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January 29, 1996

Bill Gern
Vice President for Research
Old Main
Campus

Dear Bill:

I am pleased to deliver to you Volumes 1 through 3 of our AML project completion report entitled "Methodology for the Geomorphic Classification and Design of Drainage Basins and Stream Channels in the Eastern Powder River Basin Coal Field of Wyoming." The Executive Summary, which we anticipate will receive wider distribution, is still undergoing U.S. Geological Survey review. I will deliver this document to you at the earliest possible date.

Thank you for your interest in and support of this research effort.

Sincerely,

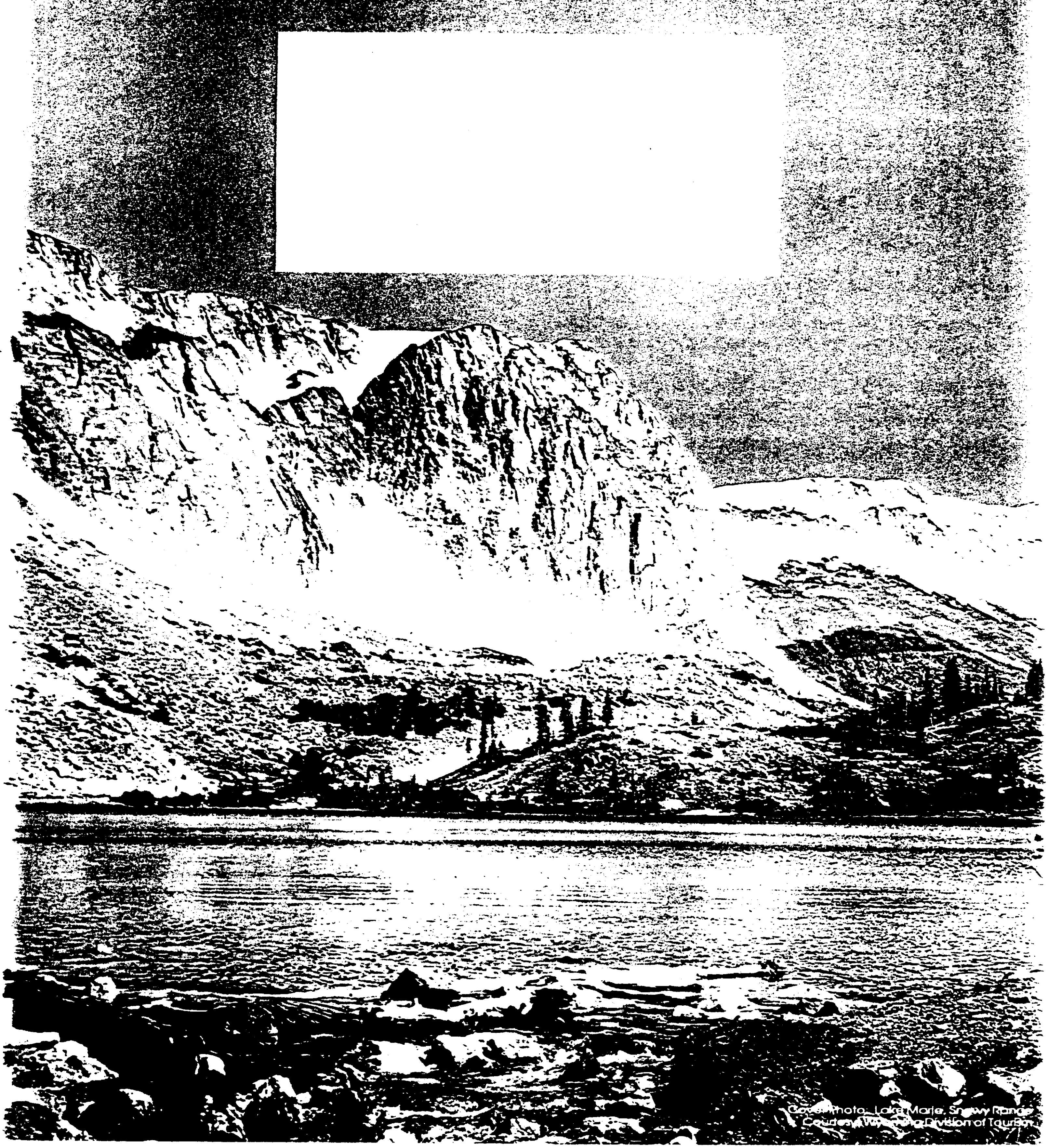
Tom

Thomas A. Wesche
Professor and Co-Principal Investigator

Enc.

cc: Steve Gloss
Hugh Lowham
Tony Anderson

WYOMING WATER RESEARCH CENTER



Cover Photo: Lake Marie, Snowy Range
Courtesy Wyoming Division of Tourism

Methodology for the Geomorphic Classification and Design of Drainage Basins and Stream Channels in the Eastern Powder River Basin Coal Field of Wyoming

Anthony J. Anderson
Lee E. Jensen
Suzy L. Noecker
Thomas A. Wesche

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Technical Report
Submitted to
The Abandoned Coal Mine Lands
Research Program

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December, 1995

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The staffs of the Wyoming Water Resources Center and the University of Wyoming Department of Range Management were instrumental in the completion of this report. We would like to commend our office technicians Lisa Reynolds and Bridgette White for their work during the delineation and digitizing portions of this study. We would also like to thank our field hand, Jeff Stafford, for his work in the collection of field data.

We would like to thank all the private landowners in Campbell County, Wyoming who allowed us access to their property for this study. We were received well by all the ranchers and coal companies in the Eastern Powder River Basin and we hope this spirit of cooperation continues in the future.

This work was supported in part by the Abandoned Coal Mine Lands Research Program at the University of Wyoming. This support was administered by the Land Quality Division of the Wyoming Department of Environmental Quality from funds returned to Wyoming from the Office of Surface Mining of the U.S. Department of the Interior.

ABSTRACT

Jensen, Lee E., Anthony J. Anderson, Suzy L. Noecker, and Thomas A. Wesche 1994. Methodology for the Geomorphic Classification and Design of Drainage Basins and Stream Channels in the Eastern Powder River Basin coal field of Wyoming. Final technical report to the Abandoned Coal Mine Land Research Program. University of Wyoming Office of Research. Laramie, Wyoming.

Current and potential coal mining operations in the Powder River Basin have increased the need for knowledge regarding drainage basin form and function in that region. The current life-of-mine estimates indicate that each mine in the region will disturb and then reclaim between 959 to 13,217 acres before completion of mining activities. Quantitative analysis of erosional landforms has derived and defined variables that can distinguish drainage basins. Three hundred eighty-four low order drainage basins were selected from USGS, 1:24000, 7.5 minute, topographic quadrangles. Fifteen quantitative and six categorical variables were used to characterize and describe each basin. Additionally, field investigations were conducted to quantify cross-sectional and longitudinal profile characteristics of 58 drainage networks.

Multivariate statistics including, principal components analysis, cluster analysis, and discriminant function analysis were used to categorize the drainage basins in each order. The resulting categories were altered as necessary after correlations of key parameters were analyzed.

The resulting classification has three strata defined by geology, basin area, and gross basin slope of the third order drainage basin. Second and first order basins were classified by the third order stream to which they are tributary.

The geomorphic characteristics of the basins in each strata were then used to develop design equations for the reconstruction of drainage basins and networks within each strata by order. Approximately 200 significant design equations were developed for reclamation in the Eastern Powder River Basin.

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CHAPTER I

INTRODUCTION

Historic surface and underground mining activities in Wyoming commonly changed the natural landscape. In some cases, these activities have resulted in detrimental effects, such as accelerated erosion and increased sediment yields, on drainage basins and stream channels. Prior to the enactment of the Surface Mining Control and Reclamation Act of 1977 (SMCRA), surface coal mines commonly were left without suitable reclamation. In addition to areas disturbed historically, considerable areas are currently (1994) being disturbed in Wyoming. Many of the active surface coal mines in Wyoming are located in the Powder River structural basin where as much as 253 square miles of land surface eventually could be disturbed by all anticipated mining (Martin et. al., 1988). Because of the significant land areas disturbed by past, present, and projected coal mining activities in Wyoming, successful mine land reclamation is of great interest to land managers, mining companies, regulatory agencies, and the general public.

The process of designing and reconstructing an ecosystem following the mining process has many facets, of which restoring the hydrologic function and stability of drainage networks is an integral part. Current drainage basin design in the Eastern Powder River Basin coal field is an attempt to meet Wyoming Department of Environmental Quality (WDEQ)/ Land Quality Division (LQD) and U.S. Office of Surface Mining (OSM) standards in the most economical and efficient manner possible. Mine land reclamation techniques rely heavily on engineering design and hydraulic behavior considerations for reclaiming drainage basins and stream channels. At present, these techniques are considered to be the most economical method of meeting WDEQ standards. Engineered channels, however, do not take into consideration the hydrologic regime of the region; they simply are designed to convey a flow of given magnitude, at a given velocity, in a stable manner.

A geomorphic approach to drainage network reclamation is an alternative to current engineering design approaches. Reclamation failures are generally a result of instability and arise as a consequence of engineering approaches that do not adequately consider geomorphic principles. A geomorphic approach to channel and drainage basin design takes into account the natural processes involved in transporting precipitation runoff and sediment (Hadley and Toy, 1987). The primary assumption of the geomorphic approach is that the drainage basin and stream network have adjusted over geologic time to climatic and lithologic conditions, thereby reflecting the hydrologic and erosional processes that control their morphology (Marston, 1978). The geomorphic approach allows for the integration of the form and process of natural landscapes into reconstruction designs. Aggradation and degradation of channels and hillslope erosion may occur but need not indicate anything more than geomorphic processes at work in the natural hydrologic regime.

Reclamation evaluation studies completed in semi-arid southwestern Wyoming suggest that channel adjustment is not necessarily a sign of instability and that "non-erosive conditions" for engineered stream channels do not exist (Western Water Consultants Inc, 1993). Engineered channels also tend to adjust to "...approach the configuration of natural channels over time." (Western Water Consultants Inc., 1993).

PURPOSE AND SCOPE

In the spring of 1992 the Abandoned Coal Mine Land Research Program funded this joint project by the Wyoming Water Resources Center and the U.S. Geological Survey (USGS), Water Resources Division entitled;

> "Methodology for the Geomorphic Classification and Design of Drainage Basins and Stream Channels in the Powder River Coal Field of Wyoming."

For the purposes of this report, the Powder River Basin refers to the structural basin between the Black Hills and the Big Horn Mountains. The Eastern Powder River Basin coal field refers to the area of mining activity along the contact between the Fort Union and Wasatch Formations in Campbell

County, Wyoming. The goal of the project was to analyze the geomorphology of drainage basins and stream channels in the Eastern Powder River Basin and to integrate that analysis into an approach for reclamation of drainage networks in the region.

OBJECTIVES OF THE STUDY

Three objectives were identified in the original project proposal. Each objective became the subject of a graduate research study at the University of Wyoming. The original project objectives and the objectives of the associated graduate research studies, are listed below.

1. Inventory, review, and summarize design procedures being used for reconstruction and reclamation of drainage basins and stream channels in the Powder River coal field in Wyoming, especially the type and extent that the geomorphic approach is used for reconstruction design.
   A) Review existing guidelines and procedures used by regulatory and land management agencies and private industry in Wyoming for reclamation design.
   B) Review literature on existing design methods and previous studies involving reconstruction and reclamation of drainage basins and stream channels.
   C) Compare and contrast the engineering and geomorphic design approaches to basin and channel reclamation.

2. Develop a classification system for drainage basins and stream channels in the Powder River coal field in Wyoming based on the natural, physical characteristics of selected groups of small drainage basins.

   A) Delineate a study area representative of the eastern Powder River Basin coal field.

   B) Select and measure a set of drainage basin and drainage network characteristics including: soils, vegetation, climate, and topography, for selected drainage basins and stream channels, using available maps, databases, and field surveys.

   C) Using the above characteristics, analyze drainage basins for similarity using multi-variate statistical techniques to categorize the drainage basins.

   D) Develop a drainage basin classification system based upon similarities and differences between the basins that are found in the categories generated.

3. Analyze and summarize the geomorphic characteristics of different classes or types of drainage basins and stream channels, thereby developing geomorphic methodology and criteria for the design of reconstructed drainage basins and stream channels.

   A) Characterize the geomorphic features of natural (undisturbed) drainage networks in the eastern Powder River Basin coal field, including both channel geometry and morphology.

   B) Formalize recognizable geomorphic relationships in graphical and equation formats.

   C) Classify drainage networks and stream channels based on their morphometric characteristics.

   D) Provide procedures to utilize the geomorphic appoach for practical reclamation design purposes.

CHAPTER II

DESCRIPTION OF THE STUDY AREA

The Powder River Basin in northeastern Wyoming is a broad structural syncline between the Bighorn Mountains to the west, the Black Hills to the east, the Casper Arch, Laramie Mountains, and Hartville uplift to the south, and the Cedar Ridge anticline in Montana to the north (Glass, 1978). A map of the defined study area is presented in Figure 1. The basin surface is considered to be in the Northern Great Plains region and part of the Missouri Plateau (Martin et al., 1988). The area is primarily underlain by Upper Cretaceous and Lower Tertiary sedimentary formations. These formations dip gently to the west in the eastern and central portions of the basin and more steeply to the east in the western portions of the basin (Glass, 1980; Knutson, 1982). Two of these formations, the Paleocene Fort Union and Eocene Wasatch formations are the principal bearers of minable coal deposits in the eastern Powder River Basin.

The coal beds in the Power River Basin represent some of the world's largest and most easily extracted supplies of coal. The coal resources in the Powder River Basin are estimated in excess of 500 billion tons of which a conservative estimate of 24 billion tons are thought to be

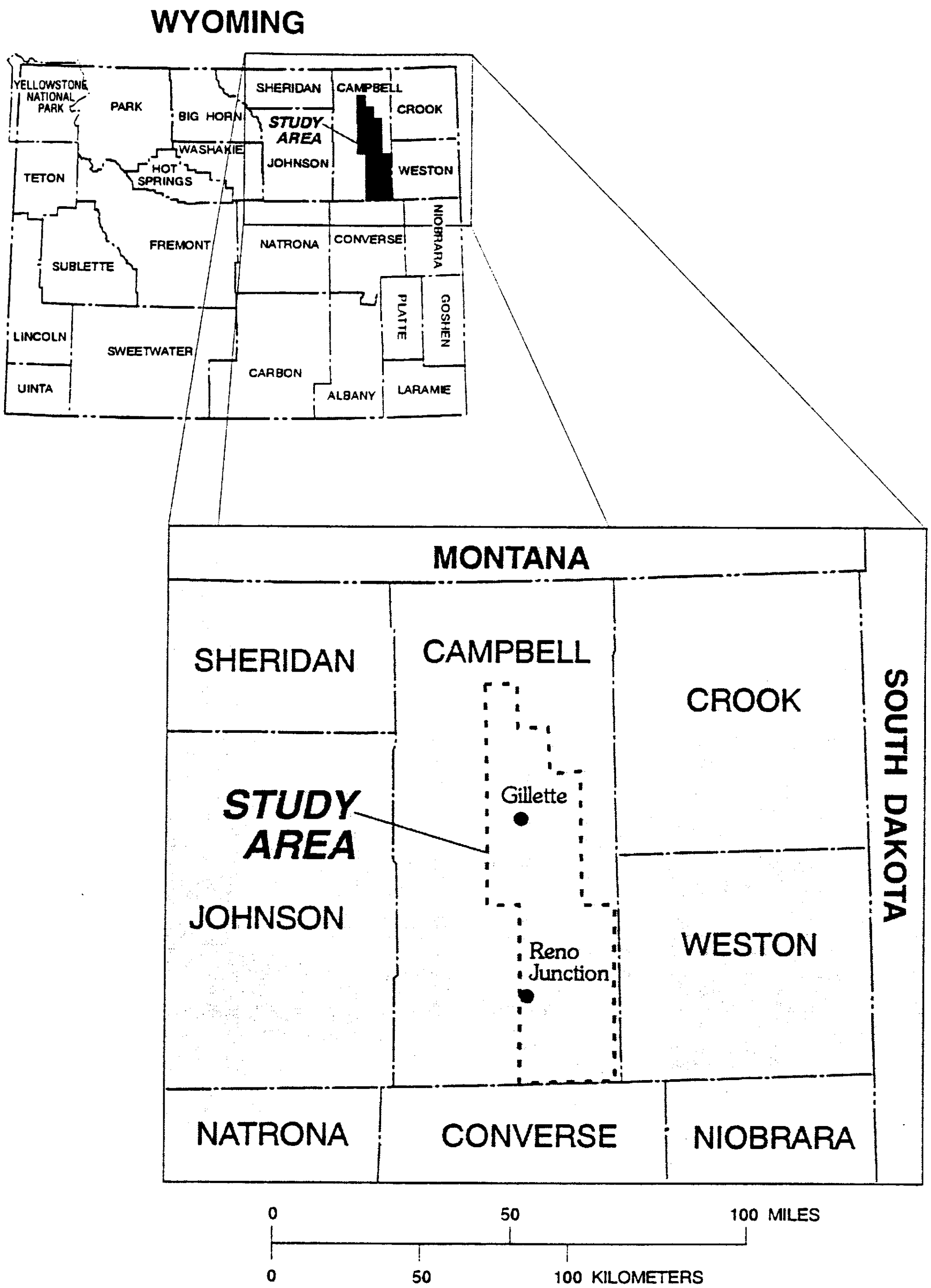


Figure 1. Location of the study area within the Eastern Powder River Basin, Wyoming.

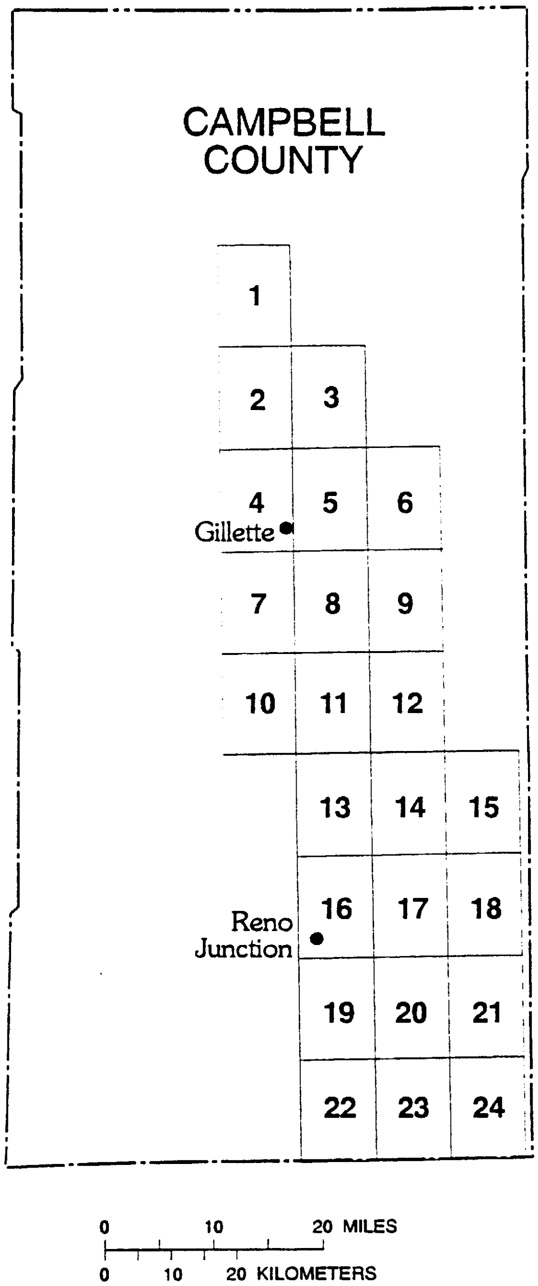
economically minable (Lowry et al., 1986). Overburden thickness throughout the Eastern Powder River Basin ranges from less than six feet to over 120 feet. The coal seams under the overburden range from less than 50 feet to over 120 ft. The shallow overburden thickness and thick coal seams create low stripping ratios which, combined with high quality, low sulfur coal, make these deposits desirable for development (Lowry et al., 1986). The low stripping ratios typically found in the Eastern Powder River Basin generally lead to an overall lowering of the land surface following mining. The lowering is attributed to the vast amount of coal removed and the lack of overburden for back-fill material (Lidstone, 1982). The lowering is so great in some instances that creating surface drainage after mining is a problem.

There are currently 15 active and several planned surface mining leases along the contact between the Fort Union and Wasatch formations. Life-of-mine estimates range from the year 1996 to the year 2026, subject to change based on coal production costs and revenue generated (Martin et al., 1988). The maximum land area to be disturbed by future mining activities ranges from 959 to 13,217 acres at each mine (Martin et al., 1988). The mines typically disturb up to 100 acres each year. Generally, there is more vertical than lateral extension of the open-pit area due to the thickness of the coal seams.

The study area lies within the Eastern Powder River Basin along the Fort Union-Wasatch Formation contact. The boundaries of the study area are presented in Figure 1 and Plate 1. The boundaries follow USGS 7.5 minute topographic maps available for the area. A map of the 7.5 minute quadrangles used to define the study is presented in Figure 2. The study area roughly coincides with that used by Martin et al. (1988), and is approximately 20 miles wide and 85 miles long.

GEOLOGY

Martin et al. (1988) describe the Paleocene Fort Union and Eocene Wasatch Formations as consisting primarily of "continental-type sediments deposited in fluvial, lacustrine and swampy environments." They also indicate that the formations are characterized by alternating layers of sandstone, siltstone, clays, and mudstone. The layers are seldom of great lateral extent and are commonly interspersed with coal. The Wasatch Formation tends to be sandier than does the Fort Union Formation (Martin et al., 1988). Subterranean burning of coals has resulted in the baking of the overlying shales and clays into "clinker" or "scoria." These clinker beds are resistant to erosion and commonly form outcrops and resistant ridges (Glassey et al., 1955).



List of 7.5-minute topographic quads:

1 Calf Creek
2 Rawhide School
3 Moyer Springs
4 Gillette West
5 Gillette East
6 Fortin Draw
7 Appel Butte
8 The Gap
9 Coyote Draw
10 Scaper Reservoir
11 The Gap SW
12 Saddle Horse Butte
13 Eagle Rock
14 Neil Butte
15 Rough Creek
16 Reno Junction
17 Hilight
18 Open A Ranch
19 Little Thunder Reservoir
20 Reno Reservoir
21 Piney Canyon NW
22 Teckla SW
23 Teckla
24 Piney Canyon SW

Figure 2. USGS 7.5 minute topographic quadrangles used to define the Eastern Powder River Basin study area.

SOILS

According to the U.S. Soil Conservation Service (SCS) general soil survey of Campbell County (Glassey et al., 1955), the soils of the basin closely reflect the underlying parent material. The soils tend to be residual in nature except for alluvial deposits in stream beds and eolian deposits scattered throughout the southern portion of the study area. Due to the semi-arid environment, very little organic matter accumulation, horizonation, or weathering has occurred. The soils tend to have a calcareous layer of accumulation due to the lack of precipitation and leaching (Glassey et al., 1955). Lowry et al. (1986) list Torriorthents and Haplargids as the predominant soils in the study area. Some Paleargids also are present in the locale (SCS, 1992). The bulk of the soils in the study area are loamy silts, sandy loams, clayey loams, or clayey soils. Loamy type soils tend to predominate in the area (SCS, 1992; and Apley, 1976).

VEGETATION

Vegetation of the Powder River basin is typical of the plains of the semi-arid west. The region is dominated by sagebrush-grasslands with high frequencies of blue grama (*Bouteloua gracilis*), needle-and-thread (*Stipa comata*), western wheatgrass (*Agropyron smithii*), and big sagebrush (*Artemesia tridentata var. wyomingensis*) (Martin et al., 1988; Apley, 1976; and Glassey et al., 1955). Riparian vegetation can vary from lush grasses to greasewood (*Sarcobatus vermiculatus*) breaks and cottonwood stands (*Populus deltoides*). Silver sage (*Artemisia cana*) is also a common plant in sandy areas. There are 4 major vegetation communities in the study area. These include: grasslands, sagebrush-grasslands, riparian communities, and ponderosa pine (*Pinus ponderosa*) (Driese and Reimers, 1992).

CLIMATE

The study area is considered to be semi-arid with mean annual rainfall ranging from about 11 to 16+ inches (Martner, 1986; Water Resources Data System (WRDS), 1992). Annual precipitation can vary widely from year to year (Apley, 1976; WRDS 1992). Precipitation tends to increase from east to west and south to north (Schaefer, 1982; WRDS, 1992) with a zone of high mean annual precipitation in the area of Gillette (Toy and Munson, 1978). About 60 to 80 percent of the mean annual precipitation falls between March and August, most in the form of high intensity thunderstorms that can vary widely in intensity and duration over short distances (Schaefer, 1982). Most of the remaining precipitation (about 20 - 40 percent) occurs as snow from November to March (Martin et al., 1988; Apley, 1976; Hadley and Schumm, 1961).

The area is characterized by long cold winters and mild summers (Hadley and Schumm, 1961). Temperatures are considered northern temperate with average daily minimums between 5 and 40 degrees F in winter and annual highs between 90 and 100 degrees F. (Schaefer, 1982; Martner, 1986). The annual growing season is approximately 120 days (Martin et al., 1988). National Weather Service records indicate that the area has substantially greater annual potential evapotranspiration than precipitation (Bureau of Land Management (BLM), 1975).

SURFACE WATER HYDROLOGY

The study area lies within three major drainage systems: the Cheyenne River, the Belle Fourche River, and the Powder River (Figure 3). The Cheyenne River system drains the southern section of the study area; the Belle Fourche River system drains the central portion; and the Little Powder River, a tributary of the Powder River, drains the northern portion. Most of the streams in the study area are ephemeral (Knutson, 1982). These streams are typical of a flashy, upper flow regime and are not exposed to the continuous low flow regime of perennial streams (Rechard, 1980). Some stream reaches intersect the ground water and flow at very low rates for portions of the year (Knutson, 1982; Martin et al., 1988). Perennial and intermittent reaches have been identified in the Rochelle Hills area (Apley, 1976), the result of natural streambed springs. Almost all other flow is in direct response to snowmelt or rainfall. The drainage pattern of all networks within the study area is primarily dendritic (Knutson, 1982). Additionally, several playa lakes have been identified throughout the study area (Apley, 1976).

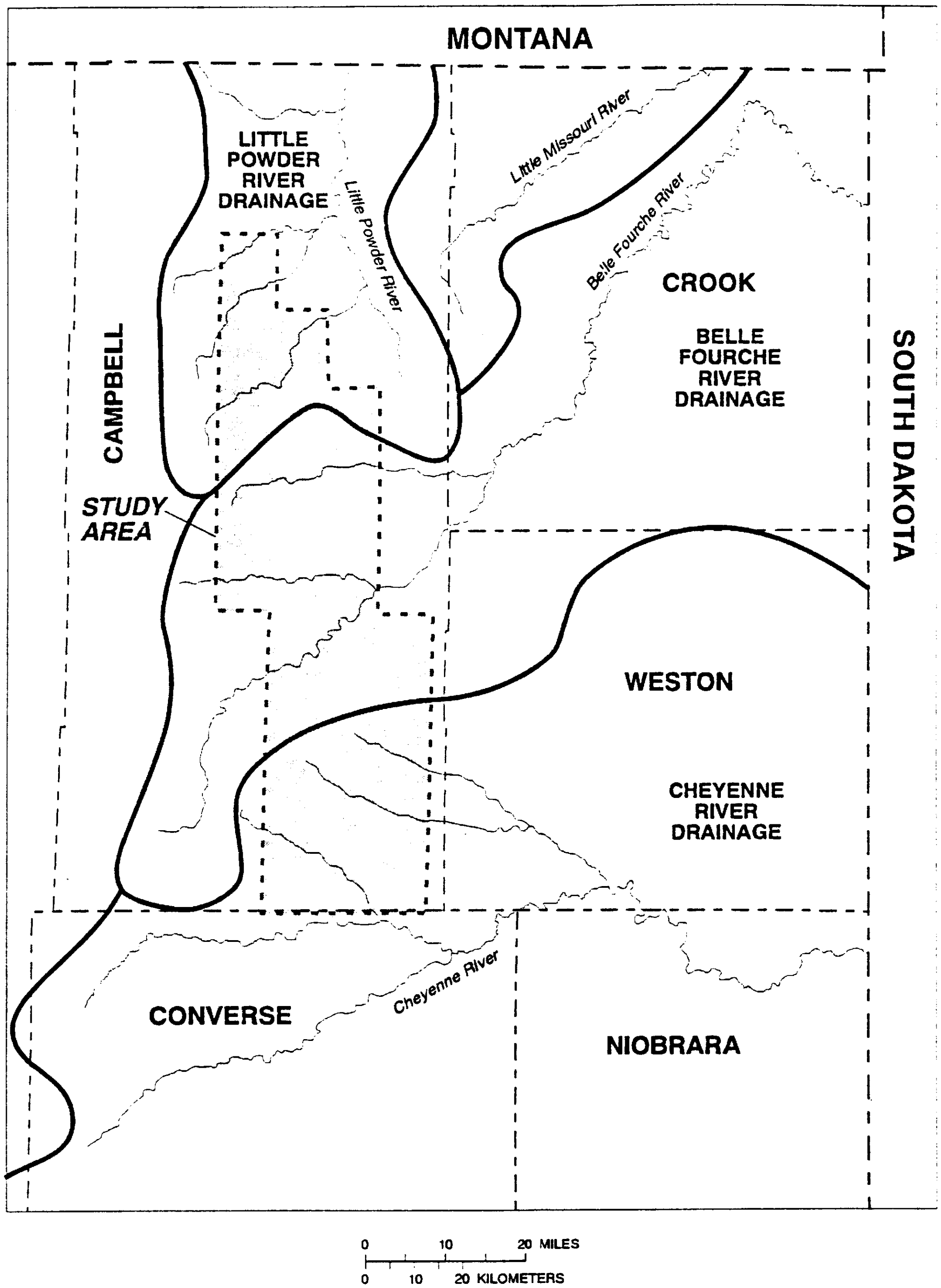


Figure 3. Delineation of the three major drainage systems in the Eastern Powder River Basin.

These playas have no drainage outlet and are easily identifiable on USGS 1:24,000 topographic maps.

Stream channels of the Eastern Powder River Basin typically experience flow less than 15 days a year and flood only 3-4 days a year (Rechard, 1980). The combined climate and soils of the area have led to the development of potholes in several streams of the study area. These streams may contain standing water year round in the depressions (Rechard, 1980), which may interrupt the channel profile and indicate intermediate stages of channel development.

In terms of channel geometry, Schaefer (1982) found that geometry was highly variable over short reaches of one half of a mile or less. This was attributed to the flow regime and soils of the area. Soils of the basin seem to significantly affect bank stability. Apley (1976) noted that channels with high clay content were armored during dry periods and susceptible to erosion in the spring when additional moisture helped disperse the clays. Additionally, Rechard (1980) noted frequent bank instability that was attributed to excessive pore-space, spring freeze/thaw action, and/or antecedent soil moisture conditions.

CHAPTER III

LEGISLATION PERTAINING TO COAL MINE RECLAMATION

FEDERAL LAWS

Surface mining of coal increased from 22% to 50% of domestic production between 1950 and 1974, with production shifting from Kentucky and West Virginia to the western states during the later years of this time span (Nehring et al., 1976). The western states were and are characterized by low population densities and had no history of large scale energy development. Although Wyoming had experienced development of oil and gas resources, agriculture was the dominant sector of the state's economy until demand for Wyoming coal increased (Nehring et al., 1976). This large scale development of coal as an energy source led to the creation of legal and institutional structures enabling Wyoming and other western states to cope with the effects of that development. The anticipated effects of development created a need for government control of reclamation.

Regulations generally emerge as a response to the demands of those who will be adversely affected by the proposed development. The regulating process is affected by the complexity of the development, perceptions of costs and benefits to individuals, uncertainty about future effects of development, political strength of individuals and groups affected, cost of information and the involvement of decision making entities (Nehring et al., 1976). Regulations tend to develop in a reactionary manner as decision makers respond to the demands of groups affected at different stages of development. Some effects of development are clearly anticipated; others are realized only when they are experienced.

Proposed coal development in Wyoming, and the nation's heightened awareness of environmental issues, occurred at about the same time. The National Environmental Policy Act (NEPA) was passed in 1969 and created the U.S. Environmental Protection Agency to implement the objectives of the legislation. In the broadest of terms, this legislation requires careful examination of possible environmental effects caused by major federal actions. NEPA requires that "all agencies of the Federal Government shall include in every recommendation or report on proposals for legislation and other major federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on 1) the environmental impact of the proposed action, 2) any adverse environmental effects which cannot be avoided should the proposal be implemented, 3) alternatives to the action, 4) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity and, 5) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented" (National Environmental Policy Act of 1969, pg. 250).

The first surface mining legislation in the United States was passed by West Virginia in 1939 and recognized the disruptive environmental effects of the industry (Toy and Hadley, 1987). In 1978, 38 states had legislation dealing with environmental controls on surface mining (Bowling, 1978). Most of these state laws are directed at problems specific to that state. The variability of laws from state to state led to variability in the level of environmental protection provided from state to state. Less stringent reclamation requirements in some areas would lower overall costs of production for operators in that area, giving them a competitive advantage in the marketplace.

The Surface Mining Control and Reclamation Act of 1977 (SMCRA) sought to establish a national program to "protect society and the environment from the adverse effects of surface coal mining operations" (Toy and Hadley, 1987). Among the most important provisions of the act are those that assure reclamation of surface mined areas. The act prohibits mining where reclamation as required by the act is not feasible, and promotes reclamation of lands disturbed by mining prior to its enactment. SMCRA created the Office of Surface Mining Reclamation and Enforcement within the U.S. Department of the Interior, established minimum performance standards for reclamation of surface mined lands, and structured the federal-state relationship in the regulation of surface coal mining (Imes and Wali, 1978). This federal-state relationship has generally taken the form of primacy, which was given to states that formulated legislation for environmental protection and reclamation standards that were at least as stringent as those set forth in federal legislation. Primacy allows the states to address their own unique reclamation problems and enforce compliance with state laws that essentially become the federal statutes under the authority of SMCRA.

Important to this report is the requirement by SMCRA that the land be returned to approximate original contour. There has been much disagreement about just what this requirement means. However, it is generally agreed upon that approximate original contour means that the shape of the land should be about the same after mining, even though it may not be at pre-mining elevation. In Wyoming, the low stripping ratios deny the opportunity to restore the landscape to its former elevation (Keefer and Hadley, 1976). SMCRA was also designed to allow states to draft their own regulations regarding the reclamation of surface mined land. Regulations had to be at least as stringent as those found in SMCRA, but allowed the states to address specific problems encountered in the reclamation of disturbed lands in their state.

Although SMCRA and NEPA are probably the two most important laws in terms of federal regulation on reclamation of surface mined lands, they are by no means the only controls placed upon the surface mining industry. The surface mining of coal is one of the most highly controlled economic activities in the United States. The National Research Council (1981) found that 21 laws affecting the coal industry have been enacted since 1970. About six of these laws apply consistently to all mines. Compliance is made more difficult by the frequent amendments made to some of the laws (Toy and Hadley, 1987). Borchert (1980), in evaluating the history of legislation governing surface mining, concluded that older laws addressed the problems but did not coordinate authority. SMCRA concentrates and channels authority, but lacks flexibility to deal with widely varied environmental settings.

The U.S. Bureau of Land Management, U.S. Forest Service and other federal land management agencies must meet requirements and responsibilities set by the Federal Land Policy and Management Act of 1976, NEPA and SMCRA. Federal Land Management Agencies have The Code of Federal Regulations (CFR) to follow in terms of permitting, leasing, and otherwise determining the manner of use or development of public lands. In the Western States, the many combinations of surface ownership and resource ownership bring many different statutes into play at a single mine site.

WYOMING LAWS

Coal has been mined in Wyoming since the middle of the 19th century, with most of the early production coming from underground mining operations (Brown, 1974). The surface mining of coal in Wyoming became more prevalent as the nation searched for cost efficient energy sources to decrease our dependence upon foreign supplies.

The Open Cut Land Reclamation Act of 1969 was passed in response to increasing production of coal, uranium and bentonite in the state. The act required operators to obtain a permit and post a bond equal to the estimated cost of reclamation. Submission of reclamation plans was optional. This act was criticized for its vague and inadequate reclamation standards. Operators were required, where practical, to make a reasonable effort to "encourage the revegetation of disturbed lands" (Session Laws of Wyoming, 1969, pg. 396). The act made no provision for reclaiming previously disturbed land (land affected by operations completed prior to May 23, 1969, the effective date of the act). Reclamation requirements of the Open Cut Land Reclamation Act required operators to grade ridges (a lengthened elevation of overburden created during the mining process) to a minimum width of 10 feet and peaks (a projecting point of overburden) to a minimum of 15 feet. This grading was in compliance with the regulation that peaks and ridges be reduced to a rolling topography for ease of revegetation and reduction of erosion. Reseeding was required where practicable and programs could be negotiated between the operator and the commissioner or examiner. Operators who strictly followed their approved reseeding programs, but met with reclamation failure were released from their reclamation obligation with respect to the reseeded land. The operator and the commissioner could enter into agreements regarding experimental methods of reseeding to satisfy reclamation obligations. Upon completion of the experiments agreed upon, the operator was released from further obligation with respect to the affected land covered by the agreement. Due to the need for reclamation experience to make specific reclamation requirements, the cost of preparing and reseeding disturbed land in Wyoming was presumed to be $50.00 per acre unless shown otherwise in an acceptable reclamation plan (Orf, 1974). More recent estimations of reclamation costs per acre in Wyoming list $4,000 as a high but essentially realistic figure (Nehring et al., 1976).

The statutory and administrative environmental protection systems of the state of Wyoming were reorganized and updated with the passage of the Environmental Quality Act of 1973. Wyoming's legislature sought to retain state control of environmental protection by setting standards comparable to minimum federal standards and by providing flexible regulatory procedures capable of adjusting to changes in federal standards (Orf, 1974). The act created the Wyoming Department of Environmental Quality (DEQ), which is composed of a director (appointed by the Governor), the Environmental Quality Council, three administrative divisions (land, air, and water quality), and an advisory board for each division.

Article 4 of the Environmental Quality Act established a process of licensing and permitting to ensure adequate reclamation of surface mined lands (Brown, 1974). Licensing is based upon submission of a detailed reclamation plan to the Land Quality Division Administrator. The Administrator and the Land Quality Advisory Board have broad discretion in denying, approving or modifying the proposed plan. An approved plan sets the performance standards for reclamation. Mine operators must submit annual reports on reclamation activity. The Administrator of the Land Quality Division is required to conduct annual inspections of mine sites and adjust bonds to correspond with changing conditions.

In 1977, SMCRA was passed and Wyoming's Environmental Quality Act of 1973 was found to be deficient in several areas:

1. segregated topsoil handling,
2. road standards,
3. effluent standards,
4. runoff and stream diversion criteria,
5. coal waste dam and embankment criteria,
6. return to approximate original contour and,
7. revegetation success standards.

Wyoming's legislature amended the Environmental Quality Act to bring it into compliance with the demands of the federal statute. Standards were established to insure stockpiling of topsoil for use in revegetation. Amendments were made to encourage reclamation activity as soon as possible after coal removal, including revegetation of a type consistent with the surrounding terrain, prevention of water pollution from mine drainage, and contouring the land in a manner that returned it to the land use set out in the reclamation plan. Wyoming's Land Quality Rules and Regulations were modified to include regulations addressing surface preparation, overburden handling and replacement techniques, revegetation standards, diversion of surface water, impoundments for water and tailings, reclamation time schedules, and standards for placement and construction of roads.

On August 24, 1976 the U.S. Department of the Interior proposed actions under the authority of 30 CFR 211.75(a) of the Department's coal mining operating regulations 41 FR 20252 to adopt the surface coal mine reclamation standards of Wyoming as the federal standards applicable to operations on federal leases in the State of Wyoming (Federal Register, 1976). The Department of the Interior entered into a Cooperative Agreement with Wyoming to allow the state to administer and enforce its reclamation laws after a public hearing in Cheyenne in September of 1976. At that meeting, most participants wanted Wyoming to be allowed to administer and enforce its own regulations regarding reclamation operations. The cooperative agreement addressed administration and enforcement of Wyoming's reclamation laws by the state. This agreement, together with the rulemaking allowed by 30 CFR 211.75(a), established a uniform and complete system of coal mine reclamation on federal licenses, which provided a high level of environmental protection and protection of federal interests (Federal Register, 1976). The agreement also contained an understanding with the State of Wyoming to cover changes in state and federal regulations. Federal approval of mining or exploration plans in Wyoming may be granted only if the plan complies with the reclamation laws and regulations of the State. Wyoming's Environmental Quality Act and Land Quality Rules and Regulations were adopted as federal standards on December 2, 1976 and published in the federal register.

Important to this report are those Land Quality Regulations pertaining to the rehabilitation of the hydrologic system that is altered by surface mining. Most of the rules and regulations set forth by the DEQ/LQD pertaining to surface water address control of erosion and prevention of water pollution. These rules and regulations are set forth in Chapter IV, Environmental Protection Performance Standards of the DEQ/LQD Rules and Regulations for Coal (Wyoming DEQ, 1989). Spoil is required to be replaced in a controlled manner that prevents pollution from runoff and prevents mass movement during and after construction, thereby providing stable drainages and hillslopes.

Diversions must be designed to assure public safety, prevent material damage outside the permit area, and minimize adverse effects to the hydrologic balance. Temporary diversions of ephemeral streams must be able to contain and pass in a non-erosive manner the peak runoff from a two-year, six-hour precipitation event or a storm duration that produces the largest peak flow as specified by the Administrator. Permanent diversions of ephemeral streams need to be able to contain and pass the 100-year, six-hour event or a storm duration that produces the largest peak flow, as specified by the administrator, in an erosionally stable manner. All diversions are required to be designed and constructed so they are erosionally and geomorphically compatible with the natural drainage system (Wyoming DEQ, 1989).

When permanent diversions are constructed, or when stream channels are being restored, regulations require: 1) restoration and maintenance of natural riparian vegetation on the banks and floodplain of the stream, 2) establishment or restoration of stream characteristics, including aquatic habitats to approximate pre-mining channel characteristics, and 3) restoration of erosionally stable stream channels and flood plains. Regulations allow riprap in diversion ditches, but vegetation is the preferred means to control surface erosion.

Guideline 8 of the Wyoming DEQ Hydrology Guidelines defines an erosionally stable stream as one that will convey the lower return period flows, which are the 5 to 10 year flows, under non-erodible conditions. Maximum permissible velocity for non-erodable channels ranges from 3 to 5 feet per second, which has been determined to be the highest velocity that will not erode (Wyoming DEQ, 1990). All diversions must be authorized by the administrator and temporary diversions must be removed when they are no longer needed for the purpose for which they were authorized. Permanent diversions must be renovated before bond release will occur (Wyoming DEQ, 1989). The affected land must be regraded and revegetated to acquire erosional and geomorphic stability. Sedimentation ponds are provided for in the rules and regulations, but are removed after stabilization and establishment of vegetation on affected lands. Permanent water impoundments are generally prohibited unless specifically authorized by the administrator.

Reclaimed land is monitored by the mining companies to determine infiltration rates, subsurface flows and the water storage characteristics of the reclaimed land and adjacent areas. Monitoring also helps to determine the effects of reclamation on the groundwater recharge capacity of reclaimed areas and the suitability of groundwater quality for current and post-mining land uses. Surface water is monitored to determine the quantity and quality of surface water flowing from affected lands, including those that have been regraded and stabilized. Monitoring helps to determine the extent of disturbance to the hydrologic balance and helps prevent degradation of water quality.

These data, while abundant, remain inconsistent, and are of little to use to reclamation personnel in the public or private sectors. The data will remain so until such time as they are organized, standardized, and stored in a manner more conducive to use by individuals concerned.

CHAPTER IV

OVERVIEW OF RECLAMATION DESIGN

Two basic approaches, geomorphic and engineering, are used in designing fluvial systems after land disturbances. Problems exist in the application of either approach (Toy and Hadley, 1987). The geomorphic approach suffers from lack of on-site studies documenting successful use of geomorphic principles for large mined areas in the arid and semi-arid western United States. The engineering approach is based on network and channel design that will accommodate expected water and sediment discharge following disturbance and reconstruction (Lowham and Smith, 1993).

As a natural component of semi-arid lands, erosion is a force to be worked with, not against, for the reclamation of disturbed lands. Natural drainages evolve over long periods of time, and in a very general sense may be considered to be in equilibrium with the climatic and physical conditions of their basins. When discussing natural landscapes, the term "stability" should not be taken literally. Often the term is construed to mean unchanging or static. Stability in a natural landscape means dynamic stability, or a continuous state of evolution in which basin surfaces and their stream channels are reacting to forces placed upon them by climate, geologic structure above and below the surface, runoff patterns and use by humans and animals (Martin, et al, 1980).

Restoration of mined land to approximate original contour is a requirement of SMCRA (U.S. Congress, 1977). In the Powder River Basin the thick coal beds and low stripping ratio prevent restoring the landscape to its former elevation (Keefer and Hadley, 1976). Toy and Hadley (1987) state that it is generally agreed that "approximate original contour" as required by law, means that the shape of the land after mining should be about the same as pre-disturbance but not necessarily at the same elevation. Gregory, et al (1986) examined some of the problems associated with the concept of "approximate original contour" as defined by SMCRA. He feels both state and federal regulations are vague and do not provide clear direction for satisfying approximate original contour requirements. Review of the regulations and their history show the central theme to be concern for postmining land use. As currently practiced, application of approximate original contour requirements may leave a surface that is "not conducive to postmining land use or to geomorphic stability" (Gregory, et al, 1986, pg. 95).

Another requirement of SMCRA (U.S. Congress, 1977) is that spoil materials "be shaped and graded in such a way as to prevent slides, erosion and water pollution" and that "adequate drainage" be provided. SMCRA basically requires that the procedures during mining and reclamation minimize the contribution of suspended materials outside the lease boundaries, control rilling and gullying, and minimize disturbance to the prevailing hydrologic balance (Lowham and Smith, 1993). Surface mines having thick coal beds are commonly exempt from the requirement of approximate original contour restoration because of their characteristic "low stripping ratio". Although adequate drainage is still required, the reclaimed landscape can be more subdued than it was before mining (Lowham and Smith, 1993).

The Wyoming Environmental Quality Act (Wyoming State Legislature, 1973) requires that each operator of a surface coal mine provide a plan to minimize disturbance to the hydrologic balance at the mine site and adjacent areas, and to protect the quantity and quality of ground and surface water during and after mining. Hydrology guidelines prepared by the Wyoming Department of Environmental Quality (1990) recommend that coal mining companies measure various drainage basin and stream channel characteristics to aid in the reclamation of drainage systems.

Restoration of stability to drainage basins altered by mining is essential to successful post mining land use. Stable hillslopes and drainage networks are needed to avoid adverse effects in offsite streams from increases in erosion and sedimentation (Lowham and Smith, 1993). Lowham and Smith (1993) also note that although reconstructed and reclaimed areas at active mine sites appear to be stable, long term stability is difficult to ascertain because the rills and gullies that form are immediately repaired.

Successful reclamation generally is considered to have been achieved when a drainage basin has relatively high revegetation success and low annual sediment yields. Field studies by Leopold et al. (1966) and Rankl (1987), support this conclusion, as their detailed monitoring showed sediment loads from eroding headcuts made a relatively minor contribution to total basin sediment yield. Laboratory studies by Parker (1977) and Zimpfer et al. (1982) indicate that basins reconstructed to simulate immature states of erosional development resulted in relatively low sediment yield. Reconstructing only second and higher order stream channels and allowing first order channels to develop naturally may yield the best results in reclamation success. Lowham and Smith (1993) conclude that this practice has the advantage of producing flatter valley hillside slopes leading to greater revegetation success and smaller sediment discharges.

Successful reconstruction of channels and basins requires the identification of characteristics that will be compatible with existing basin and hydrologic conditions. The geomorphic approach is well suited to this goal. Lowham and Smith (1993) provide empirical predictive relations for bankfull discharge (approximated by the two-year annual peak flow) that can be used in stream channel design for reconstruction. They note that testing of these relations is needed at more reclamation sites and that reconstructed channels need to be monitored to determine cross-section changes and erosion patterns.

The geomorphic approach also includes an analysis of stream pattern. Lowham and Smith (1993) conclude that reconstruction of a stable meander pattern will minimize erosion and related maintenance costs. If controlling geologic features are altered or removed during mining, empirical relations derived for stream channels in areas that are hydrologically and geologically similar to the post-mining topography could be used in channel pattern design.

Flowing water is the major natural force affecting reclaimed areas in the study area (Martin et al, 1988). Erosion and sediment transport by streams flowing across large areas of disturbed land have the potential to impact channel stability. These impacts may occur locally or some distance away, upstream or downstream. Designing stable drainage basins is critical to the type and degree of post-mining land use. The more closely post-mining topography can be restored to complement the surrounding natural conditions and approximate original contours, the greater the likelihood of stable drainage networks and successful reclamation (Bishop, 1980). Although pre-mining conditions will not be restored, the post-mining hydrologic condition needs to complement that of the surrounding area for reclamation to be considered a success.

Even though it is infrequent, runoff is the major natural force affecting semi-arid landscapes. Small basins commonly have periods of one year or more between substantial runoff events. The adjustments of an unstable reclaimed basin to the semi-arid hydrologic regime may not be noticeable until several large flows have occurred, which may take decades (Martin, et al, 1988). Rills and gullies could form rapidly, which may or may not indicate instability. It is just as probable that relatively undramatic, gradual responses will occur until substantial runoff reveals instability.

The Powder River Basin is characterized by ephemeral stream systems. These systems carry water only during periods of spring runoff and high intensity-short duration summer rainfall. Stream channels in an ephemeral system are generally narrower and shorter, but more numerous than those in a perennial system. From the divide to the mouth of an ephemeral basin the increase in channel size is accompanied by a decrease in channel numbers (Leopold and Miller, 1956). Sparse vegetation in semi-arid climates decreases the length of overland flow, increasing channel density. Erosion is naturally accelerated in semi-arid climates owing to the combination of sparse vegetation and storms that occur with enough frequency to move sediment. The physical characteristics of channels in semi-arid areas tend to reflect the attributes of the largest flows occurring in them. These high flows, depending upon the geological forms present, can create deeply incised channels with straight sided banks or broad flat bottomed channels with gently sloping banks. Because of the rarity of extremely high flows, the broad flat bottomed channels can become well vegetated between events, whereas the banks of the deeply incised channels, although remaining unvegetated, become stable between high flow events due to the absence of water working to erode the banks.

According the Heede (1981), effective erosion control and watershed rehabilitation designs must be responsive to the dynamic interactions within the natural system. Base level interactions necessitate treatment beginning downstream and proceeding upstream, starting at a location with a stable elevation that will not be lost during the life of the treatment. Topographic shaping and vegetative treatments need to proceed from headwaters downward to assure functional integrity (Heede, 1981).

Rechard (1980) examined the stream pattern characteristics of wavelength, radius of curvature, width-depth ratio and sinuosity on 11 ephemeral and intermittent streams in the eastern Powder River Basin. He developed 15 empirical design equations for use in determining proper width-depth ratios, radius of curvature, sinuosity, and mean and maximum meander length for stream restoration after surface mining. His investigations led to two possible approaches to the problem of stream restoration. One involves determining the meander patterns that existed before stream disturbance, with the characteristics then being incorporated into the stream pattern design. The other would be used if an extended period of time elapsed between disturbance and restoration. In this case pre-mining, baseline measurements of the stream would need to be compared to measurements immediately preceding restoration to determine any significant changes in the stream pattern. Stream patterns are dynamic, so changes may occur during the mining sequence. Replacing a stream pattern that has been abandoned by a stream will hamper the establishment of a stable fluvial system (Rechard, 1980).

A significant drawback discovered by Rechard during this study is that the procedures should only be used on streams considered to be "stable" and where post-mining conditions would not alter the drainage basin characteristics "significantly" (Rechard, 1980). The lack of flow in ephemeral and intermittent streams makes them difficult to analyze for stability. Some ephemeral channels allow observation of headcuts, aggradation or deposition; on others vegetation makes these features harder to detect. If drainage basin characteristics are significantly altered, a new stream pattern equilibrium pattern needs to be anticipated (Rechard, 1980). Estimations of the new pattern can be made by determining drainage area, acceptable slope and velocity (within regulation guidelines), dimensions needed for bankfull discharges, and proper meander properties such as radius of curvature and stream sinuosity for known and unknown slope values, and the selection of mean and maximum meander wavelength.

Three potential geomorphic approaches to designing a reclaimed mine surface were listed by Divis and Tarquin (1981): 1) the carbon copy, 2) terrain comparison, and 3) regime characterization. Direct restoration of previously existing conditions is the goal of carbon copy reclamation. It is based on two assumptions that do not always hold true: 1) the stream pattern before mining is stable and 2) the geomorphic factors affecting stream pattern will be identical after restoration (Rechard, 1980). Mines in the Powder River Basin are reduced in elevation by 20 to 100 feet and small scale topographic highs, such as hills and bluffs are suppressed, making carbon copy reclamation almost impossible.

Terrain comparison involves the location of a "blueprint area" with geomorphic characteristics similar to the reclaimed surface. Divis and Tarquin (1981) cite the problems of this method in terms of time, cost, and the fact that the "blueprint area" may itself be unstable, in which case it could not be used as a basis for reclamation design.

The last approach, regime characterization, is the approach addressed at length by Divis and Tarquin (1981). Although it is a "terrain matching" approach, it differs from terrain comparison in that it does not utilize the "blueprint area". The approach assumes that certain parameters such as basin area, basin relief to length ratio, and sediment texture characterize an area in terms of stability and that statistical analysis of the relationships between independent (causative) and dependent (resultant) variables can be used in a numerical description of stability. Because this approach uses well known, published methodology, has well documented application to arid regions, permits use of geomorphic-hydrologic data bases, and uses site specific variables, Divis and Tarquin (1981) believe that the regime approach is the most appropriate for reclamation planning in semi-arid Wyoming.

The regime characterization approach was used by Tarquin and Baeder (1982) in the design of two small drainage basins within the permit area of Black Thunder Mine in the Powder River Basin. Their principal objective was to produce a stable "regime" watershed, with a geohydrologic function closely approximating that of the original watershed. Tarquin and Baeder (1982) used Thunder and Lightning Draws to refine the design criteria to develop a procedure that allows for consistency and control in the design of lower order basins.

Thunder Draw was designed by using a large, oversized valley in which the stream was allowed to cut its own pilot channel. The authors note that although this procedure created an initial erosional condition, the stream adjusted quickly to what appeared to be a stable channel. Lightning Draw was designed with a pilot channel in an effort to reduce or eliminate the initial downcutting that was experienced in

Thunder Draw. A broad valley was provided by a recontoured surface to serve as a floodplain that would accommodate the 10-year flow event. The pilot channel was constructed to carry the two-year flow event. During the study, Lightning Draw experienced an unacceptable amount of erosion due to a concentration of flow in the pilot channel, insufficient application of mulch without crimping or tackifying, and the presence of a meander with a very low radius of curvature. Remedial action in Lightning Draw took the form of channel widening which allowed water spreading, reduced velocity, and permitted the stream to cut its own pilot channel.

Tarquin and Baeder (1982) concluded that the most critical factors in designing stable lower order channels are 1) design of a floodplain without a pilot channel, 2) control of flow velocity through manipulation of channel length, width and roughness, 3) establishment of sufficient radius of curvature on meander bends, 4) correct timing of revegetation and mulching, and 5) adequate field control to insure that construction conforms to the design. Both of the designed basins were part of larger fourth order basins, and while the Wyoming DEQ/LQD Guideline 8 suggests the use of a 100 year peak flow in the design of main channel floodplains, the limited drainage area and low intensity-high frequency floods were thought to be more important in determining the stability of lower order streams. Tarquin and Baeder (1982) used the 10-year peak flow as representative of bankfull discharge in

Thunder and Lightning Draws. They determined that the most important parameter in determining channel design is streamflow, which is controlled by basin characteristics, such as maximum relief and basin slope. Maximum relief is determined by measuring the difference in elevation between the mouth of the channel and the highest point in the basin. Basin slope is obtained by measuring (in miles) the lengths of all contour lines within the drainage boundary, multiplying by the contour interval (in feet) and dividing by the drainage area (in square miles). Basin slope is manipulated within the restrictions of drainage area, maximum relief, and materials balance (mulch, vegetation, riprap, and so forth determining channel roughness) to fall within pre-mining limits. This design procedure results in a first order basin for which peak flows can be predicted and a channel can be designed. Pre-mining limits are sufficiently flexible to allow adjustment of basin parameters, with the end result being a stable stream channel in a compatible basin (Tarquin and Baeder, 1982).

Tarquin and Baeder (1982), indicate that the principle design criterion for a stream channel is velocity. Stream channels establish and maintain water flow at a velocity that allows a balance between erosion and deposition. For lower order basins, reclaimed channels require a design capable of handling the 10-year flow event at a velocity of less than 5 feet per second. The Manning-Chezy equation relates all of the principal design features and was used as the principle design tool by Tarquin and Baeder (1982).

The equation is as follows:

$$Q = \frac{1.49}{n} A(R)^{2/3} S^{1/2}$$

Where: Q = streamflow (cfs)

A = channel area (ft^2)

R = hydraulic radius (ft)

S = water surface slope (ft/ft)

n = Manning's roughness coefficient

Channel area and hydraulic radius are functions of channel bottom width, sideslopes and depth of water in the channel. Although channel area has no design restrictions, limitations have been established for the ratio of channel width to water depth based on pre-mining channels. Channel sideslopes have generally been established at 3(h):1(v) which keeps streamflow concentrated in the channel without sloughing of the banks and facilitating revegetation. Arbitrary design limits, based on reclamation patterns at Black Thunder mine, were set at a maximum of 2(h):1(v) and a minimum of 5(h):1(v) slope. These limits allow the flexibility needed for design work while retaining the basic form of a channel to collect and transport water (Tarquin and Baeder, 1982).

Water surface slope is set in the basin design and is approximated by channel slope. This variable can be altered by manipulating channel length, specifically by using meanders to increase channel length. Channel slope must be at least

0.5 percent to establish a functioning channel (Tarquin and Baeder, 1982). The upper limit of channel slope is determined by streamflow velocity; if velocity is less than 5 feet per second, channel slope is deemed acceptable. At the time of Tarquin and Baeder's study, no limits had been established on the radius of curvature for meander bends due to lack of data from lower order channels. Limitations may be needed to eliminate "hair-pin curves" that become areas of instability (Tarquin and Baeder, 1982).

Channel bed material (rocks, vegetation, soil, or whatever the channel form is composed of) controls the value of Manning's roughness coefficient (n). Most reclaimed channels are grass lined and assigned an "n" value of 0.035 (Tarquin and Baeder, 1982). If the roughness of a channel needs to be increased, rocks and shrubs may be used (Wyoming DEQ, 1989). Although the use of shrubs to increase roughness is not limited, use of rock is limited to prevent overuse. These limitations are:

1. Rock should be sized such that a 10-year streamflow event will move the geometric mean size and the 25-year event will move most of the rock. The rock is to be used to decrease streamflow velocities by increasing the roughness of the channel bottom and decreasing the erosive potential of the storm. Rock is not meant to be a permanent structure.

2. Rock will be spread out to reduce interference with new vegetative communities. The intent of rock placement is to replace and simulate stream gravels that may have existed prior to mining. Gravels will generally be required when a reclaimed stream must immediately receive water from an upstream channel (natural or reclaimed).

Design criteria or limits are based on the pre-mining surface when using the regime approach, so successful reclamation depends upon thorough baseline studies. The design of the lower order channel and its basin is an iterative process allowing a channel to be tailored to a particular basin. Flexibility of design in terms of basin adjustment or manipulation allows the design of a stable channel.

A review of mine plans submitted to the State of Wyoming for approval indicate that mine operators have traditionally looked at three methods to aid in the prediction of flood peaks and volumes for streams in the Powder River Basin that have little or no records of discharge. These methods are the U.S. Soil Conservation Service's triangular hydrograph method, the Craig and Rankl method, and the Lowham method. The triangular hydrograph method is a rainfall-runoff procedure that uses the computer program TRIHYDRO. The method uses drainage area, stream length, stream elevation difference, curve number, and a minimum infiltration loss rate to compute runoff from a precipitation event of desired frequency and duration, such as the two-year, six-hour event (Carter Mining, 1985). Curve numbers and the minimum infiltration rates selected for each drainage basin are weighted for areal extent of the soils and vegetation conditions found in the drainage basin, using SCS soil maps, antecedent moisture conditions, and rangeland conditions determined by SCS technical guides.

Discharge capacities and velocities for pre-mining and reclaimed channels are determined by using a variation of Manning's equation, which accounts for varying roughness coefficients found in natural channel/floodplain cross sections.

Craig and Rankl (1978) conducted a flood-hydrograph study to define the magnitude and frequency of flood volumes and flood peaks that could be expected from drainage basins smaller than 11 $miles^2$ in the plains and valley areas of Wyoming. Rainfall and runoff data collected for 9 years were used to calibrate a rainfall-runoff model on each of 22 small basins. Long-term records of runoff volume and peak discharge were synthesized for the 22 basins (Craig and Rankl, 1978). Flood volumes and peaks of specific recurrence intervals (2, 5, 10, 25, 50 and 100 years) were related to basin characteristics with a high degree of correlation. Volumes were related to drainage area, maximum relief, and basin slope. Peaks were related to the same three characteristics with channel slope added. For design purposes, a peak and volume can be estimated from basin characteristics. Hydrographs from the study basins were used to study hydrograph shape, which resulted in the development of mean dimensionless hydrographs for each basin. A single composite mean dimensionless hydrograph was then developed for the basins. The streams used to test and develop this method were all ephemeral. Craig and Rankl (1978) found that the synthesized hydrographs were similar in shape to observed hydrographs; they believe that the concept is valid for design purposes on small, semi-arid, ephemeral streams. Although this method was originally developed for use in choosing the correct size and placement for culverts during highway construction, it has proven useful in designing channels to carry design flows required by reclamation standards in Wyoming.

A method developed by Lowham (1976) presents two techniques to estimate peak flows and mean annual flow for natural streams in Wyoming; 1) the channel-geometry method, where flow characteristics are related to channel dimensions, and 2) the basin-characteristics method, where flow characteristics are related to physiographic and climatic features of the drainage basin. Lowham (1988) used additional streamflow data to update the original estimating relations. In bothe reports, Lowham (1976, 1988) divided Wyoming into different hydrologic regions based upon hydrologic similarities such as mountains and plains.

An on-site visit to measure channel width is necessary with the channel-geometry technique. Channel width is measured at the narrowest section of a straight reach in the main channel at a section exhibiting a stable appearance. The reliability of this method for estimating annual runoff is dependent upon the correlation of annual runoff with peak flows. The principle underlying this method is that channel size is influenced by some formative or dominant discharge, to which other flow characteristics are related. Channel width is the significant variable for estimating mean annual flows with this method; it was used by Lowham (1988) to establish regression equations for peak-flow relations in perennial, intermittent, and ephemeral streams.

The basin-characteristics method is based on the assumption that certain physiographic and climatic variables produce or affect streamflow from a basin (Lowham, 1988). This method is an office technique (on-site visits are not required) that uses maps to determine basin characteristics and easily accessed climatic data such as mean annual precipitation. Drainage area, the most significant variable in this method for estimating flows, was used to develop regression equations for each hydrologic region for the 2-, 5-, 10-, 25-, 50-, and 100-year flood event. The limitation on this method is that it is applicable only to those sites where streamflows are virtually natural, and is not used where flows are significantly affected by dams, reservoirs, diversions or urbanization.

Rathburn et al. (1993) studied data from 17 natural basins adjacent to the Rainbow and Colony mines in south-central Wyoming. In that study, these basins were considered to be stable, and measurements from these basins formed the basis for stability criteria tests on reclaimed channels.

Three channel parameters (channel slope, flow velocity, and cross-sectional area) were used for long-term stability tests. A risk based channel stability analysis was presented to facilitate regulatory decisions and engineering designs by statistically comparing reclaimed channel designs with the undisturbed areas. Using one-tailed confidence intervals calculated about the mean predicted channel slope, flow velocity, and flow area from the natural data, 18 of 20 reclaimed channels at the mines were determined to be stable at a risk level of alpha = 0.1 (risk associated with accepting a channel design that does not meet stability test criteria). A more stringent test (alpha = 0.01) indicated that 16 of 20 reclaimed channels were stable. Channels not meeting the stability criteria tests had steeper slopes or smaller flow areas than the natural channels, which are aspects that enhance erosion potential (Rathburn, 1993). The major emphasis of Rathburn's research was to develop relationships between basin parameters and channel hydraulic parameters important to designing channels and affecting the stability of ephemeral channels. The reclaimed channels at the Colony and Rainbow mines form broad shallow swales. Floodplains were constructed according to Wyoming Department of Environmental Quality guidelines, but pilot channels were not used as part of the reclamation design.

CHAPTER V

METHODS

DRAINAGE BASINS SELECTION

A group of third, second, and first order drainage basins and their associated drainage networks within the study area were selected for analysis through a process of exclusion. USGS 1:24,000 quadrangle topographic maps were selected for use as they are the largest scale maps available throughout the study area. The selected drainage basins were used to represent the small drainage basins and networks of primary concern to reclamation specialists in the Eastern Powder River Basin.

The selection process began by limiting the third order basins to those having their mouths on the 24 USGS 7.5 minute topographic maps that define the study area. Those drainage basins which were partially or wholly dissected or traversed by railroad tracks, improved or hard-surfaced roads, or other severe anthropogenic disturbances were excluded from the analysis, subject to map interpretation. Additionally, those drainage basins that had significant dam development were excluded from the analysis. On the basis of these selection criteria, 64 third order drainage basins were selected for analysis (Plate 1).

The intent of the study was to maintain a systems approach to the classification system; therefore, it was necessary to ensure that the selected second order drainage basins were within the third order drainage basins and that the first order drainage basins were within the seconds. A systems approach allowed description of third order streams based not only on quantitative variables but also on the type of first and second order streams that are tributary to the higher order stream. This goal for the study was accomplished by selecting the first two second order streams that came together to form the third order channel. Those second order streams had two first order streams that came together to form the second order stream. Three, of those uppermost four first order channels within the selected seconds were randomly selected for analysis. A total of 128 second order and 192 first order channels were selected and identified using these procedures. The total sample size was 384 drainage basins.

DRAINAGE BASIN IDENTIFICATION CODES

Each selected drainage basin was identified with a 4 digit identification code (Figure 4). The first two digits are numeric. The selected third order drainage basins were numbered from 01-65 (basin 39 was removed from the study after numbering) moving north to south and west to east by 7.5 minute quadrangles. For each second and first order drainage basin within each third order drainage basin, the first two

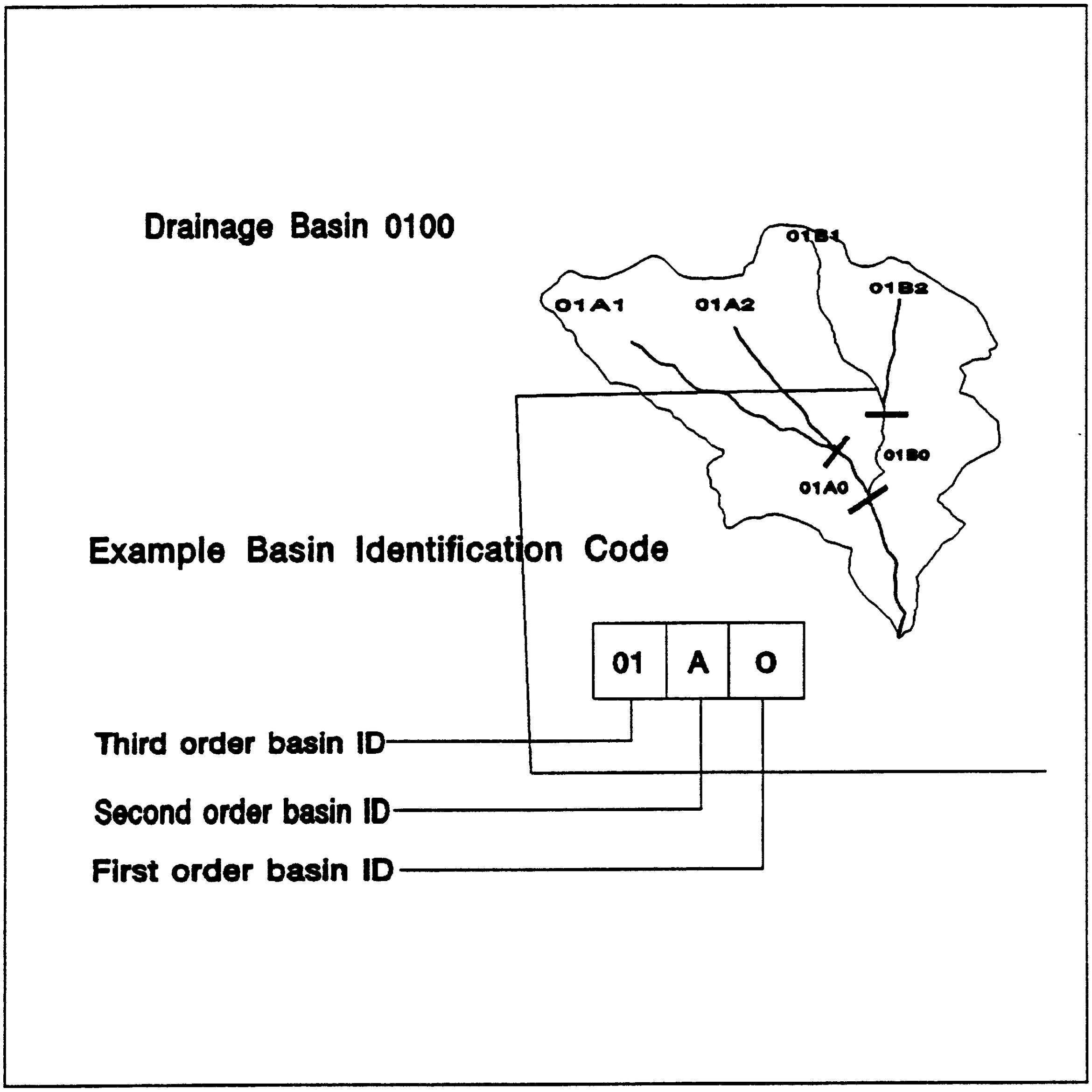


Figure 4. **Basin identification codes broken down for basin 0100.**

The first two digits indicate the third order basin. The third (alpha) character indicates the second order tributary to the third order. Moving clockwise from the mouth of the third order stream the seconds are lettered A,B,C etc.
The fourth character (numeric) indicates the first order tributary to the second order. Moving clockwise from the mouth of the second order stream the firsts are numbered 1,2,3 etc.
A basin ID code such as 1201 would indicate a first order stream directly tributary to the third order channel. The first order streams directly tributary to the third would be numbered moving clockwise from the mouth.

digits of the identification code are the same as the third order.

The third digit identifies the second order basin. Second order basins within a third order basin were labelled alphabetically starting at the mouth of the third order stream and moving clockwise around the basin. An "A" indicates the first second order stream encountered, a "B" indicates the second second order encountered, and so on. A zero in the third slot indicates that the stream is not tributary to a second order stream.

The fourth digit identifies the first order basin. First order streams within a second order were numbered starting at the mouth and moving clockwise around the second order basin. Zeros in the third and fourth slots indicate a third order basin (0100). A letter in the third slot and a zero in the fourth slot indicate a second order basin (01A0). A zero in the third slot with a number in the fourth slot indicates a first order stream directly tributary to the third order stream (1201).

Codes that can be used to locate the mouth of each drainage basin were developed and are explained in Appendix I.

DRAINAGE BASIN DELINEATION

Drainage basins were delineated on USGS 1:24,000 scale topographic maps. Drainage basin boundaries were determined by contour analysis. Contour lines were analyzed case by case to determine the appropriate location of the basin perimeter.

Lines indicating perennial, intermittent, or ephemeral streams were used as the only indicators of stream channels. The dominant channel for each second and third order basin was determined to be the channel having the greatest drainage basin area. This was determined easily by visual estimates in most cases. Where one basin was not clearly larger than another, a polar planimeter or the AUTO-CAD v.12 c2 (1992) software package were used to determine the largest area.

The lines used to determine valley lengths were indicated on the map. Stream channels were examined for changes in the overall direction of the valley. At points of direction change, the map was marked with an "x." Additional vertices were included in the valley lengths at each confluence of measured streams. The last point on any valley length line was the mouth of the stream in question. The head of the blue line on the map was considered to be the head of the valley.

MORPHOMETRIC ANALYSIS

Drainage basin characteristics that were measured or derived for this analysis are presented in Table 1. The criteria used by Martin et al. (1988) to determine some of the variables used are presented in Table 2.

Drainage basin characteristics were measured or computed from the 1:24,000 topographic maps according to the procedures used by Martin et al. (1988) with the following exceptions. The point on the drainage basin perimeter that was used for basin length, basin relief, and basin aspect measurements was

Table 1. Drainage basin characteristics determined for basins in the Eastern Powder River Basin coal field of Wyoming.

* Indicates variables that were not included in the multivariate statistical analysis.

First order	Second order	Third order
Basin Area	Basin Area	Basin Area
Basin Length	Basin Length	Basin Length
Basin Perimeter	Basin Perimeter	Basin Perimeter
Basin Relief	Basin Relief	Basin Relief
Channel Length	Main Channel Length	Main Channel Length
Valley Length	Valley Length	Valley Length
Used Relief	Number of first order channels	Number of first order channels
Relief Ratio	Total Channel Length	Number of second order channels
Ruggedness Number	Used Relief	Total Channel Length
Channel Slope	Relief Ratio	Used Relief
Sinuosity	Ruggedness Number	Relief Ratio
Drainage Density	Channel Slope	Ruggedness Number
Circularity (Shape)	Sinuosity	Channel Slope
Precipitation	Drainage Density	Sinuosity
Geology	Circularity (Shape)	Drainage Density
Scoria Abundance	Precipitation	Circularity (Shape)
*Vegetation	Geology	Precipitation
*Soils	Scoria Abundance	Geology
*Basin Aspect	*Vegetation	Scoria Abundance
*AGI#1	*Soils	*Vegetation
*AGI#2	*Basin Aspect	*Soils
*AGI#3	*AGI#1	*Basin Aspect
*AGI#4	*AGI#2	*AGI#1
	*AGI#3	*AGI#2
	*AGI#4	*AGI#3
		*AGI#4

Table 2. Drainage basin characteristics, their definitions, and procedures for delineation and measurement. (from: Martin et al. 1988)
* Indicates a variable not defined by Martin et. al. (1988)
** Indicates a definition that was altered from Martin et al. (1988) for this study.

Characteristic	Explanation of Characteristic
Basin Area (AREA)	Area, measured in a horizontal plane, from which direct surface runoff from precipitation normally drains into the stream channel upstream from the specified point.
Basin Length (BL)	**Straight line distance across the drainage basin from the point on the drainage divide nearest the head of the dominant channel to the basin mouth.
Basin Perimeter (PER)	Perimeter of the drainage basin.
Basin Relief (BASREL)	**Difference in elevation between the point on the drainage divide that would mark the intersection with the extended main stream channel and the basin mouth.
Main Channel Length (MCL)	Length of dominant channel measured using the blue streamline shown on a 1:24,000-scale topographic map.
Valley Length (VL)	Length of valley along the dominant stream channel.
Number of first order channels (NO1)	The number of first order channels within the 2nd or 3rd order basin.
Number of second order channels (NO2)	The number of 2nd order channels with the 3rd order basin.
Total Channel Length (TCL)	Summation of lengths of all stream-channels of all orders in the drainage basin. For first order streams, this is the same as Main Channel Length.

Table 2. (continued)

Used Relief (USEDREL)	Difference in elevation between two points on the stream channel. For first order basins, the points were selected at each end of the blue streamline shown on a 1:24,000-scale topographic map. For the second and greater order basins, the points were selected at 15 and 85 percent of the dominant stream channel length.
Relief Ratio (RR)	Basin Relief divided by Basin Length
*Ruggedness Number (RUG)	Basin Relief multiplied by Drainage Density
Channel Slope (CHANSLOP)	Used Relief divided by the length of stream channel between the points identified in used relief, in ratio. The channel length between the points is equal to 70 percent of the Main Channel Length. This depicts an average stream-channel slope, which should not be confused or compared with values that are measured at particular locations along stream channels.
Sinuosity (SIN)	Main Channel Length divided by Valley Length. This depicts an average sinuosity for the stream channel, which should not be confused with values that are measured at particular locations along stream-channels.
Drainage Density (DD)	Total Channel Length divided by the Basin Area.
Circularity Ratio (CIRC)	Area of the drainage basin divided by the area of a circle having the same perimeter as the drainage basin.
*Basin Aspect	Compass heading along the line of basin length from head to mouth.
*Area-Gradient Index #1 (AGI1)	AREA (mi^2)x (BASREL (ft.)/(MCL (mi.) x 5280))
*Area-Gradient Index #2 (AGI2)	AREA (mi^2) x CHANSLOP (ft./ft.)
*Area-Gradient Index #3 (AGI3)	AREA (mi^2) x ((BASREL (ft.)/(LENGTH (mi.) x 5280))
*Area-Gradient Index #4 (AGI4)	AREA (mi^2) x BASREL (ft.)

not the point on the perimeter nearest the head of the dominant channel. Contour crenulations were used to estimate the point on the perimeter where the extended channel would intersect the perimeter. If the direction indicated by contour crenulations was unclear, the last clearly indicated direction was used to determine the point of intersection with the perimeter.

Minimum basin elevation was determined at the mouth of the stream at the point of confluence with a stream of the same or higher order. The maximum basin elevation was the elevation determined for the point on the perimeter that would mark the intersection of the perimeter and the extended stream channel.

Elevations for basin relief and used relief were determined using the contour lines on the maps. All elevations were determined by visually dividing the 20 foot contour intervals into quarters. The elevation of the point in question was estimated to the nearest 5 feet. If two streams had their mouth at the same point, the elevation estimation was made using the contour interval in the direction of the dominant channel. The same minimum elevation was then used for both basins.

The maximum elevation point often was inside a closed contour line with no additional contour lines or other indicators of elevation available. Five feet was added to the elevation of the last contour line when this occurred.

Used relief elevation values were estimated after all digitizing and measurements had been accomplished and recorded.

The contour interval for maps within the study area changed from 20 feet to 10 feet as one proceeded south. The change in contour interval was essentially ignored to retain consistency in map interpretation. Only the contour lines that were multiples of 20 were used on maps with 10 foot intervals. All other contour lines were ignored for the purposes of determining elevations.

DIGITIZING

The AUTO-CAD v.12 c2 (1992) software package was used to measure areal and linear dimensions of the delineated drainage basins and their features. The digitizing hardware included a Cal-Comp model 9100 digitizing board interfaced with a Caliber micro-computer with a 386 microprocessor, 8 meg of RAM, and a math co-processor. The specifications for the Cal-Comp model 9100 are as follows (all values represent map units):

Resolution: up to 1,280 lines per inch.

Accuracy: 0.01 inch - 0.005 inch

Repeatability: 0.001 inch

A set protocol was used to digitize all drainage basins starting with equipment calibration by measurement of known areas. The procedures used to calibrate the equipment and digitize the drainage basins are described in Appendix II.

The digitizing process provided all the areal and linear measurements listed in Table 2.

Some of the variables considered (e.g. drainage density, relief ratio, sinuosity, ruggedness number, channel slope, circularity ratio and the 4 Area-Gradient Indices AGI1, AGI2, AGI3, and AGI4) are products or dividends of measured variables and constants. These were computed using a computer spreadsheet.

Measurement of basin aspect was performed by extending the line of basin length to the edge of the 1:24,000 topographic map and measuring the angle of intersection with the known North-South or East-West line represented by the edge of the map. Basin aspect was recorded categorically as a function of the compass heading determined from the angle of intersection. Categories and the associated degree values are presented in Table 3.

Table 3. Directional categories for Basin Aspect and associated directional values in (degrees) used in this study.

Category	Direction Values (Degrees)
1 (North)	0 - 45 and 316 - 359
2 (East)	46 - 135
3 (South)	136 - 225
4 (West)	226 - 315

CATEGORICAL AND SURFACE COVER VARIABLES

Six variables were treated as categorical in nature. Vegetation, soils, clinker abundance, geology, precipitation, and basin aspect were recorded numerically so that each category was represented by an integer.

Vegetation data were obtained from the University of Wyoming GAP Analysis (Driese and Reimer, 1992), a digital database of vegetative communities in Wyoming. The GAP database was developed from multispectral remote sensing data at an original scale of 1:250,000 with a minimum resolution of 1 hectare and a minimum mapping unit of 100 hectares. GAP was used to generate 1:24,000 scale overlays of the study area.

Soils data were taken from the SCS State Soil Geographic Data Base (STATSGO) (SCS, 1992). STATSGO is a digital database originally created at 1:100,000. STATSGO was used to generate 1:24,000 scale overlays of the study area.

Clinker abundance was estimated from surficial geologic Maps of the Gillette, Recluse, and Reno Junction 30'x 60' quadrangles at a scale of 1:100,000 (Reheis, 1987; Reheis and Williams, 1984; and Reheis and Coates, 1987).

Subsurface geologic data were obtained from geologic maps of the Gillette and Newcastle 1° x 2° quadrangles at a scale of 1:250,000 (Love et al., 1990 and Love et al., 1987).

Precipitation data were gathered using a contour map of Campbell County that was generated using 1990 Thirty Year

Normals obtained from the National Weather Service. The contour map was originally generated at 1:300,000 scale using ARC-INFO v. 6.11 (1992). Criteria used to select stations with adequate consistency of record were those used by Eastwood et al. (1994) for an extreme storm event study. The original contour map was modified, in consultation with the Wyoming State Climatologist (Hasfurther, 1994) to reflect other less current but relevant data. A more detailed precipitation contour map generated by Toy and Munson (1978) was referenced to modify the contour patterns of the original map.

Surface cover and precipitation categories were determined as a function of area for each drainage basin. When the predominant category was determined for a drainage basin, that basin was assigned the appropriate integer for that category. The dominant surface cover category for each variable was defined as the category that covered most of the basin. If no category covered more than 50 percent of the area, then the category that covered the greatest percentage of the basin was used as the dominant type. Overlays were used to determine the dominant surface cover category for soils and vegetation.

Six types of vegetation cover were identified in the study area and each was developed into a category (Table 4). Professional judgment was used to derive the vegetation categories. The mapping units provided were distinguished by

Table 4. Categories used to classify the vegetative communities within the Eastern Powder River Basin coal field of Wyoming. Data from the University of Wyoming GAP analysis digital database (Driese and Reimers, 1992).

Category	Description
1	Sagebrush/Ponderosa Pine Sagebrush dominated community with Ponderosa pine being the major secondary component
2	Sagebrush Sagebrush dominated community with no major secondary component.
3	Sagebrush/Grassland Sagebrush dominated community with mixed-grass prairie, cultivated pasture or cropland being the major secondary component
4	Grassland/Sagebrush Mixed-grass prairie, cultivate pasture, or cropland dominated community with sagebrush being the major secondary component.
5	Grassland Mixed-grass prairie, cultivated pasture, or cropland dominated community with no major secondary component.
6	Grassland/Ponderosa Pine Mixed-grass prairie, cultivated pasture, or cropland dominated community with Ponderosa Pine as the major secondary component.

dominant and secondary vegetation types. The percentage of cover represented by the dominant and secondary vegetation communities within the mapping unit was provided. The categories derived reflect an interpretation of the mapping units provided by Driese and Reimers (1992). The mapping units shown within a drainage basin were analyzed and the vegetation category was assigned based upon best professional judgment.

The STATSGO (SCS, 1992) map of Campbell County provided an appropriate level of soil identification and was adapted for use in this study. The already broad groupings of the STATSGO were further reduced to four textural categories (Table 5).

Precipitation, geology, and surficial geology maps were only available at small scales that differed from the topographic maps; therefore, the location of drainage basins on the larger maps had to be visually estimated.

The four categories for sub-surface geology were based upon the geologic formation that underlies the selected drainage basin (Table 6). The locations of the basins were estimated on the 1:250,000 scale maps by drawing in the 7.5 minute quadrangles on the smaller scale maps. The abundance of clinker was estimated by drawing the 7.5 minute quadrangles on the 1:100,000 scale maps and estimating a percentage of the basin covered by clinker deposits. Six categories were derived for the abundance of clinker (Table 7).

Table 5. Textural categories used to classify soils within the Eastern Powder River Basin coal field of Wyoming. Categories based on the STATSGO data base (SCS, 1992).

Category	Description
1	Fine
2	Fine loamy
3	Loamy
4	Loamy Skeletal

Table 6. Categories used to classify the subsurface geologic formations for drainage basins in the Eastern Powder River Basin coal field of Wyoming. (Variable abbreviation=SSGEO)

Category	Description
1	100 percent Wasatch Formation parent material
2	Wasatch Formation dominated mixture of Wasatch and Fort Union Formation parent material
3	Fort Union dominated mixture of Wasatch and Fort Union parent material
4	100 percent Fort Union Formation parent material

Table 7. Categories developed to classify the abundance of clinker within drainage basins in the Eastern Powder River Basin coal field of Wyoming. (Variable abbreviation = SURFGEO)

Category	Description	
0	0 percent.	No clinker present in basin.
1	0-1 percent.	A trace of clinker present.
2	1-10 percent.	Little clinker present.
3	10-25 percent.	Moderate clinker present.
4	25-50 percent.	Heavy clinker abundance.
5	> 50 percent.	Clinker dominates basin.

Climatological variations were represented by mean annual precipitation as reflected in the precipitation contour map. Five categories were defined for mean annual precipitation (Table 8). The positions of the drainage basins on the contour map were estimated using the 1:24,000 quadrangle boundaries as points of reference. Due to the small scale of the map, the mean annual precipitation estimation was applied to the third order basins. All the tributary basins of the third order basin were placed in the same category.

STATISTICAL ANALYSIS

Once the drainage basins were delineated, the parameters measured, and the data compiled, a three tiered statistical analysis was conducted. Drainage basins were presorted by order prior to analysis to avoid any problems regarding randomness caused by the selection of first and second order basins within higher order basin. The 18 variables listed in Table 1 were used in the principal components analysis (PCA). The eliminated variables were chosen based upon preliminary analysis of the clusters derived using them. After these preliminary PCA's and cluster analyses, the most distinct clusters were derived using only the indicated variables.

PCA was used to define major axes of variation among drainage basins. Cluster analysis was then used to identify groups of drainage basins with similar characteristics. The third step involved discriminant function analysis (DFA) to

Table 8. Categories developed to describe the mean annual precipitation for drainage basins in the Eastern Powder River Basin coal field of Wyoming. (Variable abbreviation = PRECIP)

Category	Mean Annual Precipitation (in inches)
1	12-13
2	13-14
3	14-15
4	15-16
5	> 16

verify the strength of similarity between groups of drainage basins identified in the cluster analysis.

According to Dunteman (1989) PCA is a multivariate statistical analysis technique having the goal of reducing the dimensionality of a data set. The measured variables are combined linearly into a single variable or principal component. According to Dunteman (1989),

> "With principal components analysis a large number of independent variables can be systematically reduced to a smaller, conceptually more coherent set of variables."

Each variable is weighted with a coefficient and the sum of all the weighted variables is the principal component. The number of components that can be generated is equal to the number of original variables (Dunteman, 1989).

The sum of the products of the coefficients and variables provided the new variables for later cluster analysis and DFA. It was hoped that PCA would explain with one variable as much as 30 or 40 percent of the variability of the data set.

Several techniques can be used to decide the appropriate number of principal components to be retained (Dunteman, 1989). These methods include graphical analysis techniques that may or may not indicate clearly the cut-off point. Other methods proposed a minimum level of explained variability, or a minimum value of the "eigenvalue" or variance of the principal component. At some point in most analyses retention of additional principal components becomes unnecessary as each new component explains only an insignificant amount of variation (Dunteman, 1989).

The goal of this study was to explain 75-80 percent of the variability within the data set with the selected principal components. This goal would have required retention of five principal components as displayed in Table 9. After further analysis,three principal components were retained to simplify the cluster analysis results. The decision to retain three principal components is supported by the scree plots of the eigenvalues in Figure 5. The break in slope of the plot was the graphical indicator of the appropriate number of principal components to retain that was mentioned by Dunteman (1989). The lack of any clear definition of the fourth and fifth principal components also contributed to the decision to

Table 61. Design relationships for field measured characteristics of Stratum C second order basins.

[VA = Valley Area (ft^2); AGI#2 = Area-Gradient Index #2 ($miles^2 \bullet ft/ft$); TW = Top Width (ft); $\bar{D}$ = Average Depth (ft); BW = Bed Width (ft); A3 = Low Bank Area (ft^2); TW3 = Top Width of the Low Bank (ft); $\bar{D}3$ = Average Depth of the Low Bank (ft)]

Design Relationship (n = 6)‡	Design Range[1]	r[2]	p-Value[3]
VA = -4854 + (286200 • AGI#2)	0.014 - 0.033	0.89	0.0175
TW = 61.13 + (0.032 * VA)	375.00 - 5554.40	0.98	0.0007
$\bar{D}$ = 5.97 + (0.003 * VA)	375.00 - 5554.40	0.89	0.0173
BW = -41.79 + (0.77 * TW)	74.17 - 244.17	0.99	0.0001
A3 = -0.14 + (0.001 * VA)	375.00 - 1636.90	0.86	0.0602
TW3 = 4.78 + (1.47 * A3)	0.27 - 3.45	0.95	0.0036
$\bar{D}3$ = 0.05 + (0.09 * A3)	0.27 - 3.45	0.99	0.0000

1 Predictive range of the independent variable(s) in the design relationship
2 Pearson Correlation Coefficient
3 Significance of the relationship; p = 0.0000 = probability < 0.00001
‡ n = 6 field sampled study reaches characterized by a high and low bank

the three strata. Conversely, these basins also have the lowest mean relief ratio, channel slope, and drainage density of the three strata.

Five third order reaches in Stratum C were field investigated, with 29 sites sampled. Of these reaches, five were characterized by a high bank (Table 62), five by a medium bank (stream channel) (Table 63), three by a low bank (low-flow channel) (Table 64), and five by a low bank #2 (second low-flow channel) (Table 65). The mean high bank top width (143.15 ft) and bed slope (0.007 ft/ft) for Stratum C third order basins were the largest among strata. The Stratum C third order stream channels (medium bank) had the lowest mean average depth, bank slope, and estimated velocity of the three strata. Additionally, the low-flow channels (low bank) and second low-flow channels (low bank #2) had the lowest mean area, top width, average depth, and estimated velocity and discharge of the three strata.

Significant geomorphic design relationships for Stratum C third order basins are presented in Tables 66-68. Basin area was the strongest independent variable for relating the drainage network to the drainage basin in this stratum. The field characteristics were related to a variety of drainage basin and network characteristics: channel slope, basin area, relief ratio, area-gradient index #1, used relief, and area-gradient index #4. Channel slope was used to predict valley area, low-flow channel (low bank) area, and the second low-

Table 62. Average of the **high bank** reach means for **Stratum C** third order basins.

	AREA (ft^2)	WETTED PERIMETER (ft)	TOP WIDTH (ft)	HYDRAULIC RADIUS (ft)	AVERAGE DEPTH (ft)	W/D RATIO	FLOODPLAIN WIDTH (ft)	BED SLOPE (ft/ft)
n†	5	5	5	5	5	5	5	5
MEAN*	1225.50	147.00	143.15	6.33	6.63	24.86	68.75	0.007
S.D.	1380.90	97.11	95.37	5.00	5.24	9.82	61.12	0.003
C.V. (%)	113	66	67	79	79	39	89	43
MINIMUM	88.20	32.10	28.45	1.98	2.10	10.19	10.15	0.004
MAXIMUM	3477.40	249.77	239.90	14.58	15.40	34.64	125.25	0.012
RANGE	3389.20	217.67	211.45	12.59	13.30	24.45	115.10	0.007

† Bed slope = channel bed slope
‡ n = average reach means for 5 study reaches; reach means = average cross section values by reach
* mean = stratum mean

Table 63. Average of the **medium bank**[1] reach means for **Stratum C** third order basins.

	AREA (ft^2)	WETTED PERIMETER (ft)	TOP WIDTH (ft)	HYDRAULIC RADIUS (ft)	AVERAGE DEPTH (ft)	W/D RATIO	BED SLOPE (ft/ft)	BANK SLOPE (ft/ft)	MANNING'S "n"[2]	VELOCITY[3] (ft/s)	DISCHARGE "Q"[3] (cfs)
n[4]	5	5	5	5	5	5	5	5	5	5	5
MEAN[5]	87.15	34.35	33.06	1.86	1.98	18.73	0.008	0.010	0.032	6.48	903.46
S.D.	79.47	22.40	22.27	1.12	1.21	10.02	0.005	0.009	0.002	5.16	1216.90
C.V. (%)	91	65	67	60	60	54	63	90	7	80	135
MINIMUM	9.30	12.23	11.33	0.77	0.83	9.13	0.000	0.001	0.030	1.51	14.04
MAXIMUM	194.10	58.10	57.25	3.23	3.33	35.58	0.012	0.025	0.034	14.94	2982.30
RANGE	184.80	45.87	45.92	2.46	2.50	26.44	0.012	0.024	0.004	13.43	2968.26

1 medium bank = high banks of a physical stream-channel
2 Manning's "n" = estimated roughness coefficient
3 estimated from Manning's equation
4 n = averaged reach means for 5 study reaches; reach means = averaged cross section values by study reach
5 mean = stratum mean

Table 64. Average of the **low bank**[1] reach means for **Stratum C** third order basins.

	AREA (ft^2)	WETTED PERIMETER (ft)	TOP WIDTH (ft)	HYDRAULIC RADIUS (ft)	AVERAGE DEPTH (ft)	W/D RATIO	BED SLOPE (ft/ft)	BANK SLOPE (ft/ft)	MANNING'S "n"[2]	VELOCITY[3] (ft/s)	DISCHARGE "Q"[3] (cfs)
n[4]	3	3	3	3	3	3	3	3	3	3	3
MEAN[5]	4.36	11.37	11.11	0.41	0.43	56.37	0.009	0.007	0.031	1.63	7.34
S.D.	1.91	4.81	4.91	0.18	0.21	37.36	0.006	0.007	0.002	0.63	3.56
C.V. (%)	44	42	44	45	48	66	59	105	6	39	49
MINIMUM	2.20	7.15	6.65	0.20	0.20	15.67	0.003	0.001	0.030	0.91	4.62
MAXIMUM	5.83	16.60	16.37	0.55	0.60	89.11	0.014	0.015	0.033	2.10	11.37
RANGE	3.63	9.45	9.72	0.35	0.40	73.45	0.011	0.015	0.003	1.19	6.75

1 low bank = low flow channel within the high banks of a physical stream-channel
2 Manning's "n" = estimated roughness coefficient
3 estimated from Manning's equation
4 n = averaged reach means for 3 study reaches; reach means = averaged cross section values by study reach
5 mean = stratum mean

Table 65. Average of the **low bank #2**[1] reach means for **Stratum C** third order basins.

	AREA (ft^2)	WETTED PERIMETER (ft)	TOP WIDTH (ft)	HYDRAULIC RADIUS (ft)	AVERAGE DEPTH (ft)	W/D RATIO	BED SLOPE (ft/ft)	BANK SLOPE (ft/ft)	MANNING'S "n"[2]	VELOCITY[3] (ft/s)	DISCHARGE "Q"[3] (cfs)
n[4]	5	5	5	5	5	5	5	5	5	5	5
MEAN[5]	0.75	4.25	4.16	0.16	0.17	55.10	0.008	0.006	0.031	0.85	0.89
S.D.	0.65	1.68	1.71	0.08	0.09	45.58	0.006	0.004	0.001	0.34	1.17
C.V. (%)	87	40	41	48	51	83	71	75	4	40	131
MINIMUM	0.15	2.10	1.90	0.06	0.06	15.00	0.000	0.001	0.030	0.54	0.13
MAXIMUM	1.60	6.00	5.95	0.28	0.30	132.70	0.014	0.013	0.033	1.42	2.92
RANGE	1.45	3.90	4.05	0.21	0.24	117.70	0.014	0.011	0.003	0.88	2.79

1 low bank #2 = second low flow channel within the high banks of a physical stream-channel
2 Manning's "n" = estimated roughness coefficient
3 estimated from Manning's equation
4 n = averaged reach means for 5 study reaches; reach means = averaged cross section values by study reach
5 mean = stratum mean estimated bankfull discharge of the stream channel. The bed slope of the stream channel was correlated to area-gradient index #1 and bank slope was correlated to bed slope. Estimated bankfull discharge of the low-flow channel (low bank) was correlated to used relief; however, discharge of the second low-flow channel (low bank #2) was correlated to area-gradient index #4. The four banks did not correlate to each other.

Table 66. Design relationships for map measured characteristics of Stratum C third order basins.

[BP = Basin Perimeter (mi); BA = Basin Area (mi^2); DD = Drainage Density (mi/mi^2); BL = Basin Length (mi); NOF = Number of First Order Basins; TCHL = Total Channel Length (mi); CS = Channel Slope (ft/ft); NOS = Number of Second Order Basins; MCL = Main Channel Length (mi); RR = Relief Ratio (ft/mi); VL = Valley Length (mi); BR = Basin Relief (ft); UR = Used Relief (ft); RNO = Ruggedness Number (mi/mi^2 * ft)]

Design Relationship (n = 22)	Design Range[1]	r[2]	p-Value[3]
$BP = 5.39\ BA^{0.51}$	2.58 - 8.65	0.87	0.0000
$DD = 4.31\ BA^{-0.28}$	2.58 - 8.65	-0.47	0.0281
$BL = 1.71\ BA^{0.51}$	2.58 - 8.65	0.76	0.0000
$NOF = 10.05\ TCHL^{1.21} CS^{0.64}$	8.09-24.04/0.004-0.016	0.86	0.0000
$NOS = 3.53\ TCHL^{0.74} CS^{0.45}$	8.09-24.04/0.004-0.016	0.69	0.0020
$MCL = 1.91\ BA^{0.63}$	2.58 - 8.65	0.78	0.0000
$TCHL = 4.31\ BA^{0.72}$	8.09 - 24.04	0.81	0.0000
$RR = 155\ BA^{-0.46}$	2.58 - 8.65	-0.51	0.0153
$VL = 1.59\ BA^{0.63}$	2.58 - 8.65	0.82	0.0000
$BR = 161\ BA^{-0.41} BL^{0.93}$	2.58 - 8.65 / 2.77 - 6.83	0.48	0.0790
$UR = 3490\ BA^{0.50} CS^{0.81}$	2.58-8.65 / 0.004-0.016	0.80	0.0001
$RNO = 0.00026\ BR^{1.12}$	140.00 - 565.00	0.86	0.0000
$CS = 0.000078\ RR^{1.07}$	39.79 - 142.30	0.90	0.0000

1 Predictive range of the independent variable(s) in the design relationship
2 Pearson Correlation Coefficient
3 Significance of the relationship; p = 0.0000 = probability < 0.00001

Table 67. Design relationships for the high bank and medium bank characteristics of Stratum C third order basins.

VA = Valley Area (ft^2); CS = Channel Slope (ft/ft); TW = Top Width (ft); $\bar{D}$ = Average Depth (ft); A2 = Stream Channel Area (ft^2); BA = Basin Area (mi^2); RR = Relief Ratio (ft/mi); Q2 = Estimated Bankfull Discharge for the Stream Channel (cfs); TW2 = Top Width of the Stream Channel (ft); $\bar{D}2$ = Average Depth of the Stream Channel (ft); V2 = Estimated Velocity of Bankfull Discharge for the Stream Channel (ft/s); BS = Bank Slope (ft/ft); GS = Ground Slope (ft/ft); AGI#1 = Area-Gradient Index #1 (mi^2 * ft/ft)]

Design Relationship (n = 5)	Design Range[1]	r[2]	p- Value[3]
$VA = -2300 + (3.58x10^5 * CS)$	0.007 - 0.016	0.94	0.0168
$TW = 2.98\ VA^{0.57}$	88.20 - 3477.40	0.97	0.0058
$\bar{D} = 0.34\ VA^{0.43}$	88.20 - 3477.40	0.95	0.0122
$A2 = 3.46x10^{-21}\ BA^{4.53}RR^{9.50}$	3.18-7.65/77-142	0.97	0.0536
$Q2 = 3.08x10^{-35}\ BA^{7.60}RR^{15.86}$	3.18-7.65/77-142	0.99	0.0118
$A2 = 1.56\ Q2^{0.61}$	14.04 - 2982.30	0.99	0.0016
$TW2 = 3.54\ A2^{0.54}$	9.30 - 194.10	0.94	0.0179
$TW2 = 4.38\ Q2^{0.33}$	14.04 - 2982.30	0.94	0.0165
$\bar{D}2 = 0.28\ A2^{0.46}$	9.30 - 194.10	0.92	0.0251
$\bar{D}2 = 0.36\ Q2^{0.28}$	14.04 - 2982.30	0.90	0.0396
$V2 = 0.65\ Q2^{0.37}$	14.04 - 2982.30	0.95	0.0116
$BS = 0.051\ GS^{0.38}$	0.00006 - 0.012	0.82	0.0902
$GS = 1.53x10^9\ AGI\#1^{10.42}$	0.059 - 0.094	0.84	0.0761

1 Predictive range of the independent variable(s) in the design relationship
2 Pearson Correlation Coefficient
3 Significance of the relationship

Table 68. Design relationships for the low-flow and second low-flow channels of Stratum C third order basins.

[Q3 = Estimated Bankfull Discharge for the Low-Flow Channel (cfs); UR = Used Relief (ft); A4 = Second Low-Flow Channel Area (ft^2); CS = Channel Slope (ft/ft); Q4 = Estimated Bankfull Discharge for the Second Low-Flow Channel (cfs); AGI#4 = Area-Gradient Index #4 (mi^2 * ft); TW4 = Top Width of the Second Low-Flow Channel (ft); $\bar{D}4$ = Average Depth of the Second Low-Flow Channel (ft); V4 = Estimated Velocity of Bankfull Discharge for the Second Low-Flow Channel (ft/s)]

Design Relationship (n = 5; n† = 3)	Design Range[1]	r[2]	p-Value[3]
$Q3 = 3.36x10^{-9}\ UR^{3.96}$†	185.00 - 250.00	0.99	0.0190
$A4 = 0.000016\ CS^{-2.16}$	0.007 - 0.016	-0.88	0.0492
$Q4 = 2.82x10^{-8}\ AGI\#4^{2.10}$	1446 - 4321	0.84	0.0751
TW4 = 2.54 + (2.16 * A4)	0.15 - 1.60	0.82	0.0857
$\bar{D}4$ = 0.08 + (0.12* A4)	0.15 - 1.60	0.88	0.0483
A4 = 0.32 + (0.49 * Q4)	0.13 - 2.92	0.87	0.0531
$\bar{D}4 = 1.29\ Q4^{0.07}$	0.13 - 2.92	0.91	0.0295
$V4 = 4.07\ Q4^{0.27}$	0.13 - 2.92	0.92	0.0270

1 Predictive range of the independent variable(s) in the design relationship
2 Pearson Correlation Coefficient
3 Significance of the relationship
† n = 3; three reaches were characterized by a low-bank

flow channel (low bank #2) area. Alternatively, basin area and relief ratio were used to predict the stream channel (medium bank) area and estimated bankfull discharge of the stream channel. The bed slope of the stream channel was correlated to area-gradient index #1 and bank slope was correlated to bed slope. Estimated bankfull discharge of the low flow channel (low bank) was correlated to used relief; however, discharge of the second low-flow channel (low bank #2) was correlated to area-gradient index #4. The four banks did not correlate with one another.

Geomorphic relationships in graphic format, regression output tables and simple linear regression plots, standard statistics by reach and by bank, cross section profiles, raw data, and photographic documentation are presented in Appendix C-3.

VEGETATION OBSERVATIONS

The reconnaissance notes were compiled by stratum and order concerning the predominant and notable vegetation characteristics (Tables 69-71). The drainage basins in Stratum A had vegetation species indicative of dry, shallow soils, and rocky areas such as Ponderosa pine, Juniper, and Bluebunch wheatgrass. Alternatively, the drainage basins in Stratum C had vegetation characteristics indicative of deep, sandy soils such as Needle-and-thread and Indian ricegrass. The drainage basins in Stratum B exhibited a combination of vegetation characteristics of both Strata A and C.

Table 69. Predominate and notable vegetation characteristics for first order basins.

Vegetation Species	**Stratum**		
Ponderosa pine (*Pinus ponderosa* Laws.)	A		
Rocky Mountain juniper (*Juniperus scopulorum* Sarg.)	A		
Chokecherry (*Prunus virginiana* L.)			C
Douglas rabbitbrush (*Chrysothamnus viscidiflorus* [Hook.] Nutt.)		B	
Big sagebrush (*Artemisia tridentata* Nutt.)	A	B	C
Silver sagebrush (*Artemisia cana* Pursh)		B	C
Gardner saltbush (*Atriplex gardneri* [Moq.] D. Dietr.)			C
Woods rose (*Rosa woodsii* Lindl.)			C
Fringed sagebrush (*Artemisia frigida* Willd.)	A		
Cudweed sagewort (*Artemisia ludoviciana* Nutt.)	A	B	
Needle-and-Thread (*Stipa comata* Trin. & Rupr.)		B	C
Western wheatgrass (*Agropyron smithii* Rydb.)	A	B	C
Bluebunch wheatgrass (*Agropyron spicatum* [Pursh] Scribn. & J.G. Smith)	A	B	
Slender wheatgrass (*Agropyron trachycaulum* [Link] Malte)	A	B	
Blue grama (*Bouteloua gracilis* [H.B.K.] Lag. exSteud)	A	B	
Prairie junegrass (*Koeleria cristata* [L.] Pers.)	A	B	
Alkali sacaton (*Sporobolus airoides* Torr.)			C
Indian ricegrass (*Oryzopsis hymenoides* [Roem. & Schult.] Ricker)			C
Kentucky bluegrass (*Poa pratensis* L.)	A	B	C
Sedge (*Carex* ssp.)	A	B	C
Scurf-pea (*Psoralea* ssp.)	A	B	C

Table 70. Predominate and notable vegetation characteristics of second order basins.

Vegetation Species	Stratum		
Big sagebrush (*Artemisia tridentata* Nutt.)	A	B	C
Silver sagebrush (*Artemisia cana* Pursh.)	A	B	C
Cudweed sagewort (*Artemisia ludoviciana* Nutt.)	A	B	
Needle-and-Thread (*Stipa comata* Trin. & Rupr.)	A	B	C
Green needlegrass (*Stipa viridula* Trin.)	A	B	
Western wheatgrass (*Agropyron smithii* Rydb.)	A	B	C
Slender wheatgrass (*Agropyron trachycaulum* [Link] Malte)		B	
Blue grama (*Bouteloua gracilis* [H.B.K.] Lag. exSteud)	A	B	C
Prairie junegrass (*Koeleria cristata* [L.] Pers.)	A	B	
Bluegrass (*Poa* ssp. L.)	A	B	C
Indian ricegrass (*Oryzopsis hymenoides* [Roem. & Schult.] Ricker)			C
Little bluestem (*Schizachyrium scoparium* [Michx.] Nash)		B	
Foxtail barley (*Hordeum jubatum* L.)		B	
Sedge (*Carex* ssp.)	A	B	C
Cattail (*Typha* ssp.)		B	
Scurf-pea (*Psoralea* ssp.)	A	B	

Table 71. Predominate and notable vegetation characteristics of third order basins.

Vegetation Species	Stratum		
Ponderosa pine (*Pinus ponderosa* Laws.)	A		
Plains cottonwood (*Populus deltoides* var. *occidentalis* Rydb.)	A		
Rocky Mountain juniper (*Juniperus scopulorum* Sarg.)	A		
Douglas rabbitbrush (*Chrysothamnus viscidiflorus* [Hook.] Nutt.)		B	
Greasewood (*Sarcobatus vermiculatus* [Hook.] Torr.)		B	
Big sagebrush (*Artemisia tridentata* Nutt.)	A	B	C
Silver sagebrush (*Artemisia cana* Pursh)	A	B	C
Fringed sagebrush (*Artemisia frigida* Willd.)	A		
Cudweed sagewort (*Artemisia ludoviciana* Nutt.)	A	B	
Needle-and-Thread (*Stipa comata* Trin. & Rupr.)	A	B	C
Green needlegrass (*Stipa viridula* Trin.)	A	B	
Western wheatgrass (*Agropyron smithii* Rydb.)	A	B	C
Slender wheatgrass (*Agropyron trachycaulum* [Link] Malte)		B	
Bluegrass (*Poa* ssp. L.)	A	B	C
Blue grama (*Bouteloua gracilis* [H.B.K.] Lag. exSteud)	A	B	C
Little bluestem (*Schizachyrium scoparium* [Michx.] Nash)		B	
Indian ricegrass (*Oryzopsis hymenoides* [Roem. & Schult.] Ricker)		B	
Prairie junegrass (*Koeleria cristata* [L.] Pers.)	A	B	C
Woods rose (*Rosa woodsii* Lindl.)	A		
Scurf-pea (*Psoralea* ssp.)	A	B	C

SURFICIAL GEOLOGY

The predominant geologic components of field sampled reaches were identified on USGS surficial geology maps (1:100,000 scale) developed by Reheis and Coates (1987) and Reheis (1987). The geologic components by stratum and order are presented in Tables 72-74. The drainage basins in Stratum A are dominated by the Fort Union Formation, residuum on the Fort Union Formation, and clinker outcrops or escarpments. The drainage basins in Stratum C are dominated by the Wasatch Formation and residuum on the Wasatch Formation. The drainage basins in Stratum B are a combination of geologic units found in both Stratum A and Stratum C.

Three reaches (two first order, one second order) in Stratum A were geologically controlled for short distances by the presence of mammoth scoria boulders aligning the valley banks and armoring the bottom. These areas were identified as confined-valley sections with a V-shape (cross-sectional). Minor sandstone outcrops were observed in Strata B and C with one exception. Consolidated and unconsolidated eolian deposited sands and silts now exposed to erosion occur in the southwest corner of the study area in a first order reach classified in Stratum B. Additionally, several significant pediment deposits were identified in all strata, with occurrences of colluvial deposition from mass wasting in two drainage basins in Stratum C. Alluvial geologic units inappropriately identified and units not identified by

Table 72. Predominant surficial geologic delineation for first order basins derived from USGS Surficial Geologic Maps developed by Reheis and Coates (1987) and Reheis (1987).

Geologic Unit	Description	Origin	Stratum		
			A	B	C
Fort Union Formation	Light-gray to yellowish-brown, fine-grained sandstone, light-gray siltstone, mudstone, and shale, brown carbonaceous shale, and coal. Includes small areas of residuum, colluvium, and sheet-wash alluvium.	Bedrock - Deposited in streams, swamps, and lakes; later consolidated by deep burial; now exposed by erosion.	X	X	
Residuum on Fort Union Formation	Gray to brown silty and sandy weathered material with variable clay content. Grades downward into unweathered Fort Union Formation. Includes areas of sheetwash alluvium and Fort Union bedrock and colluvium.	Residuum - Material derived from weathering of Fort Union Formation in place; may be modified by sheetwash and soil creep.	X	X	
Baked & Fused Rock	Bedrock altered when coal beds were burned. Mostly hard, dense, red to orange, baked shale and siltstone. Black, bubbly, sometimes glassy rock; resembles volcanic rocks. Gray or white coal ash occurs as a layer (5cm to 1.2m thick) at base of baked zone. Locally includes small areas of colluvium.	Bedrock - Overlying bedrock baked when coal beds in Wasatch and Fort Union Formations burned.	X	X	
Wasatch Formation	Brown and gray claystone and siltstone with thick lenses of coarse-grained, crossbedded, arkosic sandstone. Generally poorly consolidated but has some well-cemented resistant sandstone beds. Thin beds of coal and carbonaceous shale common locally. May include small areas of residuum and sheetwash alluvium.	Bedrock - Deposited in streams, swamps, and lakes; later consolidated by deep burial; now exposed by erosion.		X	X
Residuum on Wasatch Formation	Sandy and silty with variable clay content. Grades downward into unweathered Wasatch Formation. May contain sheetwash alluvium or eolian deposits. May include small areas of Wasatch.	Residuum - Material derived from weathering of Wasatch Formation in place; may be disturbed by sheetwash, soil creep, and erosion or deposition by wind.		X	X
Fan and Pediment Deposits	Upper 0.3-3 m commonly sheetwash alluvium; commonly grades downward into stream alluvium of sand and silt containing abundant small lenses of angular to subangular gravel. On pediments, sheetwash alluvium may overlie bedrock.	Alluvial Deposit - Deposited by ephemeral streams and by sheetwash. Fan-shaped surface formed primarily by deposition, but some areas cut on bedrock and thinly veneered with alluvium.	X[1]	X[1]	X[2]

1 These deposits were not classified by Reheis and Coates (1987) and Reheis (1987).
2 These deposits were classified as floodplain and low-terrace alluvium by Reheis and Coates (1987) and Reheis (1987).

