYSTEM

DEP=1

GENERAL LINEAR MODELS PROCEDURE

LEAST SQUARES MEANS

STYPS	WSHD	TMG LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
WOD	4	52.6933333	9	0.1790	0.2528	0.1679	0.0818	0.4908	0.0436	0.8930	0.0684	.

STYPS	WSHD	TNA LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	0.57333333	1	.	0.1771	0.7438	1.0000	1.0000	0.4425	0.1337	1.0000	1.0000
QWD	2	0.86000000	2	0.1771	.	0.2503	0.1771	0.1771	0.4914	1.0000	0.1771	0.1771
QWD	3	0.63000000	3	0.7438	0.2503	.	0.7438	0.7438	0.6179	0.1947	0.7438	0.7438
WOC	1	0.57333333	4	1.0000	0.1771	0.7438	.	1.0000	0.4425	0.1337	1.0000	1.0000
WOC	4	0.57333333	5	1.0000	0.1771	0.7438	1.0000	.	0.4425	0.1337	1.0000	1.0000
WOD	1	0.71666667	6	0.4425	0.4914	0.6179	0.4425	0.4425	.	0.4425	0.4425	0.4425
WOD	2	0.86000000	7	0.1337	1.0000	0.1947	0.1337	0.1337	0.4425	.	0.1337	0.1337
WOD	3	0.57333333	8	1.0000	0.1771	0.7438	1.0000	1.0000	0.4425	0.1337	.	1.0000
WOD	4	0.57333333	9	1.0000	0.1771	0.7438	1.0000	1.0000	0.4425	0.1337	1.0000	.

STYPS	WSHD	TK LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	6.91666667	1	.	0.0112	0.7115	0.0334	0.9960	0.4398	0.0017	0.0126	0.9476
QWD	2	8.97000000	2	0.0112	.	0.0164	0.4534	0.0113	0.0482	0.6422	0.7313	0.0127
QWD	3	7.14500000	3	0.7115	0.0164	.	0.0514	0.7156	0.6448	0.0022	0.0186	0.7643
WOC	1	8.41333333	4	0.0334	0.4534	0.0514	.	0.0337	0.1475	0.1829	0.6462	0.0382
WOC	4	6.92000000	5	0.9960	0.0113	0.7156	0.0337	.	0.4427	0.0017	0.0128	0.9516
WOD	1	7.43000000	6	0.4398	0.0482	0.6448	0.1475	0.4427	.	0.0096	0.0632	0.4788
WOD	2	9.31333333	7	0.0017	0.6422	0.0022	0.1829	0.0017	0.0096	.	0.3706	0.0019
WOD	3	8.71666667	8	0.0126	0.7313	0.0186	0.6462	0.0128	0.0632	0.3706	.	0.0145
WOD	4	6.96000000	9	0.9476	0.0127	0.7643	0.0382	0.9516	0.4788	0.0019	0.0145	.

STYPS	WSHD	SAND LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	38.8666667	1	.	0.5410	0.0149	0.2079	0.3507	0.6076	0.5497	0.2385	0.2079
QWD	2	36.2000000	2	0.5410	.	0.0072	0.5922	0.1561	0.8779	0.9388	0.6458	0.0900
QWD	3	48.5000000	3	0.0149	0.0072	.	0.0007	0.1129	0.0045	0.0036	0.0009	0.2119
WOC	1	33.8666667	4	0.2079	0.5922	0.0007	.	0.0361	0.4433	0.4948	0.9316	0.0176
WOC	4	42.5333333	5	0.3507	0.1561	0.1129	0.0361	.	0.1560	0.1344	0.0430	0.7316
WOD	1	36.8666667	6	0.6076	0.8779	0.0045	0.4433	0.1560	.	0.9316	0.4948	0.0840
WOD	2	36.5333333	7	0.5497	0.9388	0.0036	0.4948	0.1344	0.9316	.	0.5497	0.0714
WOD	3	34.2000000	8	0.2385	0.6458	0.0009	0.9316	0.0430	0.4948	0.5497	.	0.0211
WOD	4	43.8666667	9	0.2079	0.0900	0.2119	0.0176	0.7316	0.0840	0.0714	0.0211	.

STATISTICAL ANALYSIS SYSTEM
DEP=1

GENERAL LINEAR MODELS PROCEDURE

LEAST SQUARES MEANS

STYPS	WSHD	SILT LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	42.0000000	1	.	0.2075	0.1721	0.1149	0.5038	0.1610	0.4743	0.1364	0.3668
QWD	2	47.0000000	2	0.2075	.	0.0169	0.8636	0.0712	1.0000	0.5216	0.9315	0.0467
QWD	3	37.4500000	3	0.1721	0.0169	.	0.0050	0.4973	0.0079	0.0408	0.0063	0.6706
WOC	1	47.6666667	4	0.1149	0.8636	0.0050	.	0,0311	0.8477	0.3668	0.9234	0.0188
WOC	4	39.6666667	5	0.5038	0.0712	0.4973	0.0311	.	0.0459	0.1747	0.0378	0.8103
WOD	1	47.0000000	6	0.1610	1.0000	0.0079	0.8477	0.0459	.	0,4743	0.9234	0.0281
WOD	2	44.5000000	7	0.4743	0.5216	0.0408	0.3668	0.1747	0.4743	.	0.4183	0.1149
WOD	3	47.3333333	8	0.1364	0.9315	0.0063	0.9234	0.0378	0.9234	0.4183	.	0.0230
WOD	4	38.8333333	9	0.3668	0.0467	0.6706	0.0188	0.8103	0.0281	0.1149	0.0230	.

STYPS	WSHD	CLAY LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	19.1333333	1	.	0.1856	0.0021	0.6654	0.3908	0.0634	0.9137	0.5179	0.2423
QWD	2	16.8000000	2	0.1856	.	0.1045	0.3386	0.5626	0.6988	0.2175	0.4418	0.7714
QWD	3	14.0500000	3	0.0021	0.1045	.	0.0060	0.0165	0.1592	0.0028	0.0100	0.0342
WOC	1	18.4666667	4	0.6654	0.3386	0.0060	.	0.6654	0.1413	0.7454	0.8285	0.4516
WOC	4	17.8000000	5	0.3908	0.5626	0.0165	0.6654	.	0.2862	0.4516	0.8285	0.7454
WOD	1	16.1333333	6	0.0634	0.6988	0.1592	0.1413	0.2862	.	0.0781	0.2037	0.4516
WOD	2	18.9666667	7	0.9137	0.2175	0.0028	0.7454	0.4516	0.0781	.	0.5894	0.2862
WOD	3	18.1333333	8	0.5179	0.4418	0.0100	0.8285	0.8285	0.2037	0.5894	.	0.5894
WOD	4	17.3000000	9	0.2423	0.7714	0.0342	0.4516	0.7454	0.4516	0.2862	0.5894	.

NOTE: TO ENSURE OVERALL PROTECTION LEVEL, ONLY PROBABILITIES ASSOCIATED WITH PRE-PLANNED COMPARISONS SHOULD BE USED.

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

DEP=2

GENERAL LINEAR MODELS PROCEDURE

LEAST SQUARES MEANS

STYPS	WSHD	PHW LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	7.60000000	1	.	0.3975	0.0316	0.0001	0.3453	0.7504	0.3453	0.1237	0.3453
QWD	2	7.50000000	2	0.3975	.	0.0082	0.0008	0.1001	0.5705	0.1001	0.0329	0.1001
QWD	3	7.82500000	3	0.0316	0.0082	.	0.0001	0.2117	0.0154	0.2117	0.5532	0.2117
WOC	1	7.03333333	4	0.0001	0.0008	0.0001	..	0.0001	0.0001	0.0001	0.0001	0.0001
WOC	4	7.70000000	5	0.3453	0.1001	0.2117	0.0001	.	0.2127	1.0000	0.5264	1.0000
WOD	1	7.56666667	6	0.7504	0.5705	0.0154	0.0001	0.2127	.	0.2127	0.0684	0.2127
WOD	2	7.70000000	7	0.3453	0.1001	0.2117	0.0001	1.0000	0.2127	.	0.5264	1.0000
WOD	3	7.76666667	8	0.1237	0.0329	0.5532	0.0001	0.5264	0.0684	0.5264	.	0.5264
WOD	4	7.70000000	9	0.3453	0.1001	0.2117	0.0001	1.0000	0.2127	1.0000	0.5264	.

STYPS	WSHD	PHK LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	7.30000000	1	.	0.0047	0.0450	0.0003	0.0480	0.2726	0.0060	0.0362	0.2192
QWD	2	6.87500000	2	0.0047	.	0.0001	0.4216	0.2006	0.0400	0.6632	0.0001	0.0513
QWD	3	7.53750000	3	0.0450	0.0001	.	0.0001	0.0003	0.0034	0.0001	0.7343	0.0025
WOC	1	6.76666667	4	0.0003	0.4216	0.0001	.	0.0272	0.0032	0.1742	0.0001	0.0044
WOC	4	7.05000000	5	0.0480	0.2006	0.0003	0.0272	.	0.3352	0.3352	0.0004	0.4072
WOD	1	7.16666667	6	0.2726	0.0400	0.0034	0.0032	0.3352	.	0.0631	0.0032	0.8891
WOD	2	6.93333333	7	0.0060	0.6632	0.0001	0.1742	0.3352	0.0631	.	0.0001	0.0825
WOD	3	7.56666667	8	0.0362	0.0001	0.7943	0.0001	0.0004	0.0032	0.0001	.	0.0024
WOD	4	7.15000000	9	0.2192	0.0513	0.0025	0.0044	0.4072	0.8891	0.0825	0.0024	.