Table 73. Predominant surficial geologic delineation for second order basins derived from USGS Surficial Geologic Maps developed by Reheis and Coates (1987) and Reheis (1987).

Geologic Unit	Description	Origin	Stratum		
			A	B	C
Fort Union Formation	Light-gray to yellowish-brown, fine-grained sandstone, light-gray siltstone, mudstone, and shale, brown carbonaceous shale, and coal. Includes small areas of residuum, colluvium, and sheet-wash alluvium.	Bedrock - Deposited in streams, swamps, and lakes; later consolidated by deep burial; now exposed by erosion.	X	X	
Residuum on Fort Union Formation	Gray to brown silty and sandy weathered material with variable clay content. Grades downward into unweathered Fort Union Formation. Includes areas of sheetwash alluvium and Fort Union bedrock and colluvium.	Residuum - Material derived from weathering of Fort Union Formation in place; may be modified by sheetwash and soil creep.	X	X	
Baked & Fused Rock	Bedrock altered when coal beds were burned. Mostly hard, dense, red to orange, baked shale and siltstone. Black, bubbly, sometimes glassy rock; resembles volcanic rocks. Gray or white coal ash occurs as a layer (5cm to 1.2m thick) at base of baked zone. Locally includes small areas of colluvium.	Bedrock - Overlying bedrock baked when coal beds in Wasatch and Fort Union Formations burned.	X		
Wasatch Formation	Brown and gray claystone and siltstone with thick lenses of coarse-grained, crossbedded, arkosic sandstone. Generally poorly consolidated but has some well-cemented resistant sandstone beds. Thin beds of coal and carbonaceous shale common locally. May include small areas of residuum and sheetwash alluvium.	Bedrock - Deposited in streams, swamps, and lakes; later consolidated by deep burial; now exposed by erosion.		X	X
Residuum on Wasatch Formation	Sandy and silty with variable clay content. Grades downward into unweathered Wasatch Formation. May contain sheetwash alluvium or eolian deposits. May include small areas of Wasatch.	Residuum - Material derived from weathering of Wasatch Formation in place; may be disturbed by sheetwash, soil creep, and erosion or deposition by wind.		X	X
Fan and Pediment Deposits	Upper 0.3-3m commonly sheetwash alluvium; commonly grades downward into stream alluvium of sand and silt containing abundant small lenses of angular to subangular gravel. On pediments, sheetwash alluvium may overlie bedrock.	Alluvial Deposit - Deposited by ephemeral streams and by sheetwash. Fan-shaped surface formed primarily by deposition, but some areas cut on bedrock and thinly veneered with alluvium.	X[1]	X[2]	X[3]

1 These deposits were classified as floodplain and low-terrace alluvium by Reheis and Coates (1987) and Reheis (1987).
2 These deposits were not classified by Reheis and Coates (1987) and Reheis (1987).
3 Some of these deposits were classified as floodplain and low-terrace alluvium within fan and pediment deposits by Reheis and Coates (1987) and Reheis (1987).

Table 74. Predominant surficial geologic delineation for third order basins derived from USGS Surficial Geologic Maps developed by Reheis and Coates (1987) and Reheis (1987).

Geologic Unit	Description	Origin	Stratum		
			A	B	C
Fort Union Formation	Light-gray to yellowish-brown, fine-grained sandstone, light-gray siltstone, mudstone, and shale, brown carbonaceous shale, and coal. Includes small areas of residuum, colluvium, and sheet-wash alluvium.	<u>Bedrock</u> - Deposited in streams, swamps, and lakes; later consolidated by deep burial; now exposed by erosion.	X	X	
Residuum on Fort Union Formation	Gray to brown silty and sandy weathered material with variable clay content. Grades downward into unweathered Fort Union Formation. Includes areas of sheetwash alluvium and Fort Union bedrock and colluvium.	<u>Residuum</u> - Material derived from weathering of Fort Union Formation in place; may be modified by sheetwash and soil creep.	X	X	
Baked & Fused Rock	Bedrock altered when coal beds were burned. Mostly hard, dense, red to orange, baked shale and siltstone. Black, bubbly, sometimes glassy rock; resembles volcanic rocks. Gray or white coal ash occurs as a layer (5cm to 1.2m thick) at base of baked zone. Locally includes small areas of colluvium.	<u>Bedrock</u> - Overlying bedrock baked when coal beds in Wasatch and Fort Union Formations burned.	X		
Wasatch Formation	Brown and gray claystone and siltstone with thick lenses of coarse-grained, crossbedded, arkosic sandstone. Generally poorly consolidated but has some well-cemented resistant sandstone beds. Thin beds of coal and carbonaceous shale common locally. May include small areas of residuum and sheetwash alluvium.	<u>Bedrock</u> - Deposited in streams, swamps, and lakes; later consolidated by deep burial; now exposed by erosion.		X	X
Residuum on Wasatch Formation	Sandy and silty with variable clay content. Grades downward into unweathered Wasatch Formation. May contain sheetwash alluvium or eolian deposits. May include small areas of Wasatch.	<u>Residuum</u> - Material derived from weathering of Wasatch Formation in place; may be disturbed by sheetwash, soil creep, and erosion or deposition by wind.		X	X
Fan and Pediment Deposits	Upper 0.3-3m commonly sheetwash alluvium; commonly grades downward into stream alluvium of sand and silt containing abundant small lenses of angular to subangular gravel. On pediments, sheetwash alluvium may overlie bedrock.	<u>Alluvial Deposit</u> - Deposited by ephemeral streams and by sheetwash. Fan-shaped surface formed primarily by deposition, but some areas cut on bedrock and thinly veneered with alluvium.	X[1]	X	X[2]

1 These deposits are floodplain and low-terrace alluvium as classified by Reheis and Coates (1987) and Reheis (1987).
2 These deposits were classified as floodplain and low-terrace alluvium by Reheis and Coates (1987) and Reheis (1987).

previous investigators were reassigned where necessary. A disclaimer notice is presented with the geologic maps indicating that discrepancies may exist.

CHAPTER VII

DISCUSSION

COMPILATION OF THE DATABASE

The development of a uniform database for the study area provided one of the primary limitations to this project. Examination of 21 mine permits on file with WDEQ/LQD in Cheyenne revealed that the data inventoried for those documents was not adequately uniform for this analysis. Coal mine reclamation plans are commonly mapped at a scale of 1:6000 or greater but the lack of consistency between coal mine baseline analyses prevented the use of these sources of data. Most of the data used in this study are collected by the mine operators for baseline data and annual reports. The lack of consistency in scale or methods created an abundant collection of data that, for this study, were effectively useless. Alterations in scale and mapping units for the vegetation, soils, and geology maps made the mine permit data for these variables unusable as well.

Maps used in the study needed to be consistent in scale, mapping units, and level of detail throughout the study area. Therefore, the largest scale maps and databases that were available for the entire study area were used. The study area was defined by U.S.G.S 1:24,0000 scale topographic quadrangles for that reason. The selected 7.5 minute quadrangles were mapped at the same time (1969-1972) and had roughly the same degree of detail.

The soils, vegetation, geology, and surface geology of the region were not mapped at that scale. Smaller scale maps of the area or 1:24000 scale overlays developed from smaller scale maps were used to insure that all variables had a uniform level of coverage throughout the study area. This also insured consistency of mapping units throughout the study area. The final database for the study was as uniform as was possible to develop.

The soils and vegetation maps of the region that were used to develop the categories for this analysis were proven to be consistent with most of the results. Whether they are accurate remains unknown. During the process of checking the vegetation analysis with aerial photographs, mistakes were found in the depicted mapping units. The ponderosa pine communities were not always accurately mapped or represented. This condition posed no major problem due to the availability of aerial photos and the ease with which ponderosa pine or juniper can be identified from those photos; however, the other two major components of the vegetation categories (sagebrush community and mixed-grass prairie community) were not easily distinguished from one another on the aerial photographs. These distinctions may have been more clear on the multi-spectral images available to the cartographers for the GAP analysis but were not readily apparent on the aerial photographs. The authors could not therefore, check the vegetation maps for distinctions between sagebrush and grassland dominance. This condition has caused some concern over the accuracy of the vegetation mapping. However, the mapping did tend to be consistent with field observations and earlier work.

Soils of the study area were mapped and categorized in very broad and general terms. The accuracy of the large scale maps and the correlation of mapping units to drainage basins are a concern. Soil texture seemed to correlate with geologic parent material. However, the correlation conflicts with what one would expect from the geologic formations in question.

Coarser grained soils were generally coincident with the clinker outcrops and the occurrence of ponderosa pine. Hansen et al.,(1988) indicate that ponderosa pine tends to grow well in coarse grained soils. Stratum A has no indicated occurrences of the finest grained soil category. The abundance of clinker deposits and the occasional lenses of sandstone in the Fort Union Formation explain the dominance by more coarse textured soils. Below the clinker escarpment the soil textures should become finer within the finer textured parent material of the Fort Union. The soils map used does not show this pattern. The drainage basins below the escarpment continue to be listed as being coarser grained than those on the more coarsely grained Wasatch Formation. If parent material is the primary consideration, one would expect soils to be sandier on the more coarse parent material.

Field analysis of stream bed soils poses contradictions to the results as well. The drainage basins in the Powder River system were dominated by sandy parent material and had large components of sand. Glassey et al. (1955) indicate that a much of the soil in these areas that is listed as fine textured in STATSGO (SCS, 1992) is loamy. Field investigations by Munn (1994) indicated that the interbedded shales of the Wasatch Formation were providing a significant clay componenent to the soils of the area. This could well explain the STATSGO (SCS, 1992) mapping units.

The precipitation map generated for the area in consultation with the State Climatologist (Hasfurther, 1994) was consistent with other maps of similar scale generated for the region. Geology maps and surficial geology maps were available for the entire study area only at scales of 1:250,000 and 1:100,000. These maps provided a level of consistency to the determination of substrate or parent material. The small scales involved however, did not allow for fine distinction or accurate measurement of the areal extent of a formation or surficial deposit within a drainage basin.

CLASSIFICATION STRATA

The morphology of drainage basins of the Eastern Powder River Basin coal field of Wyoming appears to be controlled primarily by the geologic substrate and the surficial deposits upon which they rest. The three identified classification strata are primarily distinguished by their geologic parent materials and by their sizes and slopes. Drainage basins on the Wasatch Formation in the south of the area remain on the remnants of the Missouri Plateau (Glassey et al., 1955). This area is relatively low in relief and creates large flat drainage basins (Stratum C). Other drainage basins on the Wasatch Formation reflect the effects of greater relief and clinker deposits creating smaller, steeper basins. Where the residual deposits associated with the remnants of the Missouri Plateau have been removed, exposing the bedrock of the Wasatch Formation, the drainage basins appear to have characteristics more similar to those expected of the Fort Union Formation (drainage basins 0500, 0600, 0700, 1200).

The Fort Union Formation has two primary types of drainage basins; those that form above the clinker escarpments and flow towards the foot, and those that form below the clinker escarpment and slope across unaltered bed rock or residuum of the Fort Union Formation (drainage basins 3300, 3400, 3700, 3800). The basins sloping across the "eastward sloping plains" of Glassey et al. (1955) generally react much differently than do the basins of the clinker escarpment. The channel slopes are lower, the relief ratios are lower, and the areas are generally larger than the clinker dominated drainage basins of Stratum A.

A typical first order basin in Stratum B or C very closely resembles that of a typical first order basin characterized by Martin et al. (1988). The relief component of the first order basins in Stratum A, although not significant, is greater than Stratum B or C. About 55% of the relief of a third order basin in Stratum A occurs in the first order basins. Alternatively, the first order basins in Stratum C account for about 44% of the total third order relief.

Stratum A

Third order drainage basins in Stratum A are dominated by the Fort Union Formation. The abundance of clinker along the contact between the Fort Union and Wasatch Formations adds another defining criterion for Stratum A. In these basins, a large portion of the surface material generally consists of clinker. The resulting drainage basins tend to have high relief ratios, high drainage densities, and high channel slopes relative to the streams of the other strata. The smallest drainage basin in the study area (4800) is in Stratum A, as are some of the largest (6000, 6300). Stratum A, therefore, has the largest range of drainage basin area. Drainage basins in Stratum A have a characteristicly large relief component that is expressed in a rapid decrease in elevation at some point on the longitudinal profile of the drainage basin. This steep section of the profile is most commonly expressed in the first order drainage basins near the head of the dominant channel, but occurs later in the profile in at least two instances (basins 6000 and 1000).

Stratum A was dominated by vegetation communities that had a substantial ponderosa pine component or were covered almost entirely with the Mixed-Grass Prairie community. This condition is consistent with Apley's (1976) analysis. Apley recognized the association of the scoria and a grassland community dominated by bluebunch wheatgrass (Elymus spicatus (Pursh) Gould).

The soils of Stratum A were consistent with the vegetation and geologic maps. The drainage basins of Stratum A appear to have more coarsely grained soils than either of the other strata. This is consistent with the presence of clinker.

Stratum A appeared to have lower mean annual precipitation than did Strata B and C. The authors believe this to be a function of coincidence between the weather patterns of the area and the outcrops of clinker and the coarse textured soils they represent. It has been theorized that the pine covered scoria outcrops may provide enough relief to provide an orographic effect and an increase in precipitation (Hadley and Schumm 1961). This condition remains an unknown, due to a lack of precipitation records in the area. The authors currently believe that precipitation is probably not influenced by the small amount of relief (100-500 ft) provided by the escarpments.

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Strata B and C

Drainage basins in Stratum B are small basins that occur primarily on the Wasatch Formation. The drainage basins generally occur on the western edge of the study area and are underlain entirely by the Wasatch or are near the contact between the Fort Union and Wasatch Formations. These drainage basins are all less than about 2.6 mi^2. They are relatively steep, with moderate drainage densities. Their relief component, although less than that of Stratum A, is still substantial and, in conjunction with small drainage areas, creates a relatively high relief ratio.

Stratum C is comprised of larger drainage basins dominated by the Wasatch Formation or are located east of the clinker dominated escarpment. These basins are large (greater than about 2.6 mi^2), long, and flat. The relative lack of relief in the areas dominated by Stratum C, provides little energy for the rapid development of channels. Drainage density is low as a result of the relative stability of the substrate and the indicated lack of potential energy of position. These drainage basins are largely in the region between the clinker rich area near the Fort Union-Wasatch contact and the ridge of clinker capped hills that runs north-south through the study area (Plate 1).

Strata B and C are almost entirely dominated by the finest grained soil category. This condition is contrary to the expected result, as was mentioned above. The Wasatch

Formation, which dominates both strata, is generally thought to be sandier in texture than the Fort Union.

Glassey et al. (1955) noted that the grasses of Campbell County tend to grow better on flatter ground, on sandier soil, and in the northern part of the county. The northern areas of the county receive greater mean annual precipitation than the southern. These conditions were consistent with the database analysis and personal observations. The large flat drainage basins of Stratum C seem to support more of what was labelled Mixed-Grass prairie community, pasture land, or cultivated grasslands on the map. Those three components of the vegetation map were listed as being in the Grassland category. The drainage basins of Stratum B were commonly dominated by a sagebrush community component. These drainage basins also were more rugged, and had steeper slopes than most of their counterparts in Stratum C. A correlation with the analysis of vegetation patterns by Glassey et al. (1955) is observable in Stratum B as one moves from north to south through the basin. Stratum B shows a fairly strong southward increase in sagebrush dominance while Stratum C shows a decrease that is much less pronounced.

The drainage basins northeast of Gillette that overlie the Wasatch Formation and drain into Rawhide Creek (drainage basins 0500, 0600, 0700, and 1200) are classified in Stratum C. These drainage basins may be the product of structural controls in the geologic parent material (Knutson, 1986) and are distinct enough that they could be analyzed as a separate category.. At the third order level, however, they are not particularly distinct when examined on maps. Field examination of the second and third order streams did find substantial differences in these basins. The first order drainage basins tributary to these drainages are exceptionally steep compared to the first order drainage basins of the remainder of Stratum C. These basins appeared to be highly erosive in their upper reaches and much less so in their lower reaches. The valleys of the second order streams were very wide and apparently were trapping the sediment discharge of the unstable first order drainage basins. Signs of gradient adjustments in the lower order reaches were found during the field investigations. The sediment from first order erosion was deposited in the second order streams and was experiencing headcuts, while the third order streams appeared to be flowing over old valley fill deposits.

KEYING DRAINAGE BASINS

The dichotomous key presented as Table 20 is relatively easy to use for determining the correct stratum of a drainage basin that was not investigated in this study. The key can be used at two steps during the reclamation process. The first time would be identifying, from baseline data, the stratum of drainage basins that are going to be disturbed. The second time would be in determining the specifications of drainage basins that are to be reclaimed.

Drainage basins could be designed, when possible, to reflect the characteristics of drainage basins in the same stratum the drainage basin was in prior to disturbance. If this is not possible due to low strip ratios or the presence of clinker on the undisturbed basin, the available area and relief could be analyzed to determine what stratum that drainage basin might be designed to reflect. Either way, if the reclamation specialists can determine the area, parent material characteristics, and available relief in the reclaimed drainage basin then an appropriate stratum would be identifiable in the dichotomous key.

Several drainage basins were identified properly in the dichotomous key but perhaps might have been classified differently in the original data set. Drainage basins 1100 and 2600 of Stratum B are very much like those of Stratum A. Both basins have large clinker components (1100 is more than 50 percent clinker), have relatively steep relief ratios, and are fairly small. Drainage basin 2600 is in Stratum B due to its presence on the Wasatch, whereas basin 1100 is in Stratum B because of its small size and relatively low slope.

Drainage basins 4900 and 6100 would key out as being in different drainage basin strata than they were identified. One other drainage basin would be mis-classified due to its area. Drainage basin 4100 is the smallest basin in Stratum C (2.58 mi^2) but would key out as being in Stratum B because of its small area. The remaining 59 third order drainage basins would be identified properly using the key.

Drainage basins 3300 and 3400 would probably key out as members of Stratum A but they were not so classified in this study. These basins were distinct enough in their map characteristics, as well as in the field, that they were left out of any of the three categories. These two basins are extremely long with very low channel slopes but moderate relief ratios. They appear to initiate channel development below the clinker escarpment. This would explain the relatively high to moderate relief ratios with the seemingly contradictory low channel slopes.

RELATION TO PREVIOUS RESEARCH

Four primary land forms in the Powder River Basin have been identified by Glassey et al. (1955): 1) Rolling Divide, 2) Rochelle Hills Escarpment, 3) eastward sloping plain, and 4) deeply dissected upland. These identified landforms correspond approximately to the three classification strata of drainage basins identified by this research.

Glassey et al. (1955) identified the northern and western portions of the county as "deeply dissected upland." This dissected upland represents, for the most part, the Powder and Little Powder River drainages. Drainage basins 0500, 0600, 0700, and 1200 are consistent with the description of this region in Glassey et al. (1955). The remaining drainage basins that are tributary to the Little Powder River (1300 and

1400) are mapped as being within the "deeply dissected upland" landform (Glassey et al., 1955), but indications are that they are more similar to other described land forms. Drainage basins 1300 and 1400 form the headwaters of the Dry Fork of the Little Powder River. These drainage basins are at or near the junction of Glassey et al.'s (1955) deeply dissected upland, the Rochelle Hills escarpment, and the Rolling divide. They appear to have the characteristics of the Rolling divide more so than the other two land forms and are consistent with the remainder of the drainage basins in Stratum C. All of the above listed drainage basins are grouped in Stratum C of the classification. Basins 0500, 0600,0700, and 1200 differ from the remainder of Stratum C in that they tend to be mildly steeper than the others as third-order streams and that they have much steeper first order basins than do the other basins of that stratum.

Glassey et al. (1955) identified most of the study area as a landform they termed "rolling divide." This landform corresponds to the study area south of Gillette and extends to the Rochelle Hills in the East. Strata B and C basins were in this area. The diversity of the area would lead the authors to break the area into two or more land forms. The large flat drainage basins of Stratum C that dominate the flat areas of this region are distinctive of an area with much less available relief. They also tend to be dominated by residuum and eolian deposits. The clinker deposits of the area tend to be erosional remnants that provide relief to the area by capping the underlying material and protecting it from erosion. Very little clinker tends to show up in the Stratum C drainage basins.

This same "rolling divide" of Glassey et al. (1955) contains most of the drainage basins in Stratum B. The drainage basins of the eastern portion of the study area tend to be the smaller and steeper basins of Stratum B. They occur, for the most part, west of the clinker capped knolls and ridges that divide the area of Glassey et al.'s (1955) "rolling divide." In the eastern portion of the study area, some of the drainage basins that are in the area of the Wasatch-Fort Union contact are classified in Stratum B. These basins are on the edge of Glassey et al.'s (1955) "rolling hills" and their "Rochelle Hills escarpment." Some of the Stratum B drainage basins also occur in Glassey et al.'s (1955) "Eastern sloping plains" land form. These are east of the clinker deposits common to the Rochelle Hills. The relief component of these drainage basins is commonly provided by more substantial clinker components.

Stratum A of the classification is associated with the clinker deposits near the Fort Union-Wasatch contact. This area was identified by Glassey et al. (1955) as the "Rochelle Hills escarpment." This escarpment is capped by a thick and highly resistent layer of clinker. The resulting drainage basins have a distinct rapid decline in elevation that seems to originate in the drop from the clinker to the bottom of the escarpment. These basins are distinct in character and extend along the contact between the Fort Union and Wasatch Formations from the southeastern corner of Campbell County north to the area east of Gillette and then northwest towards Sheridan. Glassey et al. (1955) ended their Rochelle Hills escarpment in the area northeast of Gillette. The drainage basins of Stratum A, however, extend directly north of Gillette and slightly northwest of that city. The drainage basins of this area are in the northern extension of Glassey et al.'s (1955) "rolling divide" or in the deeply dissected upland. Personal observation, both from maps and in the field, indicates that the inclusion of these drainage basins in the Glassey et al.'s (1955) "Rochelle Hills Escarpment" is appropriate and that perhaps Glassey et al. (1955) were incorrect in ending the "Rochelle Hills escarpment" as far south and east as they did.

Knutson (1986) noted differences in first order drainage basins between the two geologic Formations both in the entire study area and within each of the three primary drainage systems. Knutson expected the drainage basins of the Fort Union Formation to be smaller, shorter, and steeper and to have higher ruggedness numbers and drainage densities than those of the Wasatch Formation. Although his results are consistent with this study, they were commonly contrary to his expected results when drainage basins within the three primary drainages were compared across the Fort Union-Wasatch Formation contact. The drainage networks of the Wasatch Formation, in the Little Powder River basin, appear to have higher ruggedness numbers, greater relief, and steeper first order drainage basins than their counterparts on the Fort Union as was noted by Knutson. The variables of area, length, and drainage density showed no significant differences between formations.

Knutson (1986) also found that in the Cheyenne River drainage, the relief, slope and ruggedness number were significantly different between the geologic formations, as was expected. The variables of area, length, and drainage density showed significance but in a direction contrary to the expected results. The Wasatch Formation had smaller, shorter, and more highly dissected drainages than the Fort Union. Many of the first order drainages on the Wasatch Formation that were examined by Knutson were tributary to the North Prong of the Little Thunder Creek (NPLTC). That drainage basin appears to be unique in relation to other basins on the Wasatch. The headwaters of NPLTC are in the clinker capped ridges that run through the mid-section of the study area. This condition could account for any differences in drainage network Formation found in the area. Both Divis and Tarquin (1981) and Apley (1976) indicated that they found low order channels in that area. Those findings contradict the general findings of our field investigations, that no stream channels occur on first order drainage basins of this region. The additional relief and clinker deposits of the headwaters could well generate the conditions necessary for the formation of distinct channels in first order streams.

MULTIVARIATE CLASSIFICATION IN GEOMORPHOLOGY

Two similar studies of drainage basin classification using multivariate analyses were found in the literature (Wesche, 1994; Eyles, 1970). Although both indicated that the use of cluster analysis was successful in grouping similar basins, neither reports the characteristics of the clusters with regards to the sample as a whole. The West Malaysian study by Eyles, and the study in Idaho reported by Wesche (1994) covered a wide range of terrain and drainage basin morphology. Both had larger sample sizes (410 in West Malaysia and 1,042 in Idaho). Eyles was limited to 4th order basins as reflected on 1:63,360 scale maps. Eyles classified drainage basins first by the region in which they were located relative to mountains and then by the amount of dissection in the basins. The Idaho study classified drainage basins of five orders (1-5) in four different classification steps. The basins ranged from high mountain to high plains of the intermountain region. No attempt was made to develop design equations or to run correlation analysis on the clustered drainage basins in either study.

The relative lack of diversity in the Eastern Powder River Basin coal field is reflected in the small number of classification strata developed. What appeared to be substantially diverse morphometric values yielded surprisingly few distinct groups of drainage basins as derived through principal components analysis and cluster analysis. This contrasts with reports of Eyles (1970) and Wesche (1994) wherein a relatively large number of classification groups were identified. Eyles identified six clusters in a sample size of 410 whereas the Idaho study identified 43 strata of five different orders in a sample size of over 1000. With a smaller sample size and substantially less diversity, it is not surprising to find a smaller number of strata in the Eastern Powder River Basin. As a tool for investigation multivariate statistics appear to indicate substantial similarities and differences that an investigator may not notice without some indicator. Principal components analysis can direct an investigator to significant variation within the data set and cluster analysis can identify the basins that are similar in nature based on those variables with greater variability.

The first three principal components identified three of the most important factors in this study. The first principal component was primarily a size factor and the separation of Strata B and C is based entirely upon drainage area. The second principal component was heavily weighted towards relief, slope, and geologic parent material. Geologic parent material is the first variable used to segregate drainage basins, and the presence or absence of clinker provides a later segregation of drainage basins. The third principal component was weighted towards shape, structure, and geologic variables. The shape variable of circularity was not critical to the analysis but Stratum B is distinct in its number of second order streams. Only two of the drainage basins have three second order channels while the remaining 20 all have two. This condition correlates with the relatively small size of the drainage basins in Stratum B.

Eyles (1970) used the results of the cluster analysis to develop clusters and then analyzed the clusters using professional judgment. As a result, the total of 20 clusters was reduced to 6. Drainage basins from the eliminated clusters were then re-clustered into the closest group. That procedure was used in this study to reduce the nine clusters derived from the cluster analysis to the three strata developed. Drainage basins were moved from a retained stratum to a new stratum if map or field analysis indicated that they were more like the basins of the new cluster.

FIELD OBSERVATIONS

Field reconnaissance of the drainage networks within the Eastern Powder River Basin coal field provided additional insight to the character of these systems.

First and Second Order Basins

The first order reaches that were field investigated in Strata A, B, and C, and second order reaches in Strata B and

C had two consistent characteristics: 1) gradient adjustment, and 2) lack of channel development. Field sampled second order reaches in Stratum A were observed to be more similar to third order reaches and will be discussed later. The longitudinal profile plots in Appendix A-1, B-1, and C-1 indicate the relative degree of gradient adjustment encountered in the first order reaches. All field investigated first and second order reaches were undergoing or had experienced some degree of gradient adjustment, ranging from moderate to extreme (Figures 22 and 23). Overgrazing around the turn of the century was identified as a possible cause of gradient adjustments of higher order streams in the surrounding areas by Divis and Tarquin (1981) and Knutson (1982). However, observations in this study suggest that the major gradient adjustments occurring in the Eastern Powder River Basin are from an earlier time. Gradient adjustments (headcutting) were observed in the central and upper reaches of second order drainage networks and throughout the profile of first order drainage networks. The headcuts appear to have progressed through the third order drainage networks and are now well into the first and second order drainage networks. Figure 24 shows a cottonwood tree near the base of a large headcut on a second order drainage network just below the confluence of two first order reaches. The tree is less than 100 ft from the vertical bank of the headcut. If an arbitrary tree age of 25 years is assumed, then the rate of headcut

Figure 22. Large gradient adjustment occurring on a first order reach.

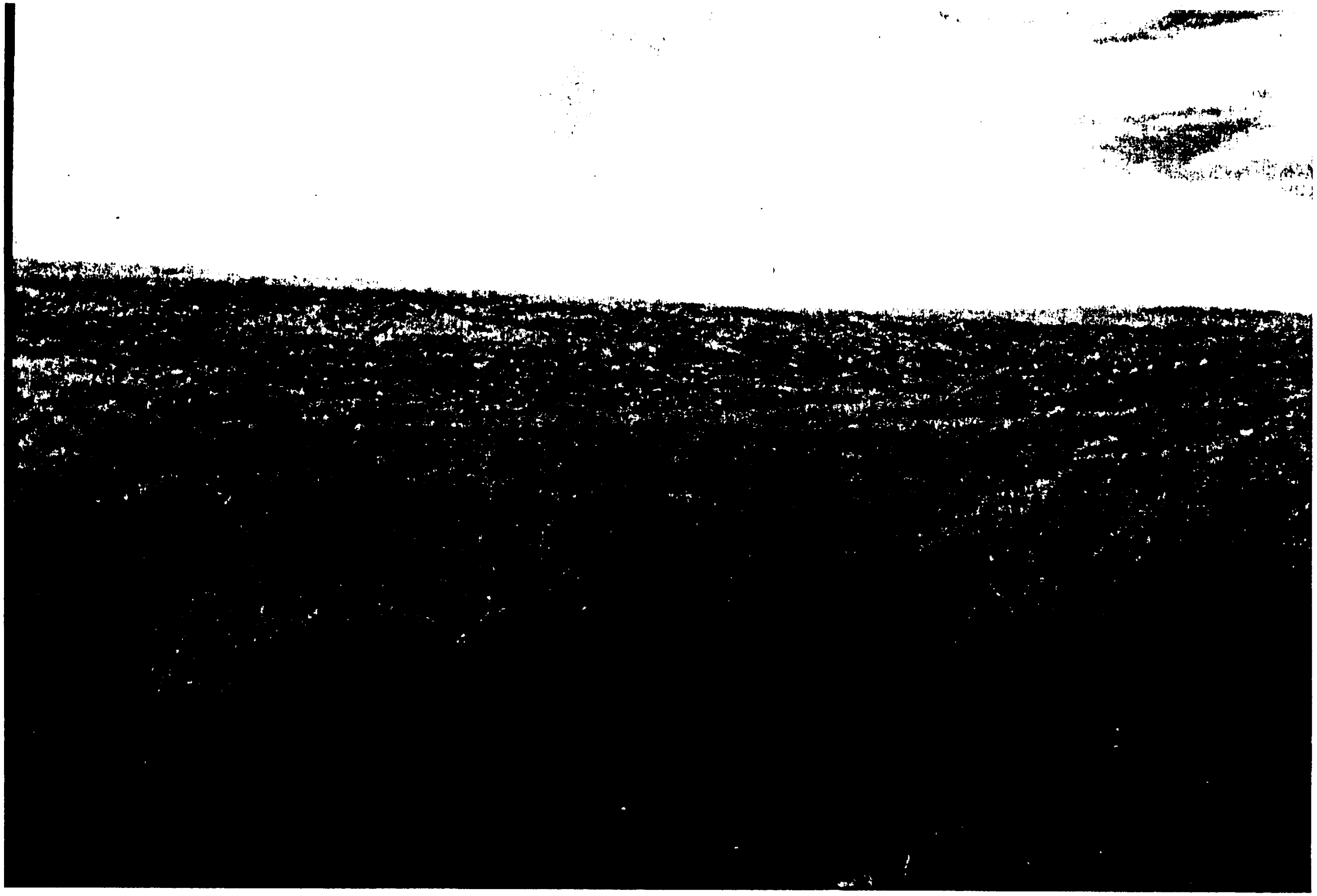

Figure 23. Relatively minor adjustments occurring on second order reach.

Figure 24. Large headcut in a second order reach just below the confluence of two first order reaches (distance from the tree to the active headcut is less than 100 ft).

progression would be approximately 4 feet per year. The reach itself is about 1.5 mi long, which indicates about 2000 years for the headcut to migrate from the mouth to its present location. Although arbitrary, the estimate does suggest that the major gradient adjustments may not have been caused by recent disturbances. It is speculated that adjustments were caused by base-level lowering of higher order streams such as the Mississippi River due to climatic changes. Also, relatively minor gradient adjustments due to anthropogenic disturbances such as roads, culverts, and dams were found during this study.

One consistent feature of all gradient adjustments was deposition of the eroded material short distances downslope from the active headcut. The deposited material caused valley-filling and altered the gradient on both large and small scales. Valley-filling occurred: 1) at the junction of a lower order network with a higher order network, 2) at the entrance of side-tributaries to the main network, 3) at the base of steep valley-slope segments, and 4) where valley margins widened (Figure 25). Several of these deposits on second order reaches and one deposit on a first order reach were identified as floodplain and low-terrace alluvium by Reheis and Coates (1987) and Reheis (1987). These deposits were re-designated as fan and pediment deposits for purposes of this study. These large, broad, and flat deposits were well stabilized with vegetation, with only minor occurrences

Figure 25. Large valley-fill from a side-tributary to a first order reach.

of gullying in the fill material. The lower end of the fill was generally a site of headcut initiation. These large deposits are now being reworked and gradients are adjusting to those below the fill area. The fill material is then redeposited down-slope and another fill area forms. Throughout the study area cross-section shape coincides with this cut-and-fill process.

Study sites were flat-bottom in profile where filling had occurred and rounded where slope adjustment was advanced (Figures 26 and 27). The shape characteristics may indicate that the rounded shape is more efficient for water transport than the flat-bottom profile. In general, areas having valleys that were flat in profile had a sagebrush - grass vegetation community, whereas valleys with rounded profiles were primarily vegetated with grasses. Field observations also indicate that subirrigation was common for flat-bottom profiles near the mouth of a reach. The water-harvesting characteristics of the flat-bottom profile were a result of steeper slopes surrounding the fill material.

Lack of channel development was the second identifying characteristic of first and second order drainage networks determined in this study (See profile plots in Appendix A-1, B-1, C-1, B-2, and C-2). The lack of channel development is a reflection of not only the gradient adjustments described above but also the ephemeral hydrologic regime of the Eastern Powder River Basin. The field investigation clearly indicates,

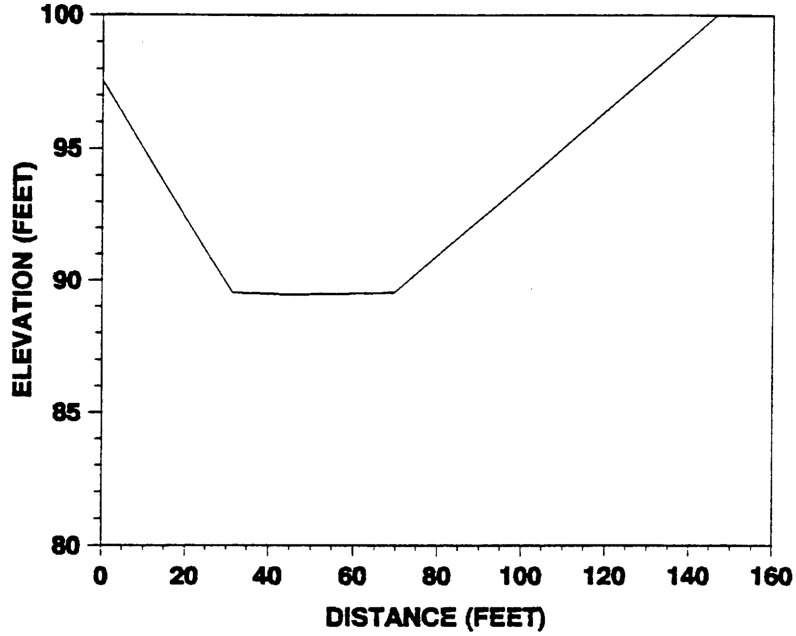

Figure 26. Typical flat-bottom profile indicative of valley-filling

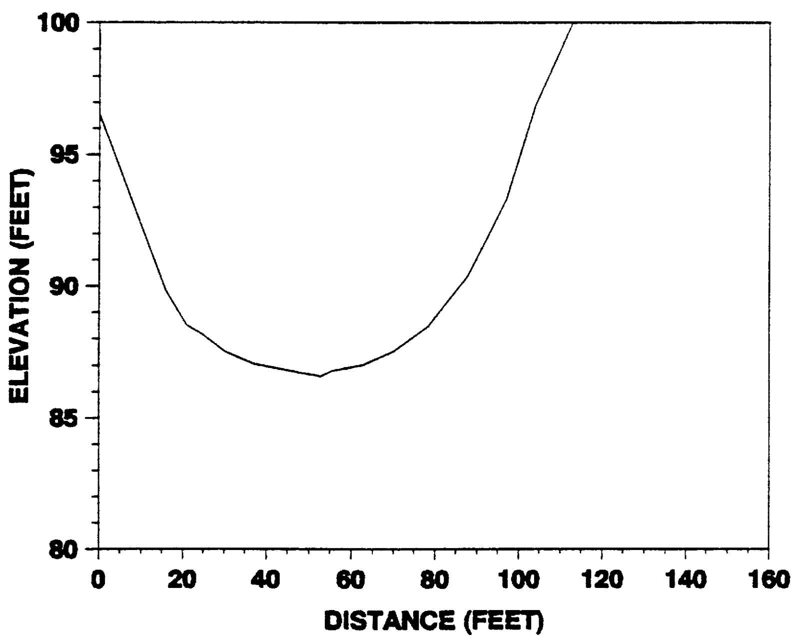

Figure 27. Typical round-bottom profile indicative of efficient water transport.

that due to the infrequent nature of formative flows, first and second order drainage networks do not at present exhibit channel formation.

Third Order Basins

All third order reaches had some degree of continuous or discontinuous channel development (See profile plots in Appendix A-2, A-3, B-3, and C-3). The characteristics of second order reaches in Stratum A were similar to the third order reaches in Stratum A; therefore, the discussion of third order reaches in Stratum A includes the second order reaches.

The reaches in Stratum A were unique among the three strata. These third order reaches had well developed, easily identifiable stream channels. The channels were in alluvium and generally had layered deposits of scoria material visible in the channel banks. These channels had well developed bar formations on the meander bends, which suggest a variety of flow frequencies and magnitudes. The channel banks were steep and were active both vertically and laterally. The channel beds were typically composed of finer clays interspersed with scoria pebbles and some larger scoria rocks. The floodplain was poorly developed in most instances. The stream channels themselves were typically lacking vegetation, with minor occurrences of some grasses and recruitment of juvenile trees inside the channel banks. The channel shape was mostly rectangular. The floodplain was generally well vegetated with a grass-shrub community and some cottonwoods near the mouth.

In general, cottonwood trees were not abundant until a fourth order or higher basin had developed. The second order reaches in Stratum A also exhibited some channel development. However, the second order reaches did not have the well developed channel characteristics of the third order reaches. Generally, second order reaches exhibited both continuous and discontinuous channel development. Although, valley margins of the second order reaches varied greatly, the third order reaches were well-defined.

The investigated reaches of Strata B and C were similar in terms of channel characteristics. The third order channels in these strata, with the exception of one reach in Stratum C, had well defined stream channels at the mouth. However, channel profiles within both strata were commonly broken in the lower reaches as a result of anthropogenic disturbances such as roads, culverts, and fields, and valley-filling as described earlier. The channels in the upper portion of these reaches were typically not well defined due to valley-filling, and immature development in the form of discontinuous channels. The continuous and discontinuous channels were typically well vegetated with grasses. The low-flow channels within the stream-channels at the mouth were difficult to identify in these reaches. The channel at the mouth was mostly V-shaped. These third order reaches were not laterally active.

The field investigations suggest that stream channels begin development at third or higher order basins. The stream channels are developing in fill material beginning at the mouth, reworking the fill material. The third order channels are at various stages of development.

POOL AND DISCONTINUOUS CHANNEL FORMATION

Pool and discontinuous channel development of the drainage basins in the Eastern Powder River Basin is uniquely complex. Each was observed to form on both geologic formations and across all orders. Pools typically formed in conjunction with areas of valley-filling and in fill material on the outside valley meanders (Figure 28). The reach gradient above the fill area was typically steeper. Flow competence appears to be dissipated at the junction of the fill material and the steeper gradient above the fill. Flow is then dispersed across the fill material until it reaches a valley meander. The valley meander is a point of constriction that concentrates this dispersed flow. Increased boundary shear and downward deflection of the flow against the outside meander bank is thought to lead to pool formation.

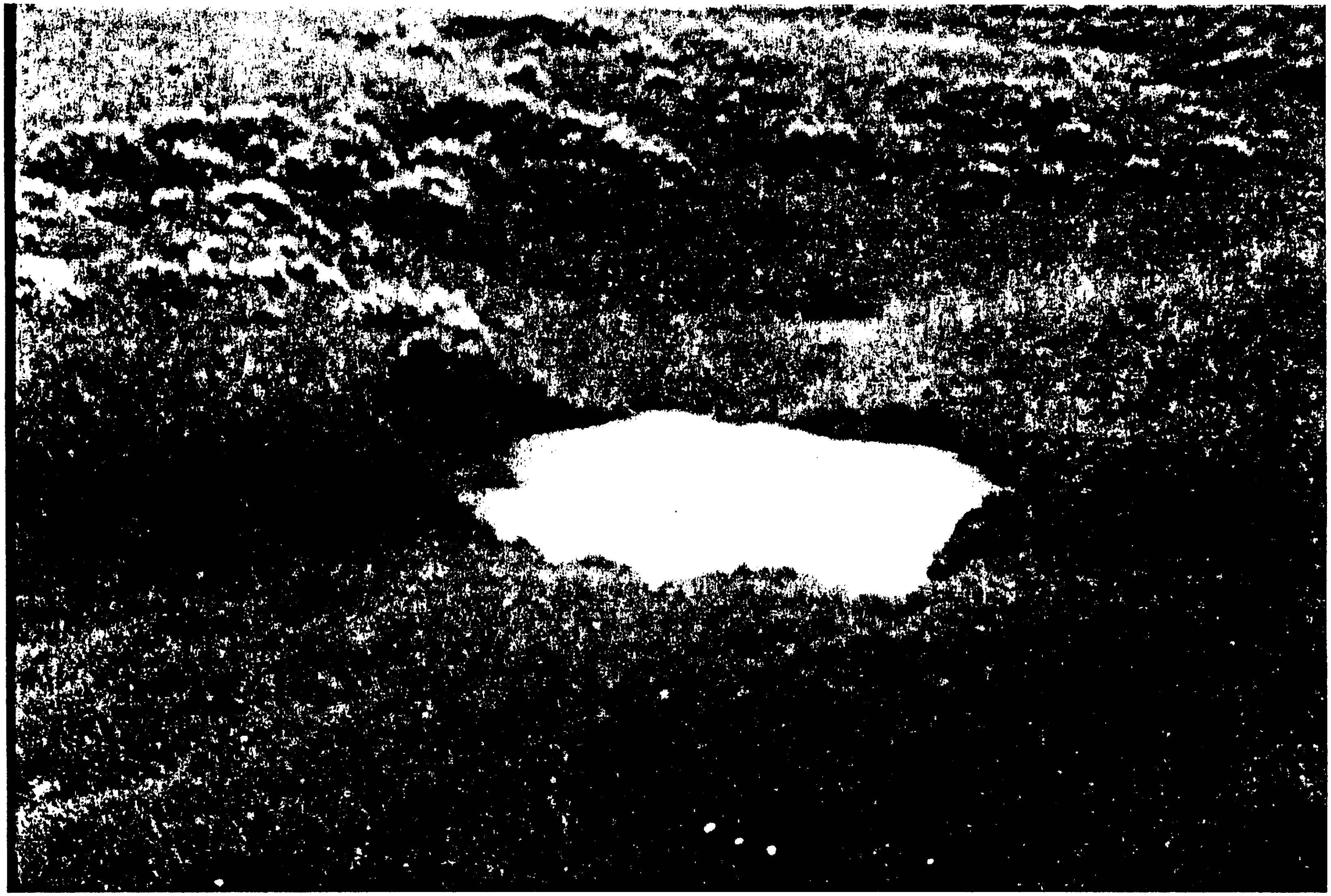

Figure 28. Pool formation in fill material on a valley meander.

Pools and discontinuous channels also form in straight, steeper gradient valley sections below the valley-fill and valley meander (Figure 29). Low and moderate flow competence is believed to be lost in the pools on the meander bends. Competence of these flows is then regained by erosion in the straight, higher gradient areas below the pool. Initially, this condition leads to the development of pools and later discontinuous channels such as that shown in Figure 29. Larger flows may be responsible for scouring material deposited by low and moderate flows in the pools and discontinous channels.

RECONSTRUCTION OF DRAINAGE BASINS AND DRAINAGE NETWORKS

Drainage basin classification efforts have defined three strata of basins in the study area, therefore, the most appropriate stratum for design needs, needs to be determined. The dichotomous key presented is relatively simple but the user needs to decide whether or not their drainage basin falls within a specified stratum. The design equations may not be appropriate if aerial, linear, or relief components of the basin of interest are outside the specified range for which the design equations were developed.

The next step is to ensure that the appropriate drainage basin order is being utilized. All design equations in this study were developed for the drainage basin order determined

Figure 29. Third order discontinous channel below a meander bend.

from blue-lines on USGS 1:24,000 topographic maps; therefore, the scales of delineation need to be in agreement. A correction factor can be developed for a particular basin by examining the basin order on the USGS 1:24,000 topographic maps and comparing it to the order at the field level or from larger scale maps. These equations should not be applied without this conversion.

The design equations from this study were developed to provide flexibility in use. For example, basin area can be used to predict the relief ratio of the basin to be designed or the relief ratio can be determined from predicted values of basin relief and basin length. Additionally, if parameters such as basin relief cannot be manipulated in the recontouring process, then the actual value can be used and parameters such as basin length can be manipulated, exercising caution. Similarly, the design equations can be used to design an entire third order basin or a first order basin within a particular third order basin.

Several geomorphic relationships should be considered before the design process begins. First, the drainage basin size, length, shape, and orientation need to be evaluated. The drainage basin size is directly related to the total basin runoff; however, the relationship is not linear (Simpson and Botz, 1985). The drainage basin length and shape also affect drainage characteristics. For example, a long, tear-drop shaped basin will not have as sharp a peak discharge as will a shorter, more circular basin of the same size. The size, length, and shape of a basin can be manipulated for the design objectives: 1) water transport, or 2) water storage. Additionally, the basin aspect can affect the amount of blowing snow that is trapped and evaporation on hillslopes and in drainage networks (Simpson and Botz, 1985). In the field, that drainage networks banks which had an east or northeast aspect typically had a significant shrub component.

Additional consideration needs to be given to hillslope design. The first consideration is that of overland flow. Overland flow dominates the first order hydrologic regime. The goal of design should be to disperse overland flow (Toy et al., 1987). The concentration of overland flow across hillslopes may initiate erosion and lead to gullying before vegetation is established. Manipulations such as deep ripping or pitting would help alleviate this problem. Divis and Tarquin (1981) noted that the distance from the drainage divide down the hillslope to the drainage network was approximately the same distance as the head of a first order drainage network to the divide. Field observations in this study indicate this distance was variable.

The shape of the hillslope also needs to be considered. There are four primary hillslope shapes: 1) concave, 2) complex, 3) uniform, and 4) convex (Toy et al, 1987) (Figure 30). The concave slope is the most desirable because the steepest portion of the slope is in the upper reaches where

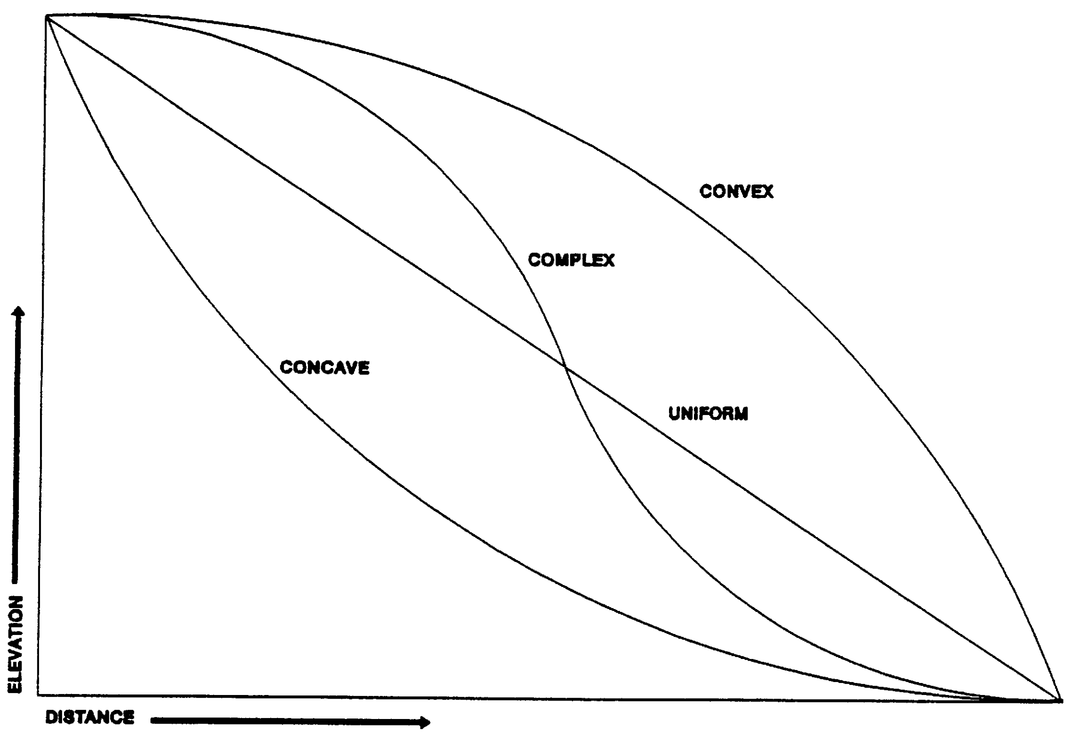

Figure 30. Schematic diagram of the four hillslope shapes: concave, complex, uniform, and convex.

the power of water is at a minimum and therefore is less erosive. The complex slopes occur most frequently in natural systems of the semiarid environment (Toy et al., 1987). Complex slopes are a combination of slopes: 1) convex in the upper reaches, 2) uniform in the center, and 3) concave in the lower reaches. The uniform slope is not as desirable as the concave or complex but is more desirable than a convex slope. Hillslope length is another important consideration. As hillslope gradient is reduced, the hillslope length increases. Alternatively, steep hillslopes are shorter (Toy et al., 1987). The advantage of shorter hillslope lengths is that the potential for the concentration of water is reduced. All four hillslope shapes were observed in the field.

The basin slope also needs to be considered. Gross basin slope, basin relief divided by basin length, is represented by relief ratio in this study. The low stripping ratios in the Eastern Powder River Basin lead to an overall surface lowering in the post-mine topography. Subsequently, basin relief becomes one of the more inflexible elements in the design process. However, the same principles that applied to hillslopes apply to basin slope and can be adjusted to meet the design objectives. If water transport is the desired outcome, then basin length should be shortened. Alternatively, if water storage is the objective, the basin should be enlarged.

The next concern in the design process is integrating the drainage basin and interfluve (hillslope) to a drainage network. The variable that relates the drainage basin and drainage network is drainage density. Drainage density presents a complex problem. First, infiltration of water on the reclaimed landscape is, at least initially, slower than the surrounding undisturbed landscape (Stiller et al., 1980); therefore, runoff is higher and drainage density will eventually increase. This condition may lead to the conclusion that drainage densities should be increased in the reclaimed environment. However, increasing drainage density can lead to increased flood peaks (Lowham and Smith, 1993; and Stiller et al., 1980). An alternative proposed by Zimpfer et al. (1982) was to not reclaim first order channels in the reclaimed environment. In general, there is a consensus among investigators that drainage densities should be decreased slightly in the reclaimed environment. Throughout the field investigations of this study, sizes of tributaries entering the main channels were variable. Also, drainage basins that were steep and had erosive soils tended to have larger tributaries and gullies entering the main channel. Alternatively, those basins of low gradient and relatively good vegetation cover had only minor gullies entering the main channel. Therefore, the drainage densities should be reclaimed to approximately the same values as those provided in this study.

It is important to note that the network order shown on the USGS 1:24,000 topographic maps does not represent the same order at the field level. A first order network shown on USGS 1:24,000 topographic maps is at least a third order network at the field level. Order will vary with map scale and geographic location; therefore, a scale conversion factor needs to be developed before utilizing drainage density values.

The next consideration is adding a gradient to the determined channel lengths. The goal of design dictates what type of gradient and profile will be reclaimed. If water transport is the objective of design, then short, moderate slopes with a concave-up profile should be designed (Toy and Hadley, 1987). However, if water harvesting and sediment control are the objective of design, then rough, broken profiles such as those observed for first order basins, is recommended. The field measured bed slope should be used for third order networks. The third order channel slope measured from the USGS 1:24,000 topographic maps encompasses the steeper slopes of the first and second order networks, which inflates the estimate (Figure 31).

The geometric dimensions of drainage networks in Stratum A, B, and C, and second order networks in Strata B and C are determined primarily by the high bank characteristics. The design equations were developed so that the valley characteristics such as high bank area could be related to

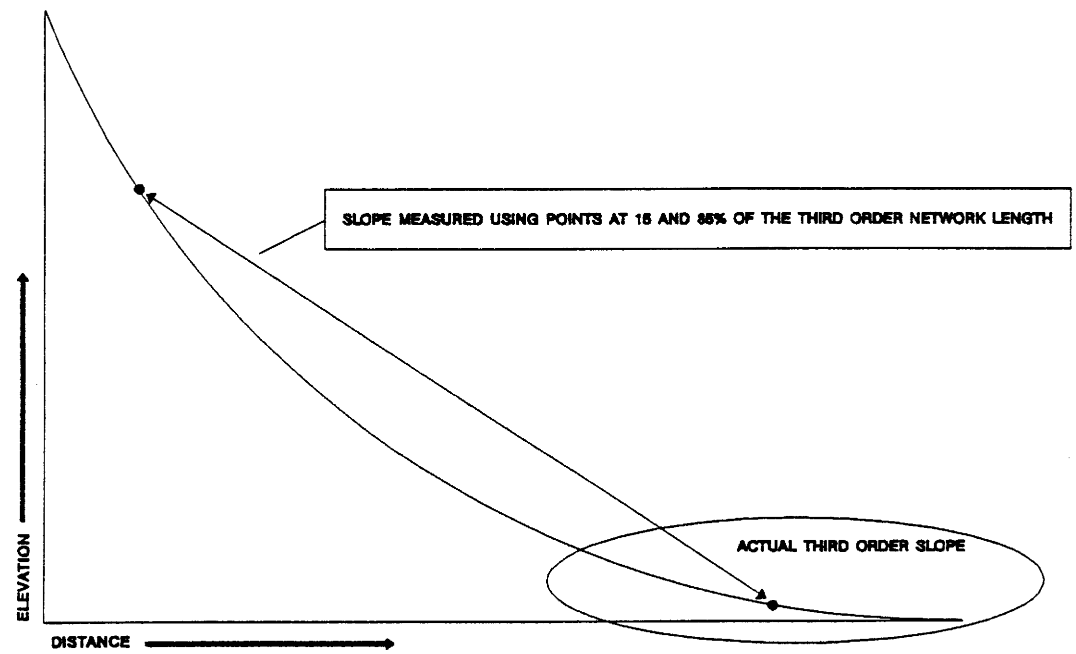

Figure 31. Diagram indicating the channel slope measured using points at 15 and 85% of the dominant channel length and the actual third order slope.

drainage basin and/or drainage network characteristics. The high bank characteristics of these drainage basins are the most distinguishing and therefore are the focus of design. Typically, the medium bank is indicative of past drainage network structure, and the low bank is representative of fill material at the junction of the bed and bank.

Broad, flat transition areas should be the focus of design for third order basins in Strata B and C. The third order reaches in Stratum A typically had well defined stream channels and therefore are the focus of design. The design equations developed using estimated bankfull discharge following the work of Leopold and Maddock (1953) are suspect. The product of coefficients rarely equal unity, which may indicate that the drainage basins do not achieve bankfull discharge at equal frequencies (Apley, 1976). Additionally, channel top width did not relate well to the estimated discharge in several instances. Therefore, the design equations developed using stream channel area are more reliable and should be used for design. The third order channels which contain discontinuous and broken profiles may also negate the use of predicted bankfull discharge in design. The valley characteristics in all three third order strata indicate the characteristics of the developing floodplain within which the stream channels are or have developed.

There are a few general points which should be considered before utilizing the design equations produced in this study.

First, the reclaimed landscape can only become part of the natural ecosystem by replicating the geomorphic forms of its' surroundings. The main problem with geomorphic designs however, is that geology has been completely disrupted during the mining process and cannot be recreated. Because replication cannot be accomplished, a close simulation of the natural geomorphic surroundings should be the goal of reconstruction efforts. The reclaimed landscape will undergo processes of adjustment to the surrounding undisturbed landscape. Furthermore, adjustment will occur through time regardless of the methods used to design that reclaimed environment. Therefore, the more closely the design of the reclaimed environment follows natural landforms, the greater the potential for minimizing adjustments and avoiding violation of natural geomorphic relationships that exist in the Eastern Powder River Basin. The drainage basins in the Eastern Powder River Basin are relatively immature and the interaction of form and process is complex. Therefore, for the landscape to form and mature, adjustments and erosion must and will occur (Figure 32 and 33).

DESIGN EXAMPLE

A design example is presented to illustrate the use of the geomorphic design equations developed in this study. In this example, a third order drainage basin in Stratum C having an

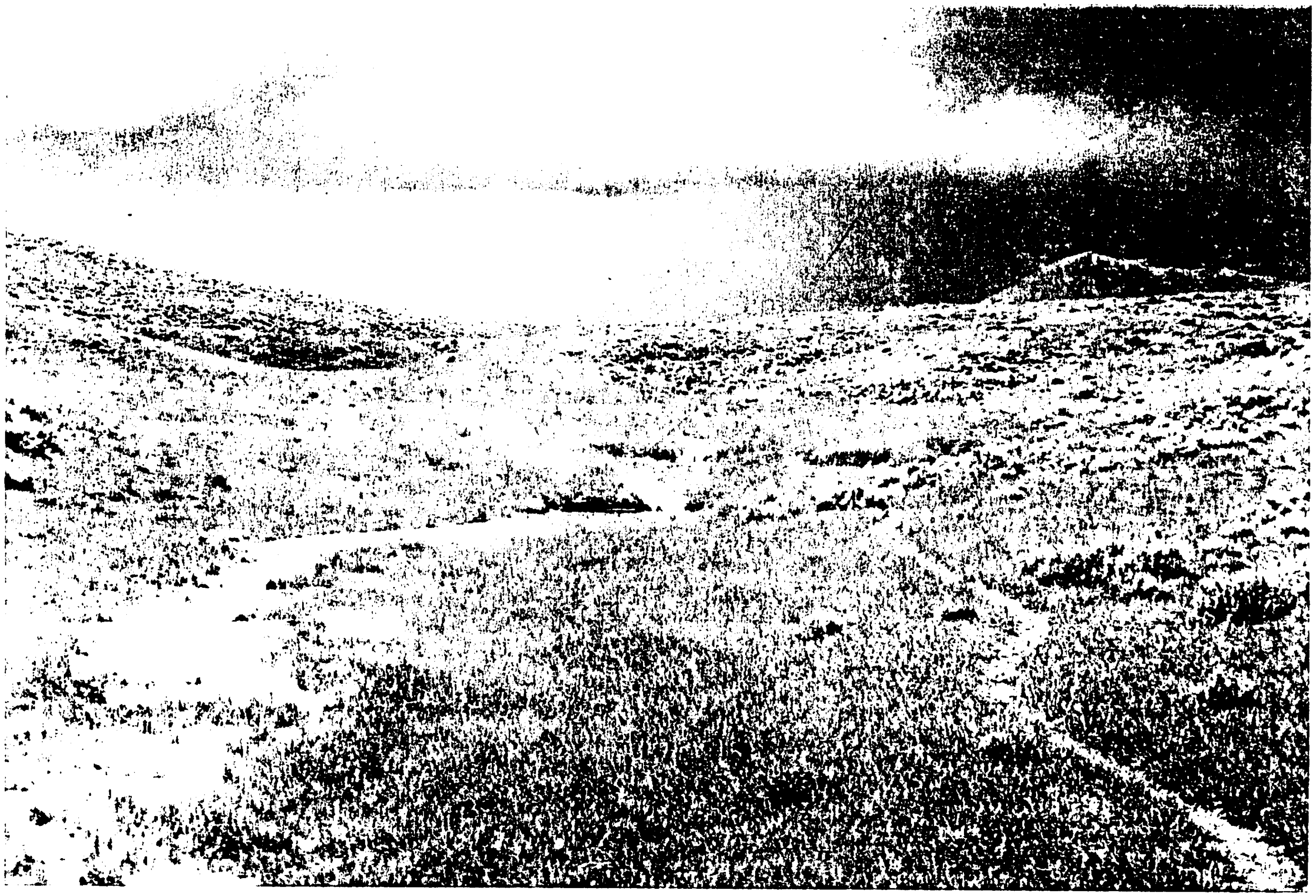

Figure 32. First order reach after short-duration, high intensity thunderstorm.

Figure 33. Fourth order reach one day after precipitation was received.

area of 5.14 mi^2 is used to complete a systems design including first and second order basins.

The design equations in Tables 66 and 67 were used to characterize the third order basin (Table 75). Based upon these equations, this third order basin would have three second order and 11 first order drainage basins. The predicted drainage density indicates that 2.73 miles of channel length should be reclaimed for every square mile of basin area. Additionally, 14 miles of channel length should be reclaimed within this basin. The main channel length should comprise 5.36 miles of the total 14 miles.

The mean basin area within each order was then used to design the lower order basins. The design equations in Tables 60 and 61 are used for second order basins (Table 76) and Tables 55 and 56 for first order basins (Table 77). Note that only 9 of the 11 first order basins are tributary to the second order basins by the relationship of total second order channel length to the number of first orders. The other two first order basins can be selectively placed. It would be anticipated that these two first order basins would be side-tributaries to the third order channel. The length of overland flow developed for the first order basins indicates the relative distance from the drainage divide to the head of each first order drainage network.

Table 75. Predicted design characteristics for a third order drainage basin in Stratum C (using a basin area of 5.14 $miles^2$).

basin perimeter =	$5.39 * 5.14^{0.51}$ =	12.42 miles
basin length =	$1.71 * 5.14^{0.51}$ =	3.94 miles
basin relief =	$161 * (5.14^{-0.41}) * (3.94^{0.93})$ =	294.54 feet
drainage density =	$4.31 * 5.14^{-0.28}$ =	2.73 mi./$mi.^2$
main channel length =	$1.91 * 5.14^{0.63}$ =	5.36 miles
total channel length =	$4.31 * 5.14^{0.72}$ =	14.00 miles
relief ratio =	$155 * 5.14^{-0.46}$ =	73.00 feet/mile
valley length =	$1.59 * 5.14^{0.63}$ =	4.46 miles
channel slope =	$0.000078 * 73.00^{1.07}$ =	0.008 ft/ft
used relief =	$3490 * (5.14^{0.50}) * (0.008^{0.81})$ =	158.42 feet
No. of second orders =	$3.53 * (14.00^{0.74}) * (0.008^{0.45})$ =	3 (2.83)
No. of first orders =	$10.05 * (14.00^{1.21}) * (0.008^{0.64})$ =	11 (11.14)
valley area =	$-2300 + (3.58x10^5 * 0.008)$ =	564.00 $feet^2$
top width =	$2.98 * 564.00^{0.57}$ =	110.27 feet
average depth =	$0.34 * 564.00^{0.43}$ =	5.18 feet

Table 76. Predicted design characteristics for a second order drainage basin in Stratum C (using a basin area of 1.41 $miles^2$).

basin perimeter =	$5.01 * 1.41^{0.57}$ =	6.09 miles
basin length =	$1.55 * 1.41^{0.54}$ =	1.87 miles
basin relief =	$135 * (1.41^{-0.30}) * (1.87^{0.79})$ =	199.67 feet
drainage density =	$2.74 * 1.41^{-0.23}$ =	2.53 mi/mi^2
main channel length =	$1.62 * 1.41^{0.69}$ =	2.05 miles
total channel length =	$2.74 * 1.41^{0.77}$ =	3.57 miles
relief ratio =	$123 * 1.41^{-0.41}$ =	106.84 ft/mi
valley length =	$1.48 * 1.41^{0.65}$ =	1.85 miles
channel slope =	$0.000097 * 106.84^{1.05}$ =	0.013 ft/ft
used relief =	$0.68 * 199.67^{0.93}$ =	93.71 feet
No. of first orders =	$1.63 * 3.57^{0.55}$ =	3 (3.28)
valley area =	-4854 + (286200 * 0.018) =	297.60 ft^2
top width =	61.13 + (0.032 * 297.60) =	70.65 feet
average depth =	5.97 + (0.003 * 297.60) =	6.86 feet
bed width =	-41.79 + (0.77 * 70.65) =	12.61 feet

Table 77. Predicted design characteristics for a first order drainage basin in Stratum C (using a basin area of 0.25 $miles^2$).

basin perimeter =	$4.78 * 0.25^{0.49} =$	2.42 miles
basin length =	$1.37 * 0.25^{0.40} =$	0.79 miles
basin relief =	$87.68 * (0.25^{-0.37}) * (0.79^{0.76}) =$	122.42 feet
drainage density =	$1.19 * 0.25^{-0.54} =$	2.52 mi/mi^2
main channel length =	$0.81 * 0.79^{1.08} =$	0.63 miles
valley length =	$0.77 * 0.79^{1.07} =$	0.60 miles
length of overland flow =	$1/(2 * 2.52) =$	0.20 miles
relief ratio =	$2.46 * 122.42^{0.88} =$	169.14 ft/mi
used relief =	$0.97 * 122.42^{0.90} =$	73.42 feet
channel slope =	$0.00042 * 169.14^{0.79} =$	0.024 ft/ft
sinuosity =	$0.98 * 0.024^{-0.02}$	1.06
valley area =	$0.68 * 122.42^{1.37} =$	493.02 ft^2
top width =	$1767 * (122.42^{-0.48}) * (1.06^{-6.75}) =$	118.65 feet
average depth =	$0.015 * 493.02^{0.93} =$	4.79 feet
bed width =	$350\ 0.006^{0.51} =$	25.76 feet

FUTURE RESEARCH

Several aspects of the geomorphic approach would benefit from further investigation. Soil samples were collected during the field investigations of this study. Approximately 600 core-tube (3 inch diameter, 8 inches deep) samples were collected. Although not analyzed in this study, these samples may provide additional stratum characterization and classification parameters such as a D50 for the bed and bank material.

The database of this study could be developed into a bond release tool. Monitoring of the reclaimed landscape would indicate if the geomorphic characteristics of the reclaimed landscape reflect characteristics similar to the undisturbed environment, thereby facilitating a scientific basis for bond release. Additional monitoring data such as infiltration, runoff, vegetation cover and production, soil type and texture, local precipitation, and a variety of other diagnostic parameters could be added to the infrastructure of the developed classification and characterized stratum to strengthen utility for design and bond release.

The length of overland flow is an additional area of concern. Because overland flow dominates the small drainage basin regime, it becomes a critical element in determining where a drainage network actually begins below the drainage divide and across hillslopes. This study observed that the length of overland flow was highly variable throughout the study area. A topographic low from the drainage divide to the head of the drainage network shown as a blue-line on USGS 1:24,000 topographic maps typically represented overland flow.

CHAPTER VIII

CONCLUSIONS

- Drainage basins of the Eastern Powder River Basin are controlled primarily by the geologic parent material upon which they are formed.

  An immediate research concern would be to extend this study to directly compare in greater detail the influences of surficial geology on the morphometric characteristics of the drainage basins.

- Drainage basins of the Eastern Powder River Basin can be distinguished by similarities of geologic material and morphometric data and to a lesser extent vegetation and soils. These groups of drainage basins can be simulated by reclamation personnel attempting to create drainage basins that reflect the current hydrologic regime of the region. The provided dichotomous key should allow reclamation personnel to identify the type of drainage basin that they are disturbing as well as the kind that they may be able to restore, based upon substrate, area, and relief factors determined in the mine plans.

This classification system of drainage basins identifies the primary forces or variables at work in shaping the drainage networks of the Powder River Basin. Used properly, it should assist mine land reclamation personnel in the private and public sectors in determining the characteristics of reconstructed basins. Such knowledge, combined with the design formulae provided, should allow the reconstruction of drainage basins and stream channels that accurately reflect the geohydrologic regime of the Powder River Basin.

- Principal components analysis and cluster analysis seem to be effective in geomorphic studies. Trends in variability in the data set and similarities in large data sets that might otherwise be missed can be identified in multivariate analysis. Close attention to the assumptions, such as multivariate normality of data, involved in these procedures may not be possible due to the non-normal nature of some of the data.

A study similar in analytical techniques to this one but without pre-sorting the drainage basins by order may yield beneficial results. It would also be of interest to eliminate the variables associated with size (where most of the variability lies) and conduct a study similar to this one on the variables that reflect properties of a drainage basin that can be compared directly between two drainage basins regardless of size. Variables such as drainage density, relief ratio, channel slope, and circularity ratio would be good examples. A similar analysis using those variables could well lead to slightly different classifications.

- First order basins in Strata A, B, and C, and second order basins in Stratum B and C are undergoing or have undergone major processes of gradient adjustment. The drainage networks within these strata should be designed using the high bank characteristics. These drainage networks exhibit both water storage and transport characteristics without channel development.

- Third order drainage networks in Strata B and C should be designed as transitional areas of deposition suitable for channel development in the upper reaches with defined channels towards the mouth. Third order drainage networks in Stratum A should be designed with stream channel characteristics throughout.

- The third order drainage basins of the Eastern Powder River Basin are in the process of gradient adjustment, exhibiting cut-and-fill processes. The major adjustments in the form of headcuts moving upstream may have begun as a result of a climatic change several thousand years ago.

- Drainage basin and network designs based upon natural geomorphic characteristics should provide a more suitable reclaimed landscape with inevitable adjustments to the surroundings than purely engineered designs.

- If studies such as this are to be made easier and more beneficial to regulatory agencies and industry, there is need for a uniform database compilation. Standard scales need to be established for maps, and procedures for measuring morphometric variables need to be standardized. Standardization would facilitate transfer of information from one mine permit to another.

  Valuable time and information could be saved by implimenting standard data collection procedures within the region so that data gathered in one location can be compared to data gathered in another. Studies wishing to examine the Eastern Powder River Basin coal field cannot use the enormous amount of available data due to the variation of data collection techniques from mine to mine.

CHAPTER IX

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Methodology for the Geomorphic Classification and Design of Drainage Basins and Stream Channels in the Eastern Powder River Basin Coal Field of Wyoming

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Technical Report
Submitted to
The Abandoned Coal Mine Lands
Research Program

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APPENDICES

APPENDIX I

DRAINAGE BASIN LOCATION CODES

A location code was developed for the study area to locate the basins without benefit of the actual maps used. The location code is an 11 digit alpha-numeric code that locates the mouth of the individual basin. The code includes a map identifier specifying the 7.5 minute quadrangle map on which the mouth appears, what is essentially a legal description of the location of the mouth, and a method of determining the correct channel (Figures 1 and 2). Users may have to identify stream orders in the area of concern prior to using the identification codes.

The first two digits of the location code are used to identify the 7.5 minute quad sheet on which the mouth of the selected drainage basin appears (Table 1.) A two digit, alphabetic code was developed for each 7.5 minute quad sheet used in the study. The next six digits are numeric and identify the township, range, and section in which a stream's mouth appears (Figure 1). The ninth and tenth digits are alphabetic and identify the quarter section and quarter, quarter section in which the mouth appears (Figure 2).

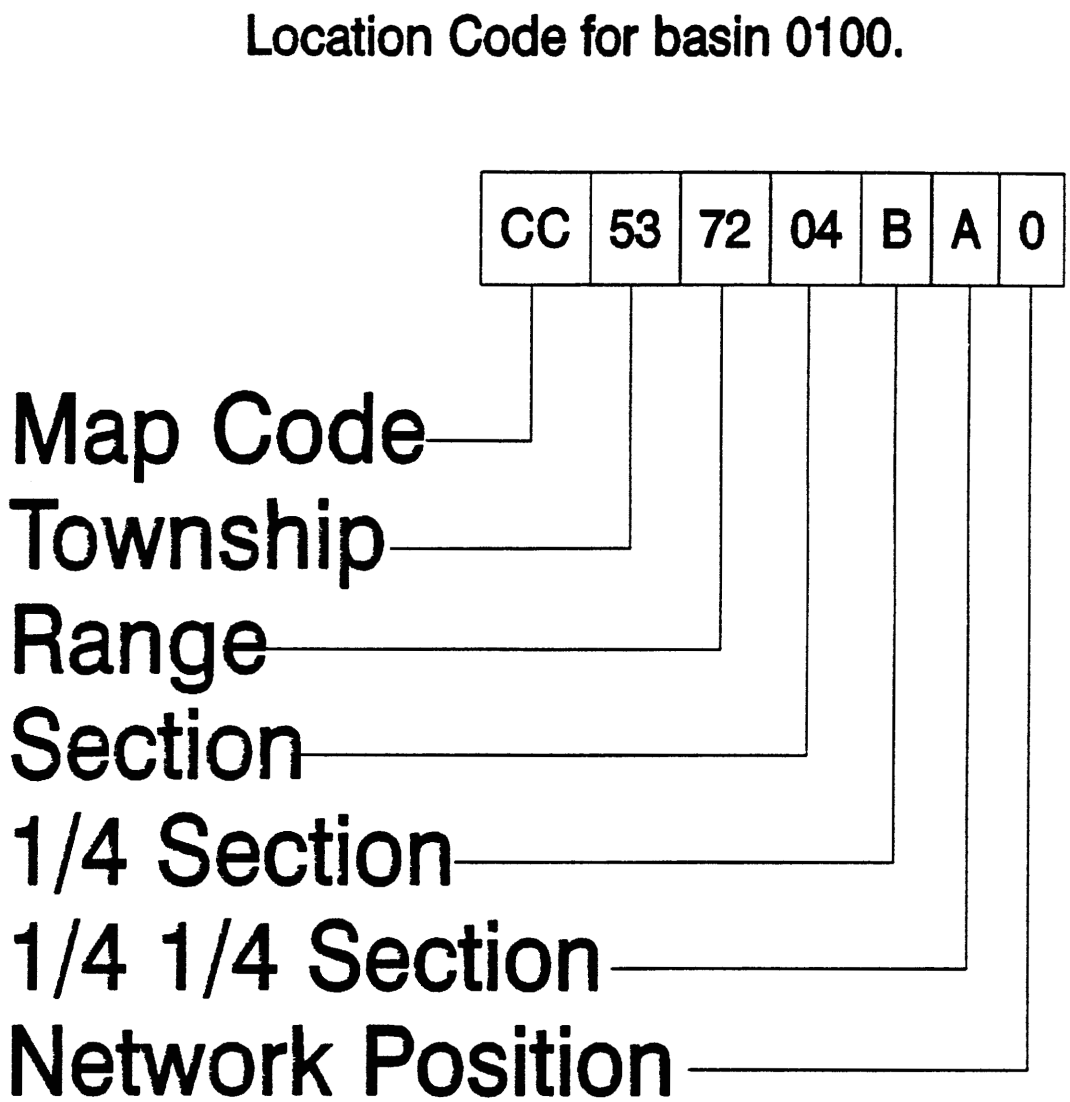


Figure 1. Analysis of the location codes developed in the Eastern Powder River Basin coal field study. The location indicated is the map location of the mouth of the third order stream that defines the drainage basin. The map codes are presented in Table 1. Township, Range and Section are those used in legal descriptions. Townships are North, Ranges are West and Sections are those listed on the USGS 1:24,000 topographic quadrangles.

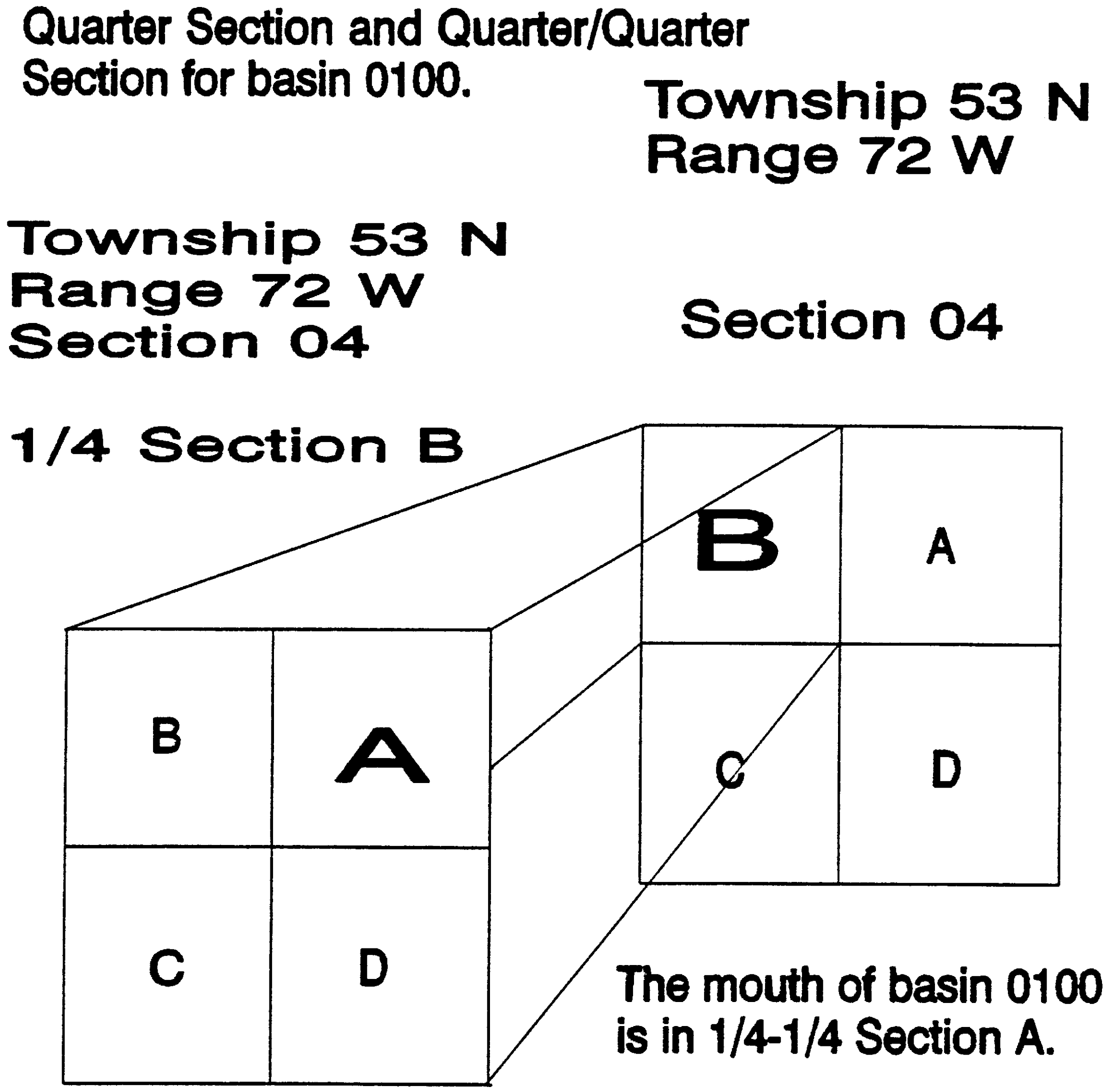


Figure 2. Analysis of 1/4 section and 1/4 1/4 section characters for basin 0100 in the Eastern Powder River Basin coal field study. Location code for basin 0100 is CC537204BA0. The B indicates the 1/4 section, the A indicates the 1/4 1/4 section.

Table 1. USGS 7.5 minute quadrangles used to define the Eastern Powder River Basin study area and their two letter abbreviations. Accessory USGS 7.5 minute quadrangles used to delineate basins that extended off the 24 primary quadrangle maps.

Primary USGS 7.5 Minute Quadrangles	**Map Code**
Calf Creek Quadrangle	CC
Rawhide School	RS
Moyer Springs	MS
Gillette West	GW
Gillette East	GE
Fortin Draw	FD
Appel Butte	AB
The Gap	TG
Coyote Draw	CD
Scaper Reservoir	SR
The Gap South West	GS
Saddle Horse Butte	SH
Eagle Rock	ER
Neil Butte	NB
Rough Creek	RC
Reno Junction	RJ
Hilight	HL
Open A Ranch	OA
Little Thunder Reservoir	LT
Reno Reservoir	RR
Piney Canyon North West	PN
Teckla South West	TS
Teckla	TK
Piney Canyon South West	PS
Accessory Maps	
Pitch Draw	PD
Oriva North West	ON
Green Hill	GH
Four Bar J Ranch	FB
Pleasantdale	PL
Three Mile Creek Reservoir	TM
Piney Canyon South East	PE

The eleventh and last digit is either an L, an R, or a 0. If two streams of the same order come together at that location an L or an R will be used. If the stream in question is on the left looking downstream an L is in the code. If the stream is on the right looking downstream an R is in the code. If the stream in question is a lower order stream that enters directly into a stream of greater order the 0 is used.

APPENDIX II

MEASUREMENT OF MORPHOMETRIC VARIABLES

Units of Measure

AUTO-CAD requires a known coordinate system be entered for each basin. The state plane coordinate system was used for this purpose. Tick marks were marked on the maps at approximately 10,000-20,000 foot intervals. If a drainage basin fell entirely on one 7.5 minute quadrangle, the 4 tick marks on the manuscript were used. If more than 4 tick marks were on a map, the 4 tick marks that came closest to surrounding the basin were used. When drainage basins were on two or more 7.5 minute quads, the map manuscripts were spliced together and the 4 tick marks on all the maps that came closest to surrounding the basin were used. Root Mean Square Errors (RMS) were recorded in the calibration process. If the RMS exceeded 20, the digitizing board was re-calibrated.

Calibration

Two squares of known dimension were drawn on the maps for each basin. Basins very near to one another often shared the same squares. One square was 1.5" x 1.5", the other was 4.0" x 4.0". These translate into squares that have perimeters, in "real world" values, of 12,000' and 32,000' respectively. The squares have "real world" areas of 9,000,000 ft^2 and

64,000,000 ft^2. These squares were digitized prior to any basin digitization. Initially, the squares were digitized to determine the accuracy of the calibration. Values for perimeter and area were recorded.

It was determined part way through the digitizing process that the values could be used to set a standard of precision. The process was altered slightly so that values differing by more than 1% from the expected values would result in the redigitizing of the squares or the digitizing Table being recalibrated until the appropriate values were reached.

Digitizing procedures

The main channel was used as the basis for all later digitizing and editing. The main channel was digitized first. Then all channels that intersected the main channel were digitized moving clockwise from the mouth of the third order basin. All tributary channels that did not intersect the main channel were digitized moving clockwise around the tributary basin. Each stream directly tributary to the third order stream was digitized in a clockwise direction around the third order basin starting at the mouth. Each stream channel tributary to a previously digitized second order stream was then digitized. These tributaries to second order channels were digitized in a clockwise direction around the second order basin. Digitizing proceeded around the second order basins in a clockwise direction around the third order basins. All digitized stream channels were then edited to fit the main channel. At no time was the main channel edited after it was satisfactorily digitized.

The main channel lengths for second and third order streams were divided using the functions of the software into 20 equal increments. The increments of 5 percent were displayed on the monitor and correlated to points on the map manuscript. The third mark from both ends was identified and marked on the manuscript. This identified the points representing 15 and 85 percent of the channel length. Elevations were later determined for these points to determine used relief.

The boundaries or perimeters of the drainage basins were digitized next. It was the intent of the project to never digitize the same line twice within a third order basin. The third order basin perimeter was digitized first. It was in turn edited to fit the main channel so that the mouth precisely intersected the perimeter. The second order perimeters were then digitized. Only the interior perimeter lines needed to be digitized because the exterior perimeters were part of the third order basin perimeter and could be edited to obtain area and perimeter measurements. Interior perimeter lines for the second order drainage basins were done in two "polylines" only. The first order perimeter lines were done in like manner to the seconds with only those perimeter lines not included in the second and third order perimeters being digitized. The selection process resulted in two adjacent first order basins in each third order basin being selected and one first order being isolated. The basin perimeter for the lone basin was digitized as one line. The basin perimeters for the adjacent basins were done as two lines only just as with the second order perimeters. Perimeter lines were edited to fit one another and to intersect the stream channels at the precise point of confluence. We insured that the basin perimeters did not cross any stream channels and that perimeters were contiguous and fit to the channel network at this time.

Valley lengths were digitized using points pre-marked on the maps. The same procedure was used for valley lengths as was used for stream channels. The main valley was digitized first and fit to the confluences of the tributary channels. The valley length line was edited to fit the stream channel by fitting a valley length vertex to the confluence of the main channel with any first or second order stream that would be measured. Only then were the tributary valley lengths measured. Valley lengths were measured only for selected basins. The valley lengths were also edited to the intersection of the basin perimeter with the mouth of the third order stream.

APPENDIX III

THE DATABASE COMPILED FOR THIS STUDY

The appendix lists the data gathered and developed for use in the classification and characterization process. The units for the variables are listed in Table 1. The data are presented by the classification strata developed in drainage basin order.

Table 1. Variables listed in Appendix IV and the units in which they are displayed.

Variable	Units
BasNum (Basin Identification Number)	None
Location Code	None
Order	None
Basin Area	$Miles^2$
Basin Length	Miles
Basin Perimeter	Miles
Maximum Elevation	Feet
Minimum Elevation	Feet
Basin Relief	Feet
Main Channel Length	Miles
Valley Length	Miles
Number of Seconds	Integer
Number of Firsts	Integer
Total Channel Length	Miles
Maximum Used Relief (Elevation)	Feet
Minimum Used Relief (Elevation)	Feet
Used Relief	Feet
Relief Ratio	Feet/Mile
Ruggedness Number	Unitless
Channel Slope	Feet/Foot
Sinuosity	Unitless
Drainage Density	$Miles/Miles^2$
Circularity	Unitless
AGI #1	Unitless
AGI #2	Unitless
AGI #3	Unitless
AGI #4	Unitless

Table 2. Third order drainage basins listed by classification stratum. Stratum A.

BASNUM	LOCATION CODE	ORDER	CAT	BASIN AREA	BASIN LENGTH	BASIN PERIMETER	MAXIMUM ELEV.	MINIMUM ELEV.	BASIN RELIEF	MAIN CHANNEL LENGTH	VALLEY LENGTH	NUMBER OF SECONDS	NUMBER OF FIRSTS	TOTAL CHANNEL LENGTH	MAXIMUM USED RELIEF	MINIMUM USED RELIEF	USEDREL
0100	CC537204BA0	3	A	1.90	2.22	7.03	4205	3855	350	2.46	2.25	2	4	5.36	4070	3875	195
0200	CC537205AA0	3	A	2.64	2.78	8.25	4265	3870	395	3.40	3.05	2	6	7.36	4085	3880	205
0300	CC537208CBR	3	A	1.48	1.88	5.60	4305	3910	395	1.94	1.88	2	5	4.64	4070	3930	140
0800	MS527215DBR	3	A	3.22	2.29	8.39	4350	4020	330	3.64	3.28	2	7	9.47	4235	4035	200
0900	MS527130ABR	3	A	3.17	2.11	9.48	4445	4140	305	2.83	2.26	4	12	10.33	4355	4170	185
1000	MS517201AB0	3	A	0.93	1.90	5.94	4525	4115	410	2.41	2.15	2	4	3.75	4390	4160	230
1700	FD507021DC0	3	A	2.66	2.91	9.24	4715	4335	380	4.66	3.60	2	10	9.19	4610	4350	260
3800	OA456921BAL	3	A	4.54	4.13	11.06	5025	4730	295	6.13	4.13	2	10	16.04	4925	4755	170
4500	PN436910BB0	3	A	1.19	2.22	5.86	4985	4605	380	2.77	2.19	2	6	5.74	4770	4620	150
4600	PN436909ABR	3	A	0.84	1.38	4.57	5000	4645	355	1.52	1.30	2	5	4.01	4825	4660	165
4700	PN436909ABL	3	A	5.04	3.03	9.96	4875	4645	230	4.33	3.58	5	17	17.72	4810	4665	145
4800	PN426904ACL	3	A	0.48	0.83	3.05	4915	4660	255	0.89	0.81	2	4	2.59	4780	4670	110
5000	PN436928CC0	3	A	2.46	2.71	7.91	4935	4525	410	3.46	2.85	2	11	12.03	4765	4545	220
5900	TK417016DC0	3	A	2.15	2.69	7.33	4925	4560	365	3.28	2.75	3	12	8.97	4745	4585	160
6000	TK417027BA0	3	A	7.43	4.66	16.16	4980	4515	465	8.00	5.81	6	29	27.46	4865	4555	310
6300	PS416921AB0	3	A	6.38	4.52	12.65	4990	4595	395	5.71	4.46	8	26	25.86	4845	4620	225
6400	PS426919ACR	3	A	1.58	2.55	7.21	5105	4775	330	3.49	2.93	2	4	5.57	5015	4805	210
6500	PS416915BBR	3	A	4.02	2.07	10.32	5145	4685	460	4.72	3.61	4	13	13.35	4990	4725	265

BASNUM	RELIEF RATIO	RUGGEDNESS NO.	CHANNEL SLOPE	SINUOSITY	DRAINAGE DENSITY	CIRCULARITY	PRECIP.	VEGETATION	SOIL	ASPECT	SURFICIAL GEOLOGY	GEOLOGY	AGI #1	AGI #2	AGI #3	AGI #4
0100	158	0.187	0.021	1.094	2.82	0.48	2	1	3	3	4	4	0.051	0.040	0.057	665.00
0200	142	0.209	0.016	1.115	2.79	0.49	2	5	3	3	4	3	0.058	0.042	0.071	1042.80
0300	210	0.235	0.020	1.033	3.15	0.59	2	1	3	4	3	3	0.057	0.030	0.059	584.60
0800	144	0.184	0.015	1.110	2.94	0.57	2	3	3	1	4	2	0.055	0.048	0.088	1062.60
0900	145	0.188	0.018	1.252	3.26	0.44	2	1	3	4	4	3	0.065	0.057	0.087	966.85
1000	215	0.314	0.026	1.123	4.04	0.33	3	1	3	4	5	2	0.030	0.024	0.038	381.30
1700	130	0.249	0.015	1.295	3.46	0.39	4	3	3	3	4	3	0.041	0.040	0.065	1010.80
3800	71	0.197	0.007	1.484	3.53	0.47	2	2	3	3	2	4	0.041	0.032	0.061	1339.30
4500	171	0.346	0.015	1.261	4.81	0.44	1	1	3	3	2	4	0.031	0.018	0.039	452.20
4600	258	0.322	0.029	1.174	4.79	0.50	1	1	2	1	4	4	0.037	0.024	0.041	298.20
4700	76	0.153	0.009	1.210	3.51	0.64	1	3	3	2	3	3	0.051	0.045	0.073	1159.20
4800	309	0.261	0.034	1.094	5.40	0.65	1	6	4	2	4	4	0.026	0.016	0.028	122.40
5000	152	0.380	0.017	1.214	4.89	0.49	1	1	2	3	3	4	0.055	0.042	0.071	1008.60
5900	135	0.288	0.013	1.191	4.17	0.50	1	5	4	4	4	4	0.045	0.028	0.055	784.75
6000	100	0.325	0.010	1.378	3.69	0.36	1	5	4	3	4	3	0.082	0.074	0.141	3454.95
6300	87	0.303	0.011	1.281	4.06	0.50	1	6	4	3	4	4	0.084	0.070	0.105	2520.10
6400	129	0.220	0.016	1.193	3.52	0.38	1	5	4	4	5	4	0.028	0.025	0.039	521.40
6500	222	0.289	0.015	1.305	3.32	0.48	1	6	4	3	5	4	0.074	0.060	0.169	1849.20

Table 2. (cont.) Third order drainage basins listed by classification stratum. Stratum B.

BASNUM	LOCATION CODE	ORDER	CAT	BASIN AREA	BASIN LENGTH	BASIN PERIMETER	MAXIMUM ELEV.	MINIMUM ELEV.	BASIN RELIEF	MAIN CHANNEL LENGTH	VALLEY LENGTH	NUMBER OF SECONDS	NUMBER OF FIRSTS	TOTAL CHANNEL LENGTH	MAXIMUM USED RELIEF	MINIMUM USED RELIEF	USEDREL
0400	RS517301AAR	3	B	1.65	2.58	6.47	4440	4175	265	3.07	2.60	2	7	6.49	4300	4195	105
1100	MS517121ABR	3	B	1.64	1.99	6.10	4580	4310	270	2.52	2.25	2	5	4.98	4435	4330	105
1500	GE507134CCR	3	B	2.14	2.61	7.29	4635	4435	200	3.04	2.64	2	4	6.33	4565	4445	120
1800	AB487205ACR	3	B	2.57	2.59	7.78	4925	4665	260	3.59	2.83	2	7	8.31	4810	4675	135
1900	AB487205ACL	3	B	1.85	1.75	6.95	4855	4665	190	2.34	1.91	2	5	5.39	4770	4675	95
2000	AB487312AA0	3	B	1.93	1.59	6.15	4860	4645	215	2.09	1.72	2	7	6.75	4735	4655	80
2100	AB487322AAR	3	B	2.12	2.35	7.27	4925	4710	215	3.51	2.76	2	5	5.60	4830	4730	100
2400	SR477303AA0	3	B	1.52	1.53	5.37	4855	4710	145	2.10	1.79	2	5	5.85	4795	4715	80
2600	GS487222BAL	3	B	1.10	1.64	4.74	4820	4555	265	1.82	1.76	2	4	3.74	4690	4565	125
3000	SH477136CC0	3	B	1.40	2.24	5.74	4770	4485	285	2.44	2.30	2	7	5.65	4665	4505	160
3500	RJ447213CCR	3	B	1.76	1.33	5.67	4995	4860	135	1.50	1.40	2	6	5.16	4930	4870	60
3600	RJ447213CCL	3	B	2.51	2.22	7.08	5060	4860	200	2.66	2.49	2	9	7.35	4975	4870	105
3700	OA456921BAR	3	B	1.99	2.44	6.91	4995	4730	265	2.95	2.24	2	6	6.90	4865	4745	120
4200	LT427107BCL	3	B	2.08	2.04	7.76	5085	4830	255	2.76	2.58	2	6	6.56	4940	4835	105
4400	RR437028DC0	3	B	2.37	2.52	7.88	4825	4655	170	2.67	2.41	2	5	5.22	4780	4670	110
4900	PN437026AB0	3	B	0.96	1.75	5.17	4880	4615	265	2.02	1.62	2	5	4.38	4715	4630	85
5200	TS417108DA0	3	B	0.94	1.10	4.55	4935	4740	195	1.16	1.07	2	5	4.35	4845	4755	90
5300	TS417108DBR	3	B	2.29	2.09	7.01	5025	4745	280	2.13	1.99	3	10	9.62	4895	4760	135
5400	TS417108DBL	3	B	1.24	1.25	6.20	4925	4745	180	1.89	1.73	2	4	4.14	4875	4765	110
5600	TK417122AD0	3	B	2.59	2.02	8.72	4910	4630	280	2.61	2.48	3	7	7.62	4825	4650	175
5700	TK417115DC0	3	B	1.91	2.07	6.54	4905	4655	250	1.95	1.77	2	6	5.94	4810	4675	135
6200	TK427136DD0	3	B	2.52	2.15	8.50	4920	4670	250	2.65	2.43	2	4	5.28	4825	4695	130

BASNUM	RELIEF RATIO	RUGGEDNESS NO.	CHANNEL SLOPE	SINUOSITY	DRAINAGE DENSITY	CIRCULARITY	PRECIP.	VEGETATION	SOIL	ASPECT	SURFICIAL GEOLOGY	GEOLOGY	AGI #1	AGI #2	AGI #3	AGI #4
0400	103	0.198	0.009	1.180	3.94	0.49	2	4	1	2	1	1	0.027	0.015	0.032	437.25
1100	136	0.155	0.011	1.122	3.04	0.55	3	3	3	3	5	2	0.033	0.018	0.042	442.80
1500	77	0.112	0.011	1.149	2.97	0.51	5	3	3	4	2	2	0.027	0.024	0.031	428.00
1800	100	0.159	0.010	1.267	3.23	0.53	4	5	1	3	1	1	0.035	0.026	0.049	668.20
1900	108	0.105	0.011	1.229	2.91	0.48	4	3	1	3	2	1	0.028	0.020	0.038	351.50
2000	135	0.143	0.010	1.212	3.50	0.64	4	5	1	2	1	1	0.038	0.019	0.049	414.95
2100	91	0.107	0.008	1.273	2.64	0.50	4	4	1	2	0	1	0.025	0.017	0.037	455.80
2400	95	0.106	0.010	1.176	3.85	0.66	4	4	1	1	0	1	0.020	0.015	0.027	220.40
2600	161	0.170	0.019	1.032	3.39	0.62	4	5	1	3	3	1	0.030	0.021	0.034	291.50
3000	127	0.219	0.018	1.060	4.05	0.53	3	3	1	4	0	1	0.031	0.025	0.034	399.00
3500	101	0.075	0.011	1.069	2.94	0.69	2	2	3	4	4	1	0.030	0.019	0.034	237.60
3600	90	0.111	0.011	1.068	2.93	0.63	2	2	1	1	3	1	0.036	0.028	0.043	502.00
3700	109	0.174	0.011	1.316	3.47	0.52	2	2	3	2	2	4	0.034	0.022	0.041	527.35
4200	125	0.153	0.010	1.069	3.16	0.43	1	4	1	4	1	1	0.036	0.021	0.049	530.40
4400	68	0.071	0.011	1.111	2.20	0.48	1	2	1	1	0	3	0.029	0.026	0.031	402.90
4900	151	0.228	0.011	1.250	4.54	0.45	1	2	4	1	3	3	0.024	0.011	0.027	254.40
5200	178	0.170	0.021	1.083	4.61	0.57	1	2	1	2	0	1	0.030	0.020	0.032	183.30
5300	134	0.222	0.017	1.070	4.19	0.59	1	2	1	3	0	1	0.057	0.039	0.058	641.20
5400	145	0.114	0.016	1.094	3.33	0.41	1	2	1	3	0	1	0.022	0.020	0.034	223.20
5600	138	0.156	0.018	1.055	2.94	0.43	1	2	1	4	0	2	0.053	0.047	0.068	725.20
5700	121	0.147	0.019	1.102	3.11	0.56	1	2	1	3	0	2	0.046	0.036	0.044	477.50
6200	116	0.099	0.013	1.093	2.09	0.44	1	2	1	2	0	2	0.045	0.033	0.055	630.00

Table 2. (cont.) Third order drainage basins listed by classification stratum. Stratum C.

BASNUM	LOCATION CODE	ORDER	CAT	BASIN AREA	BASIN LENGTH	BASIN PERIMETER	MAXIMUM ELEV.	MINIMUM ELEV.	BASIN RELIEF	MAIN CHANNEL LENGTH	VALLEY LENGTH	NUMBER OF SECONDS	NUMBER OF FIRSTS	TOTAL CHANNEL LENGTH	MAXIMUM USED RELIEF	MINIMUM USED RELIEF	USEDREL
0500	RS517312AA0	3	C	3.18	3.20	8.52	4655	4200	455	3.53	3.22	3	11	11.08	4425	4220	205
0600	RS517311AB0	3	C	3.51	3.35	11.21	4590	4235	355	3.65	3.26	2	9	10.26	4400	4250	150
0700	RS517315AD0	3	C	7.65	6.83	16.79	4825	4260	565	8.74	7.17	5	20	24.04	4535	4285	250
1200	GW517327DC0	3	C	4.00	4.47	11.77	4765	4360	405	5.22	4.47	3	15	13.51	4585	4375	210
1300	GE517225BDR	3	C	3.34	3.81	9.39	4585	4265	320	4.37	3.62	4	11	11.79	4465	4285	180
1400	GE517225BDL	3	C	4.36	3.89	12.83	4565	4265	300	6.09	4.64	3	17	14.80	4465	4280	185
1600	GE507134CCL	3	C	6.73	4.27	14.26	4765	4435	330	6.04	5.27	4	16	17.09	4600	4450	150
2200	SR477209CD0	3	C	7.40	4.41	13.47	4980	4605	375	6.15	4.80	4	17	20.37	4810	4625	185
2300	SR477218AC0	3	C	4.69	3.43	10.66	4945	4640	305	5.05	4.10	3	11	13.18	4860	4670	190
2500	GS477201AC0	3	C	6.24	4.04	13.73	4745	4510	235	4.97	4.59	2	7	10.63	4650	4535	115
2700	SH477020BC0	3	C	2.84	2.94	8.36	4725	4420	305	3.98	3.01	2	6	8.09	4585	4435	150
2800	SH477031BA0	3	C	4.16	3.82	11.31	4735	4445	290	4.95	4.18	2	7	9.79	4640	4475	165
2900	SH477126AD0	3	C	5.30	2.79	10.97	4690	4475	215	3.43	2.90	4	10	10.25	4595	4490	105
3100	ER467121CC0	3	C	5.25	3.77	11.82	4855	4580	275	6.19	4.95	2	5	11.65	4740	4610	130
3200	ER457118BC0	3	C	8.04	5.49	17.94	4985	4695	290	9.88	7.72	2	11	18.88	4865	4725	140
4000	LT437121DB0	3	C	6.86	4.65	13.53	4975	4790	185	5.89	4.90	3	16	22.19	4880	4795	85
4100	LT427107BCR	3	C	2.58	2.77	11.43	4970	4830	140	3.74	3.25	2	6	9.19	4920	4835	85
4300	RR437102CAL	3	C	8.65	5.44	17.20	4985	4730	255	6.82	6.24	3	9	22.48	4870	4745	125
5100	PN427001DD	3	C	5.13	3.15	12.18	4880	4655	225	4.58	3.68	2	13	14.42	4835	4665	170
5500	TS427121AB0	3	C	4.96	3.81	11.93	5005	4765	240	6.03	4.66	3	11	15.38	4935	4770	165
5800	TK417008AA0	3	C	4.68	3.03	12.11	4945	4615	330	4.56	3.97	3	12	10.95	4850	4650	200
6100	TK417009CC0	3	C	3.42	2.99	9.26	4905	4595	310	4.02	3.23	3	14	12.51	4775	4615	160

BASNUM	RELIEF RATIO	RUGGEDNESS NO.	CHANNEL SLOPE	SINUOSITY	DRAINAGE DENSITY	CIRCULARITY	PRECIP.	VEGETATION	SOIL	ASPECT	SURFICIAL GEOLOGY	GEOLOGY	AGI #1	AGI #2	AGI #3	AGI #4
0500	142	0.300	0.016	1.096	3.49	0.55	3	3	1	1	2	1	0.078	0.051	0.086	1446.90
0600	106	0.196	0.011	1.117	2.92	0.35	2	4	3	2	2	1	0.065	0.039	0.070	1246.05
0700	83	0.336	0.008	1.219	3.14	0.34	3	3	1	1	2	1	0.094	0.061	0.120	4322.25
1200	91	0.259	0.011	1.168	3.37	0.36	3	4	1	1	2	1	0.059	0.044	0.069	1620.00
1300	84	0.214	0.011	1.205	3.53	0.48	4	3	1	1	2	1	0.046	0.037	0.053	1068.80
1400	77	0.193	0.008	1.314	3.39	0.33	4	2	1	1	2	1	0.041	0.035	0.064	1308.00
1600	77	0.159	0.007	1.146	2.54	0.42	5	3	3	1	3	2	0.070	0.047	0.098	2220.90
2200	85	0.195	0.008	1.281	2.75	0.51	3	2	1	1	2	1	0.085	0.059	0.119	2775.00
2300	89	0.162	0.010	1.234	2.81	0.52	3	3	1	1	1	1	0.054	0.047	0.079	1430.45
2500	58	0.076	0.006	1.083	1.70	0.42	3	3	1	1	0	1	0.056	0.037	0.069	1466.40
2700	104	0.164	0.010	1.323	2.85	0.51	3	3	1	2	3	3	0.041	0.028	0.056	866.20
2800	76	0.129	0.009	1.185	2.36	0.41	2	2	1	1	3	4	0.046	0.037	0.060	1206.40
2900	77	0.079	0.008	1.182	1.94	0.55	3	3	1	2	1	4	0.063	0.042	0.077	1139.50
3100	73	0.116	0.006	1.252	2.22	0.47	2	5	1	1	1	1	0.044	0.032	0.073	1443.75
3200	53	0.129	0.004	1.280	2.35	0.31	2	4	1	3	3	1	0.045	0.032	0.081	2331.60
4000	40	0.113	0.004	1.201	3.24	0.47	1	4	1	1	1	1	0.041	0.027	0.052	1269.10
4100	50	0.094	0.006	1.153	3.56	0.25	1	2	1	3	1	1	0.018	0.015	0.024	361.20
4300	47	0.125	0.005	1.094	2.60	0.37	2	3	1	3	2	1	0.061	0.043	0.077	2205.75
5100	71	0.120	0.010	1.247	2.81	0.43	1	2	1	2	3	2	0.048	0.051	0.069	1154.25
5500	63	0.141	0.007	1.294	3.10	0.44	1	2	1	1	0	1	0.037	0.035	0.059	1190.40
5800	109	0.146	0.012	1.148	2.34	0.40	1	4	1	3	0	2	0.064	0.056	0.097	1544.40
6100	104	0.215	0.011	1.247	3.66	0.50	1	5	4	4	2	3	0.050	0.038	0.067	1060.20

Table 2. (cont.) Third order drainage basins listed by classification stratum. Stratum D.

BASNUM	LOCATION CODE	ORDER	CAT	BASIN AREA	BASIN LENGTH	BASIN PERIMETER	MAXIMUM ELEV.	MINIMUM ELEV.	BASIN RELIEF	MAIN CHANNEL LENGTH	VALLEY LENGTH	NUMBER OF SECONDS	NUMBER OF FIRSTS	TOTAL CHANNEL LENGTH	MAXIMUM USED RELIEF	MINIMUM USED RELIEF	USEDREL
3300	RC466915ACR	3	D	7.25	4.08	13.29	5110	4635	475	8.25	4.86	4	23	25.83	4910	4675	235
3400	RC466915ACL	3	D	5.56	3.62	11.70	4970	4635	335	7.01	4.01	5	19	21.60	4835	4655	180

BASNUM	RELIEF RATIO	RUGGEDNESS NO.	CHANNEL SLOPE	SINUOSITY	DRAINAGE DENSITY	CIRCULARITY	PRECIP.	VEGETATION	SOIL	ASPECT	SURFICIAL GEOLOGY	GEOLOGY	AGI #1	AGI #2	AGI #3	AGI #4
3300	116	0.321	0.008	1.696	3.56	0.52	2	1	3	1	1	4	0.079	0.058	0.159	3443.75
3400	93	0.246	0.007	1.748	3.88	0.51	2	1	3	2	1	4	0.050	0.039	0.098	1862.60

Table 3. Second order drainage basins listed by classification stratum. Stratum A.

BASNUM	LOCATION CODE	ORDER	CAT	BASIN AREA	BASIN LENGTH	BASIN PERIMETER	MAXIMUM ELEV.	MINIMUM ELEV.	BASIN RELIEF	MAIN CHANNEL LENGTH	VALLEY LENGTH	NUMBER OF FIRSTS	TOTAL CHANNEL LENGTH	MAXIMUM USED RELIEF	MINIMUM USED RELIEF	USEDREL	RELIEF RATIO
01A0	CC547233BCR	2	A	0.94	1.71	4.72	4205	3900	305	1.70	1.58	2	2.60	4090	3925	165	179
01B0	CC547233BCL	2	A	0.75	1.36	4.34	4235	3900	335	1.40	1.33	2	2.00	4090	3915	175	246
02A0	CC537205BAR	2	A	1.82	2.58	7.57	4265	3885	380	2.83	2.60	3	4.05	4095	3905	190	147
02B0	CC537205BAL	2	A	0.70	1.41	3.70	4200	3885	315	1.51	1.45	3	2.75	4040	3895	145	223
03A0	CC537217ABR	2	A	0.68	1.28	3.77	4305	3960	345	1.22	1.19	2	1.80	4090	3970	120	269
03B0	CC537217ABL	2	A	0.53	1.26	3.21	4295	3960	335	1.16	1.11	3	2.12	4070	3970	100	266
08A0	RS527221ABR	2	A	0.78	1.36	4.14	4325	4085	240	1.33	1.30	3	2.53	4195	4095	100	177
08B0	RS527221ABL	2	A	1.24	1.49	5.15	4350	4085	265	2.27	2.10	2	3.50	4250	4110	140	178
09C0	MS527129ABR	2	A	0.72	1.34	4.52	4470	4245	225	1.56	1.48	3	2.49	4405	4270	135	168
09D0	MS527129ABL	2	A	0.87	1.22	4.20	4445	4245	200	1.33	1.22	3	2.31	4370	4255	115	165
10A0	MS517105BCR	2	A	0.17	0.56	1.87	4525	4350	175	0.52	0.48	2	0.99	4435	4365	70	315
10B0	MS517105BCL	2	A	0.32	0.75	2.51	4525	4350	175	0.66	0.59	2	1.11	4445	4360	85	232
17A0	FD507021CAR	2	A	2.31	2.63	8.25	4715	4345	370	4.26	3.31	7	7.36	4610	4370	240	141
17B0	FD507021CAL	2	A	0.21	0.70	2.31	4630	4345	285	0.51	0.48	2	0.98	4400	4360	40	408
38A0	RC456917AAR	2	A	2.34	3.14	8.67	5025	4790	235	4.21	3.12	4	6.11	4940	4810	130	75
38B0	RC456917AAL	2	A	1.49	2.30	6.42	5100	4790	310	2.68	2.16	4	5.20	4955	4810	145	135
45A0	PN436904BAR	2	A	0.23	0.91	2.33	4985	4700	285	0.88	0.81	2	1.43	4795	4715	80	313
45B0	PN436904BAL	2	A	0.28	1.00	2.60	4985	4700	285	1.02	0.94	2	1.37	4850	4720	130	286
46A0	PN436909BDR	2	A	0.50	1.24	3.89	5000	4665	335	1.26	1.11	2	3.10	4835	4680	155	269
46B0	PN436909BDL	2	A	0.32	0.73	2.45	4965	4665	300	0.62	0.56	3	1.77	4740	4675	65	411
47C0	PN436905DCR	2	A	1.05	1.69	4.83	4925	4700	225	1.91	1.68	4	3.54	4825	4720	105	133

BASNUM	RUGGEDNESS NO.	CHANNEL SLOPE	SINUOSITY	DRAINAGE DENSITY	CIRCULARITY	PRECIP.	VEGETATION	SOIL	ASPECT	SURFICIAL GEOLOGY	GEOLOGY	AGI #1	AGI #2	AGI #3	AGI #4
01A0	0.160	0.026	1.081	2.77	0.53	2	1	3	2	5	4	0.032	0.024	0.032	286.70
01B0	0.169	0.034	1.056	2.67	0.50	2	1	3	3	4	4	0.034	0.026	0.035	251.25
02A0	0.160	0.018	1.088	2.22	0.40	2	5	3	3	4	3	0.046	0.033	0.051	691.60
02B0	0.234	0.026	1.048	3.92	0.64	2	1	3	3	[illegible]	3	0.026	0.018	0.030	220.50
03A0	0.172	0.027	1.023	2.63	0.60	2	1	3	4	[illegible]	[illegible]	0.0[illegible]	0.018	0.035	234.60
03B0	0.256	0.023	1.039	4.04	0.64	2	1	3	1	2	3	0.029	0.012	0.027	177.55
08A0	0.146	0.020	1.026	3.22	0.57	2	3	3	1	5	2	0.027	0.016	0.026	187.20
08B0	0.142	0.017	1.080	2.83	0.59	2	3	3	1	2	2	0.027	0.021	0.042	328.60
09C0	0.147	0.023	1.056	3.45	0.45	2	1	3	3	3	3	0.020	0.017	0.023	162.00
09D0	0.101	0.023	1.084	2.67	0.62	2	3	3	4	4	3	0.025	0.020	0.027	174.00
10A0	0.191	0.036	1.076	5.76	0.62	3	3	3	3	5	2	0.011	0.006	0.010	29.75
10B0	0.116	0.035	1.114	3.49	0.63	3	3	3	1	5	2	0.016	0.011	0.014	56.00
17A0	0.223	0.015	1.289	3.18	0.43	4	3	3	3	5	3	0.038	0.035	0.062	854.70
17B0	0.251	0.021	1.050	4.66	0.50	4	1	3	4	2	3	0.022	0.004	0.016	59.85
38A0	0.116	0.008	1.348	2.61	0.39	2	2	3	3	2	4	0.025	0.019	0.033	549.90
38B0	0.205	0.015	1.239	3.50	0.45	2	2	3	3	2	4	0.033	0.022	0.038	461.90
45A0	0.333	0.025	1.084	6.17	0.54	1	1	3	2	3	4	0.014	0.006	0.014	65.55
45B0	0.265	0.035	1.088	4.91	0.52	1	1	3	3	3	4	0.015	0.010	0.015	79.80
46A0	0.392	0.033	1.134	6.18	0.42	1	1	2	1	4	4	0.025	0.017	0.025	167.50
46B0	0.315	0.028	1.121	5.55	0.67	1	1	2	2	3	4	0.029	0.009	0.025	96.00
47C0	0.144	0.015	1.136	3.38	0.56	1	3	3	3	3	3	0.023	0.016	0.026	236.25

Table 3. (cont.) Second order drainage basins listed by classification stratum. Stratum A (cont.).