STYPS	WSHD	EC LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	433.333333	1	.	0.9399	0.6906	0.1811	0.7729	0.2327	0.9309	0.5978	0.1356
QWD	2	427.500000	2	0.9399	.	0.7856	0.2580	0.8548	0.2529	0.9983	0.5846	0.2031
QWD	3	407.500000	3	0.6906	0.7856	.	0.2931	0.9282	0.1017	0.7597	0.3408	0.2218
WOC	1	338.333333	4	0.1811	0.2580	0.2931	.	0.2865	0.0171	0.2088	0.0697	0.8662
WOC	4	413.333333	5	0.7729	0.8548	0.9282	0.2865	.	0.1439	0.8398	0.4174	0.2205
WOD	1	517.666667	6	0.2327	0.2529	0.1017	0.0171	0.1439	.	0.2024	0.4940	0.0119
WOD	2	427.333333	7	0.9309	0.9983	0.7597	0.2088	0.8398	0.2024	.	0.5399	0.1577
WOD	3	470.000000	8	0.5978	0.5846	0.3408	0.0697	0.4174	0.4940	0.5399	.	0.0502
WOD	4	326.666667	9	0.1356	0.2031	0.2218	0.8662	0.2205	0.0119	0.1577	0.0502	.

STYPS	WSHD	EXCA LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	26.8333333	1	.	0.2301	0.7859	0.0023	0.4500	0.4963	0.2004	0.4724	0.1541
QWD	2	21.0000000	2	0.2301	.	0.3004	0.0690	0.5881	0.5423	0.9581	0.5654	0.9303
QWD	3	25.7500000	3	0.7859	0.3004	.	0.0024	0.5893	0.6464	0.2671	0.6169	0.2050
WOC	1	11.9166667	4	0.0023	0.0690	0.0024	.	0.0124	0.0105	0.0393	0.0114	0.0538
WOC	4	23.5900000	5	0.4500	0.5881	0.5893	0.0124	.	0.9389	0.5843	0.9700	0.4833
WOD	1	23.9166667	6	0.4963	0.5423	0.6464	0.0105	0.9389	.	0.5335	0.9688	0.4378
WOD	2	21.2500000	7	0.2004	0.9581	0.2671	0.0393	0.5843	0.5335	.	0.5591	0.8757
WOD	3	23.7500000	8	0.4724	0.5654	0.6169	0.0114	0.9700	0.9688	0.5591	.	0.4607

STATISTICAL ANALYSIS SYSTEM
DEP=2

GENERAL LINEAR MODELS PROCEDURE

LEAST SQUARES MEANS

STYPS	WSHD	EXCA LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
WOD	4	20.5833333	9	0.1541	0.9303	0.2050	0.0538	0.4833	0.4378	0.8757	0.4607	.

STYPS	WSHD	EXMG LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	1.11000000	1	.	0.6018	0.0869	0.0001	0.0857	0.5457	0.0256	0.5457	0.0001
QWD	2	1.24500000	2	0.6018	.	0.0448	0.0001	0.2879	0.9845	0.1171	0.9845	0.0001
QWD	3	0.72500000	3	0.0869	0.0448	.	0.0001	0.0015	0.0238	0.0003	0.0238	0.0001
WOC	1	2.91333333	4	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0857
WOC	4	1.52333333	5	0.0857	0.2879	0.0015	0.0001	.	0.2448	0.5457	0.2448	0.0004
WOD	1	1.25000000	6	0.5457	0.9845	0.0238	0.0001	0.2448	.	0.0857	1.0000	0.0001
WOD	2	1.66333333	7	0.0256	0.1171	0.0003	0.0001	0.5457	0.0857	.	0.0857	0.0017
WOD	3	1.25000000	8	0.5457	0.9845	0.0238	0.0001	0.2448	1.0000	0.0857	.	0.0001
WOD	4	2.50000000	9	0.0001	0.0001	0.0001	0.0857	0.0004	0.0001	0.0017	0.0001	.