BASNUM	LOCATION CODE	ORDER	CAT	BASIN AREA	BASIN LENGTH	BASIN PERIMETER	MAXIMUM ELEV.	MINIMUM ELEV.	BASIN RELIEF	MAIN CHANNEL LENGTH	VALLEY LENGTH	NUMBER OF FIRSTS	TOTAL CHANNEL LENGTH	MAXIMUM USED RELIEF	MINIMUM USED RELIEF	USEDREL	RELIEF RATIO
47D0	PN436905DCL	2	A	0.25	1.10	2.73	4975	4700	275	0.92	0.86	2	1.76	4790	4710	80	249
48A0	PN426904DBR	2	A	0.22	0.71	2.50	4890	4680	210	0.79	0.76	2	1.19	4800	4695	105	297
48B0	PN426904DBL	2	A	0.20	0.66	2.03	4915	4680	235	0.67	0.61	2	1.19	4800	4695	105	354
50A0	PN436928CBR	2	A	0.34	1.38	3.84	4875	4530	345	1.55	1.44	2	2.10	4680	4540	140	250
50B0	PN436928CBL	2	A	2.05	2.62	7.59	4935	4530	405	3.31	2.76	9	9.78	4770	4550	220	155
59B0	PS417011CAR	2	A	0.23	0.68	1.92	4910	4710	200	0.62	0.60	2	0.99	4790	4715	75	293
59C0	PS417011CAL	2	A	0.34	0.77	2.69	4925	4710	215	0.82	0.73	3	1.61	4820	4730	90	280
60C0	PS417013ABR	2	A	2.26	1.53	7.85	4960	4735	225	3.00	2.75	6	5.61	4920	4760	160	147
60D0	PS417013ABL	2	A	1.02	1.68	5.03	4975	4735	240	1.64	1.40	5	3.73	4880	4750	130	143
63D0	PS416908AAR	2	A	1.06	2.31	5.65	4990	4745	245	2.50	2.16	2	3.09	4890	4765	125	106
63E0	PS416908AAL	2	A	0.91	2.13	5.86	4965	4745	220	2.43	2.12	2	3.11	4895	4770	125	103
64A0	PS426920CAR	2	A	0.88	1.77	5.83	5105	4840	265	2.51	2.14	2	2.87	5030	4865	165	150
64BO	PS426920CAL	2	A	0.49	1.37	3.33	5085	4840	245	1.38	1.20	2	1.72	4965	4855	110	178
65A0	PS416904ADR	2	A	0.70	1.43	4.03	5070	4875	195	1.59	1.46	3	2.67	4995	4890	105	136
65B0	PS416904ADL	2	A	1.06	1.38	5.08	5145	4875	270	1.85	1.66	3	3.09	5035	4900	135	195

BASNUM	RUGGEDNESS NO.	CHANNEL SLOPE	SINUOSITY	DRAINAGE DENSITY	CIRCULARITY	PRECIP.	VEGETATION	SOIL	ASPECT	SURFICIAL GEOLOGY	GEOLOGY	AGI #1	AGI #2	AGI #3	AGI #4
47D0	0.362	0.023	1.077	6.96	0.43	1	1	3	3	2	4	0.014	0.006	0.012	68.75
48A0	0.214	0.036	1.041	5.38	0.45	1	6	4	2	4	4	0.011	0.008	0.012	46.20
48B0	0.263	0.043	1.092	5.92	0.61	1	6	4	2	3	4	0.013	0.009	0.013	47.00
50A0	0.398	0.024	1.079	6.09	0.29	1	4	4	3	3	4	0.014	0.008	0.016	117.30
50B0	0.366	0.018	1.198	4.77	0.45	1	1	2	3	4	4	0.048	0.037	0.060	830.25
59B0	0.164	0.033	1.028	4.32	0.78	1	5	4	3	3	4	0.014	0.008	0.013	46.00
59C0	0.192	0.030	1.125	4.70	0.60	1	5	4	4	5	4	0.017	0.010	0.018	73.10
60C0	0.106	0.014	1.091	2.48	0.46	1	4	4	3	2	3	0.032	0.032	0.063	508.50
60D0	0.166	0.021	1.173	3.65	0.51	1	4	4	3	3	4	0.028	0.021	0.028	244.80
63D0	0.136	0.014	1.158	2.93	0.42	1	5	4	3	4	4	0.020	0.015	0.021	259.70
63E0	0.142	0.014	1.144	3.42	0.33	1	5	4	3	5	4	0.016	0.013	0.018	200.20
64A0	0.164	0.018	1.170	3.26	0.33	1	5	4	4	5	4	0.018	0.016	0.025	233.20
64BO	0.163	0.022	1.149	3.51	0.56	1	5	4	4	5	4	0.016	0.011	0.017	120.05
65A0	0.141	0.018	1.087	3.81	0.54	1	5	4	2	5	4	0.016	0.013	0.018	136.50
65B0	0.149	0.020	1.116	2.92	0.52	1	5	4	4	5	4	0.029	0.021	0.039	286.20

Table 3. (cont.) Second order drainage basins listed by classification stratum. Stratum B.

BASNUM	LOCATION CODE	ORDER	CAT	BASIN AREA	BASIN LENGTH	BASIN PERIMETER	MAXIMUM ELEV.	MINIMUM ELEV.	BASIN RELIEF	MAIN CHANNEL LENGTH	VALLEY LENGTH	NUMBER OF FIRSTS	TOTAL CHANNEL LENGTH	MAXIMUM USED RELIEF	MINIMUM USED RELIEF	USEDREL	RELIEF RATIO
04A0	RS527336DBR	2	B	0.95	2.08	5.13	4440	4200	240	2.49	2.09	2	2.86	4310	4215	95	115
04B0	RS527336DBL	2	B	0.63	1.28	3.78	4450	4200	250	1.20	1.15	4	3.05	4320	4215	105	195
11A0	MS517115BAR	2	B	0.62	0.80	3.43	4580	4395	185	0.92	0.86	2	1.66	4475	4400	75	230
11B0	MS517115BAL	2	B	0.45	1.05	3.06	4605	4395	210	1.10	1.04	2	1.34	4490	4405	85	199
15A0	GE497103BDR	2	B	1.00	1.96	5.47	4635	4455	180	2.12	1.93	2	2.39	4575	4475	100	92
15B0	GE497103BDL	2	B	0.78	1.97	5.31	4615	4455	160	2.12	1.94	2	3.02	4575	4470	105	81
18A0	AB497232DCR	2	B	1.41	1.87	5.77	4925	4690	235	2.46	2.02	4	4.56	4835	4700	135	126
18B0	AB497232DCL	2	B	0.89	1.55	4.58	4910	4690	220	1.54	1.40	3	2.62	4790	4695	95	142
19A0	AB497233CDR	2	B	0.94	1.01	4.43	4855	4705	150	1.23	1.03	3	2.52	4805	4710	95	149
19B0	AB497233CDL	2	B	0.46	1.07	3.45	4980	4705	275	1.14	1.10	2	1.75	4860	4715	145	258
20A0	AB487312BCR	2	B	0.51	0.98	2.88	4840	4675	165	0.93	0.85	2	1.65	4735	4680	55	168
20B0	AB487312BCL	2	B	0.71	0.94	4.12	4860	4675	185	1.08	0.94	3	1.96	4750	4685	65	197
21A0	SR487322BDR	2	B	0.21	1.63	1.89	4895	4745	150	0.57	0.54	2	0.95	4825	4755	70	92
21B0	SR487322BDL	2	B	1.38	0.67	5.93	4925	4745	180	2.37	1.97	3	3.52	4845	4755	90	270
24A0	SR477303ABR	2	B	0.53	1.47	3.38	4885	4715	170	1.49	1.40	3	2.67	4810	4720	90	116
24B0	SR477303ABL	2	B	0.96	1.43	4.57	4855	4715	140	1.88	1.60	2	2.96	4795	4720	75	98
26A0	TG487222BAR	2	B	0.49	1.39	2.88	4730	4570	160	1.00	0.97	2	1.65	4655	4575	80	115
26B0	TG487222BAL	2	B	0.52	1.04	4.42	4820	4570	250	1.55	1.50	2	1.83	4700	4585	115	241
30A0	NB467101DAR	2	B	0.27	0.97	2.31	4785	4585	200	0.73	0.71	2	1.08	4685	4600	85	207
30B0	NB467101DAL	2	B	0.32	0.85	2.69	4770	4585	185	0.95	0.92	2	1.32	4705	4600	105	218
35A0	RJ447224BAR	2	B	0.77	1.04	4.20	4995	4875	120	0.96	0.92	3	2.07	4940	4880	60	115

BASNUM	RUGGEDNESS NO.	CHANNEL SLOPE	SINUOSITY	DRAINAGE DENSITY	CIRCULARITY	PRECIP.	VEGETATION	SOIL	ASPECT	SURFICIAL GEOLOGY	GEOLOGY	AGI #1	AGI #2	AGI #3	AGI #4
04A0	0.137	0.010	1.191	3.01	0.45	2	4	1	2	1	1	0.017	0.010	0.021	228.00
04B0	0.228	0.024	1.050	4.82	0.55	2	4	1	3	1	1	0.025	0.015	0.023	157.50
11A0	0.094	0.022	1.075	2.67	0.66	3	3	3	3	5	2	0.024	0.014	0.027	114.70
11B0	0.118	0.021	1.059	2.98	0.61	3	3	3	4	5	2	0.016	0.009	0.017	94.50
15A0	0.082	0.013	1.097	2.41	0.42	5	3	3	4	2	2	0.016	0.013	0.017	180.00
15B0	0.116	0.013	1.091	3.84	0.35	5	3	3	1	2	2	0.011	0.010	0.012	124.80
18A0	0.144	0.015	1.221	3.25	0.53	4	5	1	3	1	1	0.026	0.021	0.034	331.35
18B0	0.123	0.017	1.096	2.94	0.53	4	4	1	3	1	1	0.024	0.015	0.024	195.80
19A0	0.076	0.021	1.193	2.67	0.60	4	3	1	3	2	1	0.022	0.020	0.027	141.00
19B0	0.198	0.034	1.036	3.80	0.49	4	3	1	4	2	1	0.021	0.016	0.022	126.50
20A0	0.102	0.016	1.098	3.25	0.77	4	5	1	1	0	1	0.017	0.008	0.016	84.15
20B0	0.097	0.016	1.154	2.78	0.52	4	5	1	2	0	1	0.023	0.011	0.026	131.35
21A0	0.128	0.033	1.053	4.49	0.74	4	5	1	1	0	1	0.010	0.007	0.004	31.50
21B0	0.087	0.010	1.201	2.54	0.49	4	4	1	2	0	1	0.020	0.014	0.071	248.40
24A0	0.161	0.016	1.063	5.01	0.59	4	4	1	1	0	1	0.011	0.008	0.012	90.10
24B0	0.082	0.011	1.174	3.09	0.58	4	4	1	1	0	1	0.014	0.011	0.018	134.40
26A0	0.103	0.022	1.037	3.38	0.74	4	5	1	3	4	1	0.015	0.011	0.011	78.40
26B0	0.167	0.020	1.029	3.52	0.33	4	5	1	3	3	1	0.016	0.010	0.024	130.00
30A0	0.149	0.032	1.022	3.93	0.65	3	3	1	4	0	1	0.014	0.009	0.011	54.00
30B0	0.144	0.030	1.037	4.10	0.56	3	3	1	4	0	1	0.012	0.010	0.013	59.20
35A0	0.061	0.017	1.040	2.68	0.55	2	2	3	4	4	1	0.018	0.013	0.017	92.40

Table 3. (cont.) Second order drainage basins listed by classification stratum. Stratum B (cont.).

BASNUM	LOCATION CODE	ORDER	CAT	BASIN AREA	BASIN LENGTH	BASIN PERIMETER	MAXIMUM ELEV.	MINIMUM ELEV.	BASIN RELIEF	MAIN CHANNEL LENGTH	VALLEY LENGTH	NUMBER OF FIRSTS	TOTAL CHANNEL LENGTH	MAXIMUM USED RELIEF	MINIMUM USED RELIEF	USEDREL	RELIEF RATIO
35B0	RJ447224BAL	2	B	0.77	1.04	3.86	5010	4875	135	0.93	0.92	3	2.55	4940	4885	55	130
36A0	RJ447225BDR	2	B	0.46	1.03	3.04	5060	4920	140	0.83	0.81	2	1.21	4985	4930	55	136
36B0	RJ447225BDL	2	B	0.79	1.10	3.90	5060	4920	140	1.13	1.10	4	2.47	5000	4935	65	127
37A0	RC456917ACR	2	B	0.44	1.09	3.29	4985	4800	185	0.97	0.90	2	1.61	4880	4815	65	170
37B0	RC456917ACL	2	B	0.66	1.39	4.11	4995	4800	195	1.31	1.19	2	1.89	4885	4810	75	140
42A0	LT427106CAR	2	B	0.67	1.33	4.93	5085	4855	230	1.60	1.52	2	2.23	4955	4865	90	173
42B0	LT427106CAL	2	B	0.77	1.30	4.74	5085	4855	230	1.58	1.48	3	2.74	4970	4860	110	177
44A0	RR437033ABR	2	B	0.26	0.89	2.38	4800	4670	130	0.76	0.74	2	1.16	4750	4675	75	146
44B0	RR437033ABL	2	B	2.06	2.25	7.47	4825	4670	155	2.36	2.12	3	3.75	4785	4685	100	69
49A0	PN437035ABR	2	B	0.30	0.86	2.92	4830	4690	140	0.88	0.79	3	1.87	4775	4695	80	162
49B0	PN437035ABL	2	B	0.31	0.76	2.41	4815	4690	125	0.66	0.63	2	1.15	4750	4695	55	165
52A0	TS417108DDR	2	B	0.37	1.12	3.22	4945	4750	195	1.07	0.97	2	1.57	4870	4770	100	175
52B0	TS417108DDL	2	B	0.57	0.99	3.29	4935	4750	185	1.03	0.97	3	2.66	4850	4765	85	187
53B0	TS417108ACR	2	B	0.59	1.73	4.02	5015	4760	255	1.76	1.66	3	2.72	4910	4780	130	148
53C0	TS417108ACL	2	B	0.75	1.84	4.63	5025	4760	265	1.82	1.73	4	3.53	4905	4785	120	144
54A0	TS417105DCR	2	B	0.30	1.13	2.96	4990	4810	180	0.91	0.88	2	1.41	4925	4820	105	159
54B0	TS417105DCL	2	B	0.71	0.88	4.51	4925	4810	115	0.90	0.88	2	1.74	4890	4820	70	131
56B0	TK417114ADR	2	B	0.38	0.81	2.78	4900	4720	180	0.77	0.72	2	1.31	4825	4730	95	223
56C0	TK417114ADL	2	B	0.57	0.98	3.90	4910	4720	190	1.12	1.09	2	1.73	4855	4735	120	194
57A0	TK417115BDR	2	B	0.72	1.84	4.66	4940	4695	245	1.82	1.71	2	2.44	4855	4725	130	133
57B0	TK417115BDL	2	B	0.90	1.25	4.22	4895	4695	200	1.32	1.23	3	3.50	4835	4725	110	160
62A0	TK417101BDR	2	B	1.01	1.86	4.60	4930	4735	195	1.89	1.74	2	2.34	4870	4760	110	105
62B0	TK417101BDL	2	B	1.19	1.53	5.92	4920	4735	185	1.63	1.50	2	2.19	4830	4755	75	121

BASNUM	RUGGEDNESS NO.	CHANNEL SLOPE	SINUOSITY	DRAINAGE DENSITY	CIRCULARITY	PRECIP.	VEGETATION	SOIL	ASPECT	SURFICIAL GEOLOGY	GEOLOGY	AGI #1	AGI #2	AGI #3	AGI #4
35B0	0.084	0.016	1.019	3.29	0.65	2	2	3	1	3	1	0.021	0.012	0.019	103.95
36A0	0.069	0.018	1.019	2.60	0.63	2	2	1	1	3	1	0.015	0.008	0.012	64.40
36B0	0.083	0.016	1.025	3.15	0.65	2	2	1	2		1	0.019	0.013	0.019	110.60
37A0	0.128	0.018	1.072	3.65	0.51	2	2	3	2	2	4	0.016	0.008	0.014	81.40
37B0	0.106	0.015	1.104	2.88	0.49	2	2	3	3	2	4	0.019	0.010	0.018	128.70
42A0	0.146	0.015	1.053	3.35	0.34	1	4	1	3	0	1	0.018	0.010	0.022	154.10
42B0	0.155	0.019	1.069	3.57	0.43	1	4	1	4	0	1	0.021	0.015	0.026	177.10
44A0	0.111	0.027	1.036	4.50	0.57	1	2	1	1	0	4	0.008	0.007	0.007	33.80
44B0	0.053	0.011	1.114	1.82	0.46	1	2	1	1	0	3	0.026	0.023	0.027	319.30
49A0	0.168	0.024	1.124	6.32	0.44	1	2	4	1	4	3	0.009	0.007	0.009	42.00
49B0	0.088	0.023	1.054	3.74	0.67	1	2	4	1	0	3	0.011	0.007	0.010	38.75
52A0	0.158	0.025	1.102	4.27	0.44	1	2	1	2	0	1	0.013	0.009	0.012	72.15
52B0	0.164	0.022	1.065	4.69	0.66	1	2	1	2	0	1	0.019	0.013	0.020	105.45
53B0	0.222	0.020	1.060	4.60	0.46	1	2	1	2	0	1	0.016	0.012	0.017	150.45
53C0	0.236	0.018	1.050	4.70	0.44	1	2	1	3	0	1	0.021	0.014	0.020	198.75
54A0	0.158	0.031	1.038	4.63	0.44	1	2	1	3	0	1	0.011	0.009	0.009	54.00
54B0	0.053	0.021	1.027	2.43	0.44	1	2	1	4	0	1	0.017	0.015	0.018	81.65
56B0	0.119	0.034	1.064	3.48	0.61	1	2	1	3	0	2	0.017	0.013	0.016	68.40
56C0	0.110	0.029	1.030	3.05	0.47	1	2	1	4	0	3	0.018	0.017	0.021	108.30
57A0	0.157	0.019	1.062	3.38	0.42	1	2	1	3	0	2	0.018	0.014	0.018	176.40
57B0	0.148	0.023	1.074	3.90	0.63	1	2	1	3	0	2	0.026	0.021	0.027	180.00
62A0	0.086	0.016	1.085	2.32	0.60	1	2	1	1	0	2	0.020	0.016	0.020	196.95
62B0	0.064	0.012	1.089	1.83	0.43	1	2	1	2	0	2	0.026	0.014	0.027	220.15

Table 3. (cont.) Second order drainage basins listed by classification stratum. Stratum C.

BASNUM	LOCATION CODE	ORDER	CAT	BASIN AREA	BASIN LENGTH	BASIN PERIMETER	MAXIMUM ELEV.	MINIMUM ELEV.	BASIN RELIEF	MAIN CHANNEL LENGTH	VALLEY LENGTH	NUMBER OF FIRSTS	TOTAL CHANNEL LENGTH	MAXIMUM USED RELIEF	MINIMUM USED RELIEF	USEDREL	RELIEF RATIO
05A0	RS517313AAR	2	C	0.63	1.10	3.42	4435	4250	185	1.04	1.00	2	1.64	4370	4270	100	168
05B0	RS517313AAL	2	C	1.83	2.32	6.06	4655	4250	405	2.51	2.38	7	6.44	4445	4280	165	175
06A0	RS517310AAR	2	C	2.64	2.59	8.48	4590	4270	320	2.67	2.43	6	6.51	4425	4295	130	123
06B0	RS517310AAL	2	C	0.74	1.71	4.62	4585	4270	315	1.57	1.50	3	2.77	4395	4295	100	185
07D0	GW507301CBR	2	C	0.87	1.52	4.65	4695	4440	255	1.50	1.41	4	2.89	4595	4460	135	168
07E0	GW507301CBL	2	C	1.30	2.51	6.30	4825	4440	385	2.67	2.49	3	4.15	4660	4460	200	154
12B0	GW507311DDR	2	C	0.69	1.50	4.01	4765	4535	230	1.30	1.27	2	1.90	4650	4550	100	154
12C0	GW507311DDL	2	C	0.43	1.10	2.92	4870	4535	335	1.03	0.96	3	2.10	4675	4550	125	304
13B0	GE517131CCR	2	C	0.48	1.05	3.34	4470	4335	135	1.01	0.97	2	1.28	4435	4345	90	128
13C0	GE517131CCL	2	C	1.52	2.36	6.87	4585	4335	250	2.26	2.06	4	4.51	4490	4355	135	106
14A0	GE507201CBR	2	C	0.37	0.96	2.71	4545	4360	185	0.92	0.88	2	1.42	4490	4370	120	194
14B0	GE507201CBL	2	C	2.21	2.26	8.91	4565	4360	205	2.71	2.46	6	5.36	4485	4375	110	91
16C0	TG497115BBR	2	C	1.34	1.07	5.28	4745	4530	215	1.49	1.36	4	3.05	4620	4535	85	201
16D0	TG497115BBL	2	C	0.45	0.63	3.15	4675	4530	145	0.80	0.75	2	1.11	4600	4540	60	230
22B0	SR477228CCR	2	C	0.66	1.10	3.67	4970	4790	180	0.90	0.83	3	1.95	4900	4800	100	163
22C0	SR477228CCL	2	C	0.64	1.16	3.43	4945	4790	155	1.11	1.05	2	1.82	4885	4810	75	134
23B0	SR477219CCR	2	C	1.07	1.80	4.80	4950	4740	210	2.40	1.91	4	3.82	4870	4755	115	117
23C0	SR477219CCL	2	C	2.04	1.83	7.03	4945	4740	205	2.78	2.34	2	4.53	4855	4750	105	112
25A0	GS477212DAR	2	C	0.83	1.62	4.30	4715	4565	150	1.16	1.11	2	1.73	4630	4570	60	92
25B0	GS477212DAL	2	C	3.35	2.89	11.12	4745	4565	180	3.34	3.13	2	4.79	4655	4575	80	62

BASNUM	RUGGEDNESS NO.	CHANNEL SLOPE	SINUOSITY	DRAINAGE DENSITY	CIRCULARITY	PRECIP.	VEGETATION	SOIL	ASPECT	SURFICIAL GEOLOGY	GEOLOGY	AGI #1	AGI #2	AGI #3	AGI #4
05A0	0.091	0.026	1.039	2.59	0.68	3	4	1	4	2	1	0.021	0.016	0.020	116.55
05B0	0.270	0.018	1.053	3.52	0.63	3	3	1	1	1	1	0.056	0.033	0.061	741.15
06A0	0.149	0.013	1.097	2.46	0.46	2	4	3	2	2	1	0.060	0.034	0.062	844.80
06B0	0.223	0.017	1.050	3.75	0.44	2	3	3	3	1	1	0.028	0.013	0.026	233.10
07D0	0.160	0.024	1.064	3.32	0.51	3	3	1	1	1	1	0.028	0.021	0.028	221.85
07E0	0.233	0.020	1.070	3.20	0.41	3	3	1	1	1	1	0.036	0.026	0.038	500.50
12B0	0.119	0.021	1.022	2.73	0.54	3	3	1	4	1	1	0.023	0.014	0.020	158.70
12C0	0.311	0.033	1.074	4.90	0.63	3	3	1	1	3	1	0.026	0.014	0.025	144.05
13B0	0.069	0.024	1.044	2.68	0.54	4	5	1	4	0	1	0.012	0.012	0.012	64.80
13C0	0.140	0.016	1.096	2.97	0.40	4	3	1	1	1	1	0.032	0.024	0.031	380.00
14A0	0.135	0.035	1.049	3.86	0.63	4	3	1	4	1	1	0.014	0.013	0.014	68.45
14B0	0.094	0.011	1.103	2.42	0.35	4	2	1	1	0	1	0.032	0.024	0.038	453.05
16C0	0.093	0.015	1.090	2.28	0.60	5	3	3	1	1	2	0.037	0.020	0.051	288.10
16D0	0.067	0.020	1.066	2.43	0.58	5	3	3	2	0	2	0.015	0.009	0.020	65.25
22B0	0.101	0.030	1.089	2.97	0.61	3	4	1	4	0	1	0.025	0.020	0.020	118.80
22C0	0.084	0.018	1.060	2.85	0.68	3	4	1	1	0	1	0.017	0.012	0.016	99.20
23B0	0.142	0.013	1.257	3.56	0.58	3	3	1	1	0	1	0.018	0.014	0.024	224.70
23C0	0.086	0.010	1.188	2.22	0.52	3	4	1	1	0	1	0.028	0.020	0.043	418.20
25A0	0.059	0.014	1.040	2.08	0.57	3	3	1	4	0	1	0.020	0.012	0.014	124.50
25B0	0.049	0.006	1.070	1.43	0.34	3	3	1	1	0	1	0.034	0.020	0.039	603.00

Table 3. (cont.) Second order drainage basins listed by classification stratum. Stratum C (cont.).

BASNUM	LOCATION CODE	ORDER	CAT	BASIN AREA	BASIN LENGTH	BASIN PERIMETER	MAXIMUM ELEV.	MINIMUM ELEV.	BASIN RELIEF	MAIN CHANNEL LENGTH	VALLEY LENGTH	NUMBER OF FIRSTS	TOTAL CHANNEL LENGTH	MAXIMUM USED RELIEF	MINIMUM USED RELIEF	USEDREL	RELIEF RATIO
27A0	SH477113DDR	2	C	0.71	1.50	4.36	4750	4515	235	1.46	1.36	2	1.82	4660	4530	130	157
27B0	SH477113DDL	2	C	1.20	1.64	4.71	4725	4515	210	1.75	1.57	3	3.26	4635	4530	105	128
28A0	SH477031DAB	2	C	1.05	1.84	5.58	4680	4490	190	1.96	1.75	3	3.04	4600	4505	95	103
28B0	SH477031DAL	2	C	2.57	3.18	9.16	4735	4490	245	3.97	3.54	2	4.56	4645	4530	115	77
29A0	SH477123BCR	2	C	1.70	1.58	6.91	4690	4535	155	1.62	1.44	2	1.98	4610	4525	85	98
29B0	SH477123BCL	2	C	1.26	1.75	5.35	4685	4535	150	1.30	1.18	2	1.92	4605	4550	55	86
31A0	ER467129BAR	2	C	1.67	2.79	7.21	4895	4625	270	3.08	2.87	2	3.58	4770	4645	125	97
31B0	ER467129BAL	2	C	2.89	3.70	11.00	4855	4625	230	4.60	3.83	3	6.48	4755	4645	110	62
32A0	RJ457120BCR	2	C	0.31	0.74	2.98	4950	4745	205	0.79	0.76	2	1.35	4830	4755	75	277
32B0	RJ457120BCL	2	C	6.85	4.22	15.28	4985	4745	240	7.39	6.17	9	15.03	4875	4760	115	57
40A0	LT437128ABR	2	C	4.25	4.17	10.80	4975	4795	180	5.07	4.32	6	11.14	4890	4805	85	43
40B0	LT437128ABL	2	C	0.82	1.58	4.24	4970	4795	175	1.68	1.54	3	2.84	4890	4800	90	111
41A0	LT437236DDR	2	C	0.67	1.63	3.95	5090	4890	200	1.78	1.61	2	2.86	5005	4900	105	123

BASNUM	RUGGEDNESS NO.	CHANNEL SLOPE	SINUOSITY	DRAINAGE DENSITY	CIRCULARITY	PRECIP.	VEGETATION	SOIL	ASPECT	SURFICIAL GEOLOGY	GEOLOGY	AGI #1	AGI #2	AGI #3	AGI #4
27A0	0.114	0.024	1.075	2.56	0.47	3	3	1	2	2	2	0.022	0.017	0.021	166.85
27B0	0.108	0.016	1.112	2.71	0.68	3	3	1	2	2	2	0.027	0.019	0.029	252.00
28A0	0.104	0.013	1.119	2.90	0.42	2	3	1	4	3	4	0.019	0.014	0.020	199.50
28B0	0.082	0.008	1.124	1.78	0.38	2	2	1	1	3	4	0.030	0.021	0.037	629.65
29A0	0.034	0.014	1.129	1.16	0.45	3	3	1	2	0	4	0.031	0.024	0.032	263.50
29B0	0.043	0.011	1.096	1.53	0.55	3	3	1	3	0	4	0.028	0.014	0.021	189.00
31A0	0.110	0.011	1.071	2.14	0.40	2	5	1	4	0	1	0.028	0.018	0.031	450.90
31B0	0.098	0.006	1.200	2.24	0.30	2	5	1	1	0	1	0.027	0.017	0.034	664.70
32A0	0.167	0.026	1.050	4.31	0.44	2	5	1	1	1	1	0.015	0.008	0.016	63.55
32B0	0.100	0.004	1.198	2.19	0.37	2	5	1	3	2	1	0.042	0.027	0.074	1644.00
40A0	0.089	0.005	1.174	2.62	0.46	1	3	1	1	0	1	0.029	0.021	0.035	765.00
40B0	0.114	0.015	1.089	3.45	0.58	1	4	1	1	0	1	0.016	0.012	0.017	143.50
41A0	0.161	0.016	1.103	4.26	0.54	1	2	1	4	0	1	0.014	0.011	0.016	134.00

Table 3. (cont.) Second order drainage basins listed by classification stratum. Stratum C (cont.).

BASNUM	LOCATION CODE	ORDER	CAT	BASIN AREA	BASIN LENGTH	BASIN PERIMETER	MAXIMUM ELEV.	MINIMUM ELEV.	BASIN RELIEF	MAIN CHANNEL LENGTH	VALLEY LENGTH	NUMBER OF FIRSTS	TOTAL CHANNEL LENGTH	MAXIMUM USED RELIEF	MINIMUM USED RELIEF	USEDREL	RELIEF RATIO
41B0	LT437236DDL	2	C	1.06	1.03	5.67	4970	4890	80	1.50	1.36	3	3.36	4940	4895	45	78
43A0	RJ447119ADR	2	C	0.25	0.87	2.87	5015	4875	140	0.58	0.58	2	0.97	4935	4880	55	161
43B0	RJ447119ADL	2	C	0.50	1.03	3.71	4945	4875	70	0.93	0.90	2	1.50	4900	4870	30	68
51A0	PN427001DCR	2	C	4.34	2.86	11.06	4880	4665	215	4.05	3.29	10	11.13	4845	4680	165	75
51B0	PN427010DCL	2	C	0.64	1.51	4.74	4885	4665	220	1.73	1.56	3	2.75	4790	4675	115	146
55B0	TS427130AAR	2	C	1.82	1.96	7.40	5005	4855	150	2.33	2.09	4	4.87	4975	4875	100	77
55C0	TS427130AAL	2	C	0.51	0.92	2.95	5015	4855	160	0.98	0.85	3	1.71	4935	4865	70	174
58A0	TK427034BBR	2	C	0.90	1.14	4.63	4965	4835	130	0.79	0.71	2	1.23	4875	4830	45	114
58B0	TK427034BBL	2	C	0.91	1.18	3.94	4945	4835	110	1.13	1.06	2	1.65	4890	4835	55	93
61B0	PS417003DBR	2	C	0.88	1.00	4.08	4905	4735	170	0.99	0.90	3	2.35	4840	4745	95	170
61C0	PS417003DBL	2	C	0.29	1.01	2.61	4930	4735	195	0.92	0.88	2	1.32	4865	4750	115	193

BASNUM	RUGGEDNESS NO.	CHANNEL SLOPE	SINUOSITY	DRAINAGE DENSITY	CIRCULARITY	PRECIP.	VEGETATION	SOIL	ASPECT	SURFICIAL GEOLOGY	GEOLOGY	AGI #1	AGI #2	AGI #3	AGI #4
41B0	0.048	0.008	1.108	3.18	0.41	1	2	1	3	0	1	0.011	0.008	0.016	84.80
43A0	0.102	0.025	1.008	3.83	0.38	2	2	1	3	5	1	0.011	0.006	0.008	35.00
43B0	0.040	0.009	1.039	2.99	0.46	2	2	1	3	4	1	0.007	0.005	0.006	35.00
51A0	0.104	0.011	1.232	2.56	0.45	1	3	1	2	3	2	0.044	0.048	0.062	933.10
51B0	0.178	0.018	1.104	4.28	0.36	1	2	1	2	5	4	0.015	0.012	0.018	140.80
55B0	0.076	0.012	1.116	2.68	0.42	1	2	1	1	0	1	0.022	0.022	0.027	273.00
55C0	0.102	0.019	1.153	3.35	0.74	1	2	1	2	0	1	0.016	0.010	0.017	81.60
58A0	0.034	0.015	1.112	1.37	0.53	1	4	1	3	0	2	0.028	0.014	0.019	117.00
58B0	0.038	0.013	1.069	1.81	0.74	1	4	1	4	0	2	0.017	0.012	0.016	100.10
61B0	0.086	0.026	1.105	2.67	0.66	1	5	4	3	0	2	0.029	0.023	0.028	149.60
61C0	0.167	0.034	1.053	4.52	0.54	1	5	4	4	0	3	0.012	0.010	0.011	56.55

Table 3. (cont.) Second order drainage basins listed by classification stratum. Stratum D.

BASNUM	LOCATION CODE	ORDER	CAT	BASIN AREA	BASIN LENGTH	BASIN PERIMETER	MAXIMUM ELEV.	MINIMUM ELEV.	BASIN RELIEF	MAIN CHANNEL LENGTH	VALLEY LENGTH	NUMBER OF FIRSTS	TOTAL CHANNEL LENGTH	MAXIMUM USED RELIEF	MINIMUM USED RELIEF	USEDREL	RELIEF RATIO
33A0	RC466921CDR	2	D	0.92	1.63	4.40	5065	4770	295	1.99	1.57	3	3.58	4930	4795	135	181
33B0	RC466921CDL	2	D	3.46	2.40	9.19	5110	4770	340	4.43	2.86	10	11.49	4960	4795	165	142
34A0	RC466917BCR	2	D	0.83	1.17	4.05	5030	4805	225	1.27	1.06	3	2.77	4910	4820	90	192
34B0	RC466917BCL	2	D	1.00	1.37	4.67	4970	4805	165	1.55	1.27	3	2.84	4920	4815	105	120

BASNUM	RUGGEDNESS NO.	CHANNEL SLOPE	SINUOSITY	DRAINAGE DENSITY	CIRCULARITY	PRECIP.	VEGETATION	SOIL	ASPECT	SURFICIAL GEOLOGY	GEOLOGY	AGI #1	AGI #2	AGI #3	AGI #4
33A0	0.217	0.018	1.262	3.88	0.60	2	1	3	1	0	4	0.026	0.017	0.032	271.40
33B0	0.214	0.010	1.548	3.32	0.51	2	3	3	1	0	4	0.050	0.035	0.093	1176.40
34A0	0.143	0.019	1.202	3.35	0.63	2	3	3	1	0	4	0.028	0.016	0.030	186.75
34B0	0.089	0.018	1.219	2.84	0.58	2	3	3	2	0	4	0.020	0.018	0.023	165.00

Table 4. First order drainage basins listed by classification stratum. Stratum A.

BASNUM	LOCATION CODE	ORDER	CAT	BASIN AREA	BASIN LENGTH	BASIN PERIMETER	MAXIMUM ELEV.	MINIMUM ELEV.	BASIN RELIEF	MAIN CHANNEL LENGTH	VALLEY LENGTH	MAXIMUM USED RELIEF	MINIMUM USED RELIEF	USEDREL	RELIEF RATIO	RUGGEDNESS NO.
01A1	CC547233BBR	1	A	0.55	1.46	4.45	4205	3930	275	1.41	1.30	4155	3930	225	189	0.132
01A2	CC547233BBL	1	A	0.24	0.99	2.51	4270	3930	340	0.90	0.85	4190	3930	260	343	0.243
01B1	PD547228DDR	1	A	0.28	0.99	2.63	4235	3950	285	0.94	0.91	4155	3950	205	287	0.183
02A2	CC547231ACR	1	A	0.14	0.72	2.01	4225	3990	235	0.67	0.65	4180	3990	190	324	0.212
02A3	CC547231ACL	1	A	0.92	1.49	4.47	4265	3990	275	1.43	1.35	4175	3990	185	185	0.081
02B2	CC547232CDR	1	A	0.15	0.86	2.37	4195	3920	275	0.57	0.55	4025	3920	105	319	0.201
03A1	CC537217AAR	1	A	0.35	0.87	2.70	4305	3995	310	0.79	0.77	4145	3995	150	354	0.130
03A2	CC537217AAL	1	A	0.17	0.85	2.24	4285	3995	290	0.58	0.58	4115	3995	120	341	0.183
03B2	CC537217ACL	1	A	0.18	0.83	1.97	4295	3980	315	0.74	0.71	4170	3980	190	378	0.247
08A1	RS527221ADR	1	A	0.17	0.47	2.10	4210	4125	85	0.34	0.34	4145	4125	20	181	0.032
08B1	RS527221BCR	1	A	0.25	1.33	3.13	4395	4130	265	1.24	1.18	4345	4130	215	199	0.251
08B2	RS527221BCL	1	A	0.77	1.36	4.46	4350	4130	220	1.70	1.61	4290	4130	160	162	0.092
09C1	MS527121CBR	1	A	0.14	0.69	1.65	4510	4340	170	0.47	0.46	4425	4340	85	247	0.108
09C2	MS527121CBL	1	A	0.20	0.63	2.43	4470	4340	130	0.60	0.57	4445	4340	105	205	0.072
09D1	MS527128CBR	1	A	0.15	0.49	1.93	4445	4330	115	0.45	0.43	4400	4330	70	234	0.065
10A1	MS517105BCR	1	A	0.08	0.53	1.45	4490	4355	135	0.47	0.45	4450	4355	95	256	0.155
10A2	MS517105BCL	1	A	0.09	0.53	1.51	4525	4355	170	0.49	0.46	4455	4355	100	319	0.169
10B1	MS517105BCR	1	A	0.14	0.51	1.85	4415	4355	60	0.35	0.34	4395	4355	40	118	0.029
17A3	FD507008CAR	1	A	0.26	0.77	2.33	4750	4580	170	0.86	0.80	4700	4580	120	221	0.108
17A4	FD507008CAL	1	A	0.44	0.73	3.34	4715	4580	135	1.05	0.96	4670	4580	90	185	0.061
17B2	FD507021ACL	1	A	0.10	0.55	1.48	4630	4370	260	0.35	0.33	4430	4370	60	474	0.171

BASNUM	CHANNEL SLOPE	SINUOSITY	DRAINAGE DENSITY	CIRCULARITY	PRECIP.	VEGETATION	SOIL	ASPECT	SURFICIAL GEOLOGY	GEOLOGY	AGI #1	AGI #2	AGI #3	AGI #4
01A1	0.030	1.082	2.54	0.35	2	1	3	2	5	4	0.020	0.017	0.020	151.25
01A2	0.055	1.061	3.78	0.48	2	1	3	3	5	4	0.017	0.013	0.016	81.60
01B1	0.041	1.030	3.38	0.50	2	1	3	3	4	4	0.016	0.011	0.015	79.80
02A2	0.054	1.026	4.76	0.44	2	5	3	2	3	3	0.009	0.008	0.009	32.90
02A3	0.025	1.056	1.55	0.58	2	5	3	3	5	3	0.034	0.023	0.032	253.00
02B2	0.035	1.024	3.86	0.33	2	1	3	3	3	3	0.014	0.005	0.009	41.25
03A1	0.036	1.016	2.22	0.61	2	1	3	4	3	3	0.026	0.013	0.023	108.50
03A2	0.039	1.010	3.33	0.44	2	1	3	4	1	3	0.016	0.007	0.011	49.30
03B2	0.049	1.032	4.14	0.58	2	1	3	1	2	3	0.015	0.009	0.013	56.70
08A1	0.011	1.021	2.01	0.49	2	3	3	4	5	1	0.008	0.002	0.006	14.45
08B1	0.033	1.052	5.01	0.32	2	3	3	1	2	1	0.010	0.008	0.009	66.25
08B2	0.018	1.059	2.22	0.48	2	3	3	1	0	1	0.019	0.014	0.024	169.40
09C1	0.035	1.015	3.36	0.64	2	3	3	3	2	3	0.010	0.005	0.007	23.80
09C2	0.033	1.038	2.94	0.43	2	1	3	3	4	3	0.008	0.007	0.008	26.00
09D1	0.030	1.042	2.99	0.51	2	3	3	4	4	3	0.007	0.005	0.007	17.25
10A1	0.038	1.035	6.06	0.47	3	3	3	3	5	2	0.004	0.003	0.004	10.80
10A2	0.039	1.074	5.24	0.52	3	3	3	3	5	2	0.006	0.004	0.005	15.30
10B1	0.022	1.042	2.51	0.51	3	3	3	4	5	2	0.005	0.003	0.003	8.40
17A3	0.027	1.076	3.36	0.59	4	3	3	3	5	3	0.010	0.007	0.011	44.20
17A4	0.016	1.092	2.40	0.49	4	3	3	3	5	3	0.011	0.007	0.015	59.40
17B2	0.032	1.077	3.48	0.58	4	1	3	4	2	3	0.014	0.003	0.009	26.00

Table 4. (cont.) First order drainage basins listed by classification stratum. Stratum A (cont.).

BASNUM	LOCATION CODE	ORDER	CAT	BASIN AREA	BASIN LENGTH	BASIN PERIMETER	MAXIMUM ELEV.	MINIMUM ELEV.	BASIN RELIEF	MAIN CHANNEL LENGTH	VALLEY LENGTH	MAXIMUM USED RELIEF	MINIMUM USED RELIEF	USEDREL	RELIEF RATIO	RUGGEDNESS NO.
38A2	RC456906DDL	1	A	0.72	1.84	4.22	5025	4890	135	1.42	1.31	4995	4890	105	74	0.051
38B2	RC456905DDR	1	A	0.20	0.91	2.18	5100	4920	180	0.72	0.68	5035	4920	115	197	0.120
38B3	RC456905DDL	1	A	0.14	0.71	1.75	5105	4920	185	0.48	0.47	5015	4920	95	261	0.116
45A2	PN436904BBL	1	A	0.09	0.82	1.82	4985	4715	270	0.61	0.59	4815	4715	100	329	0.357
45B1	PN446933CCR	1	A	0.15	0.62	1.80	4985	4745	240	0.59	0.56	4930	4745	185	385	0.183
45B2	PN446933CCL	1	A	0.05	0.43	1.09	4985	4745	240	0.37	0.36	4880	4745	135	555	0.343
46A1	PN436909CDR	1	A	0.18	0.62	2.07	4930	4720	210	0.71	0.68	4840	4720	120	340	0.160
46A2	PN436909CDL	1	A	0.26	0.87	2.50	5000	4720	280	0.80	0.73	4885	4720	165	323	0.163
46B2	PN436909BDR	1	A	0.08	0.77	1.51	4965	4675	290	0.40	0.39	4760	4675	85	376	0.287
47C2	PN436906AAR	1	A	0.27	0.74	2.50	4925	4790	135	0.68	0.63	4880	4790	90	183	0.065
47C3	PN436906AAL	1	A	0.12	0.58	1.63	4945	4790	155	0.40	0.39	4865	4790	75	269	0.098
47D2	PN436905DCL	1	A	0.12	0.91	2.14	4975	4720	255	0.70	0.66	4820	4720	100	280	0.275
48A1	PN426904CAR	1	A	0.07	0.43	1.24	4920	4720	200	0.40	0.39	4850	4720	130	466	0.222
48A2	PN426904CAL	1	A	0.10	0.52	1.61	4890	4720	170	0.50	0.46	4840	4720	120	330	0.168
48B2	PN426904CAL	1	A	0.08	0.54	1.41	4905	4685	220	0.52	0.49	4800	4685	115	410	0.278
50A1	PN436920DDR	1	A	0.07	0.63	1.77	4865	4595	270	0.55	0.53	4780	4595	185	426	0.384
50A2	PN436920DDL	1	A	0.13	0.68	1.86	4875	4595	280	0.62	0.59	4790	4595	195	410	0.262
50B3	PN436920AAR	1	A	0.09	0.60	1.43	4920	4660	260	0.50	0.46	4810	4660	150	432	0.259
59B1	PS417011CAR	1	A	0.12	0.68	1.81	4910	4715	195	0.58	0.56	4825	4715	110	285	0.181
59C1	PS417011DBR	1	A	0.09	0.53	1.45	4940	4755	185	0.41	0.36	4850	4755	95	347	0.170
59C2	PS417011DBL	1	A	0.11	0.45	1.42	4925	4755	170	0.41	0.37	4865	4755	110	377	0.126

BASNUM	CHANNEL SLOPE	SINUOSITY	DRAINAGE DENSITY	CIRCULARITY	PRECIP.	VEGETATION	SOIL	ASPECT	SURFICIAL GEOLOGY	GEOLOGY	AGI #1	AGI #2	AGI #3	AGI #4
38A2	0.014	1.084	1.99	0.50	2	2	3	3	0	4	0.013	0.010	0.010	97.20
38B2	0.030	1.053	3.53	0.53	2	2	3	3	2	4	0.009	0.006	0.007	36.00
38B3	0.038	1.016	3.32	0.59	2	2	3	3	1	4	0.010	0.005	0.007	25.90
45A2	0.031	1.043	6.98	0.33	1	1	3	2	4	4	0.008	0.003	0.006	24.30
45B1	0.060	1.059	4.03	0.57	1	1	3	3	4	4	0.012	0.009	0.011	36.00
45B2	0.068	1.047	7.54	0.53	1	1	3	3	3	4	0.006	0.003	0.005	12.00
46A1	0.032	1.039	4.02	0.52	1	1	2	1	3	4	0.010	0.006	0.012	37.80
46A2	0.039	1.094	3.08	0.52	1	1	2	1	5	4	0.017	0.010	0.016	72.80
46B2	0.040	1.044	5.22	0.42	1	1	2	1	3	4	0.011	0.003	0.006	23.20
47C2	0.025	1.066	2.55	0.53	1	3	3	3	4	3	0.010	0.007	0.009	36.45
47C3	0.036	1.014	3.34	0.56	1	3	3	3	4	3	0.009	0.004	0.006	18.60
47D2	0.027	1.066	5.69	0.34	1	1	3	3	2	4	0.008	0.003	0.006	30.60
48A1	0.061	1.049	5.86	0.57	1	6	4	2	4	4	0.007	0.004	0.006	14.00
48A2	0.046	1.080	5.21	0.46	1	6	4	2	4	4	0.006	0.005	0.006	17.00
48B2	0.042	1.056	6.68	0.49	1	6	4	3	3	4	0.006	0.003	0.006	17.60
50A1	0.064	1.032	7.51	0.29	1	4	2	2	3	4	0.007	0.004	0.006	18.90
50A2	0.059	1.064	4.95	0.46	1	4	4	3	3	4	0.011	0.008	0.010	36.40
50B3	0.057	1.092	5.26	0.59	1	1	2	3	5	4	0.009	0.005	0.007	23.40
59B1	0.036	1.030	4.90	0.45	1	5	4	3	3	4	0.008	0.004	0.006	23.40
59C1	0.044	1.140	4.85	0.51	1	5	4	3	3	4	0.008	0.004	0.006	16.65
59C2	0.050	1.118	3.92	0.66	1	5	4	4	3	4	0.009	0.006	0.008	18.70

Table 4. (cont.) First order drainage basins listed by classification stratum. Stratum A (cont.).

BASNUM	LOCATION CODE	ORDER	CAT	BASIN AREA	BASIN LENGTH	BASIN PERIMETER	MAXIMUM ELEV.	MINIMUM ELEV.	BASIN RELIEF	MAIN CHANNEL LENGTH	VALLEY LENGTH	MAXIMUM USED RELIEF	MINIMUM USED RELIEF	USEDREL	RELIEF RATIO	RUGGEDNESS NO.
60C4	PS417001ACL	1	A	0.23	0.58	2.21	4960	4920	40	0.44	0.42	4945	4920	25	69	0.015
60D1	PS417012DDR	1	A	0.50	1.12	3.35	4795	4795	180	0.83	0.77	4935	4795	140	160	0.057
60D2	PS417012DDL	1	A	0.10	0.54	1.51	4945	4795	150	0.57	0.53	4920	4795	125	280	0.166
63D1	PS416905BCR	1	A	0.22	0.69	2.30	4970	4835	135	0.59	0.56	4920	4835	85	195	0.071
63D2	PS416905BCL	1	A	0.29	1.10	2.79	4990	4835	155	0.93	0.91	4950	4835	115	141	0.095
63E1	PS416905AAR	1	A	0.41	1.12	3.17	4965	4845	120	1.08	1.01	4940	4845	95	107	0.060
64A2	PS246920AAL	1	A	0.44	1.72	4.01	5105	4900	205	1.76	1.59	5070	4900	170	119	0.154
64B1	PS426920DAR	1	A	0.28	0.89	2.30	5085	4895	190	0.78	0.71	4995	4895	100	214	0.102
64B2	PS426920DAL	1	A	0.05	0.48	1.09	5000	4895	105	0.34	0.33	4960	4895	65	220	0.126
65A2	PS426933DDR	1	A	0.31	0.93	2.72	5070	4925	145	0.97	0.90	5035	4925	110	156	0.084
65A3	PS426933DDL	1	A	0.19	0.62	1.97	5085	4925	160	0.56	0.51	5025	4925	100	259	0.090
65B2	PS426934CDR	1	A	0.21	0.73	2.21	5100	4950	150	0.68	0.65	5055	4950	105	205	0.092

BASNUM	CHANNEL SLOPE	SINUOSITY	DRAINAGE DENSITY	CIRCULARITY	PRECIP.	VEGETATION	SOIL	ASPECT	SURFICIAL GEOLOGY	GEOLOGY	AGI #1	AGI #2	AGI #3	AGI #4
60C4	0.011	1.039	1.92	0.58	1	4	4	1	0	3	0.004	0.003	0.003	9.20
60D1	0.032	1.073	1.66	0.56	1	4	4	3	0	4	0.021	0.016	0.015	90.00
60D2	0.042	1.074	5.85	0.53	1	5	4	4	1	4	0.005	0.004	0.005	15.00
63D1	0.027	1.055	2.76	0.51	1	5	4	2	3	4	0.010	0.006	0.008	29.70
63D2	0.023	1.021	3.22	0.47	1	5	4	3	5	4	0.009	0.007	0.008	44.95
63E1	0.017	1.065	2.65	0.51	1	5	4	3	5	4	0.009	0.007	0.008	49.20
64A2	0.018	1.104	3.97	0.35	1	5	4	4	4	4	0.010	0.008	0.010	90.20
64B1	0.024	1.094	2.82	0.66	1	5	4	4	5	4	0.013	0.007	0.011	53.20
64B2	0.037	1.006	6.33	0.56	1	5	4	4	5	4	0.003	0.002	0.002	5.25
65A2	0.022	1.076	3.07	0.53	1	5	4	3	5	4	0.009	0.007	0.009	44.95
65A3	0.034	1.096	2.96	0.61	1	5	4	3	5	4	0.010	0.006	0.009	30.40
65B2	0.029	1.050	3.24	0.54	1	5	4	4	5	4	0.009	0.006	0.008	31.50

Table 4. (cont.) First order drainage basins listed by classification stratum. Stratum B.

BASNUM	LOCATION CODE	ORDER	CAT	BASIN AREA	BASIN LENGTH	BASIN PERIMETER	MAXIMUM ELEV.	MINIMUM ELEV.	BASIN RELIEF	MAIN CHANNEL LENGTH	VALLEY LENGTH	MAXIMUM USED RELIEF	MINIMUM USED RELIEF	USEDREL	RELIEF RATIO	RUGGEDNESS NO.
04A1	RS527326CAR	1	B	0.18	0.51	1.96	4440	4305	135	0.41	0.40	4365	4305	60	263	0.058
04A2	RS527326CAL	1	B	0.08	0.45	1.20	4485	4305	180	0.37	0.35	4395	4305	90	402	0.159
04B2	RS527336BAR	1	B	0.13	0.79	1.99	4525	4270	255	0.77	0.75	4425	4270	155	324	0.290
11A1	MS517115BAR	1	B	0.34	0.70	2.97	4570	4405	165	0.71	0.67	4505	4405	100	236	0.067
11B1	GH517115ADR	1	B	0.09	0.63	1.54	4605	4440	165	0.49	0.47	4535	4440	95	262	0.164
11B2	GH517115ADL	1	B	0.07	0.47	1.24	4560	4440	120	0.24	0.24	4465	4440	25	254	0.077
15A1	FD497102DCR	1	B	0.10	0.49	1.34	4580	4535	45	0.28	0.25	4565	4535	30	92	0.023
15B1	CD497111BCR	1	B	0.20	1.14	2.58	4675	4520	155	0.90	0.87	4635	4520	115	136	0.132
15B2	CD497111BCL	1	B	0.26	0.90	2.94	4615	4520	95	0.82	0.79	4615	4520	95	105	0.057
18A2	AB497231BAR	1	B	0.18	0.79	2.21	4935	4800	135	0.59	0.55	4885	4800	85	170	0.084
18A3	AB497231BAL	1	B	0.21	0.67	1.86	4925	4800	125	0.65	0.64	4920	4800	120	186	0.074
18B1	AB497232BAR	1	B	0.31	0.82	2.33	4910	4745	165	0.68	0.65	4815	4745	70	201	0.069
19A1	AB497233BDR	1	B	0.17	0.80	1.93	4895	4720	175	0.56	0.54	4815	4720	95	219	0.109
19A2	AB497233BDL	1	B	0.44	0.67	3.06	4855	4720	135	0.84	0.71	4840	4720	120	201	0.049
19B2	AB497233DCL	1	B	0.17	0.83	2.26	4935	4715	220	0.61	0.59	4840	4715	125	265	0.151
20A1	AB487312CBR	1	B	0.37	0.91	2.64	4840	4680	160	0.82	0.74	4760	4680	80	175	0.067
20A2	AB487312CBL	1	B	0.13	0.80	1.91	5000	4680	320	0.72	0.61	4780	4680	100	399	0.341
20B2	AB487311DCL	1	B	0.15	0.54	1.79	4820	4735	85	0.28	0.26	4780	4735	45	157	0.029
21A1	SR487322CAR	1	B	0.08	0.50	1.24	4845	4755	90	0.38	0.37	4805	4755	50	179	0.083
21B2	PL487321DBR	1	B	0.27	0.88	2.39	4890	4805	85	0.52	0.48	4850	4805	45	96	0.030
21B3	PL487321DBL	1	B	0.44	0.80	3.08	4925	4805	120	0.98	0.85	4875	4805	70	150	0.050

BASNUM	CHANNEL SLOPE	SINUOSITY	DRAINAGE DENSITY	CIRCULARITY	PRECIP.	VEGETATION	SOIL	ASPECT	SURFICIAL GEOLOGY	GEOLOGY	AGI #1	AGI #2	AGI #3	AGI #4
04A1	0.028	1.017	2.25	0.59	2	4	1	3	1	1	0.011	0.005	0.009	24.30
04A2	0.046	1.065	4.67	0.69	2	4	1	4	1	1	0.007	0.004	0.006	14.40
04B2	0.038	1.027	6.01	0.41	2	4	1	3	1	1	0.008	0.005	0.008	33.15
11A1	0.027	1.064	2.13	0.48	3	3	3	3	5	2	0.015	0.009	0.015	56.10
11B1	0.037	1.049	5.24	0.49	3	3	3	4	5	2	0.006	0.003	0.004	14.85
11B2	0.020	1.025	3.39	0.58	3	3	3	4	4	2	0.007	0.001	0.003	8.40
15A1	0.020	1.094	2.65	0.73	5	3	3	4	0	2	0.003	0.002	0.002	4.50
15B1	0.024	1.037	4.49	0.38	5	3	3	4	0	1	0.007	0.005	0.005	31.00
15B2	0.022	1.031	3.16	0.38	5	3	3	1	2	1	0.006	0.006	0.005	24.70
18A2	0.027	1.082	3.28	0.47	4	5	1	2	1	1	0.008	0.005	0.006	24.30
18A3	0.035	1.027	3.12	0.76	4	5	1	3	1	1	0.008	0.007	0.007	26.25
18B1	0.019	1.051	2.19	0.72	4	3	1	3	1	1	0.014	0.006	0.012	51.15
19A1	0.032	1.037	3.30	0.58	4	3	1	3	2	1	0.010	0.005	0.007	29.75
19A2	0.027	1.186	1.91	0.59	4	4	1	3	2	1	0.013	0.012	0.017	59.40
19B2	0.039	1.030	3.62	0.42	4	3	1	4	2	1	0.012	0.007	0.009	37.40
20A1	0.019	1.102	2.21	0.67	4	5	1	1	0	1	0.014	0.007	0.012	59.20
20A2	0.026	1.186	5.62	0.44	4	5	1	1	0	1	0.011	0.003	0.010	41.60
20B2	0.031	1.078	1.79	0.61	4	5	1	3	0	1	0.009	0.005	0.004	12.75
21A1	0.025	1.037	4.89	0.64	4	5	1	1	0	1	0.004	0.002	0.003	7.20
21B2	0.017	1.084	1.89	0.60	4	5	1	1	0	1	0.008	0.005	0.005	22.95
21B3	0.014	1.145	2.21	0.59	4	3	1	1	0	1	0.010	0.006	0.013	52.80

Table 4. (cont.) First order drainage basins listed by classification stratum. Stratum B.

BASNUM	LOCATION CODE	ORDER	CAT	BASIN AREA	BASIN LENGTH	BASIN PERIMETER	MAXIMUM ELEV.	MINIMUM ELEV.	BASIN RELIEF	MAIN CHANNEL LENGTH	VALLEY LENGTH	MAXIMUM USED RELIEF	MINIMUM USED RELIEF	USEDREL	RELIEF RATIO	RUGGEDNESS NO.
24A1	SR477303DAR	1	B	0.10	0.77	1.77	4885	4745	140	0.59	0.58	4815	4745	70	182	0.149
24A2	SR477303DAL	1	B	0.21	0.95	2.21	4885	4745	140	0.84	0.83	4850	4745	105	147	0.108
24B2	SR477303ACL	1	B	0.55	1.22	3.84	4855	4720	135	1.64	1.40	4820	4720	100	111	0.076
26A2	TG487222BAL	1	B	0.27	0.46	2.43	4730	4575	155	0.81	0.78	4695	4575	120	333	0.089
26B1	TG487215ACR	1	B	0.14	0.75	1.97	4820	4640	180	0.62	0.60	4755	4640	115	240	0.146
26B2	TG487215ACL	1	B	0.08	0.85	1.20	4800	4640	160	0.28	0.28	4700	4640	60	188	0.112
30A1	NB467101DAR	1	B	0.09	0.47	1.26	4755	4595	160	0.35	0.34	4695	4595	100	341	0.121
30A2	NB467101DAL	1	B	0.18	0.82	1.98	4785	4595	190	0.67	0.66	4725	4595	130	233	0.131
30B2	NB467107BBL	1	B	0.09	0.55	1.37	4785	4640	145	0.36	0.35	4715	4640	75	265	0.116
35A2	RJ447213DDR	1	B	0.08	0.68	1.55	5085	4910	175	0.46	0.44	5000	4910	90	256	0.190
35A3	RJ447213DDL	1	B	0.36	0.70	2.84	4995	4910	85	0.47	0.46	4960	4910	50	121	0.021
35B3	RJ447224ACL	1	B	0.22	0.71	2.09	5010	4895	115	0.56	0.55	4970	4895	75	163	0.055
36A2	RJ447225BDL	1	B	0.30	0.81	2.39	5060	4940	120	0.61	0.60	5000	4940	60	148	0.047
36B2	RJ447226DDR	1	B	0.10	0.53	1.43	5130	4980	150	0.36	0.36	5055	4980	75	283	0.102
36B3	RJ447226DDL	1	B	0.16	0.49	1.68	5060	4980	80	0.35	0.34	5030	4980	50	163	0.033
37A2	RC456917BDL	1	B	0.14	0.78	2.15	5005	4825	180	0.64	0.59	4920	4825	95	231	0.151
37B1	RC456917BAR	1	B	0.14	0.72	1.88	5020	4830	190	0.58	0.56	4925	4830	95	263	0.148
37B2	RC456917BAL	1	B	0.40	0.97	3.24	4995	4830	165	0.83	0.76	4905	4830	75	170	0.064
42A2	LT427106CAL	1	B	0.34	1.24	3.65	5085	4865	220	1.39	1.32	4995	4865	130	178	0.168
42B1	LT427106DCR	1	B	0.32	1.02	2.76	5085	4870	215	1.19	1.14	5010	4870	140	211	0.150
42B2	LT427106DCL	1	B	0.32	0.91	2.95	4910	4870	40	0.80	0.78	4895	4870	25	44	0.019

BASNUM	CHANNEL SLOPE	SINUOSITY	DRAINAGE DENSITY	CIRCULARITY	PRECIP.	VEGETATION	SOIL	ASPECT	SURFICIAL GEOLOGY	GEOLOGY	AGI #1	AGI #2	AGI #3	AGI #4
24A1	0.023	1.013	5.60	0.42	4	4	1	4	0	1	0.004	0.002	0.003	14.00
24A2	0.024	1.021	4.08	0.53	4	4	1	1	0	1	0.007	0.005	0.006	29.40
24B2	0.012	1.175	2.98	0.47	4	4	1	1	0	1	0.009	0.007	0.012	74.25
26A2	0.028	1.035	3.04	0.57	4	5	1	3	2	1	0.010	0.008	0.017	41.85
26B1	0.035	1.029	4.29	0.47	4	5	1	3	2	1	C.008	0.005	0.006	25.20
26B2	0.040	1.015	3.69	0.67	4	5	1	3	2	1	0.009	0.003	0.003	12.80
30A1	0.055	1.007	3.98	0.69	3	3	1	4	0	1	0.008	0.005	0.006	14.40
30A2	0.037	1.019	3.65	0.59	3	3	1	4	0	1	0.010	0.007	0.008	34.20
30B2	0.039	1.031	4.22	0.58	3	3	1	1	0	1	0.007	0.004	0.005	13.05
35A2	0.037	1.046	5.73	0.42	2	2	3	3	3	1	0.006	0.003	0.004	14.00
35A3	0.020	1.030	1.30	0.56	2	2	3	4	4	1	0.012	0.007	0.008	30.60
35B3	0.025	1.020	2.52	0.64	2	2	3	1	3	1	0.009	0.006	0.007	25.30
36A2	0.019	1.015	2.05	0.65	2	2	1	1	2	1	0.011	0.006	0.008	36.00
36B2	0.039	1.017	3.58	0.62	2	2	1	1	0	1	0.008	0.004	0.005	15.00
36B3	0.027	1.021	2.19	0.71	2	2	1	2	0	1	0.007	0.004	0.005	12.80
37A2	0.028	1.096	4.44	0.39	2	2	3	2	1	4	0.007	0.004	0.006	25.20
37B1	0.031	1.041	4.11	0.50	2	2	3	2	2	4	0.009	0.004	0.007	26.60
37B2	0.017	1.091	2.06	0.48	2	2	3	3	2	4	0.015	0.007	0.013	66.00
42A2	0.018	1.056	4.04	0.32	1	4	1	4	0	1	0.010	0.006	0.011	74.80
42B1	0.022	1.044	3.69	0.53	1	4	1	4	0	1	0.011	0.007	0.013	68.80
42B2	0.006	1.019	2.50	0.46	1	4	1	4	0	1	0.003	0.002	0.003	12.80

Table 4. (cont.) First order drainage basins listed by classification stratum. Stratum B (cont.).

BASNUM	LOCATION CODE	ORDER	CAT	BASIN AREA	BASIN LENGTH	BASIN PERIMETER	MAXIMUM ELEV.	MINIMUM ELEV.	BASIN RELIEF	MAIN CHANNEL LENGTH	VALLEY LENGTH	MAXIMUM USED RELIEF	MINIMUM USED RELIEF	USEDREL	RELIEF RATIO	RUGGEDNESS NO.
44A1	RR437033ADR	1	B	0.09	0.49	1.54	4775	4700	75	0.39	0.39	4760	4700	60	154	0.065
44A2	RR437033ADL	1	B	0.10	0.63	1.61	4800	4700	100	0.46	0.44	4770	4700	70	160	0.085
44B2	RR427004ADL	1	B	0.19	0.88	2.19	4850	4775	75	0.58	0.58	4820	4775	45	85	0.042
49A2	PN437035DAR	1	B	0.05	0.41	1.03	4835	4715	120	0.39	0.38	4810	4715	95	293	0.188
49B1	PN437035ACR	1	B	0.18	0.66	1.83	4815	4695	120	0.50	0.48	4770	4695	75	181	0.064
49B2	PN437035ACL	1	B	0.11	0.46	1.96	4850	4695	155	0.49	0.45	4810	4695	115	335	0.131
52A2	TS417117ABL	1	B	0.15	0.62	1.78	4945	4790	155	0.50	0.45	4870	4790	80	250	0.099
52B2	TS417108CAR	1	B	0.12	0.83	2.08	4935	4765	170	0.81	0.78	4910	4765	145	205	0.211
52B3	TS417108CAL	1	B	0.17	0.77	2.10	4945	4765	180	0.72	0.69	4890	4765	125	233	0.142
53B2	TS417105CCR	1	B	0.09	0.58	1.39	4955	4825	130	0.49	0.45	4910	4825	85	224	0.138
53C1	TS417106ADR	1	B	0.12	0.41	1.63	5005	4875	130	0.39	0.38	4935	4875	60	314	0.078
53C2	TS417106ADL	1	B	0.16	0.68	2.03	5025	4875	150	0.49	0.49	4960	4875	85	220	0.088

BASNUM	CHANNEL SLOPE	SINUOSITY	DRAINAGE DENSITY	CIRCULARITY	PRECIP.	VEGETATION	SOIL	ASPECT	SURFICIAL GEOLOGY	GEOLOGY	AGI #1	AGI #2	AGI #3	AGI #4
44A1	0.029	1.021	4.59	0.46	1	2	1	1	0	4	0.003	0.003	0.003	6.75
44A2	0.029	1.037	4.46	0.49	1	2	1	1	0	4	0.004	0.003	0.003	10.00
44B2	0.015	1.002	2.99	0.51	1	2	1	1	0	3	0.005	0.003	0.003	14.25
49A2	0.046	1.029	8.28	0.56	1	2	4	4	4	3	0.003	0.002	0.003	6.00
49B1	0.029	1.038	2.82	0.66	1	2	4	1	0	3	0.008	0.005	0.006	21.60
49B2	0.044	1.106	4.45	0.36	1	2	4	1	0	3	0.007	0.005	0.007	17.05
52A2	0.030	1.102	3.37	0.59	1	2	1	1	0	1	0.009	0.005	0.007	23.25
52B2	0.034	1.046	6.54	0.36	1	2	1	1	0	1	0.005	0.004	0.005	20.40
52B3	0.033	1.044	4.16	0.49	1	2	1	2	0	1	0.008	0.006	0.008	30.60
53B2	0.033	1.096	5.61	0.57	1	2	1	2	0	1	0.005	0.003	0.004	11.70
53C1	0.029	1.025	3.16	0.59	1	2	1	3	0	1	0.008	0.003	0.007	15.60
53C2	0.033	1.013	3.10	0.48	1	2	1	3	0	1	0.009	0.005	0.007	24.00

Table 4. (cont.) First order drainage basins listed by classification stratum. Stratum B (cont.).

BASNUM	LOCATION CODE	ORDER	CAT	BASIN AREA	BASIN LENGTH	BASIN PERIMETER	MAXIMUM ELEV.	MINIMUM ELEV.	BASIN RELIEF	MAIN CHANNEL LENGTH	VALLEY LENGTH	MAXIMUM USED RELIEF	MINIMUM USED RELIEF	USEDREL	RELIEF RATIO	RUGGEDNESS NO.
54A1	TS417105CAR	1	B	0.19	1.00	2.55	4990	4820	170	0.79	0.76	4955	4820	135	171	0.133
54A2	TS417105CAL	1	B	0.09	0.62	1.55	4965	4820	145	0.49	0.48	4920	4820	100	236	0.146
54B1	TS417105DAR	1	B	0.25	1.04	2.83	4985	4835	150	0.84	0.82	4950	4835	115	144	0.094
56B1	TK417114AAR	1	B	0.12	0.53	1.58	4900	4755	145	0.40	0.39	4860	4755	105	273	0.089
56B2	TK417114AAL	1	B	0.18	0.63	1.89	4930	4755	175	0.55	0.49	4860	4755	105	278	0.099
[illegible]	TK417114DAL	1	B	0.19	0.71	2.12	4870	4775	95	0.60	0.58	4850	4775	75	133	0.057
57A2	TS417109ADL	1	B	0.27	0.88	2.72	4940	4800	140	0.75	0.69	4885	4800	85	159	0.073
57B1	TS417110CDR	1	B	0.27	0.83	2.56	4895	4755	140	0.87	0.79	4895	4755	140	168	0.085
57B2	TS417110CDL	1	B	0.21	0.85	2.59	4955	4755	200	0.77	0.70	4955	4755	200	234	0.142
62A2	TK417112BDL	1	B	0.40	1.01	2.94	4930	4820	110	0.92	0.88	4895	4820	75	109	0.047
62B1	TK417102DCR	1	B	0.13	0.55	1.60	4905	4815	90	0.45	0.39	4880	4815	65	162	0.058
62B2	TK417102DCL	1	B	0.33	0.80	2.59	4920	4815	105	0.62	0.58	4855	4815	40	132	0.037

BASNUM	CHANNEL SLOPE	SINUOSITY	DRAINAGE DENSITY	CIRCULARITY	PRECIP.	VEGETATION	SOIL	ASPECT	SURFICIAL GEOLOGY	GEOLOGY	AGI #1	AGI #2	AGI #3	AGI #4
54A1	0.032	1.040	4.13	0.37	1	2	1	3	0	1	0.008	0.006	0.006	32.30
54A2	0.038	1.035	5.33	0.48	1	2	1	3	0	1	0.005	0.003	0.004	13.05
54B1	0.026	1.026	3.30	0.40	1	2	1	3	0	1	0.008	0.007	0.007	37.50
56B1	0.049	1.039	3.24	0.62	1	2	1	3	0	2	0.008	0.006	0.006	17.40
56B2	0.036	1.116	2.98	0.64	1	2	1	4	0	2	0.011	0.006	0.009	31.50
56C2	0.024	1.038	3.17	0.53	1	2	1	4	0	2	0.006	0.005	0.005	18.05
57A2	0.022	1.078	2.75	0.46	1	2	1	3	0	1	0.010	0.006	0.008	37.60
57B1	0.031	1.102	3.22	0.52	1	2	1	3	0	1	0.008	0.008	0.009	37.80
57B2	0.049	1.114	3.75	0.39	1	2	1	3	0	1	0.010	0.010	0.009	42.00
62A2	0.015	1.036	2.27	0.59	1	2	1	1	0	1	0.009	0.006	0.008	44.00
62B1	0.028	1.139	3.42	0.64	1	2	1	1	0	1	0.005	0.004	0.004	11.70
62B2	0.012	1.075	1.88	0.62	1	2	1	2	0	1	0.011	0.004	0.008	34.65

Table 4. (cont.) First order drainage basins listed by classification stratum. Stratum C.

BASNUM	LOCATION CODE	ORDER	CAT	BASIN AREA	BASIN LENGTH	BASIN PERIMETER	MAXIMUM ELEV.	MINIMUM ELEV.	BASIN RELIEF	MAIN CHANNEL LENGTH	VALLEY LENGTH	MAXIMUM USED RELIEF	MINIMUM USED RELIEF	USEDREL	RELIEF RATIO	RUGGEDNESS NO.
05A1	RS517218BCR	1	C	0.25	0.70	2.19	4435	4300	135	0.60	0.57	4405	4300	105	192	0.060
05A2	RS517218BCL	1	C	0.19	0.71	1.90	4560	4300	260	0.60	0.59	4425	4300	125	368	0.160
05B4	RS517324DBL	1	C	0.08	0.44	1.42	4605	4395	210	0.35	0.34	4510	4395	115	482	0.181
06A3	ON517304BBR	1	C	0.14	0.67	1.83	4610	4395	215	0.50	0.48	4530	4395	135	323	0.150
06A4	ON517304BBL	1	C	0.13	0.56	1.86	4585	4395	190	0.48	0.47	4525	4395	130	339	0.128
06B1	RS517303BAR	1	C	0.17	0.71	1.88	4585	4355	230	0.52	0.51	4460	4355	105	325	0.136
07D3	GW507301DCR	1	C	0.11	0.53	1.64	4685	4510	175	0.40	0.38	4615	4510	105	331	0.125
07D4	GW507301DCL	1	C	0.35	0.94	2.77	4685	4510	175	0.85	0.81	4650	4510	140	186	0.082
07E3	GW507313ABL	1	C	0.10	0.62	1.81	4845	4590	255	0.48	0.46	4735	4590	145	409	0.243
12B1	GW507313BBR	1	C	0.31	1.00	2.56	4765	4580	185	0.80	0.78	4695	4580	115	185	0.089
12B2	GW507313BBL	1	C	0.13	0.61	1.83	4865	4580	285	0.59	0.58	4790	4580	210	465	0.246
12C2	GW507314ABR	1	C	0.08	0.64	1.60	4875	4590	285	0.58	0.57	4780	4585	195	447	0.385
13B1	GE517131DDR	1	C	0.11	0.41	1.76	4470	4415	55	0.25	0.24	4450	4415	35	136	0.024
13B2	GE517131DDL	1	C	0.10	0.46	1.34	4495	4415	80	0.27	0.27	4455	4415	40	174	0.043
13C3	GE507106CAR	1	C	0.22	0.67	1.95	4440	4400	40	0.51	0.43	4425	4400	25	60	0.017
14A2	GE507201CDL	1	C	0.18	0.50	1.68	4545	4420	125	0.43	0.41	4525	4420	105	248	0.057
14B2	GE507212DDR	1	C	0.39	0.80	2.93	4565	4475	90	0.56	0.54	4520	4475	45	112	0.025
14B3	GE507212DDL	1	C	0.16	0.78	1.90	4565	4475	90	0.38	0.35	4500	4475	25	115	0.041
16C1	TG497122ABR	1	C	0.29	0.61	2.09	4650	4590	60	0.52	0.50	4640	4590	50	98	0.020
16C2	TG497122ABL	1	C	0.40	0.56	3.04	4745	4590	155	0.47	0.45	4680	4590	90	279	0.035
16D1	TG497115BBR	1	C	0.07	0.50	1.29	4690	4540	150	0.36	0.35	4620	4540	80	298	0.144

BASNUM	CHANNEL SLOPE	SINUOSITY	DRAINAGE DENSITY	CIRCULARITY	PRECIP.	VEGETATION	SOIL	ASPECT	SURFICIAL GEOLOGY	GEOLOGY	AGI #1	AGI #2	AGI #3	AGI #4
05A1	0.033	1.044	2.36	0.66	3	4	1	4	2	1	0.011	0.008	0.009	33.75
05A2	0.039	1.028	3.26	0.65	3	3	1	1	2	1	0.016	0.007	0.013	49.40
05B4	0.062	1.033	4.54	0.48	3	3	1	2	0	1	0.009	0.005	0.007	16.80
06A3	0.051	1.041	3.68	0.51	2	4	3	2	3	1	0.011	0.007	0.009	30.10
06A4	0.051	1.026	3.55	0.49	2	3	3	3	3	1	0.010	0.007	0.008	24.70
06B1	0.038	1.026	3.12	0.59	2	3	3	3	1	1	0.014	0.006	0.010	39.10
07D3	0.050	1.033	3.76	0.49	3	3	1	4	1	1	0.009	0.006	0.007	19.25
07D4	0.031	1.053	2.46	0.57	3	3	1	1	1	1	0.014	0.011	0.012	61.25
07E3	0.057	1.051	5.03	0.37	3	3	1	1	1	1	0.010	0.006	0.008	25.50
12B1	0.039	1.025	2.55	0.60	3	3	1	1	1	1	0.014	0.012	0.011	57.35
12B2	0.067	1.022	4.56	0.49	3	3	1	1	2	1	0.012	0.009	0.011	37.05
12C2	0.064	1.018	7.14	0.40	3	3	1	1	3	1	0.007	0.005	0.007	22.80
13B1	0.027	1.023	2.27	0.44	4	5	1	4	0	1	0.005	0.003	0.003	6.05
13B2	0.028	1.001	2.86	0.67	4	5	1	1	0	1	0.006	0.003	0.003	8.00
13C3	0.009	1.164	2.29	0.73	4	5	1	4	0	1	0.003	0.002	0.003	8.80
14A2	0.046	1.053	2.41	0.79	4	3	1	4	0	1	0.010	0.008	0.008	22.50
14B2	0.015	1.045	1.46	0.56	4	2	1	4	0	1	0.012	0.006	0.008	35.10
14B3	0.012	1.083	2.38	0.56	4	5	1	1	0	1	0.007	0.002	0.003	14.40
16C1	0.018	1.046	1.80	0.83	5	3	3	4	0	2	0.006	0.005	0.005	17.40
16C2	0.036	1.052	1.19	0.54	5	3	3	2	0	2	0.025	0.014	0.021	62.00
16D1	0.042	1.023	5.07	0.54	5	3	3	1	0	2	0.006	0.003	0.004	10.50

Table 4. (cont.) First order drainage basins listed by classification stratum. Stratum C (cont.).

BASNUM	LOCATION CODE	ORDER	CAT	BASIN AREA	BASIN LENGTH	BASIN PERIMETER	MAXIMUM ELEV.	MINIMUM ELEV.	BASIN RELIEF	MAIN CHANNEL LENGTH	VALLEY LENGTH	MAXIMUM USED RELIEF	MINIMUM USED RELIEF	USEDREL	RELIEF RATIO	RUGGEDNESS NO.
22B1	SR477228CDR	1	C	0.09	0.44	1.39	4970	4830	140	0.40	0.36	4915	4830	85	315	0.113
22B2	SR477228CDL	1	C	0.09	0.48	1.36	4930	4830	100	0.30	0.28	4875	4830	45	208	0.061
22C2	SR477228CCL	1	C	0.50	1.12	3.42	4945	4795	150	1.07	1.01	4900	4795	105	134	0.061
23B2	SR477230CBR	1	C	0.09	0.63	1.51	4945	4820	125	0.40	0.37	4870	4820	50	199	0.106
23C2	SR477325CCR	1	C	0.18	0.83	1.93	4965	4855	110	0.52	0.46	4905	4855	50	133	0.059
23C3	SR477325CCL	1	C	0.34	0.64	2.56	4945	4855	90	0.39	0.34	4890	4855	35	141	0.020
25A1	GS477107CAR	1	C	0.39	1.18	3.25	4715	4590	125	0.58	0.55	4640	4590	50	106	0.036
25A2	GS477212DDR	1	C	0.15	0.83	1.83	4715	4590	125	0.57	0.56	4655	4590	65	151	0.088
25B2	GS477212DDL	1	C	0.24	1.09	3.05	4785	4655	130	0.77	0.75	4725	4655	70	119	0.081
27A1	SH477113DDR	1	C	0.17	0.53	1.76	4630	4520	110	0.36	0.34	4570	4520	50	209	0.045
27B1	SH477113ACR	1	C	0.14	0.75	1.91	4715	4555	160	0.61	0.58	4660	4555	105	213	0.132
27B2	SH477113ACL	1	C	0.48	1.14	3.15	4725	4555	170	1.03	1.00	4690	4555	135	149	0.069
28A2	NB467005CAR	1	C	0.24	0.66	2.28	4680	4585	95	0.55	0.49	4635	4585	50	145	0.041
28A3	NB467005CAL	1	C	0.20	0.74	2.32	4700	4585	115	0.71	0.67	4665	4585	80	155	0.077
28B2	SH477031DDL	1	C	0.24	0.76	2.54	4740	4515	225	0.59	0.56	4610	4515	95	296	0.103
29A1	GS477122BBR	1	C	0.14	0.56	1.68	4725	4605	120	0.35	0.34	4640	4605	35	213	0.057
29A2	GS477122BBL	1	C	0.25	0.65	2.26	4690	4605	85	0.34	0.34	4625	4605	20	131	0.022
29B2	SH477115DAL	1	C	0.41	0.80	2.79	4715	4580	135	0.62	0.59	4655	4580	75	168	0.039

BASNUM	CHANNEL SLOPE	SINUOSITY	DRAINAGE DENSITY	CIRCULARITY	PRECIP.	VEGETATION	SOIL	ASPECT	SURFICIAL GEOLOGY	GEOLOGY	AGI #1	AGI #2	AGI #3	AGI #4
22B1	0.040	1.108	4.28	0.61	3	3	1	4	0	1	0.006	0.004	0.005	12.60
22B2	0.028	1.083	3.24	0.64	3	3	1	4	0	1	0.006	0.003	0.004	9.00
22C2	0.019	1.062	2.16	0.53	3	4	1	1	0	1	0.013	0.010	0.013	75.00
23B2	0.024	1.078	4.47	0.49	3	2	1	4	0	1	0.005	0.002	0.003	11.25
23C2	0.018	1.134	2.84	0.61	3	5	1	4	0	1	0.007	0.003	0.005	19.80
23C3	0.017	1.161	1.17	0.65	3	5	1	1	0	1	0.015	0.006	0.009	30.60
25A1	0.016	1.055	1.50	0.46	3	3	1	4	0	1	0.016	0.006	0.008	48.75
25A2	0.022	1.015	3.70	0.58	3	3	1	1	0	1	0.006	0.003	0.004	18.75
25B2	0.017	1.031	3.28	0.32	3	3	1	1	0	1	0.008	0.004	0.005	31.20
27A1	0.026	1.055	2.14	0.68	3	3	1	1	3	3	0.010	0.004	0.007	18.70
27B1	0.033	1.051	4.37	0.48	3	3	1	2	0	2	0.007	0.005	0.006	22.40
27B2	0.025	1.033	2.13	0.61	3	3	1	2	0	2	0.015	0.012	0.014	81.60
28A2	0.017	1.108	2.26	0.58	2	2	1	4	3	4	0.008	0.004	0.007	22.80
28A3	0.021	1.053	3.51	0.47	2	2	1	1	3	4	0.006	0.004	0.006	23.00
28B2	0.031	1.057	2.41	0.48	2	3	1	1	2	4	0.017	0.007	0.013	54.00
29A1	0.019	1.022	2.53	0.62	3	3	1	2	0	4	0.009	0.003	0.006	16.80
29A2	0.011	1.009	1.35	0.62	3	3	1	3	0	4	0.012	0.003	0.006	21.25
29B2	0.023	1.046	1.53	0.66	3	3	1	3	0	4	0.017	0.009	0.013	55.35

Table 4. (cont.) First order drainage basins listed by classification stratum. Stratum C (cont.)

BASNUM	LOCATION CODE	ORDER	CAT	BASIN AREA	BASIN LENGTH	BASIN PERIMETER	MAXIMUM ELEV.	MINIMUM ELEV.	BASIN RELIEF	MAIN CHANNEL LENGTH	VALLEY LENGTH	MAXIMUM USED RELIEF	MINIMUM USED RELIEF	USEDREL	RELIEF RATIO	RUGGEDNESS NO.
31A1	ER467133ACR	1	C	0.19	0.72	2.11	4855	4720	135	0.50	0.49	4795	4720	75	188	0.068
31A2	ER467133ACL	1	C	0.35	1.05	3.03	4895	4720	175	1.09	1.01	4835	4720	115	167	0.103
31B2	ER457104BDL	1	C	0.64	1.38	3.97	4855	4720	135	1.31	1.17	4825	4720	105	98	0.052
32A2	RJ457120BCL	1	C	0.10	0.68	1.84	4915	4755	160	0.56	0.54	4840	4755	85	234	0.164
32B7	RJ447104BCR	1	C	0.41	1.08	3.64	4985	4880	105	1.02	0.93	4940	4880	60	97	0.050
32B8	RJ447104BCL	1	C	0.24	0.92	2.79	4990	4880	110	0.75	0.72	4935	4880	55	119	0.065
40A2	RR427102BCL	1	C	0.26	1.18	2.89	4975	4875	100	1.12	1.07	4975	4800	175	85	0.080
40B1	LT417128ACR	1	C	0.13	0.67	1.78	4970	4820	150	0.60	0.57	4870	4820	50	223	0.133
40B2	LT417128ACL	1	C	0.23	0.92	2.51	4875	4820	55	0.83	0.81	4940	4820	120	60	0.037
41A1	LT437236DBL	1	C	0.35	1.47	3.71	5090	4900	190	1.56	1.42	5050	4900	150	130	0.159
41B1	LT437131BCR	1	C	0.25	0.74	2.64	4970	4915	55	0.72	0.69	4960	4915	45	74	0.030
41B2	LT437131BCL	1	C	0.16	0.47	1.88	4985	4915	70	0.59	0.55	4940	4915	25	148	0.048
43A2	RJ447119AAL	1	C	0.17	0.80	2.44	5015	4880	135	0.49	0.49	4950	4880	70	169	0.072
43B1	RJ447117CCR	1	C	0.14	0.84	2.02	5015	4880	135	0.56	0.56	4950	4880	70	161	0.104
43B2	RJ447117CCL	1	C	0.20	0.50	2.37	4945	4880	65	0.54	0.52	4915	4880	35	131	0.033

BASNUM	CHANNEL SLOPE	SINUOSITY	DRAINAGE DENSITY	CIRCULARITY	PRECIP.	VEGETATION	SOIL	ASPECT	SURFICIAL GEOLOGY	GEOLOGY	AGI #1	AGI #2	AGI #3	AGI #4
31A1	0.028	1.036	2.66	0.53	2	5	1	4	0	1	0.010	0.005	0.007	25.65
31A2	0.020	1.081	3.11	0.48	2	5	1	1	0	1	0.011	0.007	0.011	61.25
31B2	0.015	1.121	2.05	0.51	2	5	1	4	0	1	0.012	0.010	0.012	86.40
32A2	0.029	1.028	5.42	0.38	2	5	1	2	1	1	0.005	0.003	0.004	16.00
32B7	0.011	1.103	2.51	0.39	2	2	1	3	4	1	0.008	0.005	0.008	43.05
32B8	0.014	1.048	3.11	0.39	2	2	1	4	3	1	0.007	0.003	0.005	26.40
40A2	0.030	1.039	4.21	0.40	1	3	1	1	0	1	0.004	0.008	0.004	26.00
40B1	0.016	1.045	4.68	0.51	1	3	1	1	0	1	0.006	0.002	0.005	19.50
40B2	0.027	1.026	3.59	0.46	1	4	1	1	0	1	0.003	0.006	0.003	12.65
41A1	0.018	1.097	4.43	0.32	1	2	1	3	0	1	0.008	0.006	0.009	66.50
41B1	0.012	1.042	2.86	0.45	1	2	1	3	0	1	0.004	0.003	0.004	13.75
41B2	0.008	1.087	3.62	0.59	1	2	1	3	0	1	0.004	0.001	0.004	11.20
43A2	0.027	1.009	2.82	0.37	2	2	1	3	5	1	0.009	0.005	0.005	22.95
43B1	0.024	1.011	4.08	0.42	2	2	1	3	5	1	0.006	0.003	0.004	18.90
43B2	0.012	1.046	2.66	0.46	2	2	1	3	3	1	0.005	0.002	0.005	13.00

Table 4. (cont.) First order drainage basins listed by classification stratum. Stratum C (cont.).

BASNUM	LOCATION CODE	ORDER	CAT	BASIN AREA	BASIN LENGTH	BASIN PERIMETER	MAXIMUM ELEV.	MINIMUM ELEV.	BASIN RELIEF	MAIN CHANNEL LENGTH	VALLEY LENGTH	MAXIMUM USED RELIEF	MINIMUM USED RELIEF	USEDREL	RELIEF RATIO	RUGGEDNESS NO.
51A5	PN427010ADR	1	C	0.62	1.54	3.83	4900	4770	130	1.35	1.32	4880	4770	110	84	0.053
51A6	PN427010ADL	1	C	0.91	1.21	4.81	4880	4770	110	1.33	1.29	4875	4770	105	91	0.030
51B2	PN427001BBL	1	C	0.08	0.45	1.16	4810	4735	75	0.40	0.39	4795	4735	60	169	0.071
55B2	TS427130DCR	1	C	0.55	1.04	3.26	5005	4930	75	0.95	0.93	4995	4930	65	72	0.025
55C2	TS427130BAR	1	C	0.21	0.62	1.90	5015	4885	130	0.60	0.51	4975	4885	90	208	0.070
55C3	TS427130BAL	1	C	0.05	0.40	1.13	4945	4885	60	0.35	0.33	4935	4885	50	152	0.087
58A2	TK427027CDL	1	C	0.43	0.84	3.22	4965	4850	115	0.41	0.38	4990	4850	140	137	0.021
58B1	TK427034ABR	1	C	0.49	0.89	3.18	4945	4845	100	0.75	0.69	4900	4845	55	112	0.029
58B2	TK427034ABL	1	C	0.29	0.70	2.40	4910	4845	65	0.51	0.46	4895	4845	50	93	0.021
61B1	PS417003ADR	1	C	0.33	0.70	2.81	4905	4770	155	0.63	0.59	4875	4770	105	221	0.057
61B2	PS417003ADL	1	C	0.21	0.84	2.14	4930	4770	160	0.59	0.53	4880	4770	110	191	0.086
61C2	PS417003DAL	1	C	0.11	0.48	1.44	4910	4780	130	0.40	0.39	4850	4780	70	269	0.093

BASNUM	CHANNEL SLOPE	SINUOSITY	DRAINAGE DENSITY	CIRCULARITY	PRECIP.	VEGETATION	SOIL	ASPECT	SURFICIAL GEOLOGY	GEOLOGY	AGI #1	AGI #2	AGI #3	AGI #4
51A5	0.015	1.021	2.15	0.54	1	3	1	1	0	1	0.011	0.009	0.010	80.60
51A6	0.015	1.031	1.46	0.49	1	3	1	1	0	1	0.014	0.014	0.016	100.10
51B2	0.028	1.025	5.03	0.74	1	2	1	3	5	4	0.003	0.002	0.003	6.00
55B2	0.013	1.029	1.75	0.64	1	2	1	1	0	1	0.008	0.007	0.008	41.25
55C2	0.028	1.168	2.86	0.73	1	2	1	3	0	1	0.009	0.006	0.008	27.30
55C3	0.027	1.062	7.70	0.45	1	2	1	2	0	1	0.002	0.001	0.001	3.00
58A2	0.064	1.095	0.96	0.52	1	4	1	3	0	2	0.023	0.028	0.011	49.45
58B1	0.014	1.092	1.54	0.61	1	4	1	4	0	2	0.012	0.007	0.010	49.00
58B2	0.018	1.104	1.74	0.64	1	4	1	4	0	2	0.007	0.005	0.005	18.85
61B1	0.032	1.068	1.93	0.52	1	4	4	3	0	2	0.015	0.011	0.014	51.15
61B2	0.035	1.117	2.85	0.57	1	4	4	4	0	2	0.011	0.007	0.008	33.60
61C2	0.033	1.016	3.78	0.64	1	5	4	4	0	3	0.007	0.004	0.006	14.30

Table 4. (cont.) First order drainage basins listed by classification stratum. Stratum D.

BASNUM	LOCATION CODE	ORDER	CAT	BASIN AREA	BASIN LENGTH	BASIN PERIMETER	MAXIMUM ELEV.	MINIMUM ELEV.	BASIN RELIEF	MAIN CHANNEL LENGTH	VALLEY LENGTH	MAXIMUM USED RELIEF	MINIMUM USED RELIEF	USEDREL	RELIEF RATIO	RUGGEDNESS NO.
33A2	RE466928DBR	1	D	0.16	0.73	1.87	5060	4850	210	0.62	0.59	4980	4850	130	287	0.156
33B3	RC466932BDR	1	D	0.21	0.79	2.21	5090	4955	135	0.61	0.59	5030	4955	75	170	0.073
33B4	RC466932BDL	1	D	0.26	0.93	2.25	5110	4955	155	0.71	0.69	5040	4955	85	167	0.081
34A2	RC466917CBL	1	D	0.24	0.94	2.52	5045	4835	210	0.87	0.79	4955	4835	120	223	0.144
34B2	RC466918BAR	1	D	0.15	0.50	1.96	4960	4875	85	0.39	0.34	4920	4875	45	169	0.042
34B3	RC466918BAL	1	D	0.18	0.71	2.00	4970	4875	95	0.61	0.57	4945	4875	70	133	0.060

BASNUM	CHANNEL SLOPE	SINUOSITY	DRAINAGE DENSITY	CIRCULARITY	PRECIP.	VEGETATION	SOIL	ASPECT	SURFICIAL GEOLOGY	GEOLOGY	AGI #1	AGI #2	AGI #3	AGI #4
33A2	0.040	1.042	3.91	0.57	2	1	3	1	0	4	0.010	0.006	0.009	33.60
33B3	0.023	1.033	2.86	0.55	2	2	3	4	0	4	0.009	0.005	0.007	28.35
33B4	0.023	1.030	2.74	0.64	2	1	3	1	0	4	0.011	0.006	0.008	40.30
34A2	0.026	1.100	3.62	0.48	2	3	3	1	0	4	0.011	0.006	0.010	50.40
34B2	0.022	1.129	2.62	0.49	2	3	3	3	0	4	0.006	0.003	0.005	12.75
34B3	0.022	1.063	3.32	0.57	2	3	3	3	0	4	0.005	0.004	0.005	17.10

APPENDIX IV

SECOND ORDER CLASSIFICATION STRATA STATISTICS,
CORRELATION TABLES, ANALYSIS OF VARIANCE RESULTS,
AND CATEGORICAL DATA PRESENTATION

Table 1. Results of the Principal Components Analysis of the second order drainage basins. Eigenvalues, and the proportion of the variability within the data set that they represent are presented. Factors 1,2, and 3 were retained for the cluster analysis. These first three components retain 74.14 % of the variability contained within 18 variables used in the principal components analysis.

Initial Factor Method: Principal Components

Prior Communality Estimates: ONE

Eigenvalues of the Correlation Matrix: Total = 17 Average = 1

	1	2	3	4	5	6	7	8	9
Eigenvalue	7.1071	3.7339	1.3038	1.0661	0.9747	0.6951	0.6279	0.4279	0.3675
Difference	3.3731	2.4301	0.2378	0.0914	0.2796	0.0672	0.2000	0.0604	0.0787
Proportion	0.4181	0.2196	0.0767	0.0627	0.0573	0.0409	0.0369	0.0252	0.0216
Cumulative	0.4181	0.6377	0.7144	0.7771	0.8344	0.8753	0.9123	0.9374	0.9590

	10	11	12	13	14	15	16	17
Eigenvalue	0.2887	0.2352	0.0818	0.0376	0.0210	0.0149	0.0114	0.0055
Difference	0.0535	0.1534	0.0442	0.0166	0.0062	0.0034	0.0060	
Proportion	0.0170	0.0138	0.0048	0.0022	0.0012	0.0009	0.0007	0.0003
Cumulative	0.9760	0.9899	0.9947	0.9969	0.9981	0.9990	0.9997	1.0000

6 factors will be retained by the NFACTOR criterion.

Initial Factor Method: Principal Components

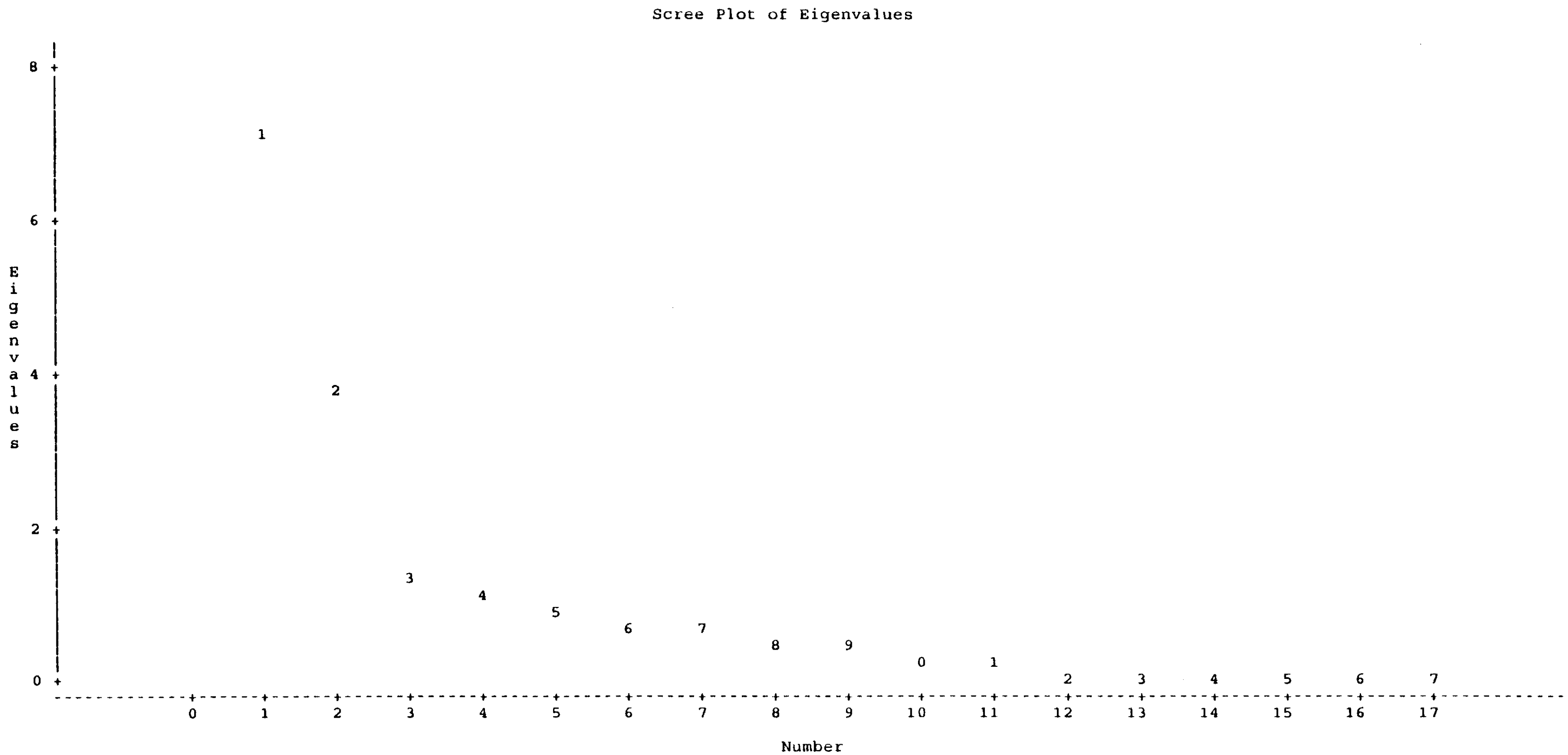


Figure 1. A scree plot of the eigenvalues of each principal component derived from the second order basin principal component analysis, plotted against the number of the component. The break in slope at 3 indicates a possible point at which the selection of components should cease.

Table 3. (cont). Summary statistics for second order drainage basins investigated in the Powder River Basin Coal Field identified in Classification Stratum A.

Stratum A n = 36	No. of Firsts	Rugged-ness Number	Circularity Ratio	AGI#1[†] (miles^{2}x ft./ft.)	AGI#2[††] (miles^{2}x ft./ft.)	AGI#3[‡] (miles^{2}x ft./ft.)	AGI#4[‡‡] (miles^{2}x feet)	Maximum Elevation (feet)	Minimum Elevation (feet)	Maximum Used Relief (feet)	Minimum Used Relief (feet)
Mean[1]	3	0.20	0.51	0.024	0.016	0.027	238.67	4755.40	4485.60	4627.40	4502.40
Lower 90% C.L.[2]	3	0.18	0.48	0.021	0.014	0.023	178.82	4666.60	4391.60	4534.70	4408.10
Upper 90% C.L.[3]	3	0.23	0.54	0.027	0.019	0.031	298.52	4844.20	4579.60	4720.00	4596.60
S.D.[4]	2	0.08	0.11	0.009	0.009	0.014	212.54	315.30	333.81	329.09	334.84
C.V. (%)[5]	53	41	21	39	53	52	89	7	7	7	7
Median	2	0.17	0.52	0.024	0.016	0.025	182.16	4920.00	4672.50	4790.00	4687.50
Minimum	2	0.10	0.29	0.011	0.004	0.010	30.06	4200.00	3885.00	4040.00	3895.00
Maximum	9	0.40	0.78	0.048	0.037	0.063	855.16	5145.00	4875.00	5035.00	4900.00
Range	7	0.30	0.48	0.037	0.032	0.053	825.11	945.00	990.00	995.00	1005.00

1 Arithmetic mean
2 Lower 90% confidence interval of the arithmetic mean
3 Upper 90% confidence interval of the arithmetic mean
4 Standard deviation of the arithmetic mean
5 Coefficient of variation, in percent

Table 4. (cont). Summary statistics for second order drainage basins investigated in the Powder River Basin Coal Field identified in Classification Stratum B.

Stratum B n = 44	No. of Firsts	Rugged-ness Number	Circularity Ratio	AGI#1† (miles²x ft./ft.)	AGI#2†† (miles²x ft./ft.)	AGI#3‡ (miles²x ft./ft.)	AGI#4‡‡ (miles²x feet)	Maximum Elevation (feet)	Minimum Elevation (feet)	Maximum Used Relief (feet)	Minimum Used Relief (feet)
Mean[1]	2	0.12	0.54	0.018	0.012	0.019	129.40	4869.00	4682.50	4785.80	4694.90
Lower 90% C.L.[2]	2	0.11	0.51	0.016	0.011	0.017	111.61	4829.90	4641.50	4745.50	4654.00
Upper 90% C.L.[3]	3	0.14	0.56	0.019	0.013	0.022	147.18	4908.10	4723.50	4826.10	4735.80
S.D.[4]	1	0.05	0.11	0.005	0.004	0.010	70.18	154.31	161.87	158.93	161.52
C.V. (%)[5]	27	37	20	27	32	53	54	3	3	3	3
Median	2	0.12	0.53	0.018	0.012	0.018	120.12	4905.00	4710.00	4827.50	4722.50
Minimum	2	0.05	0.33	0.008	0.007	0.004	31.76	4440.00	4200.00	4310.00	4215.00
Maximum	4	0.24	0.77	0.026	0.024	0.071	330.51	5085.00	4920.00	5000.00	4935.00
Range	2	0.18	0.44	0.017	0.017	0.067	298.75	645.00	720.00	690.00	720.00

1 Arithmetic mean
2 Lower 90% confidence interval of the arithmetic mean
3 Upper 90% confidence interval of the arithmetic mean
4 Standard deviation of the arithmetic mean
5 Coefficient of variation, in percent

Table 5. Summary statistics for second order drainage basins investigated in the Powder River Basin Coal Field identified in Classification Stratum C.

Stratum C n = 44	Basin Area (miles^2)	Basin Length (miles)	Basin Perimeter (miles)	Basin Relief (feet)	Main Channel Length (miles)	Valley Length (miles)	Total Channel Length (miles)	Used Relief (feet)	Relief Ratio (ft./mile)	Channel Slope (ft./ft.)	Sinuosity	Drainage Density (miles/miles^2)
Mean[1]	1.41	1.77	5.69	203.86	1.99	1.78	3.56	99.32	132.39	0.017	1.10	2.85
Lower 90% C.L.[2]	1.08	1.55	4.97	186.10	1.64	1.49	2.82	90.73	118.00	0.015	1.08	2.63
Upper 90% C.L.[3]	1.74	2.00	6.41	221.63	2.33	2.07	4.29	107.91	146.77	0.019	1.11	3.07
S.D.[4]	1.30	0.89	2.84	70.09	1.36	1.13	2.90	33.91	56.77	0.008	0.05	0.87
C.V.(%)[5]	92	50	50	34	68	64	82	34	43	46	5	31
Median	0.90	1.58	4.68	197.50	1.54	1.42	2.81	100.00	122.97	0.016	1.09	2.70
Minimum	0.25	0.63	2.61	70.00	0.58	0.58	0.97	30.00	43.17	0.004	1.01	1.16
Maximum	6.85	4.22	15.28	405.00	7.39	6.17	15.03	200.00	304.35	0.035	1.26	4.90
Range	6.60	3.59	12.66	335.00	6.80	5.59	14.06	170.00	261.18	0.031	0.25	3.73

1 Arithmetic mean
2 Lower 90% confidence interval of the arithmetic mean
3 Upper 90% confidence interval of the arithmetic mean
4 Standard deviation of the arithmetic mean
5 Coefficient of variation, in percent

Table 5. (cont). Summary statistics for second order drainage basins investigated in the Powder River Basin Coal Field identified in Classification Stratum C.

Stratum C n = 44	No. of Firsts	Rugged-ness Number	Circularity Ratio	AGI#1† (miles^{2}x ft./ft.)	AGI#2†† (miles^{2}x ft./ft.)	AGI#3‡ (miles^{2}x ft./ft.)	AGI#4‡‡ (miles^{2}x feet)	Maximum Elevation (feet)	Minimum Elevation (feet)	Maximum Used Relief (feet)	Minimum Used Relief (feet)
Mean[1]	3	0.11	0.51	0.025	0.018	0.028	305.68	4811.80	4608.00	4720.20	4620.90
Lower 90% C.L.[2]	3	0.10	0.48	0.022	0.015	0.024	225.66	4769.60	4558.00	4674.90	4572.10
Upper 90% C.L.[3]	4	0.13	0.54	0.028	0.020	0.031	385.70	4854.00	4657.90	4765.60	4669.70
S.D.[4]	2	0.06	0.11	0.011	0.008	0.015	315.75	166.54	197.09	179.04	192.67
C.V. (%)[5]	58	54	22	45	47	56	103	3	4	4	4
Median	3	0.10	0.51	0.026	0.016	0.022	177.60	4862.50	4595.00	4715.00	4610.00
Minimum	2	0.03	0.30	0.007	0.004	0.006	35.05	4435.00	4250.00	4370.00	4270.00
Maximum	10	0.31	0.74	0.060	0.048	0.074	1645.00	5090.00	4890.00	5005.00	4900.00
Range	8	0.28	0.44	0.053	0.044	0.067	1609.95	655.00	640.00	635.00	630.00

1 Arithmetic mean
2 Lower 90% confidence interval of the arithmetic mean
3 Upper 90% confidence interval of the arithmetic mean
4 Standard deviation of the arithmetic mean
5 Coefficient of variation, in percent

Table 6. Results of analysis of variance and multiple comparisons performed on second-order drainage basins comparing means of strata A, B, and C.

Differences between stratum detected using a Scheffe's test (alpha=0.10) are indicated with a '+'. Comparisons for which no significant difference was found are marked with a '-'.

The p-value for the Analysis of variance is given under ANOVA P-value.
All tests performed with the SAS software package on data transformed to the Log base 10.

Variable/ Units	ANOVA P-Value	Strata A v. B	Strata A v. B	Strata B v. C
Area (mile^2)	0.0006	-	+	+
Basin Length (miles)	0.0091	-	-	+
Main Channel Length (miles)	0.0340	-	-	+
Total Channel Length (miles)	0.0286	-	-	+
Number of 1st order streams	0.0741	-	-	+
Basin Relief (ft)	0.0001	+	+	-
Used Relief (ft)	0.0004	+	+	-
Relief Ratio (ft/mile)	0.0001	+	+	+
Channel Slope (ft/ft)	0.0002	-	+	+
Drainage Density (miles/mile^2)	0.0001	-	+	+
Sinuosity (unitless)	0.0515	+	-	-
Circularity (unitless)	0.4777	-	-	-

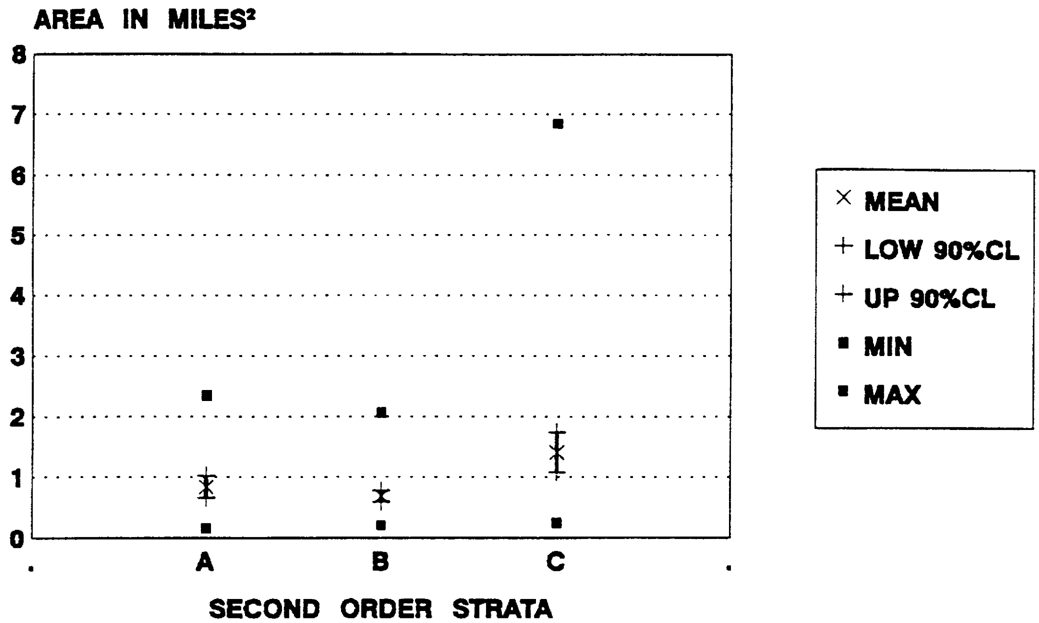


Figure 2. Means, 90% confidence limits, and ranges of area in each of the three strata of second order drainage basins in the Powder River Basin. (LOW 90%CL = Lower 90% confidence limit, UP 90%CL = Upper 90% confidence limit.)

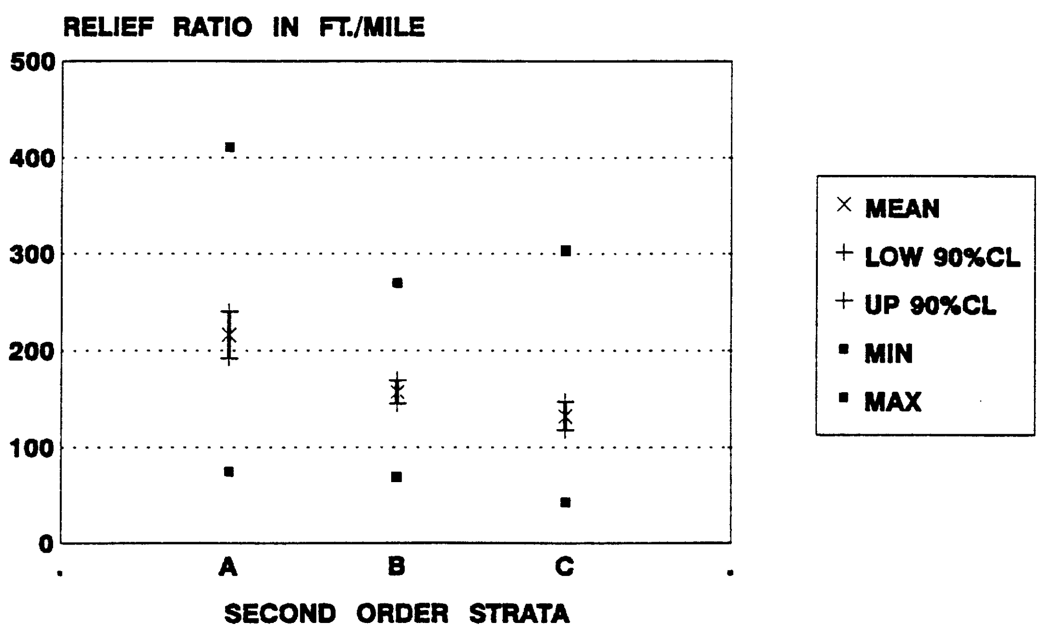


Figure 3. Means, 90% confidence limits, and ranges of relief ratio in each of the three strata of second order drainage basins in the Powder River Basin. (LOW 90%CL = Lower 90% confidence limit, UP 90%CL = Upper 90% confidence limit.)