STYPS	WSHD	EXNA LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	0.04000000	1	.	0.0118	0.0217	0.3101	0.3101	1.0000	0.0512	1.0000	1.0000
QWD	2	-0.00000000	2	0.0118	.	0.4697	0.0015	0.0781	0.0118	0.3626	0.0118	0.0118
QWD	3	0.01000000	3	0.0217	0.4697	.	0.0019	0.1798	0.0217	0.7833	0.0217	0.0217
WOC	1	0.05333333	4	0.3101	0.0015	0.0019	.	0.0512	0.3101	0.0057	0.3101	0.3101
WOC	4	0.02666667	5	0.3101	0.0781	0.1798	0.0512	.	0.3101	0.3101	0.3101	0.3101
WOD	1	0.04000000	6	1.0000	0.0118	0.0217	0.3101	0.3101	.	0.0512	1.0000	1.0000
WOD	2	0.01333333	7	0.0512	0.3626	0.7833	0.0057	0.3101	0.0512	.	0.0512	0.0512
WOD	3	0.04000000	8	1.0000	0.0118	0.0217	0.3101	0.3101	1.0000	0.0512	.	1.0000
WOD	4	0.04000000	9	1.0000	0.0118	0.0217	0.3101	0.3101	1.0000	0.0512	1.0000	.

STYPS	WSHD	EXK LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	0.27333333	1	.	0.5492	0.2470	0.0033	0.0976	1.0000	0.0424	0.0720	0.7068
QWD	2	0.31500000	2	0.5492	.	0.1066	0.0265	0.3535	0.5492	0.1959	0.2863	0.7913
QWD	3	0.20500000	3	0.2470	0.1066	.	0.0001	0.0067	0.2470	0.0024	0.0045	0.1258
WOC	1	0.48000000	4	0.0033	0.0265	0.0001	.	0.1188	0.0033	0.2452	0.1577	0.0076
WOC	4	0.38000000	5	0.0976	0.3535	0.0067	0.1188	.	0.0976	0.6674	0.8717	0.1890
WOD	1	0.27333333	6	1.0000	0.5492	0.2470	0.0033	0.0976	.	0.0424	0.0720	0.7068
WOD	2	0.40666667	7	0.0424	0.1959	0.0024	0.2452	0.6674	0.0424	.	0.7879	0.0883
WOD	3	0.39000000	8	0.0720	0.2863	0.0045	0.1577	0.8717	0.0720	0.7879	.	0.1437
WOD	4	0.29666667	9	0.7068	0.7913	0.1258	0.0076	0.1890	0.7068	0.0883	0.1437	.

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

DEP=2

GENERAL LINEAR MODELS PROCEDURE

LEAST SQUARES MEANS

STYPS	WSHD	CEC LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	13.5133333	1	.	0.4735	0.0085	0.0799	0.9318	0.2212	0.9116	0.8915	0.7804
QWD	2	12.6650000	2	0.4735	.	0.0837	0.0279	0.5211	0.6929	0.4158	0.4033	0.6377
QWD	3	10.6525000	3	0.0085	0.0837	.	0.0001	0.0104	0.1278	0.0066	0.0062	0.0163
WOC	1	15.4366667	4	0.0799	0.0279	0.0001	.	0.0679	0.0059	0.0983	0.1030	0.0464
WOC	4	13.4233333	5	0.9318	0.5211	0.0104	0.0679	.	0.2532	0.8442	0.8244	0.8466
WOD	1	12.2000000	6	0.2212	0.6929	0.1278	0.0059	0.2532	.	0.1845	0.1769	0.3380
WOD	2	13.6300000	7	0.9116	0.4158	0.0066	0.0983	0.8442	0.1845	.	0.9798	0.6970
WOD	3	13.6566667	8	0.8915	0.4033	0.0062	0.1030	0.8244	0.1769	0.9798	.	0.6785
WOD	4	13.2200000	9	0.7804	0.6377	0.0163	0.0464	0.8466	0.3380	0.6970	0.6785	.

STYPS	WSHD	TP LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	149.333333	1	.	0.3617	0.1824	0.0001	0.4135	0.8689	0.0508	0.5116	0.1114
QWD	2	141.000000	2	0.3617	.	0.8155	0.0006	0.8536	0.4420	0.3617	0.1422	0.5814
QWD	3	139.000000	3	0.1824	0.8155	.	0.0002	0.6285	0.2427	0.4064	0.0498	0.6919
WOC	1	104.000000	4	0.0001	0.0006	0.0002	.	0.0001	0.0001	0.0021	0.0001	0.0008
WOC	4	142.666667	5	0.4135	0.8536	0.6285	0.0001	.	0.5116	0.2253	0.1492	0.4135
WOD	1	148.000000	6	0.8689	0.4420	0.2427	0.0001	0.5116	.	0.0702	0.4135	0.1492
WOD	2	132.666667	7	0.0508	0.3617	0.4064	0.0021	0.2253	0.0702	.	0.0128	0.6805
WOD	3	154.666667	8	0.5116	0.1422	0.0498	0.0001	0.1492	0.4135	0.0128	.	0.0308
WOD	4	136.000000	9	0.1114	0.5814	0.6919	0.0008	0.4135	0.1492	0.6805	0.0308	.