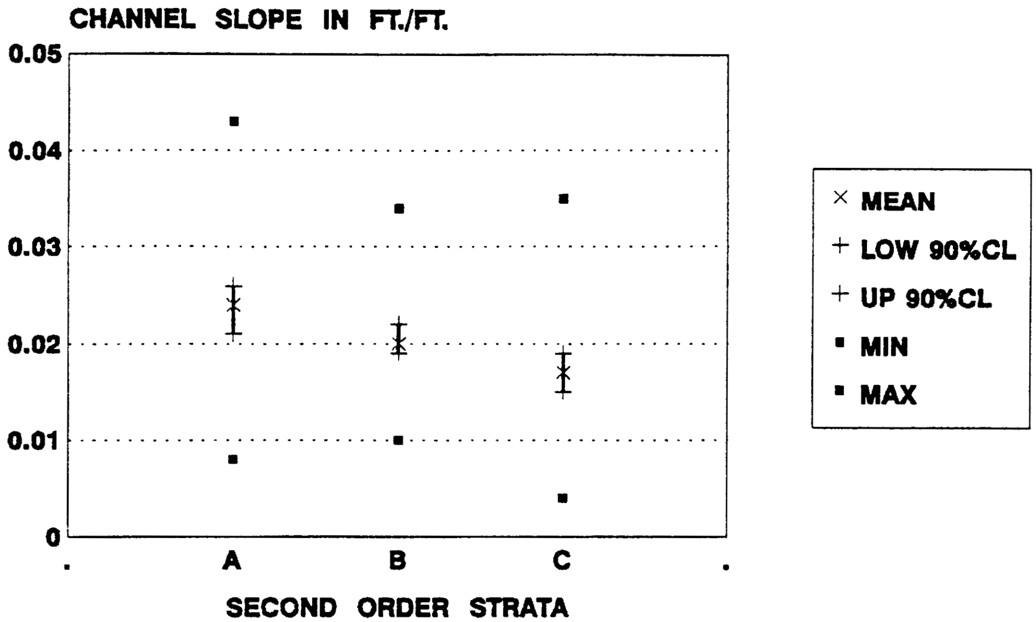


Figure 4. Means, 90% confidence limits, and ranges of channel slope in each of the three strata of second order drainage basins in the Powder River Basin. (LOW 90%CL = Lower 90% confidence limit, UP 90%CL = Upper 90% confidence limit.)

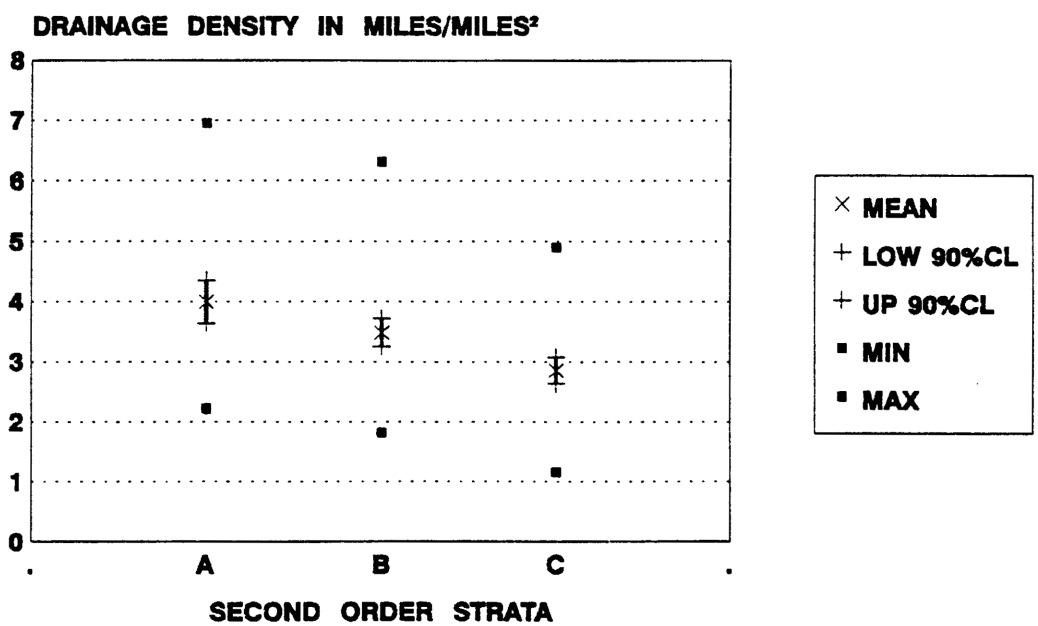
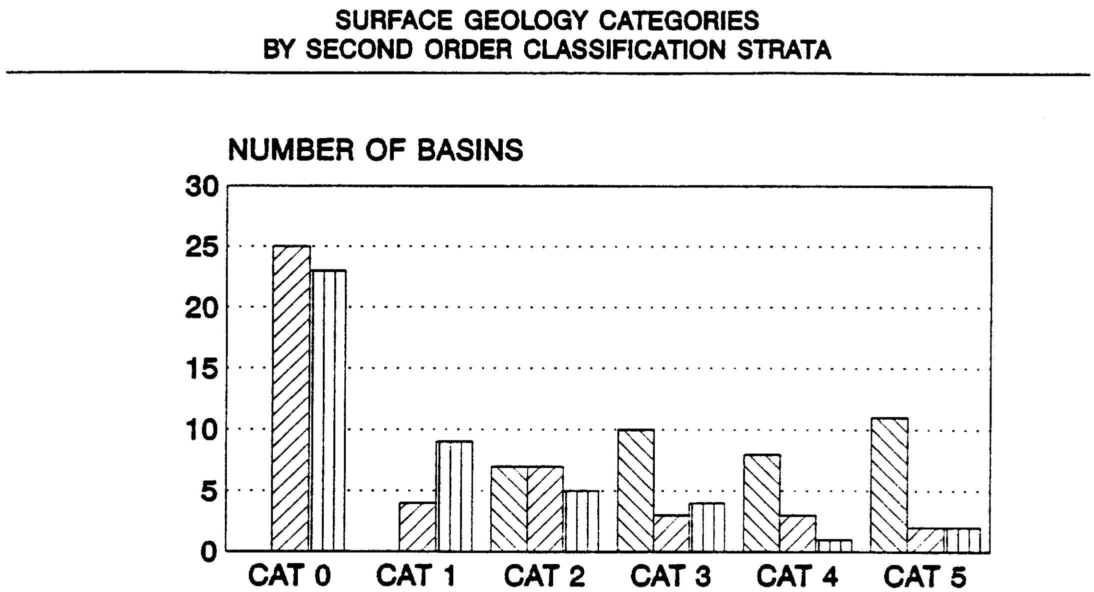


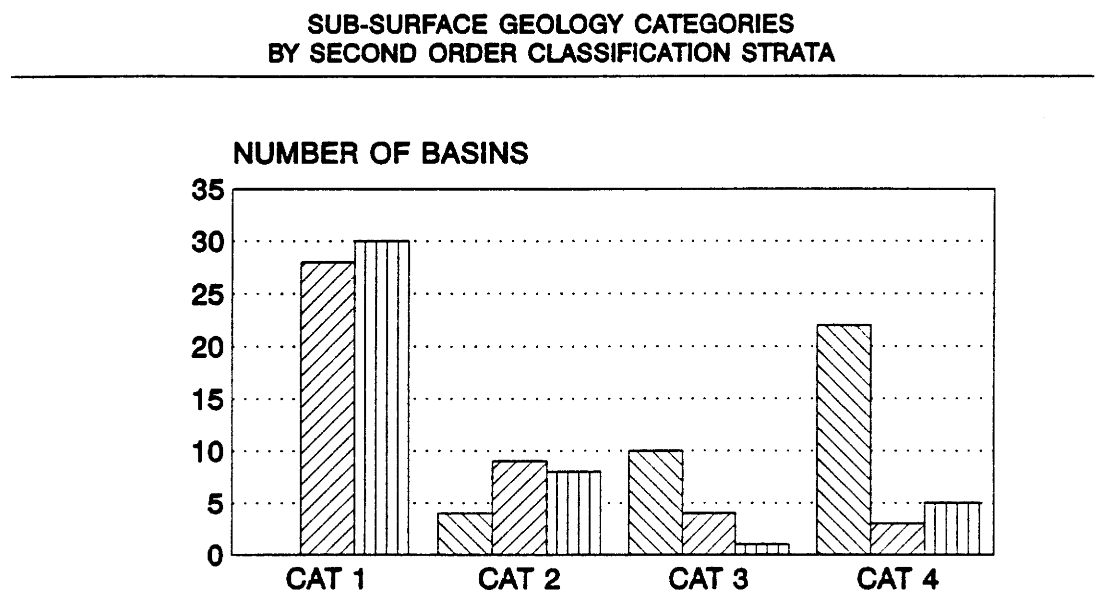
Figure 5. Means, 90% confidence limits, and ranges of drainage density in each of the three strata of second order drainage basins in the Powder River Basin. (LOW 90%CL = Lower 90% confidence limit, UP 90%CL = Upper 90% confidence limit.)



	CAT 0	CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
STRATA A	0	0	7	10	8	11
STRATA B	25	4	7	3	3	2
STRATA C	23	9	5	4	1	2

CATEGORY

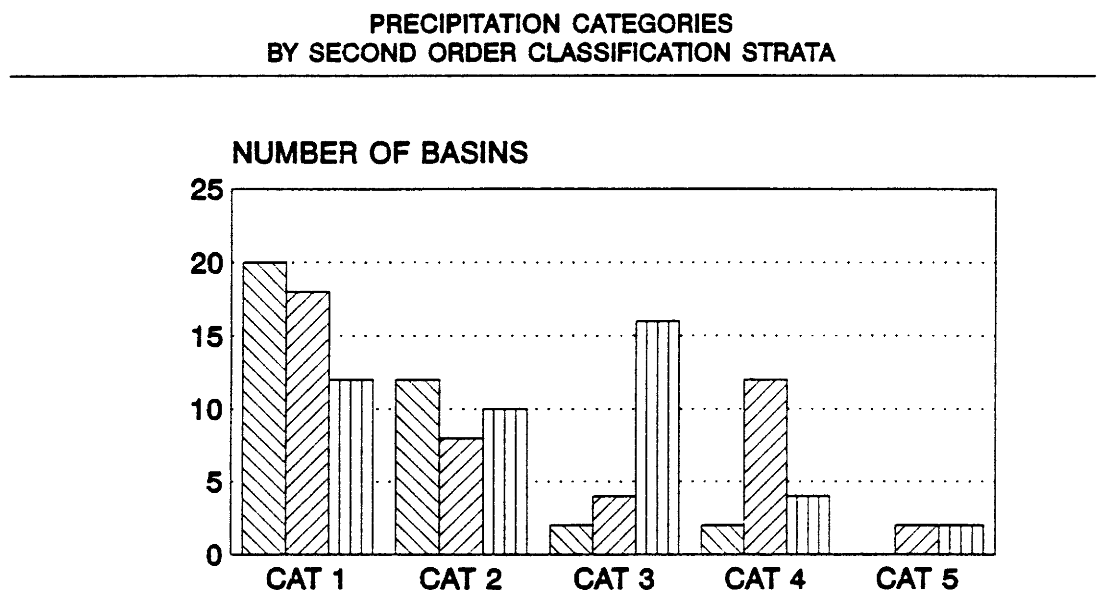
Figure 6. Comparison of the number of drainage basins in each surface geology category, in each strata, for investigated second order drainage basins in the Powder River Basin Coal Field.



	CAT 1	CAT 2	CAT 3	CAT 4
STRATA A	0	4	10	22
STRATA B	28	9	4	3
STRATA C	30	8	1	5

CATEGORY

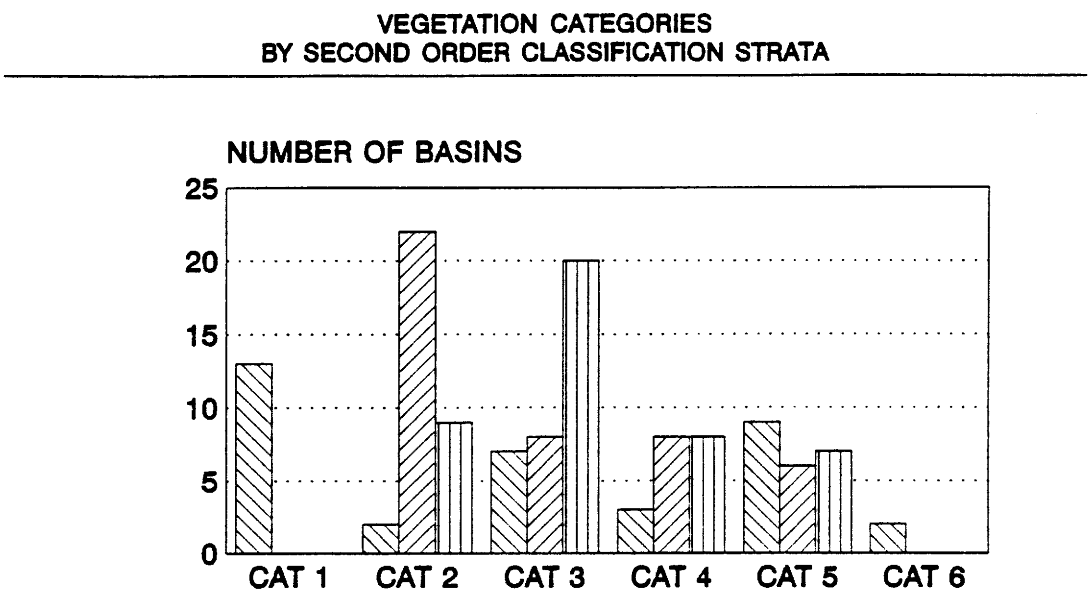
Figure 7. Comparison of the number of drainage basins in each geology category, in each strata, for investigated second order drainage basins in the Powder River Basin Coal Field.



	CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
STRATA A	20	12	2	2	0
STRATA B	18	8	4	12	2
STRATA C	12	10	16	4	2

CATEGORY

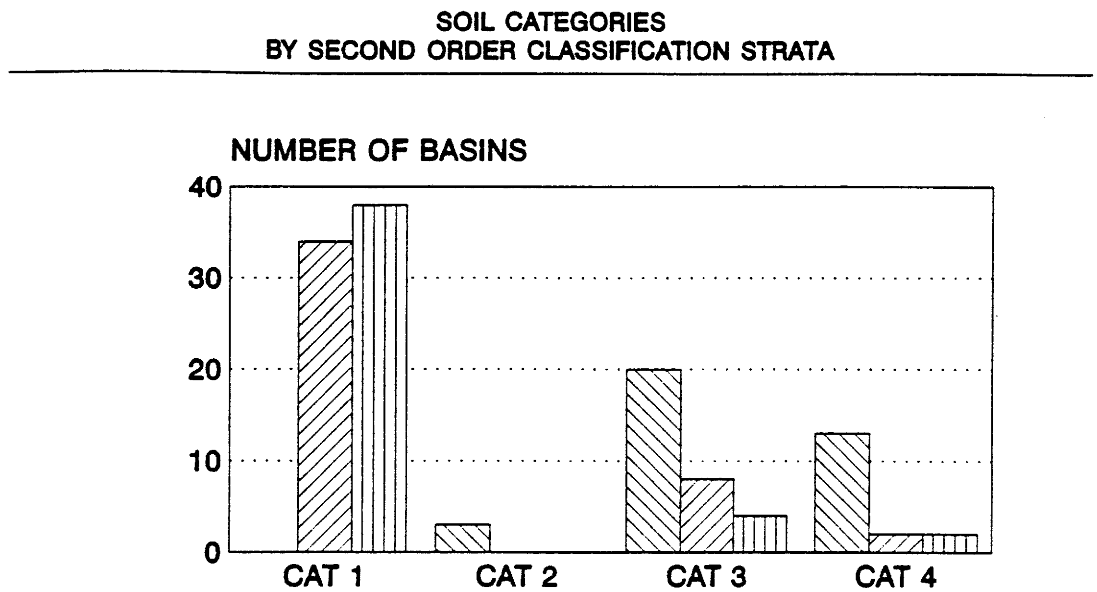
Figure 8. Comparison of the number of drainage basins in each precipitation category, in each strata, for investigated second order drainage basins in the Powder River Basin Coal Field.



	CAT 1	CAT 2	CAT 3	CAT 4	CAT 5	CAT 6
STRATA A	13	2	7	3	9	2
STRATA B	0	22	8	8	6	0
STRATA C	0	9	20	8	7	0

VEGETATION CATEGORY

Figure 9. Comparison of the number of drainage basins in each vegetation category, in each strata, for investigated second order drainage basins in the Powder River Basin Coal Field.



	CAT 1	CAT 2	CAT 3	CAT 4
STRATA A	0	3	20	13
STRATA B	34	0	8	2
STRATA C	38	0	4	2

CATEGORY

Figure 10. Comparison of the number of drainage basins in each soil category, in each strata, for investigated second order drainage basins in the Powder River Basin Coal Field.

APPENDIX V

FIRST ORDER CLASSIFICATION STRATA STATISTICS, CORRELATION TABLES, ANALYSIS OF VARIANCE RESULTS, AND CATEGORICAL DATA PRESENTATION

Table 1. Results of the Principal Components Analysis of the first order drainage basins. Eigenvalues, and the proportion of the variability within the data set that they represent are presented. Factors 1,2, and 3 were retained for the cluster analysis. These first three components retain 74.14 % of the variability contained within 18 variables used in the principal components analysis.

Initial Factor Method: Principal Components

Prior Communality Estimates: ONE

Eigenvalues of the Correlation Matrix: Total = 15 Average = 1

	1	2	3	4	5	6	7	8
Eigenvalue	5.2067	3.8436	1.3684	1.2088	0.9708	0.7975	0.4895	0.3909
Difference	1.3631	2.4752	0.1596	0.2380	0.1733	0.3080	0.0986	0.0704
Proportion	0.3471	0.2562	0.0912	0.0806	0.0647	0.0532	0.0326	0.0261
Cumulative	0.3471	0.6034	0.6946	0.7752	0.8399	0.8931	0.9257	0.9518

	9	10	11	12	13	14	15
Eigenvalue	0.3205	0.1846	0.1119	0.0557	0.0298	0.0131	0.0078
Difference	0.1359	0.0727	0.0562	0.0259	0.0167	0.0053	
Proportion	0.0214	0.0123	0.0075	0.0037	0.0020	0.0009	0.0005
Cumulative	0.9731	0.9854	0.9929	0.9966	0.9986	0.9995	1.0000

6 factors will be retained by the NFACTOR criterion.

Initial Factor Method: Principal Components

Scree Plot of Eigenvalues

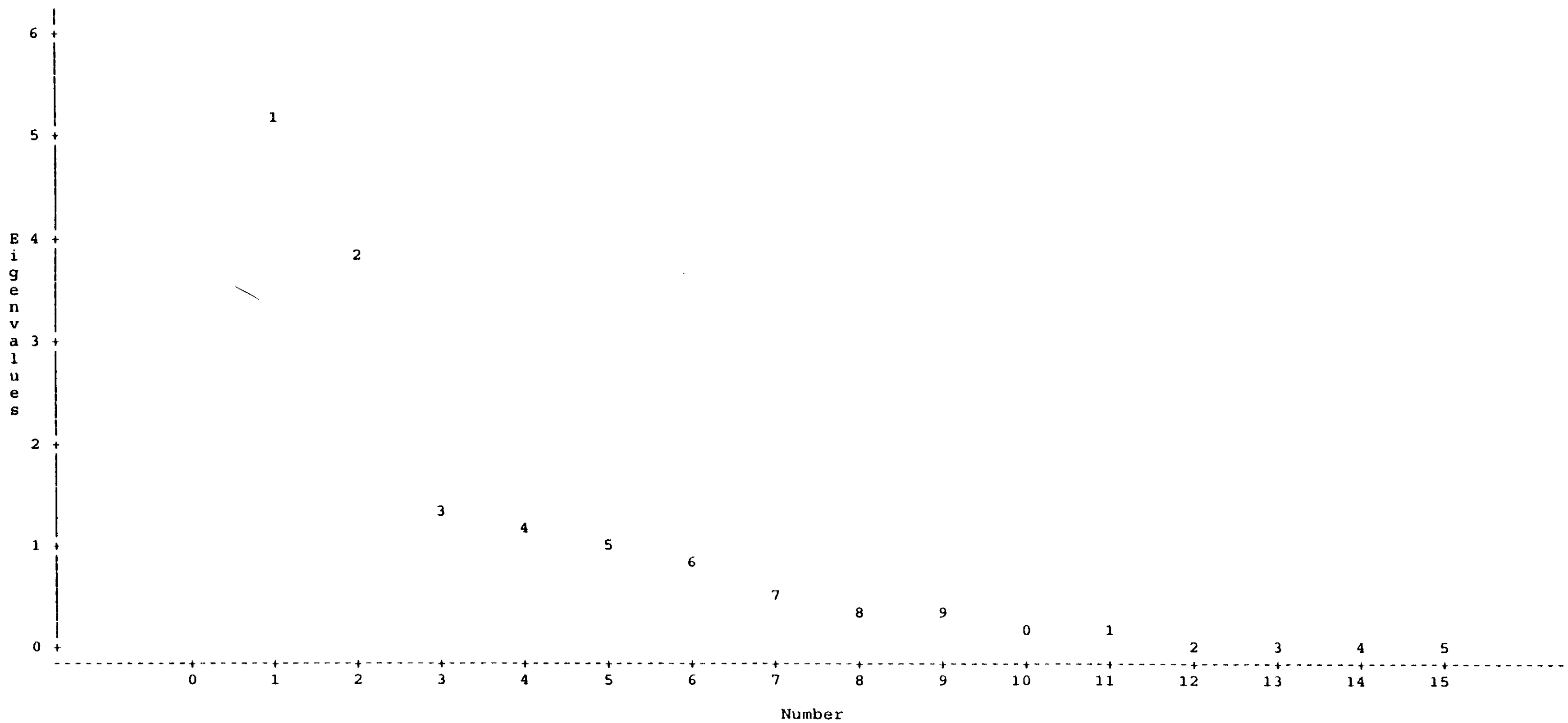


Figure 1. A scree plot of the eigenvalues of each principal component derived from the first order basin principal component analysis, plotted against the number of the component. The break in slope at 3 indicates a possible point at which the selection of components should cease.

Table 2. The coefficients derived for the first 6 principal components, from the first order drainage basins. The values in each Factor column were used as coefficients of the corresponding variable for the indicated principal component. The coefficients and variables were combined in a linear equation to derive the values later put into the cluster analysis.

Initial Factor Method: Principal Components

Standardized Scoring Coefficients

	FACTOR1	FACTOR2	FACTOR3	FACTOR4	FACTOR5	FACTOR6
AREA	-0.14425	0.13801	-0.02336	0.19742	-0.08190	-0.11465
BL	-0.10328	0.19848	0.05764	-0.08441	-0.05969	-0.01746
PER	-0.13783	0.17277	-0.00004	0.03305	-0.06233	0.01071
BASREL	0.11370	0.17486	0.10476	0.20844	-0.06764	-0.00742
MCL	-0.09224	0.21346	0.04783	-0.03367	0.04694	0.02319
USEDREL	0.07556	0.20765	0.10845	0.15889	-0.05173	-0.22271
RR	0.17108	0.03551	0.06573	0.23924	0.00411	-0.04818
RUG	0.15738	0.11783	0.11694	-0.07583	0.10192	0.11418
CHANSLOP	0.16179	0.03640	0.09904	0.20394	-0.05850	-0.30136
SIN	-0.04157	0.02846	-0.02362	0.31419	0.86024	0.35967
DD	0.15067	0.02878	0.07099	-0.34442	0.19999	0.15112
CIRC	-0.03267	-0.14725	-0.06340	0.52580	-0.04926	-0.34483
PRECIP	-0.02855	-0.07125	0.41855	0.29316	-0.29955	0.67492
SURFGEO	0.06704	0.06681	-0.40855	0.09706	-0.34679	0.59658
SSGEO	0.05848	0.05735	-0.56777	0.12835	0.01360	0.03705

Table 3. Summary statistics for first order drainage basins investigated in the Powder River Basin Coal Field identified in Classification Stratum A.

Stratum A n = 54	Basin Area (miles²)	Basin Length (miles)	Basin Perimeter (miles)	Basin Relief (feet)	Main Channel Length (miles)	Valley Length (miles)	Used Relief (feet)	Relief Ratio (ft./mile)	Channel Slope (ft./ft.)	Sinuosity	Drainage Density (miles/miles²)
Mean[1]	0.23	0.80	2.26	199.54	0.71	0.67	122.31	272.21	0.035	1.06	3.93
Lower 90% C.L.[2]	0.18	0.72	2.06	183.76	0.63	0.60	110.98	247.55	0.032	1.05	3.58
Upper 90% C.L.[3]	0.27	0.87	2.45	215.32	0.79	0.74	133.65	296.86	0.039	1.06	4.27
S.D.[4]	0.18	0.32	0.86	69.26	0.34	0.31	49.75	108.23	0.014	0.03	1.53
C.V.(%)[5]	81	40	38	35	48	47	41	40	39	3	39
Median	0.17	0.72	2.08	187.50	0.60	0.58	110.00	264.53	0.034	1.05	3.43
Minimum	0.05	0.43	1.09	40.00	0.34	0.33	20.00	68.83	0.011	1.01	1.55
Maximum	0.92	1.84	4.47	340.00	1.76	1.61	260.00	554.86	0.068	1.14	7.54
Range	0.87	1.41	3.38	300.00	1.42	1.28	240.00	486.03	0.057	0.13	6.00

1 Arithmetic mean
2 Lower 90% confidence interval of the arithmetic mean
3 Upper 90% confidence interval of the arithmetic mean
4 Standard deviation of the arithmetic mean
5 Coefficient of variation, in percent

Table 3. (cont.) Summary statistics for first order drainage basins investigated in the Powder River Basin Coal Field identified in Classification Stratum A.

Stratum A n = 54	Rugged-ness Number	Circularity Ratio	Length of Overland Flow (miles)	AGI#1† ($miles^2$ x ft./ft.)	AGI#2†† ($miles^2$ x ft./ft.)	AGI#3‡ ($miles^2$ x ft./ft.)	AGI#4‡‡ ($miles^2$ x feet)	Maximum Elevation (feet)	Minimum Elevation (feet)	Maximum Used Relief (feet)	Minimum Used Relief (feet)
Mean[1]	0.15	0.50	0.15	0.011	0.007	0.010	45.56	4746.90	4550.60	4673.00	4550.60
Lower 90% C.L.[2]	0.13	0.48	0.13	0.009	0.006	0.008	35.38	4676.00	4473.10	4599.50	4473.10
Upper 90% C.L.[3]	0.17	0.52	0.16	0.012	0.008	0.011	55.73	4817.70	4628.20	4746.40	4628.20
S.D.[4]	0.09	0.09	0.06	0.006	0.004	0.006	44.66	311.18	340.20	322.42	340.20
C.V. (%)[5]	56	17	40	52	60	58	98	7	7	7	7
Median	0.14	0.51	0.15	0.009	0.006	0.008	31.47	4915.00	4715.00	4817.50	4715.00
Minimum	0.01	0.29	0.07	0.003	0.002	0.002	5.59	4195.00	3920.00	4025.00	3920.00
Maximum	0.38	0.66	0.32	0.034	0.023	0.032	253.70	5105.00	4950.00	5070.00	4950.00
Range	0.37	0.37	0.26	0.031	0.021	0.030	248.11	910.00	1030.00	1045.00	1030.00

1 Arithmetic mean
2 Lower 90% confidence interval of the arithmetic mean
3 Upper 90% confidence interval of the arithmetic mean
4 Standard deviation of the arithmetic mean
5 Coefficient of variation, in percent

Table 4. Summary statistics for first order drainage basins investigated in the Powder River Basin Coal Field identified in Classification Stratum B.

Stratum B n = 66	Basin Area (miles^2)	Basin Length (miles)	Basin Perimeter (miles)	Basin Relief (feet)	Main Channel Length (miles)	Valley Length (miles)	Used Relief (feet)	Relief Ratio (ft./mile)	Channel Slope (ft./ft.)	Sinuosity	Drainage Density (miles/ miles^2)
Mean[1]	0.20	0.73	2.12	143.86	0.63	0.59	89.17	206.05	0.029	1.06	3.59
Lower 90% C.L.[2]	0.18	0.69	1.99	134.18	0.57	0.54	82.31	190.73	0.027	1.05	3.32
Upper 90%C.L.[3]	0.22	0.77	2.25	153.55	0.68	0.64	96.03	221.36	0.031	1.06	3.86
S.D.[4]	0.11	0.20	0.62	47.16	0.25	0.23	33.40	74.57	0.010	0.04	1.31
C.V.(%)[5]	55	27	29	33	41	39	37	36	34	4	36
Median	0.17	0.74	2.01	145.00	0.59	0.58	87.50	194.63	0.028	1.04	3.34
Minimum	0.05	0.41	1.03	40.00	0.24	0.24	25.00	43.77	0.006	1.00	1.30
Maximum	0.55	1.24	3.84	320.00	1.64	1.40	200.00	401.95	0.055	1.19	8.28
Range	0.50	0.83	2.81	280.00	1.40	1.16	175.00	358.18	0.049	0.18	6.97

1 Arithmetic mean
2 Lower 90% confidence interval of the arithmetic mean
3 Upper 90% confidence interval of the arithmetic mean
4 Standard deviation of the arithmetic mean
5 Coefficient of variation, in percent

Table 4. (cont). Summary statistics for first order drainage basins investigated in the Powder River Basin Coal Field identified in Classification Stratum B.

Stratum B n = 66	Ruggedness Number	Circularity Ratio	Length of Overland Flow (miles)	AGI#1† (miles^{2}* ft./ft.)	AGI#2†† (miles^{2}* ft./ft.)	AGI#3‡ (miles^{2}* ft./ft.)	AGI#4‡‡ (miles^{2}* feet)	Maximum Elevation (feet)	Minimum Elevation (feet)	Maximum Used Relief (feet)	Minimum Used Relief (feet)
Mean[1]	0.10	0.54	0.16	0.008	0.005	0.007	28.29	4871.10	4727.20	4816.40	4727.20
Lower 90% C.L.[2]	0.09	0.52	0.15	0.008	0.005	0.006	24.74	4839.80	4695.40	4784.70	4695.40
Upper 90% C.L.[3]	0.11	0.56	0.17	0.009	0.005	0.008	31.84	4902.30	4759.00	4848.10	4759.00
S.D.[4]	0.06	0.11	0.06	0.003	0.002	0.003	17.27	152.21	154.69	154.28	154.69
C.V. (%)[5]	58	20	38	35	39	48	61	3	3	3	3
Median	0.09	0.55	0.15	0.008	0.005	0.007	25.08	4902.50	4755.00	4850.00	4755.00
Minimum	0.02	0.32	0.06	0.003	0.001	0.002	4.73	4440.00	4270.00	4365.00	4270.00
Maximum	0.34	0.76	0.38	0.015	0.012	0.017	75.81	5130.00	4980.00	5055.00	4980.00
Range	0.32	0.44	0.32	0.012	0.011	0.015	71.08	690.00	710.00	690.00	710.00

1 Arithmetic mean
2 Lower 90% confidence interval of the arithmetic mean
3 Upper 90% confidence interval of the arithmetic mean
4 Standard deviation of the arithmetic mean
5 Coefficient of variation, in percent

Table 5. Summary statistics for first order drainage basins investigated in the Powder River Basin Coal Field identified in Classification Stratum C.

Stratum C n = 66	Basin Area (miles²)	Basin Length (miles)	Basin Perimeter (miles)	Basin Relief (feet)	Main Channel Length (miles)	Valley Length (miles)	Used Relief (feet)	Relief Ratio (ft./mile)	Channel Slope (ft./ft.)	Sinuosity	Drainage Density (miles/ miles²)
Mean[1]	0.25	0.76	2.32	133.86	0.62	0.59	84.32	191.51	0.028	1.06	3.06
Lower 90% C.L.[2]	0.21	0.71	2.16	122.34	0.57	0.54	75.68	171.01	0.025	1.05	2.79
Upper 90% C.L.[3]	0.28	0.82	2.48	145.39	0.68	0.65	92.96	212.00	0.031	1.06	3.34
S.D.[4]	0.16	0.26	0.77	56.10	0.28	0.26	42.08	99.78	0.015	0.04	1.35
C.V.(%)[5]	65	34	33	42	45	45	50	52	52	4	44
Median	0.21	0.70	2.13	130.00	0.56	0.53	77.50	167.47	0.027	1.05	2.84
Minimum	0.05	0.40	1.13	40.00	0.25	0.24	20.00	59.76	0.008	1.00	0.96
Maximum	0.91	1.54	4.81	285.00	1.56	1.42	210.00	481.92	0.067	1.17	7.70
Range	0.87	1.15	3.68	245.00	1.31	1.18	190.00	422.16	0.059	0.17	6.73

1 Arithmetic mean
2 Lower 90% confidence interval of the arithmetic mean
3 Upper 90% confidence interval of the arithmetic mean
4 Standard deviation of the arithmetic mean
5 Coefficient of variation, in percent

Table 5. (cont). Summary statistics for first order drainage basins investigated in the Powder River Basin Coal Field identified in Classification Stratum C.

Stratum C n = 66	Rugged-ness Number	Circularity Ratio	Length of Overland Flow (miles)	AGI#1† (miles^{2}* ft./ft.)	AGI#2†† (miles^{2}* ft./ft.)	AGI#3‡ (miles^{2}* ft./ft.)	AGI#4‡‡ (miles^{2}* feet)	Maximum Elevation (feet)	Minimum Elevation (feet)	Maximum Used Relief (feet)	Minimum Used Relief (feet)
Mean[1]	0.08	0.54	0.20	0.009	0.006	0.007	31.94	4802.30	4668.80	4751.90	4667.60
Lower 90% C.L.[2]	0.07	0.52	0.18	0.008	0.005	0.007	27.41	4767.80	4631.60	4715.50	4630.60
Upper 90% C.L.[3]	0.10	0.57	0.22	0.010	0.007	0.008	36.48	4836.90	4706.00	4788.30	4704.60
S.D.[4]	0.06	0.11	0.09	0.005	0.004	0.004	22.10	168.13	181.07	177.27	180.03
C.V. (%)[5]	77	20	46	49	67	50	69	4	4	4	4
Median	0.07	0.54	0.18	0.009	0.005	0.007	24.05	4855.00	4687.50	4792.50	4687.50
Minimum	0.02	0.32	0.07	0.001	0.001	0.001	2.74	4435.00	4300.00	4405.00	4300.00
Maximum	0.39	0.83	0.52	0.025	0.028	0.021	100.20	5090.00	4930.00	5050.00	4930.00
Range	0.37	0.52	0.45	0.023	0.026	0.020	97.46	655.00	630.00	645.00	630.00

1 Arithmetic mean
2 Lower 90% confidence interval of the arithmetic mean
3 Upper 90% confidence interval of the arithmetic mean
4 Standard deviation of the arithmetic mean
5 Coefficient of variation, in percent

Table 6. Results of analysis of variance and multiple comparisons performed on first-order drainage basins comparing means of strata A, B, and C. Differences between strata detected using a Scheffe's test (alpha=0.10) are indicated with a '+'. Comparisons for which no significant difference was found are marked with a '-'. The p-value for the Analysis of variance is given under ANOVA P-value. All tests performed with the SAS software package on data transformed to the Log base 10.

Variable/ Units	ANOVA P-Value	Strata A v. B	Strata A v. C	Strata B v. C
Area ($mile^2$)	0.2053	-	-	-
Basin Length (miles)	0.6633	-	-	-
Main Channel Length (miles)	0.2280	-	-	-
Basin Relief (ft)	0.0001	+	+	-
Used Relief (ft)	0.0001	+	+	-
Relief Ratio (ft/mile)	0.0001	+	+	-
Channel Slope (ft/ft)	0.0021	+	+	-
Drainage Density ($miles/mile^2$)	0.0010	-	+	+
Sinuosity (unitless)	0.9992	-	-	-
Circularity (unitless)	0.1238	-	-	-

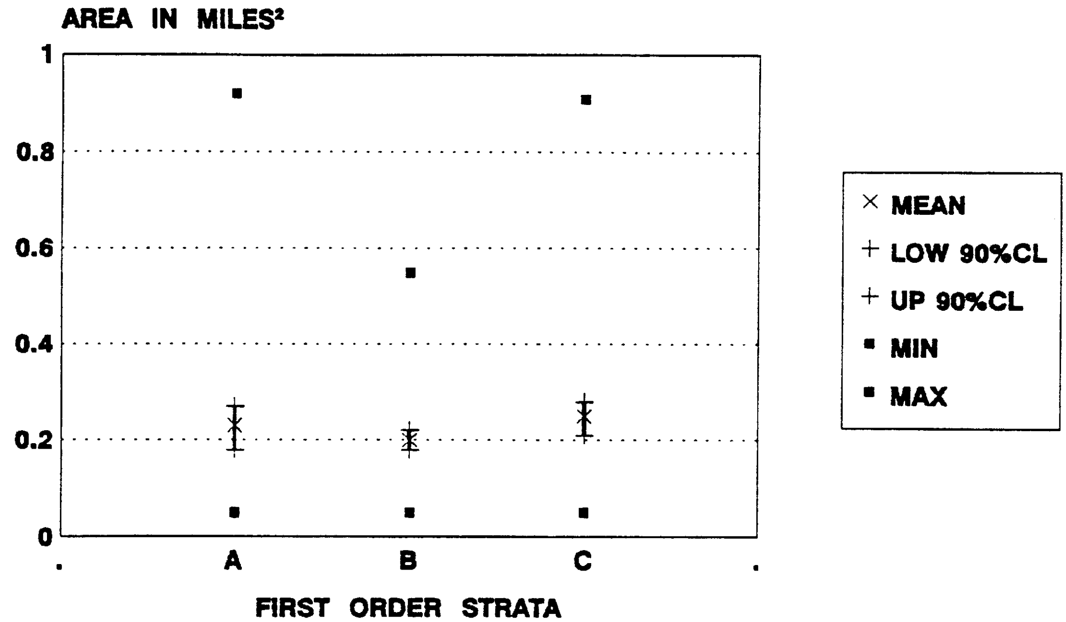


Figure 2. Means, 90% confidence limits, and ranges of area in each of the three strata of first order drainage basins in the Powder River Basin. (LOW 90%CL = Lower 90% confidence limit, UP 90%CL = Upper 90% confidence limit.)

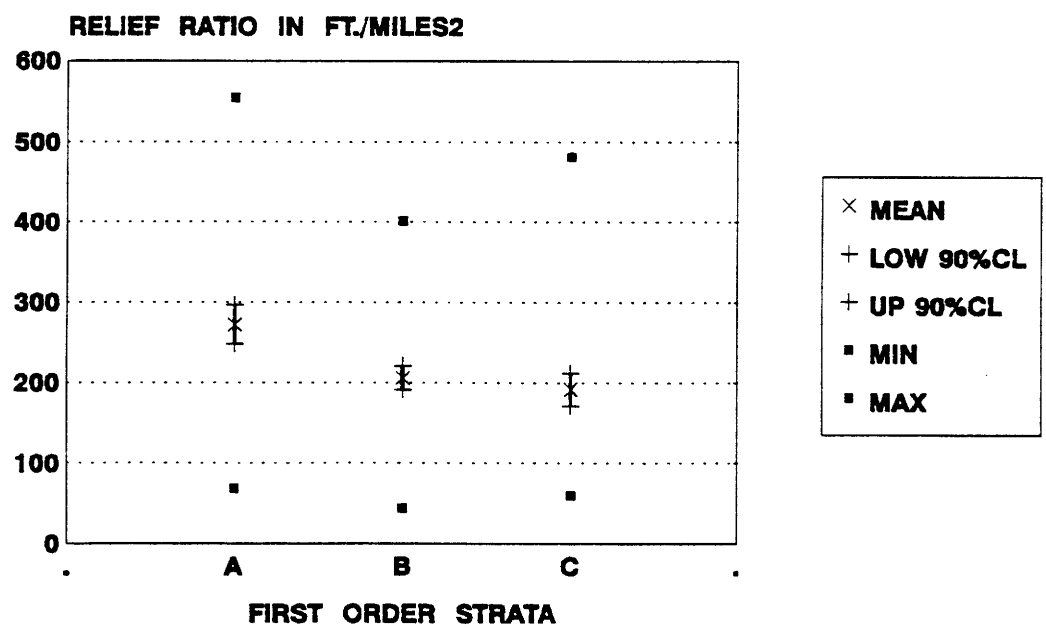


Figure 3. Means, 90% confidence limits, and ranges of relief ratio in each of the three strata of first order drainage basins in the Powder River Basin. (LOW 90%CL = Lower 90% confidence limit, UP 90%CL = Upper 90% confidence limit.)

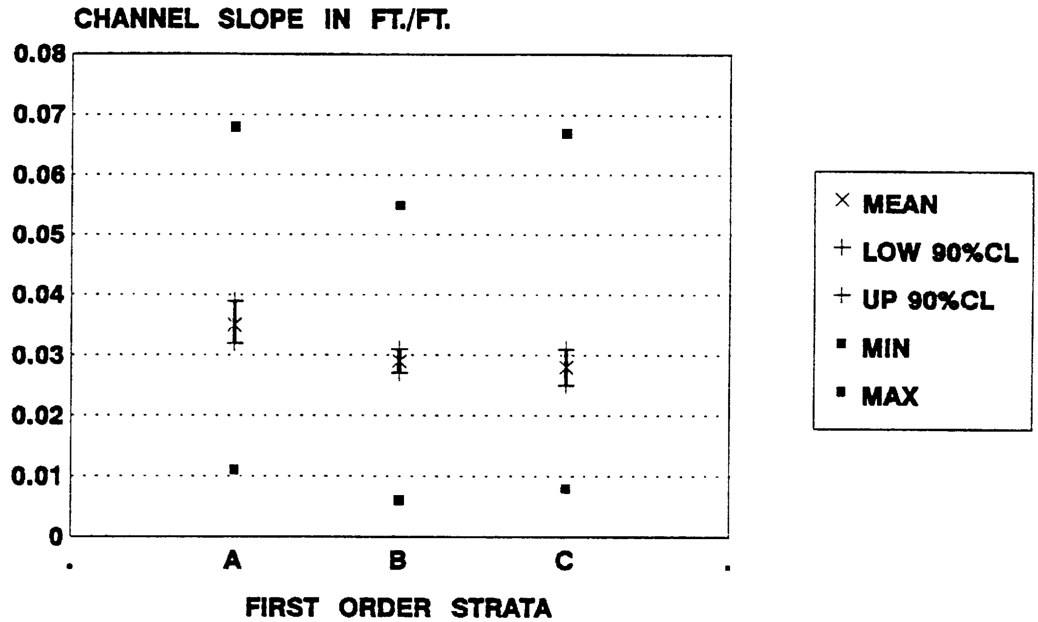
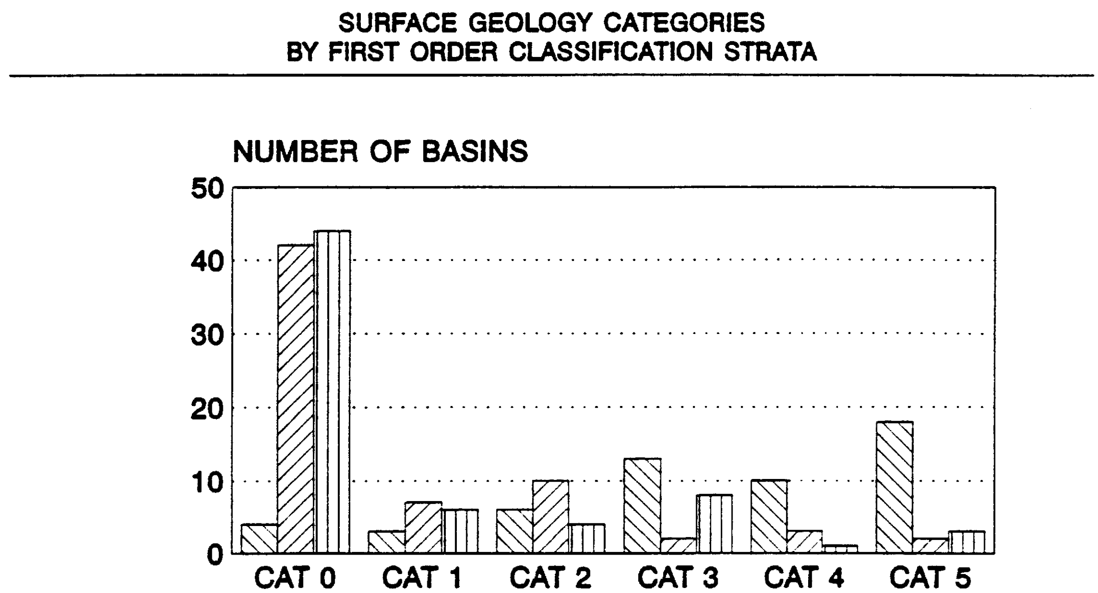


Figure 4. Means, 90% confidence limits, and ranges of channel slope in each of the three strata of first order drainage basins in the Powder River Basin. (LOW 90%CL = Lower 90% confidence limit, UP 90%CL = Upper 90% confidence limit.)

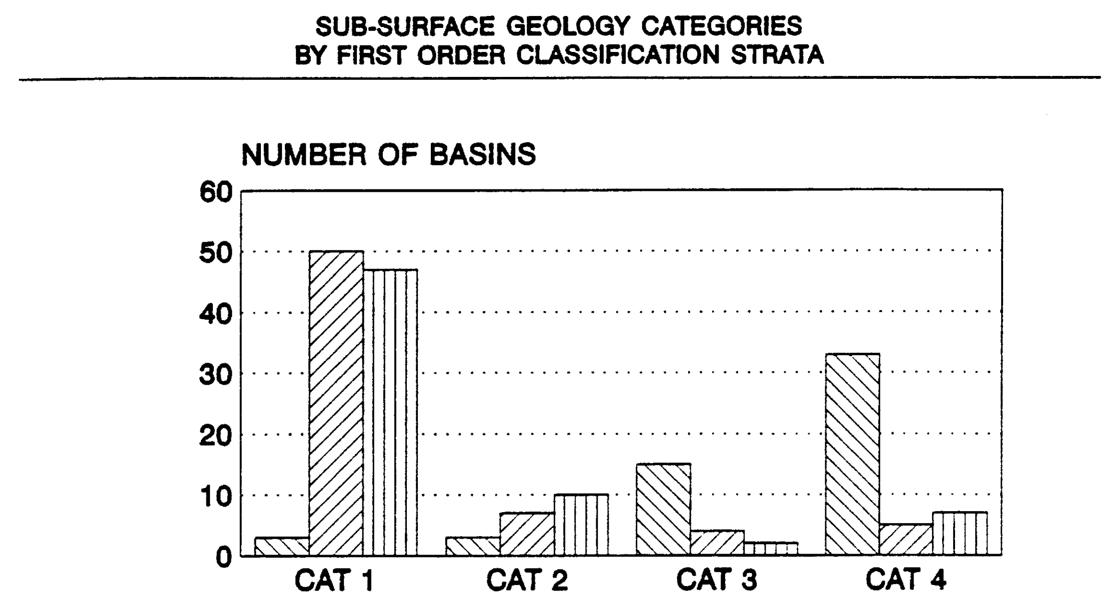
Figure 5. Means, 90% confidence limits, and ranges of drainage density in each of the three strata of first order drainage basins in the Powder River Basin. (LOW 90%CL = Lower 90% confidence limit, UP 90%CL = Upper 90% confidence limit.)



	CAT 0	CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
STRATA A	4	3	6	13	10	18
STRATA B	42	7	10	2	3	2
STRATA C	44	6	4	8	1	3

CATEGORY

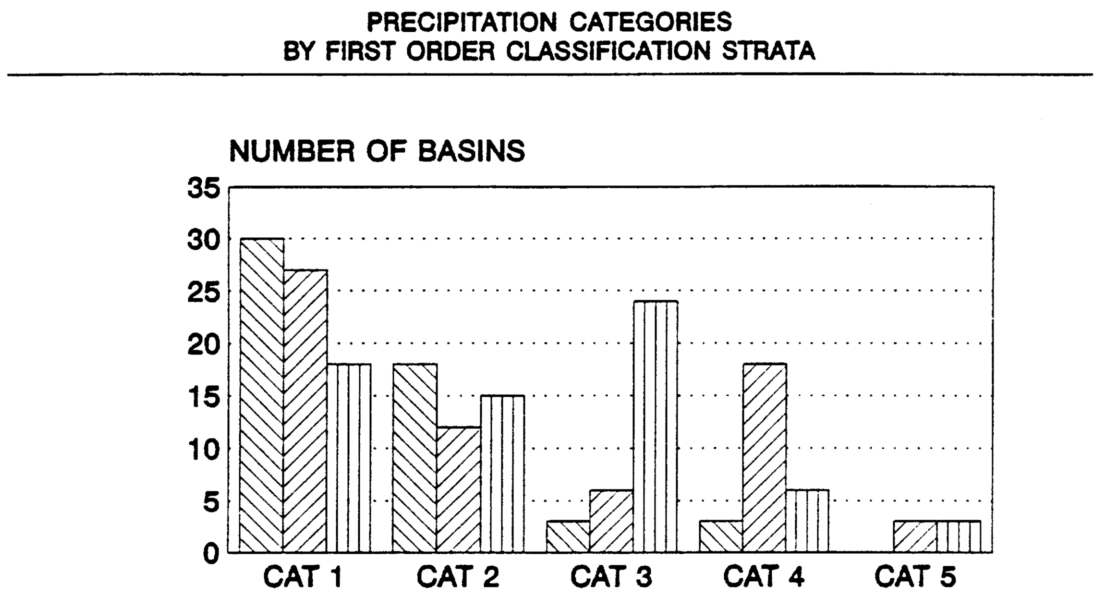
Figure 6. Comparison of the number of drainage basins in each subsurface geology category, in each strata, for investigated first order drainage basins in the Powder River Basin Coal Field.



	CAT 1	CAT 2	CAT 3	CAT 4
STRATA A	3	3	15	33
STRATA B	50	7	4	5
STRATA C	47	10	2	7

CATEGORY

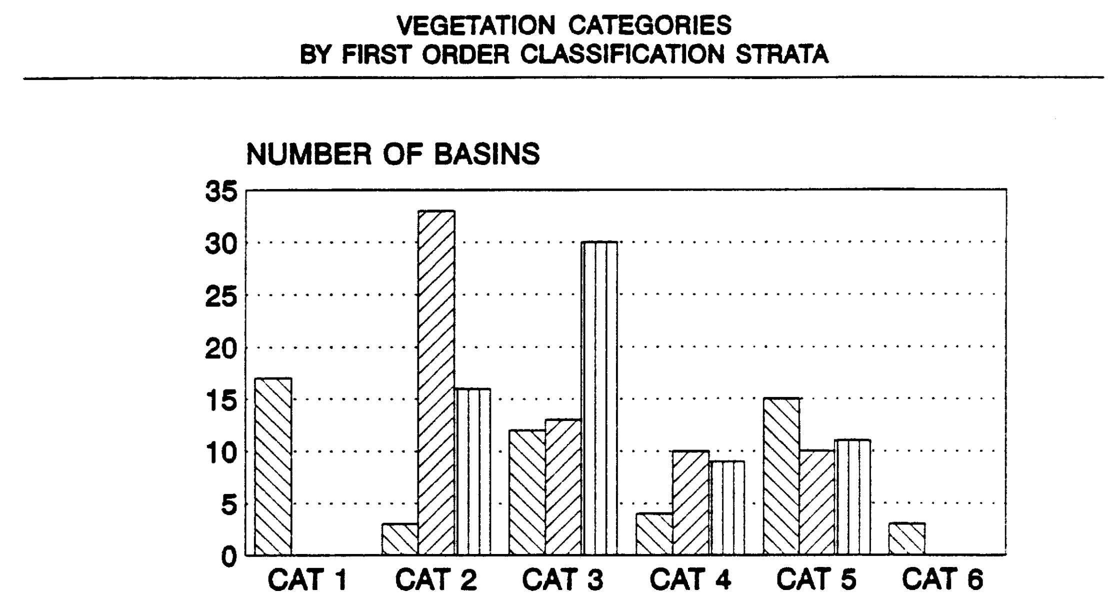
Figure 7. Comparison of the number of drainage basins in each geology category, in each strata, for investigated first order drainage basins in the Powder River Basin Coal Field.



	CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
STRATA A	30	18	3	3	0
STRATA B	27	12	6	18	3
STRATA C	18	15	24	6	3

CATEGORY

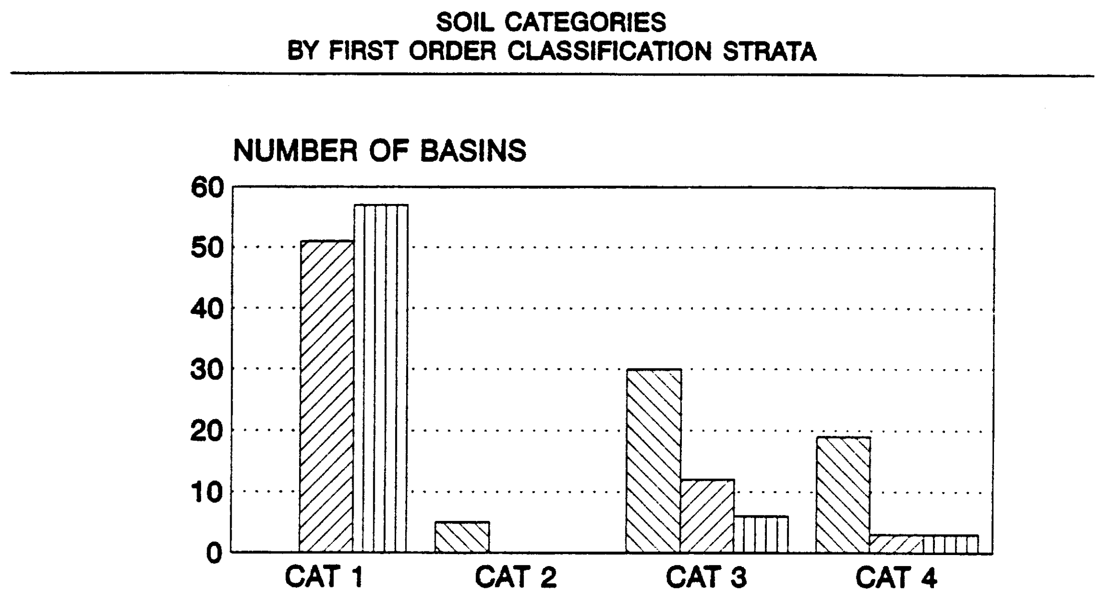
Figure 8. Comparison of the number of drainage basins in each precipitation category, in each strata, for investigated first order drainage basins in the Powder River Basin Coal Field.



	CAT 1	CAT 2	CAT 3	CAT 4	CAT 5	CAT 6
STRATA A	17	3	12	4	15	3
STRATA B	0	33	13	10	10	0
STRATA C	0	16	30	9	11	0

CATEGORY

Figure 9. Comparison of the number of drainage basins in each vegetation category, in each strata, for investigated first order drainage basins in the Powder River Basin Coal Field.



	CAT 1	CAT 2	CAT 3	CAT 4
STRATA A	0	5	30	19
STRATA B	51	0	12	3
STRATA C	57	0	6	3

CATEGORY

Figure 10. Comparison of the number of drainage basins in each soil category, in each strata, for investigated first order drainage basins in the Powder River Basin Coal Field.

APPENDIX A-1

STRATA "A" - FIRST ORDER

Description of Contents	Page
Geomorphic Relationships in Graph Format	322 - 324
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Descriptive Statistics by Study Reach and by Bank	340 - 346
Cross-Section Plots by Study Site and Study Reach	347 - 356
Longitudinal Profiles by Study Reach	357 - 357
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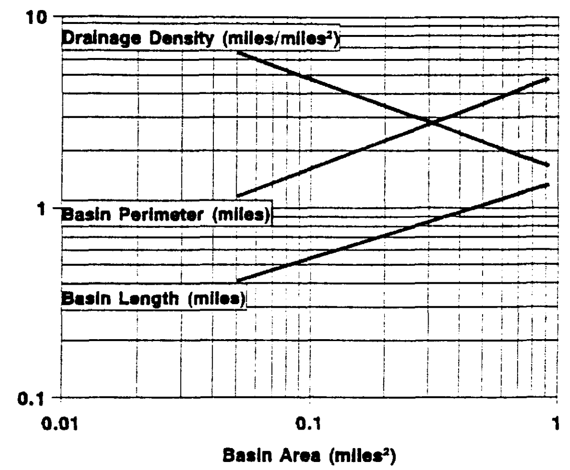
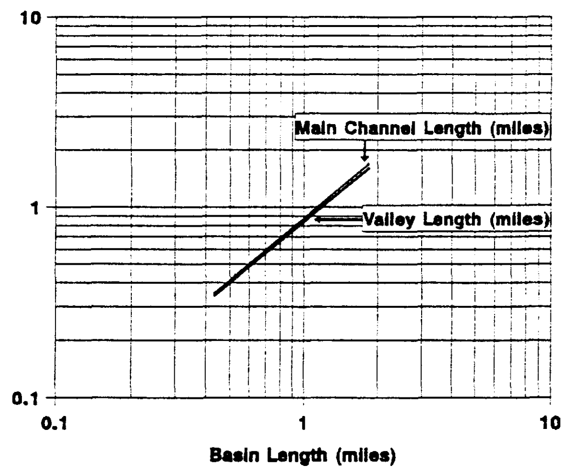
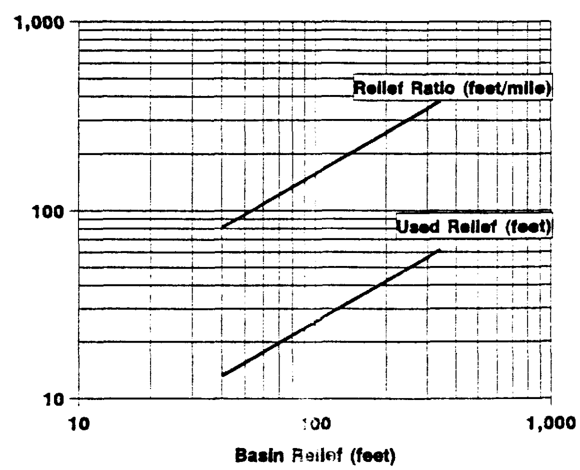


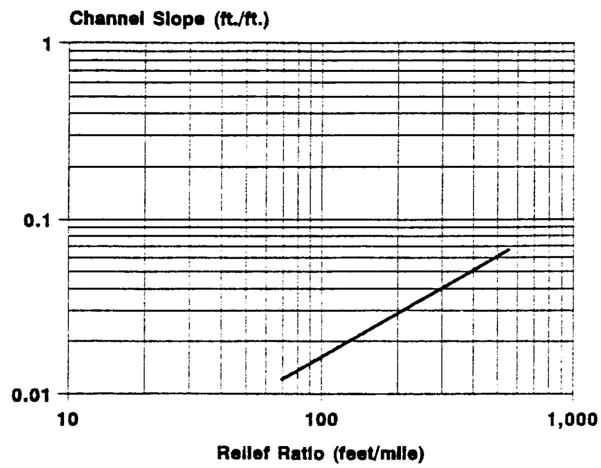
Drainage Density (miles/miles²)
Basin Perimeter (miles)
Basin Length (miles)
10
1
0.1
0.01
0.1
1
Basin Area (miles²)

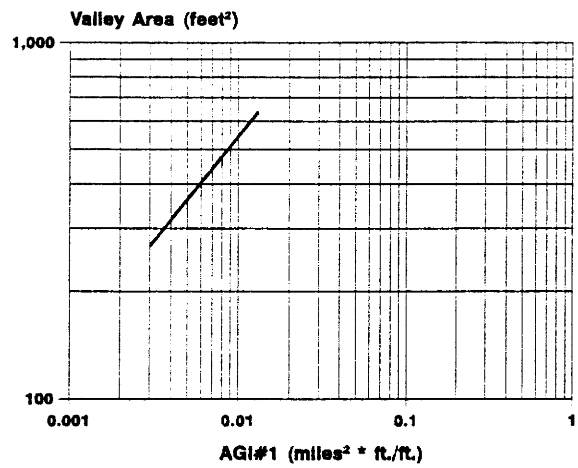


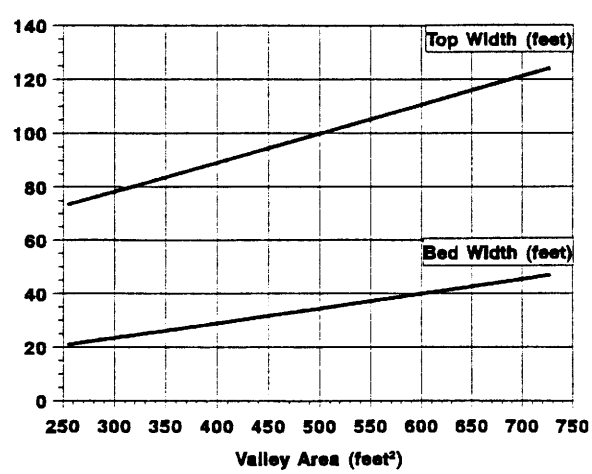
Main Channel Length (miles)
Valley Length (miles)
10
1
0.1
0.1
1
10
Basin Length (miles)

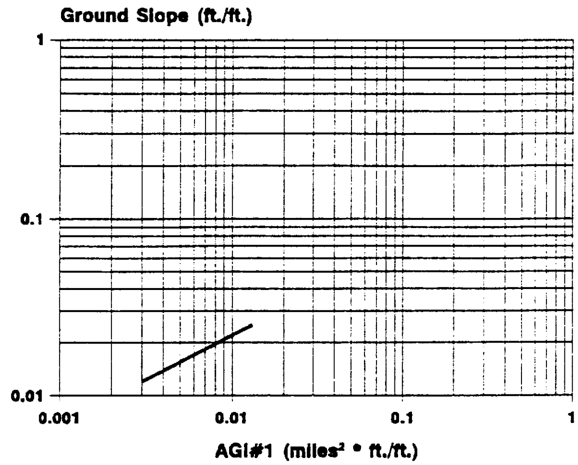


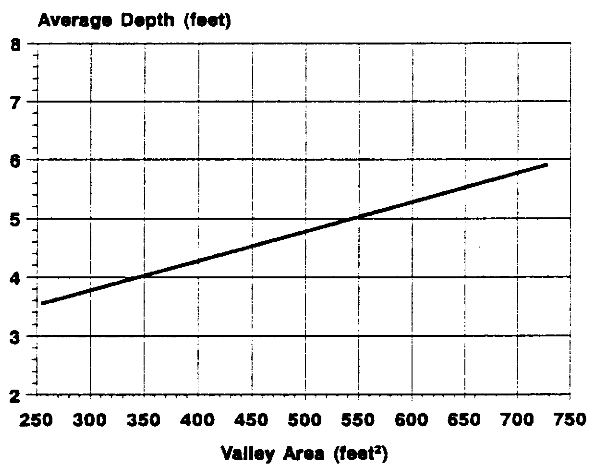
Relief Ratio (feet/mile)
Used Relief (feet)
1,000
100
10
10
100
1,000
Basin Relief (feet)


Channel Slope (ft./ft.)
1
0.1
0.01
10
100
1,000
Relief Ratio (feet/mile)


Valley Area (feet²)
1,000
100
0.001
0.01
0.1
1
AGI#1 (miles² * ft./ft.)


Top Width (feet)
Bed Width (feet)
140
120
100
80
60
40
20
0
250 300 350 400 450 500 550 600 650 700 750
Valley Area (feet²)


Ground Slope (ft./ft.)
1
0.1
0.01
0.001
0.01
0.1
1
AGI#1 (miles² * ft./ft.)


Average Depth (feet)
8
7
6
5
4
3
2
250 300 350 400 450 500 550 600 650 700 750
Valley Area (feet²)

Strata "A" first order regression output for basin perimeter versus basin area.

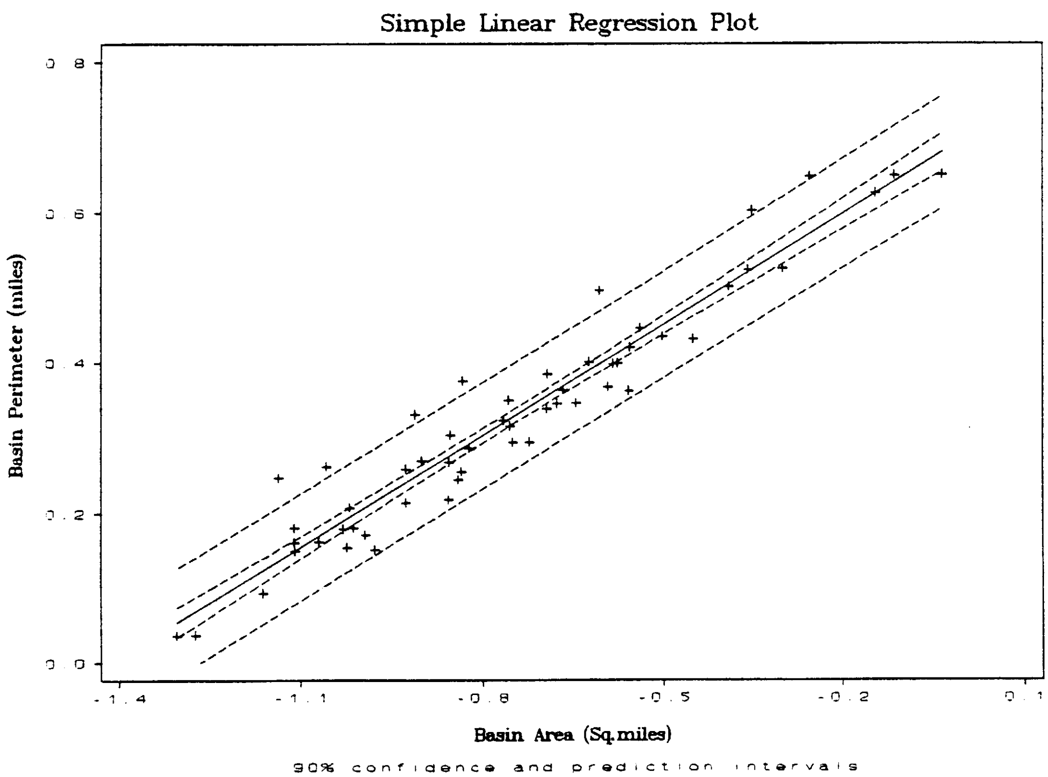
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BASIN PERIMETER

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.69772	0.01564	44.61	0.0000
BA	0.49401	0.01937	25.51	0.0000

R-SQUARED	0.9260	RESID. MEAN SQUARE (MSE)	0.00174
ADJUSTED R-SQUARED	0.9246	STANDARD DEVIATION	0.04175

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.13384	1.13384	650.54	0.0000
RESIDUAL	52	0.09063	0.00174		
TOTAL	53	1.22448			

CASES INCLUDED 54 MISSING CASES 0



Strata "A" first order regression output for drainage density versus basin area.

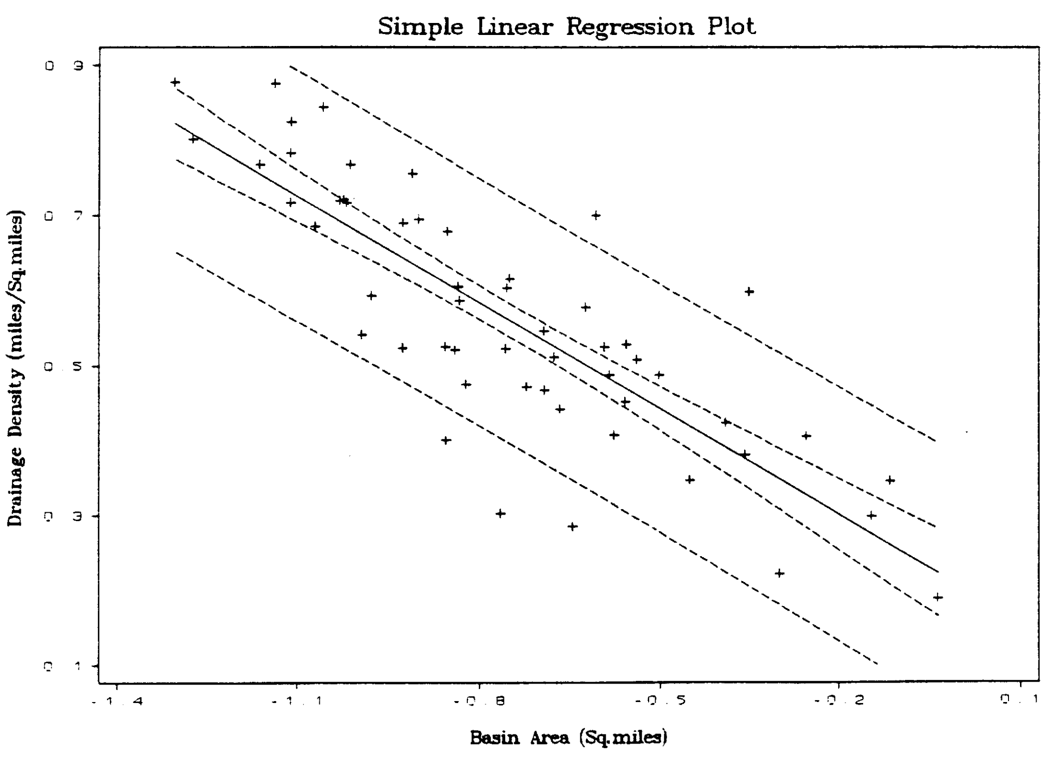
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF DRAINAGE DENSITY

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.20664	0.03652	5.66	0.0000
BA	-0.47228	0.04523	-10.44	0.0000

R-SQUARED	0.6771	RESID. MEAN SQUARE (MSE)	0.00950
ADJUSTED R-SQUARED	0.6709	STANDARD DEVIATION	0.09749

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.03629	1.03629	109.03	0.0000
RESIDUAL	52	0.49425	0.00950		
TOTAL	53	1.53054			

CASES INCLUDED 54 MISSING CASES 0



Strata "A" first order regression output for basin length versus basin area.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BASIN LENGTH

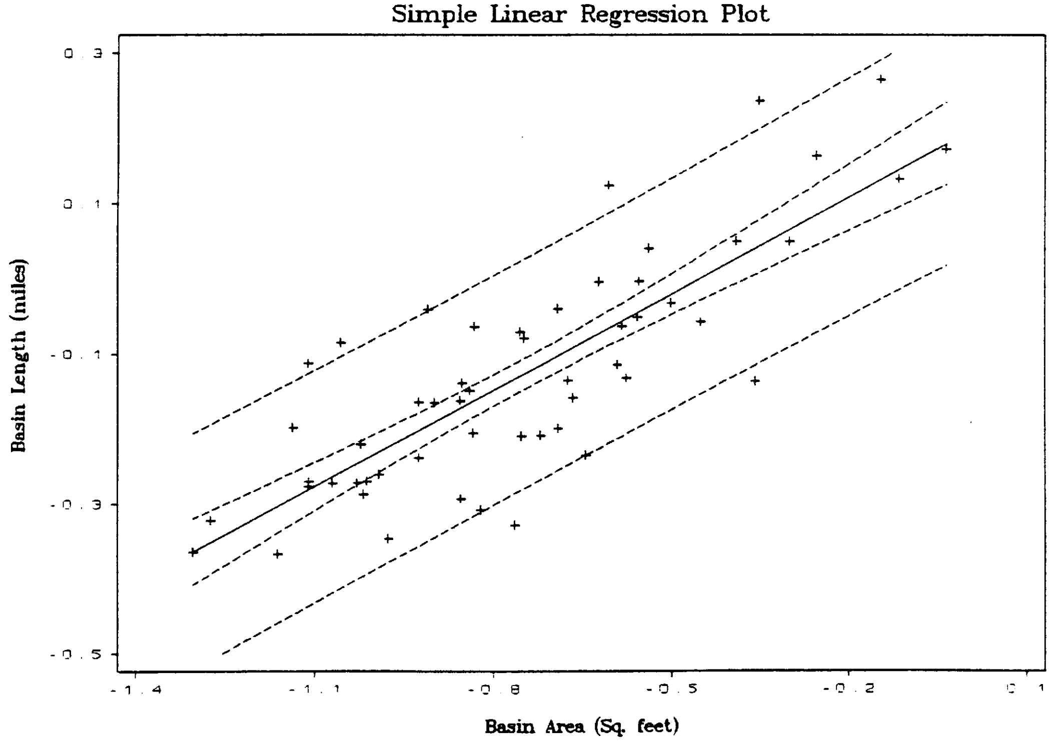
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.19496	0.03394	5.74	0.0000
BA	0.42865	0.04204	10.20	0.0000

R-SQUARED	0.6666	RESID. MEAN SQUARE (MSE)	0.00821
ADJUSTED R-SQUARED	0.6602	STANDARD DEVIATION	0.09061

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.85364	0.85364	103.96	0.0000
RESIDUAL	52	0.42697	0.00821		
TOTAL	53	1.28061			

CASES INCLUDED 54 MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "A" first order regression output for main channel length versus basin length.

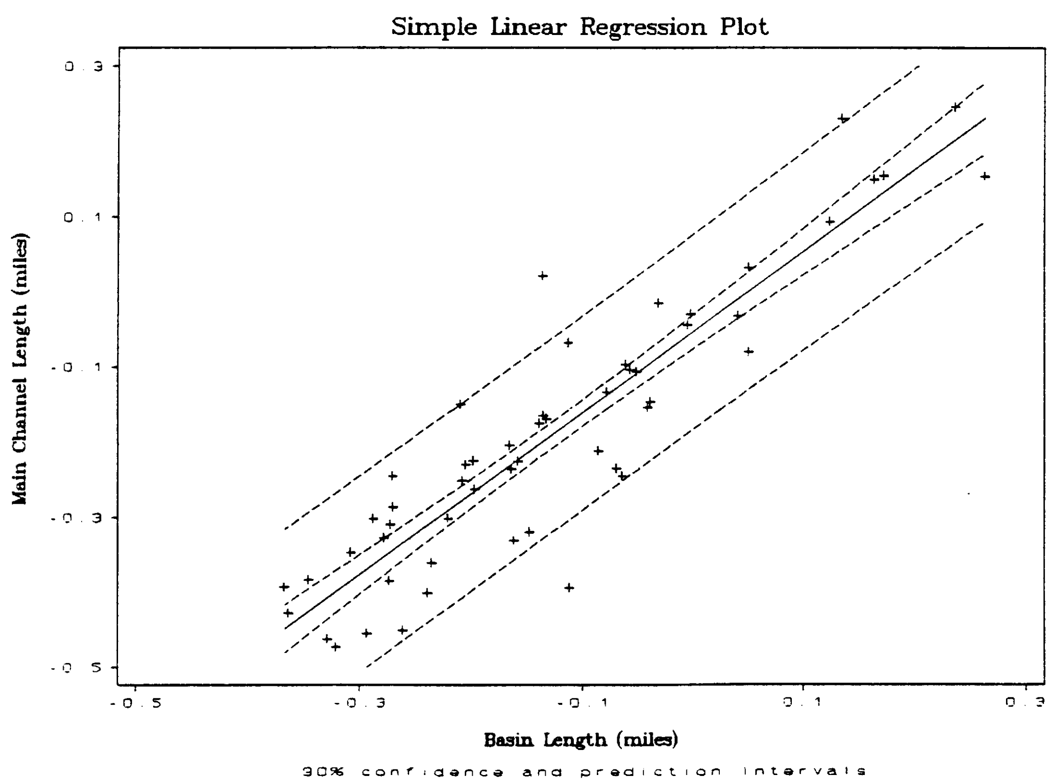
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF MAIN CHANNEL LENGTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.05311	0.01352	-3.93	0.0003
BL	1.07638	0.06761	15.92	0.0000

R-SQUARED	0.8298	RESID. MEAN SQUARE (MSE)	0.00585
ADJUSTED R-SQUARED	0.8265	STANDARD DEVIATION	0.07651

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.48370	1.48370	253.47	0.0000
RESIDUAL	52	0.30439	0.00585		
TOTAL	53	1.78809			

CASES INCLUDED 54 MISSING CASES 0



Strata "A" first order regression output for valley length versus basin length.

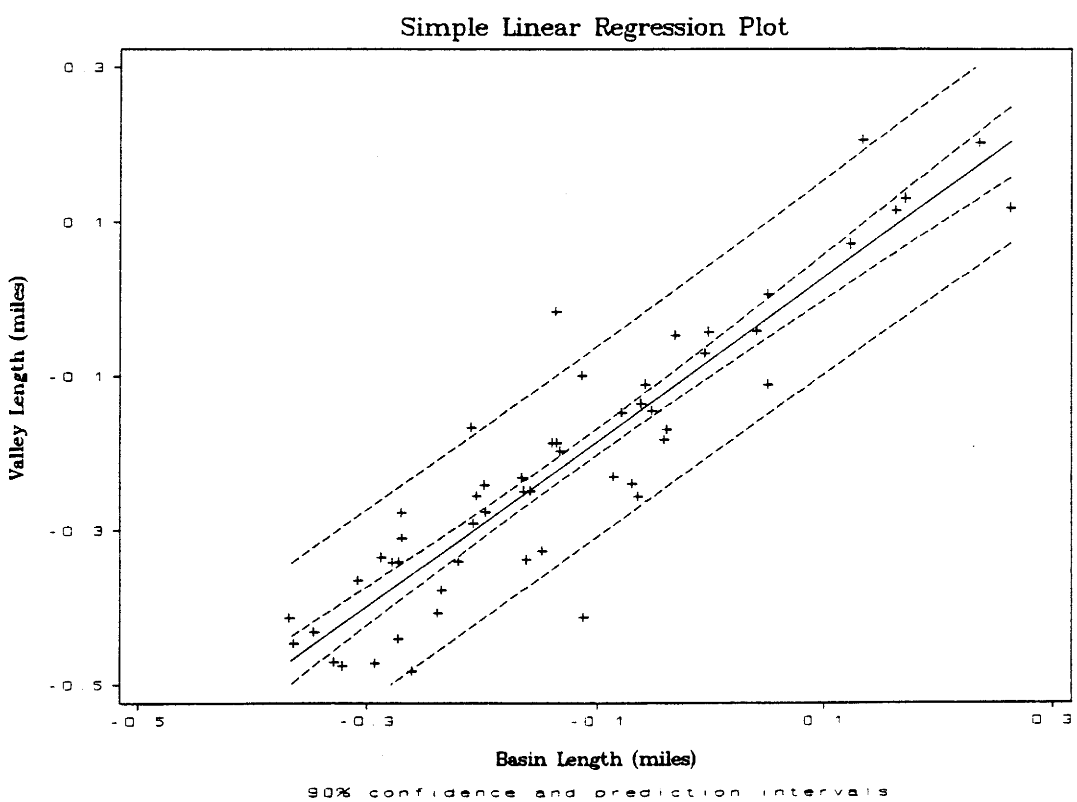
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF VALLEY LENGTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.07757	0.01292	-6.01	0.0000
BL	1.06713	0.06461	16.52	0.0000

R-SQUARED	0.8399	RESID. MEAN SQUARE (MSE)	0.00535
ADJUSTED R-SQUARED	0.8368	STANDARD DEVIATION	0.07312

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.45833	1.45833	272.79	0.0000
RESIDUAL	52	0.27799	0.00535		
TOTAL	53	1.73632			

CASES INCLUDED 54 MISSING CASES 0



Strata "A" first order regression output of basin relief versus basin area and basin length.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BASIN RELIEF

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	2.03080	0.07173	28.31	0.0000
BA	-0.51518	0.12035	-4.28	0.0001
BL	1.17699	0.22924	5.13	0.0000

R-SQUARED	0.3410	RESID. MEAN SQUARE (MSE)	0.02244
ADJUSTED R-SQUARED	0.3151	STANDARD DEVIATION	0.14979

SOURCE	DF	SS	MS	F	P
REGRESSION	2	0.59201	0.29601	13.19	0.0000
RESIDUAL	51	1.14428	0.02244		
TOTAL	53	1.73629			

CASES INCLUDED 54 MISSING CASES 0

Strata "A" first order regression output for used relief versus basin relief.

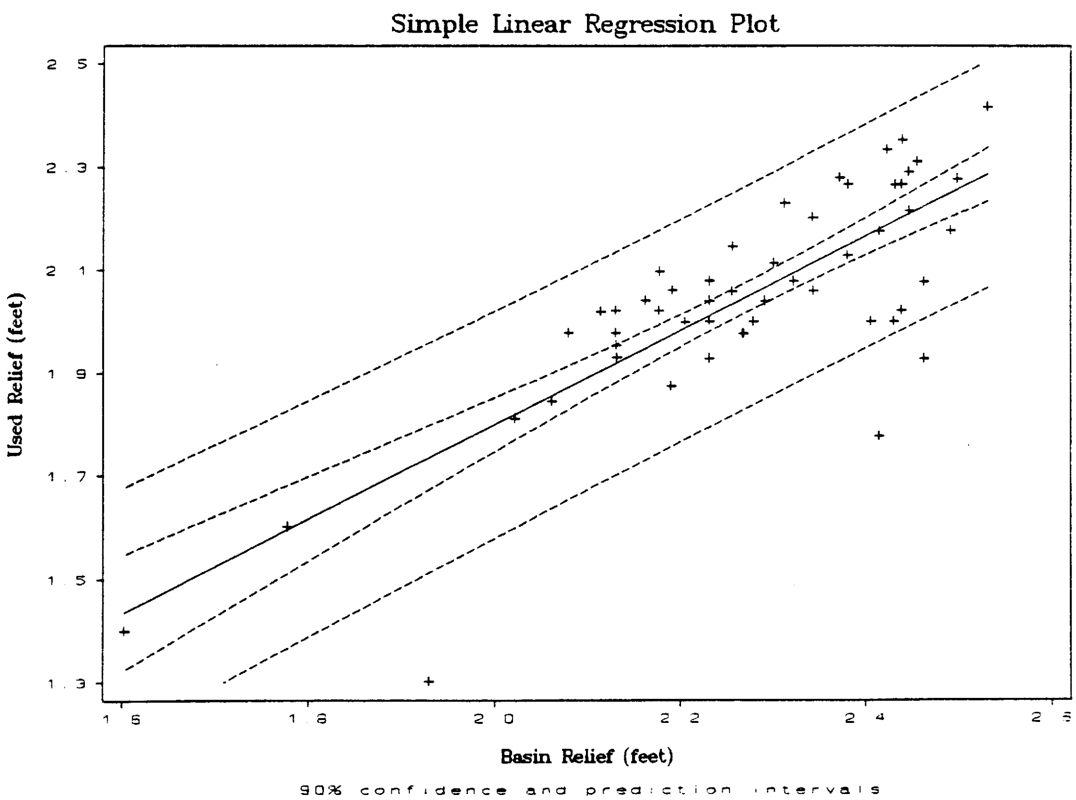
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF USED RELIEF

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.03109	0.22079	-0.14	0.8886
BR	0.91567	0.09704	9.44	0.0000

R-SQUARED	0.6313	RESID. MEAN SQUARE (MSE)	0.01635
ADJUSTED R-SQUARED	0.6242	STANDARD DEVIATION	0.12786

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.45580	1.45580	89.04	0.0000
RESIDUAL	52	0.85015	0.01635		
TOTAL	53	2.30595			

CASES INCLUDED 54 MISSING CASES 0



Strata "A" first order regression output for relief ratio versus basin relief.

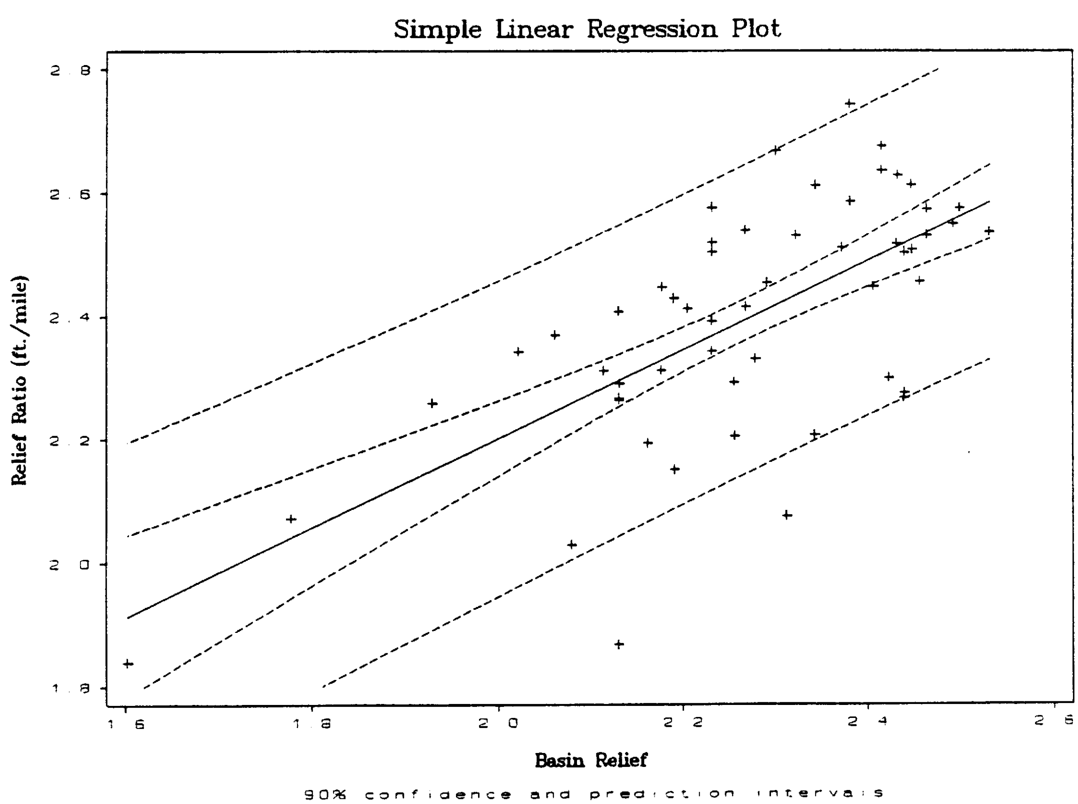
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RELIEF RATIO

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.75627	0.25648	2.95	0.0048
BR	0.72280	0.11272	6.41	0.0000

R-SQUARED	0.4416	RESID. MEAN SQUARE (MSE)	0.02206
ADJUSTED R-SQUARED	0.4308	STANDARD DEVIATION	0.14853

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.90711	0.90711	41.12	0.0000
RESIDUAL	52	1.14720	0.02206		
TOTAL	53	2.05431			

CASES INCLUDED 54 MISSING CASES 0



Strata "A" first order regression output for ruggedness number versus basin relief.

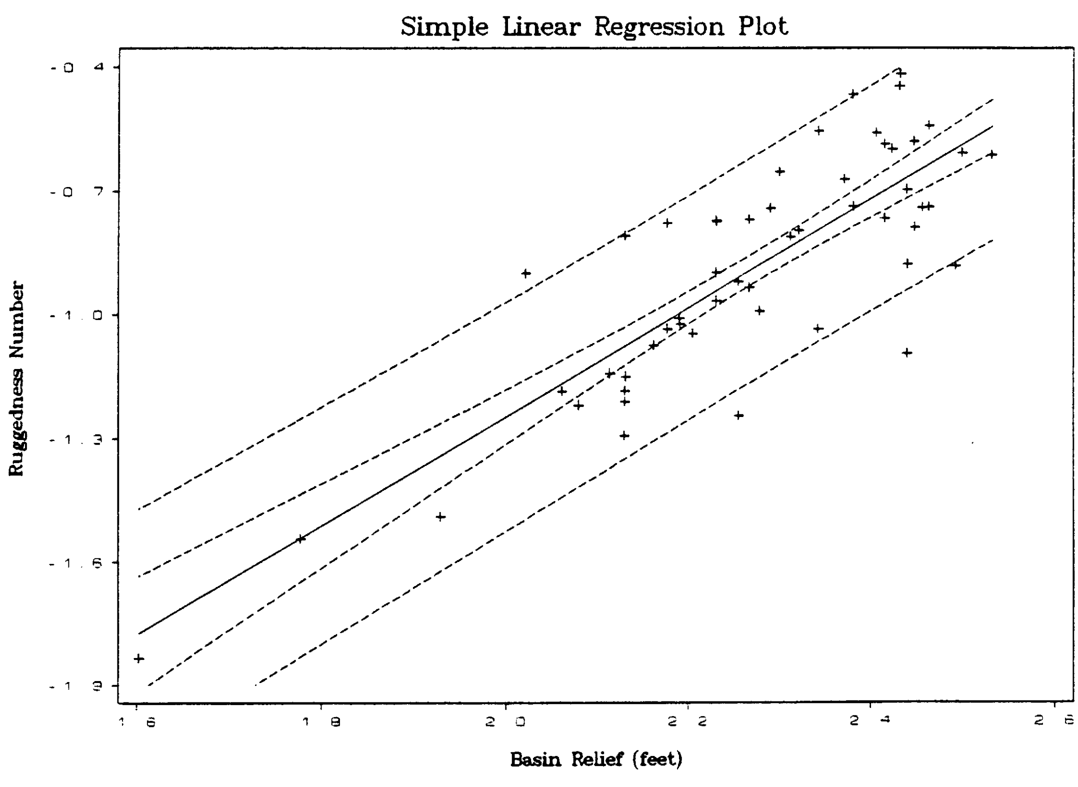
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RUGGEDNESS NUMBER

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-3.89834	0.27791	-14.03	0.0000
BR	1.32519	0.12214	10.85	0.0000

R-SQUARED	0.6936	RESID. MEAN SQUARE (MSE)	0.02590
ADJUSTED R-SQUARED	0.6877	STANDARD DEVIATION	0.16094

SOURCE	DF	SS	MS	F	P
REGRESSION	1	3.04917	3.04917	117.72	0.0000
RESIDUAL	52	1.34693	0.02590		
TOTAL	53	4.39610			

CASES INCLUDED 54 MISSING CASES 0



Strata "A" first order regression output for valley area versus area gradient index #1.

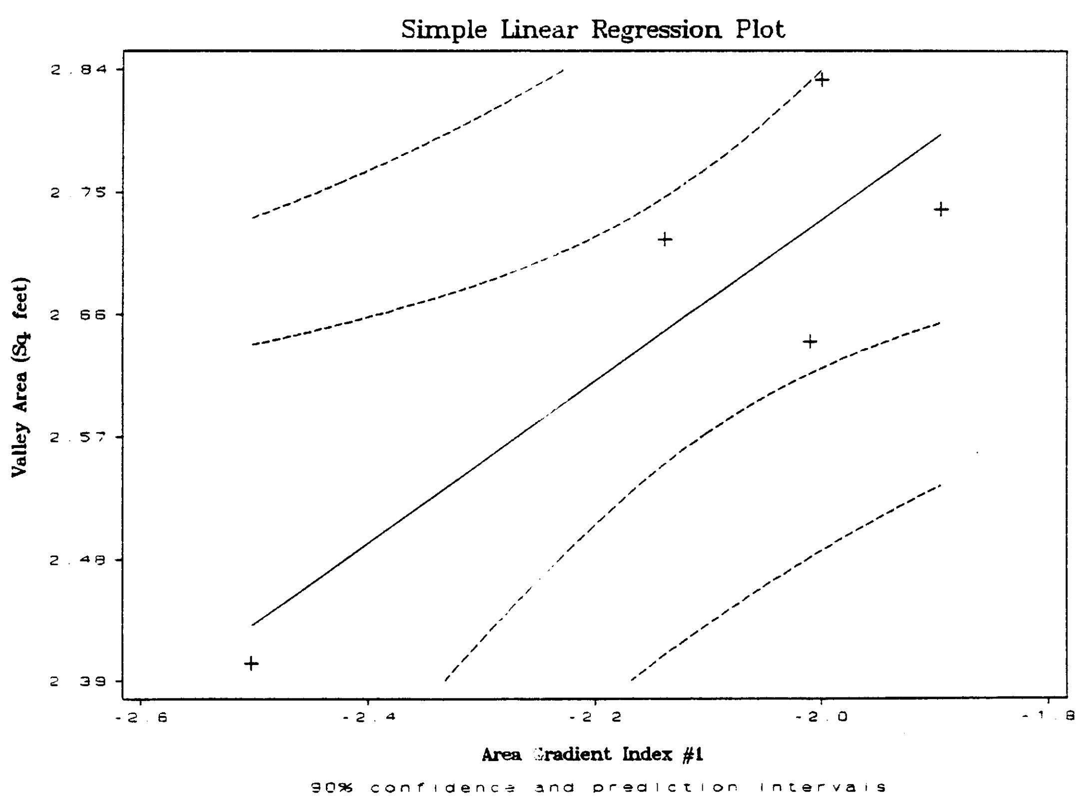
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF VALLEY AREA

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	3.91713	0.41489	9.44	0.0025
AGI1	0.59357	0.19577	3.03	0.0562

R-SQUARED	0.7539	RESID. MEAN SQUARE (MSE)	0.00858
ADJUSTED R-SQUARED	0.6719	STANDARD DEVIATION	0.09265

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.07891	0.07891	9.19	0.0562
RESIDUAL	3	0.02575	0.00858		
TOTAL	4	0.10466			

CASES INCLUDED 5   MISSING CASES 1



Strata "A" first order regression output for top width versus valley area.

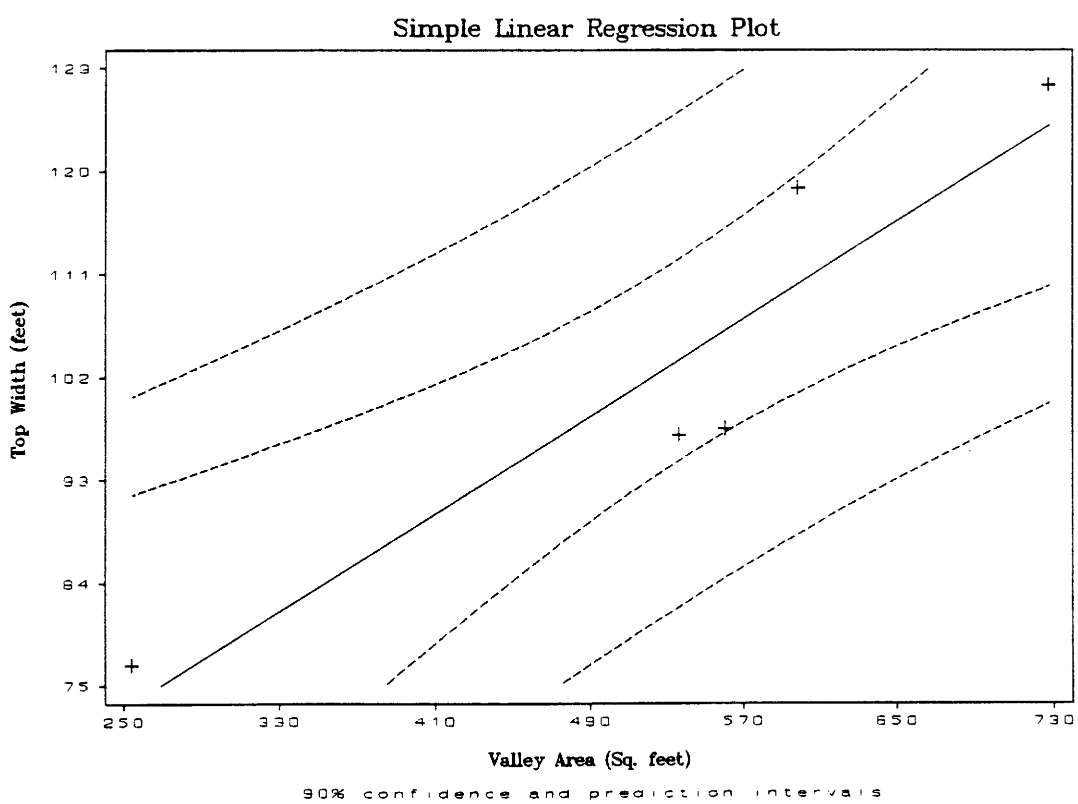
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOP WIDTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	46.2594	13.4772	3.43	0.0415
A	0.10684	0.02418	4.42	0.0215

R-SQUARED	0.8669	RESID. MEAN SQUARE (MSE)	70.4815
ADJUSTED R-SQUARED	0.8225	STANDARD DEVIATION	8.39533

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1376.68	1376.68	19.53	0.0215
RESIDUAL	3	211.445	70.4815		
TOTAL	4	1588.12			

CASES INCLUDED 5 MISSING CASES 1



Strata "A" first order regression output for average depth versus valley area.

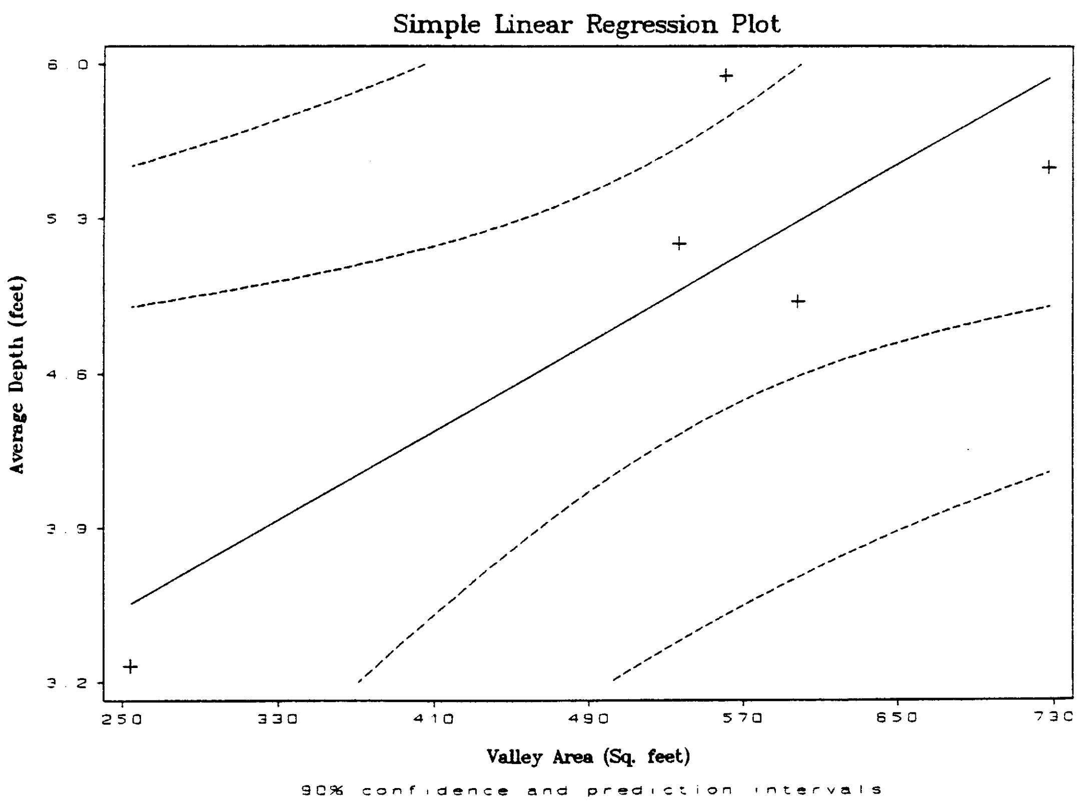
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AVERAGE DEPTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	2.27848	0.99207	2.30	0.1053
A	0.00503	0.00178	2.83	0.0663

R-SQUARED	0.7272	RESID. MEAN SQUARE (MSE)	0.38191
ADJUSTED R-SQUARED	0.6363	STANDARD DEVIATION	0.61799

SOURCE	DF	SS	MS	F	P
REGRESSION	1	3.05475	3.05475	8.00	0.0663
RESIDUAL	3	1.14574	0.38191		
TOTAL	4	4.20049			

CASES INCLUDED 5 MISSING CASES 1



Strata "A" first order regression output of bed width versus valley area.

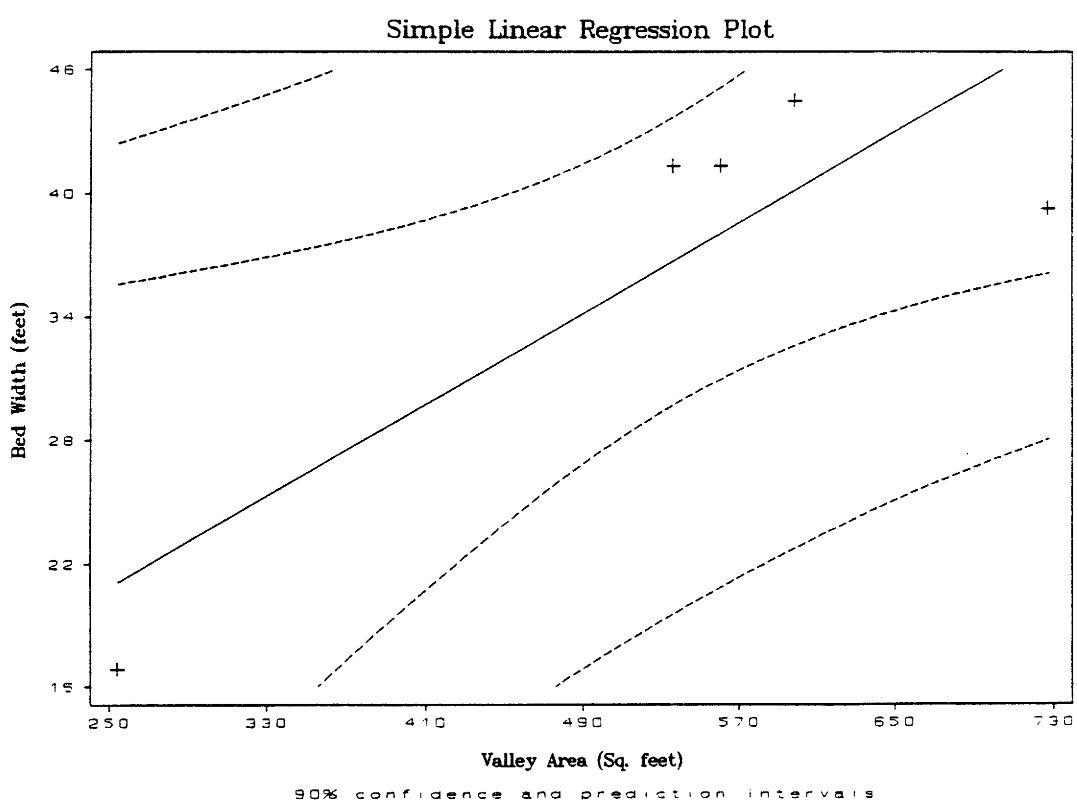
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BED WIDTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	7.00693	10.6906	0.66	0.5590
A	0.05538	0.01918	2.89	0.0631

R-SQUARED	0.7355	RESID. MEAN SQUARE (MSE)	44.3490
ADJUSTED R-SQUARED	0.6473	STANDARD DEVIATION	6.65950

SOURCE	DF	SS	MS	F	P
REGRESSION	1	369.914	369.914	8.34	0.0631
RESIDUAL	3	133.047	44.3490		
TOTAL	4	502.961			

CASES INCLUDED 5 MISSING CASES 1



Strata "A" first order regression output for ground slope versus area gradient index #1.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF GROUND SLOPE

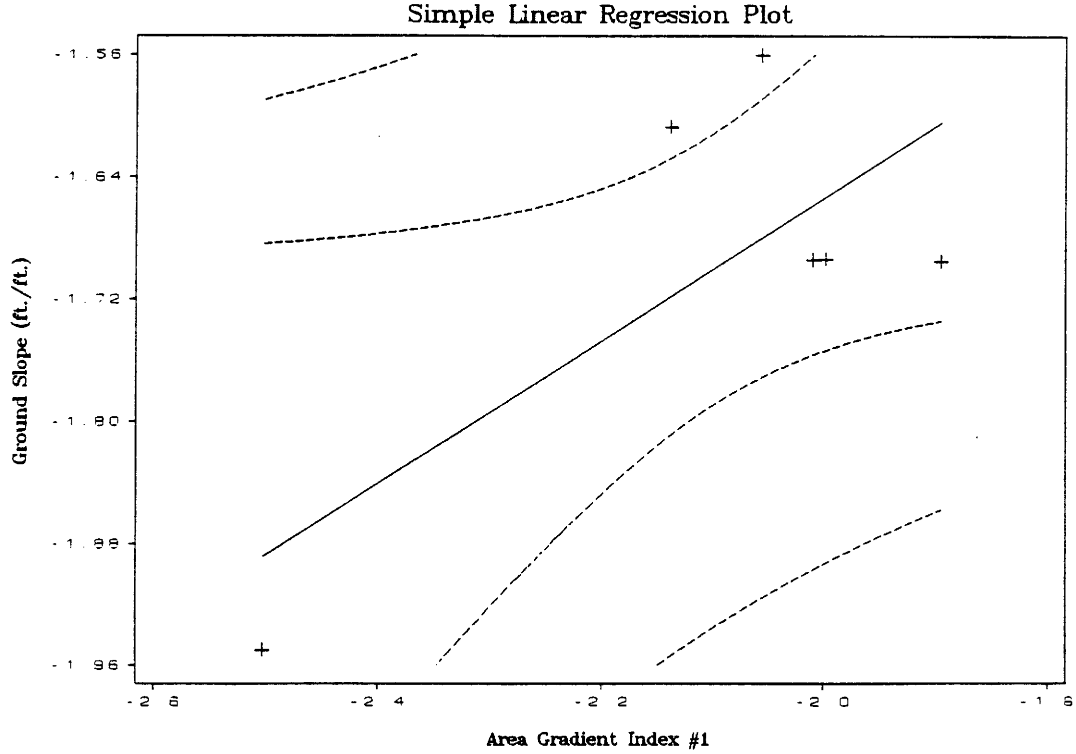
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.72043	0.45277	-1.59	0.1868
AGI1	0.46673	0.21471	2.17	0.0954

R-SQUARED	0.5416	RESID. MEAN SQUARE (MSE)	0.01043
ADJUSTED R-SQUARED	0.4270	STANDARD DEVIATION	0.10213

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.04929	0.04929	4.73	0.0954
RESIDUAL	4	0.04173	0.01043		
TOTAL	5	0.09102			

CASES INCLUDED 6 MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

High bank reach means reach for **Strata "A"** first orders.

BASIN ID 09D1	**AREA** (ft.^{2})	**WETTED PERIMETER** (ft.)	**TOP WIDTH** (ft.)	**HYDRAULIC RADIUS**	**AVERAGE DEPTH** (ft.)	**W/D RATIO**	**BED WIDTH** (ft.)	**AVERAGE SLOPE** (ft/ft)
n	4	4	4	4	4	4	2	2
MEAN	560.77	102.88	97.53	5.58	5.95	17.47	41.35	0.026
S.D.	243.14	49.45	50.46	0.77	1.05	11.91	16.90	0.012
C.V. (%)	43	48	52	14	18	68	41	47
MINIMUM	315.80	61.20	57.00	4.70	4.70	8.95	29.40	0.018
MAXIMUM	770.70	164.90	163.50	6.40	7.00	34.79	53.30	0.035
RANGE	454.90	103.70	106.50	1.70	2.30	25.83	23.90	0.017

BASIN ID 47C2	**AREA** (ft.^{2})	**WETTED PERIMETER** (ft.)	**TOP WIDTH** (ft.)	**HYDRAULIC RADIUS**	**AVERAGE DEPTH** (ft.)	**W/D RATIO**	**BED WIDTH** (ft.)	**AVERAGE SLOPE** (ft/ft)
n	3	3	3	3	3	3	4	4
MEAN	727.57	130.83	127.50	5.37	5.53	23.60	39.28	0.021
S.D.	347.13	22.49	22.07	1.59	1.63	3.29	18.45	0.007
C.V. (%)	48	17	17	30	29	14	47	32
MINIMUM	526.20	114.10	110.70	4.30	4.40	20.61	20.70	0.014
MAXIMUM	1128.40	156.40	152.50	7.20	7.40	27.11	59.20	0.030
RANGE	602.20	42.30	41.80	2.90	3.00	6.51	38.50	0.016

BASIN ID 64A2	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	8	8	8	8	8	8	4	4
MEAN	536.54	100.27	96.99	4.98	5.19	22.43	41.35	0.023
S.D.	400.14	23.84	22.44	2.60	2.80	10.74	4.54	0.013
C.V. (%)	75	24	23	52	54	48	11	58
MINIMUM	213.30	67.90	66.00	2.50	2.50	11.01	34.90	0.011
MAXIMUM	1377.90	143.40	135.90	9.60	10.10	45.16	45.30	0.041
RANGE	1164.60	75.50	69.90	7.10	7.60	34.15	10.40	0.030

BASIN ID 64B1	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	5	5	5	5	5	5	4	4
MEAN	598.00	121.38	118.46	4.80	4.92	25.95	44.45	0.023
S.D.	271.94	22.50	22.35	1.73	1.82	6.80	27.26	0.011
C.V. (%)	45	19	19	36	37	26	61	49
MINIMUM	317.60	97.00	96.00	3.10	3.20	14.84	15.20	0.007
MAXIMUM	905.20	155.90	153.60	7.20	7.50	33.09	81.00	0.034
RANGE	587.60	58.90	57.60	4.10	4.30	18.25	65.80	0.027

BASIN ID 64B2	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	4	4	4	4	4	4	4	4
MEAN	254.15	77.90	76.85	3.28	3.28	23.46	16.88	0.012
S.D.	24.97	5.29	5.28	0.13	0.13	1.13	9.51	0.005
C.V. (%)	10	7	7	4	4	5	56	39
MINIMUM	218.30	70.80	69.80	3.10	3.10	22.52	10.60	0.005
MAXIMUM	274.80	83.60	82.60	3.40	3.40	25.03	31.00	0.016
RANGE	56.50	12.80	12.80	0.30	0.30	2.51	20.40	0.010

Medium bank reach means for **Strata "A"** first orders.

BASIN ID 47C2	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	2.00	2.00	2.00	2.00	2.00	2.00
MEAN	155.90	59.85	58.50	2.60	2.70	22.70
S.D.	28.14	5.30	5.23	0.71	0.71	7.88
C.V. (%)	18.05	8.86	8.94	27.20	26.19	34.73
MINIMUM	136.00	56.10	54.80	2.10	2.20	17.13
MAXIMUM	175.80	63.60	62.20	3.10	3.20	28.27
RANGE	39.80	7.50	7.40	1.00	1.00	11.15

BASIN ID 47C3	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	4.00	4.00	4.00	4.00	4.00	4.00
MEAN	129.82	42.05	40.03	3.05	3.20	12.63
S.D.	35.45	5.50	4.94	0.51	0.56	1.21
C.V. (%)	27.31	13.09	12.35	16.61	17.49	9.61
MINIMUM	80.30	33.90	32.70	2.40	2.50	11.27
MAXIMUM	156.20	46.00	43.50	3.50	3.70	14.07
RANGE	75.90	12.10	10.80	1.10	1.20	2.80

BASIN ID 64A2	AREA ($ft.^2$)	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	6.00	6.00	6.00	6.00	6.00	6.00
MEAN	9.98	10.98	10.20	0.82	0.88	11.59
S.D.	6.55	4.73	4.39	0.27	0.34	2.16
C.V. (%)	65.66	43.10	43.03	33.24	38.17	18.63
MINIMUM	2.20	5.30	5.00	0.40	0.40	9.25
MAXIMUM	18.10	17.70	16.80	1.10	1.20	15.27
RANGE	15.90	12.40	11.80	0.70	0.80	6.02

BASIN ID 64B1	AREA ($ft.^2$)	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	3.00	3.00	3.00	3.00	3.00	3.00
MEAN	29.27	20.83	19.63	1.50	1.60	25.38
S.D.	17.85	3.07	3.93	0.96	1.06	30.20
C.V. (%)	60.98	14.72	20.02	64.29	66.14	118.99
MINIMUM	9.50	18.20	16.70	0.40	0.40	7.54
MAXIMUM	44.20	24.20	24.10	2.20	2.40	60.25
RANGE	34.70	6.00	7.40	1.80	2.00	52.71

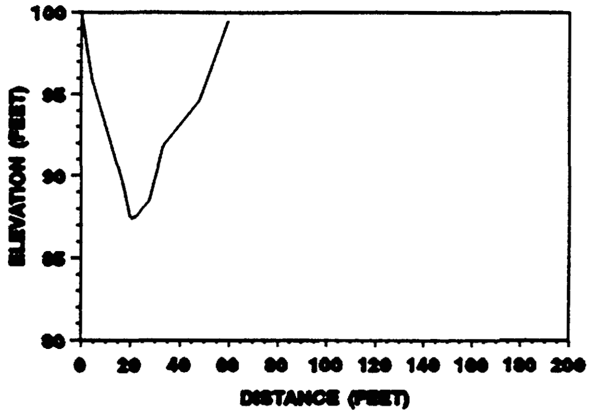
Low bank reach means for **Strata "A"** first orders.

BASIN ID 09D1	AREA ($ft.^2$)	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	2	2	2	2	2	2
MEAN	1.70	6.00	5.85	0.20	0.20	25.17
S.D.	2.26	5.94	5.87	0.14	0.14	11.55
C.V. (%)	133.10	99.00	100.32	70.71	70.71	45.89
MINIMUM	0.10	1.80	1.70	0.10	0.10	17.00
MAXIMUM	3.30	10.20	10.00	0.30	0.30	33.33
RANGE	3.20	8.40	8.30	0.20	0.20	16.33

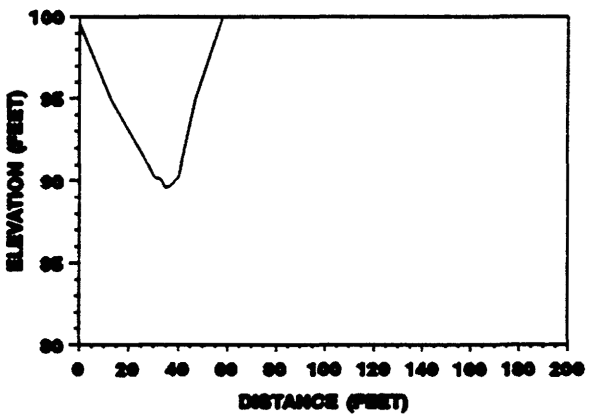
BASIN ID 47C2	AREA ($ft.^2$)	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	2	2	2	2	2	2
MEAN	7.50	30.15	28.95	0.25	0.25	124.58
S.D.	1.13	7.14	6.72	0.07	0.07	62.11
C.V. (%)	15.09	23.69	23.20	28.28	28.28	49.85
MINIMUM	6.70	25.10	24.20	0.20	0.20	80.67
MAXIMUM	8.30	35.20	33.70	0.30	0.30	168.50
RANGE	1.60	10.10	9.50	0.10	0.10	87.83

BASIN ID 64A2	AREA ($ft.^2$)	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	2	2	2	2	2	2
MEAN	2.00	5.40	5.05	0.35	0.35	15.95
S.D.	1.56	1.84	1.63	0.21	0.21	5.02
C.V. (%)	77.78	34.05	32.21	60.61	60.61	31.48
MINIMUM	0.90	4.10	3.90	0.20	0.20	12.40
MAXIMUM	3.10	6.70	6.20	0.50	0.50	19.50
RANGE	2.20	2.60	2.30	0.30	0.30	7.10

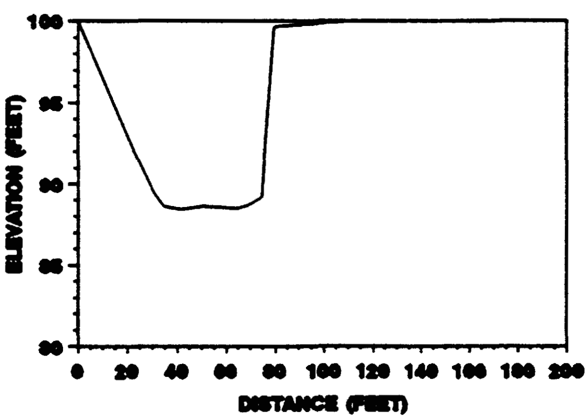
WINDMILL DRAW, 09D1
CROSS SECTION 6+68.80



WINDMILL DRAW, 09D1
CROSS SECTION 6+23.80

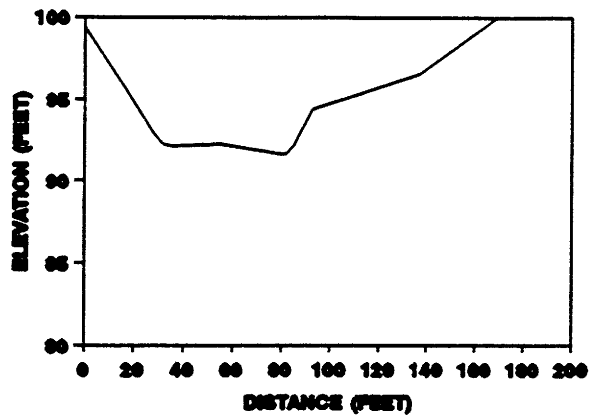


WINDMILL DRAW, 09D1
CROSS SECTION 10+90.40



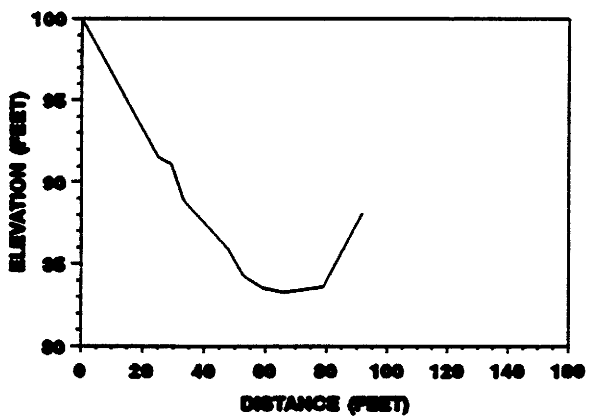
WINDMILL DRAW, 09D1

CROSS SECTION 13+67.40



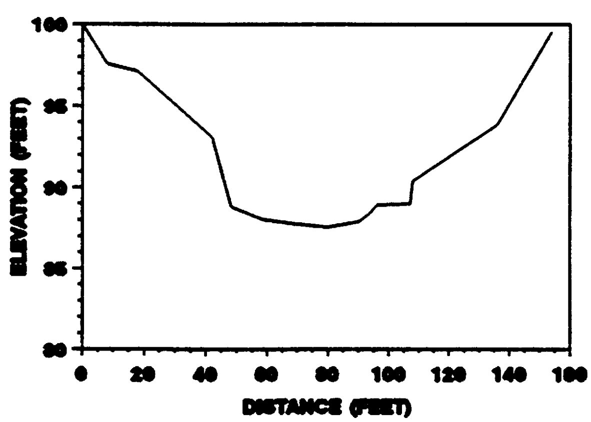
H A CREEK, 47C2

CROSS SECTION 0+00.00

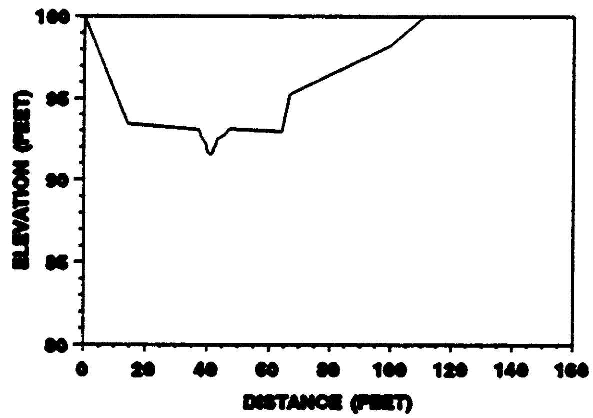


H A CREEK, 47C2

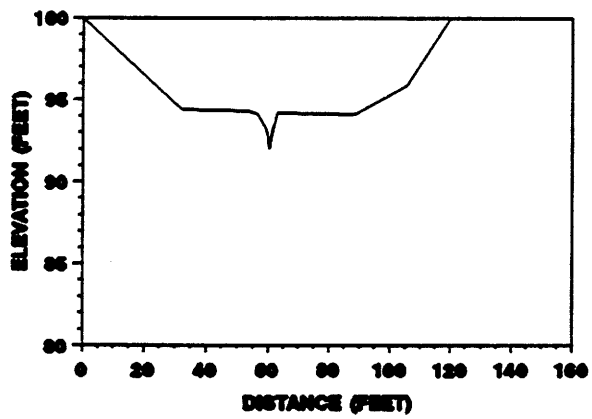
CROSS SECTION 3+75.00



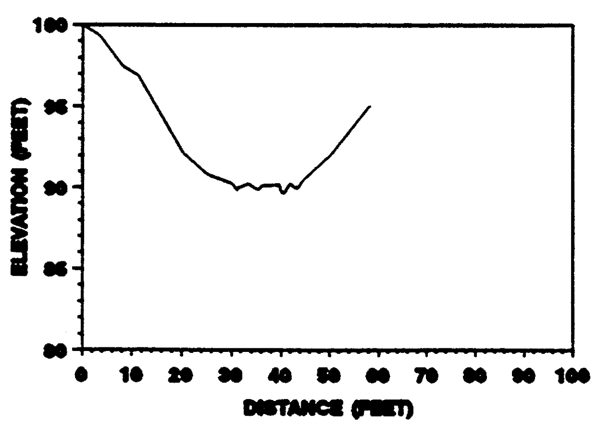
H A CREEK, 47C2
CROSS SECTION 9+75.00



H A CREEK, 47C2
CROSS SECTION 10+65.20

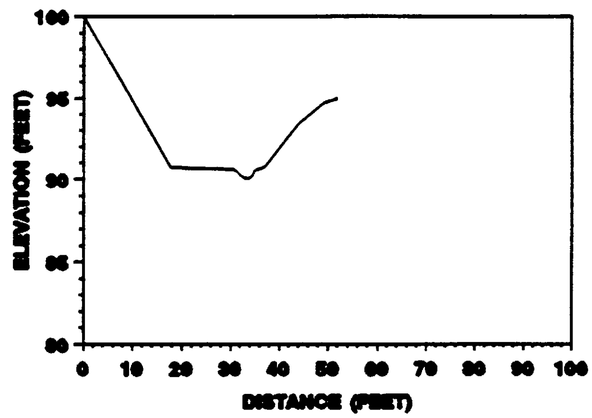


H A CREEK, 47C3
CROSS SECTION 0+00.00



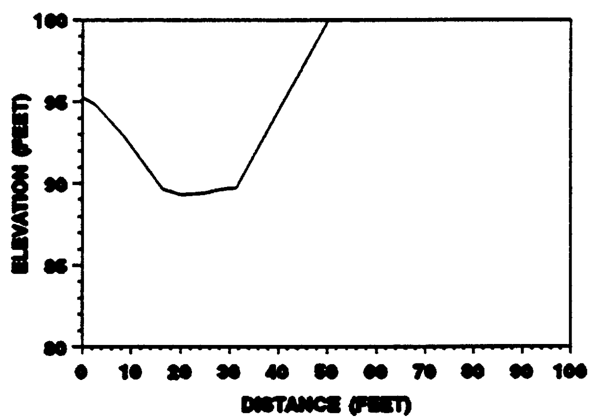
H A CREEK, 47C3

CROSS SECTION 1+46.50



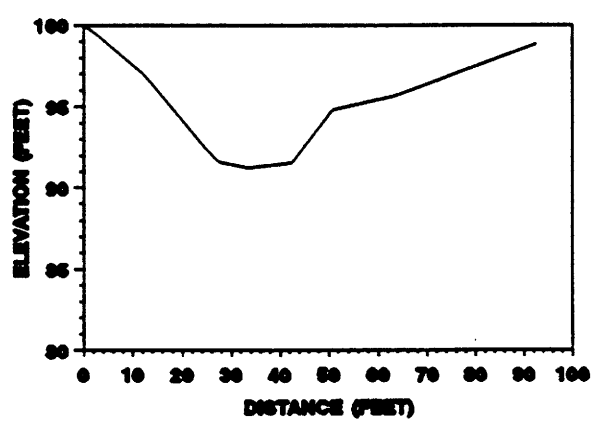
H A CREEK, 47C3

CROSS SECTION 5+97.50



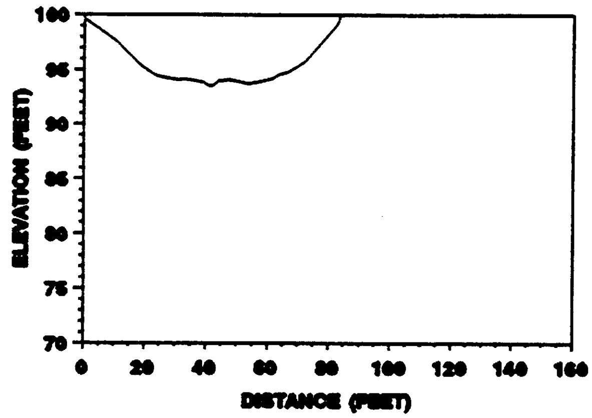
H A CREEK, 47C3

CROSS SECTION 9+90.00



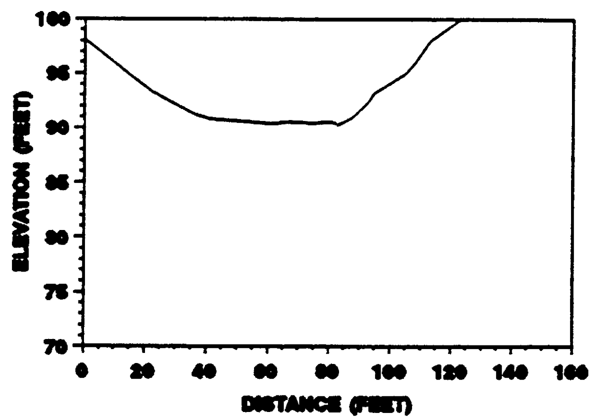
SCHOOL CREEK, 64A2

CROSS SECTION 0+[illegible]



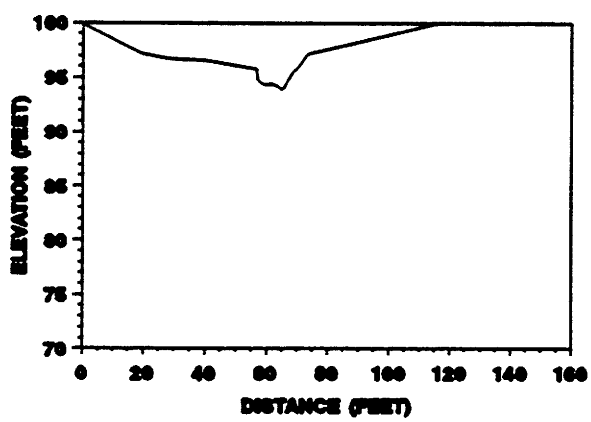
SCHOOL CREEK, 64A2

CROSS SECTION 1+15.00



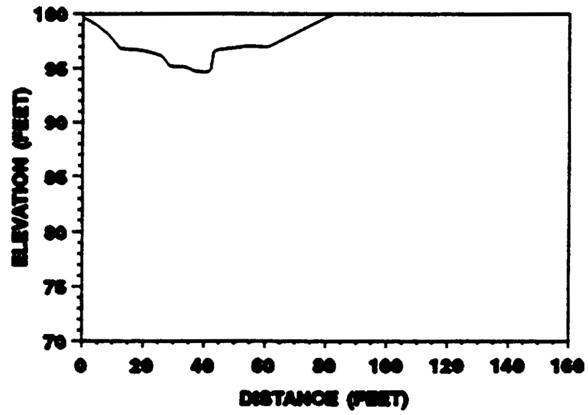
SCHOOL CREEK, 64A2

CROSS SECTION 0+[illegible]



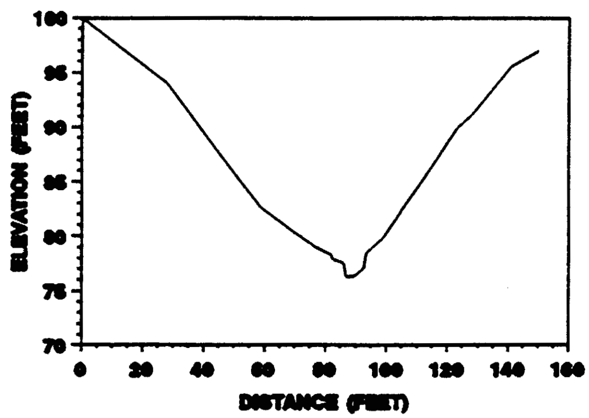
SCHOOL CREEK, 64A2

CROSS SECTION 0+53.00



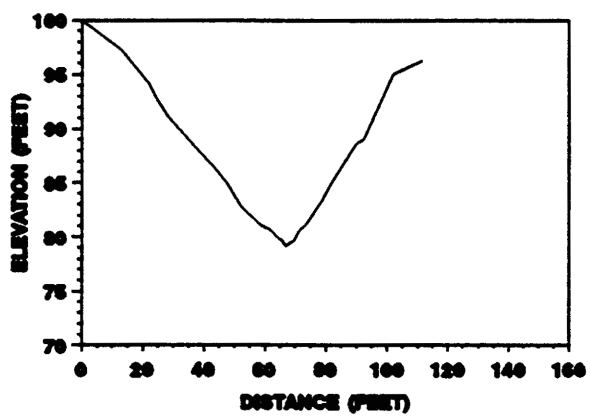
SCHOOL CREEK, 64A2

CROSS SECTION 0+68.00

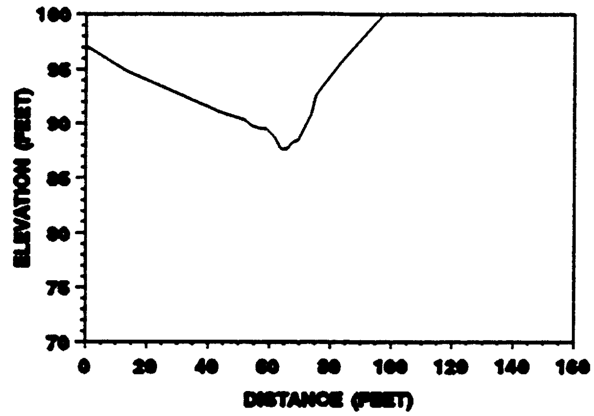


SCHOOL CREEK, 64A2

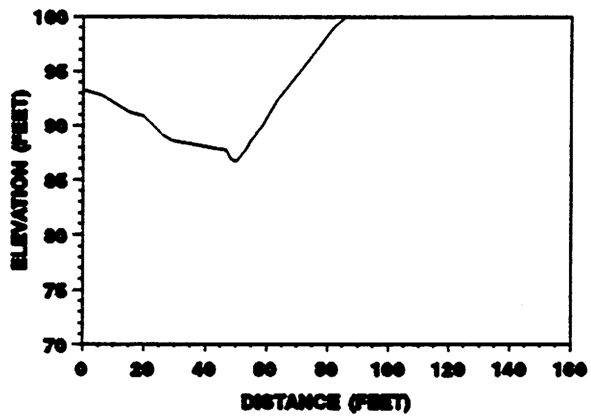
CROSS SECTION 0+71.50



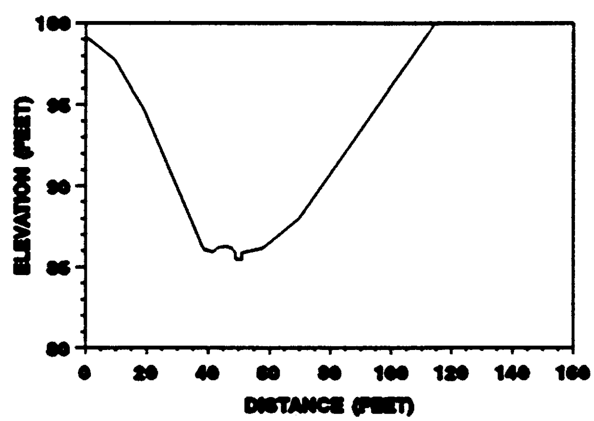
SCHOOL CREEK, 64A2
CROSS SECTION 0+[illegible]



SCHOOL CREEK, 64A2
CROSS SECTION 0+[illegible]

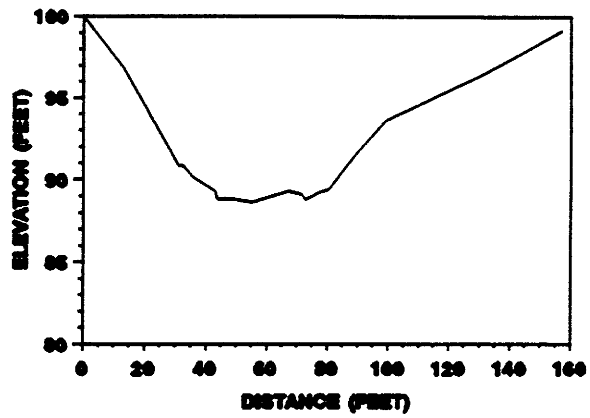


SCHOOL CREEK, 64B1
CROSS SECTION 0+[illegible]



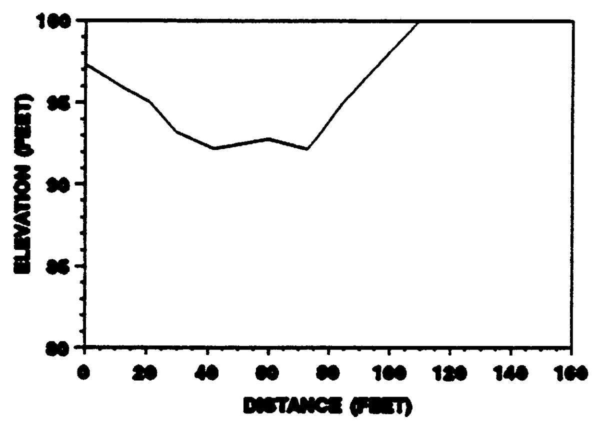
SCHOOL CREEK, 64B1

CROSS SECTION 10+68.30



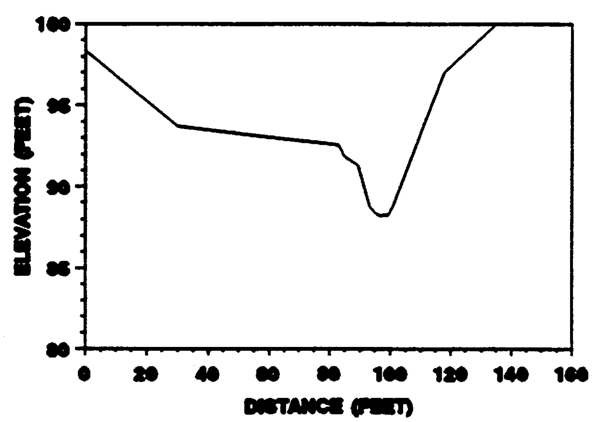
SCHOOL CREEK, 64B1

CROSS SECTION 11+57.80



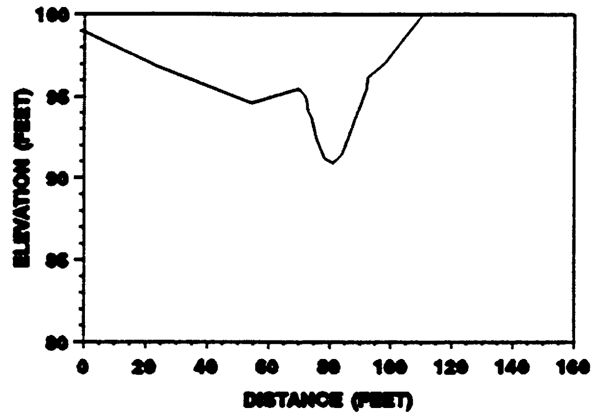
SCHOOL CREEK, 64B1

CROSS SECTION 20+32.80



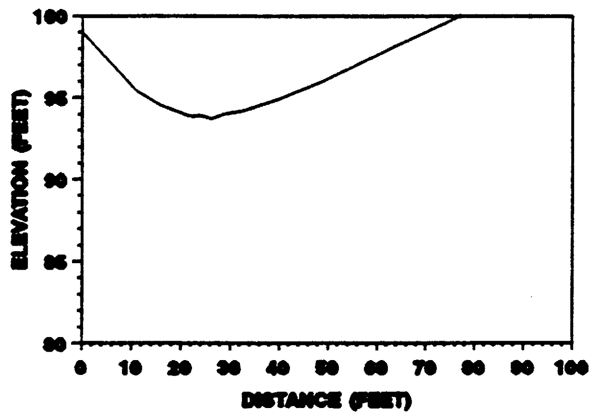
SCHOOL CREEK, 64B1

CROSS SECTION 24+28.00



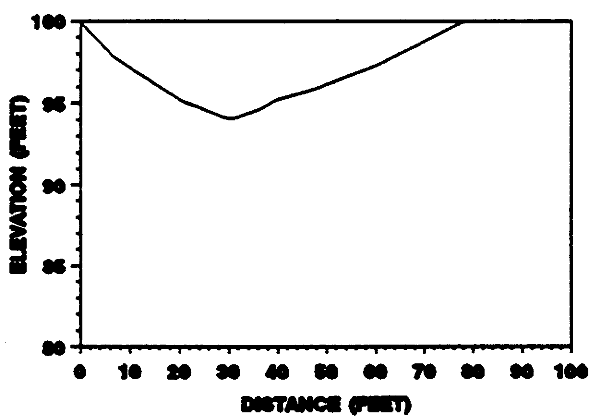
SCHOOL CREEK, 64B2

CROSS SECTION 0+00.00

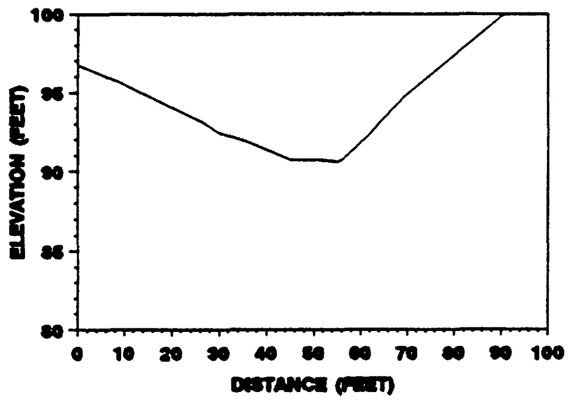


SCHOOL CREEK, 64B2

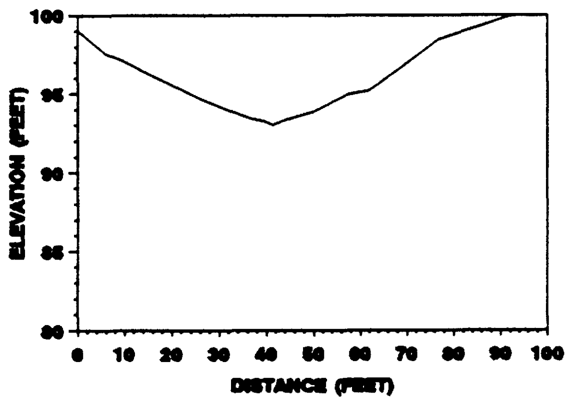
CROSS SECTION 1+74.00



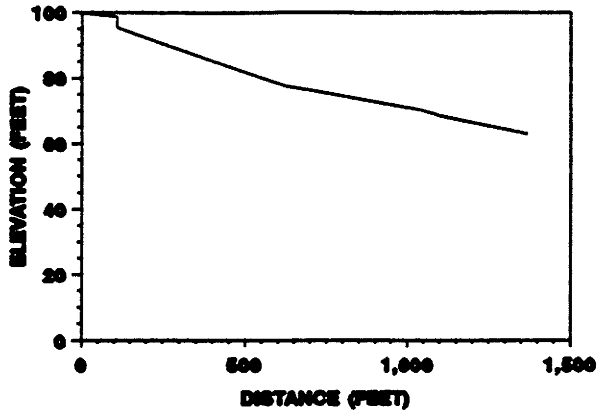
SCHOOL CREEK, 64B2
CROSS SECTION 6+63.20



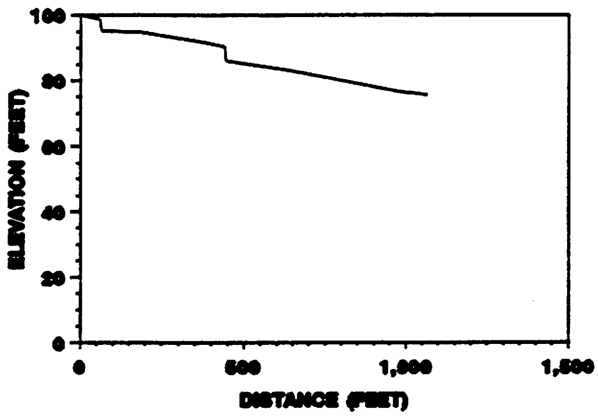
SCHOOL CREEK, 64B2
CROSS SECTION 6+22.70



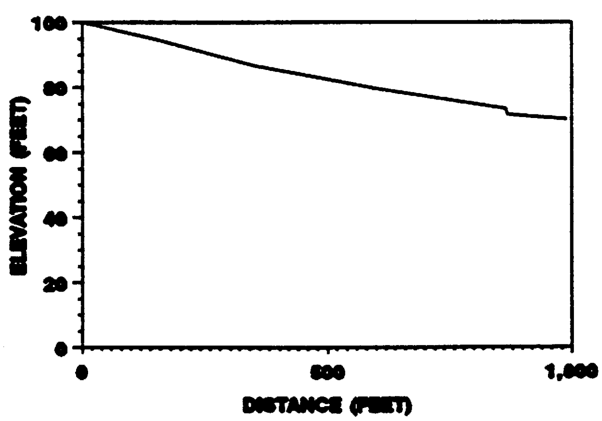
WINDMILL DRAW, 09D1
LONGITUDINAL PROFILE



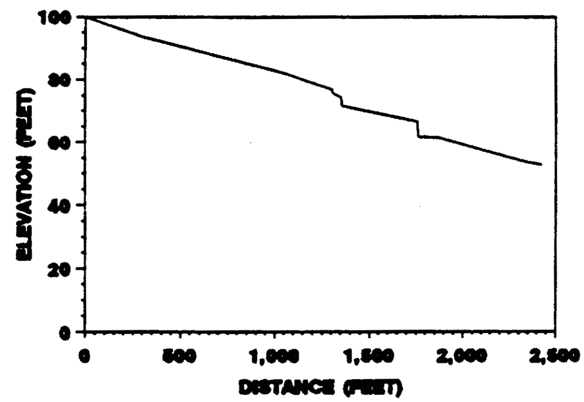
H A CREEK, 47C2
LONGITUDINAL PROFILE



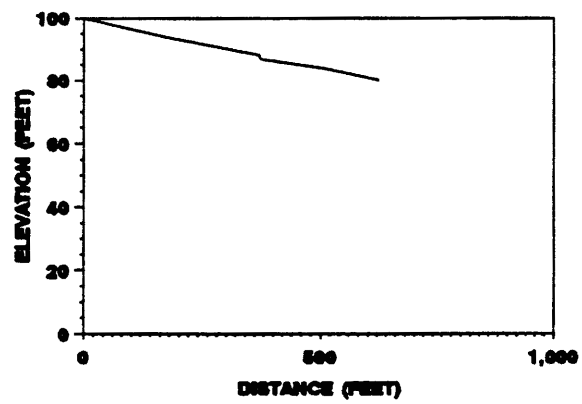
H A CREEK, 47C3
LONGITUDINAL PROFILE



SCHOOL CREEK, 64B1
LONGITUDINAL PROFILE



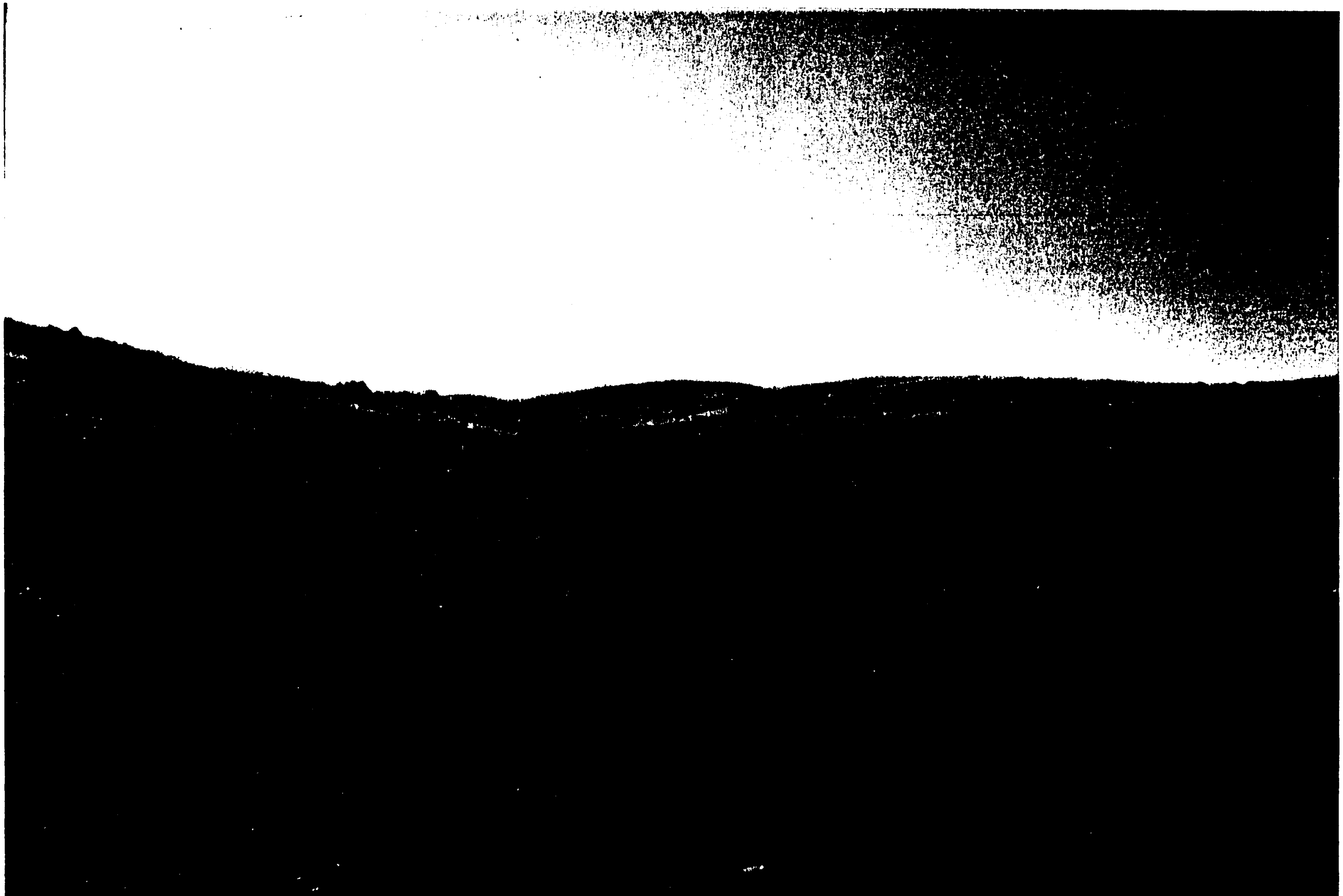
SCHOOL CREEK, 64B2
LONGITUDINAL PROFILE



Strata "A" first order raw data by study reach, cross section, and bank identification.

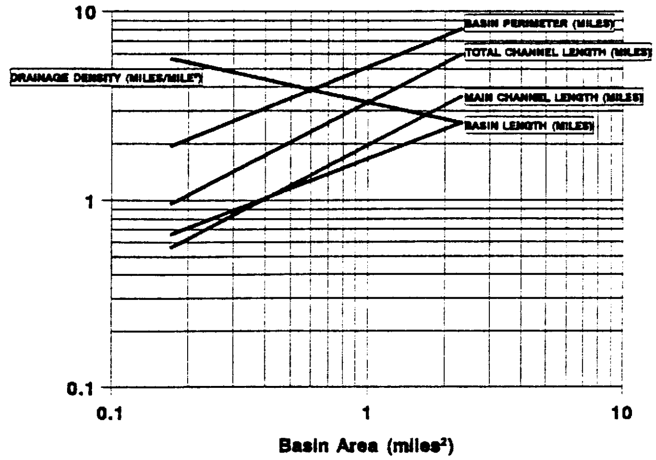
BASIN I.D.	CROSS SECTION NUMBER	BANK I.D.	AREA ($feet^2$)	TOP WIDTH (feet)	AVERAGE DEPTH (feet)	BED WIDTH (feet)
09D1	0+00.00	HIGH	387.70	59.10	6.60	
09D1	6+23.90	HIGH	315.80	57.00	5.50	
09D1	10+99.40	HIGH	770.70	110.50	7.00	29.40
09D1	13+67.4	HIGH	768.90	163.50	4.70	53.30
47C2	3+75.60	HIGH	1128.40	152.50	7.40	26.80
47C2	9+75.60	HIGH	526.20	110.70	4.80	50.40
47C2	10+65.20	HIGH	528.10	119.30	4.40	59.20
64A2	0+00.00A	HIGH	348.60	83.40	4.20	34.90
64A2	1+15.00A	HIGH	615.10	113.20	5.40	45.30
64A2	0+00.00B	HIGH	284.40	112.90	2.50	43.50
64A2	0+53.00B	HIGH	213.30	80.50	2.70	41.70
64A2	0+00.00C	HIGH	1377.90	135.90	10.10	
64A2	0+71.50C	HIGH	828.60	95.80	8.70	
64A2	0+00.00D	HIGH	405.40	88.20	4.60	
64A2	0+66.80D	HIGH	219.00	66.00	3.30	
64B1	0+00.00	HIGH	835.10	111.30	7.50	15.20
64B1	10+68.30	HIGH	905.20	153.60	5.90	38.40
64B1	11+57.80	HIGH	317.60	96.00	3.30	43.20
64B1	23+32.60	HIGH	592.10	125.50	4.70	81.00
64B1	24+20.60	HIGH	340.00	105.90	3.20	
64B2	0+00.00	HIGH	218.30	69.80	3.10	13.80
64B2	1+74.50	HIGH	257.10	77.50	3.30	31.00
64B2	5+03.20	HIGH	266.40	77.50	3.40	12.10
64B2	6+22.70	HIGH	274.80	82.60	3.30	10.60

BASIN I.D.	CROSS SECTION NUMBER	BANK I.D.	AREA (feet²)	TOP WIDTH (feet)	AVERAGE DEPTH (feet)
47C2	0+00.00	MEDIUM	175.80	54.80	3.20
47C2	3+75.60	MEDIUM	136.00	62.20	2.20
47C3	0+00.00	MEDIUM	154.70	43.50	3.60
47C3	1+48.50	MEDIUM	128.10	42.20	3.00
47C3	5+97.50	MEDIUM	156.20	41.70	3.70
47C3	9+90.00	MEDIUM	80.30	32.70	2.50
64A2	0+00.00B	MEDIUM	15.50	12.80	1.20
64A2	0+53.00B	MEDIUM	18.10	16.80	1.10
64A2	0+00.00C	MEDIUM	13.10	11.10	1.20
64A2	0+71.50C	MEDIUM	7.50	9.50	0.80
64A2	0+00.00D	MEDIUM	2.20	5.00	0.40
64A2	0+66.80D	MEDIUM	3.50	6.00	0.60
64B1	10+68.30	MEDIUM	9.50	24.10	0.40
64B1	23+32.60	MEDIUM	34.10	16.70	2.00
64B1	24+20.60	MEDIUM	44.20	18.10	2.40
09D1	0+00.00	LOW	0.10	1.70	0.10
09D1	6+23.90	LOW	3.30	10.00	0.30
47C2	9+75.60	LOW	8.30	24.20	0.30
47C2	10+65.20	LOW	6.70	33.70	0.20
64A2	0+00.00	LOW	3.10	6.20	0.50
64A2	0+71.50	LOW	0.90	3.90	0.20

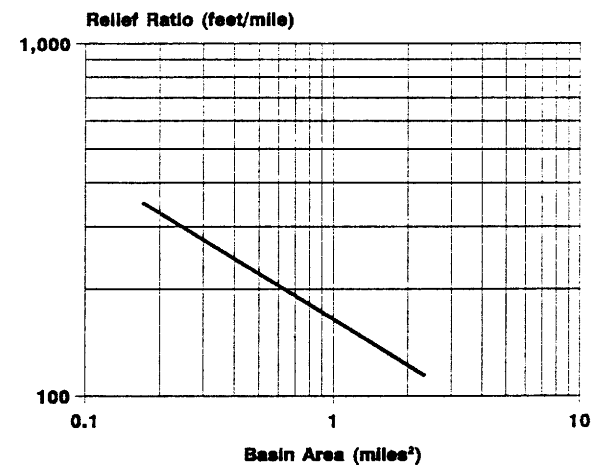


APPENDIX A-2

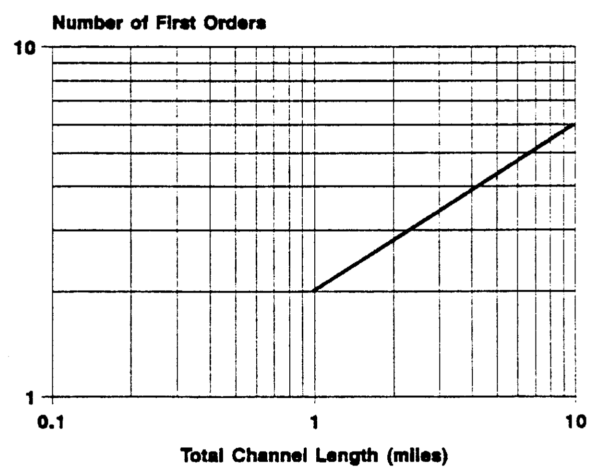
STRATA "A" - SECOND ORDER



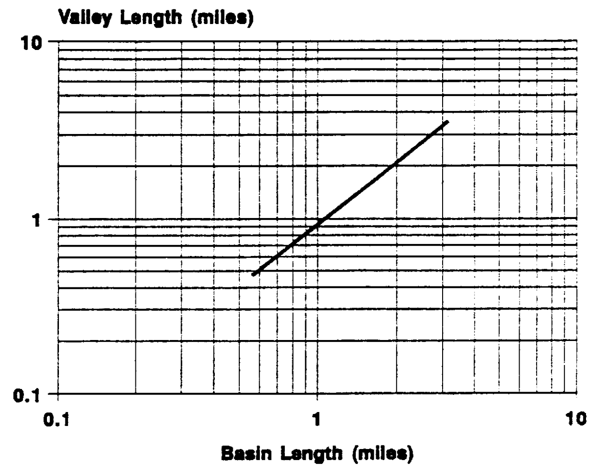
10
BASIN PERIMETER (MILES)
TOTAL CHANNEL LENGTH (MILES)
DRAINAGE DENSITY (MILES/MILE²)
MAIN CHANNEL LENGTH (MILES)
BASIN LENGTH (MILES)
1
0.1
0.1
1
10
Basin Area (miles²)

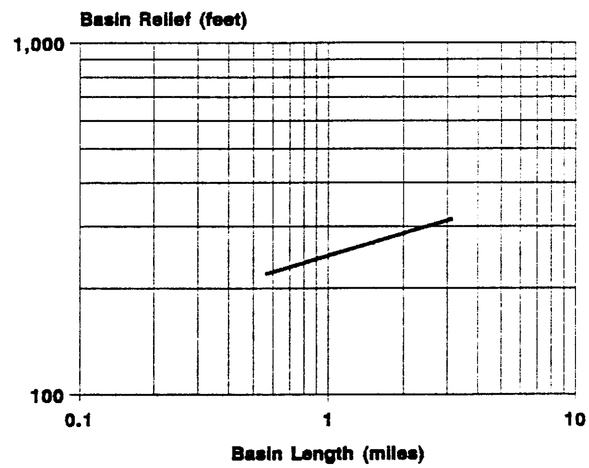


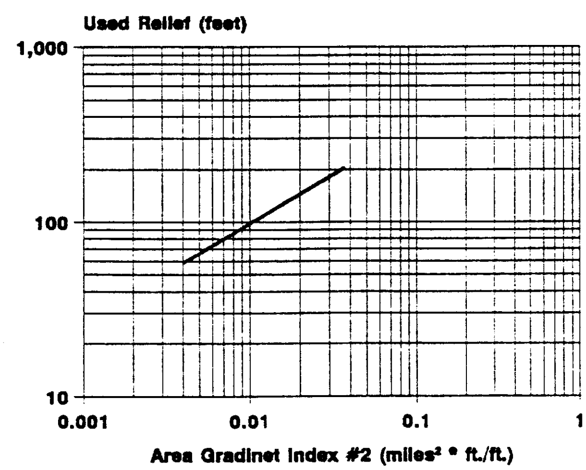
Relief Ratio (feet/mile)
1,000
100
0.1
1
10
Basin Area (miles²)

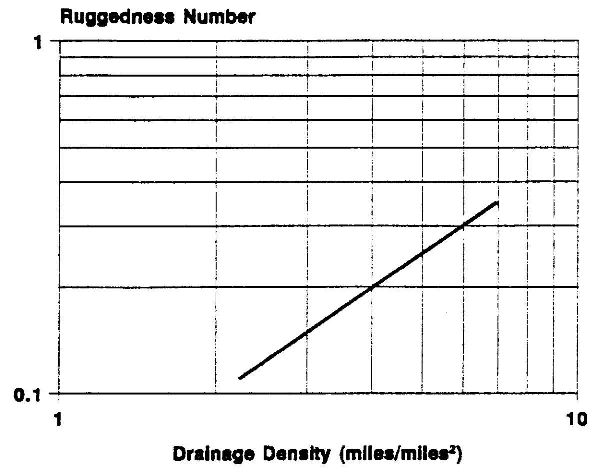


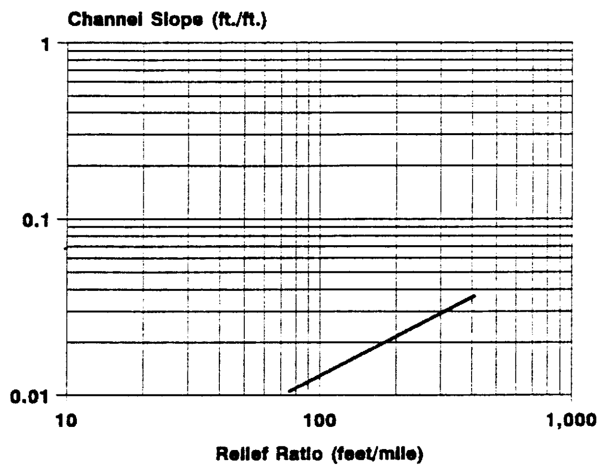
Number of First Orders
10
1
0.1
1
10
Total Channel Length (miles)

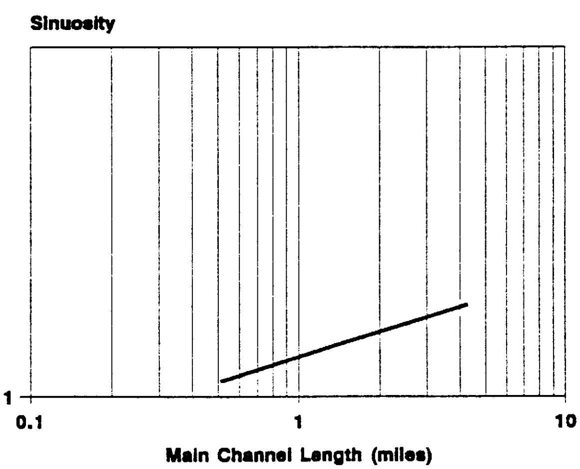

Valley Length (miles)
10
1
0.1
0.1
1
10
Basin Length (miles)

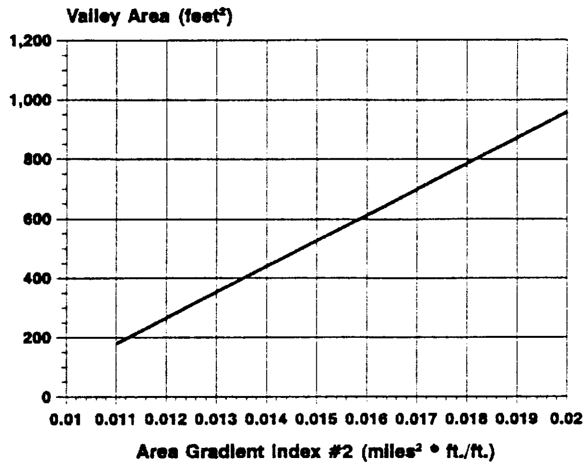

Basin Relief (feet)
1,000
100
0.1
1
10
Basin Length (miles)

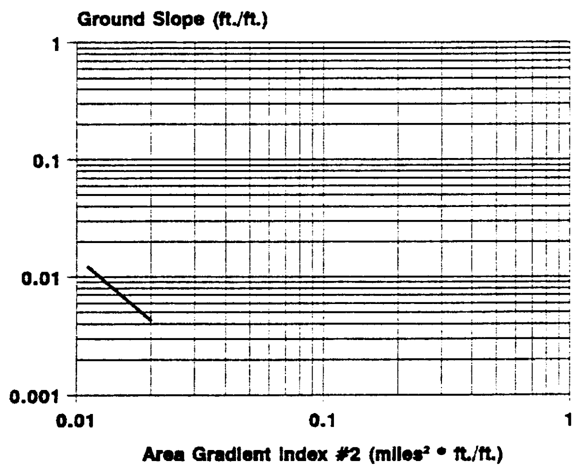

Used Relief (feet)
1,000
100
10
0.001
0.01
0.1
1
Area Gradinet Index #2 (miles² * ft./ft.)

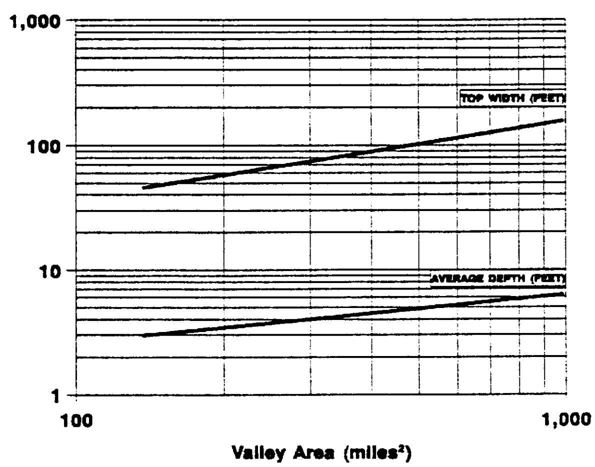

Ruggedness Number
1
0.1
1
10
Drainage Density (miles/miles²)

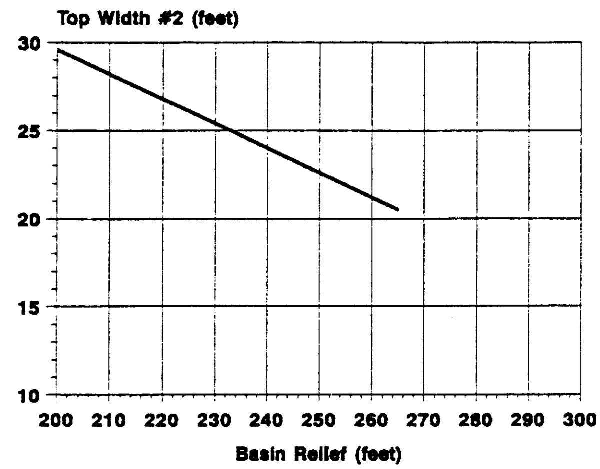

Channel Slope (ft./ft.)
1
0.1
0.01
10
100
1,000
Relief Ratio (feet/mile)

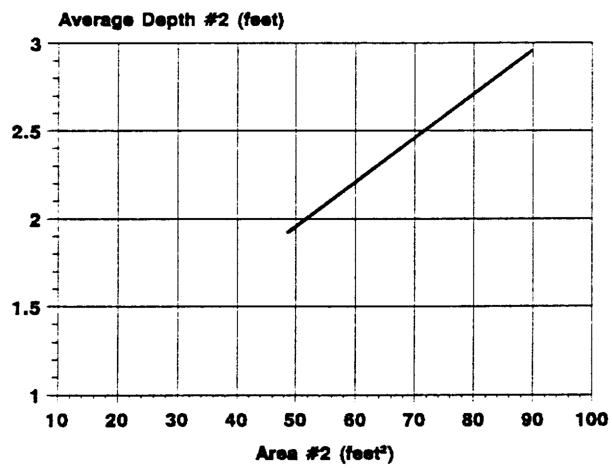

Sinuosity
1
0.1
1
10
Main Channel Length (miles)

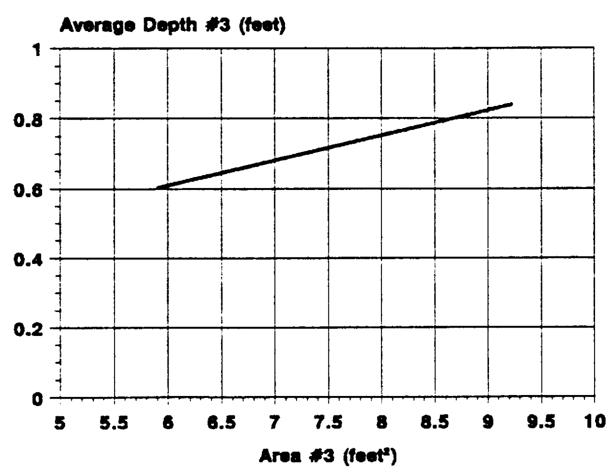

Valley Area (feet²)
1,200
1,000
800
600
400
200
0
0.01 0.011 0.012 0.013 0.014 0.015 0.016 0.017 0.018 0.019 0.02
Area Gradient Index #2 (miles² • ft./ft.)


Ground Slope (ft./ft.)
1
0.1
0.01
0.001
0.01
0.1
1
Area Gradient Index #2 (miles² • ft./ft.)


1,000
100
10
1
TOP WIDTH (FEET)
AVERAGE DEPTH (FEET)
100
1,000
Valley Area (miles²)


Top Width #2 (feet)
30
25
20
15
10
200 210 220 230 240 250 260 270 280 290 300
Basin Relief (feet)


Average Depth #2 (feet)
3
2.5
2
1.5
1
10 20 30 40 50 60 70 80 90 100
Area #2 (feet²)


Average Depth #3 (feet)
1
0.8
0.6
0.4
0.2
0
5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10
Area #3 (feet²)

Strata "A" second order regression output for basin perimeter versus basin area.

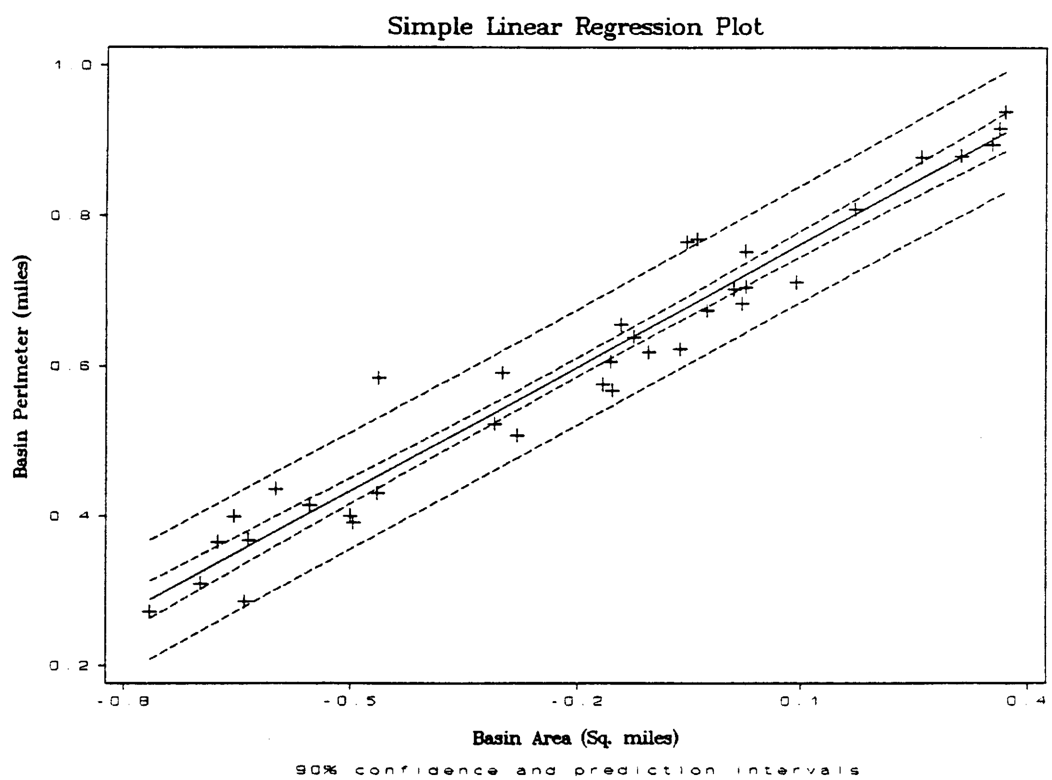
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BASIN PERIMETER

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.70849	0.00868	81.63	0.0000
BA	0.54943	0.02251	24.40	0.0000

R-SQUARED	0.9460	RESID. MEAN SQUARE (MSE)	0.00201
ADJUSTED R-SQUARED	0.9444	STANDARD DEVIATION	0.04484

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.19748	1.19748	595.54	0.0000
RESIDUAL	34	0.06837	0.00201		
TOTAL	35	1.26584			

CASES INCLUDED 36 MISSING CASES 0



Strata "A" second order regression output for drainage density versus basin area.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF DRAINAGE DENSITY

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.52157	0.01731	30.13	0.0000
BA	-0.30327	0.04490	-6.75	0.0000

R-SQUARED	0.5730	RESID. MEAN SQUARE (MSE)	0.00800
ADJUSTED R-SQUARED	0.5604	STANDARD DEVIATION	0.08943

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.36485	0.36485	45.62	0.0000
RESIDUAL	34	0.27192	0.00800		
TOTAL	35	0.63677			

CASES INCLUDED 36 MISSING CASES 0

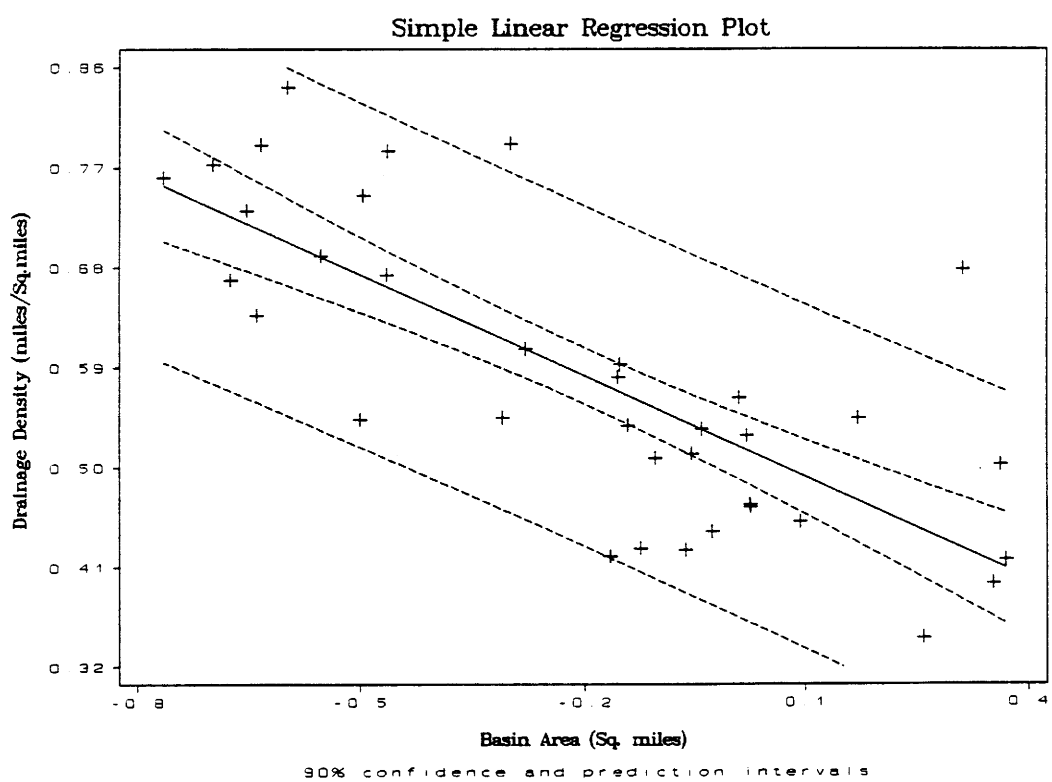


Figure 17

Strata "A" second order regression output for basin length versus basin area.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BASIN LENGTH

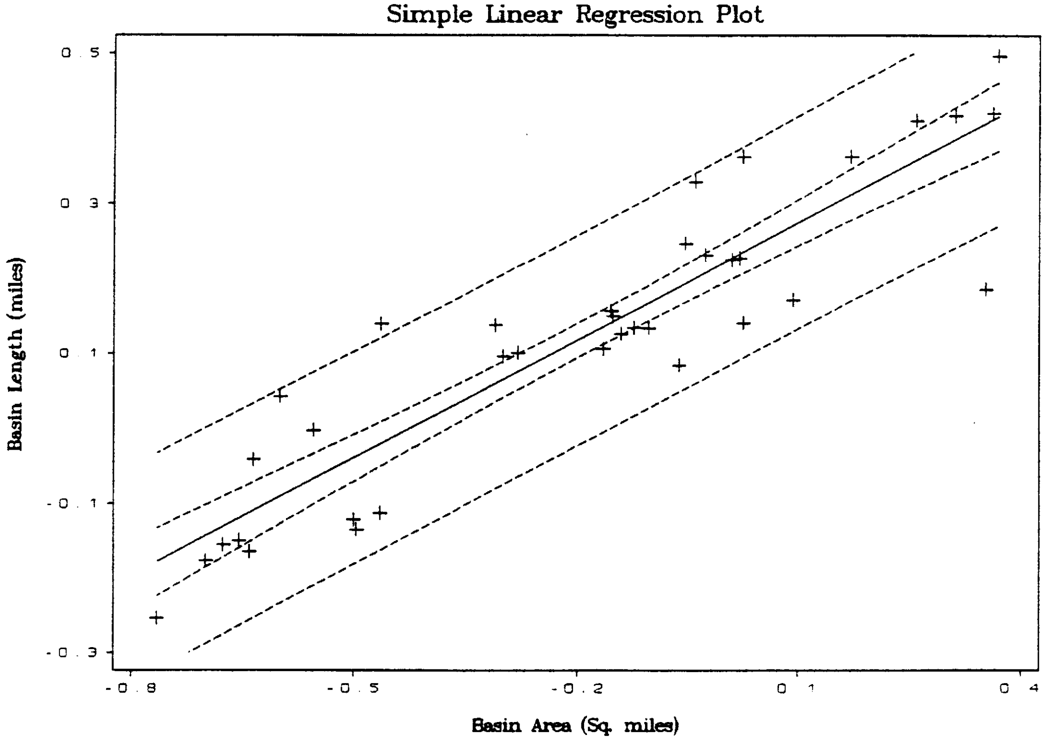
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.22272	0.01585	14.05	0.0000
BA	0.52403	0.04111	12.75	0.0000

R-SQUARED	0.8270	RESID. MEAN SQUARE (MSE)	0.00670
ADJUSTED R-SQUARED	0.8219	STANDARD DEVIATION	0.08188

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.08930	1.08930	162.49	0.0000
RESIDUAL	34	0.22792	0.00670		
TOTAL	35	1.31723			

CASES INCLUDED 36   MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "A" second order regression output for main channel length versus basin area.

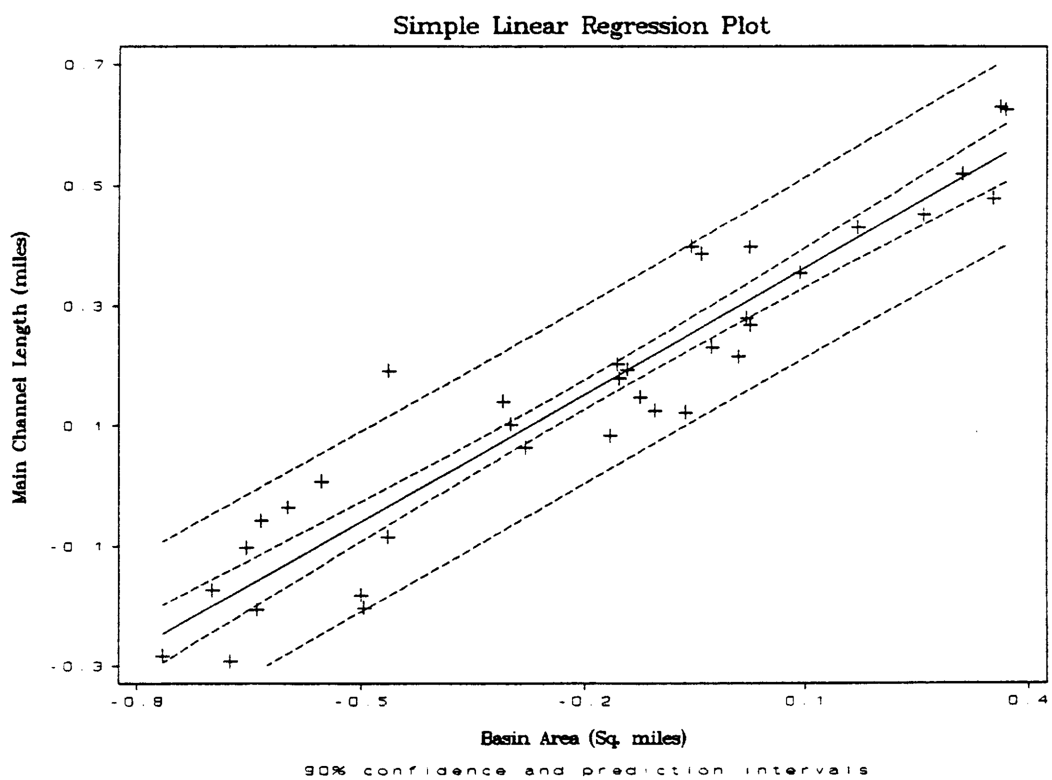
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF MAIN CHANNEL LENGTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.29340	0.01676	17.51	0.0000
BA	0.70529	0.04347	16.23	0.0000

R-SQUARED	0.8856	RESID. MEAN SQUARE (MSE)	0.00749
ADJUSTED R-SQUARED	0.8823	STANDARD DEVIATION	0.08657

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.97321	1.97321	263.28	0.0000
RESIDUAL	34	0.25482	0.00749		
TOTAL	35	2.22803			

CASES INCLUDED 36   MISSING CASES 0



Strata "A" second order regression output for total channel length versus basin area.

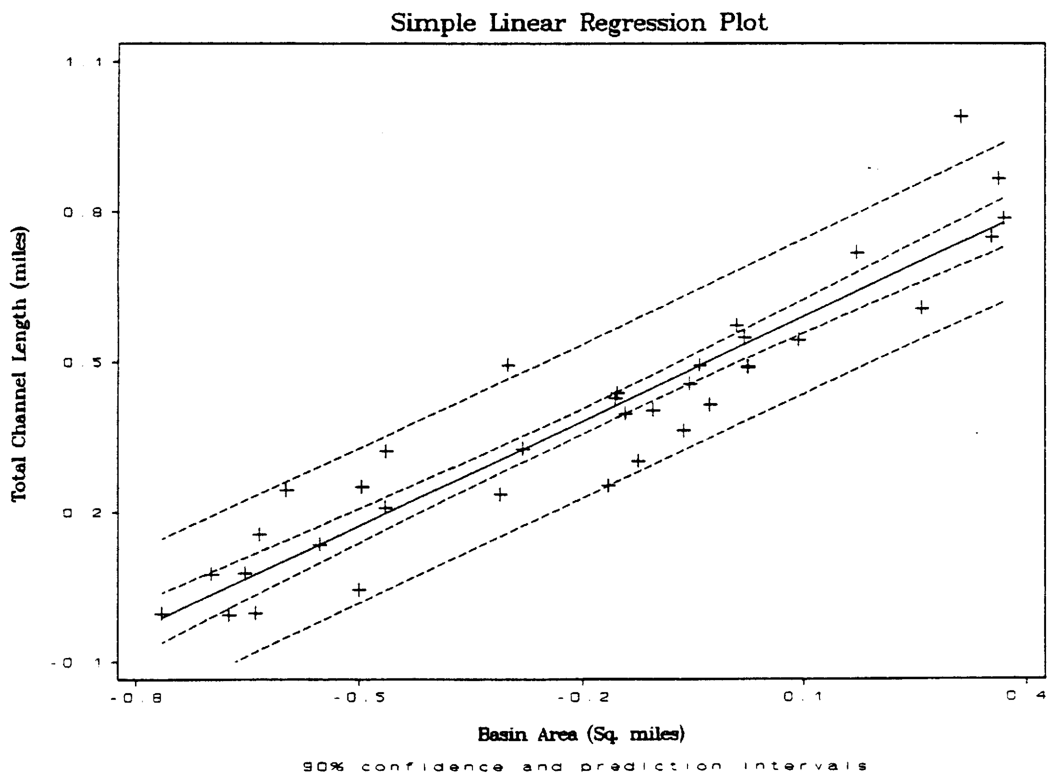
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOTAL CHANNEL LENGTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.52157	0.01731	30.13	0.0000
BA	0.69673	0.04490	15.52	0.0000

R-SQUARED	0.8763	RESID. MEAN SQUARE (MSE)	0.00800
ADJUSTED R-SQUARED	0.8726	STANDARD DEVIATION	0.08943

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.92559	1.92559	240.77	0.0000
RESIDUAL	34	0.27192	0.00800		
TOTAL	35	2.19751			

CASES INCLUDED 36   MISSING CASES 0



Strata "A" second order regression output for number of first orders versus total channel length.

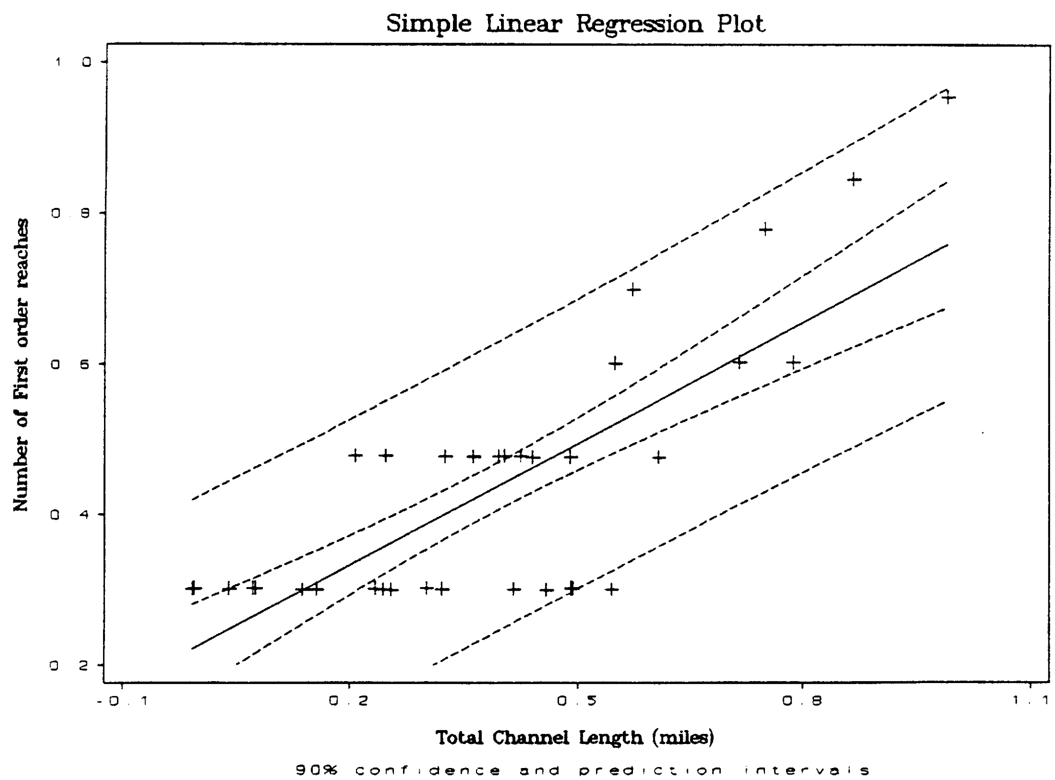
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF NUMBER OF FIRSTS

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.22491	0.03462	6.50	0.0000
TCHL	0.53946	0.07569	7.13	0.0000

R-SQUARED	0.5991	RESID. MEAN SQUARE (MSE)	0.01259
ADJUSTED R-SQUARED	0.5873	STANDARD DEVIATION	0.11220

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.63951	0.63951	50.80	0.0000
RESIDUAL	34	0.42799	0.01259		
TOTAL	35	1.06750			

CASES INCLUDED 36 MISSING CASES 0



Strata "A" second order regression output for valley length versus basin length.

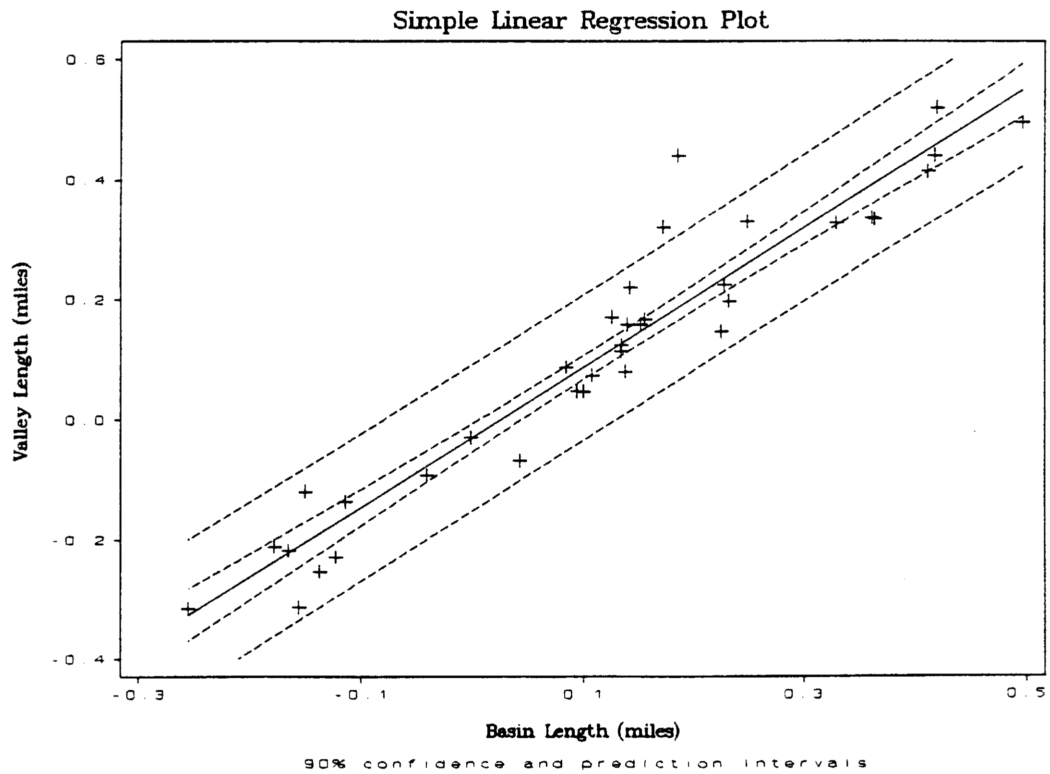
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF VALLEY LENGTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.02948	0.01387	-2.13	0.0409
BL	1.16532	0.06143	18.97	0.0000

R-SQUARED	0.9137	RESID. MEAN SQUARE (MSE)	0.00497
ADJUSTED R-SQUARED	0.9111	STANDARD DEVIATION	0.07051

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.78875	1.78875	359.83	0.0000
RESIDUAL	34	0.16902	0.00497		
TOTAL	35	1.95777			

CASES INCLUDED 36 MISSING CASES 0



Strata "A" second order regression output of basin relief versus basin length.

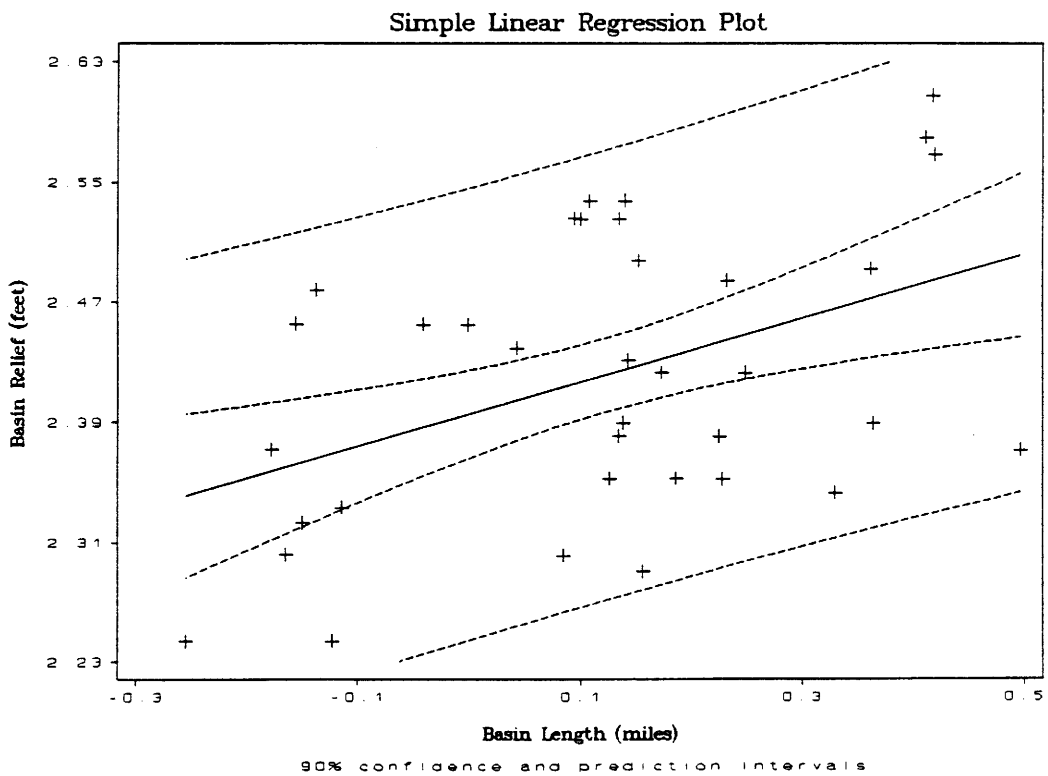
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BASIN RELIEF

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	2.39525	0.01723	138.98	0.0000
BL	0.21360	0.07632	2.80	0.0084

R-SQUARED	0.1872	RESID. MEAN SQUARE (MSE)	0.00767
ADJUSTED R-SQUARED	0.1633	STANDARD DEVIATION	0.08760

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.06010	0.06010	7.83	0.0084
RESIDUAL	34	0.26089	0.00767		
TOTAL	35	0.32099			

CASES INCLUDED 36 MISSING CASES 0



Strata "A" second order regression output for used relief versus area gradient index #2.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF USED RELIEF

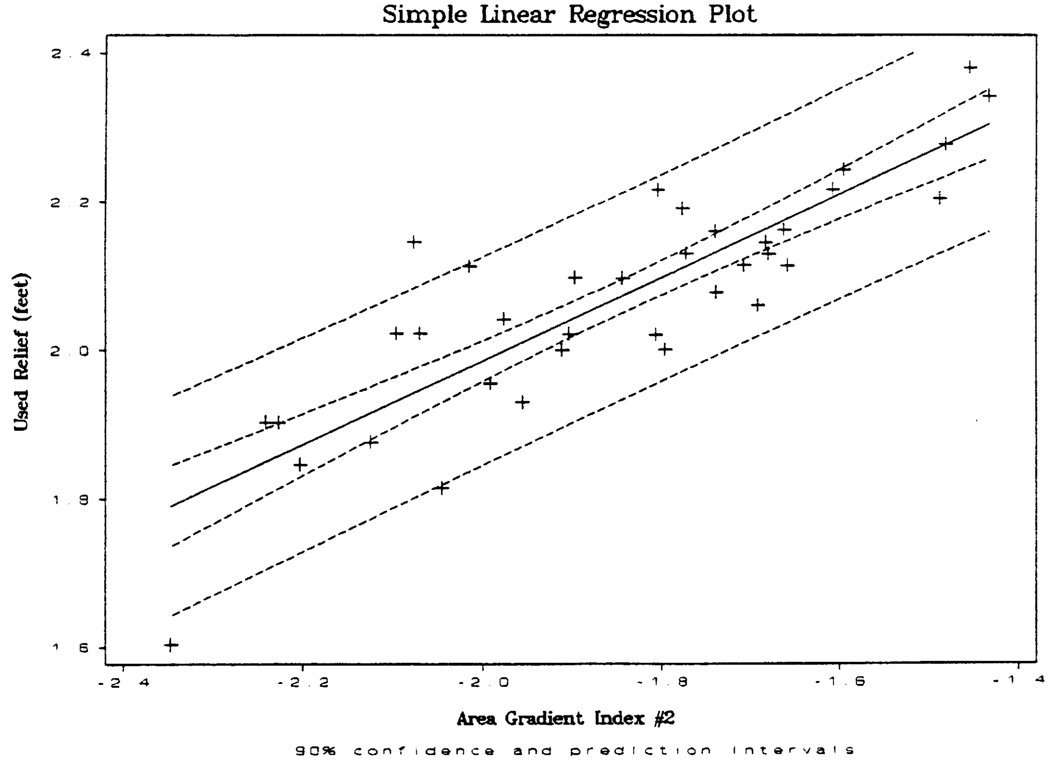
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	3.11128	0.10820	28.75	0.0000
AGI2	0.56282	0.05811	9.69	0.0000

R-SQUARED	0.7340	RESID. MEAN SQUARE (MSE)	0.00662
ADJUSTED R-SQUARED	0.7261	STANDARD DEVIATION	0.08134

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.62057	0.62057	93.80	0.0000
RESIDUAL	34	0.22493	0.00662		
TOTAL	35	0.84550			

CASES INCLUDED 36   MISSING CASES 0

Simple Linear Regression Plot



Strata "A" second order regression output for relief ratio versus basin area.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RELIEF RATIO

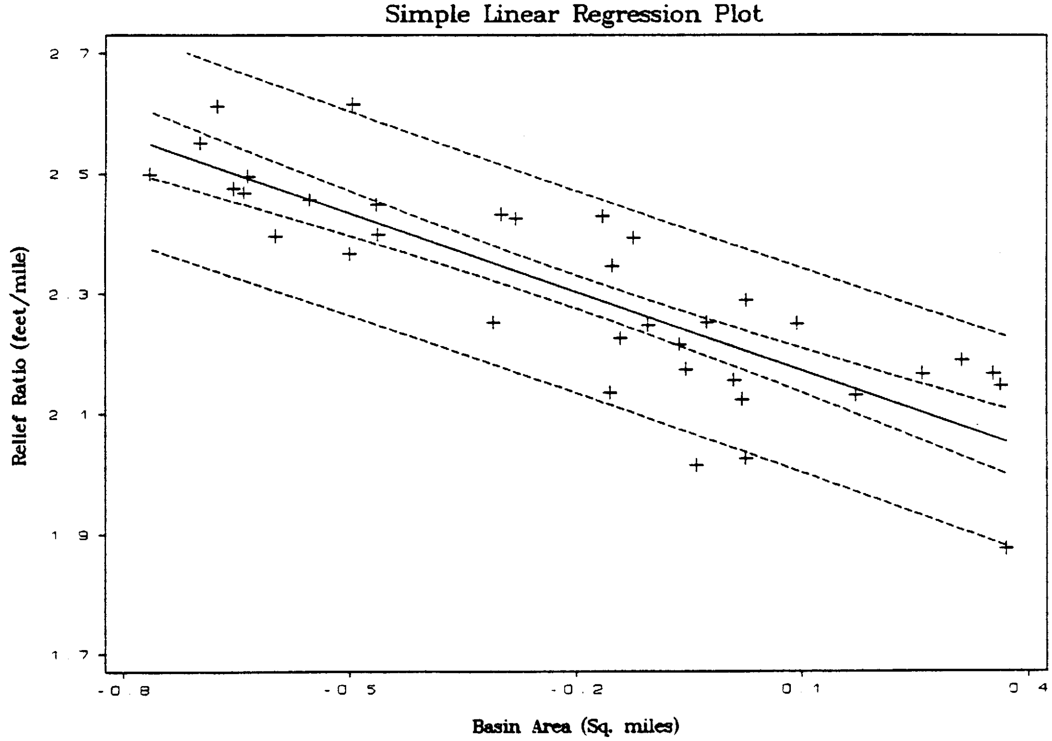
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	2.21569	0.01896	116.87	0.0000
BA	-0.43464	0.04918	-8.84	0.0000

R-SQUARED	0.6968	RESID. MEAN SQUARE (MSE)	0.00959
ADJUSTED R-SQUARED	0.6878	STANDARD DEVIATION	0.09794

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.74936	0.74936	78.12	0.0000
RESIDUAL	34	0.32614	0.00959		
TOTAL	35	1.07551			

CASES INCLUDED 36   MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "A" second order regression output for ruggedness number versus drainage density.

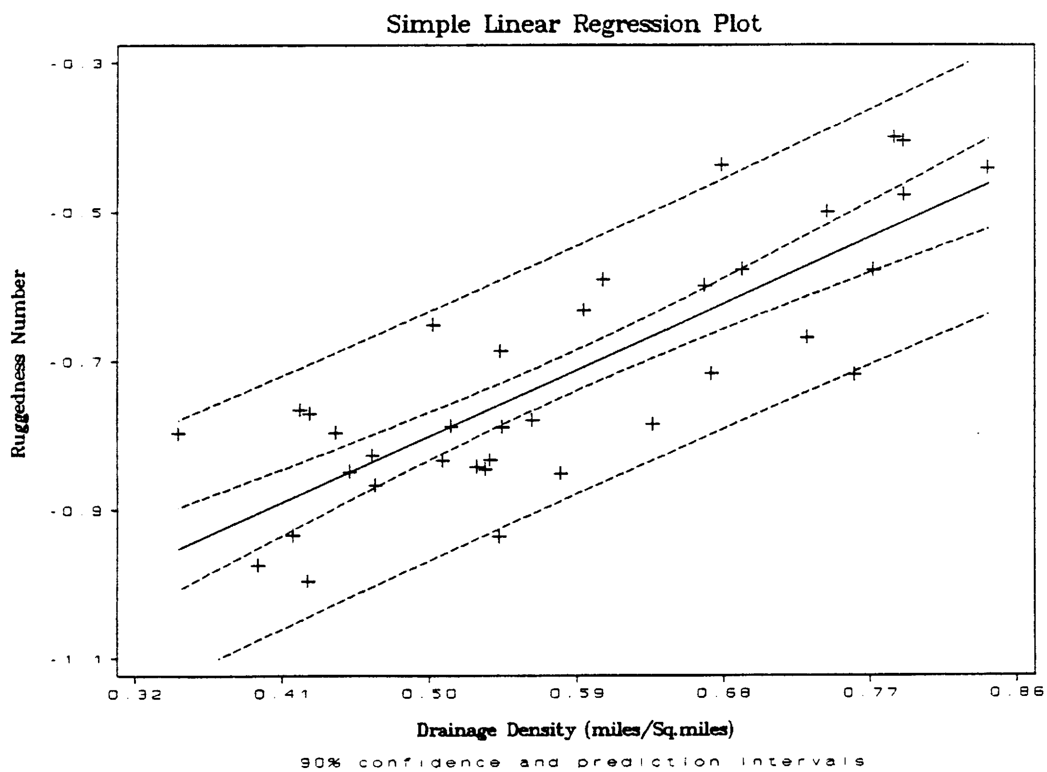
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RUGGEDNESS NUMBER

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-1.29530	0.07257	-17.85	0.0000
DD	0.98890	0.12175	8.12	0.0000

R-SQUARED	0.6599	RESID. MEAN SQUARE (MSE)	0.00944
ADJUSTED R-SQUARED	0.6499	STANDARD DEVIATION	0.09715

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.62271	0.62271	65.98	0.0000
RESIDUAL	34	0.32091	0.00944		
TOTAL	35	0.94363			

CASES INCLUDED 36 MISSING CASES 0



Strata "A" second order regression output for channel slope versus relief ratio.

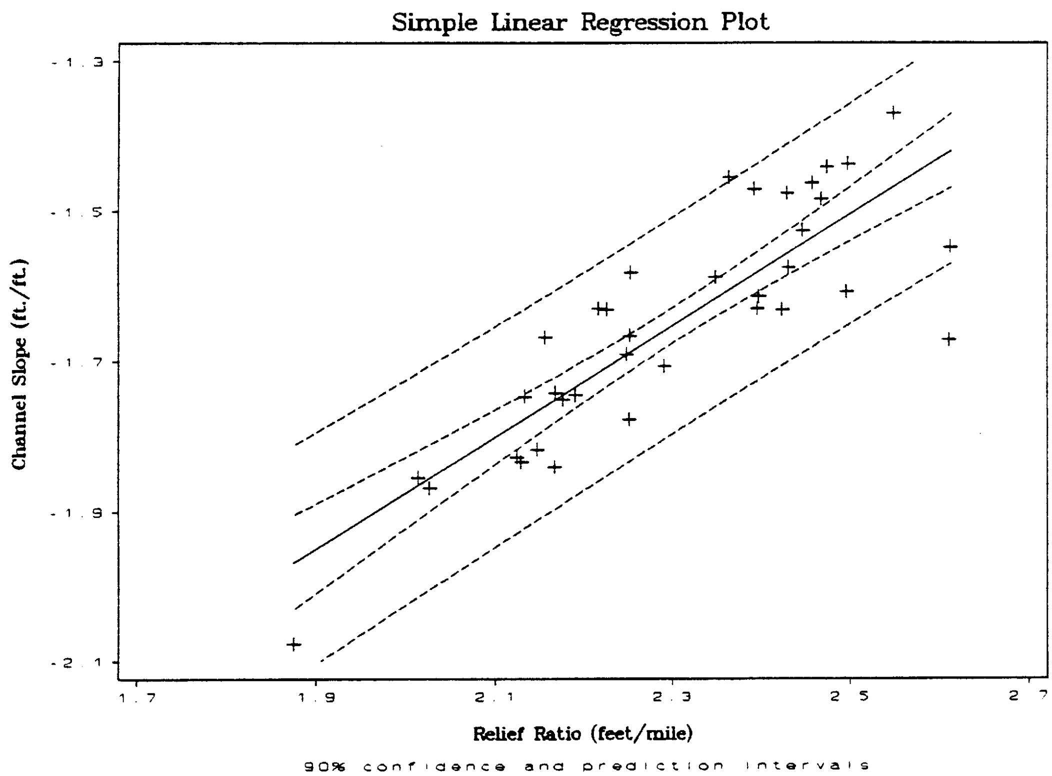
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF CHANNEL SLOPE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-3.36195	0.18724	-17.96	0.0000
RR	0.74347	0.08115	9.16	0.0000

R-SQUARED	0.7117	RESID. MEAN SQUARE (MSE)	0.00708
ADJUSTED R-SQUARED	0.7032	STANDARD DEVIATION	0.08416

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.59449	0.59449	83.94	0.0000
RESIDUAL	34	0.24080	0.00708		
TOTAL	35	0.83529			

CASES INCLUDED 36 MISSING CASES 0



Strata "A" second order regression output for sinuosity versus main channel length.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF SINUOSITY

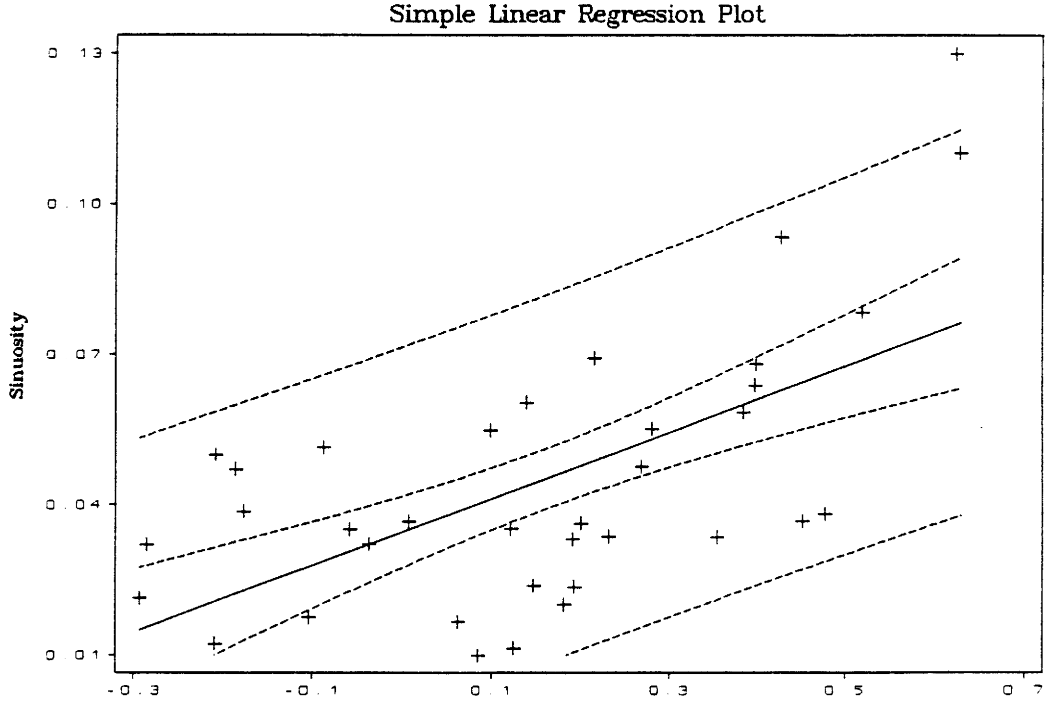
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.03450	0.00420	8.20	0.0000
MCHL	0.06635	0.01434	4.63	0.0001

R-SQUARED	0.3863	RESID. MEAN SQUARE (MSE)	4.583E-04
ADJUSTED R-SQUARED	0.3682	STANDARD DEVIATION	0.02141

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.00981	0.00981	21.40	0.0001
RESIDUAL	34	0.01558	4.583E-04		
TOTAL	35	0.02539			

CASES INCLUDED 36 MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "A" second order regression output for valley area versus area gradient index #2.

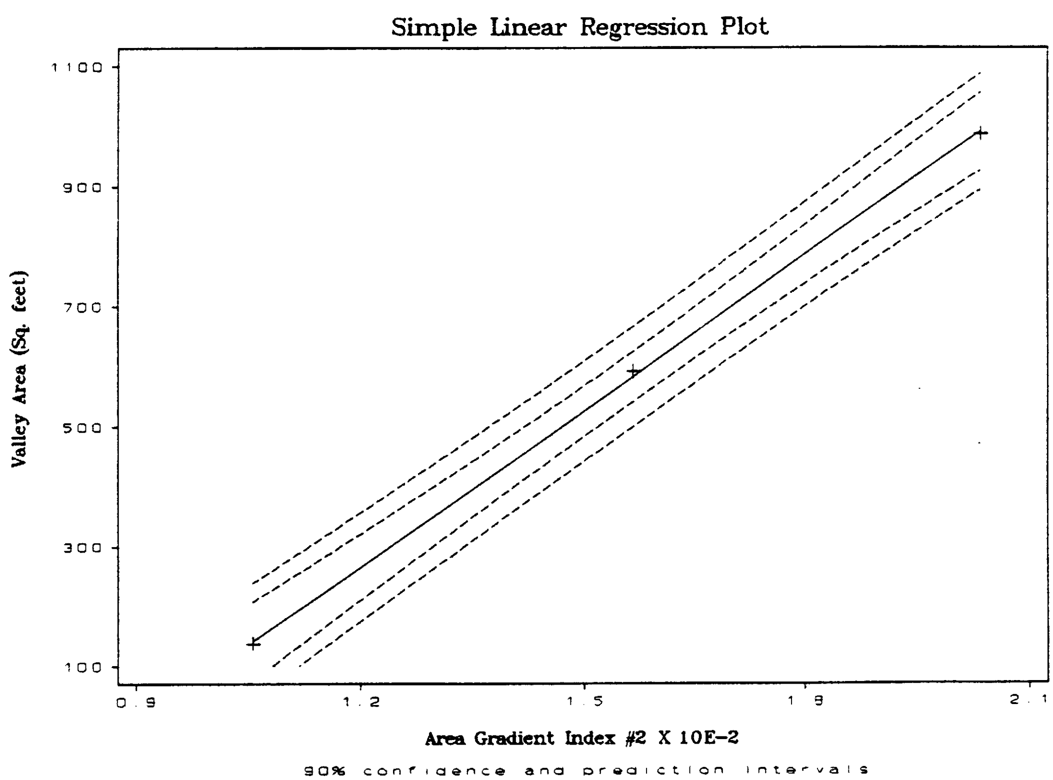
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF VALLEY AREA

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-776.140	26.3895	-29.41	0.0216
AGI2	86818.7	1646.13	52.74	0.0121

R-SQUARED	0.9996	RESID. MEAN SQUARE (MSE)	129.786
ADJUSTED R-SQUARED	0.9993	STANDARD DEVIATION	11.3924

SOURCE	DF	SS	MS	F	P
REGRESSION	1	3.610E+05	3.610E+05	2781.61	0.0121
RESIDUAL	1	129.786	129.786		
TOTAL	2	3.611E+05			

CASES INCLUDED 3 MISSING CASES 1



Strata "A" second order regression output for top width versus valley area.

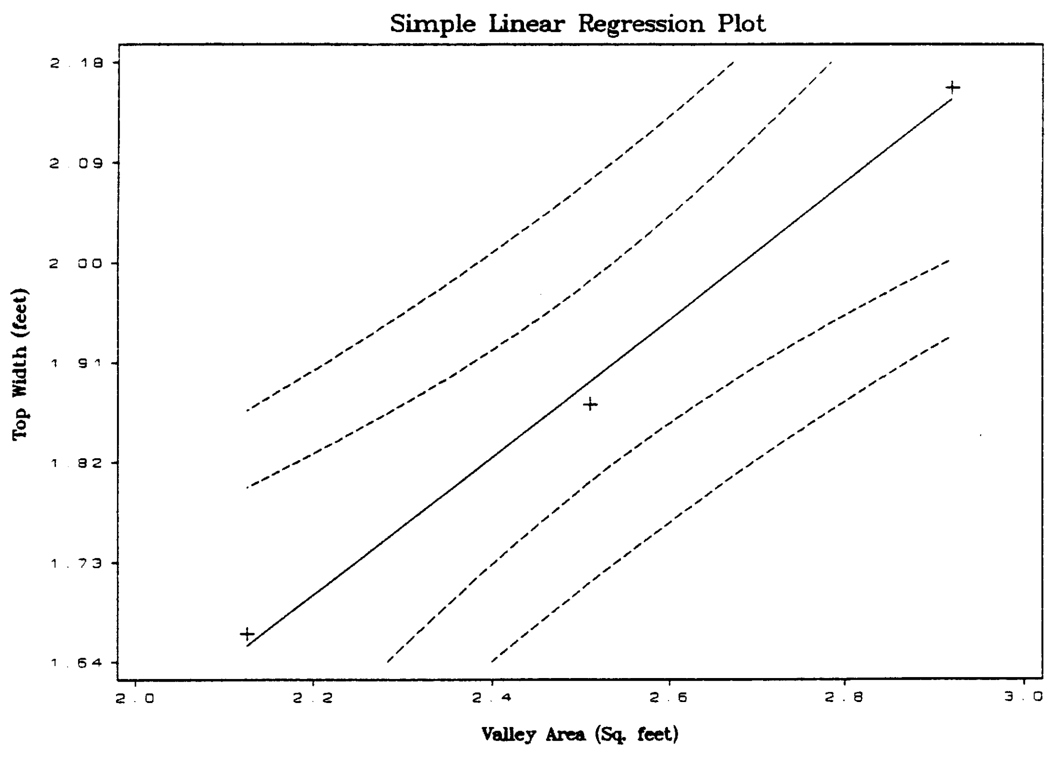
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOP WIDTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.33641	0.11256	2.99	0.2056
A	0.62028	0.04434	13.99	0.0454

R-SQUARED	0.9949	RESID. MEAN SQUARE (MSE)	6.194E-04
ADJUSTED R-SQUARED	0.9898	STANDARD DEVIATION	0.02489

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.12123	0.12123	195.72	0.0454
RESIDUAL	1	6.194E-04	6.194E-04		
TOTAL	2	0.12184			

CASES INCLUDED 3 MISSING CASES 1



Strata "A" second order regression output for ground slope versus area gradient index #2.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF GROUND SLOPE

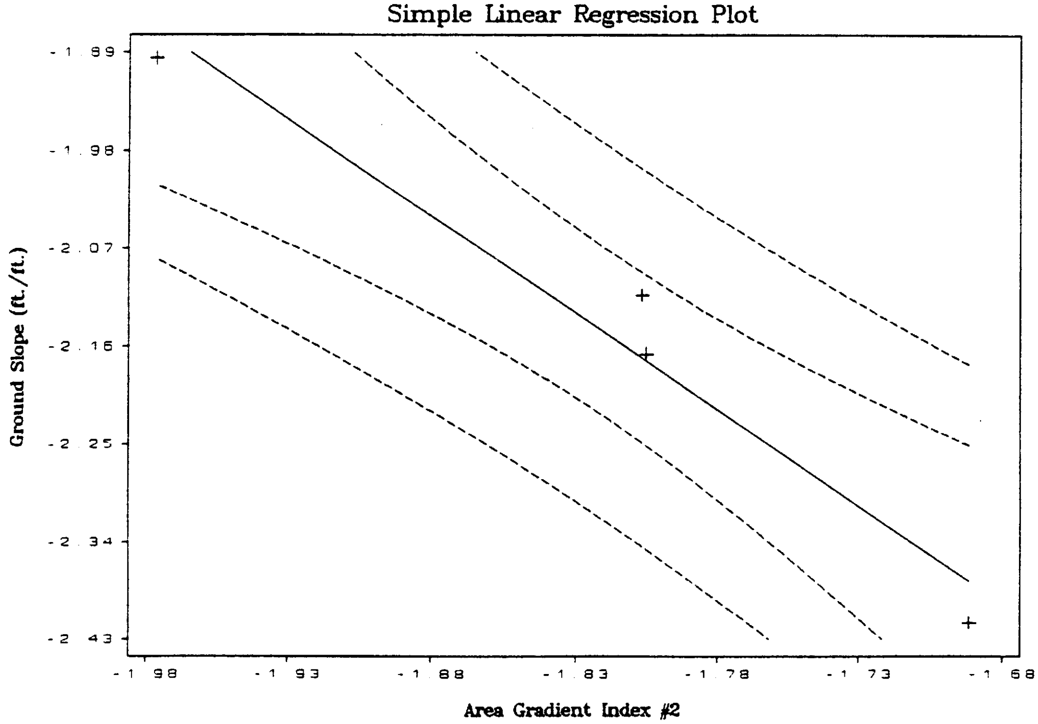
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-5.38804	0.47683	-11.30	0.0077
AGI2	-1.78060	0.26160	-6.81	0.0209

R-SQUARED	0.9586	RESID. MEAN SQUARE (MSE)	0.00283
ADJUSTED R-SQUARED	0.9379	STANDARD DEVIATION	0.05317

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.13098	0.13098	46.33	0.0209
RESIDUAL	2	0.00565	0.00283		
TOTAL	3	0.13663			

CASES INCLUDED 4 MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "A" second order regression output of area #2 versus main channel length and channel slope.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AREA #2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	262.200	13.6655	19.19	0.0331
MCHL	-36.9641	3.21158	-11.51	0.0552
CHS	-6809.90	462.204	-14.73	0.0431

R-SQUARED	0.9955	RESID. MEAN SQUARE (MSE)	4.77825
ADJUSTED R-SQUARED	0.9864	STANDARD DEVIATION	2.18592

SOURCE	DF	SS	MS	F	P
REGRESSION	2	1049.85	524.927	109.86	0.0673
RESIDUAL	1	4.77825	4.77825		
TOTAL	3	1054.63			

CASES INCLUDED 4 MISSING CASES 0

Strata "A" second order regression output for top width #2 versus basin relief.

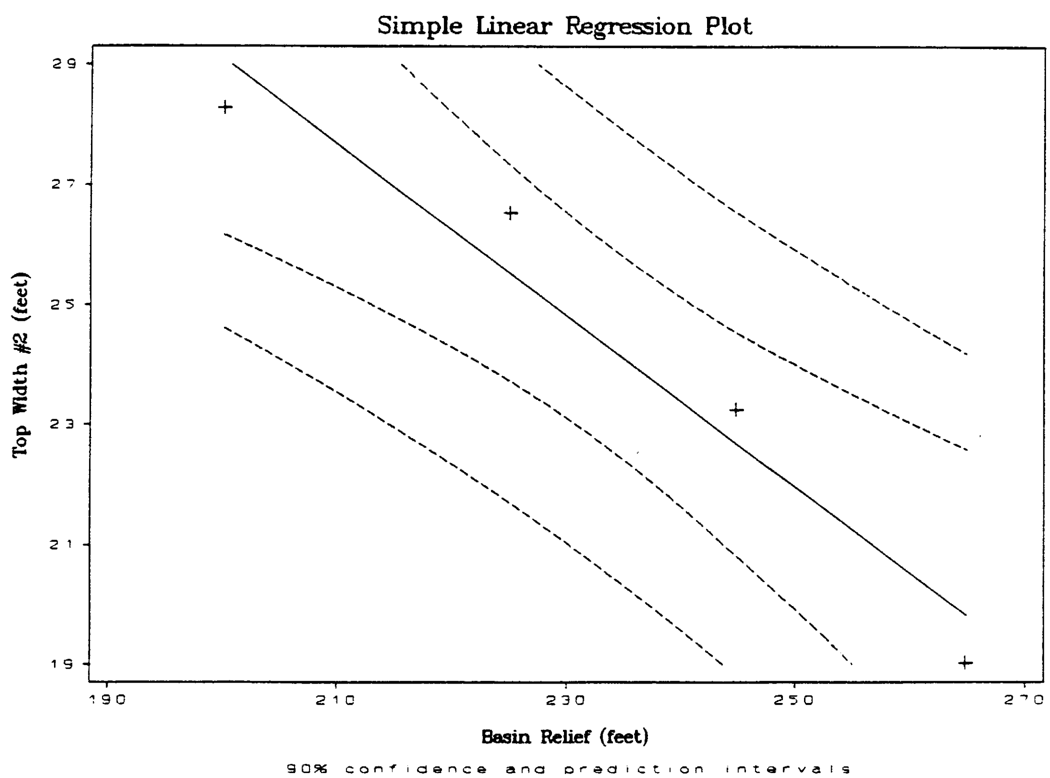
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOP WIDTH #2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	57.5923	5.65040	10.19	0.0095
BR	-0.14253	0.02405	-5.93	0.0273

R-SQUARED	0.9461	RESID. MEAN SQUARE (MSE)	1.34068
ADJUSTED R-SQUARED	0.9192	STANDARD DEVIATION	1.15788

SOURCE	DF	SS	MS	F	P
REGRESSION	1	47.1074	47.1074	35.14	0.0273
RESIDUAL	2	2.68136	1.34068		
TOTAL	3	49.7888			

CASES INCLUDED 4   MISSING CASES 0



Strata "A" second order regression output for average depth #2 versus area #2.

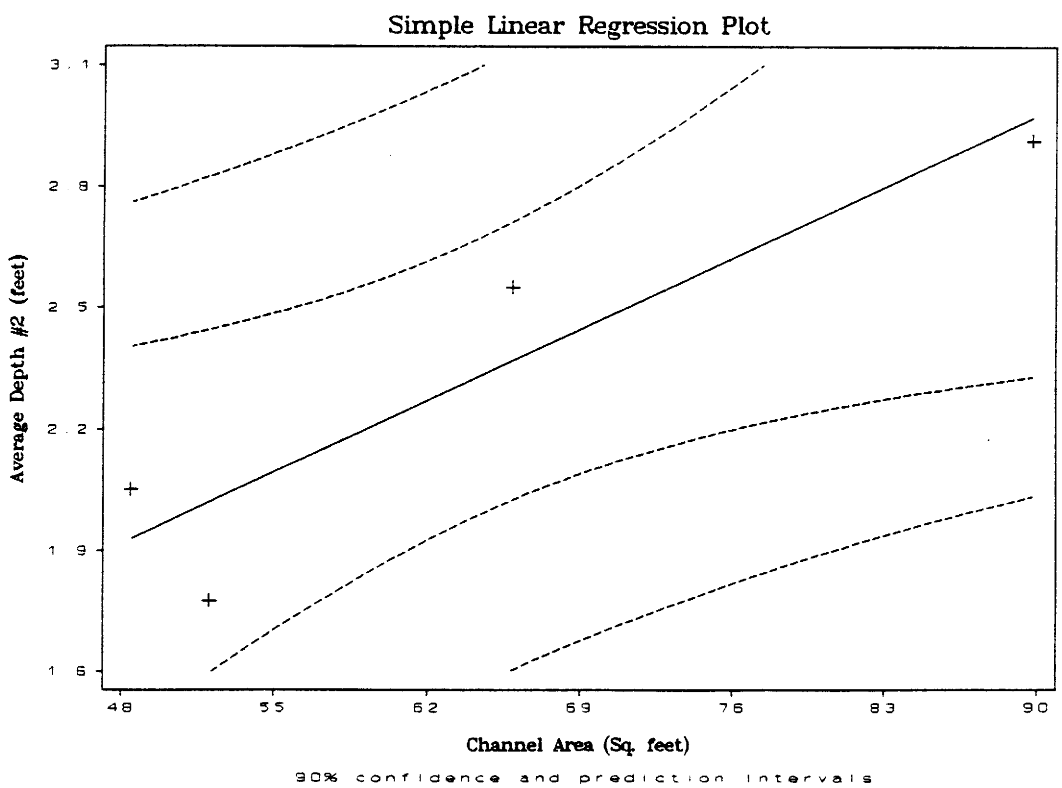
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AVERAGE DEPTH #2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.70926	0.47628	1.49	0.2749
A2	0.02519	0.00721	3.50	0.0730

R-SQUARED	0.8593	RESID. MEAN SQUARE (MSE)	0.05478
ADJUSTED R-SQUARED	0.7890	STANDARD DEVIATION	0.23406

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.66927	0.66927	12.22	0.0730
RESIDUAL	2	0.10957	0.05478		
TOTAL	3	0.77884			

CASES INCLUDED 4 MISSING CASES 0



Strata "A" second order regression output for channel area #3 versus basin area and basin relief.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF CHANNEL AREA #3

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	5.60795	0.23847	23.52	0.0271
BA	-5.09582	0.10138	-50.26	0.0127
BR	0.02490	8.595E-04	28.97	0.0220

R-SQUARED	0.9998	RESID. MEAN SQUARE (MSE)	0.00158
ADJUSTED R-SQUARED	0.9993	STANDARD DEVIATION	0.03980

SOURCE	DF	SS	MS	F	P
REGRESSION	2	7.13388	3.56694	2251.77	0.0149
RESIDUAL	1	0.00158	0.00158		
TOTAL	3	7.13547			

CASES INCLUDED 4 MISSING CASES 0

Strata "A" second order regression output for top width #3 versus channel slope and sinuosity.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOP WIDTH #3

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	4.30588	1.49622	2.88	0.2129
CHS	-223.095	11.4119	-19.55	0.0325
SIN	8.80509	1.19907	7.34	0.0862

R-SQUARED	0.9988	RESID. MEAN SQUARE (MSE)	0.00396
ADJUSTED R-SQUARED	0.9965	STANDARD DEVIATION	0.06292

SOURCE	DF	SS	MS	F	P
REGRESSION	2	3.43292	1.71646	433.57	0.0339
RESIDUAL	1	0.00396	0.00396		
TOTAL	3	3.43687			

CASES INCLUDED 4 MISSING CASES 0

Strata "A" second order regression output for average depth #3 versus area #3.