STYPS	WSHD	AP LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	0.00000000	1	.	0.3644	0.6546	0.2713	0.0406	0.1642	0.0944	0.0083	0.4968
QWD	2	1.10000000	2	0.3644	.	0.5694	0.9335	0.3106	0.7182	0.5248	0.1026	0.7600
QWD	3	0.45000000	3	0.6546	0.5694	.	0.4581	0.0730	0.2878	0.1692	0.0142	0.7778
WOC	1	1.20000000	4	0.2713	0.9335	0.4581	.	0.2979	0.7562	0.5363	0.0841	0.6642
WOC	4	2.33333333	5	0.0406	0.3106	0.0730	0.2979	.	0.4591	0.6642	0.4591	0.1476
WOD	1	1.53333333	6	0.1642	0.7182	0.2878	0.7562	0.4591	.	0.7562	0.1476	0.4591
WOD	2	1.86666667	7	0.0944	0.5248	0.1692	0.5363	0.6642	0.7562	.	0.2465	0.2979
WOD	3	3.13333333	8	0.0083	0.1026	0.0142	0.0841	0.4591	0.1476	0.2465	.	0.0357
WOD	4	0.73333333	9	0.4968	0.7600	0.7778	0.6642	0.1476	0.4591	0.2979	0.0357	.

STYPS	WSHD	OM LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	1.44000000	1	.	0.7784	0.6255	0.9088	0.6076	0.4489	0.3651	0.1638	0.3460
QWD	2	1.49500000	2	0.7784	.	0.4694	0.7015	0.4611	0.6889	0.2788	0.3246	0.2647
QWD	3	1.36000000	3	0.6255	0.4694	.	0.7139	0.9512	0.2020	0.6255	0.0554	0.5972
WOC	1	1.42000000	4	0.9088	0.7015	0.7139	.	0.6892	0.3850	0.4269	0.1343	0.4056
WOC	4	1.35000000	5	0.6076	0.4611	0.9512	0.6892	.	0.2111	0.6892	0.0639	0.6615
WOD	1	1.57333333	6	0.4489	0.6889	0.2020	0.3850	0.2111	.	0.1057	0.5067	0.0986
WOD	2	1.28000000	7	0.3651	0.2788	0.6255	0.4269	0.6892	0.1057	.	0.0285	0.9695
WOD	3	1.69000000	8	0.1638	0.3246	0.0554	0.1343	0.0639	0.5067	0.0285	.	0.0264

STATISTICAL ANALYSIS SYSTEM

DEP=2

GENERAL LINEAR MODELS PROCEDURE

LEAST SQUARES MEANS

STYPS	WSHD	OM LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
WOD	4	1.27333333	9	0.3460	0.2647	0.5972	0.4056	0.6615	0.0986	0.9695	0.0264	.

STYPS	WSHD	TKN LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	1344.00000	1	.	1.0000	0.4133	0.7970	0.6079	0.7970	0.6079	0.6079	0.7970
QWD	2	1344.00000	2	1.0000	.	0.4697	0.8180	0.6460	0.8180	0.6460	0.6460	0.8180
QWD	3	1120.00000	3	0.4133	0.4697	.	0.5835	0.1798	0.2789	0.7833	0.1798	0.5835
WOC	1	1269.33333	4	0.7970	0.8180	0.5835	.	0.4436	0.6079	0.7970	0.4436	1.0000
WOC	4	1493.33333	5	0.6079	0.6460	0.1798	0.4436	.	0.7970	0.3101	1.0000	0.4436
WOD	1	1418.66667	6	0.7970	0.8180	0.2789	0.6079	0.7970	.	0.4436	0.7970	0.6079
WOD	2	1194.66667	7	0.6079	0.6460	0.7833	0.7970	0.3101	0.4436	.	0.3101	0.7970
WOD	3	1493.33333	8	0.6079	0.6460	0.1798	0.4436	1.0000	0.7970	0.3101	.	0.4436
WOD	4	1269.33333	9	0.7970	0.8180	0.5835	1.0000	0.4436	0.6079	0.7970	0.4436	.

STYPS	WSHD	SCA LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	0.37333333	1	.	0.8066	0.7811	0.0608	0.9128	0.0546	0.4795	0.2812	0.0608
QWD	2	0.39000000	2	0.8066	.	0.6158	0.0566	0.7320	0.1292	0.3829	0.4657	0.0566
QWD	3	0.35750000	3	0.7811	0.6158	.	0.0799	0.8721	0.0233	0.6301	0.1589	0.0799
WOC	1	0.25333333	4	0.0608	0.0566	0.0799	.	0.0751	0.0007	0.2176	0.0060	1.0000
WOC	4	0.36666667	5	0.9128	0.7320	0.8721	0.0751	.	0.0439	0.5488	0.2374	0.0751
WOD	1	0.49666667	6	0.0546	0.1292	0.0233	0.0007	0.0439	.	0.0124	0.3575	0.0007
WOD	2	0.33000000	7	0.4795	0.3829	0.6301	0.2176	0.5488	0.0124	.	0.0834	0.2176
WOD	3	0.44000000	8	0.2812	0.4657	0.1589	0.0060	0.2374	0.3575	0.0834	.	0.0060
WOD	4	0.25333333	9	0.0608	0.0566	0.0799	1.0000	0.0751	0.0007	0.2176	0.0060	.