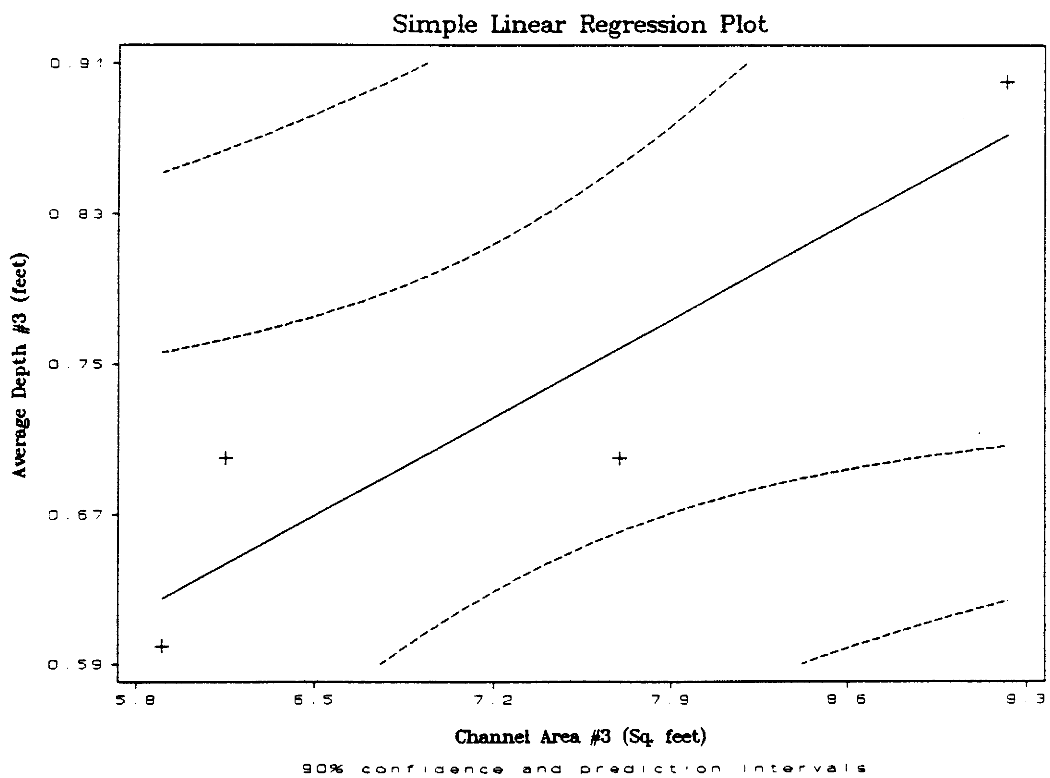
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AVERAGE DEPTH #3

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.18632	0.17484	1.07	0.3982
A3	0.07436	0.02374	3.13	0.0886

R-SQUARED	0.8307	RESID. MEAN SQUARE (MSE)	0.00402
ADJUSTED R-SQUARED	0.7461	STANDARD DEVIATION	0.06340

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.03946	0.03946	9.82	0.0886
RESIDUAL	2	0.00804	0.00402		
TOTAL	3	0.04750			

CASES INCLUDED 4 MISSING CASES 0



High bank reach means for **Strata "A"** second order

BASIN ID 09D0	**AREA** (ft.^{2})	**WETTED PERIMETER** (ft.)	**TOP WIDTH** (ft.)	**HYDRAULIC RADIUS**	**AVERAGE DEPTH** (ft.)	**W/D RATIO**	**BED WIDTH** (ft.)	**AVERAGE SLOPE** (ft/ft)
n	4.00	4.00	4.00	4.00	4.00	4.00	2.00	2.00
MEAN	985.53	162.85	158.03	5.70	5.90	26.01	119.90	0.004
S.D.	573.30	76.65	75.22	1.21	1.27	9.01	16.97	0.003
C.V. (%)	58.17	47.07	47.60	21.25	21.57	34.64	14.15	61.19
MINIMUM	315.40	81.30	78.00	3.90	4.00	17.34	107.90	0.002
MAXIMUM	1515.40	239.20	233.50	6.50	6.70	35.92	131.90	0.006
RANGE	1200.00	157.90	155.50	2.60	2.70	18.58	24.00	0.004

BASIN ID 64A0	**AREA** (ft.^{2})	**WETTED PERIMETER** (ft.)	**TOP WIDTH** (ft.)	**HYDRAULIC RADIUS**	**AVERAGE DEPTH** (ft.)	**W/D RATIO**	**BED WIDTH** (ft.)	**AVERAGE SLOPE** (ft/ft)
n	6.00	6.00	6.00	6.00	6.00	6.00	2.00	3.00
MEAN	593.23	83.58	78.42	5.62	6.08	20.79	21.40	0.007
S.D.	691.55	32.49	27.38	4.93	5.58	13.77	0.14	0.001
C.V. (%)	116.57	38.87	34.92	87.85	91.68	66.26	0.66	15.32
MINIMUM	125.40	49.60	47.50	1.70	1.70	7.71	21.30	0.006
MAXIMUM	1673.10	134.90	121.70	12.40	13.70	45.65	21.50	0.008
RANGE	1547.70	85.30	74.20	10.70	12.00	37.94	0.20	0.002

BASIN ID 64B0	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	4.00	4.00	4.00	4.00	4.00	4.00		2.00
MEAN	136.47	53.30	50.25	2.73	2.95	19.18		0.014
S.D.	33.17	22.01	22.66	0.50	0.70	12.19		0.010
C.V. (%)	24.31	41.30	45.09	18.32	23.57	63.56		66.32
MINIMUM	102.90	33.30	29.40	2.20	2.30	8.40		0.008
MAXIMUM	171.80	72.80	70.20	3.20	3.60	30.22		0.021
RANGE	68.90	39.50	40.80	1.00	1.30	21.82		0.014

Medium bank reach means for **Strata "A"** second order

BASIN ID 09D0	AREA $(ft.^2)$	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	4.00	4.00	4.00	4.00	4.00	4.00	2.00	2.00
MEAN	52.03	31.03	28.28	1.53	1.78	20.26	119.90	0.004
S.D.	48.02	25.32	23.77	1.19	1.48	14.24	16.97	0.003
C.V. (%)	92.31	81.62	84.05	78.03	83.10	70.29	14.15	61.19
MINIMUM	6.70	12.60	11.90	0.50	0.60	5.59	107.90	0.002
MAXIMUM	101.70	68.00	63.40	3.20	3.90	39.63	131.90	0.006
RANGE	95.00	55.40	51.50	2.70	3.30	34.04	24.00	0.004

BASIN ID 47C0	AREA $(ft.^2)$	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	6.00	6.00	6.00	6.00	6.00	6.00	6.00	3.00
MEAN	89.80	29.60	26.55	2.47	2.92	8.28	16.17	0.008
S.D.	97.12	20.79	21.43	0.96	0.79	4.87	11.22	0.004
C.V. (%)	108.16	70.24	80.71	38.86	26.95	58.78	69.37	48.27
MINIMUM	18.60	11.70	8.20	1.60	2.20	3.15	4.20	0.004
MAXIMUM	271.10	64.30	61.80	4.20	4.40	14.30	32.60	0.012
RANGE	252.50	52.60	53.60	2.60	2.20	11.15	28.40	0.007

BASIN ID 64A0	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	4.00	4.00	4.00	4.00	4.00	4.00	2.00	3.00
MEAN	48.45	20.70	19.03	1.88	2.05	10.21	21.40	0.007
S.D.	45.17	11.23	10.07	1.14	1.29	2.81	0.14	0.001
C.V. (%)	93.23	54.25	52.91	61.02	63.04	27.52	0.66	15.32
MINIMUM	7.50	10.60	10.10	0.70	0.70	8.76	21.30	0.006
MAXIMUM	95.70	32.00	28.90	3.00	3.30	14.43	21.50	0.008
RANGE	88.20	21.40	18.80	2.30	2.60	5.67	0.20	0.002

BASIN ID 64B0	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	4.00	4.00	4.00	4.00	4.00	4.00		2.00
MEAN	65.95	25.58	23.25	2.35	2.55	9.54		0.014
S.D.	39.72	10.01	8.99	1.00	1.17	2.15		0.010
C.V. (%)	60.22	39.15	38.65	42.34	45.79	22.56		66.32
MINIMUM	10.40	10.70	10.00	1.00	1.00	7.26		0.008
MAXIMUM	99.40	32.40	29.30	3.10	3.50	12.30		0.021
RANGE	89.00	21.70	19.30	2.10	2.50	5.05		0.014

Low bank reach means for **Strata "A"** second order

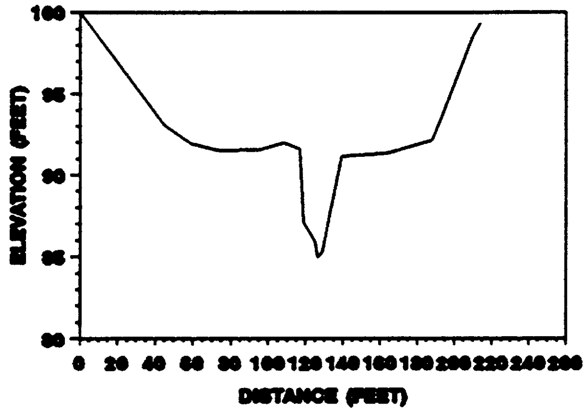
BASIN ID 09D0	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	4	4	4	4	4	4
MEAN	6.15	9.20	8.60	0.65	0.70	16.57
S.D.	5.01	4.67	4.76	0.29	0.29	16.84
C.V. (%)	81.42	50.78	55.33	44.41	42.06	101.58
MINIMUM	2.80	4.70	4.00	0.30	0.30	5.71
MAXIMUM	13.60	13.90	13.00	1.00	1.00	41.33
RANGE	10.80	9.20	9.00	0.70	0.70	35.62

BASIN ID 47C0	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	4	4	4	4	4	4
MEAN	5.90	11.55	11.00	0.55	0.60	24.58
S.D.	2.50	2.30	2.62	0.26	0.32	17.05
C.V. (%)	42.36	19.90	23.78	48.11	52.71	69.38
MINIMUM	3.80	8.60	8.10	0.30	0.30	9.50
MAXIMUM	9.50	13.70	13.50	0.90	1.00	45.00
RANGE	5.70	5.10	5.40	0.60	0.70	35.50

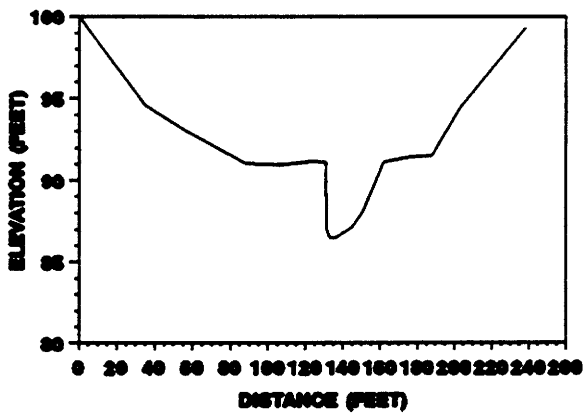
BASIN ID 64A0	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	3	3	3	3	3	3
MEAN	7.70	11.00	10.60	0.67	0.70	15.09
S.D.	2.91	2.03	2.00	0.15	0.10	0.82
C.V. (%)	37.73	18.45	18.84	22.91	14.29	5.41
MINIMUM	4.90	9.20	8.90	0.50	0.60	14.43
MAXIMUM	10.70	13.20	12.80	0.80	0.80	16.00
RANGE	5.80	4.00	3.90	0.30	0.20	1.57

BASIN ID 64B0	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	4	4	4	4	4	4
MEAN	9.23	10.30	9.65	0.85	0.90	10.71
S.D.	4.81	2.92	2.67	0.24	0.23	0.82
C.V. (%)	52.10	28.38	27.68	28.01	25.66	7.64
MINIMUM	5.10	7.60	7.10	0.60	0.70	9.91
MAXIMUM	14.50	13.80	12.80	1.10	1.10	11.64
RANGE	9.40	6.20	5.70	0.50	0.40	1.73

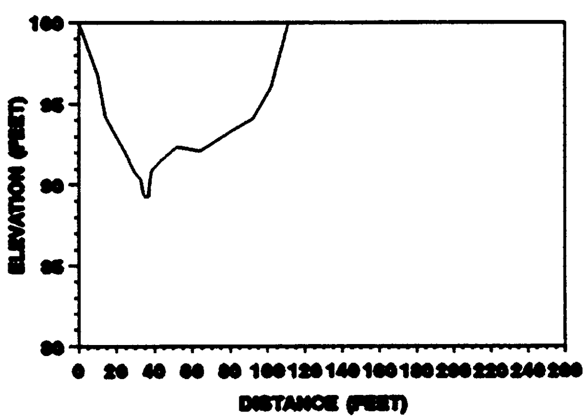
WINDMILL DRAW, 09D0
CROSS SECTION 0+00.00



WINDMILL DRAW, 09D0
CROSS SECTION 1+08.20

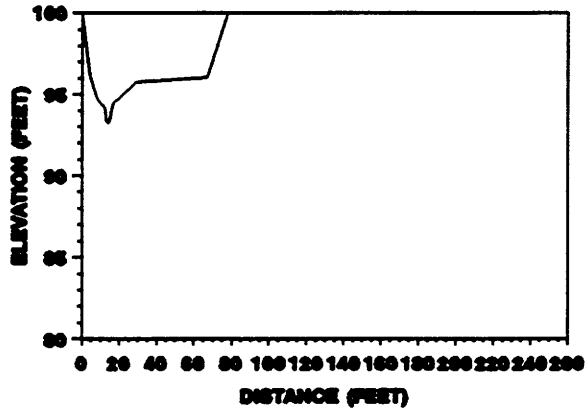


WINDMILL DRAW,09D0
CROSS SECTION 0+00.00



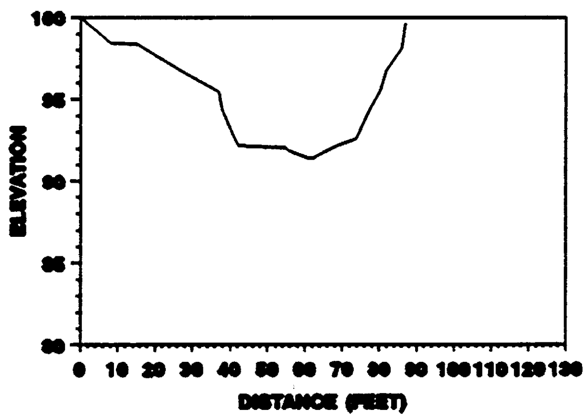
WINDMILL DRAW, 09D0

CROSS SECTION 0+72.00



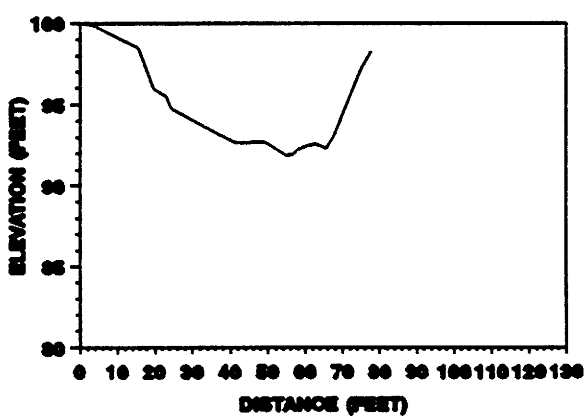
H A CREEK, 47C0

CROSS SECTION 0+00.00

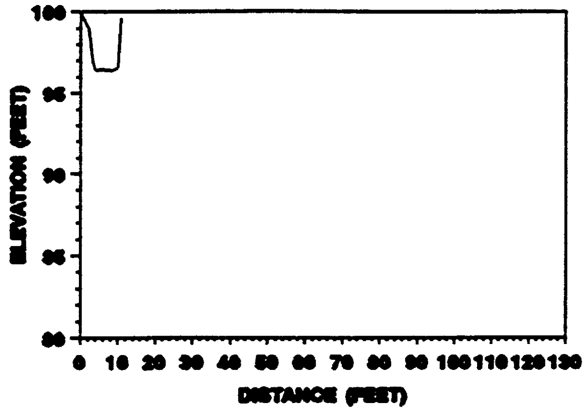


H A CREEK, 47C0

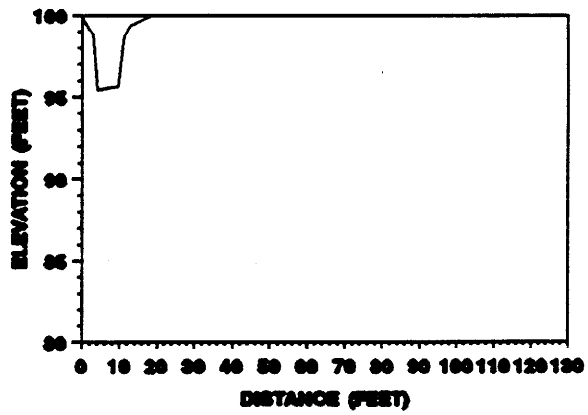
CROSS SECTION 0+48.30



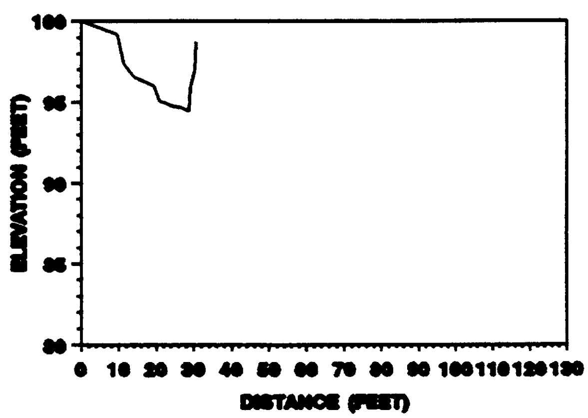
H A CREEK, 47C0
CROSS SECTION 0+00.00



H A CREEK, 47C0
CROSS SECTION 0+00.20

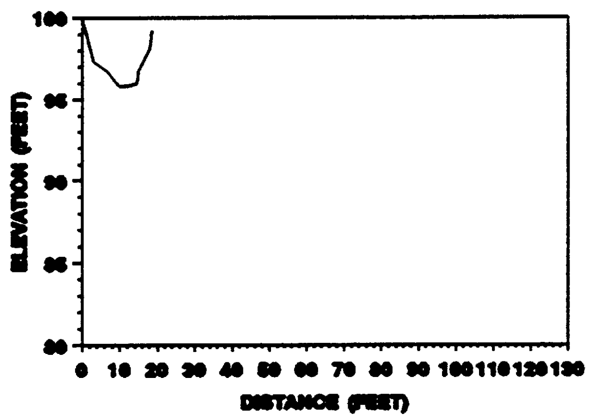


H A CREEK, 47C0
CROSS SECTION 0+00.00



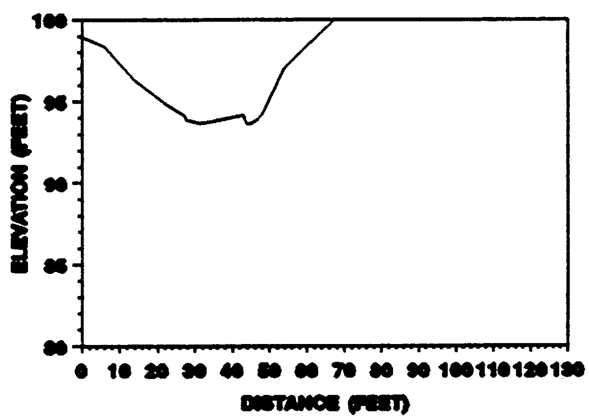
H A CREEK,47C0

CROSS SECTION 0+51.20



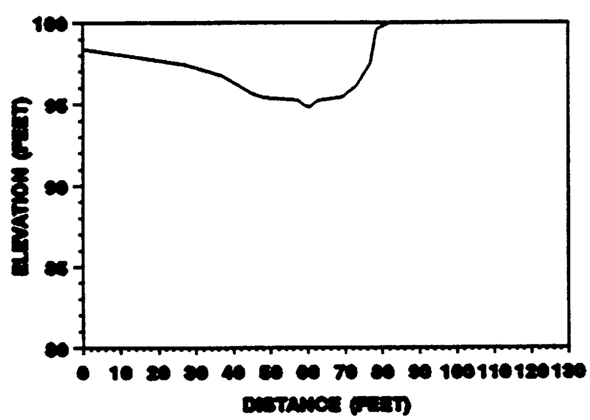
SCHOOL CREEK, 64A0

CROSS SECTION 0+60.60

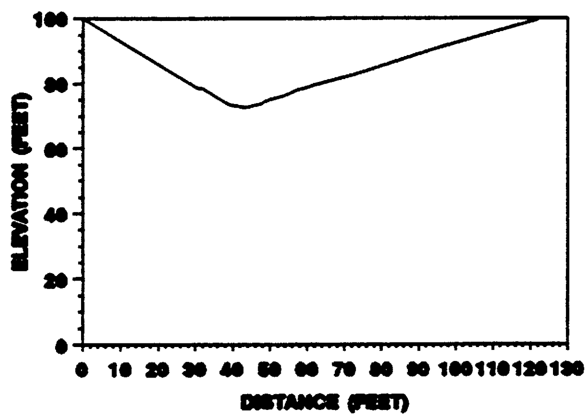


SCHOOL CREEK, 64A0

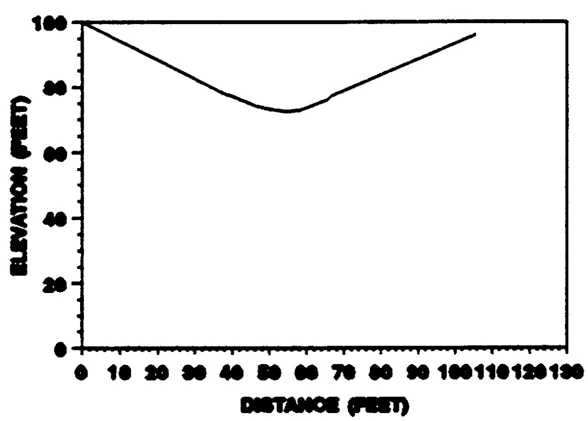
CROSS SECTION 0+86.60



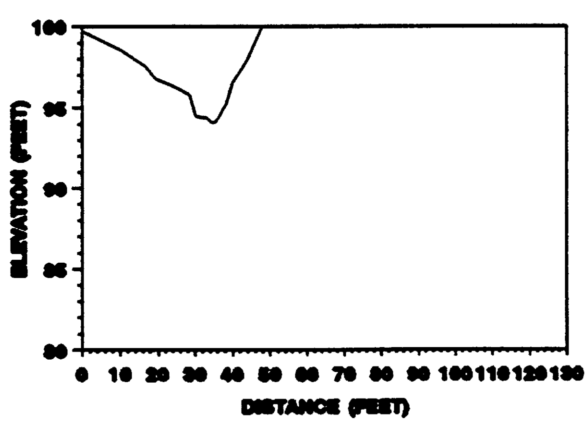
SCHOOL CREEK, 64A0
CROSS SECTION 0+60.00



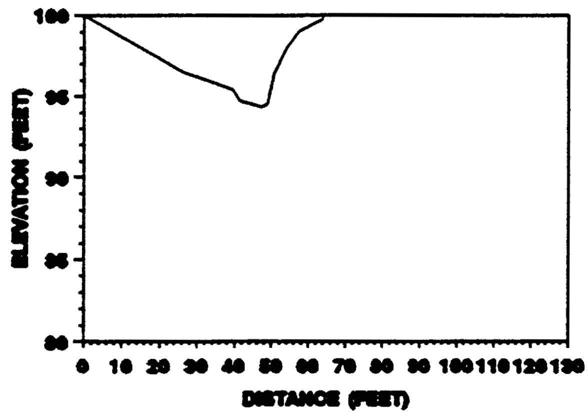
SCHOOL CREEK, 64A0
CROSS SECTION 0+62.00



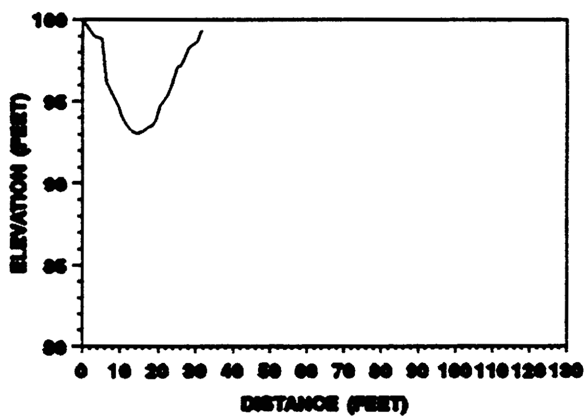
SCHOOL CREEK, 64A0
CROSS SECTION 0+60.00



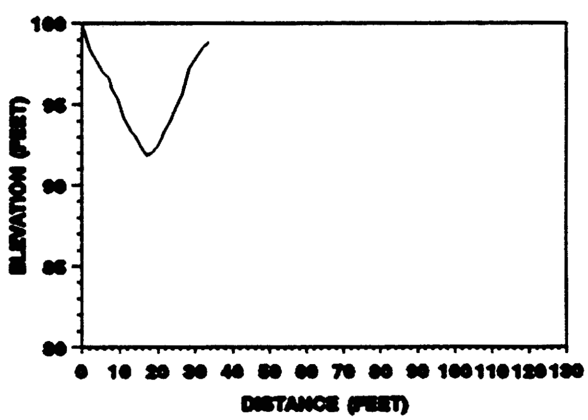
SCHOOL CREEK, 64A0
CROSS SECTION 0+00.00



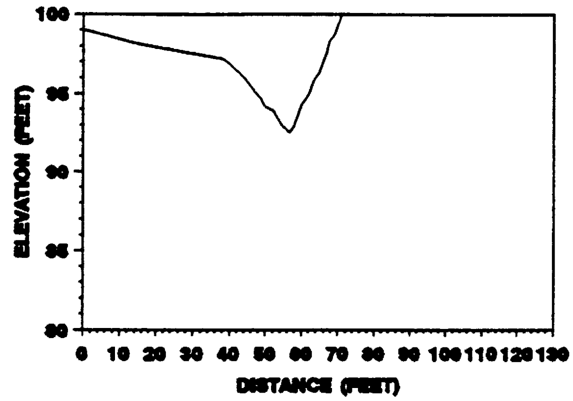
SCHOOL CREEK, 64B0
CROSS SECTION 0+00.00



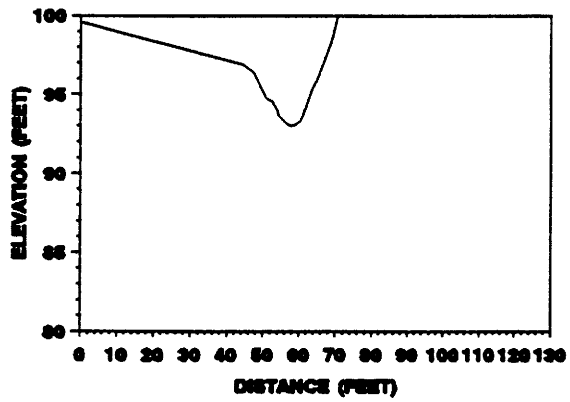
SCHOOL CREEK, 64B0
CROSS SECTION 0+95.50



SCHOOL CREEK, 64B0
CROSS SECTION 0+00.00



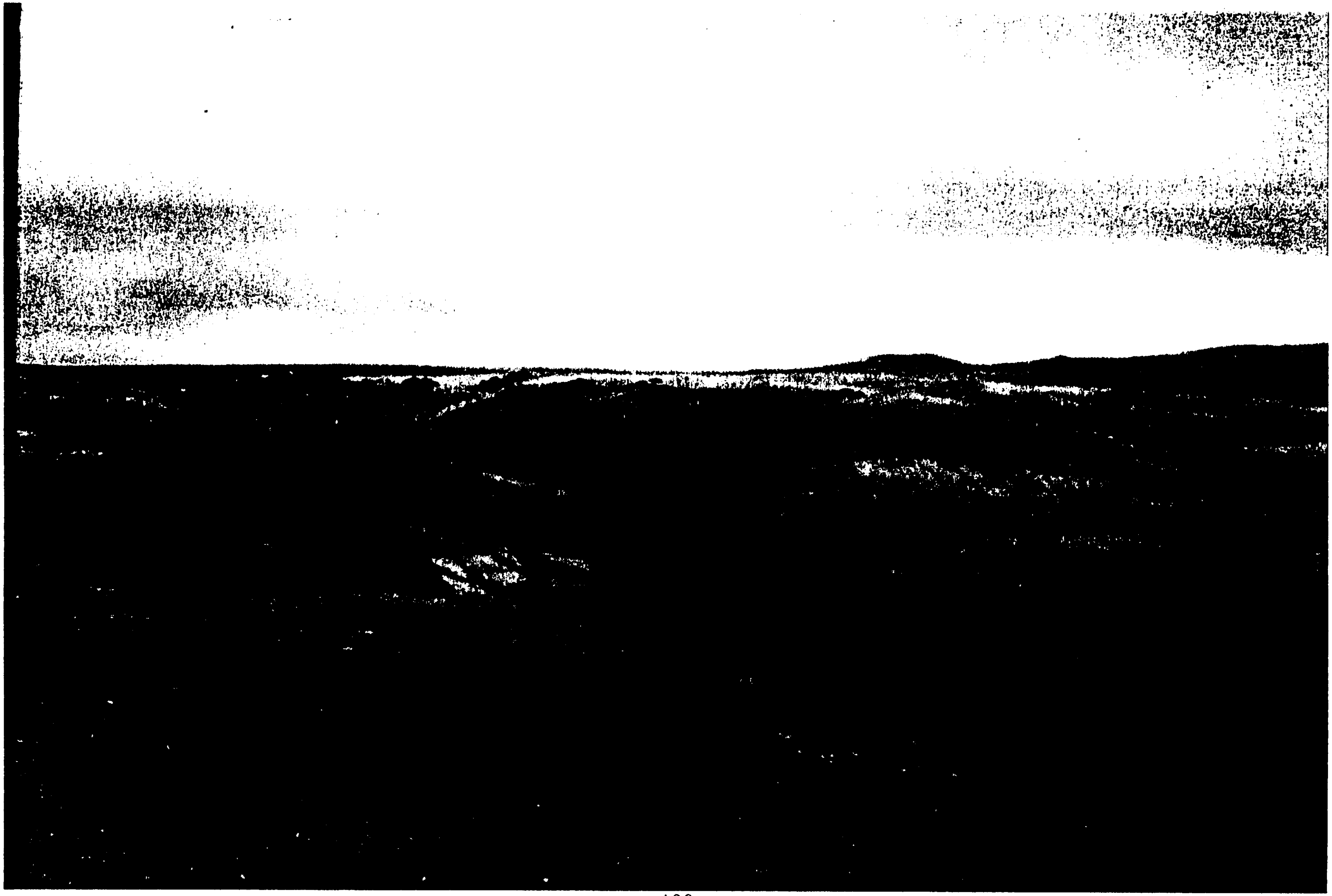
SCHOOL CREEK, 64B0
CROSS SECTION 0+34.00



Strata "A" second order raw data by study reach, cross section, and bank identification.

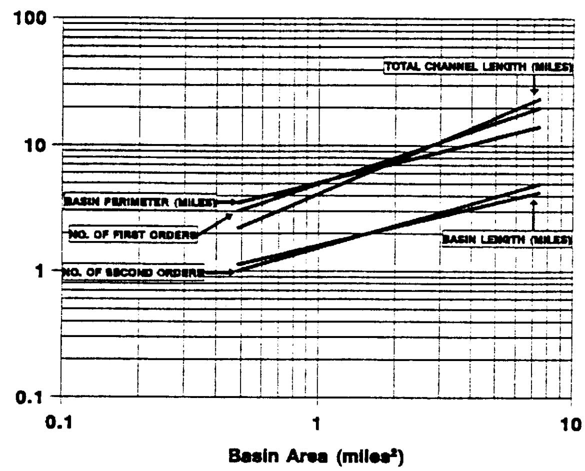
BASIN I.D.	CROSS SECTION NUMBER	BANK I.D.	AREA (feet^2)	TOP WIDTH (feet)	AVERAGE DEPTH (feet)	FLOOD-PLAIN WIDTH (feet)
09D0	0+00.00A	HIGH	1406.60	209.60	6.70	131.90
09D0	1+03.30A	HIGH	1515.40	233.50	6.50	107.90
09D0	0+00.00B	HIGH	704.70	111.00	6.40	
09D0	0+72.00B	HIGH	315.40	78.00	4.00	
64A0	0+00.00A	HIGH	195.90	62.40	3.10	21.30
64A0	0+88.00A	HIGH	135.10	77.60	1.70	21.50
64A0	0+00.00B	HIGH	1673.10	121.70	13.70	
64A0	0+62.00B	HIGH	1266.70	98.70	12.80	
64A0	0+00.00C	HIGH	125.40	47.50	2.60	
64A0	0+69.00C	HIGH	163.20	62.60	2.60	
64B0	0+00.00A	HIGH	102.90	29.40	3.50	
64B0	0+95.50A	HIGH	114.10	31.90	3.60	
64B0	0+00.00B	HIGH	157.10	69.50	2.30	
64B0	0+34.00B	HIGH	171.80	70.20	2.40	
09D0	0+00.00A	MEDIUM	84.40	21.80	3.90	
09D0	1+03.30A	MEDIUM	101.70	63.40	1.60	
09D0	0+00.00B	MEDIUM	15.30	16.00	1.00	
09D0	0+72.00B	MEDIUM	6.70	11.90	0.60	
47C0	0+00.00A	MEDIUM	126.50	42.90	3.00	32.60
47C0	0+48.30A	MEDIUM	271.10	61.80	4.40	25.80
47C0	0+00.00B	MEDIUM	18.60	8.30	2.20	4.20
47C0	0+90.20B	MEDIUM	21.50	8.20	2.60	5.50
47C0	0+00.00C	MEDIUM	58.70	20.40	2.90	15.70
47C0	0+51.20C	MEDIUM	42.40	17.70	2.40	13.20

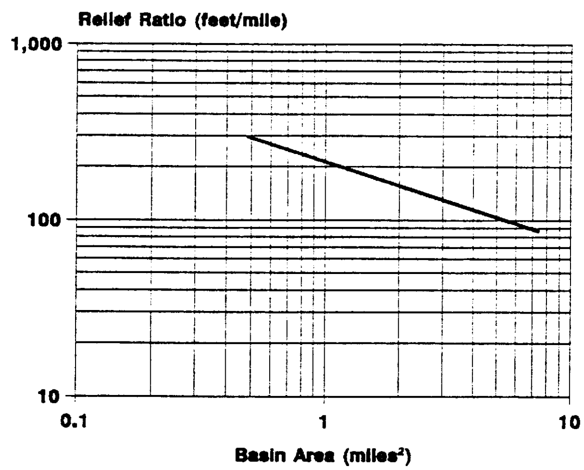
BASIN I.D.	CROSS SECTION NUMBER	BANK I.D.	AREA ($feet^2$)	TOP WIDTH (feet)	AVERAGE DEPTH (feet)
64A0	0+00.00B	MEDIUM	95.70	28.90	3.30
64A0	0+62.00B	MEDIUM	78.40	26.50	3.00
64A0	0+00.00C	MEDIUM	12.20	10.60	1.20
64A0	0+69.00C	MEDIUM	7.50	10.10	0.70
64B0	0+00.00A	MEDIUM	88.90	25.40	3.50
64B0	0+95.50A	MEDIUM	99.40	29.30	3.40
64B0	0+00.00B	MEDIUM	65.10	28.30	2.30
64B0	0+34.00B	MEDIUM	10.40	10.00	1.00
09D0	0+00.00A	LOW	13.60	13.00	1.00
09D0	1+03.30A	LOW	4.30	12.40	0.30
09D0	0+00.00B	LOW	3.90	5.00	0.80
09D0	0+72.00B	LOW	2.80	4.00	0.70
47C0	0+00.00A	LOW	4.80	12.90	0.40
47C0	0+48.30A	LOW	3.80	13.50	0.30
47C0	0+00.00C	LOW	9.50	9.50	1.00
47C0	0+51.20C	LOW	5.50	8.10	0.70
64A0	0+00.00B	LOW	4.90	8.90	0.60
64A0	0+62.00B	LOW	10.70	12.80	0.80
64A0	0+69.00C	LOW	7.50	10.10	0.70
64B0	0+00.00A	LOW	12.10	10.90	1.10
64B0	0+95.50A	LOW	5.10	7.10	0.70
64B0	0+00.00B	LOW	14.50	12.80	1.10
64B0	0+34.00B	LOW	5.20	7.80	0.70

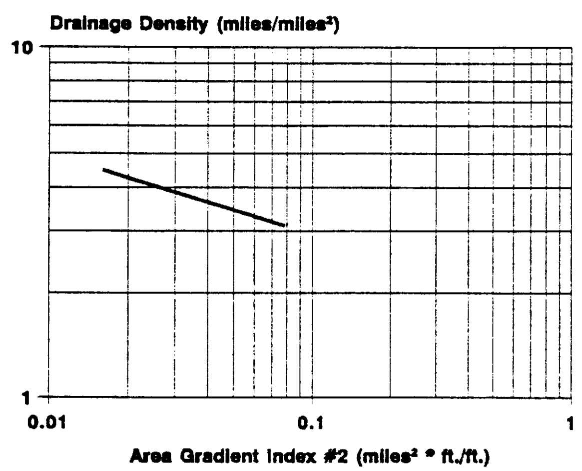


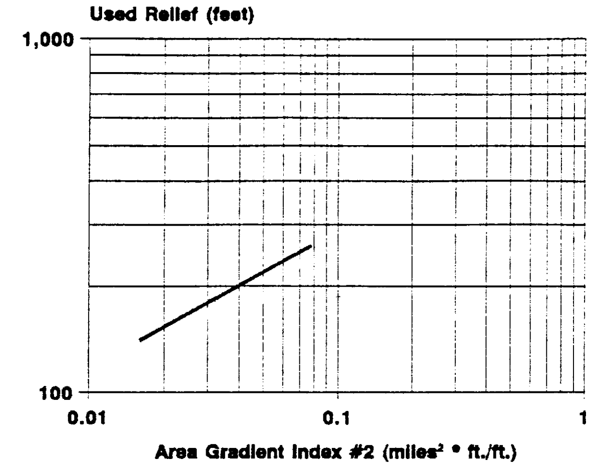
APPENDIX A-3

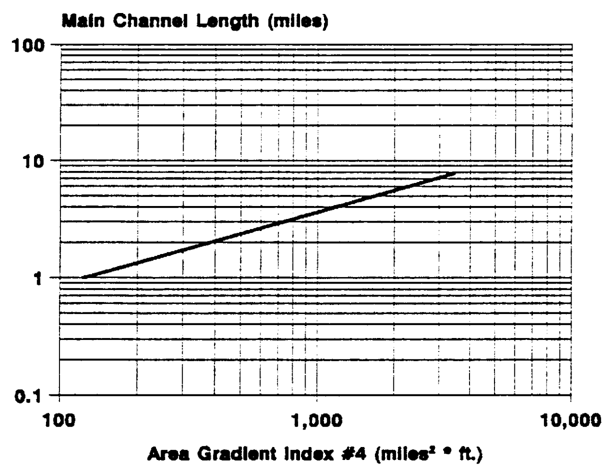
STRATA "A" - THIRD ORDER


100
10
1
0.1
TOTAL CHANNEL LENGTH (MILES)
BASIN PERIMETER (MILES)
NO. OF FIRST ORDERS
NO. OF SECOND ORDERS
BASIN LENGTH (MILES)
0.1
1
10
Basin Area (miles²)


Relief Ratio (feet/mile)
1,000
100
10
0.1
1
10
Basin Area (miles²)


Drainage Density (miles/miles²)
10
1
0.01
0.1
1
Area Gradient Index #2 (miles² * ft./ft.)


Used Relief (feet)
1,000
100
0.01
0.1
1
Area Gradient Index #2 (miles² * ft./ft.)


Main Channel Length (miles)
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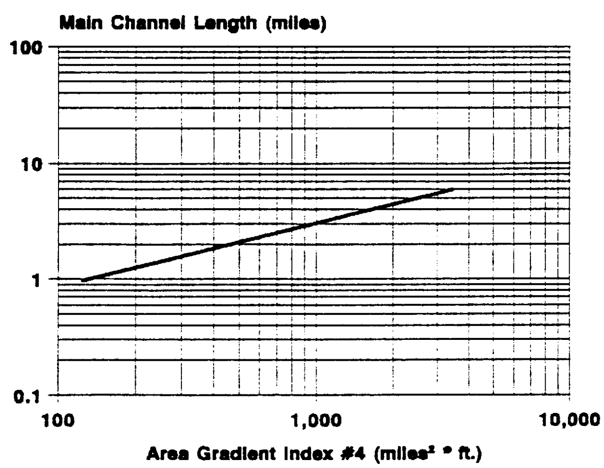
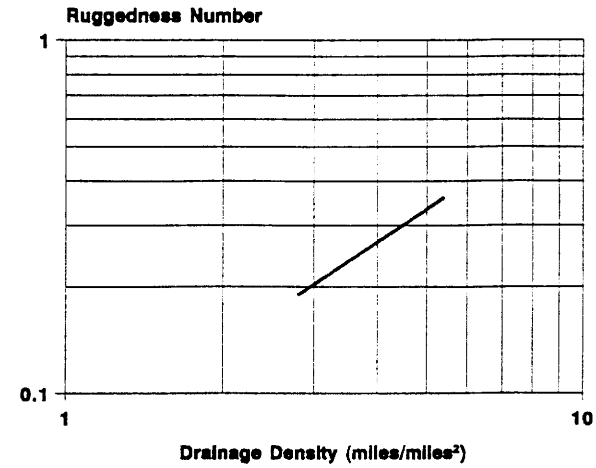
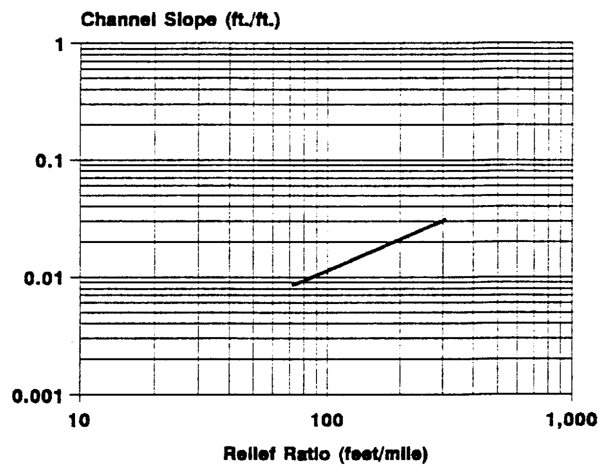
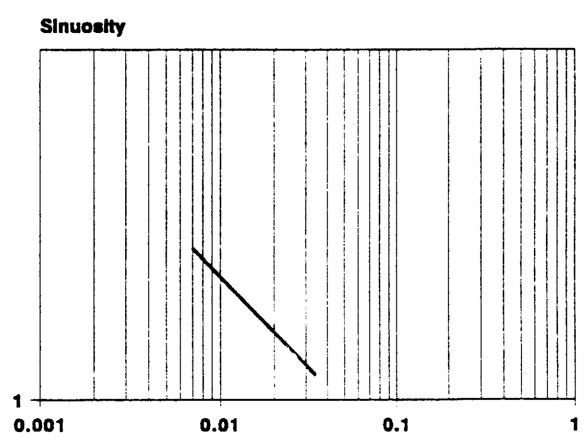
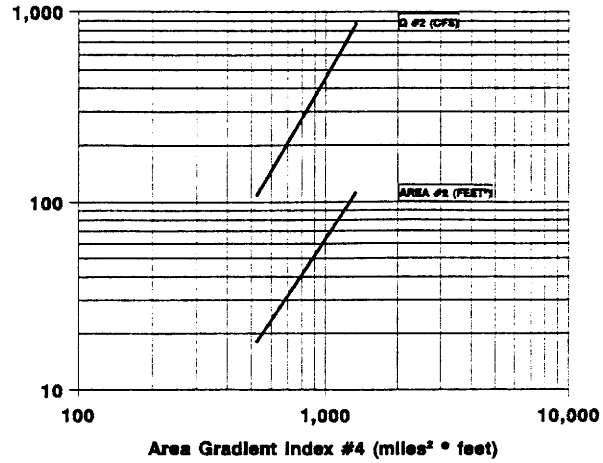
10
1
0.1
100
1,000
10,000
Area Gradient Index #4 (miles² * ft.)

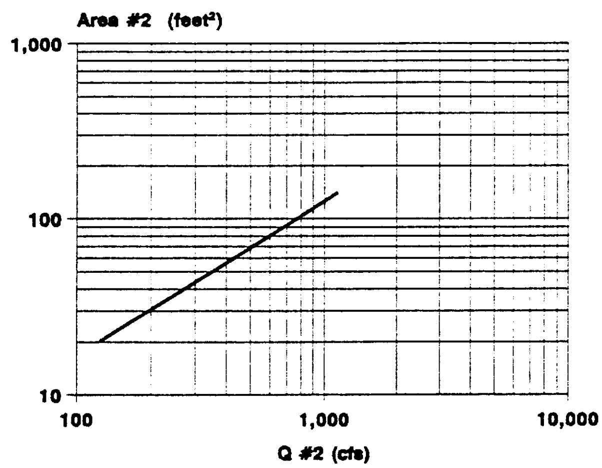

Main Channel Length (miles)
100
10
1
0.1
100
1,000
10,000
Area Gradient Index #4 (miles² * ft.)

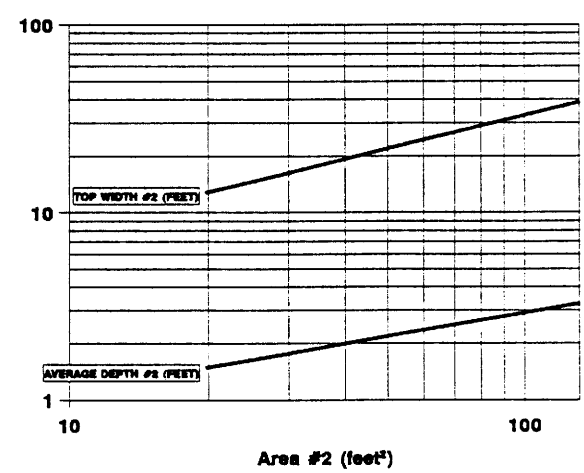

Ruggedness Number
1
0.1
1
10
Drainage Density (miles/miles²)

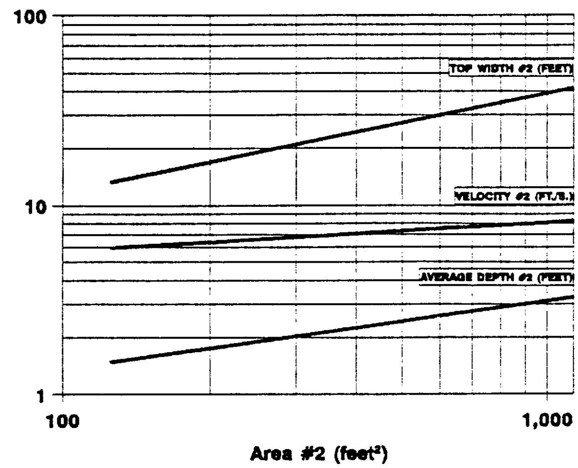

Channel Slope (ft./ft.)
1
0.1
0.01
0.001
10
100
1,000
Relief Ratio (feet/mile)

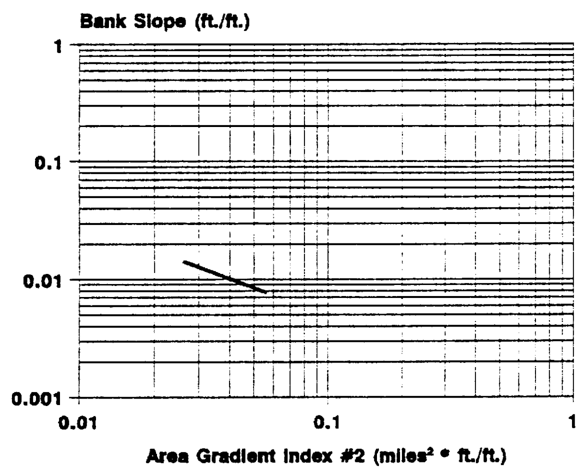

Sinuosity
1
0.001
0.01
0.1
1

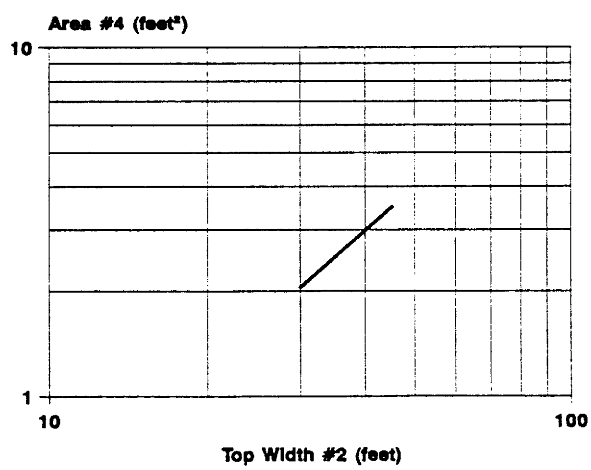

1,000
100
10
100
1,000
10,000
Q #2 (CFS)
AREA #2 (FEET²)
Area Gradient Index #4 (miles² * feet)

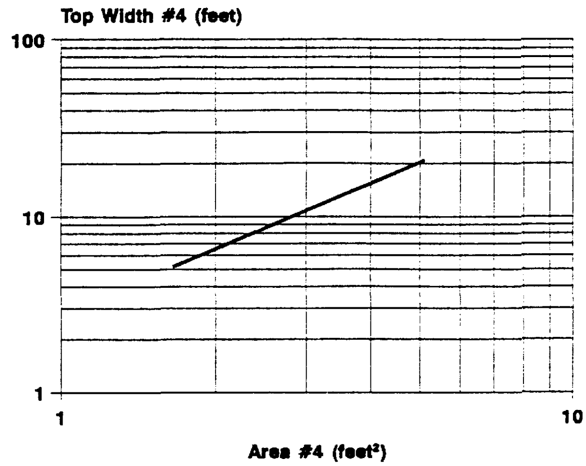

Area #2 (feet²)
1,000
100
10
100
1,000
10,000
Q #2 (cfs)

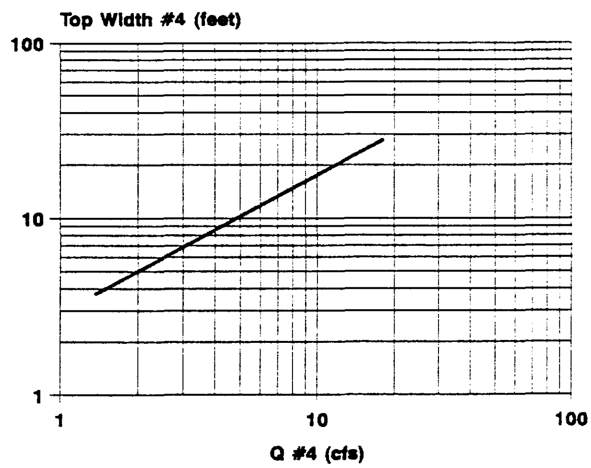

100
10
1
10
100
TOP WIDTH #2 (FEET)
AVERAGE DEPTH #2 (FEET)
Area #2 (feet²)


100
10
1
TOP WIDTH #2 (FEET)
VELOCITY #2 (FT./S.)
AVERAGE DEPTH #2 (FEET)
100
1,000
Area #2 (feet²)


Bank Slope (ft./ft.)
1
0.1
0.01
0.001
0.01
0.1
1
Area Gradient Index #2 (miles² * ft./ft.)


Area #4 (feet²)
10
1
10
100
Top Width #2 (feet)


Top Width #4 (feet)
100
10
1
1
10
Area #4 (feet²)


Top Width #4 (feet)
100
10
1
1
10
100
Q #4 (cfs)

Strata "A" third order regression output for basin perimeter versus basin area.

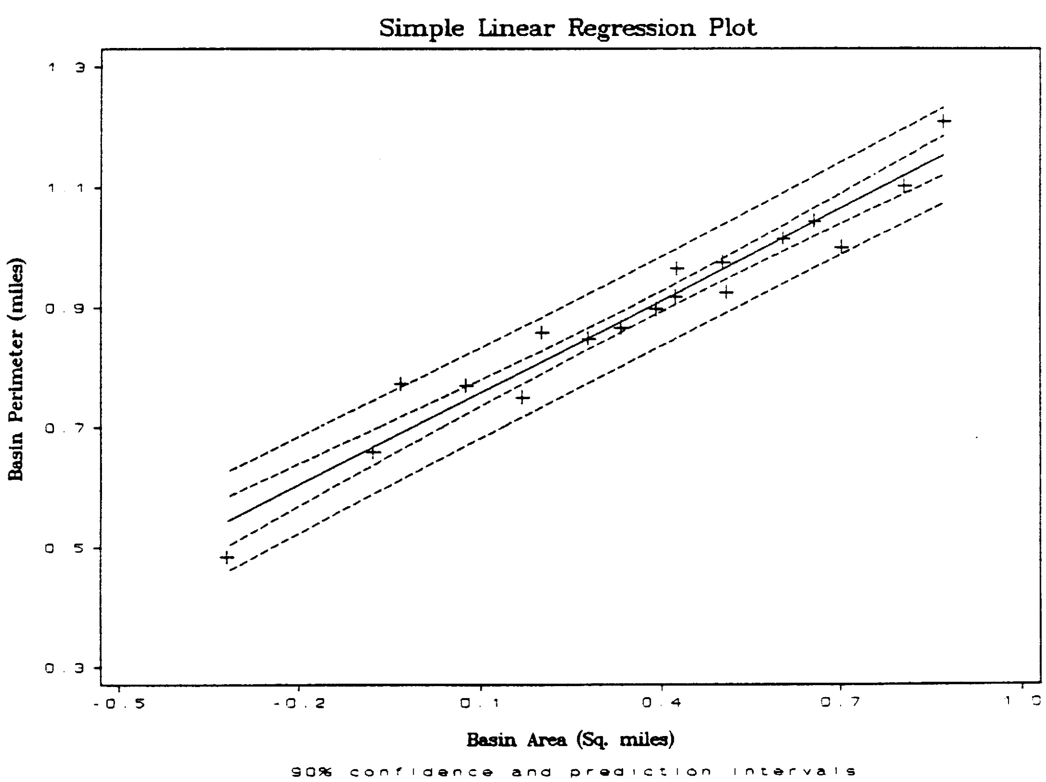
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BASIN PERIMETER

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.70625	0.01501	47.05	0.0000
BA	0.51238	0.03149	16.27	0.0000

R-SQUARED	0.9430	RESID. MEAN SQUARE (MSE)	0.00172
ADJUSTED R-SQUARED	0.9394	STANDARD DEVIATION	0.04144

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.45455	0.45455	264.72	0.0000
RESIDUAL	16	0.02747	0.00172		
TOTAL	17	0.48202			

CASES INCLUDED 18 MISSING CASES 0



Strata "A" third order regression output for drainage density versus area gradient index #2.

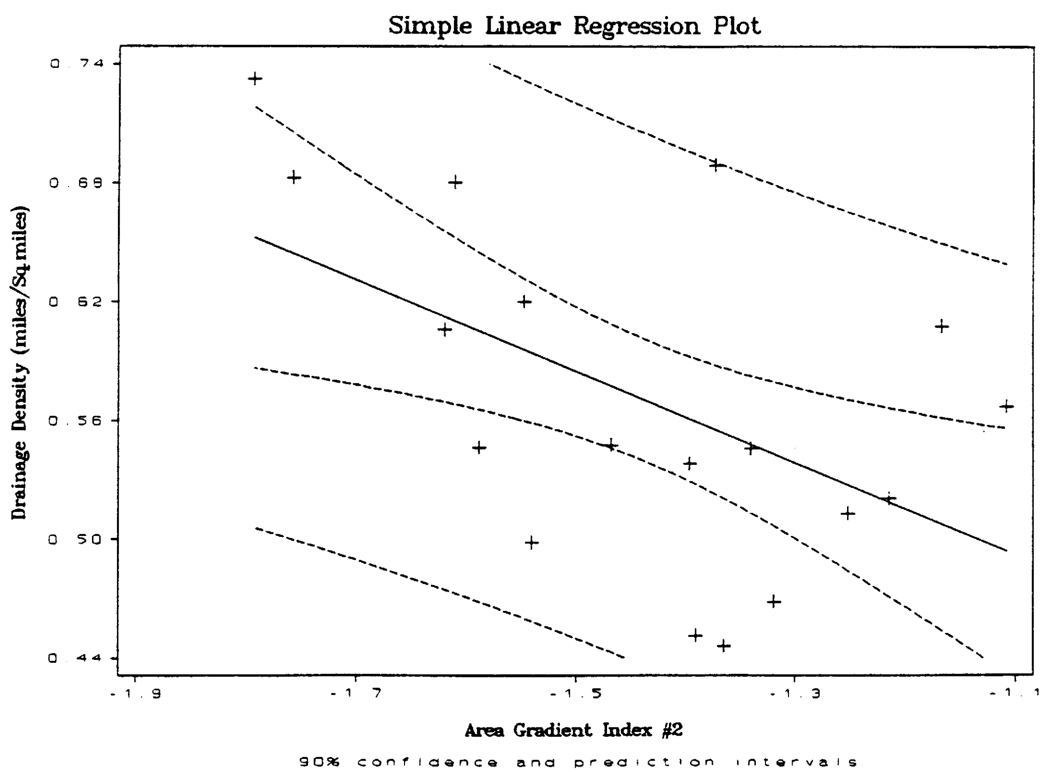
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF DRAINAGE DENSITY

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.23829	0.13584	1.75	0.0985
AGI2	-0.23103	0.09377	-2.46	0.0255

R-SQUARED	0.2750	RESID. MEAN SQUARE (MSE)	0.00563
ADJUSTED R-SQUARED	0.2297	STANDARD DEVIATION	0.07505

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.03418	0.03418	6.07	0.0255
RESIDUAL	16	0.09011	0.00563		
TOTAL	17	0.12429			

CASES INCLUDED 18   MISSING CASES 0



Strata "A" third order regression output for basin length versus basin area.

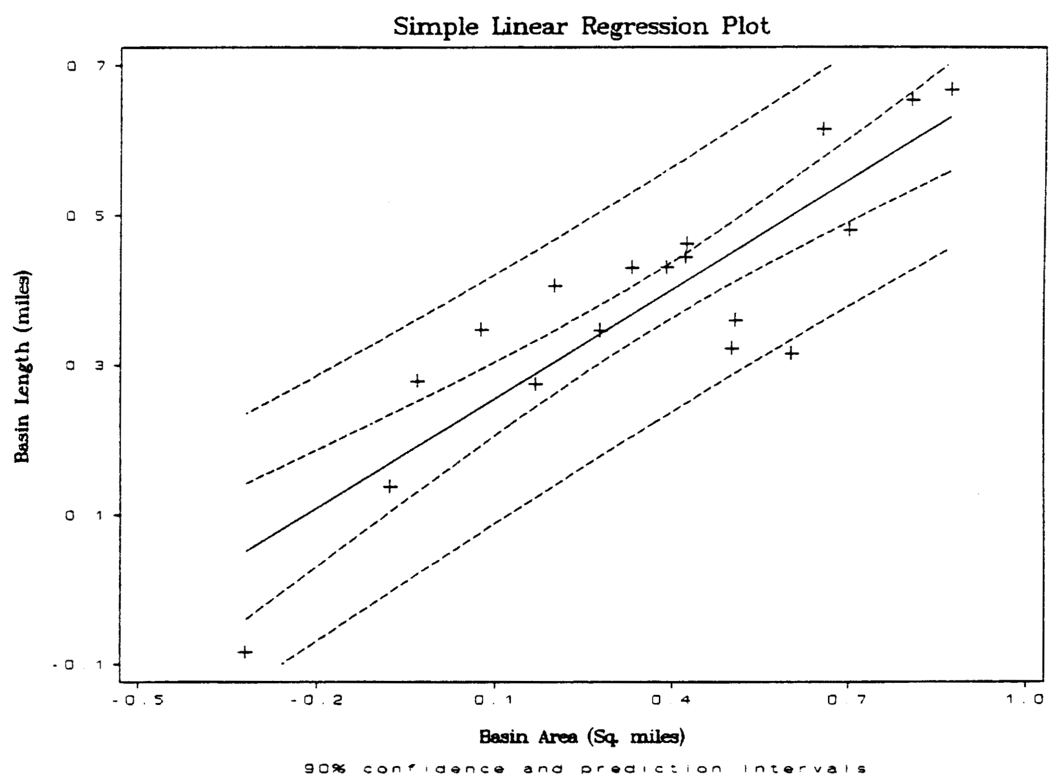
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BASIN LENGTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.20668	0.03305	6.25	0.0000
BA	0.48799	0.06935	7.04	0.0000

R-SQUARED	0.7558	RESID. MEAN SQUARE (MSE)	0.00833
ADJUSTED R-SQUARED	0.7405	STANDARD DEVIATION	0.09125

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.41230	0.41230	49.51	0.0000
RESIDUAL	16	0.13324	0.00833		
TOTAL	17	0.54553			

CASES INCLUDED 18 MISSING CASES 0



Strata "A" third order regression output for number of first orders versus basin area.

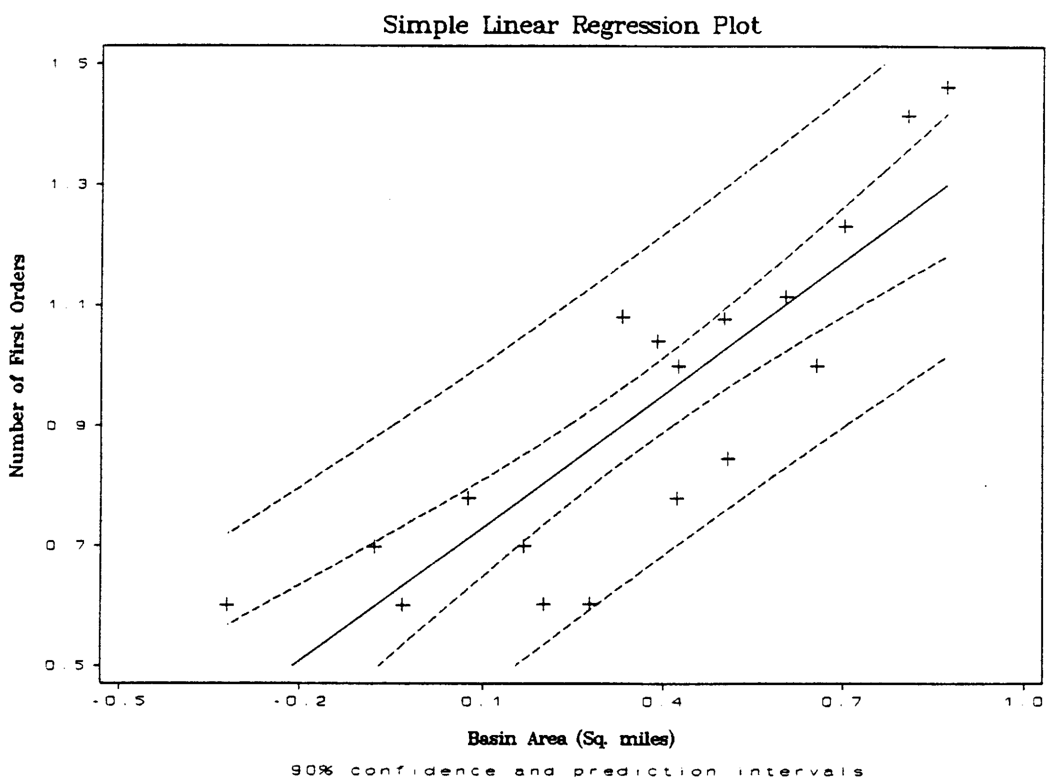
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF FIRSTS

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.65657	0.05394	12.17	0.0000
BA	0.73851	0.11316	6.53	0.0000

R-SQUARED	0.7269	RESID. MEAN SQUARE (MSE)	0.02217
ADJUSTED R-SQUARED	0.7098	STANDARD DEVIATION	0.14890

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.94428	0.94428	42.59	0.0000
RESIDUAL	16	0.35476	0.02217		
TOTAL	17	1.29904			

CASES INCLUDED 18   MISSING CASES 0



Strata "A" third order regression output for number of second orders versus basin area.

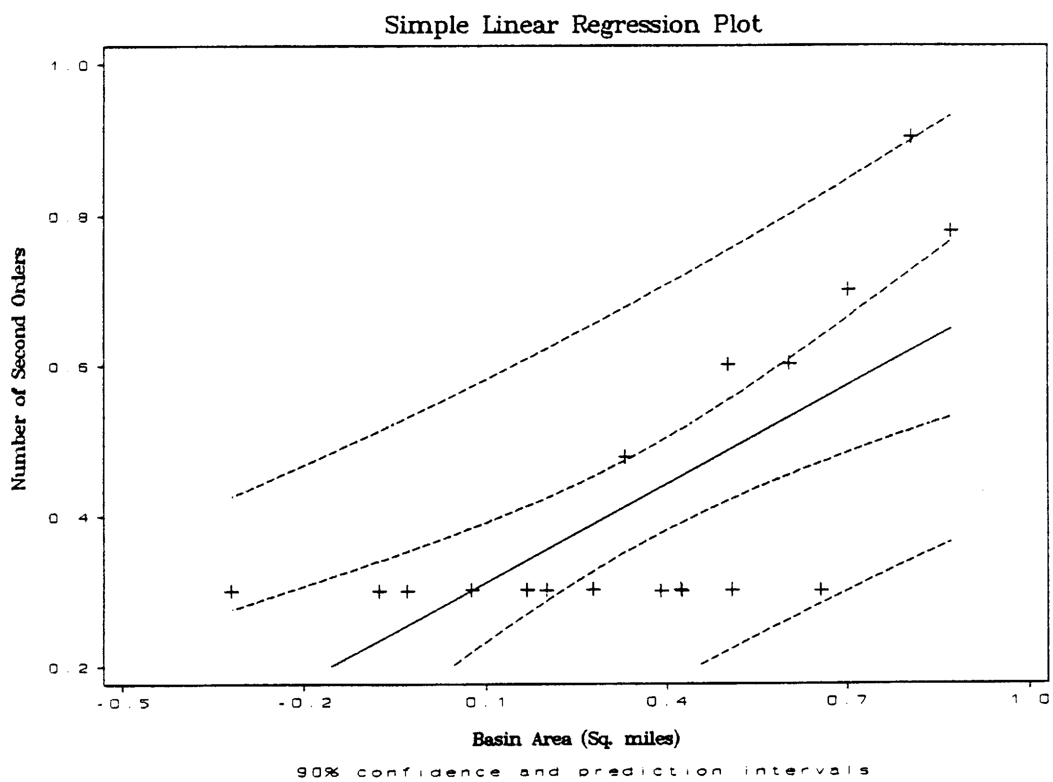
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF SECONDS

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.26852	0.05349	5.02	0.0001
BA	0.43603	0.11224	3.88	0.0013

R-SQUARED	0.4854	RESID. MEAN SQUARE (MSE)	0.02181
ADJUSTED R-SQUARED	0.4532	STANDARD DEVIATION	0.14769

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.32918	0.32918	15.09	0.0013
RESIDUAL	16	0.34898	0.02181		
TOTAL	17	0.67815			

CASES INCLUDED 18 MISSING CASES 0



Strata "A" third order regression output for total channel length versus basin area.

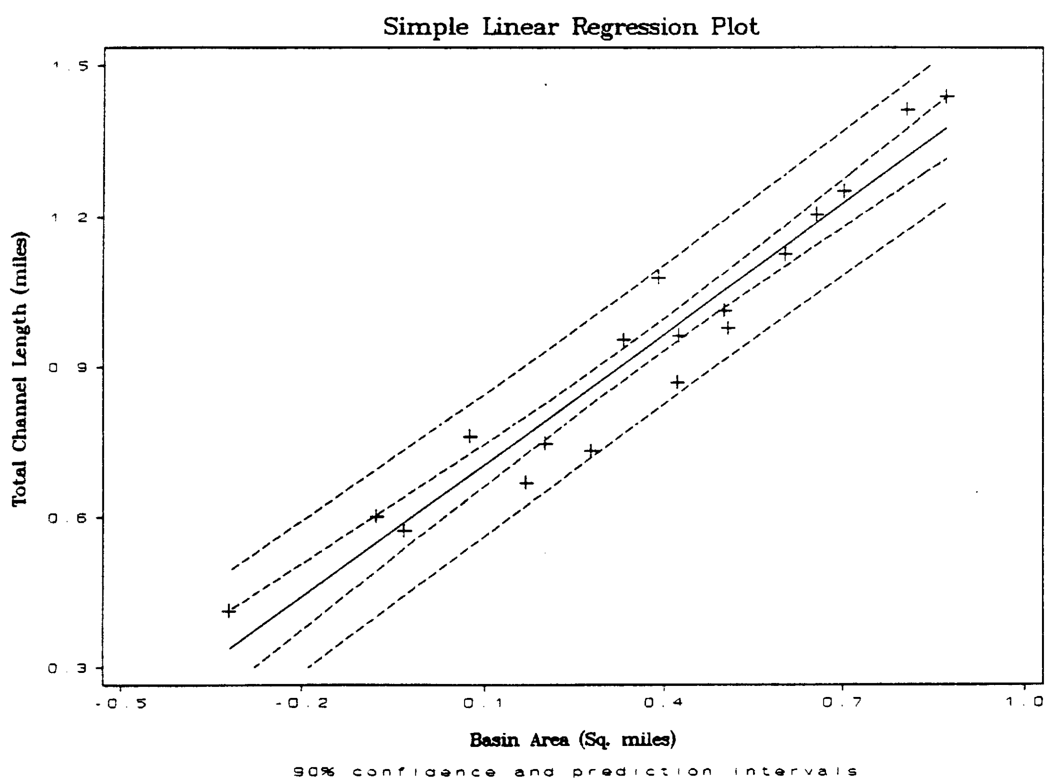
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOTAL CHANNEL LENGTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.61598	0.02812	21.90	0.0000
BA	0.87321	0.05901	14.80	0.0000

R-SQUARED	0.9319	RESID. MEAN SQUARE (MSE)	0.00603
ADJUSTED R-SQUARED	0.9277	STANDARD DEVIATION	0.07764

SOURCE	DF	SS	MS	F	P
REGRESSION	1	.32016	1.32016	218.98	0.0000
RESIDUAL	16	0.09646	0.00603		
TOTAL	17	1.41662			

CASES INCLUDED 18   MISSING CASES 0



Strata "A" third order regression output for relief ratio versus basin area.

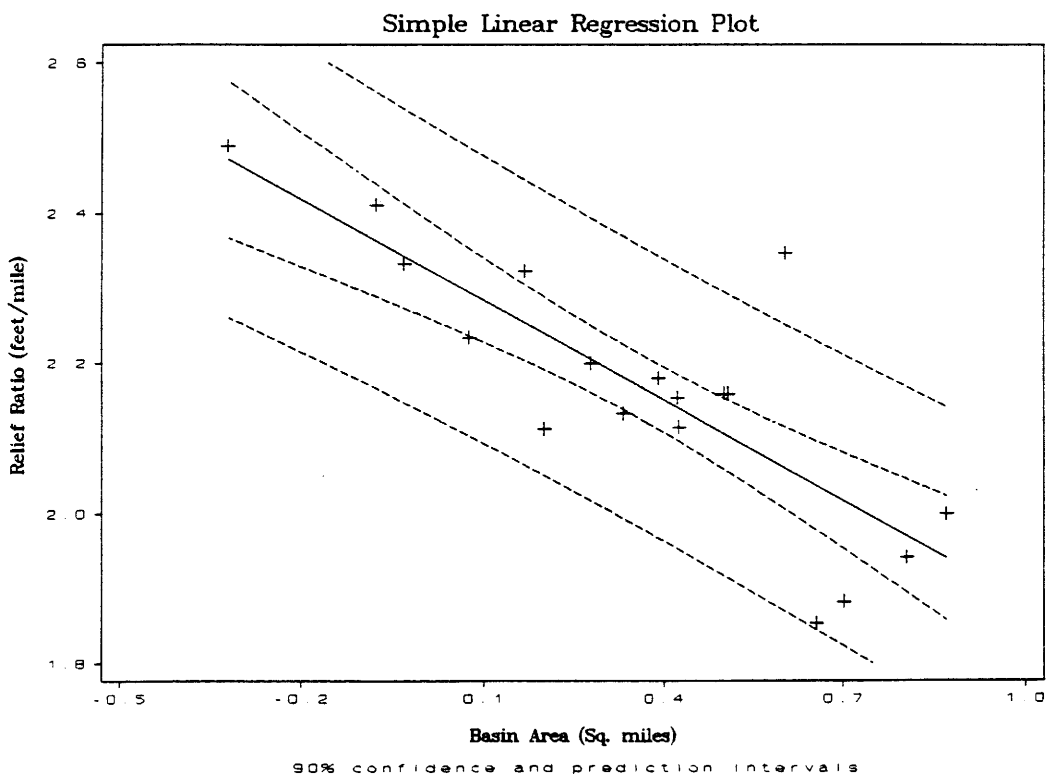
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RELIEF RATIO

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	2.32919	0.03797	61.34	0.0000
BA	-0.44568	0.07967	-5.59	0.0000

R-SQUARED	0.6617	RESID. MEAN SQUARE (MSE)	0.01099
ADJUSTED R-SQUARED	0.6405	STANDARD DEVIATION	0.10483

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.34391	0.34391	31.29	0.0000
RESIDUAL	16	0.17584	0.01099		
TOTAL	17	0.51974			

CASES INCLUDED 18 MISSING CASES 0



Strata "A" third order regression output for main channel length versus area gradient index #4.

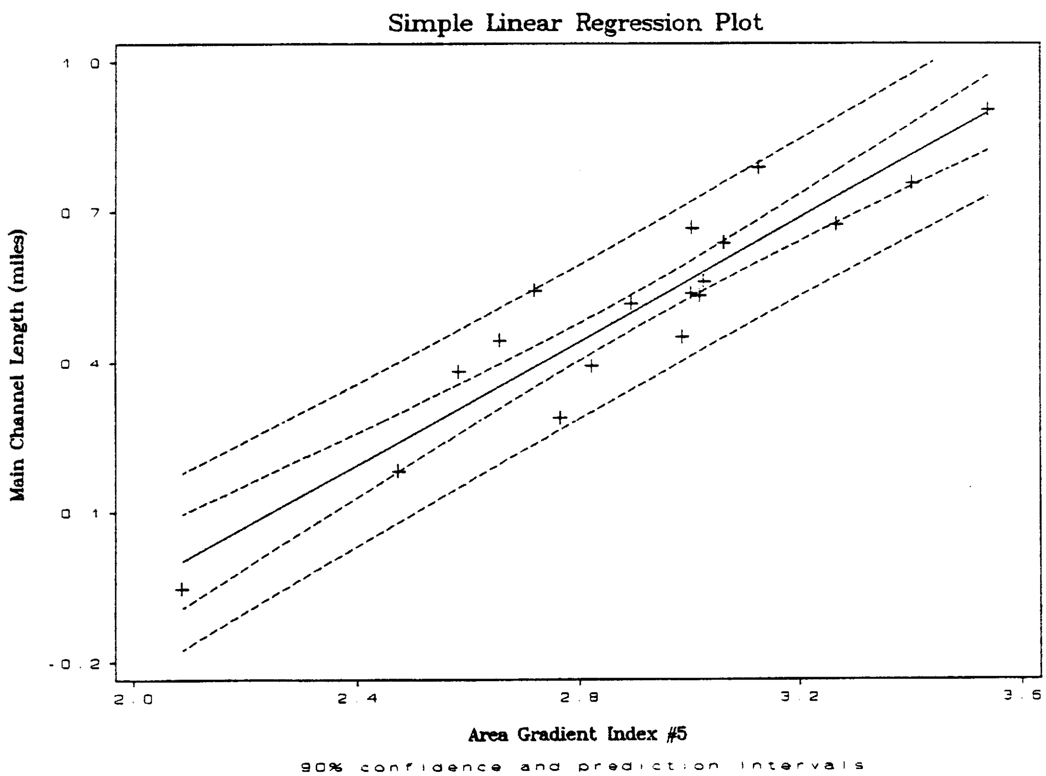
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF MAIN CHANNEL LENGTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-1.28837	0.17797	-7.24	0.0000
AGI4	0.61777	0.06070	10.18	0.0000

R-SQUARED	0.8662	RESID. MEAN SQUARE (MSE)	0.00733
ADJUSTED R-SQUARED	0.8578	STANDARD DEVIATION	0.08561

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.75925	0.75925	103.59	0.0000
RESIDUAL	16	0.11728	0.00733		
TOTAL	17	0.87653			

CASES INCLUDED 18 MISSING CASES 0



Strata "A" third order regression output for valley length versus area gradient index #4.

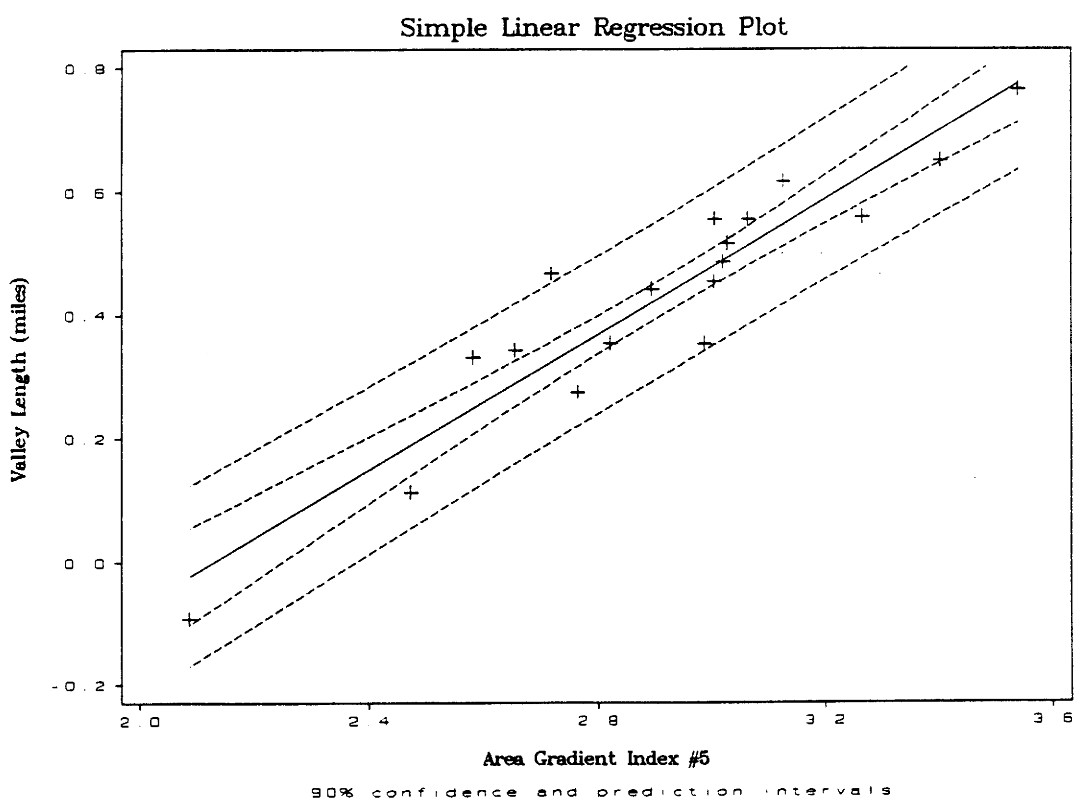
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF VALLEY LENGTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-1.16877	0.14794	-7.90	0.0000
AGI4	0.54869	0.05046	10.87	0.0000

R-SQUARED	0.8808	RESID. MEAN SQUARE (MSE)	0.00507
ADJUSTED R-SQUARED	0.8734	STANDARD DEVIATION	0.07117

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.59896	0.59896	118.25	0.0000
RESIDUAL	16	0.08105	0.00507		
TOTAL	17	0.68000			

CASES INCLUDED 18 MISSING CASES 0



Strata "A" third order regression output of basin relief versus main channel length and channel slope.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BASIN RELIEF

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	3.46768	0.25973	13.35	0.0000
MCHL	0.55035	0.13111	4.20	0.0008
CHS	0.66618	0.17592	3.79	0.0018

R-SQUARED	0.5407	RESID. MEAN SQUARE (MSE)	0.00342
ADJUSTED R-SQUARED	0.4795	STANDARD DEVIATION	0.05845

SOURCE	DF	SS	MS	F	P
REGRESSION	2	0.06034	0.03017	8.83	0.0029
RESIDUAL	15	0.05125	0.00342		
TOTAL	17	0.11160			

CASES INCLUDED 18 MISSING CASES 0

Strata "A" third order regression output for used relief versus area gradient index #2.

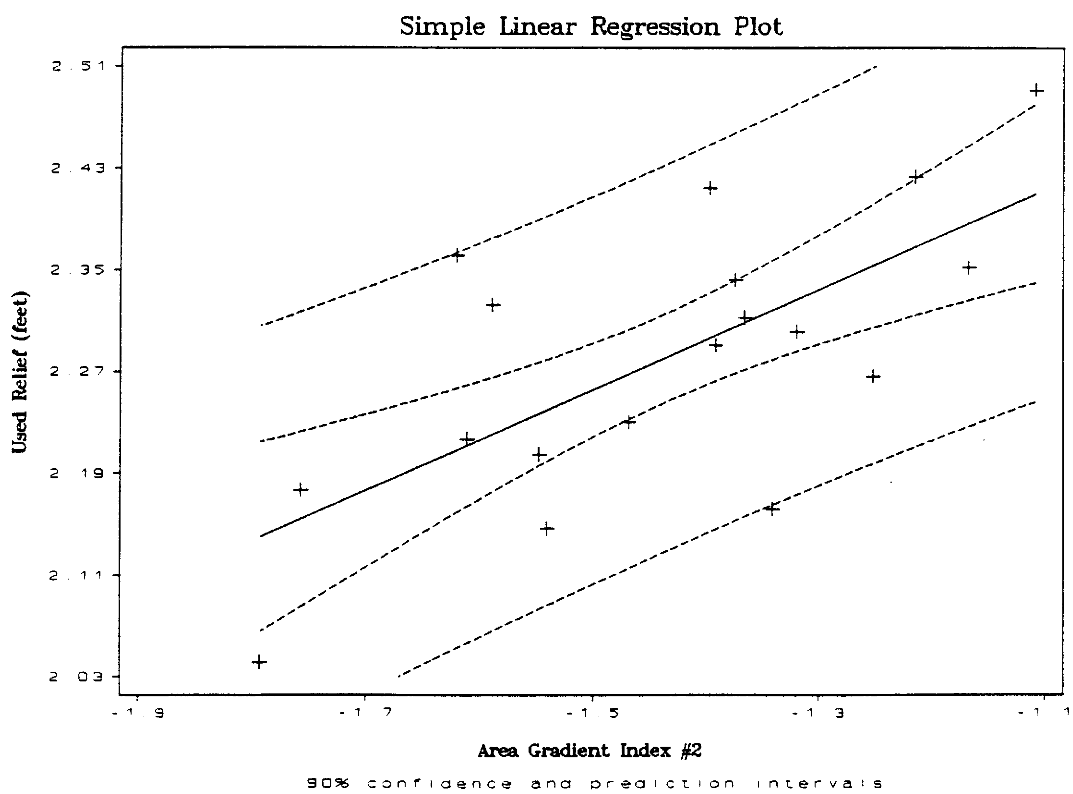
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF USED RELIEF

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	2.84782	0.15327	18.58	0.0000
AGI2	0.39477	0.10581	3.73	0.0018

R-SQUARED	0.4652	RESID. MEAN SQUARE (MSE)	0.00717
ADJUSTED R-SQUARED	0.4318	STANDARD DEVIATION	0.08468

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.09981	0.09981	13.92	0.0018
RESIDUAL	16	0.11472	0.00717		
TOTAL	17	0.21453			

CASES INCLUDED 18   MISSING CASES 0



Strata "A" third order regression output for ruggedness number versus drainage density.

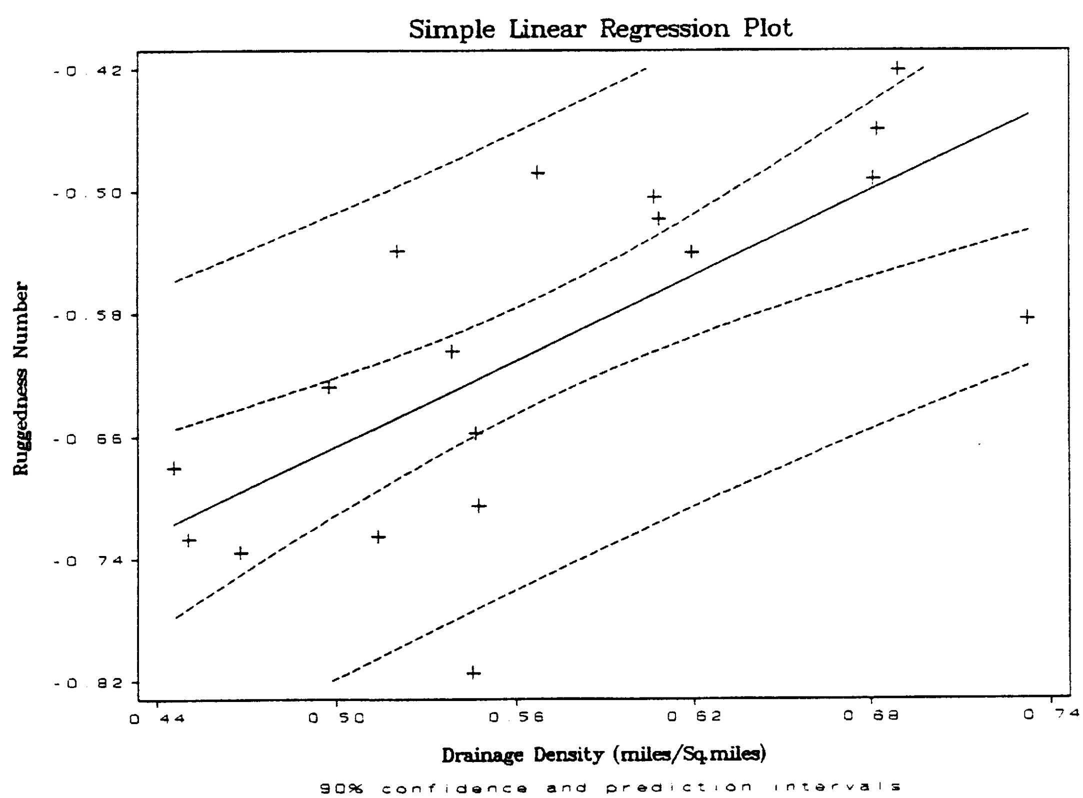
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RUGGEDNESS NUMBER

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-1.13012	0.13608	-8.31	0.0000
DD	0.92749	0.23619	3.93	0.0012

R-SQUARED	0.4908	RESID. MEAN SQUARE (MSE)	0.00693
ADJUSTED R-SQUARED	0.4589	STANDARD DEVIATION	0.08327

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.10692	0.10692	15.42	0.0012
RESIDUAL	16	0.11094	0.00693		
TOTAL	17	0.21786			

CASES INCLUDED 18 MISSING CASES 0



Strata "A" third order regression output for channel slope versus relief ratio.

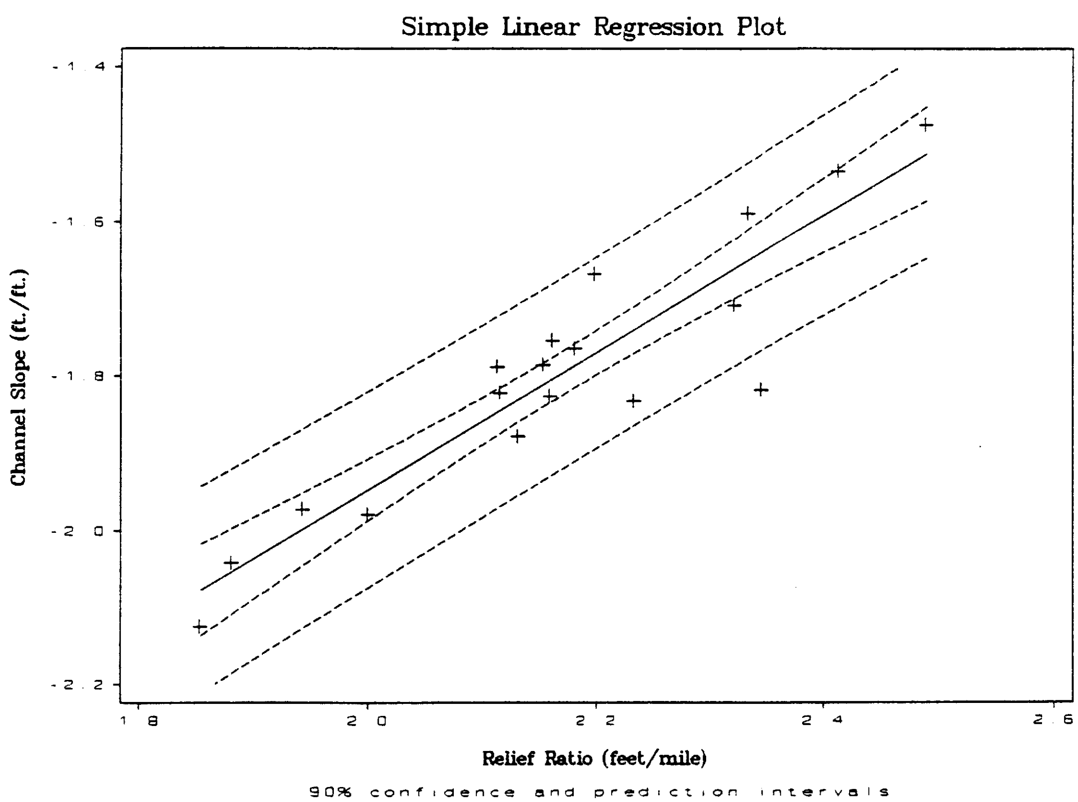
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF CHANNEL SLOPE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-3.72509	0.20816	-17.90	0.0000
RR	0.88887	0.09572	9.29	0.0000

R-SQUARED	0.8435	RESID. MEAN SQUARE (MSE)	0.00476
ADJUSTED R-SQUARED	0.8337	STANDARD DEVIATION	0.06901

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.41064	0.41064	86.22	0.0000
RESIDUAL	16	0.07620	0.00476		
TOTAL	17	0.48684			

CASES INCLUDED 18   MISSING CASES 0



Strata "A" third order regression output for sinuosity versus channel slope.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF SINUOSITY

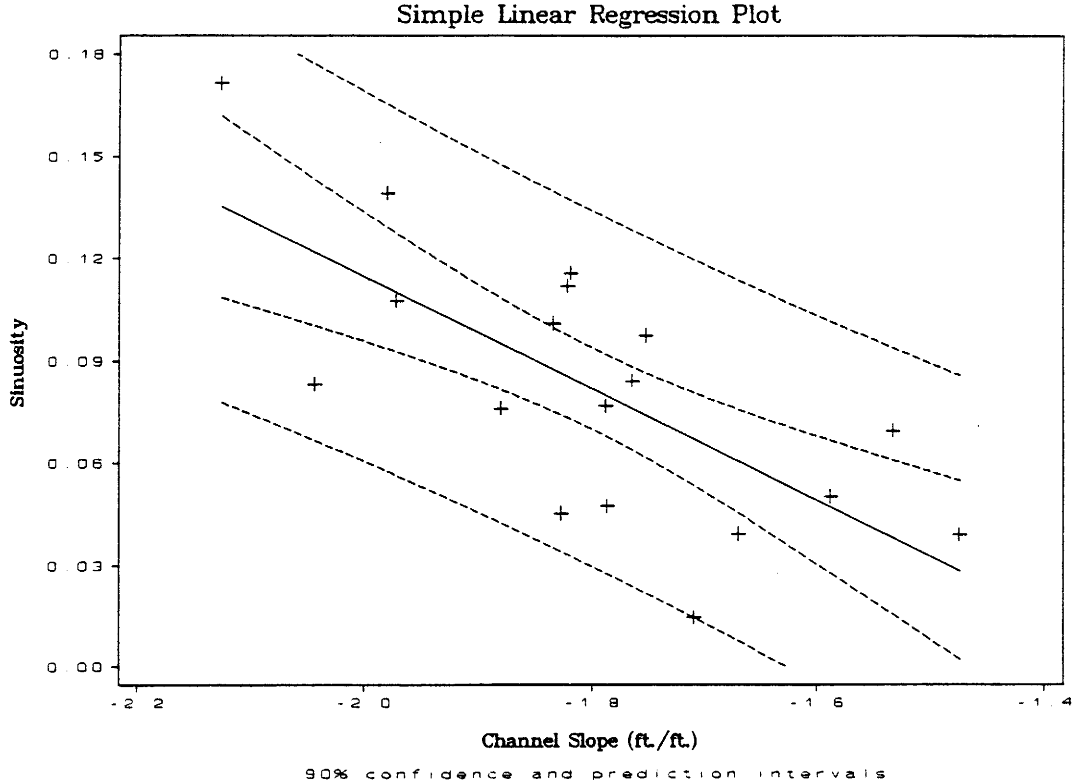
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.21336	0.07537	-2.83	0.0120
CHS	-0.16404	0.04174	-3.93	0.0012

R-SQUARED	0.4912	RESID. MEAN SQUARE (MSE)	8.483E-04
ADJUSTED R-SQUARED	0.4594	STANDARD DEVIATION	0.02913

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.01310	0.01310	15.44	0.0012
RESIDUAL	16	0.01357	8.483E-04		
TOTAL	17	0.02667			

CASES INCLUDED 18 MISSING CASES 0

Simple Linear Regression Plot



Strata "A" third order regression output for area #2 versus area gradient index #4.

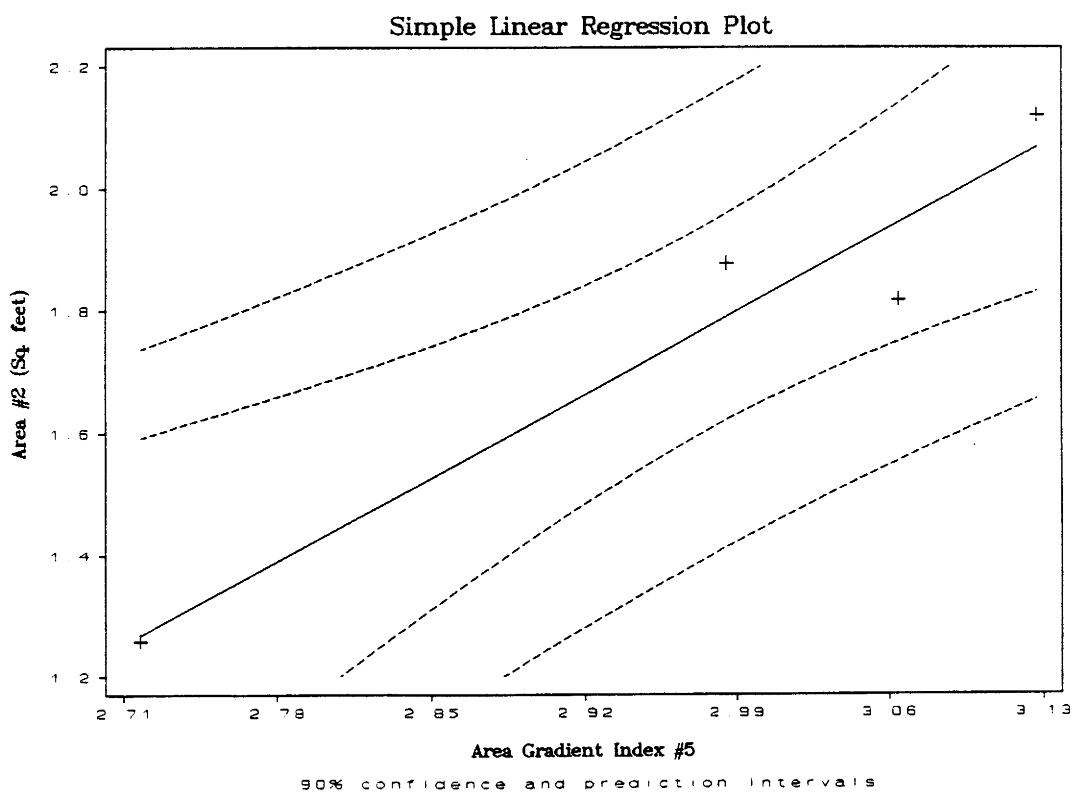
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF A2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-4.03890	1.10342	-3.66	0.0672
AGI4	1.95281	0.37056	5.27	0.0342

R-SQUARED	0.9328	RESID. MEAN SQUARE (MSE)	0.01337
ADJUSTED R-SQUARED	0.8992	STANDARD DEVIATION	0.11564

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.37137	0.37137	27.77	0.0342
RESIDUAL	2	0.02674	0.01337		
TOTAL	3	0.39812			

CASES INCLUDED 4 MISSING CASES 0



Strata "A" third order regression output for Q2 versus area gradient index #4.

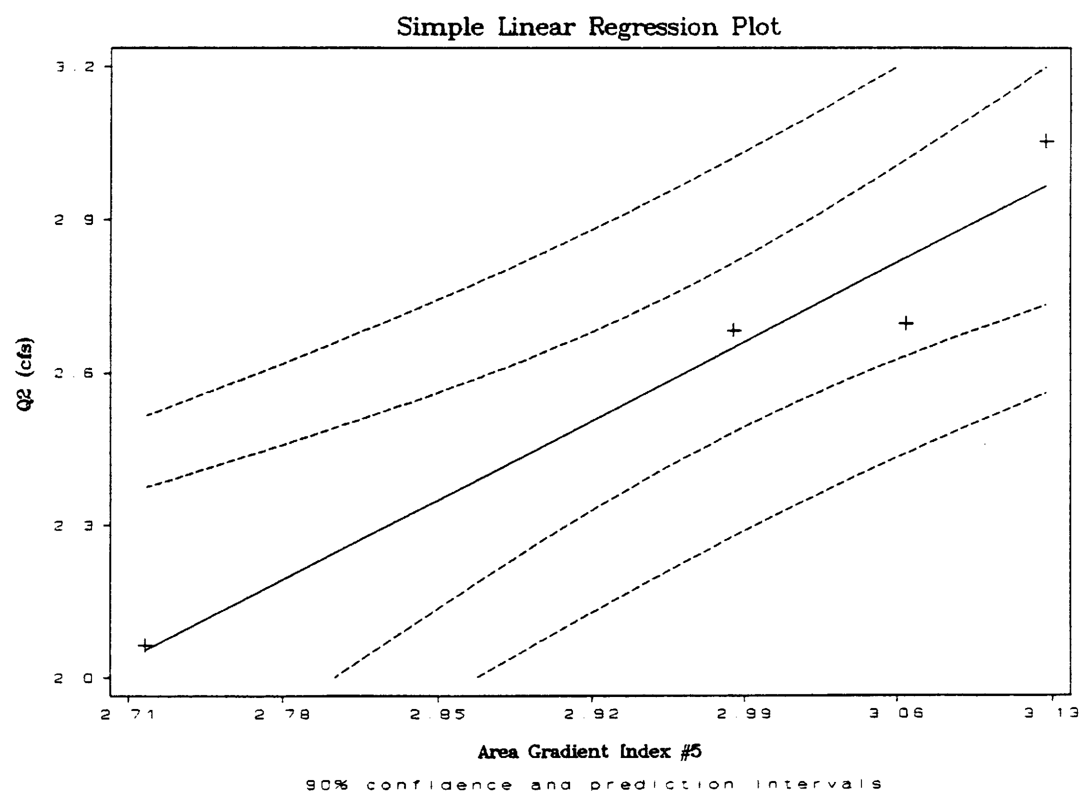
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF Q2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-3.98492	1.08577	-3.67	0.0669
AGI4	2.22257	0.36463	6.10	0.0259

R-SQUARED	0.9489	RESID. MEAN SQUARE (MSE)	0.01295
ADJUSTED R-SQUARED	0.9234	STANDARD DEVIATION	0.11379

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.48106	0.48106	37.15	0.0259
RESIDUAL	2	0.02590	0.01295		
TOTAL	3	0.50696			

CASES INCLUDED 4   MISSING CASES 0



Strata "A" third order regression output for area #2 versus Q2.

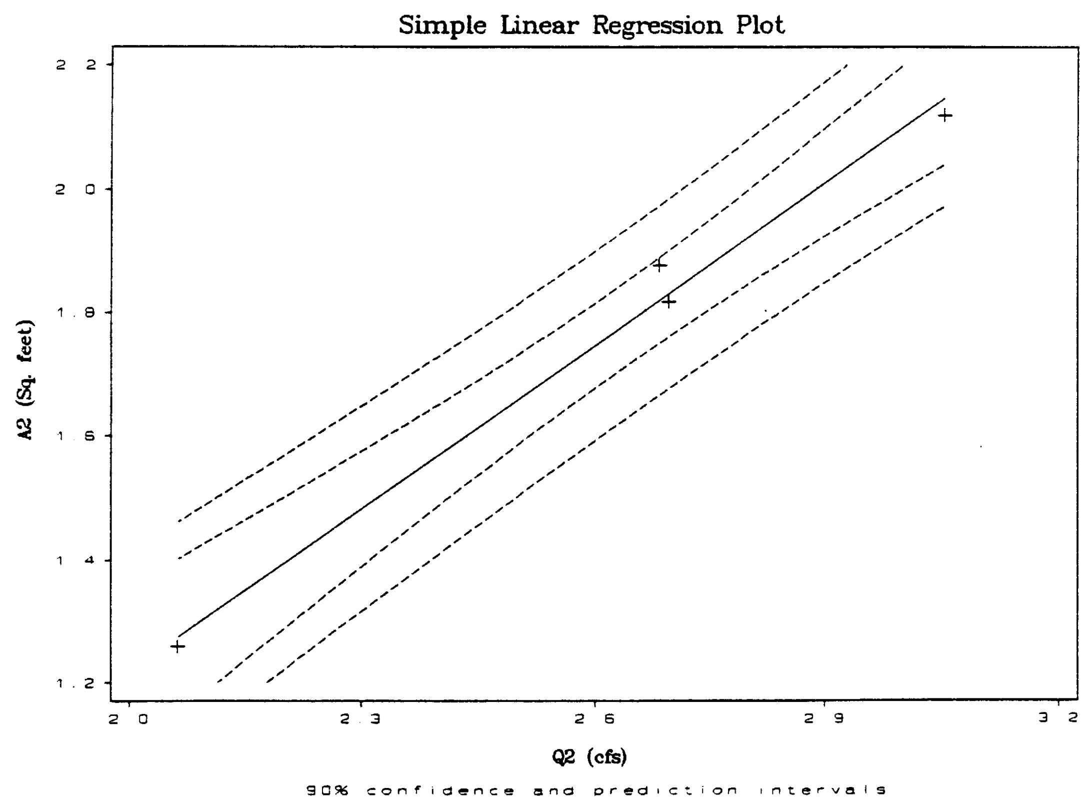
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF A2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.54449	0.17490	-3.11	0.0895
Q2	0.88124	0.06604	13.34	0.0056

R-SQUARED	0.9889	RESID. MEAN SQUARE (MSE)	0.00221
ADJUSTED R-SQUARED	0.9833	STANDARD DEVIATION	0.04702

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.39369	0.39369	178.05	0.0056
RESIDUAL	2	0.00442	0.00221		
TOTAL	3	0.39812			

CASES INCLUDED 4 MISSING CASES 0



Strata "A" third order regression output for top width #2 versus area #2.

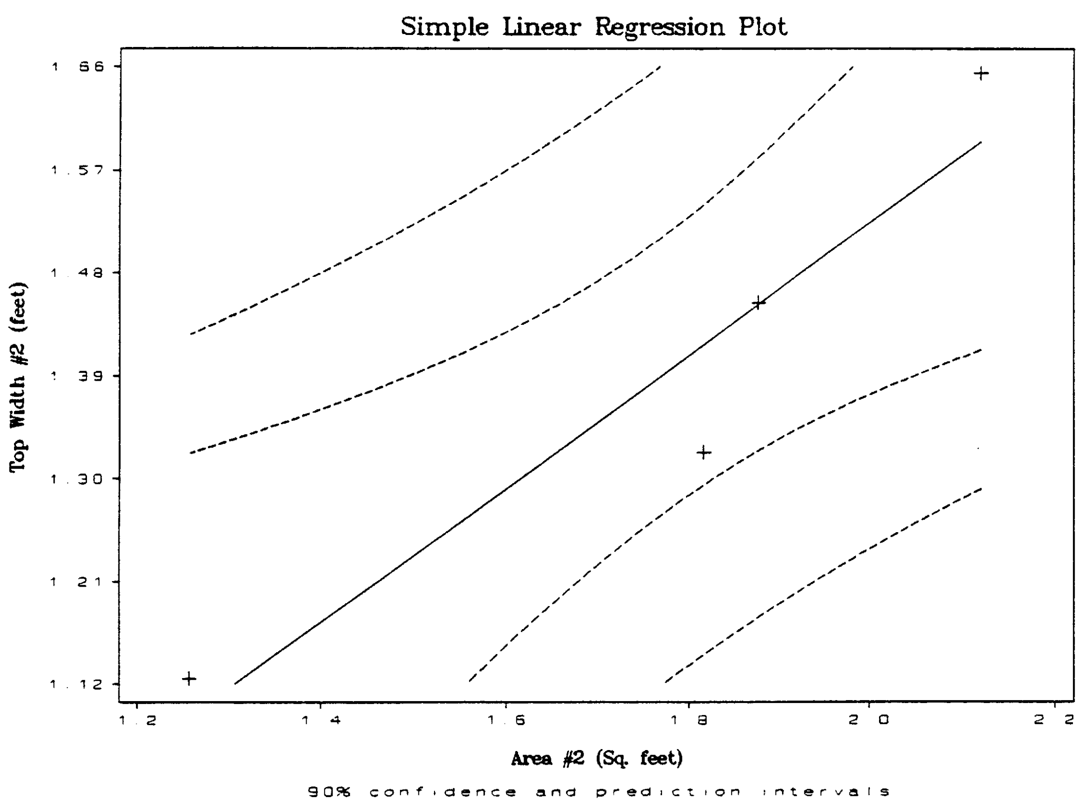
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOP WIDTH #2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.35675	0.23664	1.51	0.2707
A2	0.58388	0.13176	4.43	0.0473

R-SQUARED	0.9076	RESID. MEAN SQUARE (MSE)	0.00691
ADJUSTED R-SQUARED	0.8614	STANDARD DEVIATION	0.08314

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.13573	0.13573	19.64	0.0473
RESIDUAL	2	0.01382	0.00691		
TOTAL	3	0.14955			

CASES INCLUDED 4 MISSING CASES 0



Strata "A" third order regression output of top width #2 versus Q2.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOP WIDTH #2

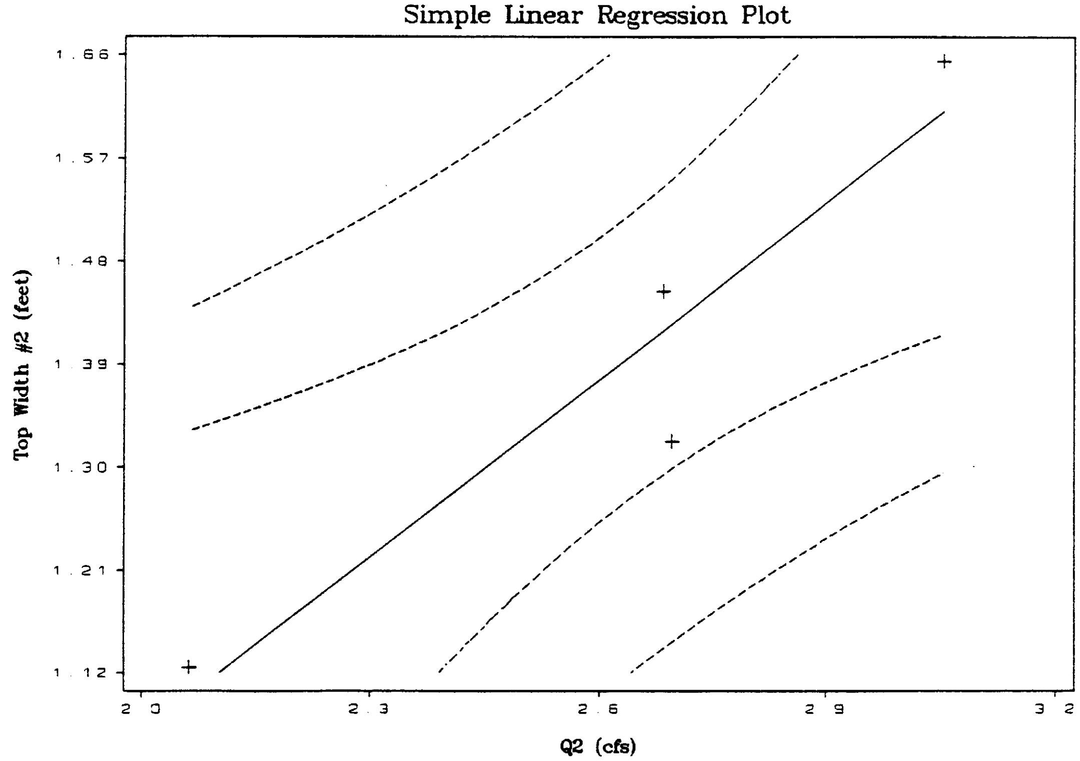
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.03457	0.31651	0.11	0.9230
Q2	0.51616	0.11952	4.32	0.0497

R-SQUARED	0.9032	RESID. MEAN SQUARE (MSE)	0.00724
ADJUSTED R-SQUARED	0.8547	STANDARD DEVIATION	0.08510

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.13507	0.13507	18.65	0.0497
RESIDUAL	2	0.01448	0.00724		
TOTAL	3	0.14955			

CASES INCLUDED 4 MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "A" third order regression output for average depth #2 versus area #2.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AVERAGE DEPTH #2

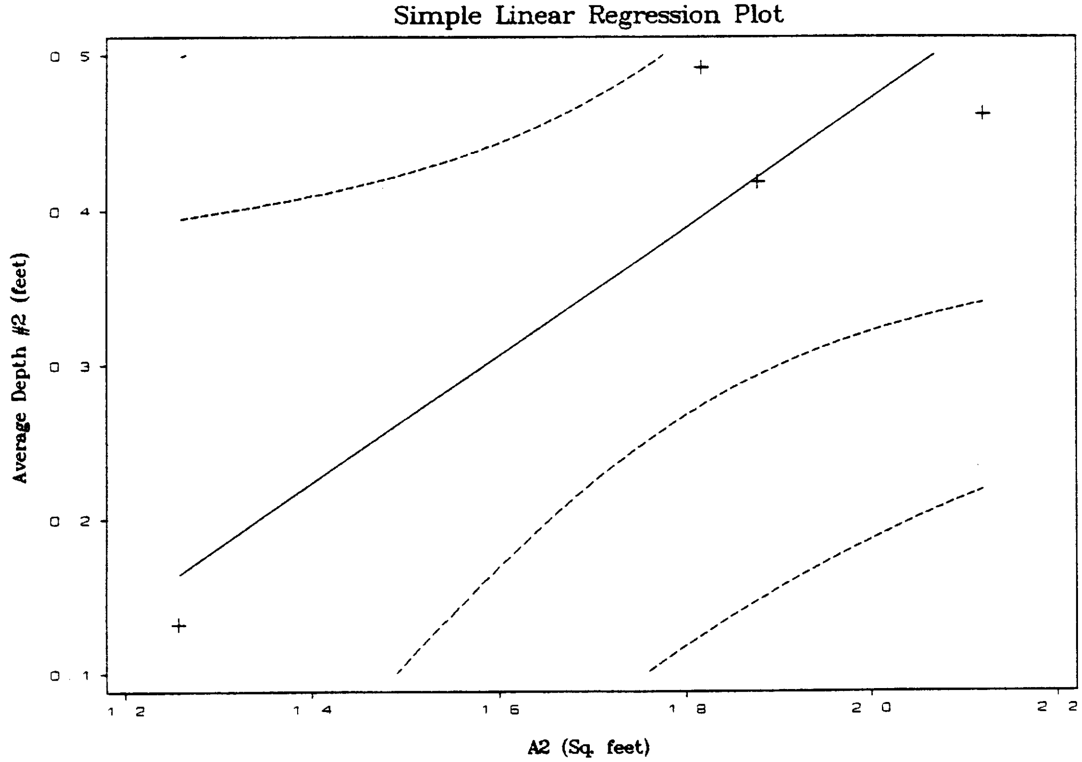
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.35752	0.23621	-1.51	0.2693
A2	0.41484	0.13152	3.15	0.0875

R-SQUARED	0.8326	RESID. MEAN SQUARE (MSE)	0.00689
ADJUSTED R-SQUARED	0.7489	STANDARD DEVIATION	0.08298

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.06851	0.06851	9.95	0.0875
RESIDUAL	2	0.01377	0.00689		
TOTAL	3	0.08229			

CASES INCLUDED 4   MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "A" third order regression output for average depth #2 versus Q2.

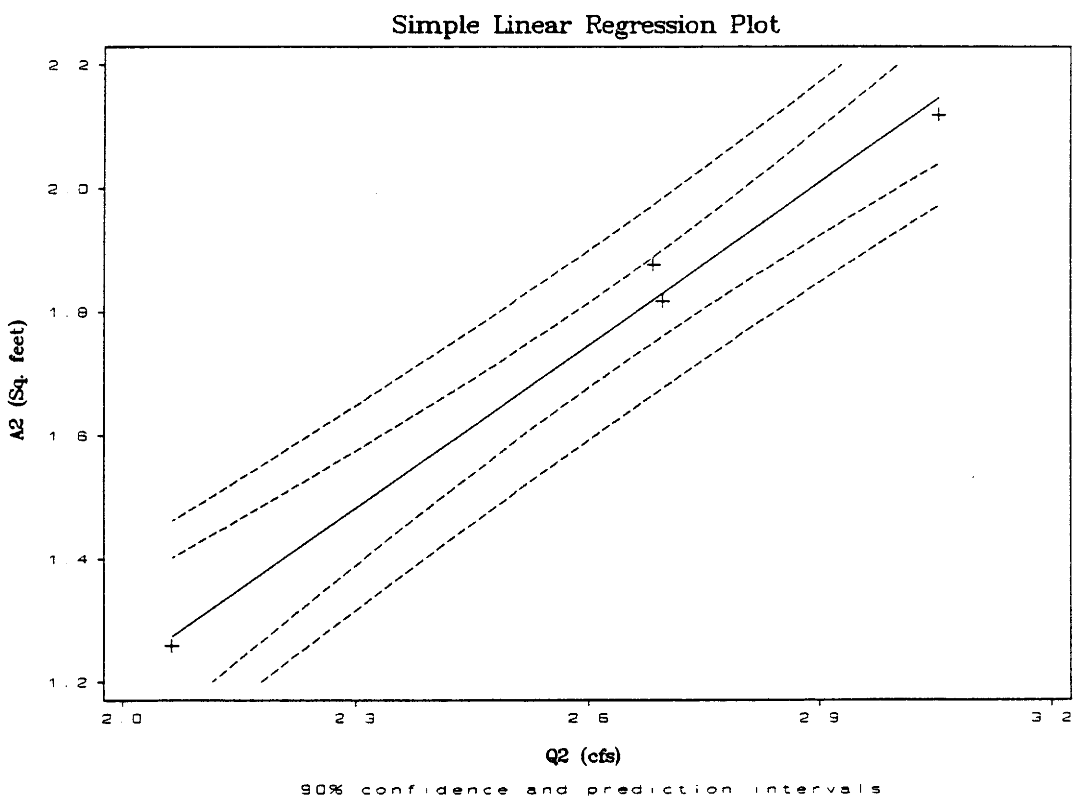
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AVERAGE DEPTH #2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.57976	0.32261	-1.80	0.2141
Q2	0.36419	0.12182	2.99	0.0960

R-SQUARED	0.8171	RESID. MEAN SQUARE (MSE)	0.00752
ADJUSTED R-SQUARED	0.7257	STANDARD DEVIATION	0.08674

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.06724	0.06724	8.94	0.0960
RESIDUAL	2	0.01505	0.00752		
TOTAL	3	0.08229			

CASES INCLUDED 4 MISSING CASES 0



Strata "A" third order regression output for velocity #2 versus Q2.