STYPS	WSHD	SMG LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	0.05000000	1	.	0.9459	0.0001	0.6145	0.0001	0.8795	0.8399	0.0001	0.0001
QWD	2	0.05500000	2	0.9459	.	0.0004	0.7014	0.0001	0.9459	0.9100	0.0001	0.0001
QWD	3	0.35500000	3	0.0001	0.0004	.	0.0003	0.0049	0.0001	0.0001	0.0055	0.0001
WOC	1	0.08333333	4	0.6145	0.7014	0.0003	.	0.0001	0.7240	0.7620	0.0001	0.0001
WOC	4	0.55000000	5	0.0001	0.0001	0.0049	0.0001	.	0.0001	0.0001	0.9597	0.0500
WOD	1	0.06000000	6	0.8795	0.9459	0.0001	0.7240	0.0001	.	0.9597	0.0001	0.0001
WOD	2	0.06333333	7	0.8399	0.9100	0.0001	0.7620	0.0001	0.9597	.	0.0001	0.0001
WOD	3	0.54666667	8	0.0001	0.0001	0.0055	0.0001	0.9597	0.0001	0.0001	.	0.0452
WOD	4	0.68666667	9	0.0001	0.0001	0.0001	0.0001	0.0500	0.0001	0.0001	0.0452	.

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

DEP=2

GENERAL LINEAR MODELS PROCEDURE

LEAST SQUARES MEANS

STYPS	WSHD	SNA LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	0.01133333	1	.	0.4483	0.7668	0.7329	0.6699	0.2407	0.4455	0 4455	0.2747
QWD	2	0.00800000	2	0.4483	.	0.5880	0.2921	0.7029	0.7601	0.9391	0.9391	0.0915
QWD	3	0.01025000	3	0.7668	0.5880	.	0.5103	0.8730	0.3325	0.6007	0.6007	0.1495
WOC	1	0.01266667	4	0.7329	0.2921	0.5103	.	0.4455	0.1362	0.2747	0.2747	0.4455
WOC	4	0.00966667	5	0.6699	0.7029	0.8730	0.4455	.	0.4455	0.7329	0.7329	0.1362
WOD	1	0.00666667	6	0.2407	0.7601	0.3325	0.1362	0.4455	.	0.6699	0.6699	0.0310
WOD	2	0.00833333	7	0.4455	0.9391	0.6007	0.2747	0.7329	0.6699	.	1.0000	0.0727
WOD	3	0.00833333	8	0.4455	0.9391	0.6007	0.2747	0.7329	0.6699	1.0000	.	0.0727
WOD	4	0.01566667	9	0.2747	0.0915	0.1495	0.4455	0.1362	0.0310	0.0727	0.0727	.

STYPS	WSHD	SK LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
OWD	1	0.01500000	1	.	0.4189	0.7931	0.6409	0.1464	0.1587	0.3793	0.2511	0.5452
OWD	2	0.02150000	2	0.4189	.	0.5320	0.6916	0.6024	0.6315	0.9833	0.8181	0.1848
OWD	3	0.01675000	3	0.7931	0.5320	.	0.8124	0.1917	0.2081	0.4945	0.3298	0.3670
WOC	1	0.01833333	4	0.6409	0.6916	0.8124	.	0.3105	0.3324	0.6745	0.4859	0.2897
WOC	4	0.02566667	5	0.1464	0.6024	0.1917	0.3105	.	0.9627	0.5452	0.7437	0.0468
WOD	1	0.02533333	6	0.1587	0.6315	0.2081	0.3324	0.9627	.	0.5762	0.7792	0.0514
WOD	2	0.02133333	7	0.3793	0.9833	0.4945	0.6745	0.5452	0.5762	.	0.7792	0.1464
WOD	3	0.02333333	8	0.2511	0.8181	0.3298	0.4859	0.7437	0.7792	0.7792	.	0.0882
WOD	4	0.01066667	9	0.5452	0.1848	0.3670	0.2897	0.0468	0.0514	0.1464	0.0882	.