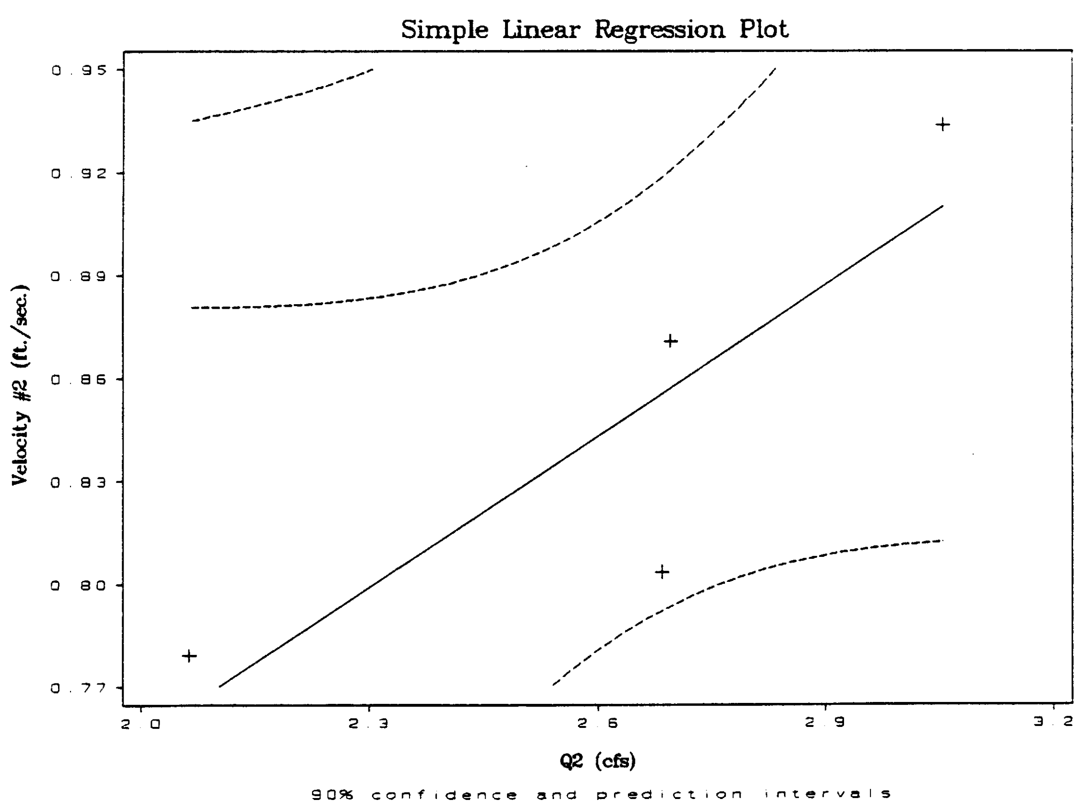
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF VELOCITY #2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.46087	0.15883	2.90	0.1011
Q2	0.14707	0.05998	2.45	0.1337

R-SQUARED	0.7504	RESID. MEAN SQUARE (MSE)	0.00182
ADJUSTED R-SQUARED	0.6256	STANDARD DEVIATION	0.04270

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.01097	0.01097	6.01	0.1337
RESIDUAL	2	0.00365	0.00182		
TOTAL	3	0.01461			

CASES INCLUDED 4   MISSING CASES 0



Strata "A" third order regression output for bank slope versus area gradient index #2.

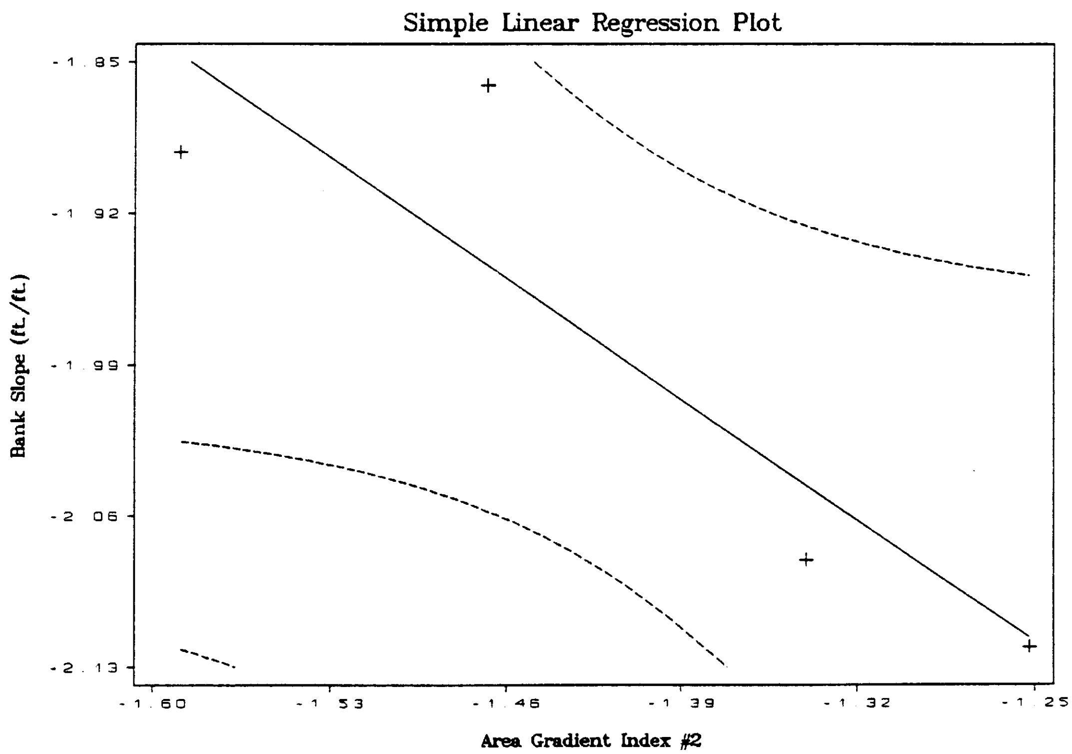
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BANK SLOPE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-3.11542	0.39699	-7.85	0.0159
AGI2	-0.79813	0.27997	-2.85	0.1042

R-SQUARED	0.7025	RESID. MEAN SQUARE (MSE)	0.00510
ADJUSTED R-SQUARED	0.[illegible]038	STANDARD DEVIATION	0.07144

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.04148	0.04148	8.13	0.1042
RESIDUAL	2	0.01021	0.00510		
TOTAL	3	0.05169			

CASES INCLUDED 4 MISSING CASES 0



90% confidence and prediction intervals

Strata "A" third order regression output for area #4 versus top width #2.

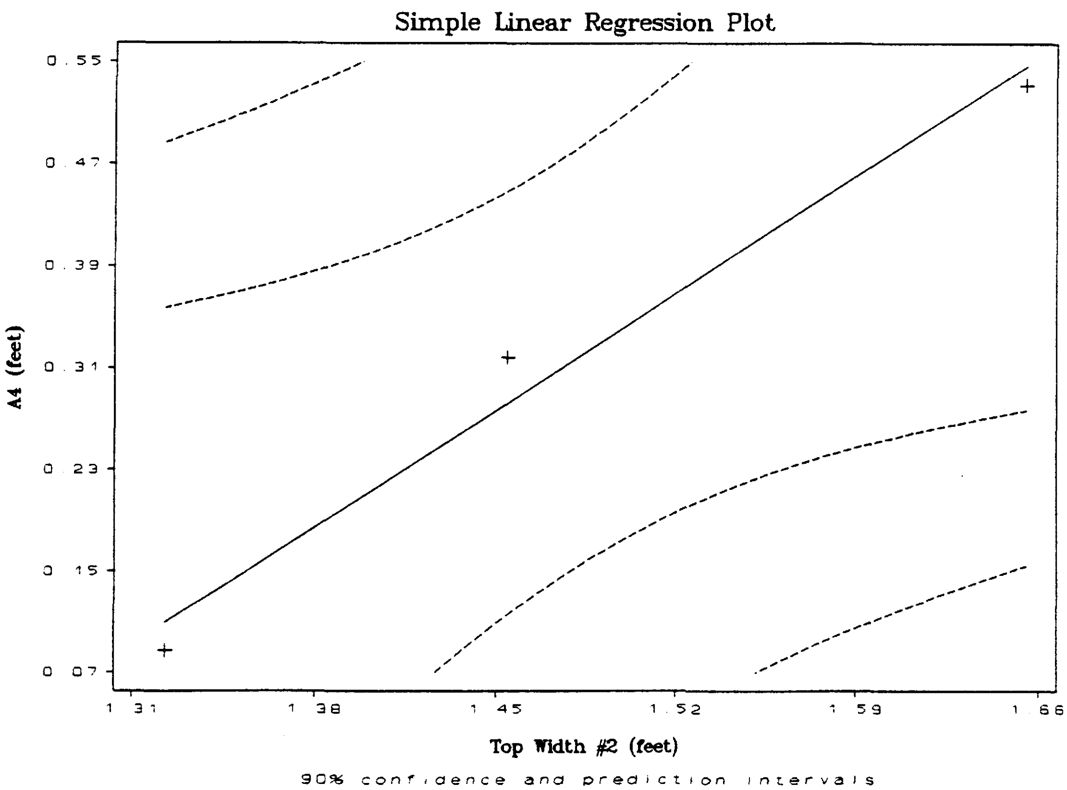
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF A4

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-1.63033	0.28216	-5.78	0.1091
TW2	1.31514	0.19018	6.92	0.0914

R-SQUARED	0.9795	RESID. MEAN SQUARE (MSE)	0.00203
ADJUSTED R-SQUARED	0.9590	STANDARD DEVIATION	0.04506

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.09708	0.09708	47.82	0.0914
RESIDUAL	1	0.00203	0.00203		
TOTAL	2	0.09911			

CASES INCLUDED 3 MISSING CASES 1



Strata "A" third order regression output for top width #4 versus area #4.

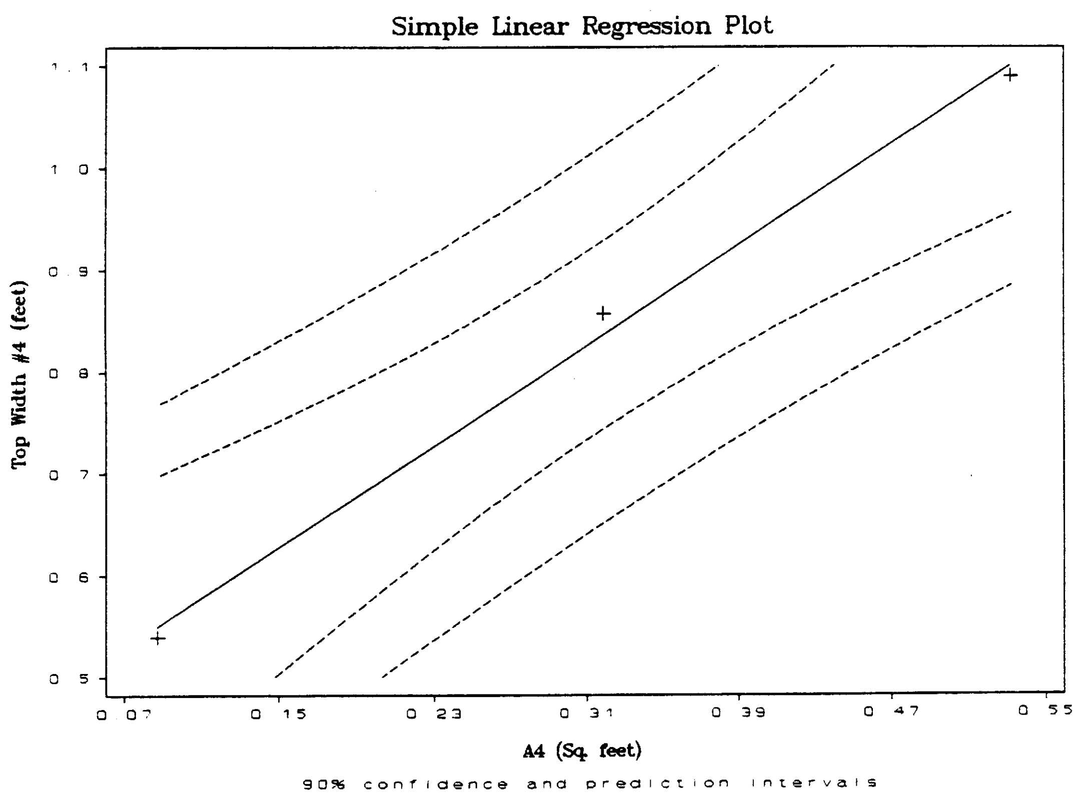
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOP WIDTH #4

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.44178	0.02914	15.16	0.0419
A4	1.23841	0.08059	15.37	0.0414

R-SQUARED	0.9958	RESID. MEAN SQUARE (MSE)	6.436E-04
ADJUSTED R-SQUARED	0.9916	STANDARD DEVIATION	0.02537

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.15200	0.15200	236.15	0.0414
RESIDUAL	1	6.436E-04	6.436E-04		
TOTAL	2	0.15264			

CASES INCLUDED 3 MISSING CASES 1



Strata "A" third order regression output for top width #4 versus Q4.

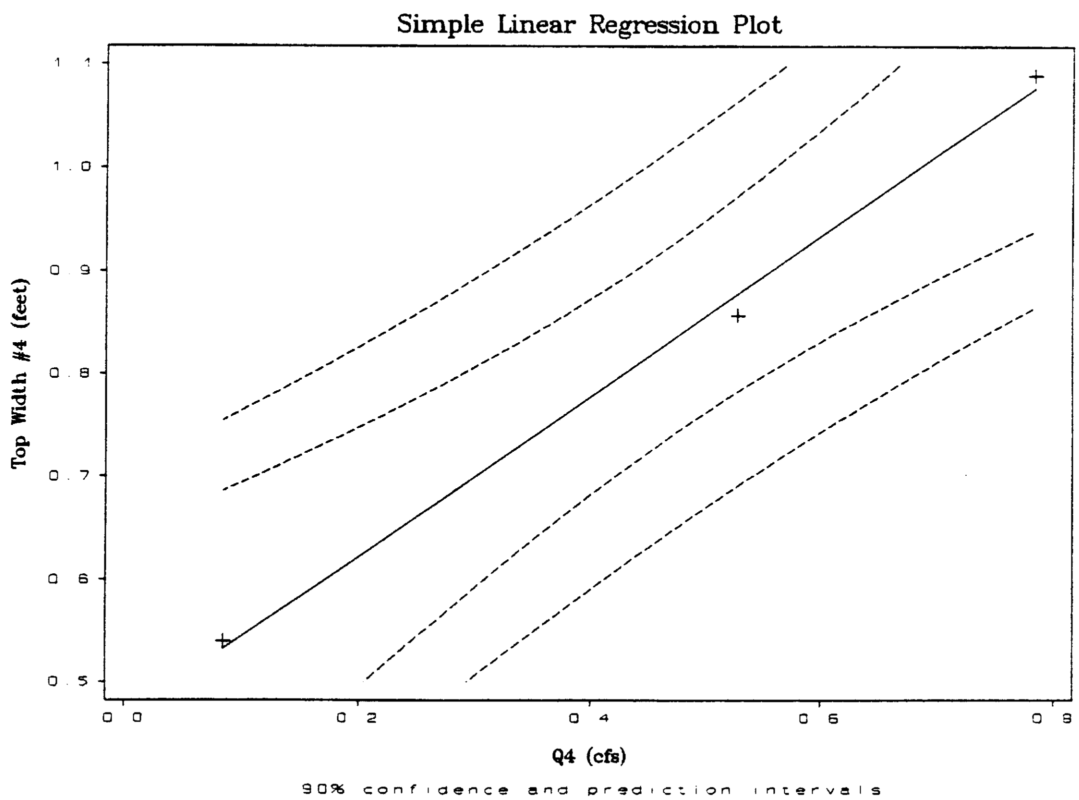
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOP WIDTH #4

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.46531	0.02795	16.65	0.0382
Q4	0.78101	0.05106	15.30	0.0416

R-SQUARED	0.9957	RESID. MEAN SQUARE (MSE)	6.496E-04
ADJUSTED R-SQUARED	0.9915	STANDARD DEVIATION	0.02549

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.15199	0.15199	233.98	0.0416
RESIDUAL	1	6.496E-04	6.496E-04		
TOTAL	2	0.15264			

CASES INCLUDED 3 MISSING CASES 1



High bank reach means for **Strata "A"** third order

Basin ID 0900	**Area (ft^2)**	**Wetted Perimeter (ft)**	**Top Width (ft)**	**Hydraulic Radius**	**Average Depth (ft)**	**W/D Ratio**	**Bed Slope (ft/ft)**
n	2	2	2	2	2	2	2
Mean	1136.20	235.30	232.05	4.35	4.40	69.71	0.007
S.D.	983.06	41.58	40.16	3.11	3.18	45.14	0.001
C.V. (%)	86.52	17.67	17.31	71.52	72.32	64.75	19.46
Minimum	441.05	205.90	203.65	2.15	2.15	37.79	0.006
Maximum	1831.30	264.70	260.45	6.55	6.65	101.63	0.008
Range	1390.25	58.80	56.80	4.40	4.50	63.84	0.002

Basin ID 6400	**Area (ft^2)**	**Wetted Perimeter (ft)**	**Top Width (ft)**	**Hydraulic Radius**	**Average Depth (ft)**	**W/D Ratio**	**Bed Slope (ft/ft)**
n	2	2	2	2	2	2	2
Mean	323.83	129.70	127.80	2.53	2.60	51.91	0.006
S.D.	297.16	119.64	120.21	0.04	0.14	50.12	0.002
C.V. (%)	91.77	92.25	94.06	1.40	5.44	96.56	34.42
Minimum	113.70	45.10	42.80	2.50	2.50	16.47	0.004
Maximum	533.95	214.30	212.80	2.55	2.70	87.35	0.007
Range	420.25	169.20	170.00	0.05	0.20	70.88	0.003

Medium bank reach means for Strata "A" third order

Basin ID 0900	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	4	4	4	4	4	4	4	4	4	4	4
Mean	86.35	32.96	29.90	2.60	2.90	13.36	0.010	0.011	0.04	7.88	856.34
S.D.	52.73	9.85	9.56	1.20	1.42	10.23	0.004	0.010	0.00	5.38	913.76
C.V. (%)	61.07	29.88	31.99	46.13	49.07	76.53	36.94	86.35	5.25	68.27	106.71
Minimum	40.35	22.35	20.75	1.45	1.50	6.39	0.006	0.003	0.04	3.21	129.68
Maximum	160.85	42.70	40.60	4.05	4.55	28.44	0.014	0.022	0.04	12.98	2088.40
Range	120.50	20.35	19.85	2.60	3.05	22.05	0.008	0.019	0.00	9.77	1958.72

Basin ID 3800	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	1	1	1	1	1	1	1	1	1	1	1
Mean	131.85	47.90	45.25	2.75	2.90	15.64	0.005	0.014	0.04	8.59	1132.20
S.D.	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.00	0.00	0.00
C.V. (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.00	0.00	0.00
Minimum	131.85	47.90	45.25	2.75	2.90	15.64	0.005	0.014	0.04	8.59	1132.20
Maximum	131.85	47.90	45.25	2.75	2.90	15.64	0.005	0.014	0.04	8.59	1132.20
Range	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.00	0.00	0.00

Basin ID 4700	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	3	3	3	3	3	3	3	3	3	3	3
Mean	69.23	26.95	22.25	2.57	3.20	7.72	0.005	0.023	0.03	9.17	659.31
S.D.	21.12	8.05	8.50	0.50	0.85	5.01	0.006	0.034	0.00	7.58	588.25
C.V. (%)	30.51	29.86	38.22	19.61	26.70	64.81	105.32	150.02	2.94	82.69	89.22
Minimum	46.15	18.35	13.90	2.10	2.30	4.22	0.001	0.003	0.03	4.50	207.49
Maximum	87.60	34.30	30.90	3.10	4.00	13.46	0.012	0.062	0.04	17.91	1324.50
Range	41.45	15.95	17.00	1.00	1.70	9.24	0.011	0.059	0.00	13.41	1117.01

Basin ID 6400	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	2	2	2	2	2	2	2	2	2	2	2
Mean	19.73	14.93	13.75	1.28	1.38	9.99	0.006	0.014	0.03	6.10	124.73
S.D.	5.90	3.57	3.46	0.04	0.04	2.11	0.002	0.006	0.00	1.48	65.18
C.V. (%)	29.93	23.93	25.20	2.77	2.57	21.14	34.42	43.73	0.00	24.21	52.25
Minimum	15.55	12.40	11.30	1.25	1.35	8.50	0.004	0.009	0.03	5.06	78.65
Maximum	23.90	17.45	16.20	1.30	1.40	11.49	0.007	0.018	0.03	7.15	170.82
Range	8.35	5.05	4.90	0.05	0.05	2.99	0.003	0.008	0.00	2.09	92.17

Low bank reach means for **Strata "A"** third order

Basin ID 3800	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	1	1	1	1	1	1	1	1	1	1	1
Mean	70.30	29.50	27.65	2.40	2.50	11.69	0.005	0.015	0.036	9.01	633.38
S.D.	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.00
C.V. (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Minimum	70.30	29.50	27.65	2.40	2.50	11.69	0.005	0.015	0.036	9.01	633.38
Maximum	70.30	29.50	27.65	2.40	2.50	11.69	0.005	0.015	0.036	9.01	633.38
Range	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.00

Basin ID 4700	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	3	3	3	3	3	3	3	3	3	3	3
Mean	17.60	13.93	11.50	1.27	1.53	7.54	0.005	0.013	0.034	5.48	93.59
S.D.	2.61	2.32	1.69	0.08	0.03	1.03	0.006	0.010	0.000	2.15	29.83
C.V. (%)	14.82	16.64	14.73	6.03	1.88	13.68	105.32	76.21	0.00	39.15	31.87
Minimum	15.60	11.80	10.15	1.20	1.50	6.68	0.001	0.004	0.034	3.29	67.57
Maximum	20.55	16.40	13.40	1.35	1.55	8.68	0.012	0.023	0.034	7.58	126.14
Range	4.95	4.60	3.25	0.15	0.05	2.01	0.011	0.019	0.000	4.29	58.57

Low bank # 2 reach means for Strata "A" third order

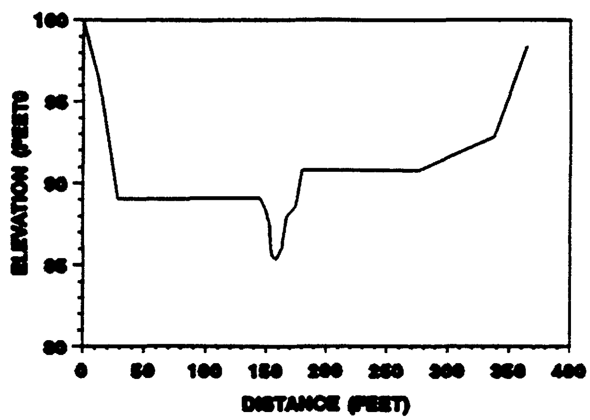
Basin ID 0900	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	4	4	4	4	4	4	4	4	4	4	4
Mean	5.10	8.63	8.16	0.44	0.49	36.40	0.010	0.009	0.036	2.21	18.14
S.D.	5.21	4.98	4.62	0.40	0.46	30.08	0.004	0.007	0.001	2.11	21.59
C.V. (%)	102.17	57.80	56.58	90.67	92.81	82.64	36.94	76.63	3.21	95.44	118.99
Minimum	0.35	3.95	3.90	0.07	0.07	8.75	0.006	0.003	0.035	0.50	0.18
Maximum	10.35	15.15	14.40	0.90	1.00	76.95	0.014	0.018	0.037	5.02	44.17
Range	10.00	11.20	10.50	0.83	0.93	68.20	0.008	0.015	0.002	4.52	44.00

Basin ID 3800	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	1	1	1	1	1	1	1	1	1	1	1
Mean	3.90	12.60	12.50	0.30	0.30	44.13	0.005	0.008	0.038	1.56	6.07
S.D.	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.00
C.V. (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Minimum	3.90	12.60	12.50	0.30	0.30	44.13	0.005	0.008	0.038	1.56	6.07
Maximum	3.90	12.60	12.50	0.30	0.30	44.13	0.005	0.008	0.038	1.56	6.07
Range	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.00

Basin ID 4700	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	3	3	3	3	3	3	3	3	3	3	3
Mean	1.65	4.07	3.62	0.35	0.40	12.12	0.005	0.002	0.035	0.88	1.36
S.D.	1.08	0.81	0.47	0.15	0.20	3.74	0.006	0.001	0.001	0.25	0.67
C.V. (%)	65.56	19.99	13.07	42.86	50.00	30.83	105.32	64.02	3.33	28.58	49.49
Minimum	0.75	3.35	3.25	0.20	0.20	8.97	0.001	0.001	0.034	0.67	0.61
Maximum	2.85	4.95	4.15	0.50	0.60	16.25	0.012	0.003	0.036	1.16	1.90
Range	2.10	1.60	0.90	0.30	0.40	7.28	0.011	0.003	0.002	0.49	1.30

WINDMILL DRAW, 0900

CROSS SECTION 0+00.00



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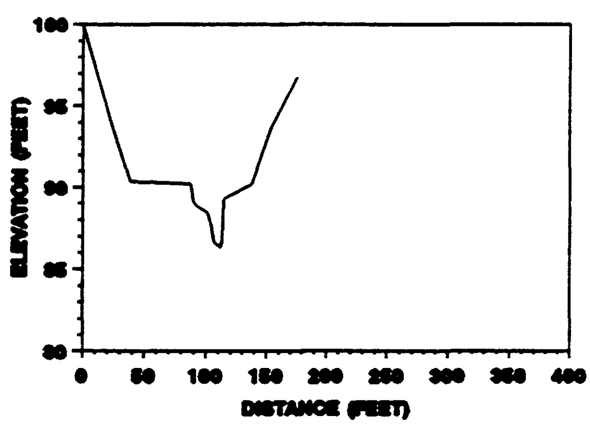

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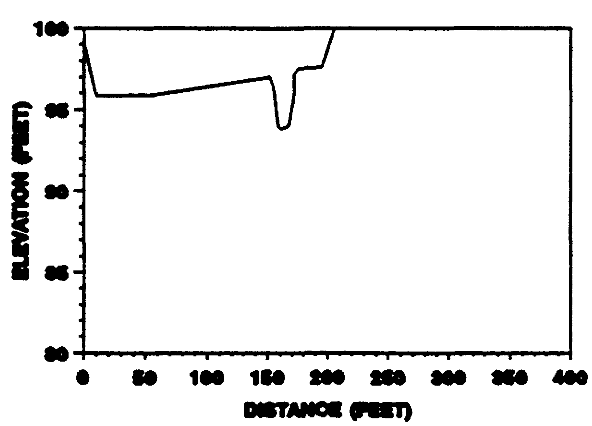

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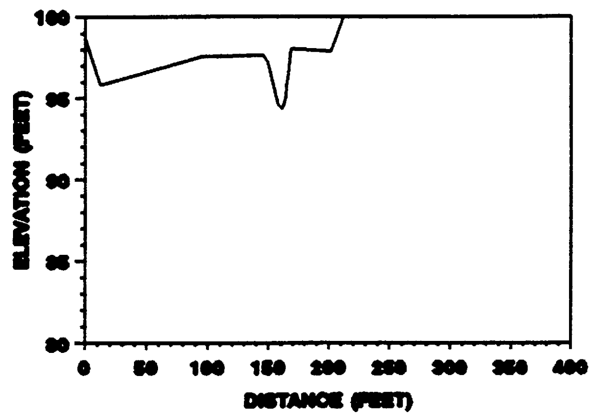

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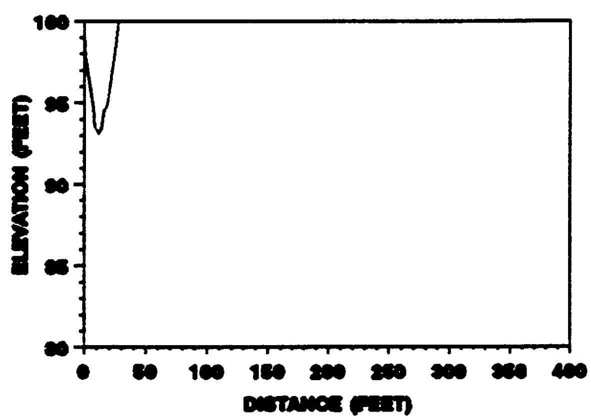

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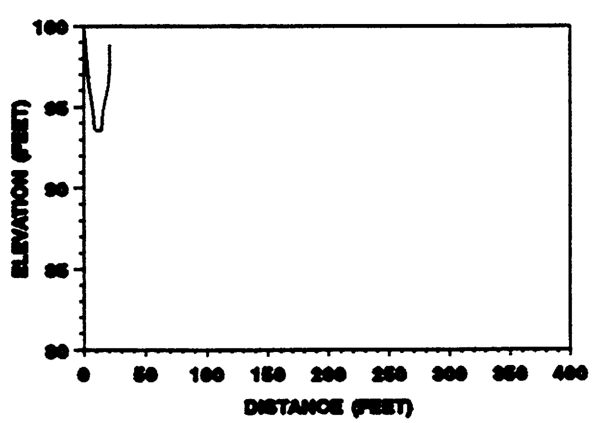

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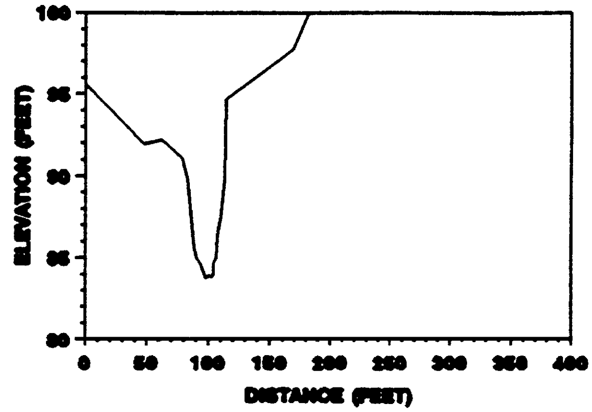

WINDMILL DRAW, 0900
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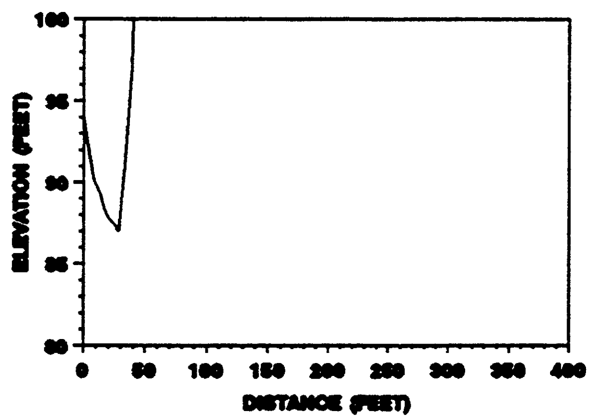
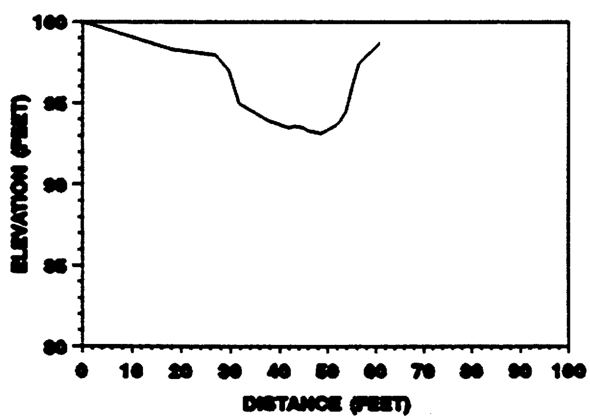
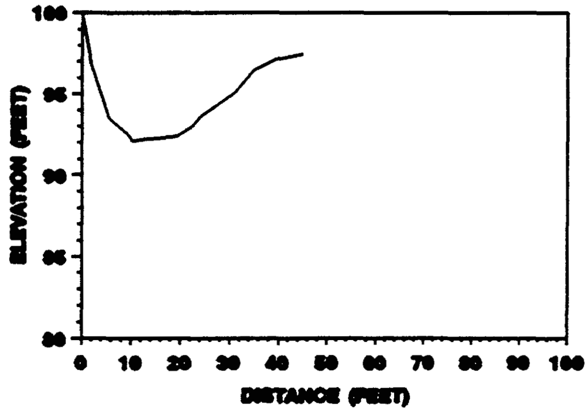


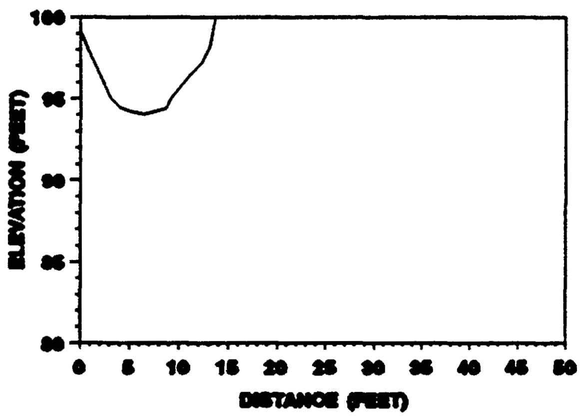
BACON CREEK, 3800
CROSS SECTION 0+00.00



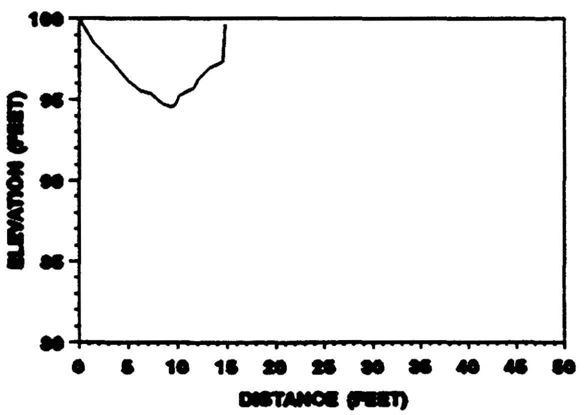
BACON CREEK, 3800
CROSS SECTION 1+36.30



H A CREEK, 4700
CROSS SECTION 0+60.60

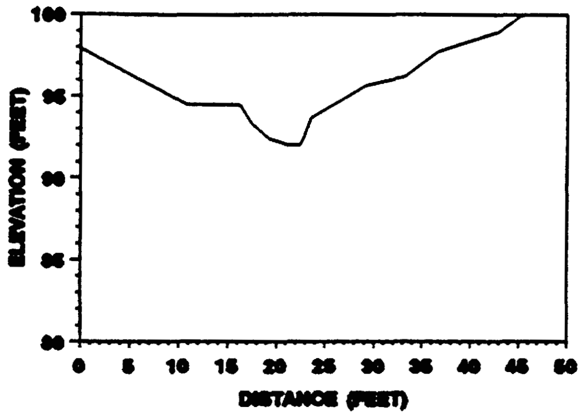


H A CREEK, 4700
CROSS SECTION 1+60.50



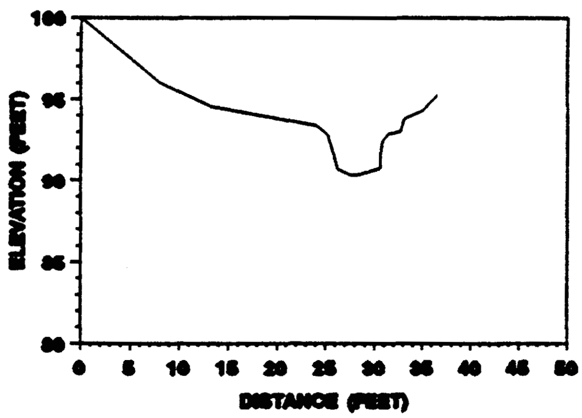
H A CREEK, 4700

CROSS SECTION 0+60.00



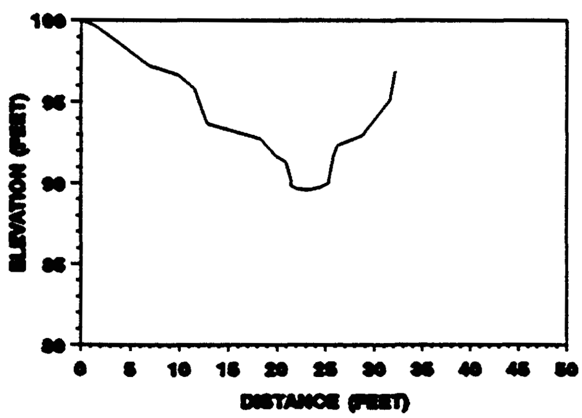
H A CREEK, 4700

CROSS SECTION 0+76.10

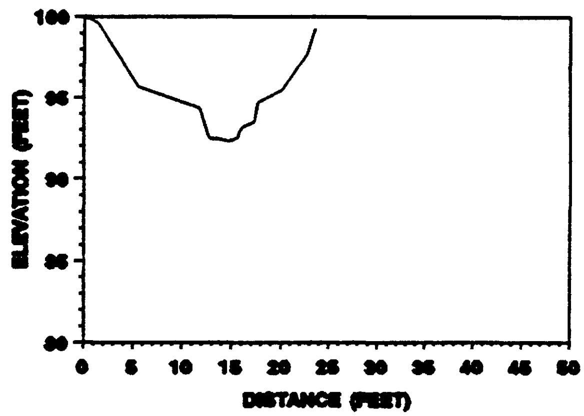


H A CREEK, 4700

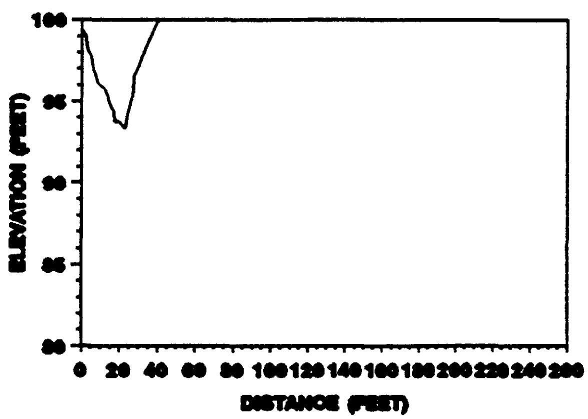
CROSS SECTION 0+90.00



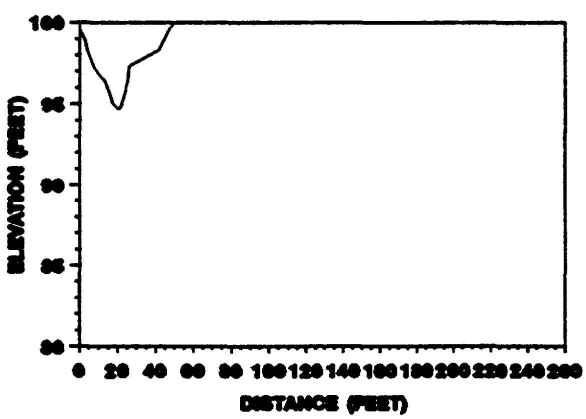
H A CREEK, 4700
CROSS SECTION 0+88.50



SCHOOL CREEK, 6400
CROSS SECTION 0+60.00

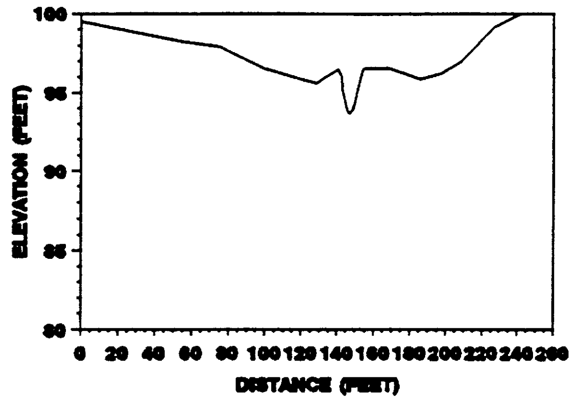


SCHOOL CREEK, 6400
CROSS SECTION 1+24.00



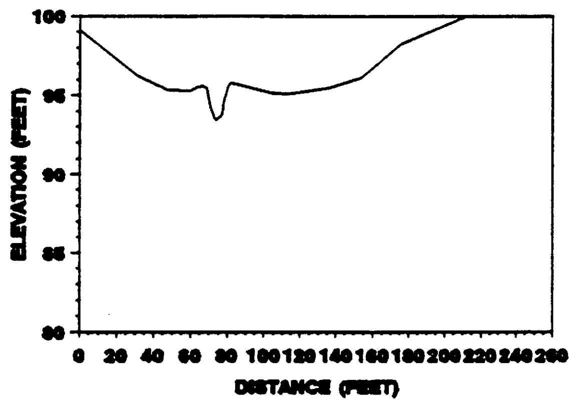
SCHOOL CREEK, 6400

CROSS SECTION 0+00.00



SCHOOL CREEK, 6400

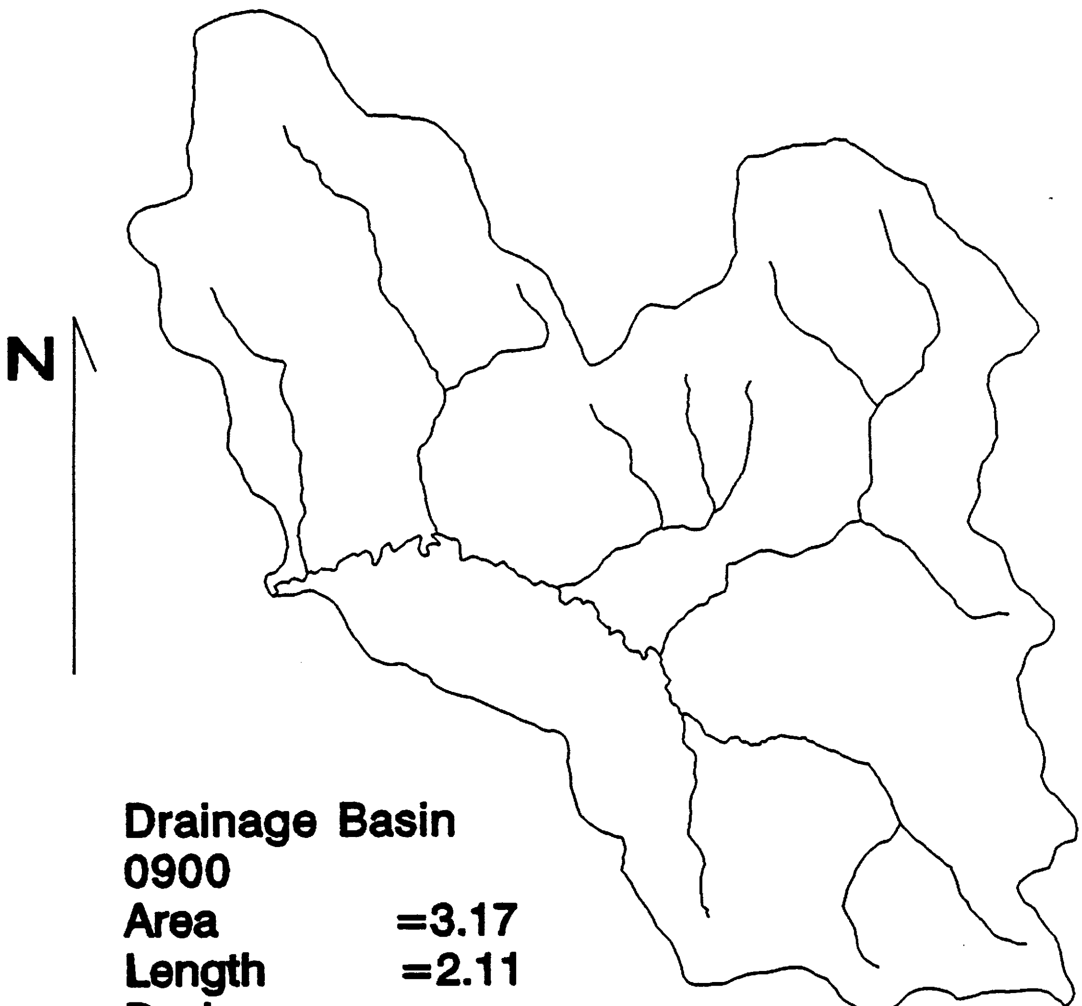
CROSS SECTION 0+38.00



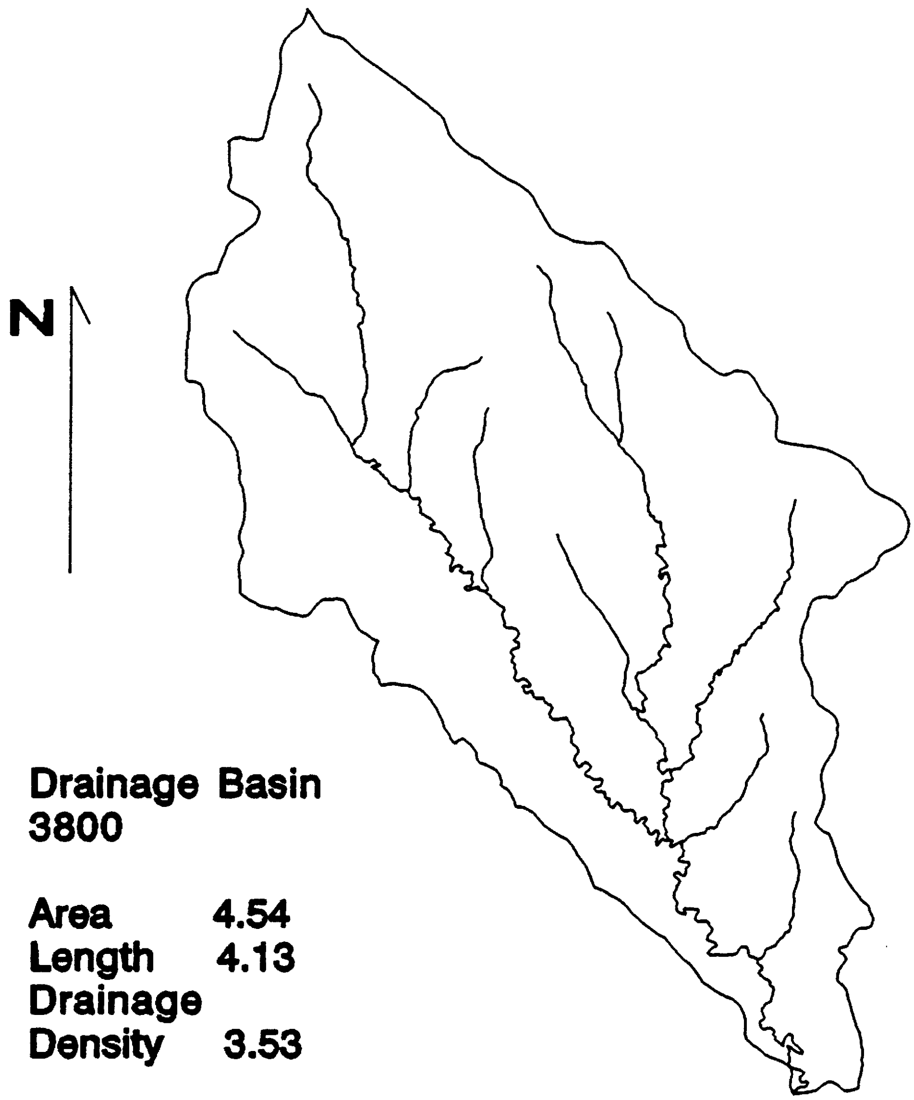
Strata "A" third order raw data by study reach, cross section, and bank identification.

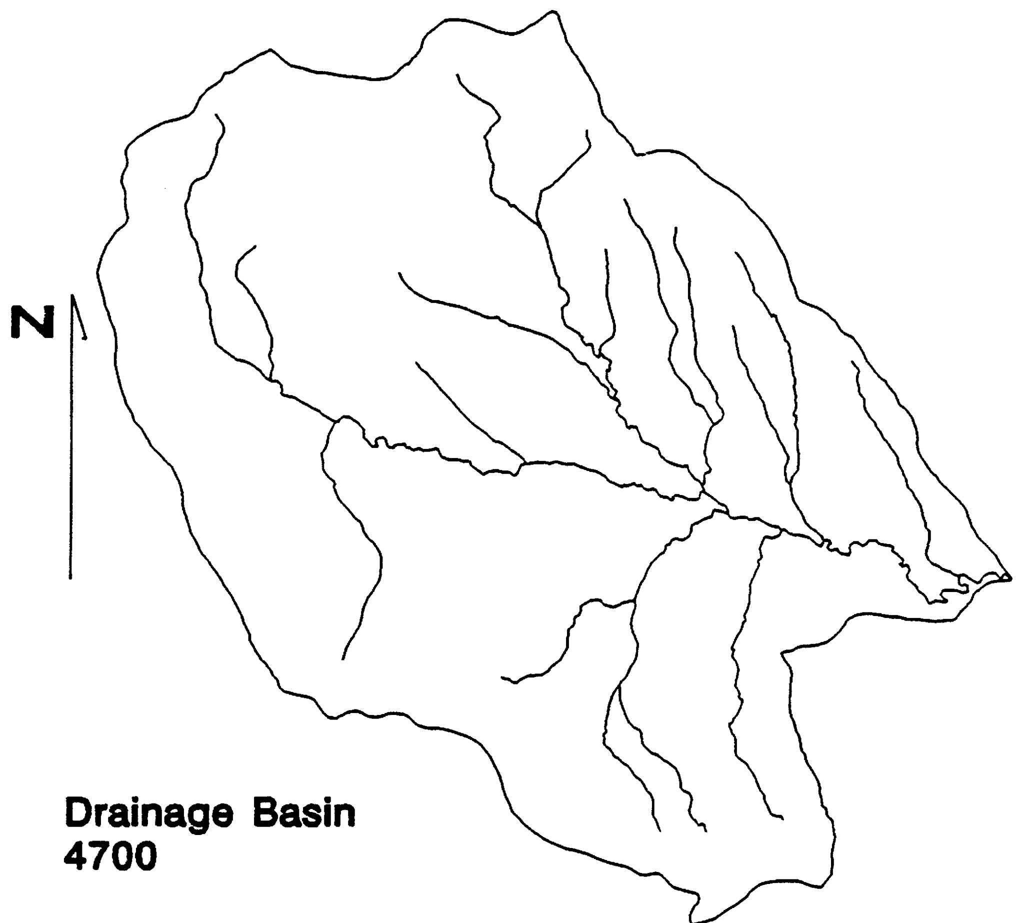
BASIN I.D.	CROSS SECTION NUMBER	BANK I.D.	AREA (feet²)	TOP WIDTH (feet)	AVERAGE DEPTH (feet)	FLOOD-PLAIN WIDTH (feet)
0900	0+00.00A	HIGH	2751.20	357.90	7.70	154.40
0900	0+61.90A	HIGH	911.50	163.00	5.60	99.50
0900	7+83.10A	HIGH	547.10	201.50	2.70	190.40
0900	8+56.10A	HIGH	335.00	205.80	1.60	199.80
6400	0+00.00A	HIGH	118.90	38.20	3.10	
6400	1+24.00A	HIGH	108.50	47.40	2.30	
6400	0+00.00B	HIGH	522.50	233.00	2.20	
6400	0+88.00B	HIGH	545.40	192.60	2.80	
0900	0+00.00A	MEDIUM	53.10	30.80	1.70	
0900	0+61.90A	MEDIUM	67.90	50.40	1.30	
0900	7+83.10A	MEDIUM	43.50	20.20	2.20	
0900	8+56.10A	MEDIUM	37.20	21.30	1.70	
0900	0+00.00B	MEDIUM	96.50	26.50	3.60	
0900	0+87.80B	MEDIUM	70.90	19.50	3.60	
0900	5+98.80B	MEDIUM	163.10	34.30	4.70	
0900	6+57.80B	MEDIUM	158.60	36.20	4.40	
3800	0+00.00A	MEDIUM	133.20	47.10	2.80	
3800	1+36.30A	MEDIUM	130.50	43.40	3.00	
4700	0+00.00A	MEDIUM	45.90	13.40	3.40	
4700	1+09.50A	MEDIUM	46.40	14.40	3.20	
4700	0+00.00B	MEDIUM	97.80	36.00	2.70	
4700	0+76.10B	MEDIUM	50.10	25.80	1.90	
4700	0+00.00C	MEDIUM	87.20	22.20	3.90	
4700	0+88.50C	MEDIUM	88.00	21.70	4.10	
6400	0+00.00A	MEDIUM	35.00	20.20	1.70	
6400	1+24.00A	MEDIUM	12.80	12.20	1.10	

BASIN I.D.	CROSS SECTION NUMBER	BANK I.D.	AREA (feet^2)	TOP WIDTH (feet)	AVERAGE DEPTH (feet)
6400	0+00.00B	MEDIUM	16.60	11.00	1.50
6400	0+88.00B	MEDIUM	14.50	11.60	1.20
3800	0+00.00A	LOW	87.60	28.10	3.10
3800	1+36.30A	LOW	53.00	27.20	1.90
4700	0+00.00A	LOW	15.20	9.10	1.70
4700	1+09.50A	LOW	16.00	11.20	1.40
4700	0+00.00B	LOW	13.30	9.40	1.40
4700	0+76.10B	LOW	20.00	12.50	1.60
4700	0+00.00C	LOW	18.90	12.00	1.60
4700	0+88.50C	LOW	22.20	14.80	1.50
0900	0+00.00A	LOW #2	0.60	5.00	0.10
0900	0+61.90A	LOW #2	1.20	6.20	0.20
0900	7+83.10A	LOW #2	0.10	3.30	0.03
0900	8+56.10A	LOW #2	0.60	4.50	0.10
0900	0+00.00B	LOW #2	9.90	9.80	1.00
0900	0+87.80B	LOW #2	7.70	7.70	1.00
0900	5+98.80B	LOW #2	10.60	15.70	0.70
0900	6+57.80B	LOW #2	10.10	13.10	0.80
3800	0+00.00A	LOW #2	5.80	14.70	0.40
3800	1+36.30A	LOW #2	2.00	10.30	0.20
4700	0+00.00A	LOW #2	1.00	4.60	0.20
4700	1+09.50A	LOW #2	0.50	1.90	0.20
4700	0+00.00B	LOW #2	0.80	3.50	0.20
4700	0+76.10B	LOW #2	4.90	4.80	1.00
4700	0+00.00C	LOW #2	1.70	3.80	0.50
4700	0+88.50C	LOW #2	1.00	3.10	0.30



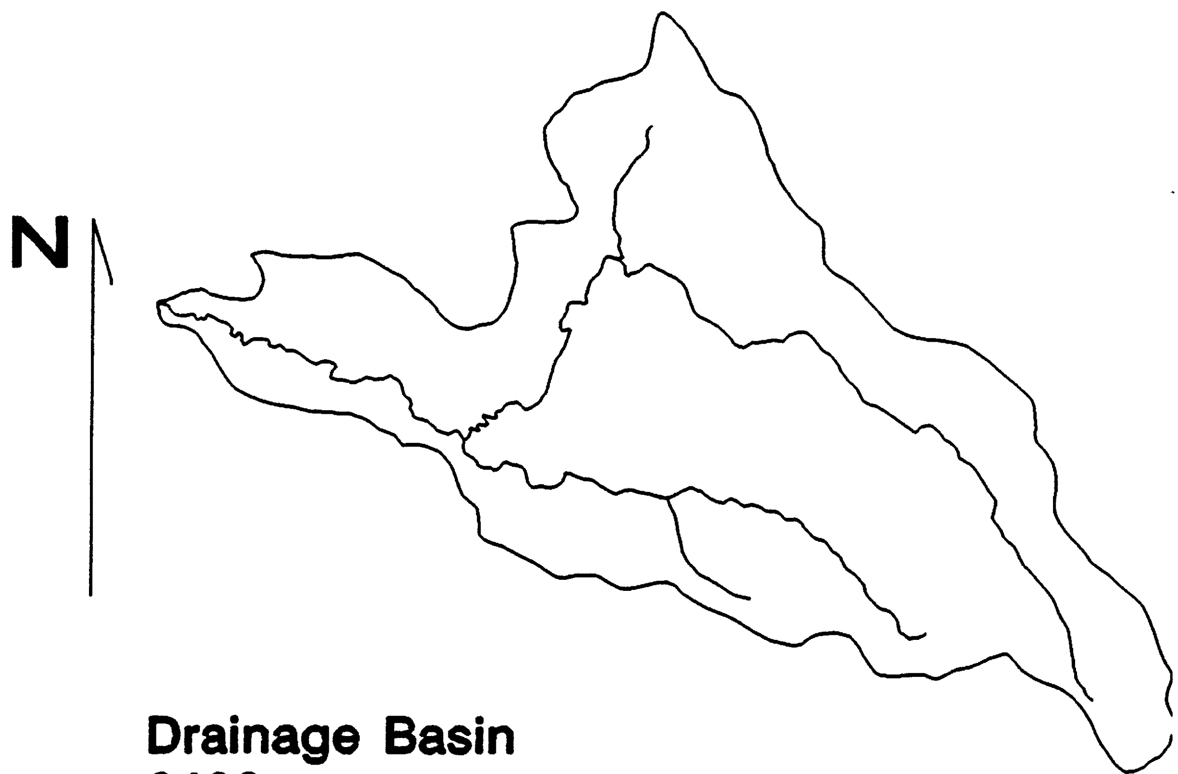
Drainage Basin
0900
Area =3.17
Length =2.11
Drainage
Density =3.26


N
Drainage Basin
3800
Area 4.54
Length 4.13
Drainage
Density 3.53



Drainage Basin
4700

Area 5.04
Length 3.03
Drainage
Density 3.51



Drainage Basin
6400

Area 1.58
Length 2.55
Drainage
Density 3.52

Wyoming Water Research Center

Cover Photo: Lake Marie, Snowy Range
Courtesy Wyoming Division of Tourism

Methodology for the Geomorphic Classification and Design of Drainage Basins and Stream Channels in the Eastern Powder River Basin Coal Field of Wyoming

Anthony J. Anderson
Lee E. Jensen
Suzy L. Noecker
Thomas A. Wesche

Volume 3 of 3
Appendices (pgs. 466 - 812)
December 1995
WWRC-94-20

Technical Report
Submitted to
The Abandoned Coal Mine Lands
Research Program

Prepared by

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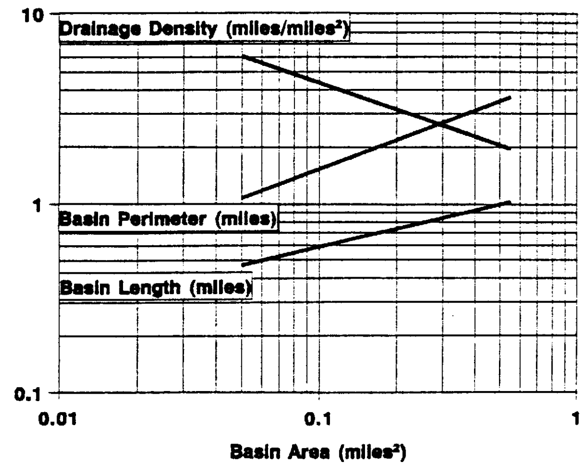
Wyoming Water Resources Center
University of Wyoming
Laramie, Wyoming

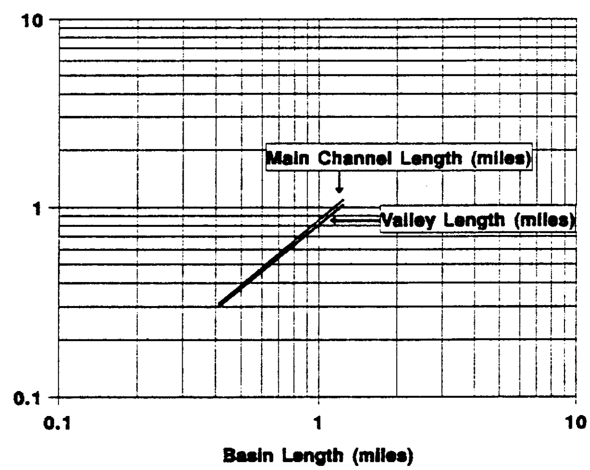
December, 1995

APPENDIX B-1

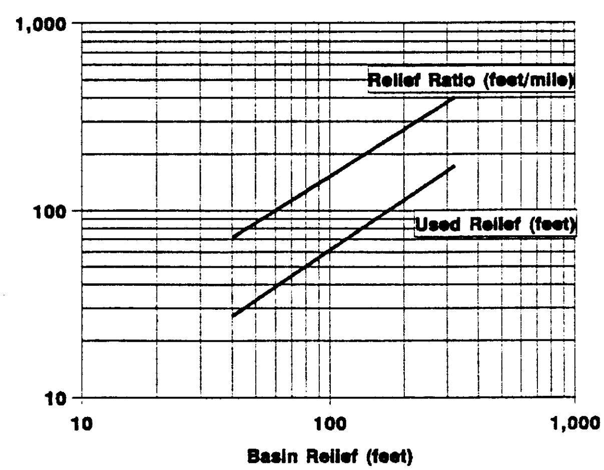
STRATA "B" - FIRST ORDER



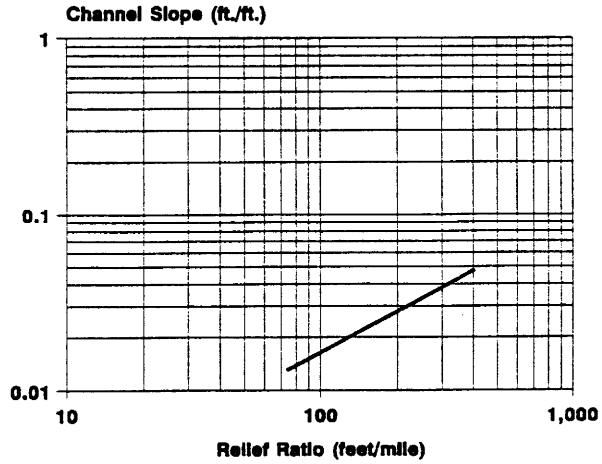
10
Drainage Density (miles/miles²)
1
Basin Perimeter (miles)
Basin Length (miles)
0.1
0.01
0.1
1
Basin Area (miles²)

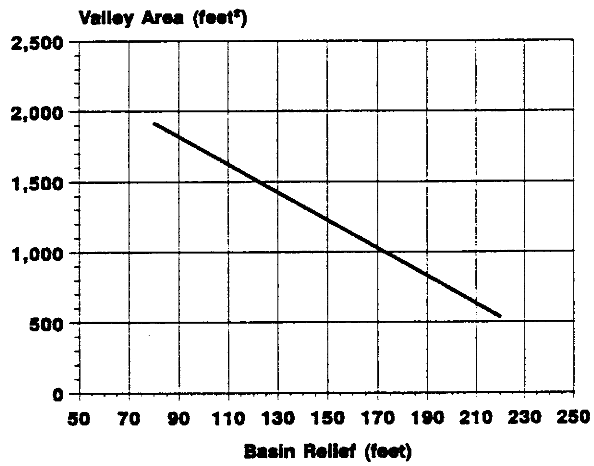


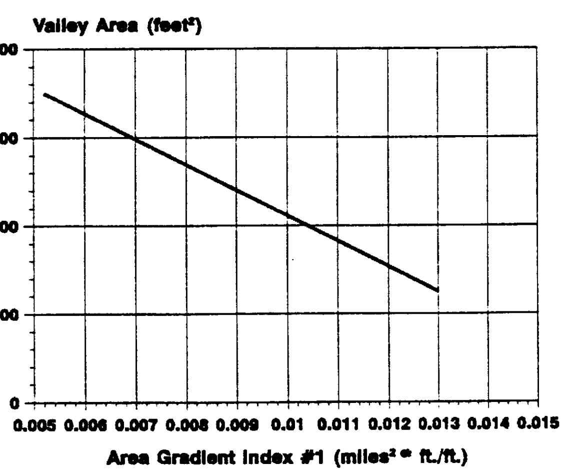
10
Main Channel Length (miles)
1
Valley Length (miles)
0.1
0.1
1
10
Basin Length (miles)

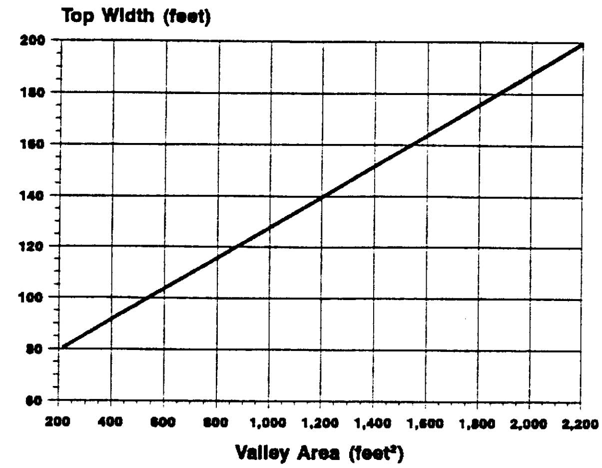


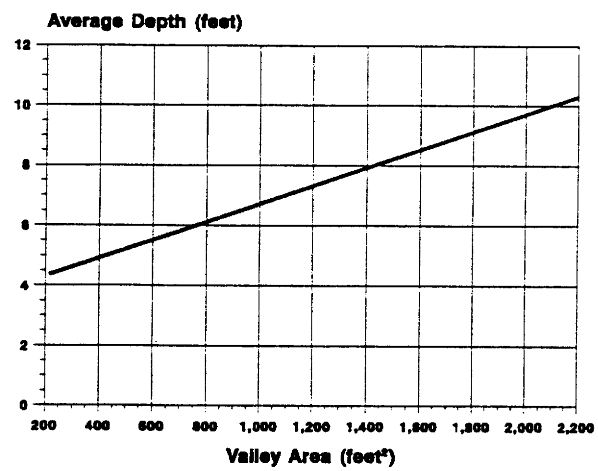
1,000
Relief Ratio (feet/mile)
100
Used Relief (feet)
10
10
100
1,000
Basin Relief (feet)

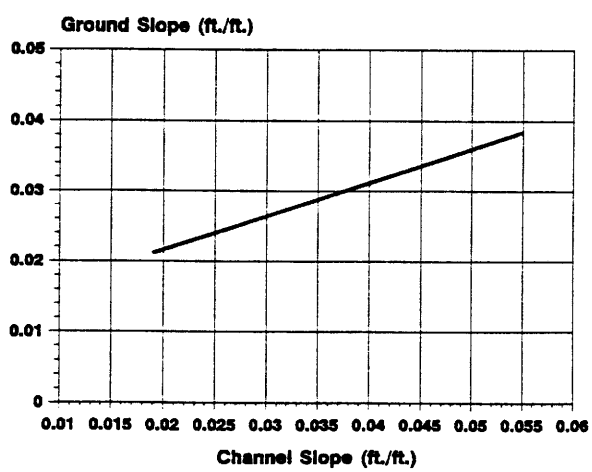

Channel Slope (ft./ft.)
1
0.1
0.01
10
100
1,000
Relief Ratio (feet/mile)


Valley Area (feet²)
2,500
2,000
1,500
1,000
500
0
50 70 90 110 130 150 170 190 210 230 250
Basin Relief (feet)


Valley Area (feet²)
2,000
1,500
1,000
500
0
0.005 0.006 0.007 0.008 0.009 0.01 0.011 0.012 0.013 0.014 0.015
Area Gradient Index #1 (miles² * ft./ft.)


Top Width (feet)
200
180
160
140
120
100
80
60
200 400 600 800 1,000 1,200 1,400 1,600 1,800 2,000 2,200
Valley Area (feet²)


Average Depth (feet)
12
10
8
6
4
2
0
200 400 600 800 1,000 1,200 1,400 1,600 1,800 2,000 2,200
Valley Area (feet²)


Ground Slope (ft./ft.)
0.05
0.04
0.03
0.02
0.01
0
0.01 0.015 0.02 0.025 0.03 0.035 0.04 0.045 0.05 0.055 0.06
Channel Slope (ft./ft.)

Strata "B" first order regression output for basin perimeter versus basin area.

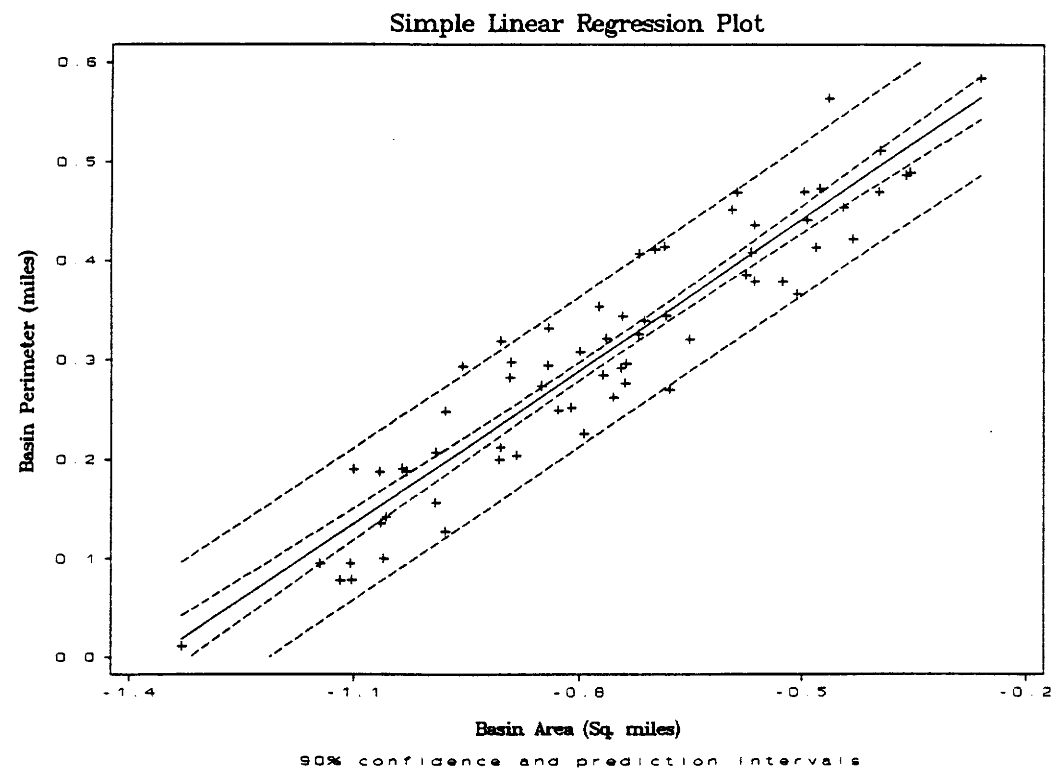
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BASIN PERIMETER

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.69749	0.01875	37.20	0.0000
BA	0.51142	0.02348	21.78	0.0000

R-SQUARED	0.8811	RESID. MEAN SQUARE (MSE)	0.00202
ADJUSTED R-SQUARED	0.8793	STANDARD DEVIATION	0.04490

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.95624	0.95624	474.36	0.0000
RESIDUAL	64	0.12901	0.00202		
TOTAL	65	1.08525			

CASES INCLUDED 66 MISSING CASES 0



Strata "B" first order regression output for drainage density versus basin area.

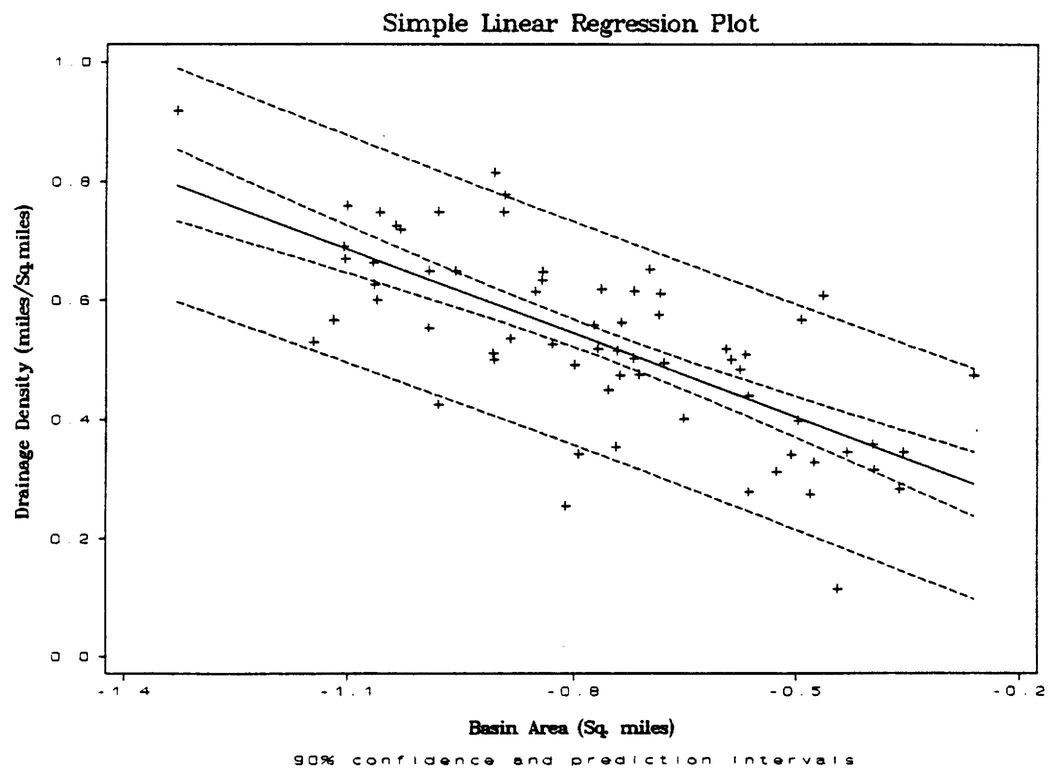
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF DRAINAGE DENSITY

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.16886	0.04664	3.62	0.0006
BA	-0.46963	0.05841	-8.04	0.0000

R-SQUARED	0.5025	RESID. MEAN SQUARE (MSE)	0.01247
ADJUSTED R-SQUARED	0.4947	STANDARD DEVIATION	0.11169

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.80634	0.80634	64.64	0.0000
RESIDUAL	64	0.79835	0.01247		
TOTAL	65	1.60469			

CASES INCLUDED 66 MISSING CASES 0



Strata "B" first order regression output for basin length versus basin area.

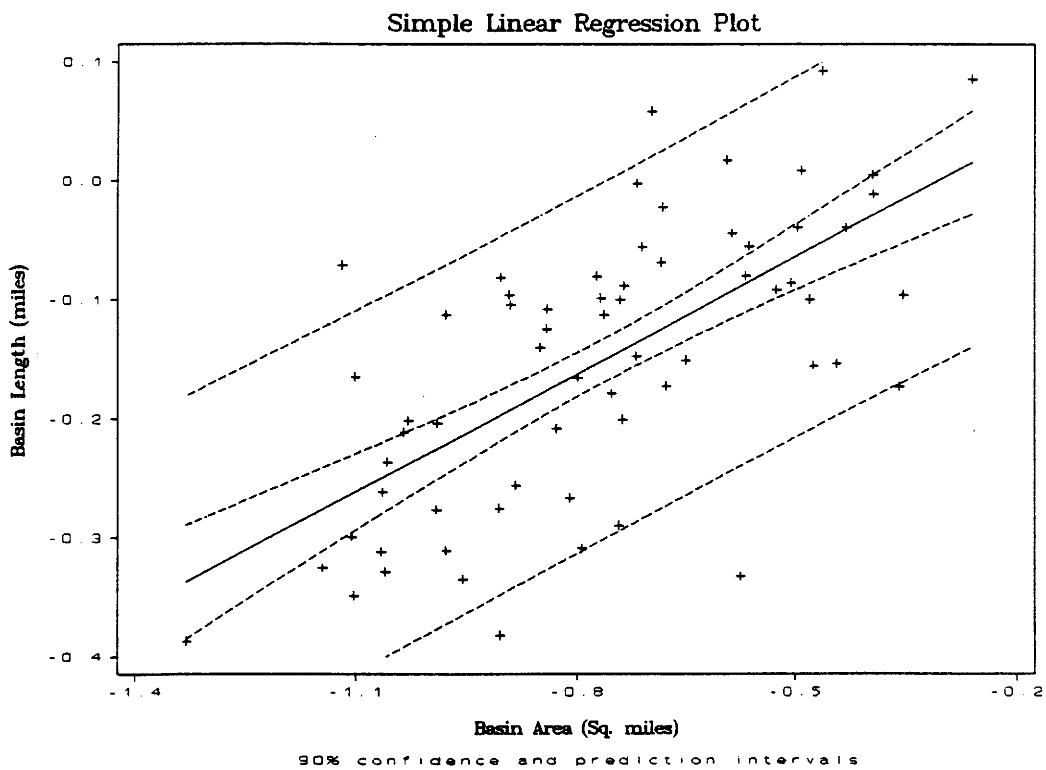
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BASIN LENGTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.10107	0.03728	2.71	0.0086
BA	0.32954	0.04669	7.06	0.0000

R-SQUARED	0.4377	RESID. MEAN SQUARE (MSE)	0.00797
ADJUSTED R-SQUARED	0.4289	STANDARD DEVIATION	0.08928

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.39703	0.39703	49.81	0.0000
RESIDUAL	64	0.51015	0.00797		
TOTAL	65	0.90719			

CASES INCLUDED 66 MISSING CASES 0



Strata "B" first order regression output for main channel length versus basin length.

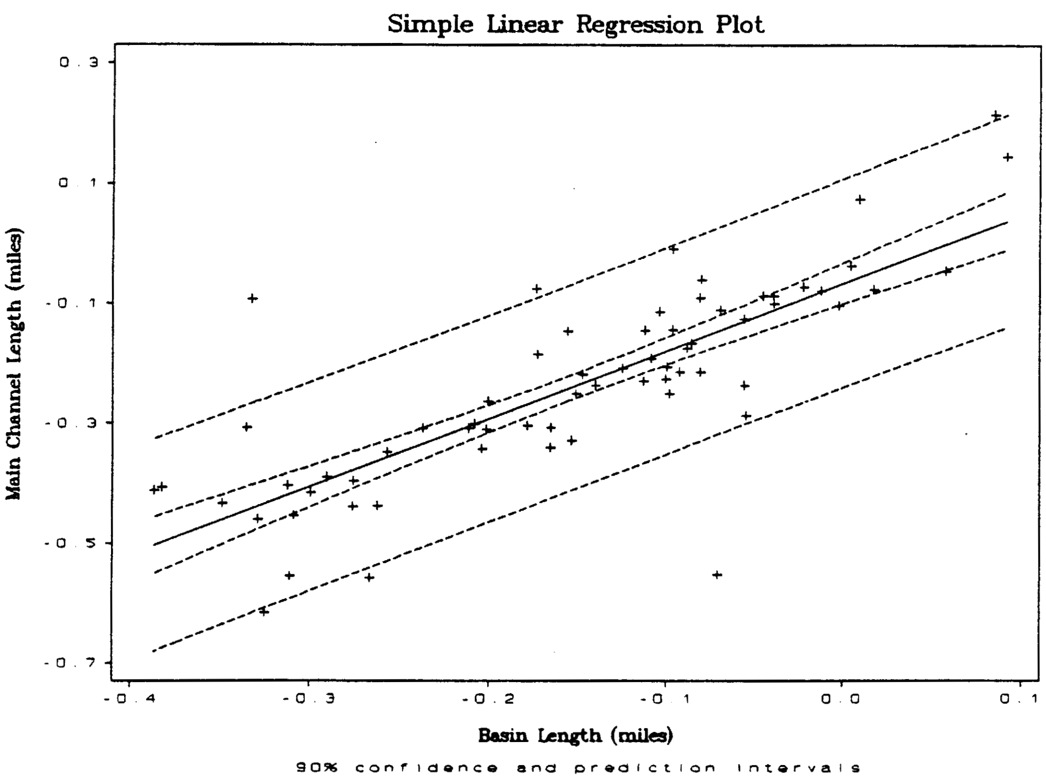
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF MAIN CHANNEL LENGTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.06581	0.02044	-3.22	0.0020
BL	1.13048	0.10721	10.54	0.0000

R-SQUARED	0.6347	RESID. MEAN SQUARE (MSE)	0.01043
ADJUSTED R-SQUARED	0.6290	STANDARD DEVIATION	0.10212

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.15937	1.15937	111.18	0.0000
RESIDUAL	64	0.66737	0.01043		
TOTAL	65	1.82674			

CASES INCLUDED 66 MISSING CASES 0



Strata "B" first order regression output for valley length versus basin length.

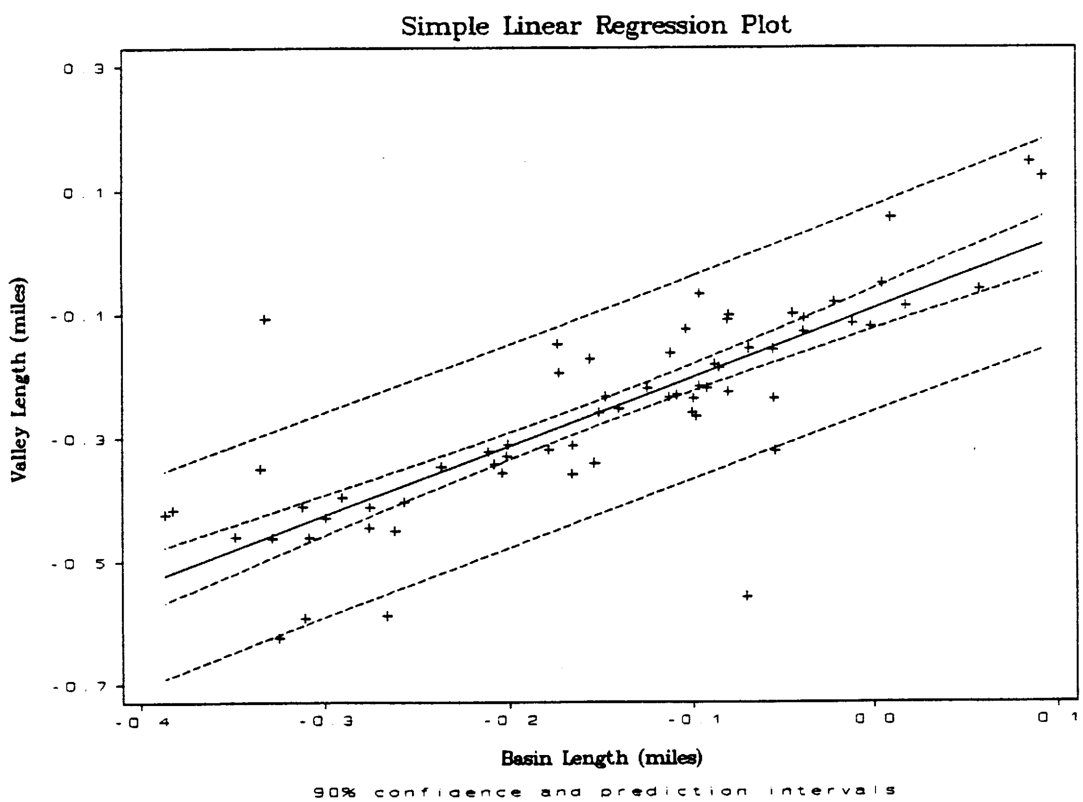
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF VALLEY LENGTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.09190	0.01953	-4.71	0.0000
BL	1.11185	0.10244	10.85	0.0000

R-SQUARED	0.6480	RESID. MEAN SQUARE (MSE)	0.00952
ADJUSTED R-SQUARED	0.6425	STANDARD DEVIATION	0.09757

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.12148	1.12148	117.81	0.0000
RESIDUAL	64	0.60923	0.00952		
TOTAL	65	1.73071			

CASES INCLUDED 66 MISSING CASES 0



Strata "B" first order regression output of basin relief versus basin area and basin length.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BR

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	2.05128	0.06566	31.24	0.0000
BA	-0.22635	0.10385	-2.18	0.0330
BL	0.60635	0.20848	2.91	0.0050

R-SQUARED	0.1198	RESID. MEAN SQUARE (MSE)	0.02217
ADJUSTED R-SQUARED	0.0919	STANDARD DEVIATION	0.14891

SOURCE	DF	SS	MS	F	P
REGRESSION	2	0.19014	0.09507	4.29	0.0177
RESIDUAL	63	1.39689	0.02217		
TOTAL	65	1.58703			

CASES INCLUDED 66   MISSING CASES 0

Strata "B" first order regression output for used relief versus basin relief.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF USED RELIEF

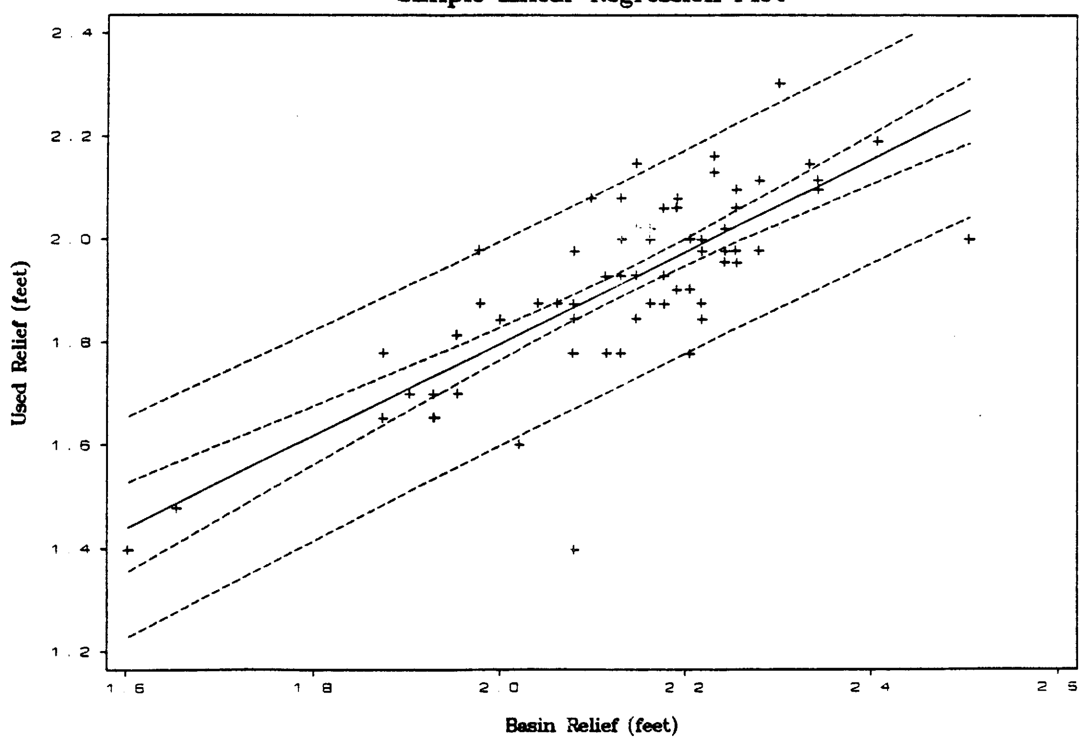
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.00918	0.19941	0.05	0.9634
BR	0.89422	0.09325	9.59	0.0000

R-SQUARED	0.5896	RESID. MEAN SQUARE (MSE)	0.01380
ADJUSTED R-SQUARED	0.5832	STANDARD DEVIATION	0.11747

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.26904	1.26904	91.96	0.0000
RESIDUAL	64	0.88319	0.01380		
TOTAL	65	2.15223			

CASES INCLUDED 66 MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "B" first order regression output for relief ratio versus basin relief.

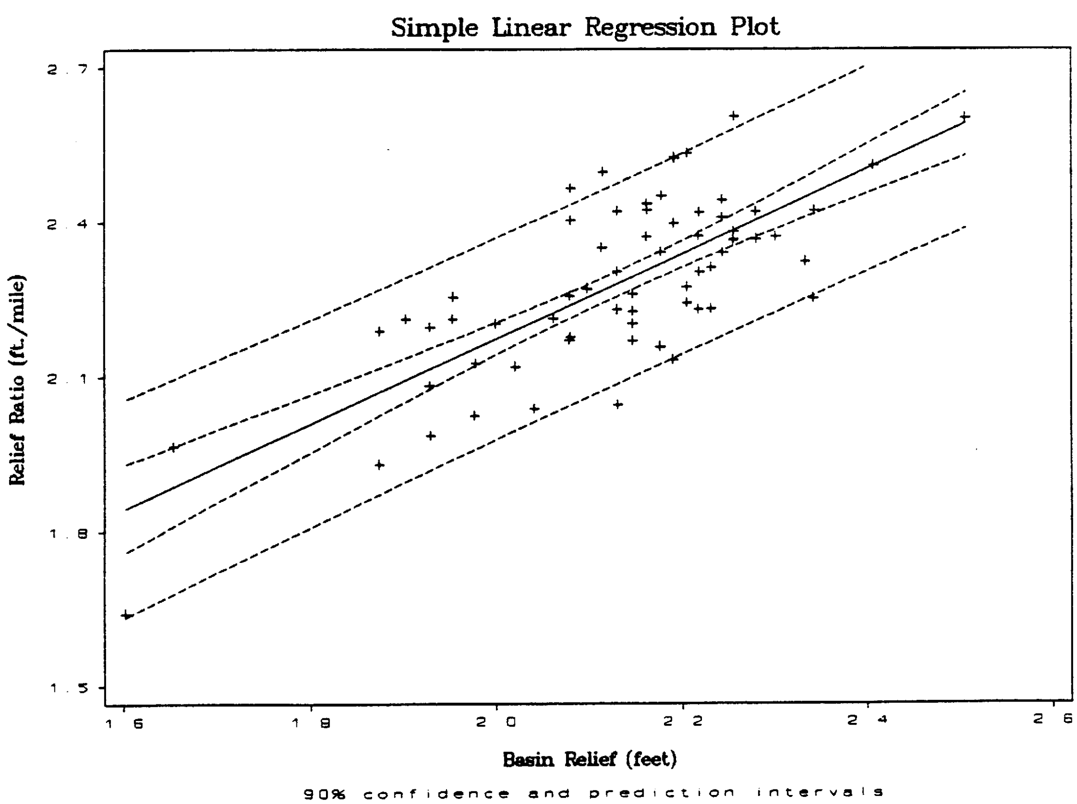
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RELIEF RATIO

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.52312	0.19662	2.66	0.0099
BR	0.82523	0.09195	8.97	0.0000

R-SQUARED	0.5572	RESID. MEAN SQUARE (MSE)	0.01342
ADJUSTED R-SQUARED	0.5503	STANDARD DEVIATION	0.11583

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.08078	1.08078	80.55	0.0000
RESIDUAL	64	0.85872	0.01342		
TOTAL	65	1.93950			

CASES INCLUDED 66 MISSING CASES 0



Strata "B" first order regression output for ruggedness number versus basin relief.

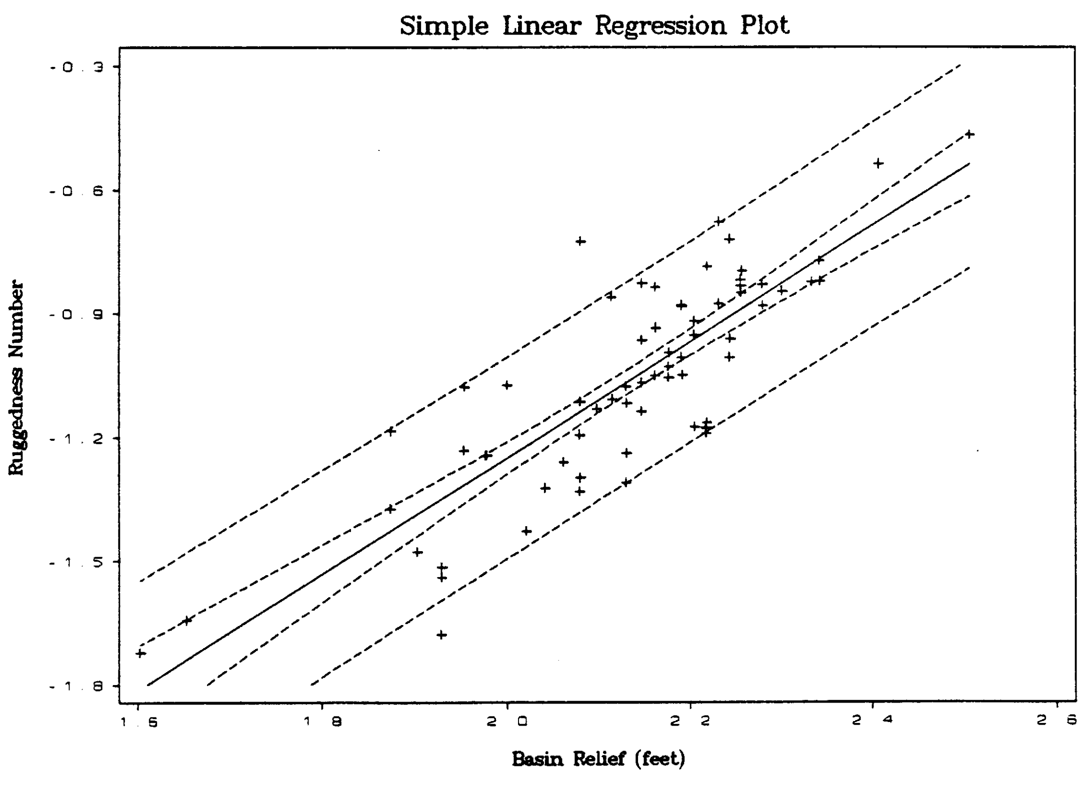
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RUGGEDNESS NUMBER

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-4.06963	0.24544	-16.58	0.0000
BR	1.40987	0.11478	12.28	0.0000

R-SQUARED	0.7022	RESID. MEAN SQUARE (MSE)	0.02091
ADJUSTED R-SQUARED	0.6975	STANDARD DEVIATION	0.14459

SOURCE	DF	SS	MS	F	P
REGRESSION	1	3.15461	3.15461	150.88	0.0000
RESIDUAL	64	1.33808	0.02091		
TOTAL	65	4.49269			

CASES INCLUDED 66 MISSING CASES 0



Strata "B" first order regression output for channel slope versus relief ratio.

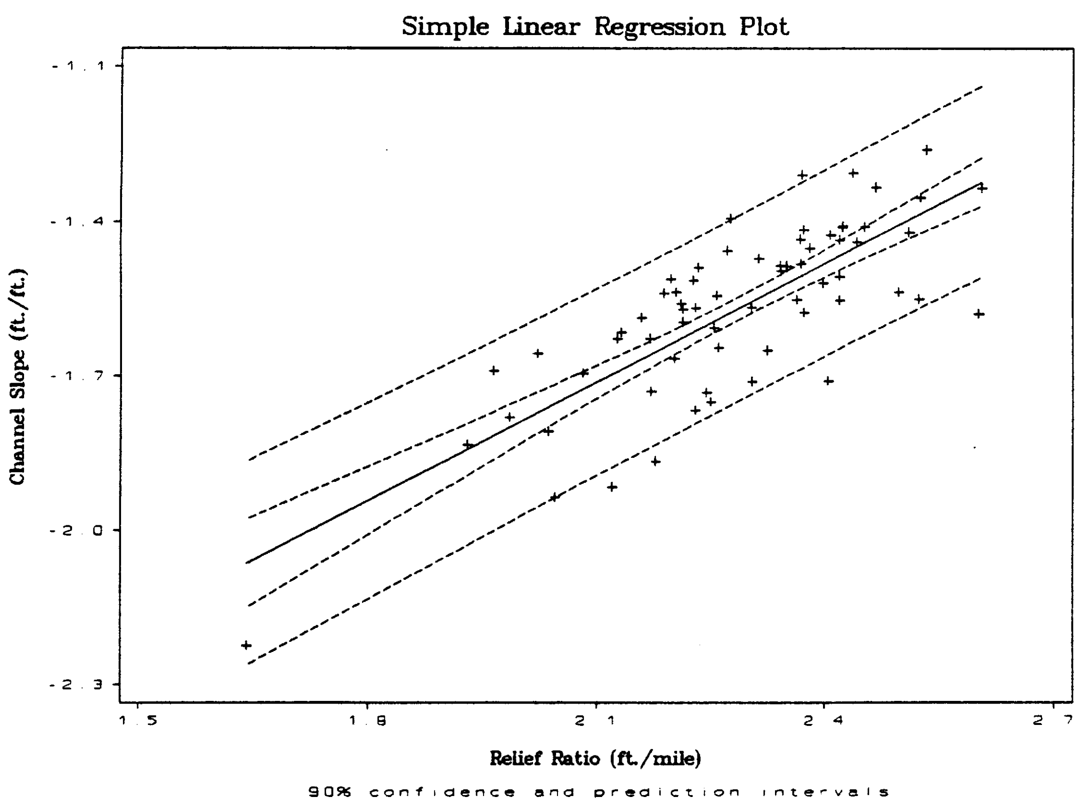
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF CHANNEL SLOPE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-3.32847	0.17633	-18.88	0.0000
RR	0.76999	0.07701	10.00	0.0000

R-SQUARED	0.6097	RESID. MEAN SQUARE (MSE)	0.01150
ADJUSTED R-SQUARED	0.6036	STANDARD DEVIATION	0.10726

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.14989	1.14989	99.96	0.0000
RESIDUAL	64	0.73624	0.01150		
TOTAL	65	1.88613			

CASES INCLUDED 66 MISSING CASES 0



Strata "B" first order regression output for sinuosity versus area gradient index # 3.

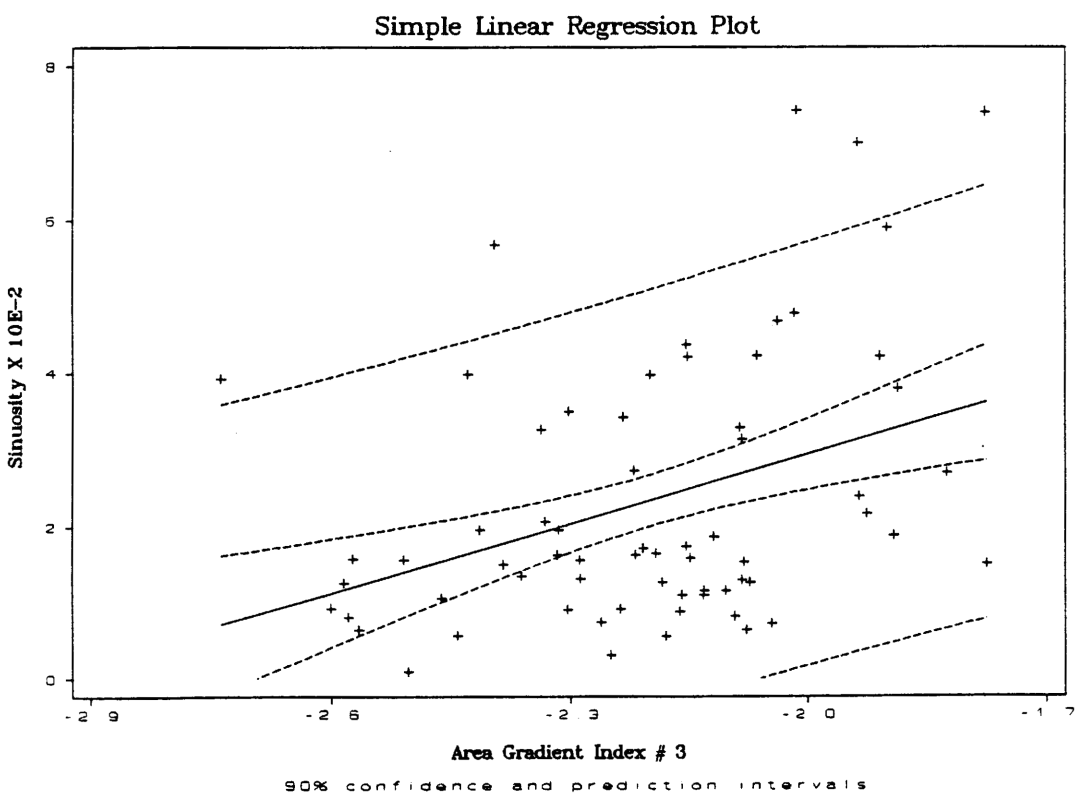
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF SINUOSITY

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.08999	0.02094	4.30	0.0001
AGI3	0.03028	0.00946	3.20	0.0021

R-SQUARED	0.1379	RESID. MEAN SQUARE (MSE)	2.680E-04
ADJUSTED R-SQUARED	0.1244	STANDARD DEVIATION	0.01637

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.00274	0.00274	10.24	0.0021
RESIDUAL	64	0.01715	2.680E-04		
TOTAL	65	0.01990			

CASES INCLUDED 66 MISSING CASES 0



Strata "B" first order regression output for valley area versus basin relief.

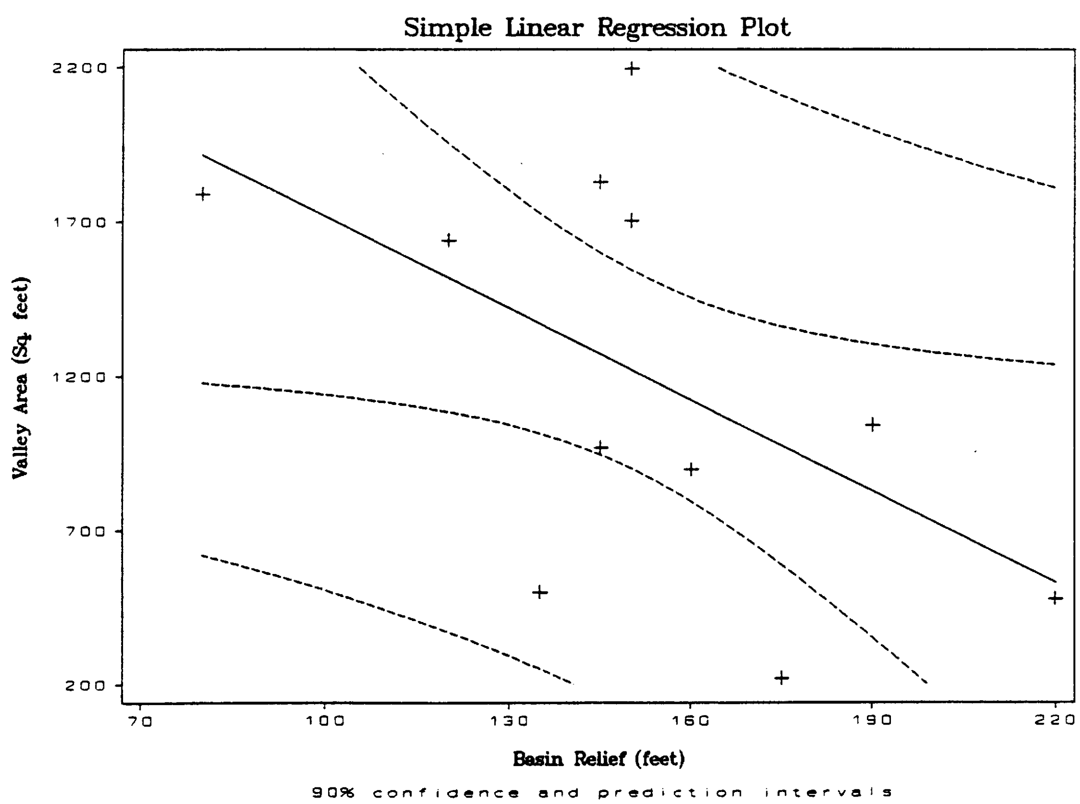
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF VALLEY AREA

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	2706.46	785.534	3.45	0.0073
BR	-9.88317	5.04392	-1.96	0.0817

R-SQUARED	0.2990	RESID. MEAN SQUARE (MSE)	3.374E+05
ADJUSTED R-SQUARED	0.2211	STANDARD DEVIATION	580.898

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.296E+06	1.296E+06	3.84	0.0817
RESIDUAL	9	3.037E+06	3.374E+05		
TOTAL	10	4.333E+06			

CASES INCLUDED 11   MISSING CASES 0



Strata "B" first order regression output for valley area versus area gradient index #1.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF VALLEY AREA

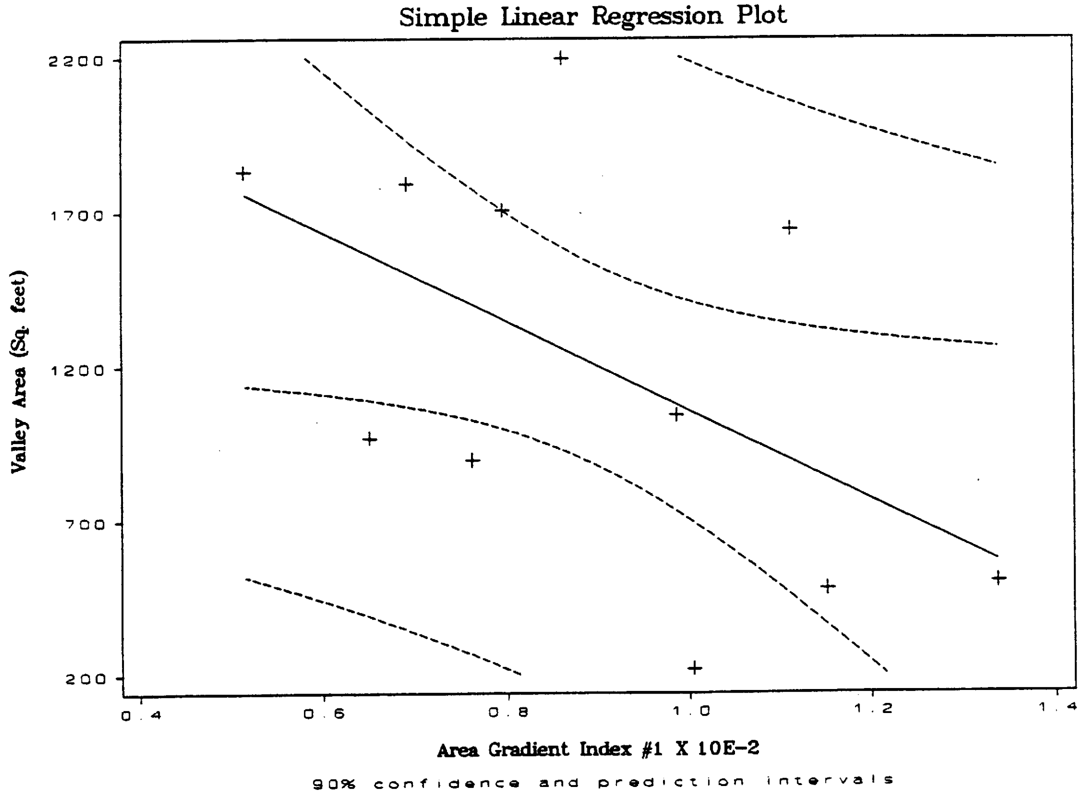
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	2496.61	698.714	3.57	0.0060
AGI1	-1.440E+05	75433.5	-1.91	0.0886

R-SQUARED	0.2882	RESID. MEAN SQUARE (MSE)	3.426E+05
ADJUSTED R-SQUARED	0.2091	STANDARD DEVIATION	585.361

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.249E+06	1.249E+06	3.64	0.0886
RESIDUAL	9	3.084E+06	3.426E+05		
TOTAL	10	4.333E+06			

CASES INCLUDED 11 MISSING CASES 0

Simple Linear Regression Plot



Strata "B" first order regression output for top width versus valley area.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOP WIDTH

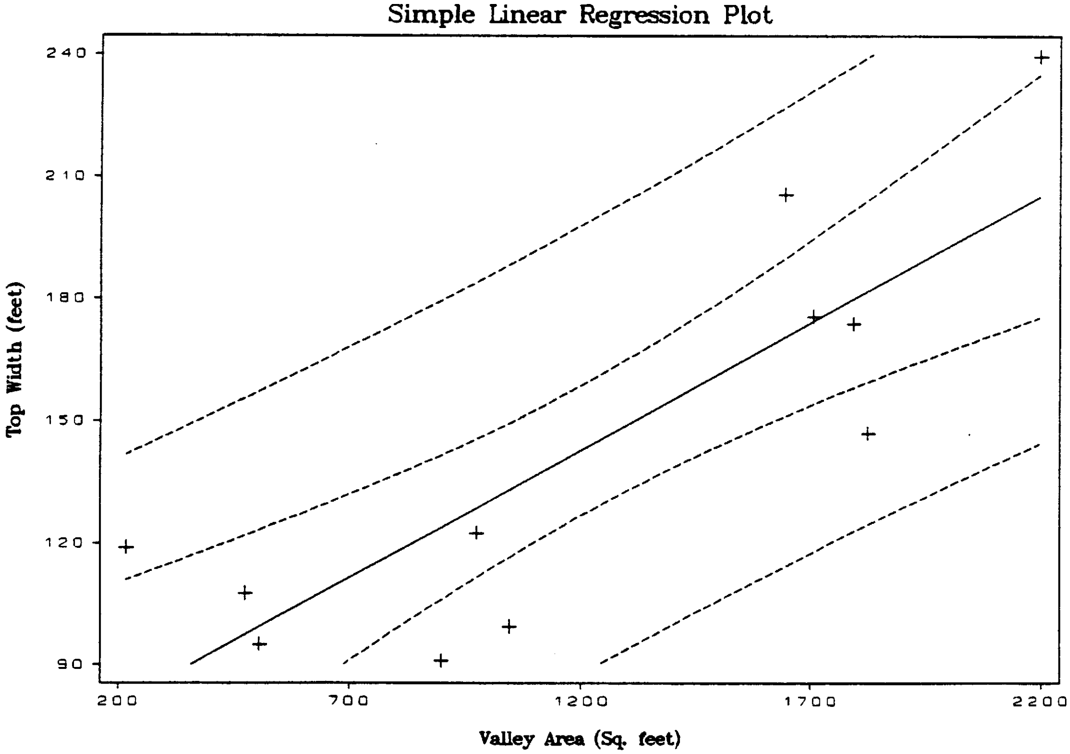
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	67.6820	18.8313	3.59	0.0058
A	0.06265	0.01385	4.52	0.0014

R-SQUARED	0.6945	RESID. MEAN SQUARE (MSE)	831.230
ADJUSTED R-SQUARED	0.6606	STANDARD DEVIATION	28.8311

SOURCE	DF	SS	MS	F	P
REGRESSION	1	17007.7	17007.7	20.46	0.0014
RESIDUAL	9	7481.07	831.230		
TOTAL	10	24488.8			

CASES INCLUDED 11 MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "B" first order regression output for average depth versus valley area.

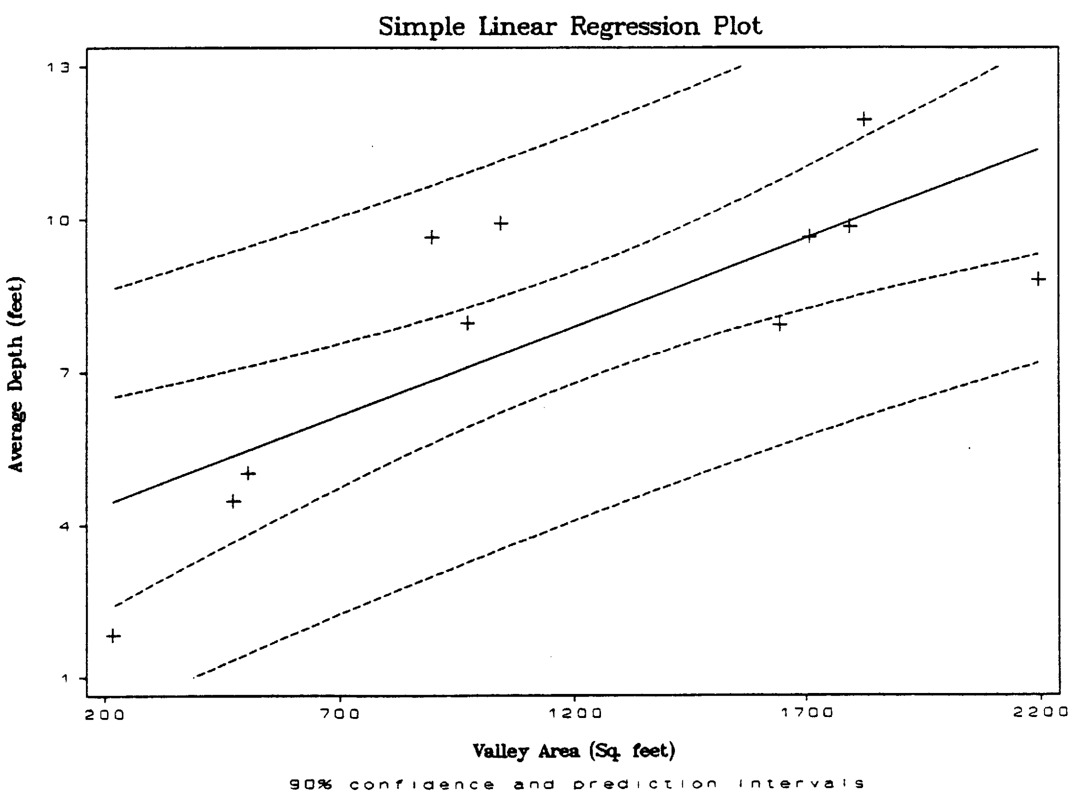
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AVERAGE DEPTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	3.71127	1.29711	2.86	0.0187
A	0.00348	9.541E-04	3.65	0.0053

R-SQUARED	0.5968	RESID. MEAN SQUARE (MSE)	3.94378
ADJUSTED R-SQUARED	0.5520	STANDARD DEVIATION	1.98590

SOURCE	DF	SS	MS	F	P
REGRESSION	1	52.5365	52.5365	13.32	0.0053
RESIDUAL	9	35.4940	3.94378		
TOTAL	10	88.0305			

CASES INCLUDED 11   MISSING CASES 0



Strata "B" first order regression output for ground slope versus channel slope.