STYPS	WSHD	TCA LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	133.333333	1	.	0.9681	0.7294	0.0043	0.0243	0.0299	0.0151	0.0344	0.0313
QWD	2	135.000000	2	0.9681	.	0.7285	0.0084	0.0379	0.0455	0.0251	0.0513	0.0473
QWD	3	121.250000	3	0.7294	0.7285	.	0.0057	0.0352	0.0437	0.0214	0.0505	0.0459
WOC	1	13.333333	4	0.0043	0.0084	0.0057	.	0.4315	0.3766	0.5704	0.3426	0.3650
WOC	4	42.916667	5	0.0243	0.0379	0.0352	0.4315	.	0.9199	0.8232	0.8669	0.9022
WOD	1	46.666667	6	0.0299	0.0455	0.0437	0.3766	0.9199	.	0.7462	0.9465	0.9822
WOD	2	34.583333	7	0.0151	0.0251	0.0214	0.5704	0.8232	0.7462	.	0.6963	0.7294
WOD	3	49.166667	8	0.0344	0.0513	0.0505	0.3426	0.8669	0.9465	0.6963	.	0.9643
WOD	4	47.500000	9	0.0313	0.0473	0.0459	0.3650	0.9022	0.9822	0.7294	0.9643	.

STYPS	WSHD	TMG LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	87.4966667	1	.	0.5720	0.2314	0.0076	0.1033	0.6730	0.0883	0.4022	0.3368
QWD	2	77.0800000	2	0.5720	.	0.6331	0.0490	0.3501	0.8499	0.3139	0.8501	0.7624
QWD	3	68.7450000	3	0.2314	0.6331	.	0.0641	0.5585	0.4455	0.5004	0.7516	0.8563
WOC	1	38.8866667	4	0.0076	0.0490	0.0641	.	0.2143	0.0191	0.2451	0.0458	0.0589
WOC	4	59.7200000	5	0.1033	0.3501	0.5585	0.2143	.	0.2143	0.9327	0.4021	0.4751
WOD	1	80.5533333	6	0.6730	0.8499	0.4455	0.0191	0.2143	.	0.1866	0.6730	0.5839
WOD	2	58.3333333	7	0.0883	0.3139	0.5004	0.2451	0.9327	0.1866	.	0.3577	0.4256
WOD	3	73.6100000	8	0.4022	0.8501	0.7516	0.0458	0.4021	0.6730	0.3577	.	0.8990

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

DEP=2

GENERAL LINEAR MODELS PROCEDURE

LEAST SQUARES MEANS

STYPS	WSHD	TMG LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
WOD	4	71.5266667	9	0.3368	0.7624	0.8563	0.0589	0.4751	0.5839	0.4256	0.8990	.

STYPS	WSHD	TNA LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	0.64666667	1	.	0.2249	0.8079	0.6503	0.1706	0.1770	0.6349	0.1770	0.6503
QWD	2	0.86000000	2	0.2249	.	0.1703	0.4095	0.0208	1.0000	0.1085	1.0000	0.4095
QWD	3	0.63000000	3	0.9079	0.1703	.	0.5493	0.1761	0.1227	0.6946	0.1227	0.5493
WOC	1	0.71666667	4	0.6503	0.4095	0.5493	.	0.0752	0.3576	0.3576	0.3576	1.0000
WOC	4	0.43000000	5	0.1706	0.0208	0.1761	0.0752	.	0.0110	0.3576	0.0110	0.0752
WOD	1	0.86000000	6	0.1770	1.0000	0.1227	0.3576	0.0110	.	0.0752	1.0000	0.3576
WOD	2	0.57333333	7	0.6349	0.1085	0.6946	0.3576	0.3576	0.0752	.	0.0752	0.3576
WOD	3	0.86000000	8	0.1770	1.0000	0.1227	0.3576	0.0110	1.0000	0.0752	.	0.3576
WOD	4	0.71666667	9	0.6503	0.4095	0.5493	1.0000	0.0752	0.3576	0.3576	0.3576	.

STYPS	WSHD	TK LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	7.30666667	1	.	0.0418	0.5414	0.0908	0.2532	0.8843	0.1584	0.0416	0.8442
QWD	2	9.35500000	2	0.0418	.	0.0104	0.5599	0.0045	0.0542	0.3927	0.8206	0.0592
QWD	3	6.82000000	3	0.5414	0.0104	.	0.0208	0.5305	0.4454	0.0415	0.0082	0.4143
WOC	1	8.80000000	4	0.0908	0.5599	0.0208	.	0.0083	0.1185	0.7563	0.6889	0.1298
WOC	4	6.32000000	5	0.2532	0.0045	0.5305	0.0083	.	0.2007	0.0162	0.0034	0.1845
WOD	1	7.43000000	6	0.8843	0.0542	0.4454	0.1185	0.2007	.	0.2020	0.0557	0.9592
WOD	2	8.53666667	7	0.1584	0.3927	0.0415	0.7563	0.0162	0.2020	.	0.4796	0.2195
WOD	3	9.14000000	8	0.0416	0.8206	0.0082	0.6889	0.0034	0.0557	0.4796	.	0.0615
WOD	4	7.47333333	9	0.8442	0.0592	0.4143	0.1298	0.1845	0.9592	0.2195	0.0615	.

STYPS	WSHD	SAND LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	36.5333333	1	.	0.9366	0.0021	0.2563	0.2934	0.2228	0.7225	1.0000	0.4798
QWD	2	36.2000000	2	0.9366	.	0.0044	0.3458	0.3082	0.2419	0.8115	0.9366	0.4771
QWD	3	48.9500000	3	0.0021	0.0044	.	0.0001	0.0255	0.0378	0.0009	0.0021	0.0113
WOC	1	32.2000000	4	0.2563	0.3458	0.0001	.	0.0368	0.0255	0.4275	0.2563	0.0744
WOC	4	40.5333333	5	0.2934	0.3082	0.0255	0.0368	.	0.8589	0.1662	0.2934	0.7225
WOD	1	41.2000000	6	0.2228	0.2419	0.0378	0.0255	0.8589	.	0.1219	0.2228	0.5950
WOD	2	35.2000000	7	0.7225	0.8115	0.0009	0.4275	0.1662	0.1219	.	0.7225	0.2934
WOD	3	36.5333333	8	1.0000	0.9366	0.0021	0.2563	0.2934	0.2228	0.7225	.	0.4798
WOD	4	39.2000000	9	0.4798	0.4771	0.0113	0.0744	0.7225	0.5950	0.2934	0.4798	.

STATISTICAL ANALYSIS SYSTEM
DEP=2

GENERAL LINEAR MODELS PROCEDURE

LEAST SQUARES MEANS

STYPS	WSHD	SILT LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	40.3333333	1	.	0.2579	0.2275	0.0907	0.6361	0.7864	0.0539	0.0411	0.8922
QWD	2	43.5000000	2	0.2579	.	0.0314	0.6720	0.4701	0.3685	0.5074	0.4345	0.2129
QWD	3	37.5000000	3	0.2275	0.0314	.	0.0054	0.0947	0.1401	0.0028	0.0020	0.2848
WOC	1	44.6666667	4	0.0907	0.6720	0.0054	.	0.2079	0.1478	0.7864	0.6848	0.0702
WOC	4	41.5000000	5	0.6361	0.4701	0.0947	0.2079	.	0.8389	0.1312	0.1028	0.5438
WOD	1	41.0000000	6	0.7864	0.3685	0.1401	0.1478	0.8389	.	0.0907	0.0702	0.6848
WOD	2	45.3333333	7	0.0539	0.5074	0.0028	0.7864	0.1312	0.0907	.	0.8922	0.0411
WOD	3	45.6666667	8	0.0411	0.4345	0.0020	0.6848	0.1028	0.0702	0.8922	.	0.0312
WOD	4	40.0000000	9	0.8922	0.2129	0.2848	0.0702	0.5438	0.6848	0.0411	0.0312	.

STYPS	WSHD	CLAY LSMEAN	PROB > |T| HO: LSMEAN(I)=LSMEAN(J) I/J	1	2	3	4	5	6	7	8	9
QWD	1	23.1333333	1	.	0.1235	0.0001	1.0000	0.0040	0.0032	0.0311	0.0032	0.1541
QWD	2	20.3000000	2	0.1235	.	0.0199	0.1235	0.1999	0.1711	0.6403	0.1711	0.7788
QWD	3	16.0500000	3	0.0001	0.0199	.	0.0001	0.2079	0.2484	0.0317	0.2484	0.0046
WOC	1	23.1333333	4	1.0000	0.1235	0.0001	.	0.0040	0.0032	0.0311	0.0032	0.1541
WOC	4	17.9666667	5	0.0040	0.1999	0.2079	0.0040	.	0.9165	0.3515	0.9165	0.0876
WOD	1	17.8000000	6	0.0032	0.1711	0.2484	0.0032	0.9165	.	0.3020	1.0000	0.0718
WOD	2	19.4666667	7	0.0311	0.6403	0.0317	0.0311	0.3515	0.3020	.	0.3020	0.4064
WOD	3	17.8000000	8	0.0032	0.1711	0.2484	0.0032	0.9165	1.0000	0.3020	.	0.0718
WOD	4	20.8000000	9	0.1541	0.7788	0.0046	0.1541	0.0876	0.0718	0.4064	0.0718	.

NOTE: TO ENSURE OVERALL PROTECTION LEVEL, ONLY PROBABILITIES ASSOCIATED WITH PRE-PLANNED COMPARISONS SHOULD BE USED.

VITA

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Doctor of Philosophy

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