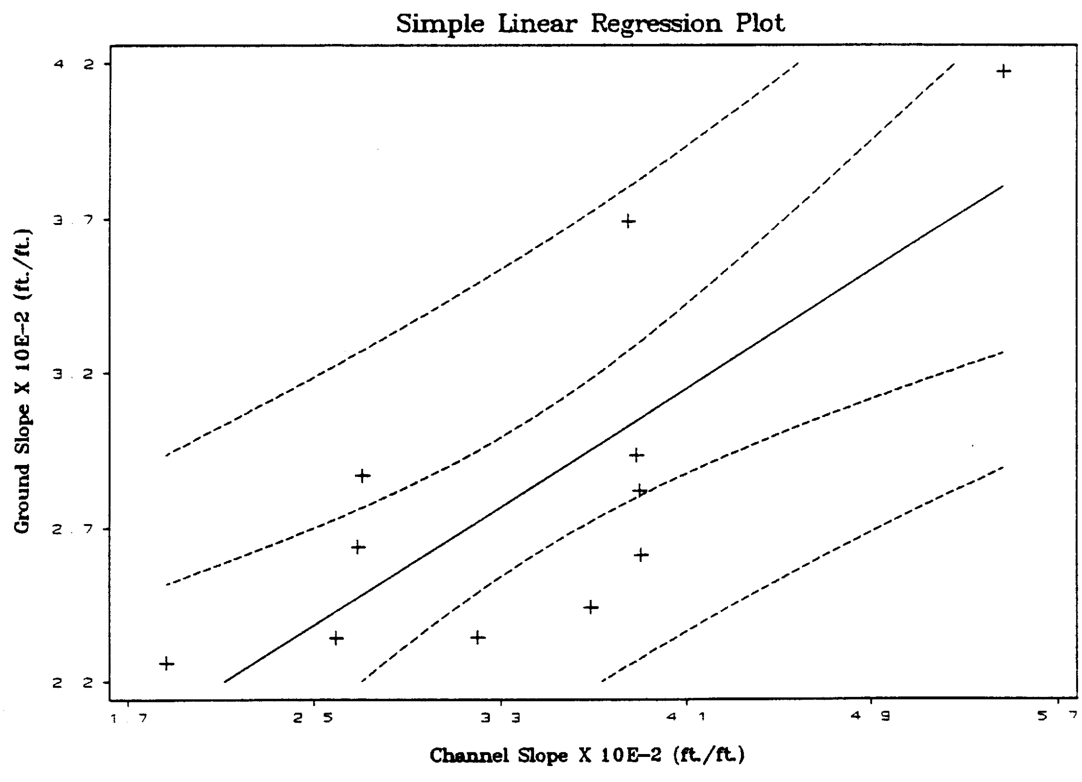
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF GROUND SLOPE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.01185	0.00468	2.53	0.0322
CHS	0.47932	0.13190	3.63	0.0055

R-SQUARED	0.5947	RESID. MEAN SQUARE (MSE)	1.616E-05
ADJUSTED R-SQUARED	0.5497	STANDARD DEVIATION	0.00402

SOURCE	DF	SS	MS	F	P
REGRESSION	1	2.134E-04	2.134E-04	13.21	0.0055
RESIDUAL	9	1.454E-04	1.616E-05		
TOTAL	10	3.589E-04			

CASES INCLUDED 11 MISSING CASES 0



High bank reach means for **Strata "B"** first orders.

BASIN ID 19A1	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	5.00	5.00	5.00	5.00	5.00	5.00		6.00
MEAN	215.08	119.36	118.66	1.80	1.82	67.49		0.023
S.D.	100.05	53.46	53.47	0.29	0.29	36.50		0.007
C.V. (%)	46.52	44.79	45.07	16.20	15.73	54.08		31.86
MINIMUM	108.20	59.30	58.70	1.40	1.40	32.61		0.016
MAXIMUM	312.30	167.20	167.10	2.20	2.20	119.36		0.036
RANGE	204.10	107.90	108.40	0.80	0.80	86.75		0.019

BASIN ID 19A2	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	5.00	5.00	5.00	5.00	5.00	5.00	3.00	12.00
MEAN	504.26	97.48	95.20	4.96	5.04	19.35	24.23	0.029
S.D.	235.57	21.76	21.33	1.46	1.46	3.14	2.05	0.019
C.V. (%)	46.72	22.32	22.41	29.45	28.88	16.22	8.46	66.00
MINIMUM	245.30	68.70	66.70	3.10	3.20	17.03	22.20	0.014
MAXIMUM	723.60	114.80	111.50	6.40	6.50	24.31	26.30	0.085
RANGE	478.30	46.10	44.80	3.30	3.30	7.28	4.10	0.071

BASIN ID 19B2	AREA (ft.²)	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	5.00	5.00	5.00	5.00	5.00	5.00	4.00	9.00
MEAN	475.50	109.32	107.32	4.36	4.46	27.54	21.40	0.029
S.D.	194.34	4.43	4.36	1.84	1.89	10.69	12.11	0.007
C.V. (%)	40.87	4.05	4.07	42.19	42.29	38.82	56.58	23.95
MINIMUM	296.90	103.00	101.90	2.60	2.70	14.35	14.00	0.015
MAXIMUM	740.00	113.40	111.20	7.00	7.20	40.85	39.50	0.041
RANGE	443.10	10.40	9.30	4.40	4.50	26.51	25.50	0.025

BASIN ID 30A1	AREA (ft.²)	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	3.00	3.00	3.00	3.00	3.00	3.00	3.00	5.00
MEAN	895.67	98.00	90.77	8.87	9.63	9.27	25.43	0.042
S.D.	395.77	31.38	32.18	1.21	0.90	2.48	12.90	0.016
C.V. (%)	44.19	32.02	35.45	13.60	9.36	26.73	50.74	38.69
MINIMUM	514.40	67.40	59.40	7.60	8.70	6.83	11.90	0.022
MAXIMUM	1304.50	130.10	123.70	10.00	10.50	11.78	37.60	0.061
RANGE	790.10	62.70	64.30	2.40	1.80	4.95	25.70	0.039

BASIN ID 30A2	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
MEAN	1042.90	108.20	99.30	9.05	9.93	9.83	27.73	0.024
S.D.	575.99	35.93	36.86	2.62	2.49	2.45	6.72	0.004
C.V. (%)	55.23	33.21	37.12	28.99	25.07	24.88	24.23	17.43
MINIMUM	366.80	60.80	50.30	6.00	7.30	6.89	21.10	0.020
MAXIMUM	1743.40	141.00	131.40	12.40	13.30	12.88	35.40	0.030
RANGE	1376.60	80.20	81.10	6.40	6.00	5.98	14.30	0.010

BASIN ID 30B2	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	4.00	4.00	4.00	4.00	4.00	4.00	4.00	7.00
MEAN	971.75	127.92	122.68	7.65	7.98	15.95	31.25	0.028
S.D.	151.06	9.83	10.60	1.42	1.56	3.92	7.18	0.014
C.V. (%)	15.55	7.69	8.64	18.56	19.60	24.59	22.98	48.42
MINIMUM	752.00	116.40	109.40	6.00	6.20	11.16	22.50	0.011
MAXIMUM	1077.40	140.10	135.30	9.30	9.80	19.71	39.60	0.044
RANGE	325.40	23.70	25.90	3.30	3.60	8.55	17.10	0.034

BASIN ID 36A2	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	4.00	4.00	4.00	4.00	4.00	4.00	4.00	5.00
MEAN	1640.90	208.15	205.70	7.85	7.93	25.93	34.95	0.023
S.D.	471.36	54.97	55.70	0.56	0.59	6.79	9.30	0.013
C.V. (%)	28.73	26.41	27.08	7.09	7.38	26.16	26.61	56.88
MINIMUM	1036.40	145.70	143.10	7.10	7.20	19.88	26.90	0.014
MAXIMUM	2054.20	254.50	252.90	8.40	8.60	32.42	43.30	0.045
RANGE	1017.80	108.80	109.80	1.30	1.40	12.55	16.40	0.031

BASIN ID 36B2	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	4.00	4.00	4.00	4.00	4.00	4.00	2.00	7.00
MEAN	1704.90	181.53	175.68	9.33	9.65	18.34	53.55	0.026
S.D.	363.88	21.16	19.86	1.20	1.32	2.27	8.56	0.010
C.V. (%)	21.34	11.66	11.30	12.91	13.71	12.36	15.98	37.25
MINIMUM	1245.50	155.60	152.20	8.00	8.20	16.67	47.50	0.017
MAXIMUM	2130.00	200.90	195.40	10.80	11.30	21.47	59.60	0.046
RANGE	884.50	45.30	43.20	2.80	3.10	4.80	12.10	0.029

BASIN ID 36B3	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	6.00	6.00	6.00	6.00	6.00	6.00	4.00	9.00
MEAN	1793.10	177.97	174.08	9.63	9.87	18.03	25.70	0.026
S.D.	882.95	36.27	35.21	2.69	2.76	2.10	5.61	0.008
C.V. (%)	49.24	20.38	20.23	27.97	27.98	11.64	21.84	30.96
MINIMUM	1026.60	143.70	140.90	7.00	7.10	15.38	22.40	0.014
MAXIMUM	3294.70	242.60	237.30	13.60	13.90	21.44	34.10	0.043
RANGE	2268.10	98.90	96.40	6.60	6.80	6.06	11.70	0.029

BASIN ID 54A2	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	4.00	4.00	4.00	4.00	4.00	4.00	4.00	5.00
MEAN	1826.90	153.47	146.82	11.43	11.93	12.64	25.80	0.037
S.D.	789.48	31.20	29.10	3.31	3.48	1.59	7.78	0.005
C.V. (%)	43.21	20.33	19.82	28.96	29.16	12.61	30.14	13.86
MINIMUM	753.10	108.40	104.80	6.90	7.20	11.03	15.70	0.032
MAXIMUM	2654.60	179.80	171.00	14.80	15.50	14.56	34.60	0.043
RANGE	1901.50	71.40	66.20	7.90	8.30	3.52	18.90	0.012

BASIN ID 54B1	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	5.00	5.00	5.00	5.00	5.00	5.00	5.00	10.00
MEAN	2195.20	244.10	239.48	8.54	8.80	28.51	17.14	0.023
S.D.	1332.00	106.45	106.84	2.69	2.78	13.24	8.20	0.007
C.V. (%)	60.68	43.61	44.61	31.47	31.59	46.41	47.84	28.13
MINIMUM	723.40	97.00	91.40	4.80	4.90	11.57	6.30	0.014
MAXIMUM	3681.20	378.90	377.50	12.10	12.50	42.90	25.00	0.038
RANGE	2957.80	281.90	286.10	7.30	7.60	31.33	18.70	0.024

Medium bank reach means for **Strata "B"** first orders.

BASIN ID 19A1	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	5.00	5.00	5.00	5.00	5.00	5.00
MEAN	3.14	13.14	13.04	0.28	0.30	56.83
S.D.	1.14	6.26	6.37	0.13	0.17	38.34
C.V. (%)	36.35	47.62	48.83	46.57	57.74	67.47
MINIMUM	1.30	6.20	5.80	0.20	0.20	9.67
MAXIMUM	4.40	19.80	19.80	0.50	0.60	99.00
RANGE	3.10	13.60	14.00	0.30	0.40	89.33

BASIN ID 19A2	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	4.00	4.00	4.00	4.00	4.00	4.00
MEAN	46.15	26.25	25.73	1.20	1.23	31.61
S.D.	50.25	18.22	17.66	1.10	1.13	17.33
C.V. (%)	108.89	69.42	68.63	91.54	91.97	54.84
MINIMUM	2.70	10.30	10.30	0.20	0.20	16.91
MAXIMUM	97.30	45.20	44.40	2.20	2.20	55.00
RANGE	94.60	34.90	34.10	2.00	2.00	38.09

BASIN ID 19B2	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	3.00	3.00	3.00	3.00	3.00	3.00
MEAN	74.37	37.00	35.90	2.00	2.10	17.28
S.D.	20.28	11.52	11.96	0.10	0.10	6.56
C.V. (%)	27.27	31.14	33.30	5.00	4.76	37.97
MINIMUM	60.20	30.10	28.70	1.90	2.00	13.32
MAXIMUM	97.60	50.30	49.70	2.10	2.20	24.85
RANGE	37.40	20.20	21.00	0.20	0.20	11.53

BASIN ID 30A2	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	2.00	2.00	2.00	2.00	2.00	2.00
MEAN	509.45	78.20	73.65	6.50	6.90	10.67
S.D.	7.00	0.99	1.20	0.00	0.00	0.17
C.V. (%)	1.37	1.27	1.63	0.00	0.00	1.63
MINIMUM	504.50	77.50	72.80	6.50	6.90	10.55
MAXIMUM	514.40	78.90	74.50	6.50	6.90	10.80
RANGE	9.90	1.40	1.70	0.00	0.00	0.25

BASIN ID 30B2	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	4.00	4.00	4.00	4.00	4.00	4.00
MEAN	339.60	71.28	68.23	4.70	4.93	13.81
S.D.	90.96	10.71	10.57	0.59	0.62	0.47
C.V. (%)	26.79	15.03	15.49	12.53	12.67	3.37
MINIMUM	222.00	57.20	54.10	3.90	4.10	13.20
MAXIMUM	442.70	83.20	79.70	5.30	5.60	14.23
RANGE	220.70	26.00	25.60	1.40	1.50	1.04

BASIN ID 36A2	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	4.00	4.00	4.00	4.00	4.00	4.00
MEAN	167.10	78.60	78.15	2.05	2.08	37.84
S.D.	73.51	21.07	21.13	0.41	0.46	7.69
C.V. (%)	43.99	26.80	27.03	20.11	22.04	20.32
MINIMUM	97.90	58.90	58.30	1.60	1.60	29.15
MAXIMUM	258.90	97.80	97.30	2.60	2.70	47.75
RANGE	161.00	38.90	39.00	1.00	1.10	18.60

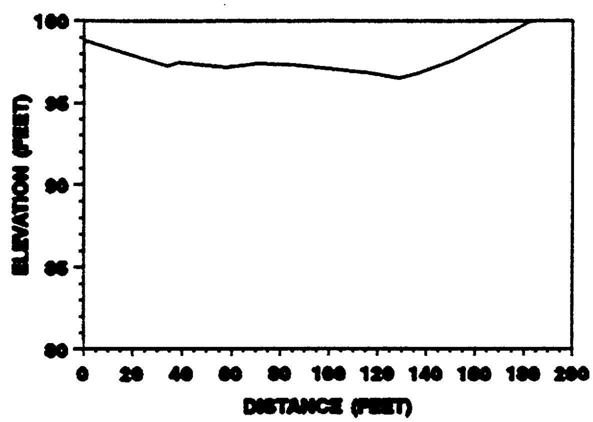
BASIN ID 36B2	AREA $(ft.^2)$	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	4.00	4.00	4.00	4.00	4.00	4.00
MEAN	4.20	8.88	8.10	0.53	0.68	19.37
S.D.	1.43	4.73	5.49	0.17	0.39	20.06
C.V. (%)	33.95	53.27	67.82	32.53	57.22	103.58
MINIMUM	2.50	4.50	3.10	0.30	0.30	2.58
MAXIMUM	5.90	13.90	13.80	0.70	1.20	46.00
RANGE	3.40	9.40	10.70	0.40	0.90	43.42

BASIN ID 36B3	AREA $(ft.^2)$	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	6.00	6.00	6.00	6.00	6.00	6.00
MEAN	2.80	9.07	8.95	0.30	0.30	31.03
S.D.	1.41	2.09	2.10	0.09	0.09	7.73
C.V. (%)	50.31	23.07	23.45	29.81	29.81	24.92
MINIMUM	1.10	5.60	5.50	0.20	0.20	20.50
MAXIMUM	5.10	11.70	11.60	0.40	0.40	43.50
RANGE	4.00	6.10	6.10	0.20	0.20	23.00

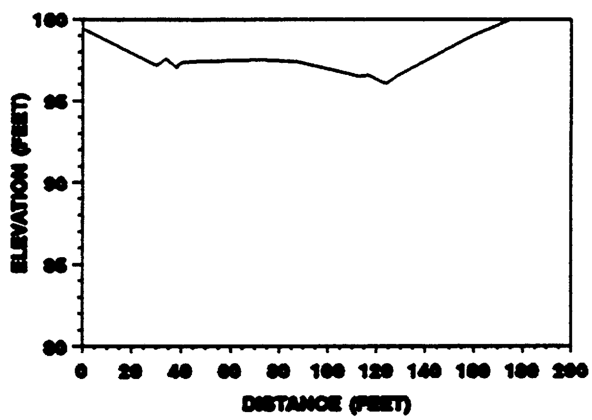
BASIN ID 54A2	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	2.00	2.00	2.00	2.00	2.00	2.00
MEAN	3.45	11.20	11.05	0.30	0.30	41.38
S.D.	1.63	0.14	0.07	0.14	0.14	19.27
C.V. (%)	47.14	1.26	0.64	47.14	47.14	46.57
MINIMUM	2.30	11.10	11.00	0.20	0.20	27.75
MAXIMUM	4.60	11.30	11.10	0.40	0.40	55.00
RANGE	2.30	0.20	0.10	0.20	0.20	27.25

BASIN ID 54B1	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	3.00	3.00	3.00	3.00	3.00	3.00
MEAN	326.03	65.97	62.73	4.60	4.87	12.93
S.D.	190.80	21.22	20.26	1.55	1.65	1.07
C.V. (%)	58.52	32.17	32.30	33.75	33.91	8.26
MINIMUM	128.50	42.30	40.00	3.00	3.20	12.14
MAXIMUM	509.30	83.30	78.90	6.10	6.50	14.14
RANGE	380.80	41.00	38.90	3.10	3.30	2.01

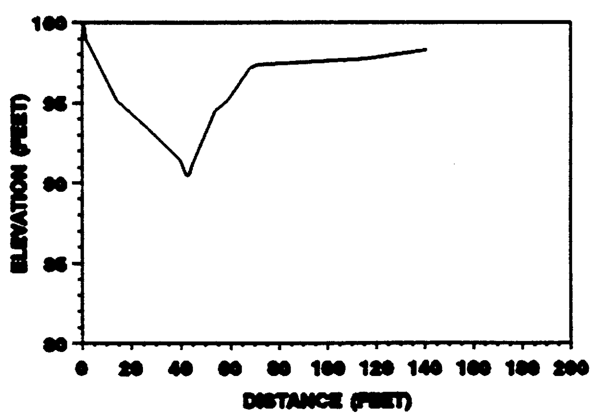
BONE PILE CREEK, 19A1
CROSS SECTION 0+00.00



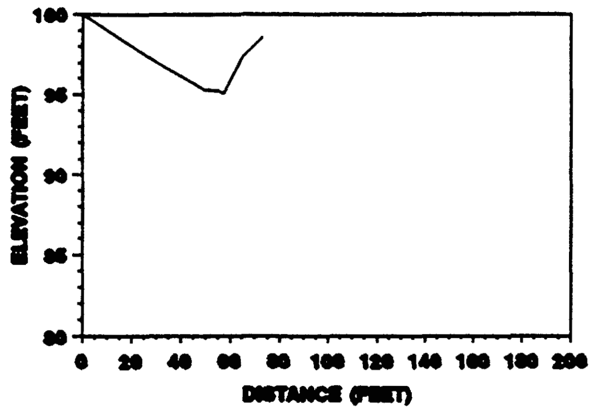
BONE PILE CREEK, 19A1
CROSS SECTION 2+51.00



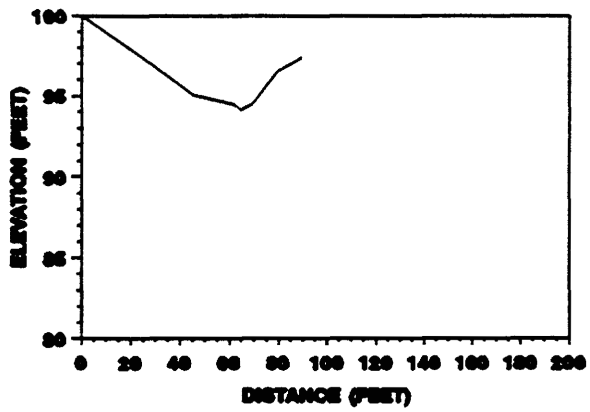
BONE PILE CREEK, 19A1
CROSS SECTION @ 3+51.20



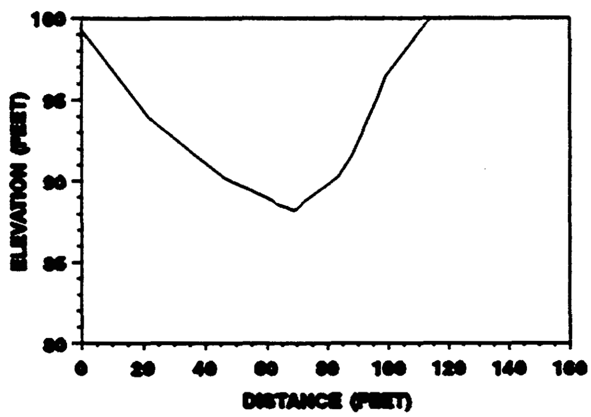
BONE PILE CREEK, 19A1
CROSS SECTION @ 14+56.60



BONE PILE CREEK, 19A1
CROSS SECTION @ 15+59.90

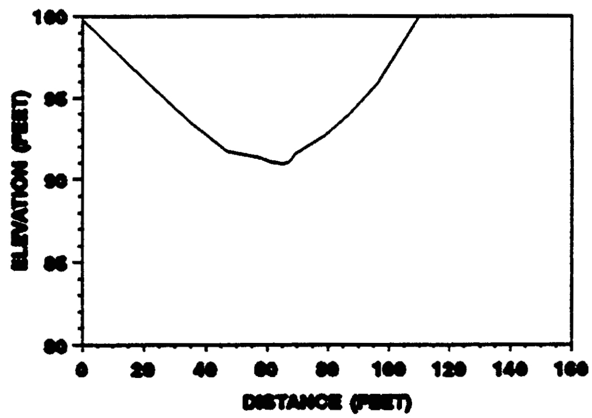


BONE PILE CREEK, 19A2
CROSS SECTION 0+00.00



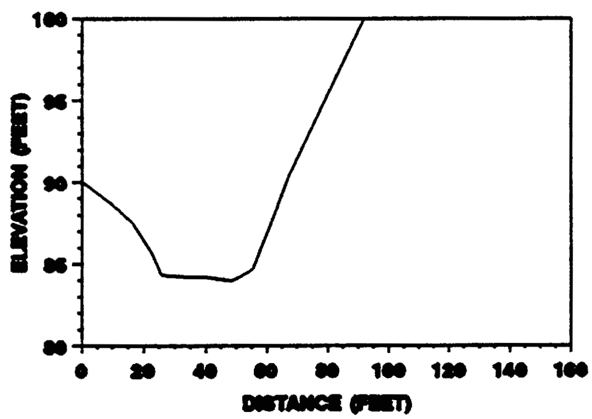
BONE PILE CREEK, 19B2

CROSS SECTION 2+41.10



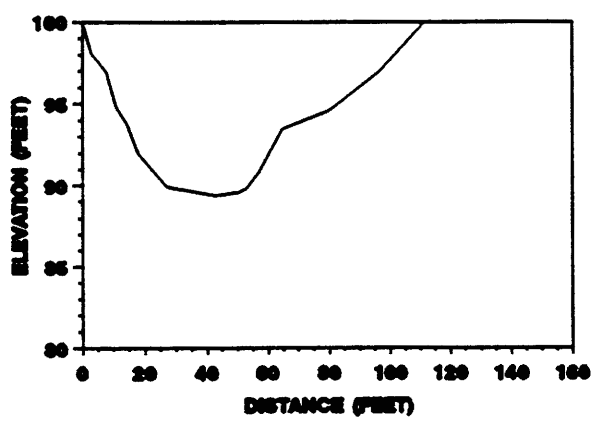
BONE PILE CREEK, 19A2

CROSS SECTION 11+15.80



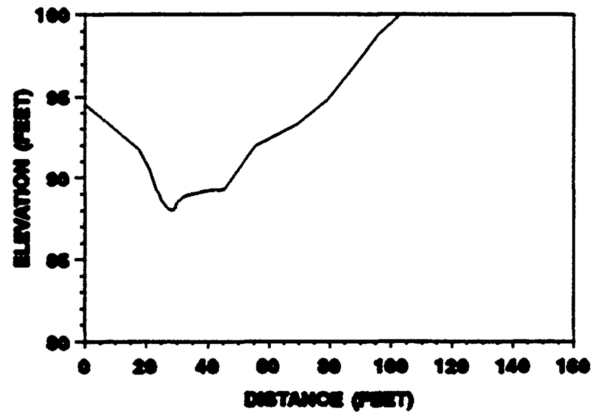
BONE PILE CREEK, 19A2

CROSS SECTION 36+34.10



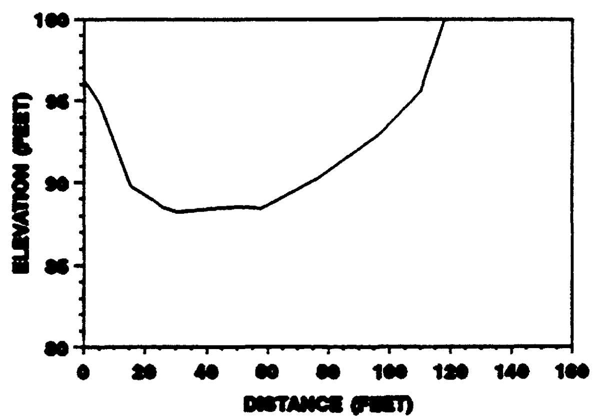
BONE PILE CREEK, 19A2

CROSS SECTION 30+08.10



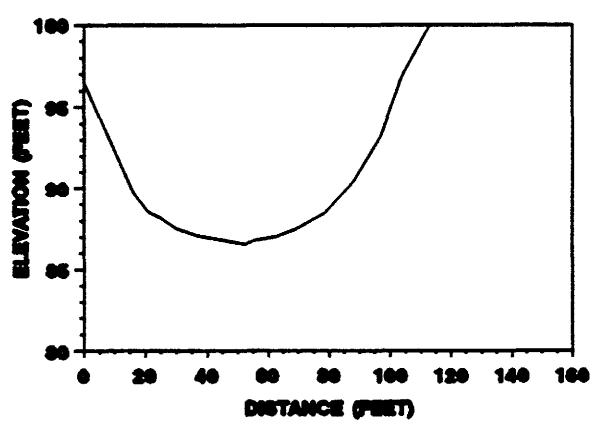
BONE PILE CREEK, 19B2

CROSS SECTION 0+08.00



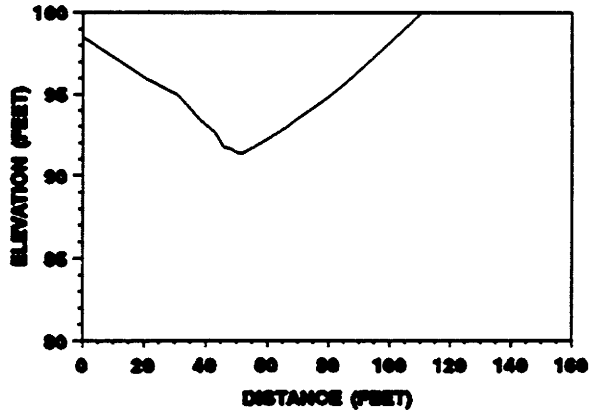
BONE PILE CREEK, 19B2

CROSS SECTION 2+19.00



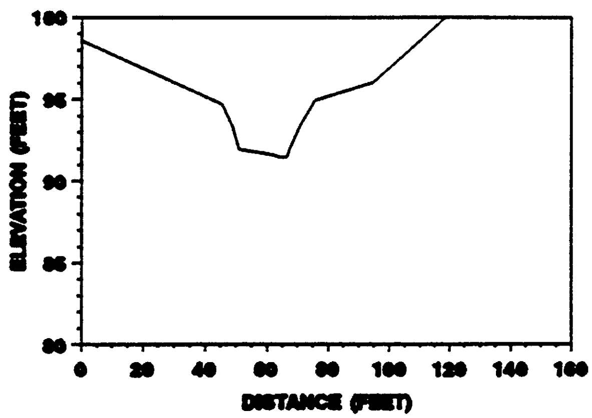
BONE PILE CREEK, 1982

CROSS SECTION 9+15.90



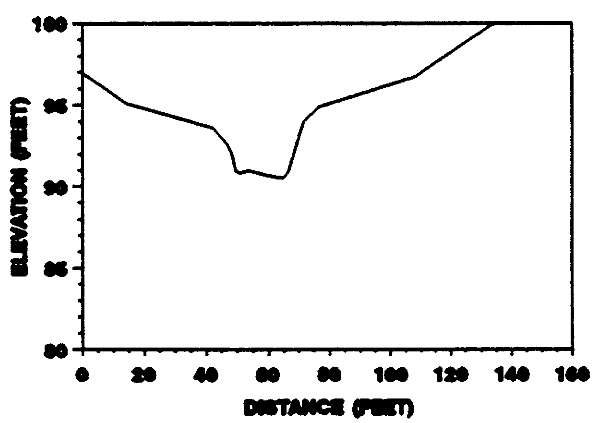
BONE PILE CREEK, 1982

CROSS SECTION 19+82.20



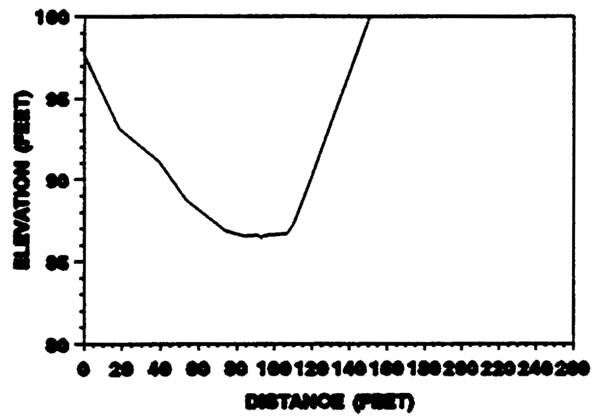
BONE PILE CREEK, 1982

CROSS SECTION 29+70.20



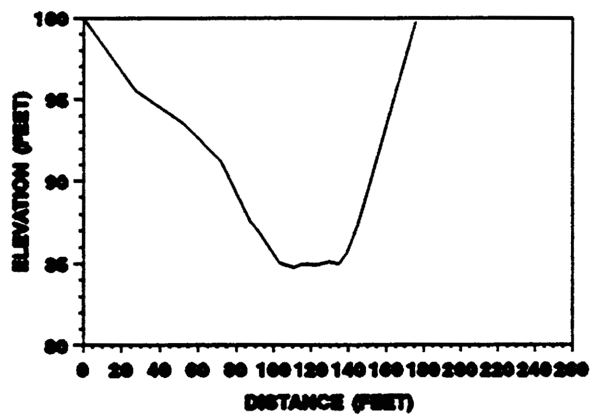
HAY CREEK, 36A2

CROSS SECTION 0+00.00



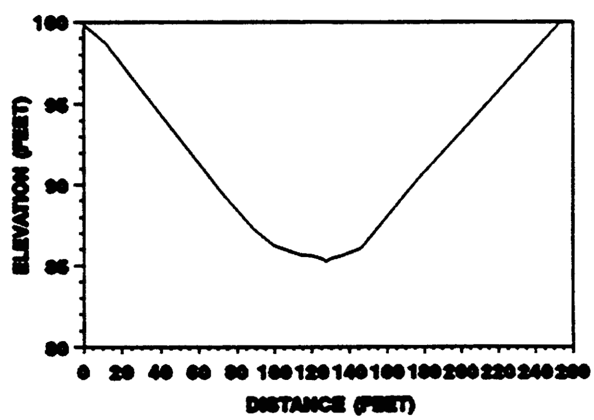
HAY CREEK, 36A2

CROSS SECTION 1+05.00



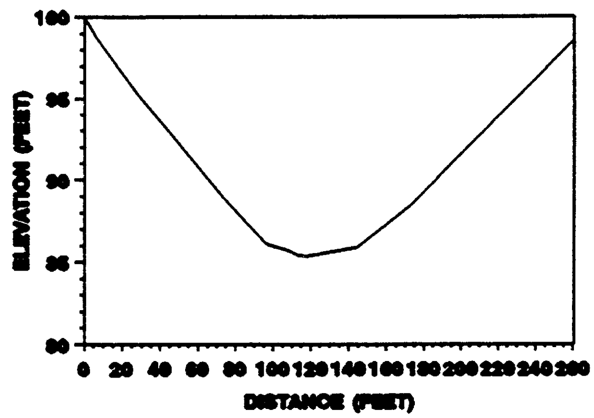
HAY CREEK, 36A2

CROSS SECTION 9+38.00



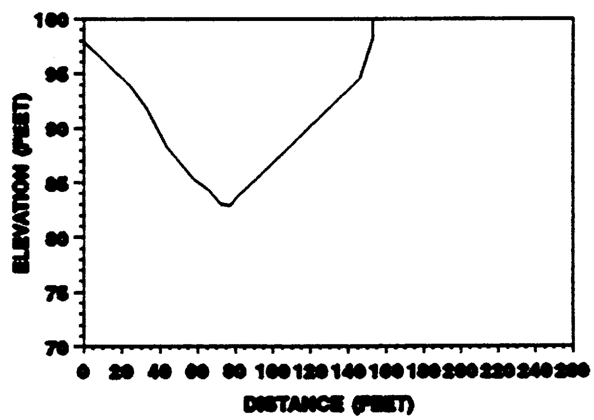
HAY CREEK, 36A2

CROSS SECTION 10+34.50



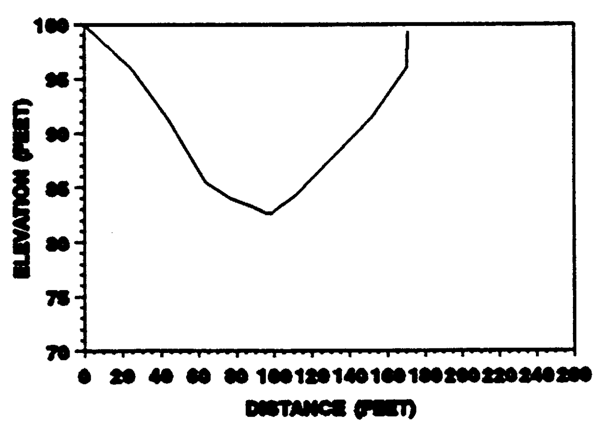
HAY CREEK, 36B2

CROSS SECTION 0+08.00

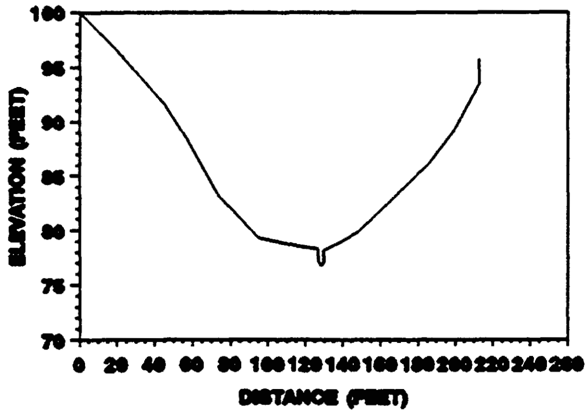


HAY CREEK, 36B2

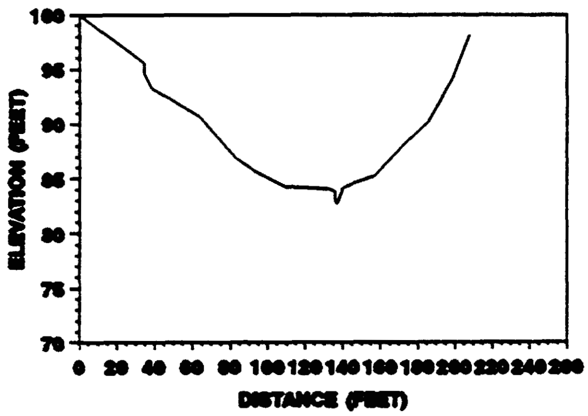
CROSS SECTION 0+65.50



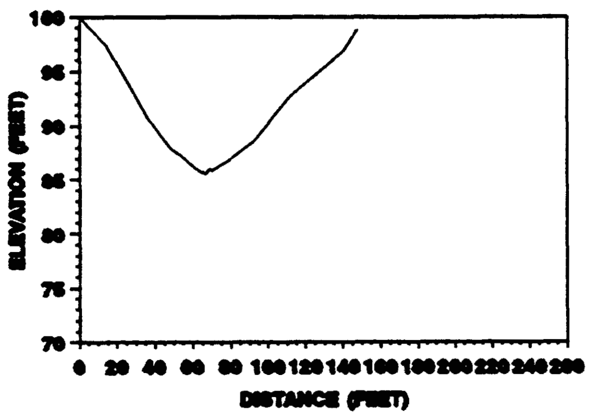
HAY CREEK, 36B2
CROSS SECTION 5+44.30



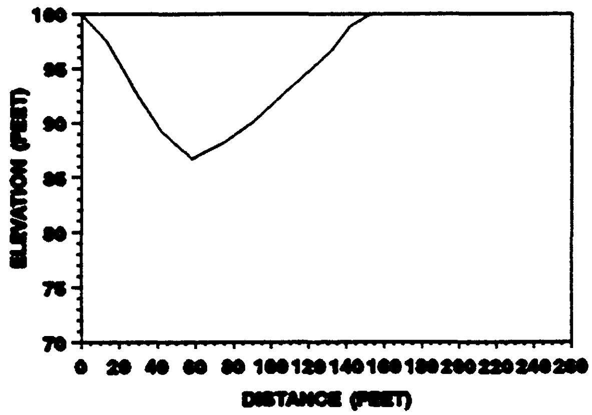
HAY CREEK, 36B2
CROSS SECTION 6+48.30



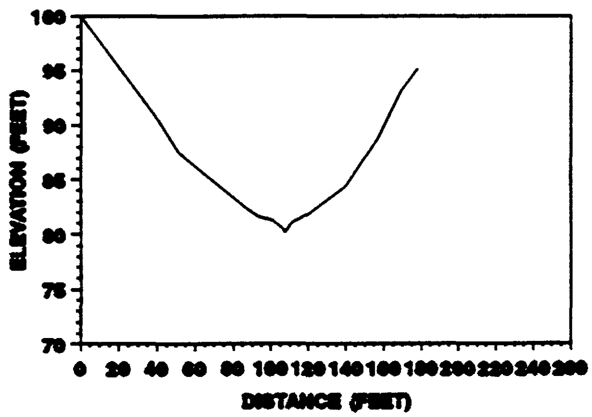
HAY CREEK, 36B3
CROSS SECTION 0+00.00



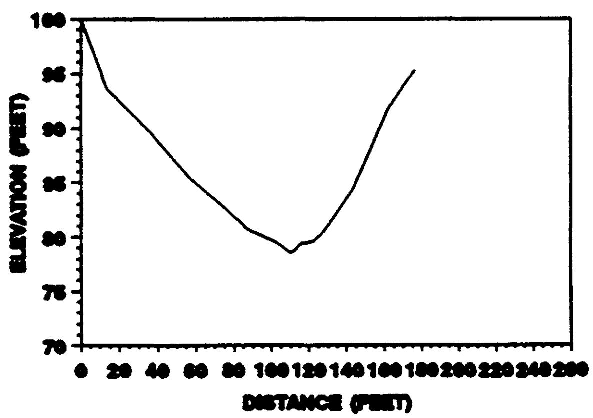
HAY CREEK, 36B3
CROSS SECTION 6+66.00



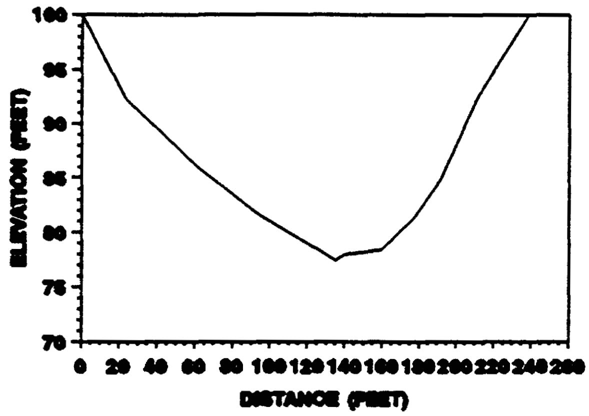
HAY CREEK, 36B3
CROSS SECTION 3+79.20



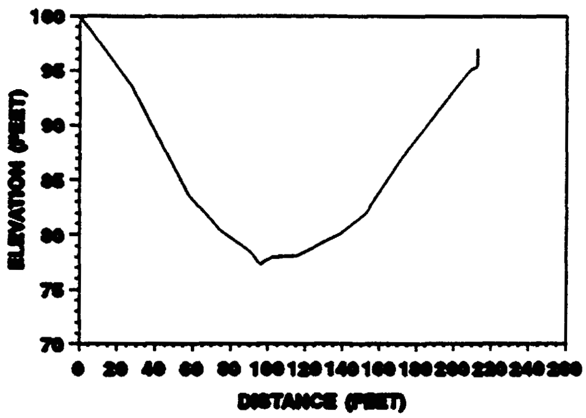
HAY CREEK, 36B3
CROSS SECTION 9+46.00



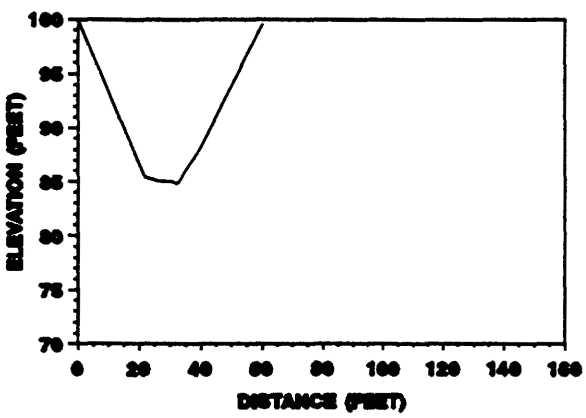
HAY CREEK, 36B3
CROSS SECTION 13+40.00



HAY CREEK, 36B3
CROSS SECTION 15+32.00

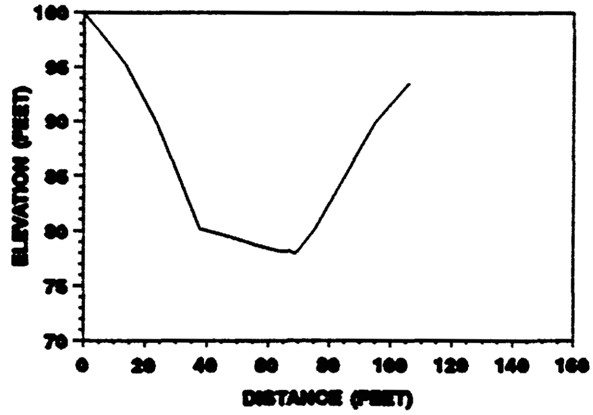


BELLE FOURCHE RIVER, 30A1
CROSS SECTION 0+00.00



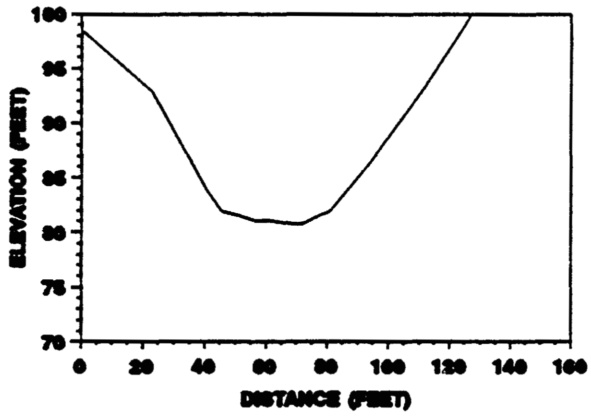
BELLE FOURCHE RIVER, 30A1

CROSS SECTION 2+00.00



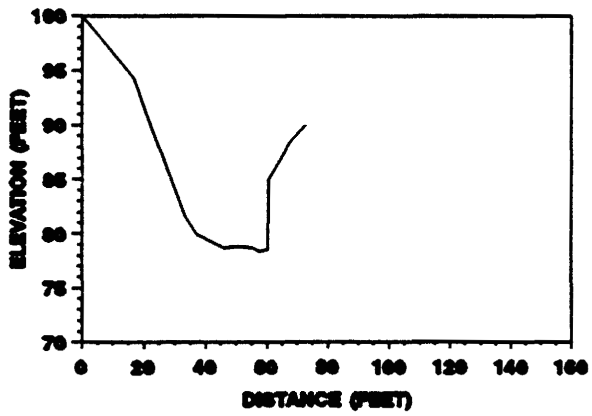
BELLE FOURCHE RIVER, 30A1

CROSS SECTION 3+31.00



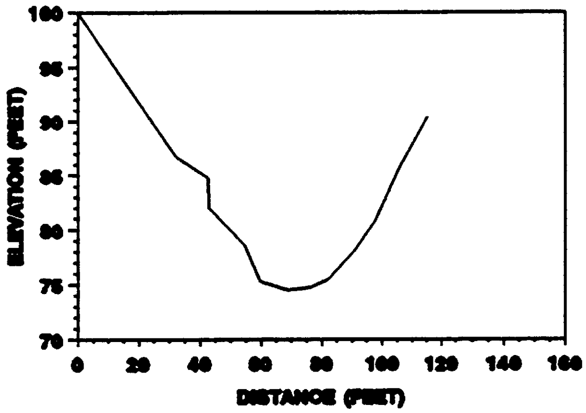
BELLE FOURCHE RIVER, 30A2

CROSS SECTION 0+00.00



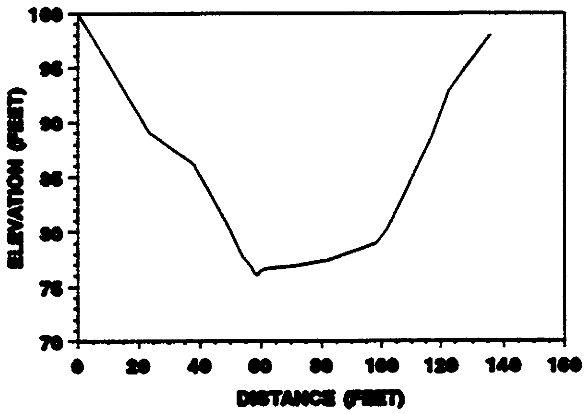
BELLE FOURCHE RIVER, 30A2

CROSS SECTION 1+59.80



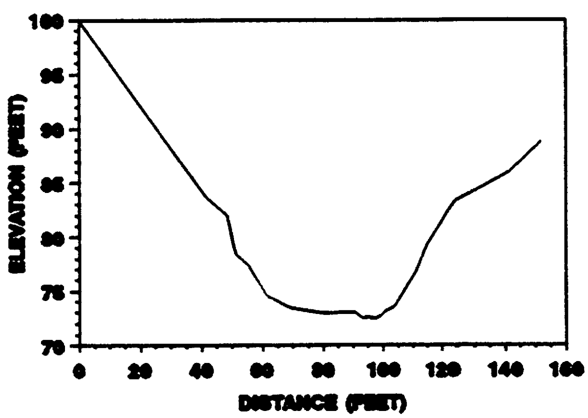
BELLE FOURCHE RIVER, 30A2

CROSS SECTION 6+77.50



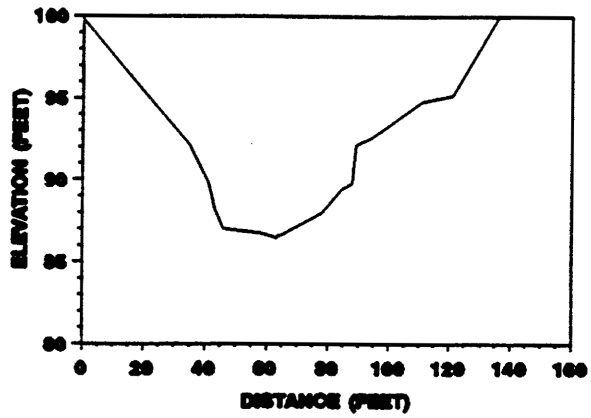
BELLE FOURCHE RIVER, 30A2

CROSS SECTION 3+46.70



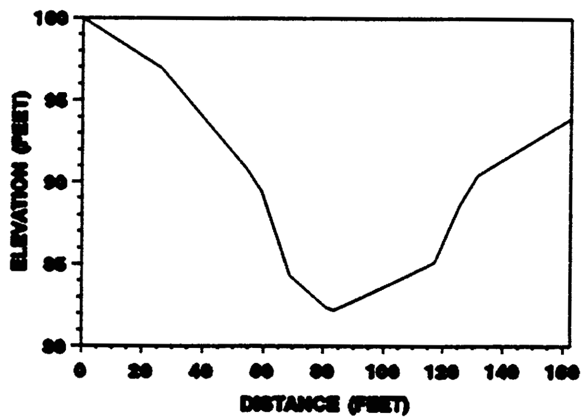
BELLE FOURCHE RIVER, 30B2

CROSS SECTION 0+00.00



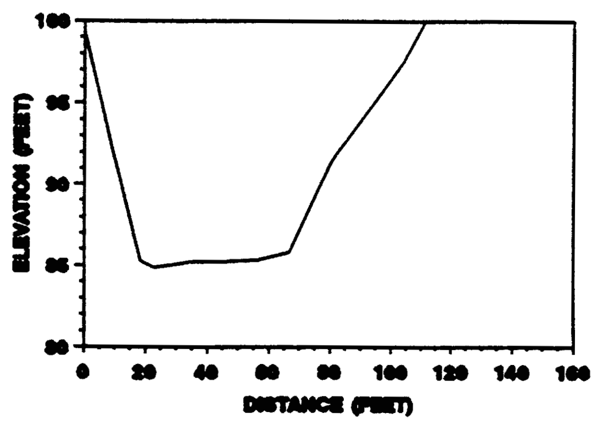
BELLE FOURCHE RIVER, 30B2

CROSS SECTION 1+22.30



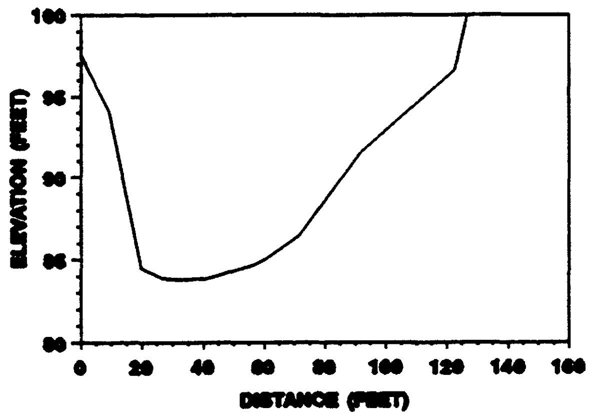
BELLE FOURCHE RIVER, 30B2

CROSS SECTION 7+[illegible]



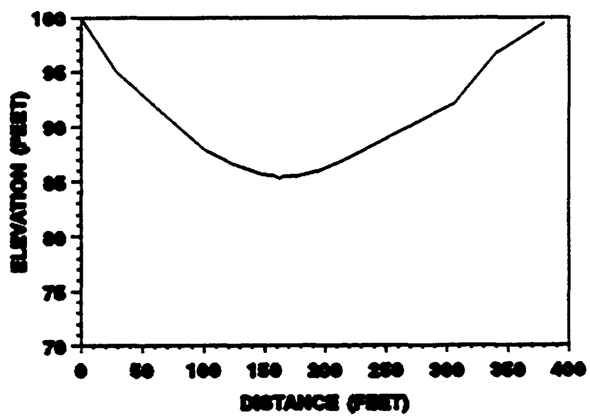
BELLE FOURCHE RIVER, 30B2

CROSS SECTION 9+82.90



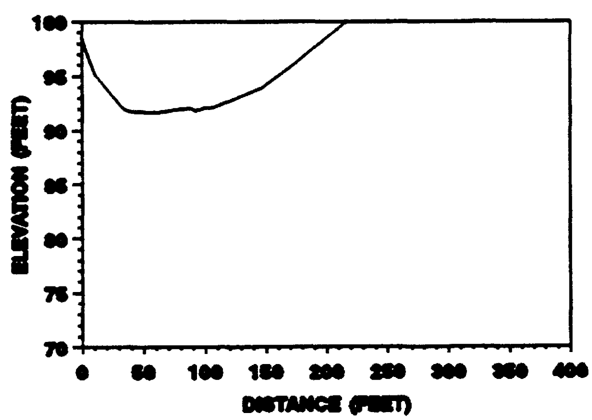
HORSE CREEK, 54B1

CROSS SECTION 0+00.00



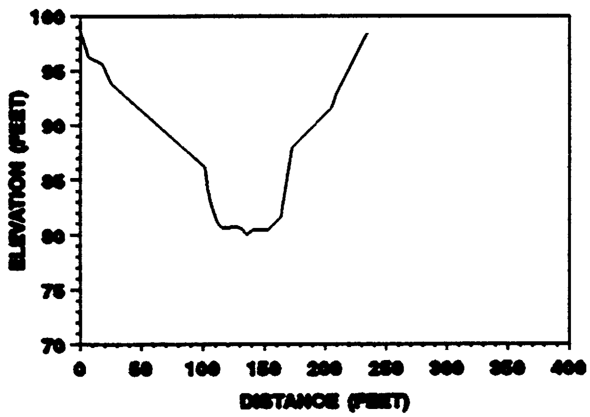
HORSE CREEK, 54B1

CROSS SECTION 1+00.50



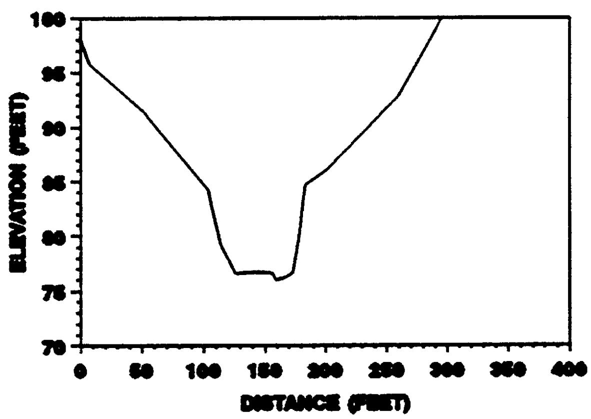
HORSE CREEK, 54B1

CROSS SECTION 10+07.30



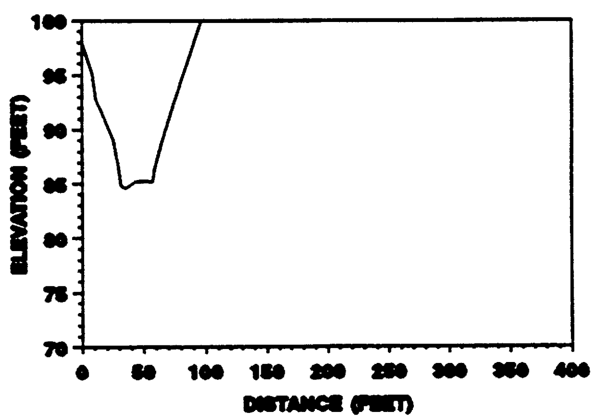
HORSE CREEK, 54B1

CROSS SECTION 12+36.30

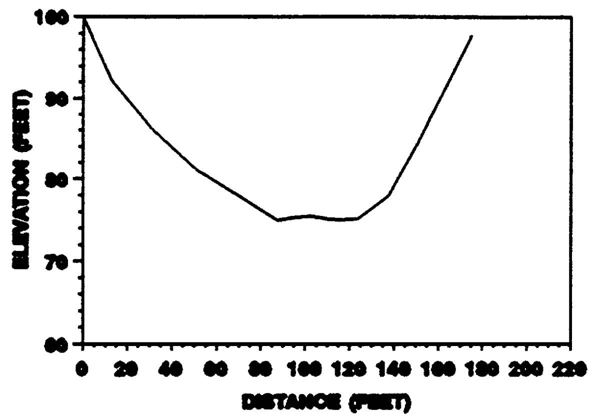


HORSE CREEK, 54B1

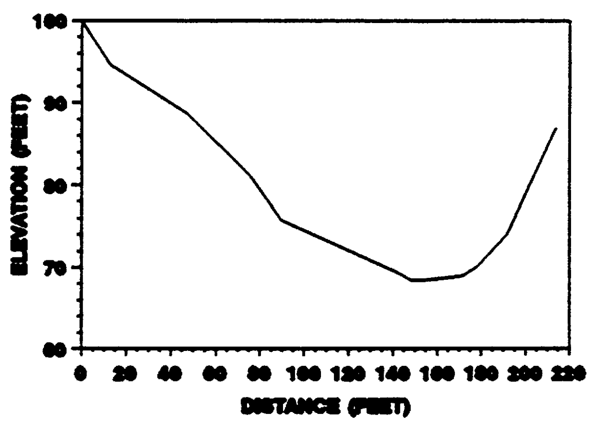
CROSS SECTION 22+96.10



HORSE CREEK, 54A2
CROSS SECTION 0+00.00



HORSE CREEK, 54A2
CROSS SECTION 1+37.50



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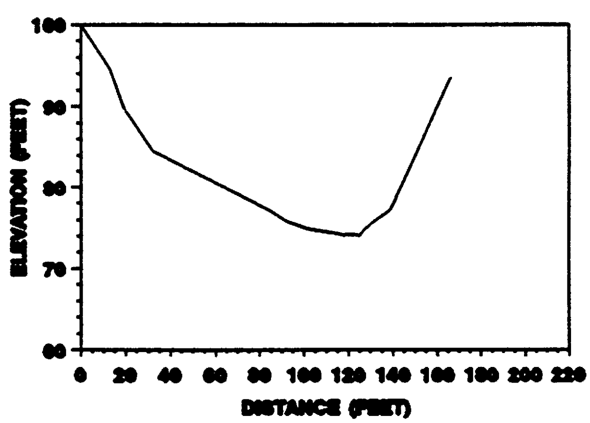
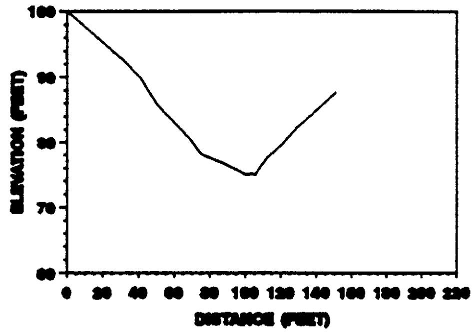
CROSS SECTION 7+64.50

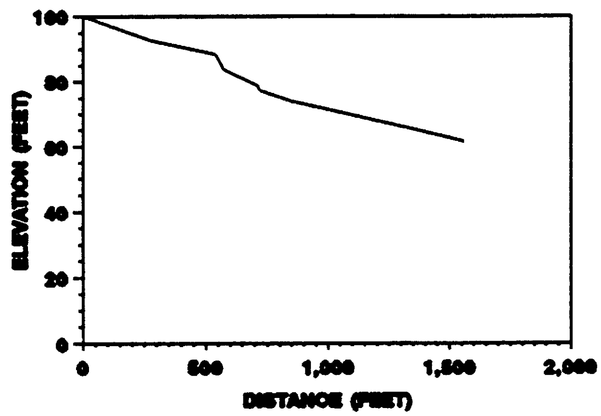


HORSE CREEK, 54A2

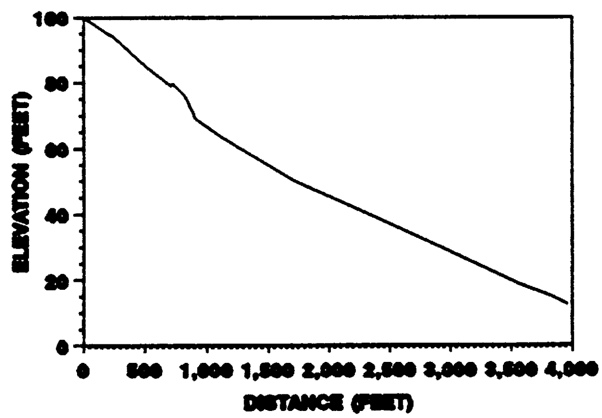
CROSS SECTION [illegible]



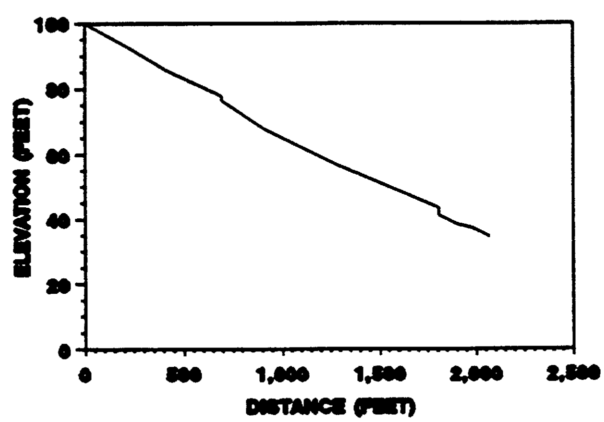
BONE PILE CREEK, 19A1
LONGITUDINAL PROFILE

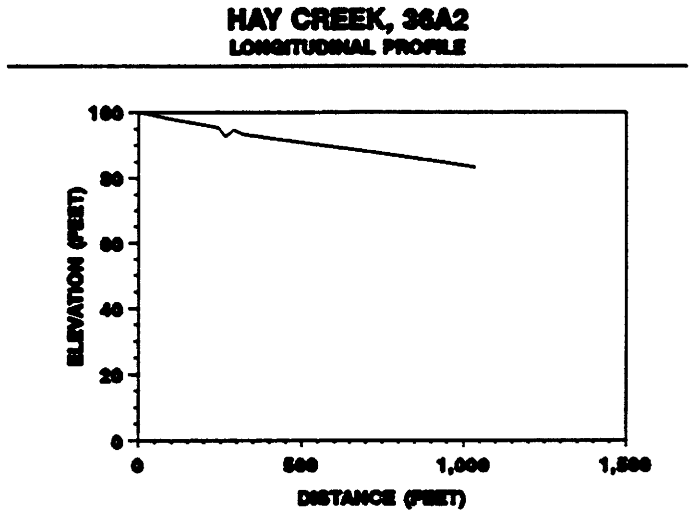


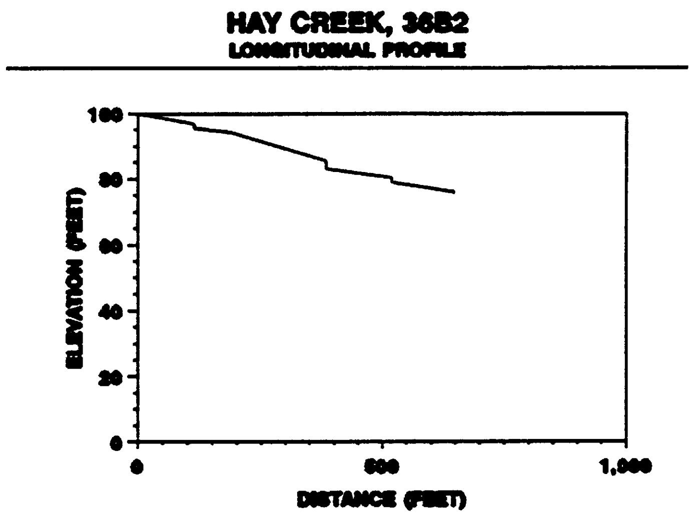
BONE PILE CREEK, 19A2
LONGITUDINAL PROFILE

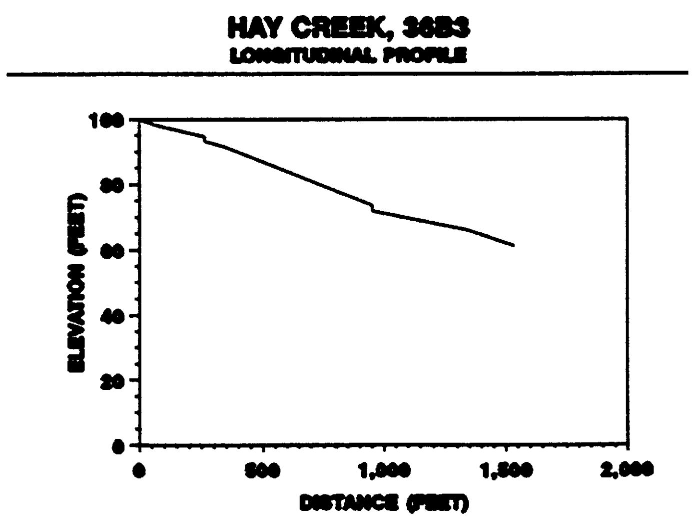


BONE PILE CREEK, 19B2
LONGITUDINAL PROFILE

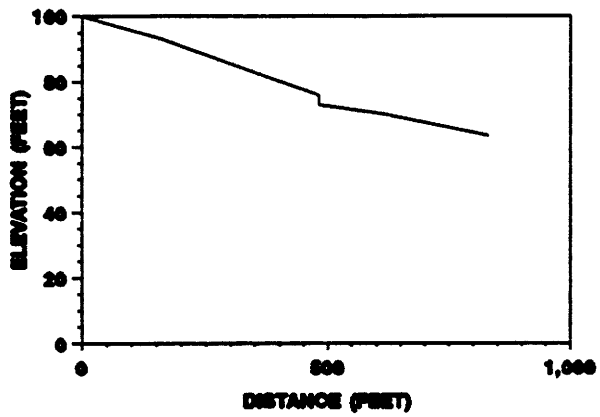



HAY CREEK, 36A2
LONGITUDINAL PROFILE
ELEVATION (FEET)
DISTANCE (FEET)
0
20
40
60
80
100
0
500
1,000
1,500

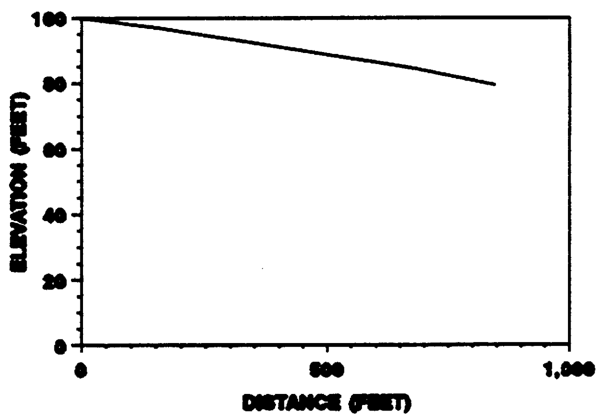

HAY CREEK, 36B2
LONGITUDINAL PROFILE
ELEVATION (FEET)
DISTANCE (FEET)
0
20
40
60
80
100
0
500
1,000


HAY CREEK, 36B3
LONGITUDINAL PROFILE
ELEVATION (FEET)
DISTANCE (FEET)
0
20
40
60
80
100
0
500
1,000
1,500
2,000

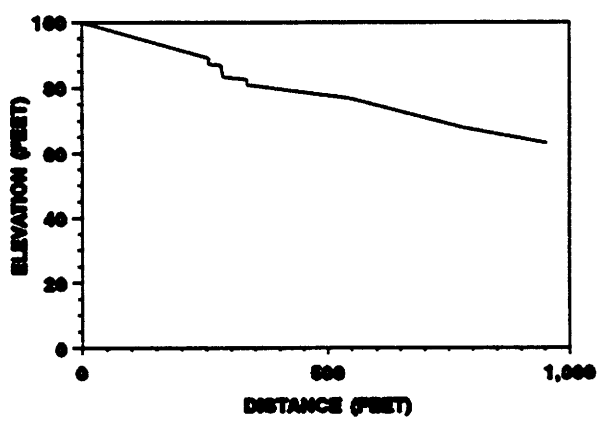
BELLE FOURCHE RIVER, 30A1
LONGITUDINAL PROFILE



BELLE FOURCHE RIVER, 30A2
LONGITUDINAL PROFILE

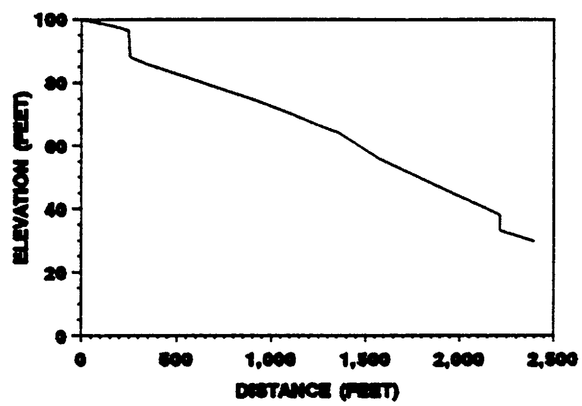


BELLE FOURCHE RIVER, 30B2
LONGITUDINAL PROFILE



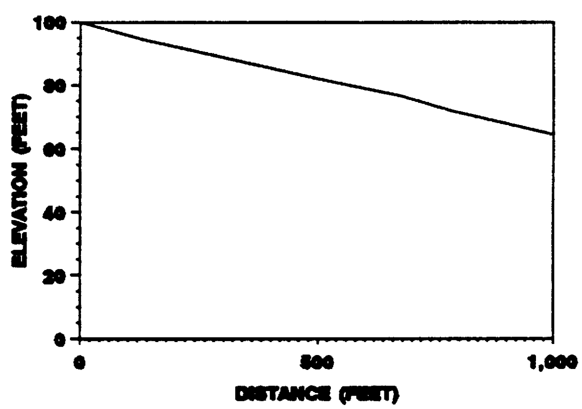
HORSE CREEK, 54B1

LONGITUDINAL PROFILE



HORSE CREEK, 54A2

LONGITUDINAL PROFILE



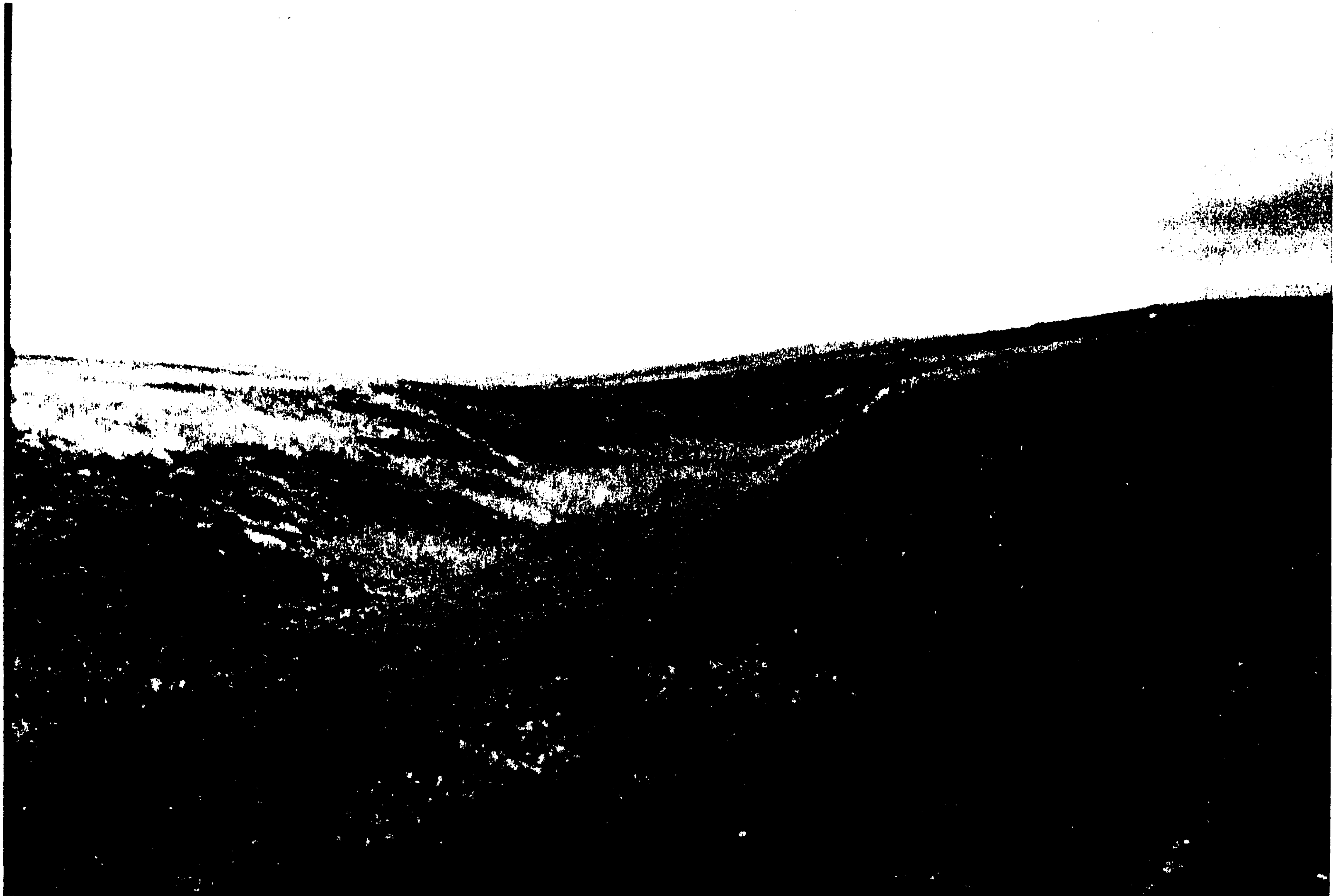
Strata "B" first order raw data by study reach, cross section, and bank identification.

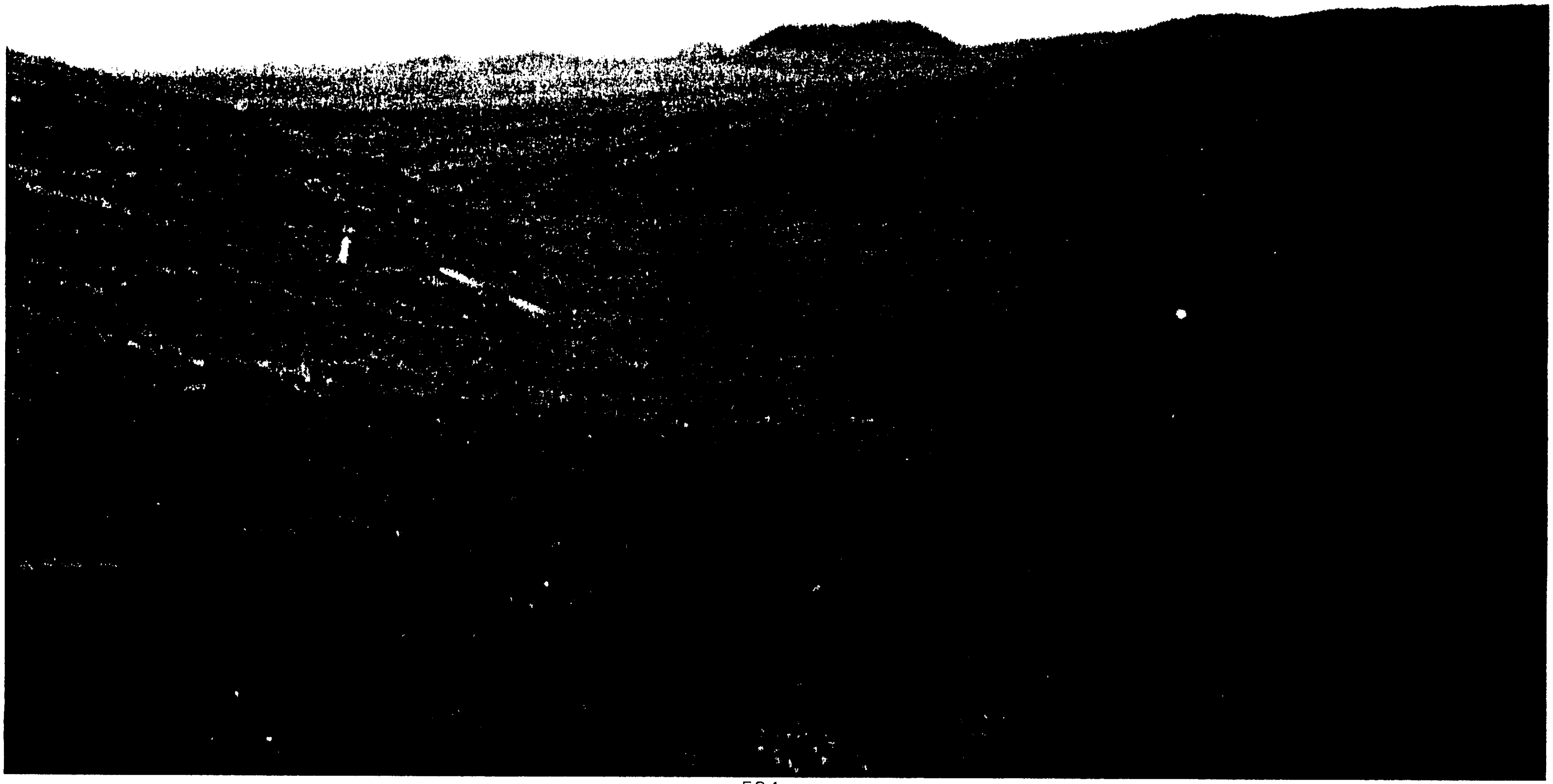
BASIN I.D.	CROSS SECTION NUMBER	BANK I.D.	AREA (feet^2)	TOP WIDTH (feet)	AVERAGE DEPTH (feet)	BED WIDTH (feet)
19A1	0+00.00	HIGH	233.70	167.10	1.40	
19A1	2+81.00	HIGH	312.30	166.00	1.90	
19A1	8+51.20	HIGH	307.50	136.90	2.20	
19A1	14+56.60	HIGH	108.20	58.70	1.80	
19A1	15+59.90	HIGH	113.70	64.60	1.80	
19A2	0+00.00	HIGH	723.60	110.70	6.50	
19A2	2+41.10	HIGH	583.60	109.30	5.30	
19A2	11+15.50	HIGH	261.10	66.70	3.90	26.30
19A2	38+34.10	HIGH	707.70	111.50	6.30	24.20
19A2	39+68.10	HIGH	245.30	77.80	3.20	22.20
19B2	0+00.00	HIGH	622.90	111.20	5.60	14.00
19B2	2+19.00	HIGH	740.00	103.30	7.20	39.50
19B2	9+15.90	HIGH	370.60	101.90	3.60	
19B2	19+82.20	HIGH	347.10	109.90	3.20	16.40
19B2	20+70.20	HIGH	296.90	110.30	2.70	15.70
30A1	0+00.00	HIGH	514.40	59.40	8.70	11.90
30A1	2+00.60	HIGH	868.10	89.20	9.70	37.60
30A1	8+31.60	HIGH	1304.50	123.70	10.50	26.80
30A2	0+00.00	HIGH	366.80	50.30	7.30	23.20
30A2	1+50.00	HIGH	877.10	91.90	9.50	21.10
30A2	6+77.50	HIGH	1743.40	131.40	13.30	31.20
30A2	8+46.70	HIGH	1184.30	123.60	9.60	35.40
30B2	0+00.00	HIGH	993.50	135.30	7.30	22.50
30B2	1+22.30	HIGH	752.00	122.20	6.20	39.60
30B2	7+83.80	HIGH	1077.40	109.40	9.80	29.40
30B2	9+52.80	HIGH	1064.10	123.80	8.60	33.50

BASIN I.D.	CROSS SECTION NUMBER	BANK I.D.	AREA (feet²)	TOP WIDTH (feet)	AVERAGE DEPTH (feet)	BED WIDTH (feet)
36A2	0+00.00	HIGH	1036.40	143.10	7.20	26.90
36A2	1+05.80	HIGH	1499.90	174.40	8.60	26.90
36A2	9+38.00	HIGH	2054.20	252.40	8.10	43.30
36A2	10+34.90	HIGH	1973.20	252.90	7.80	42.70
36B2	0+00.00	HIGH	1245.50	152.20	8.20	
36B2	0+95.50	HIGH	1672.70	166.70	10.00	
36B2	5+44.30	HIGH	2130.00	188.40	11.30	47.50
36B2	6+48.80	HIGH	1771.40	195.40	9.10	59.60
36B3	0+00.00	HIGH	1026.60	140.90	7.30	
36B3	0+66.60	HIGH	1078.00	152.20	7.10	
36B3	8+79.20	HIGH	1378.40	157.30	8.80	23.30
36B3	9+46.60	HIGH	1606.90	166.10	9.70	22.40
36B3	13+40.80	HIGH	3294.70	237.30	13.90	34.10
36B3	15+32.80	HIGH	2374.20	190.70	12.40	23.00
54A2	0+00.00	HIGH	2654.60	171.00	15.50	15.70
54A2	1+37.50	HIGH	1923.50	159.70	12.00	27.20
54A2	7+84.50	HIGH	1976.40	151.80	13.00	25.70
54A2	9+54.50	HIGH	753.10	104.80	7.20	34.60
54B1	0+00.00	HIGH	3306.40	377.50	8.80	6.30
54B1	1+88.50	HIGH	978.70	201.10	4.90	24.30
54B1	10+97.80	HIGH	2286.20	231.80	9.90	25.00
54B1	12+35.30	HIGH	3681.20	295.60	12.50	18.90
54B1	23+95.10	HIGH	723.40	91.40	7.90	11.20

BASIN I.D.	CROSS SECTION NUMBER	BANK I.D.	AREA (feet²)	TOP WIDTH (feet)	AVERAGE DEPTH (feet)
19A1	0+00.00	MEDIUM	3.10	19.80	0.20
19A1	2+81.00	MEDIUM	3.60	18.70	0.20
19A1	8+51.20	MEDIUM	3.30	5.80	0.60
19A1	14+56.60	MEDIUM	4.40	13.50	0.30
19A1	15+59.90	MEDIUM	1.30	7.40	0.20
19A2	0+00.00	MEDIUM	3.30	10.30	0.30
19A2	2+41.10	MEDIUM	2.70	11.00	0.20
19A2	38+34.10	MEDIUM	97.30	44.40	2.20
19A2	39+68.10	MEDIUM	81.30	37.20	2.20
19B2	9+15.90	MEDIUM	97.60	49.70	2.00
19B2	19+82.20	MEDIUM	65.30	29.30	2.20
19B2	20+70.20	MEDIUM	60.20	28.70	2.10
30A2	6+77.50	MEDIUM	514.40	74.50	6.90
30A2	8+46.70	MEDIUM	504.50	72.80	6.90
30B2	0+00.00	MEDIUM	222.00	54.10	4.10
30B2	1+22.30	MEDIUM	335.50	69.10	4.90
30B2	7+83.80	MEDIUM	358.20	70.00	5.10
30B2	9+52.80	MEDIUM	442.70	79.70	5.60
36A2	0+00.00	MEDIUM	97.90	61.50	1.60
36A2	1+05.80	MEDIUM	118.80	58.30	2.00
36A2	9+38.00	MEDIUM	258.90	97.30	2.70
36A2	10+34.90	MEDIUM	192.80	95.50	2.00
36B2	0+00.00	MEDIUM	5.90	11.80	0.50
36B2	0+95.50	MEDIUM	4.60	13.80	0.30
36B2	5+44.30	MEDIUM	3.80	3.10	1.20
36B2	6+48.80	MEDIUM	2.50	3.70	0.70

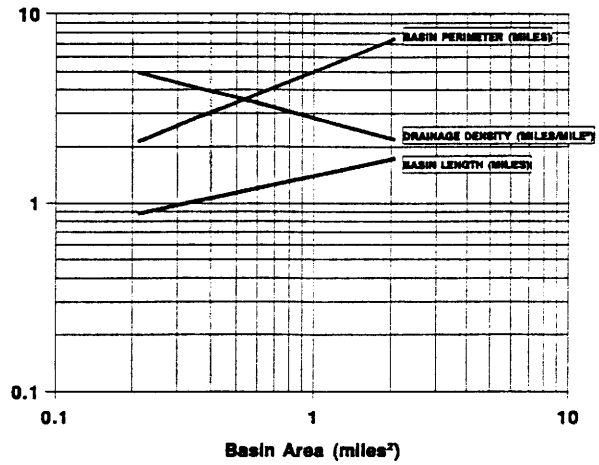
BASIN I.D.	CROSS SECTION NUMBER	BANK I.D.	AREA (feet^2)	TOP WIDTH (feet)	AVERAGE DEPTH (feet)
36B3	0+00.00	MEDIUM	1.60	8.70	0.20
36B3	0+66.60	MEDIUM	1.10	5.50	0.20
36B3	9+46.60	MEDIUM	5.10	11.60	0.40
36B3	8+79.20	MEDIUM	3.30	8.20	0.40
36B3	13+40.80	MEDIUM	3.00	10.50	0.30
36B3	15+32.80	MEDIUM	2.70	9.20	0.30
54A2	7+84.50	MEDIUM	2.30	11.00	0.20
54A2	9+54.50	MEDIUM	4.60	11.10	0.40
54B1	10+97.80	MEDIUM	340.30	69.30	4.90
54B1	12+35.30	MEDIUM	509.30	78.90	6.50
54B1	23+95.10	MEDIUM	128.50	40.00	3.20
19A1	2+81.00	LOW	0.30	4.00	0.10
19A1	8+51.20	LOW	0.10	1.60	0.10
19A1	14+56.60	LOW	0.30	2.60	0.10
19A1	15+59.90	LOW	0.20	2.10	0.10
19A2	0+00.00	LOW	0.30	3.20	0.10
19A2	2+41.10	LOW	0.30	5.50	0.10
19A2	39+68.10	LOW	4.00	8.10	0.50
30A2	6+77.50	LOW	1.10	4.00	0.30
30A2	8+46.70	LOW	4.90	23.10	0.20
36A2	9+38.00	LOW	3.20	22.50	0.10
36A2	10+34.90	LOW	1.20	13.60	0.10



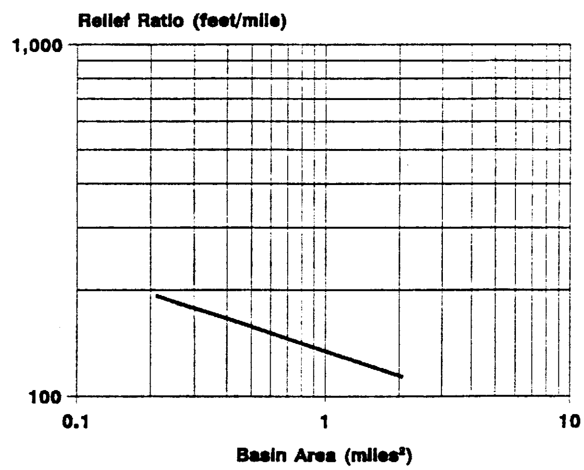


APPENDIX B-2

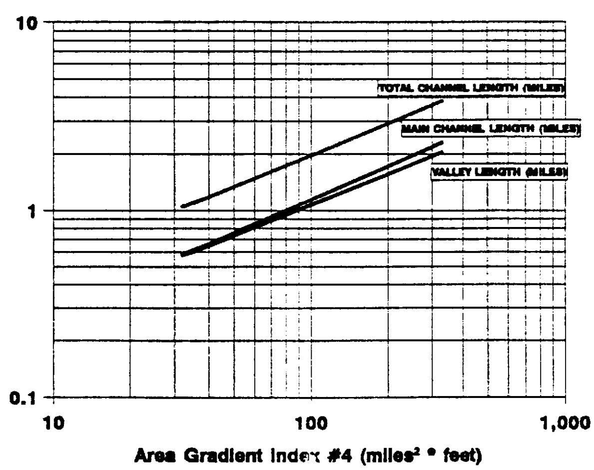
STRATA "B" - SECOND ORDER



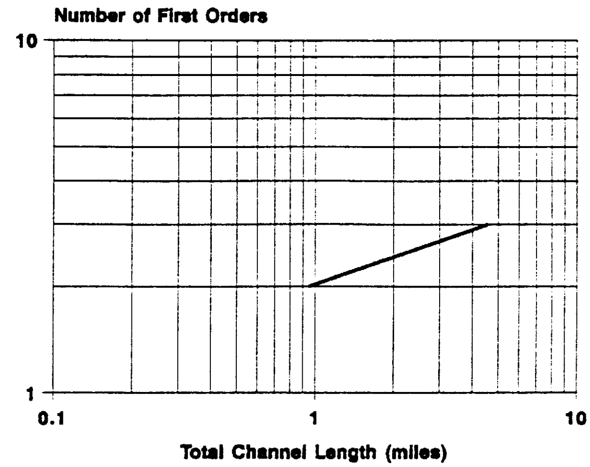
10
1
0.1
0.1
1
10
BASIN PERIMETER (MILES)
DRAINAGE DENSITY (MILES/MILE²)
BASIN LENGTH (MILES)
Basin Area (miles²)

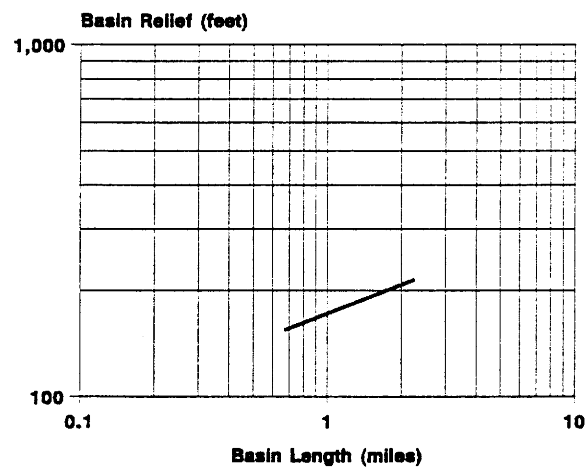


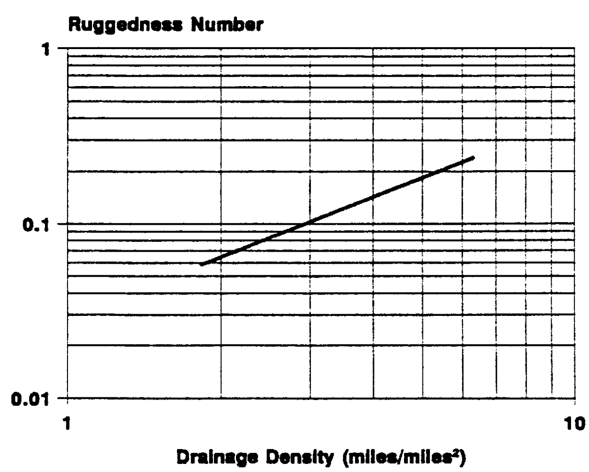
Relief Ratio (feet/mile)
1,000
100
0.1
1
10
Basin Area (miles²)

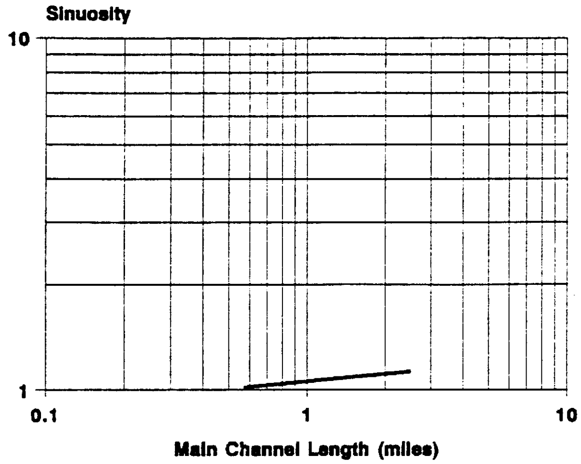


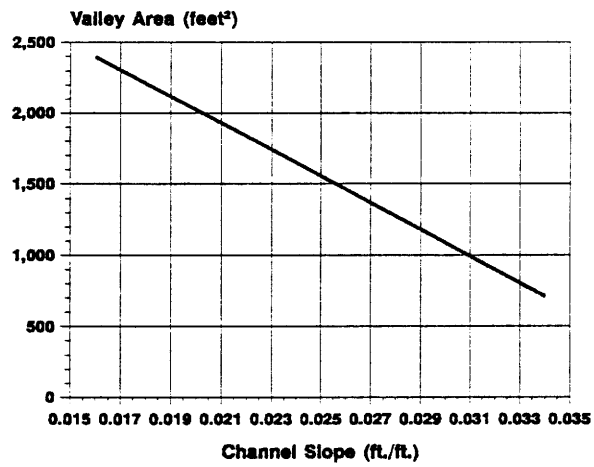
10
1
0.1
10
100
1,000
TOTAL CHANNEL LENGTH (MILES)
MAIN CHANNEL LENGTH (MILES)
VALLEY LENGTH (MILES)
Area Gradient Index #4 (miles² * feet)

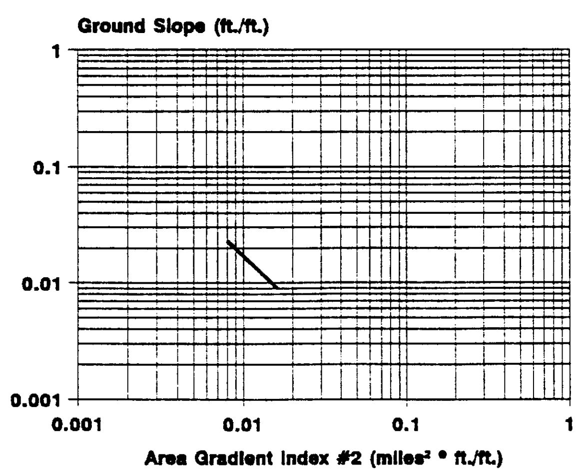

Number of First Orders
10
1
0.1
1
10
Total Channel Length (miles)

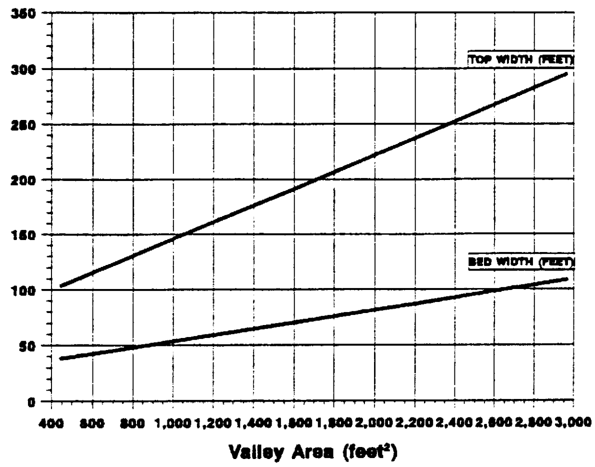

Basin Relief (feet)
1,000
100
0.1
1
10
Basin Length (miles)

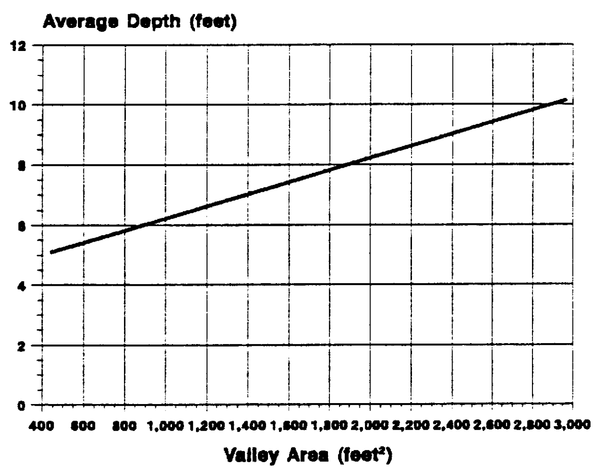

Ruggedness Number
1
0.1
0.01
1
10
Drainage Density (miles/miles²)

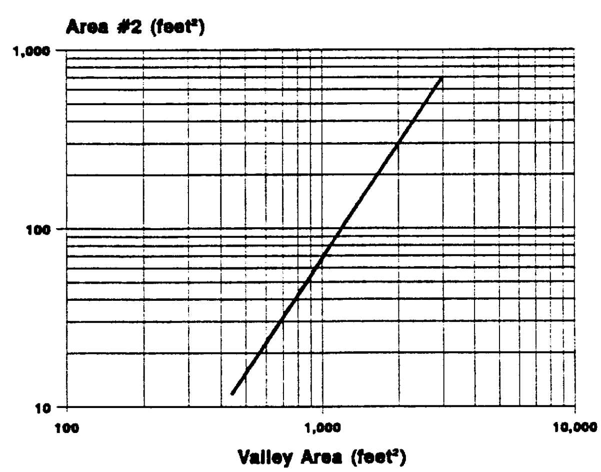

Sinuosity
10
1
0.1
1
10
Main Channel Length (miles)

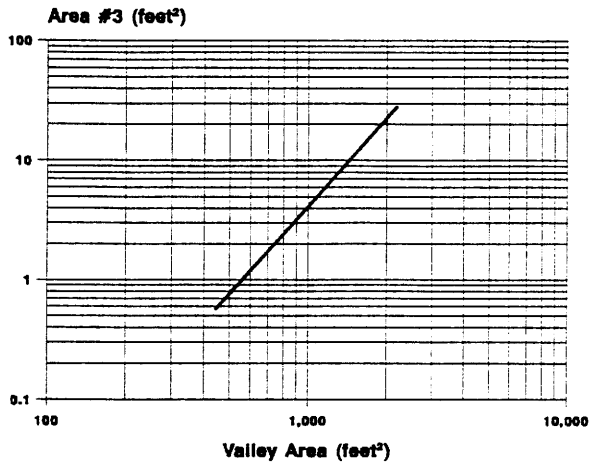

Valley Area (feet²)
2,500
2,000
1,500
1,000
500
0
0.015 0.017 0.019 0.021 0.023 0.025 0.027 0.029 0.031 0.033 0.035
Channel Slope (ft./ft.)

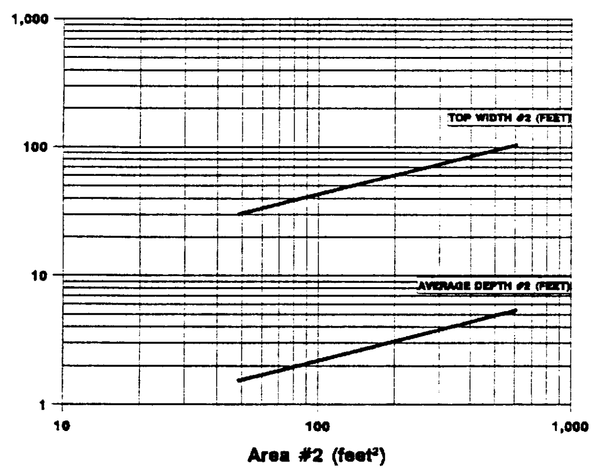

Ground Slope (ft./ft.)
1
0.1
0.01
0.001
0.001
0.01
0.1
1
Area Gradient Index #2 (miles² * ft./ft.)

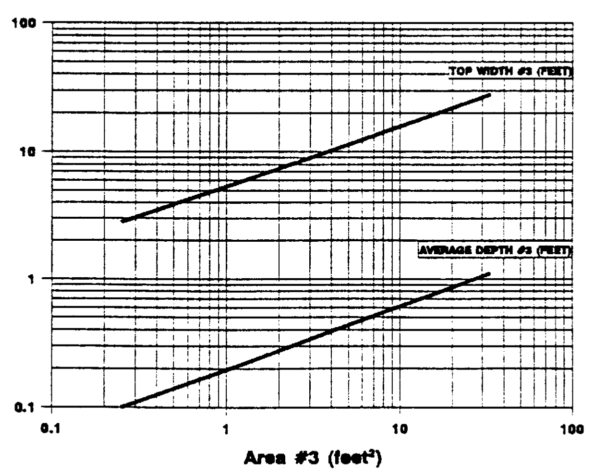

TOP WIDTH (FEET)
BED WIDTH (FEET)
Valley Area (feet²)


Average Depth (feet)
Valley Area (feet²)


Area #2 (feet²)
Valley Area (feet²)


Area #3 (feet²)
100
10
1
0.1
100
1,000
10,000
Valley Area (feet²)


1,000
100
10
1
TOP WIDTH #2 (FEET)
AVERAGE DEPTH #2 (FEET)
10
100
1,000
Area #2 (feet²)


100
10
1
0.1
TOP WIDTH #3 (FEET)
AVERAGE DEPTH #3 (FEET)
0.1
1
10
100
Area #3 (feet²)

Strata "B" second order regression output for basin perimeter versus basin area.

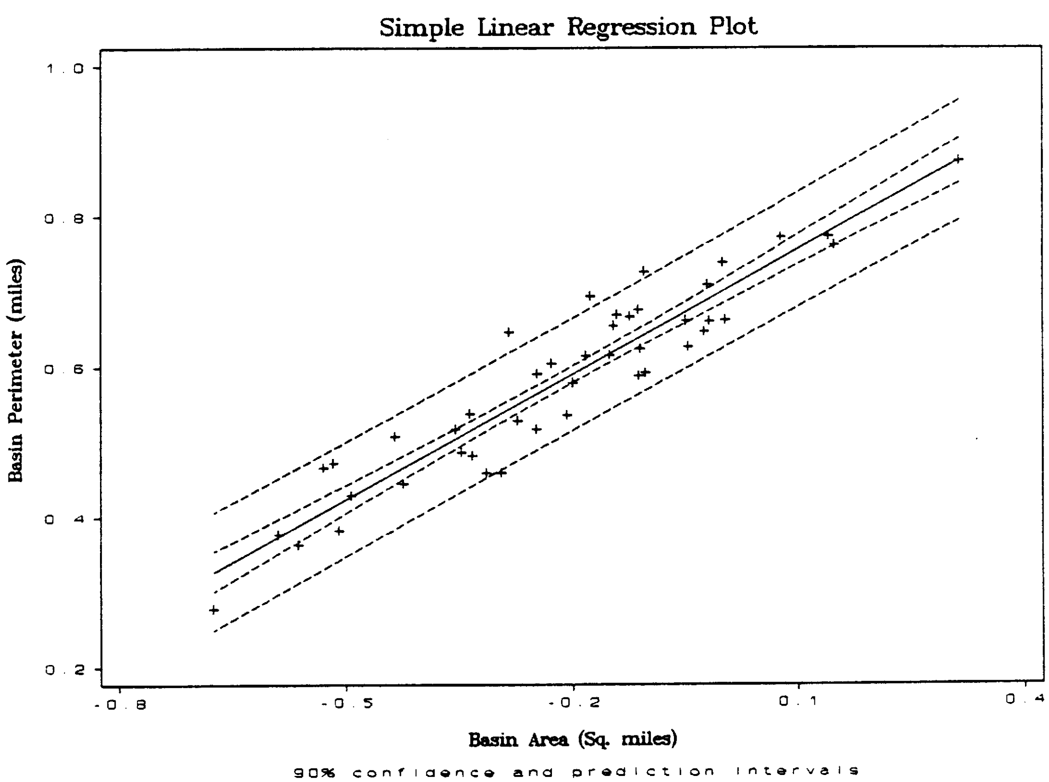
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BASIN PERIMETER

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.70066	0.00937	74.76	0.0000
BA	0.55343	0.03123	17.72	0.0000

R-SQUARED	0.8821	RESID. MEAN SQUARE (MSE)	0.00193
ADJUSTED R-SQUARED	0.8793	STANDARD DEVIATION	0.04389

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.60509	0.60509	314.11	0.0000
RESIDUAL	42	0.08091	0.00193		
TOTAL	43	0.68600			

CASES INCLUDED 44   MISSING CASES 0



Strata "B" second order regression output for drainage density versus basin area.

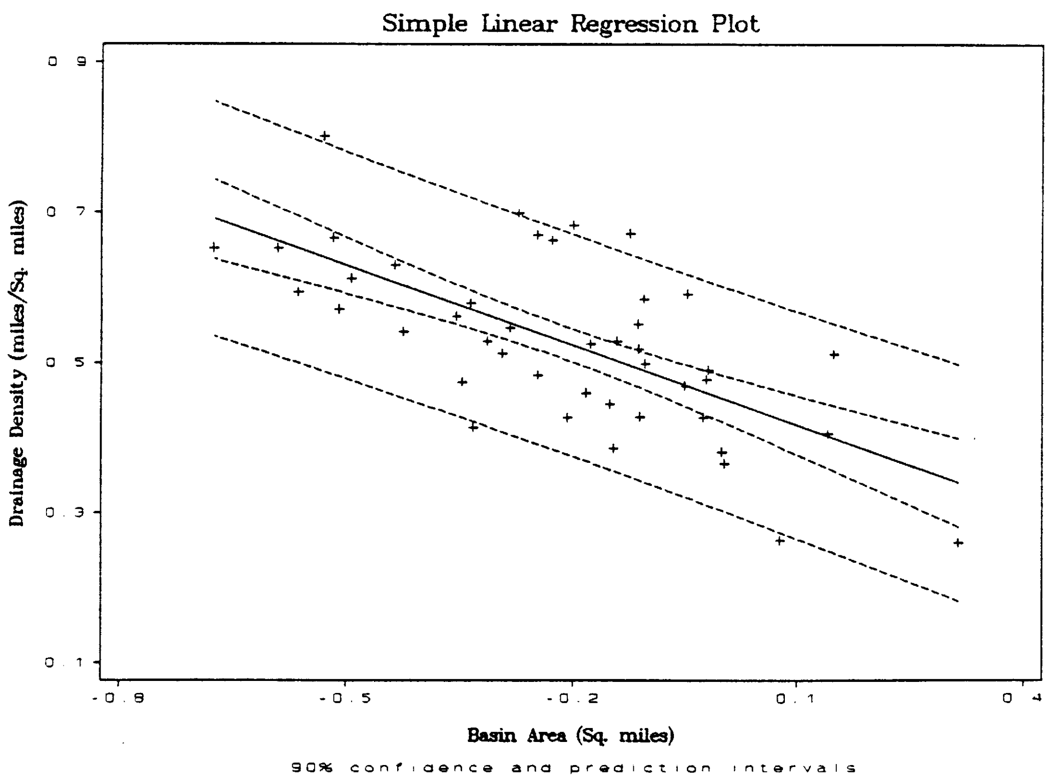
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF DRAINAGE DENSITY

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.45189	0.01860	24.29	0.0000
BA	-0.35528	0.06198	-5.73	0.0000

R-SQUARED	0.4390	RESID. MEAN SQUARE (MSE)	0.00759
ADJUSTED R-SQUARED	0.4256	STANDARD DEVIATION	0.08711

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.24936	0.24936	32.86	0.0000
RESIDUAL	42	0.31871	0.00759		
TOTAL	43	0.56807			

CASES INCLUDED 44 MISSING CASES 0



Strata "B" second order regression output for basin length versus basin area.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BASIN LENGTH

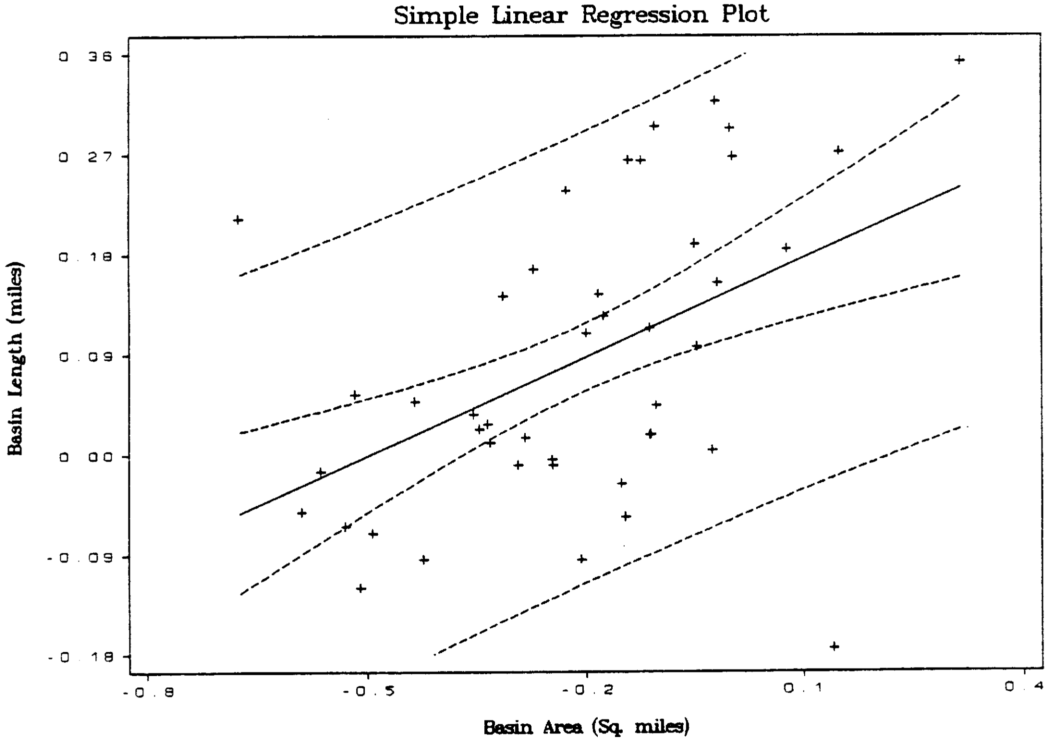
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.14714	0.02556	5.76	0.0000
BA	0.29594	0.08515	3.48	0.0012

R-SQUARED	0.2234	RESID. MEAN SQUARE (MSE)	0.01432
ADJUSTED R-SQUARED	0.2049	STANDARD DEVIATION	0.11968

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.17302	0.17302	12.08	0.0012
RESIDUAL	42	0.60161	0.01432		
TOTAL	43	0.77463			

CASES INCLUDED 44   MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "B" second order regression output for main channel length versus area gradient index #4.

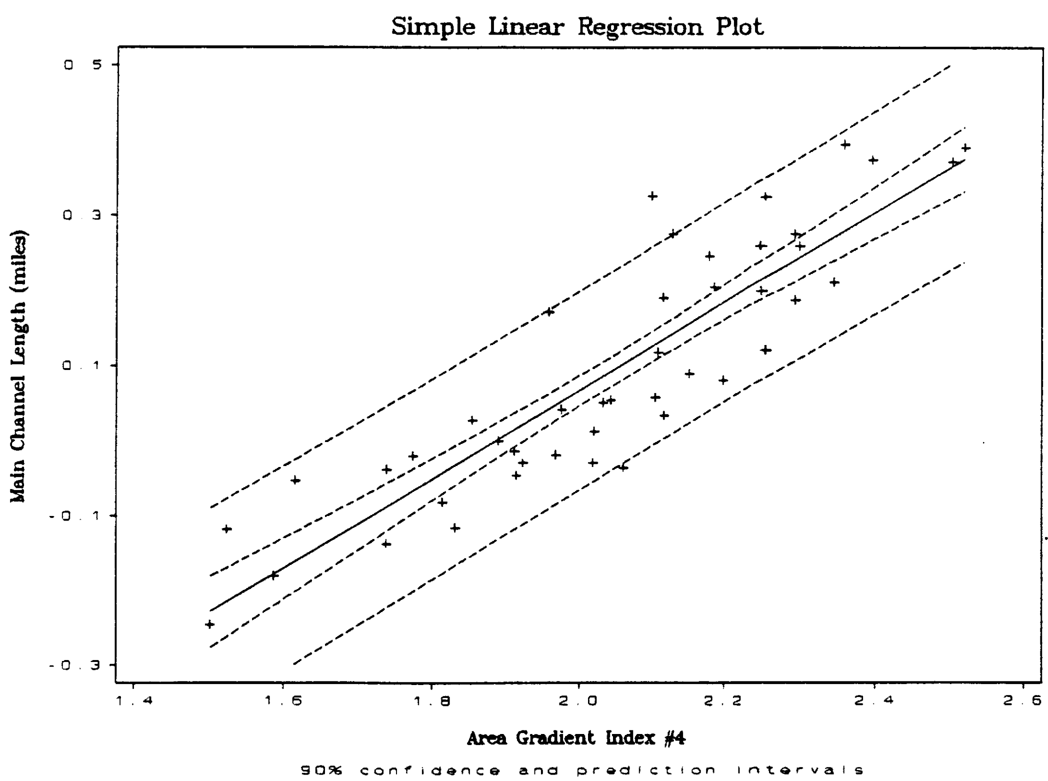
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF MAIN CHANNEL LENGTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-1.12050	0.09842	-11.39	0.0000
AGI4	0.59375	0.04773	12.44	0.0000

R-SQUARED	0.7865	RESID. MEAN SQUARE (MSE)	0.00604
ADJUSTED R-SQUARED	0.7815	STANDARD DEVIATION	0.07774

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.93516	0.93516	154.75	0.0000
RESIDUAL	42	0.25380	0.00604		
TOTAL	43	1.18896			

CASES INCLUDED 44 MISSING CASES 0



Strata "B" second order regression output for valley length versus area gradient index #4.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF VALLEY LENGTH

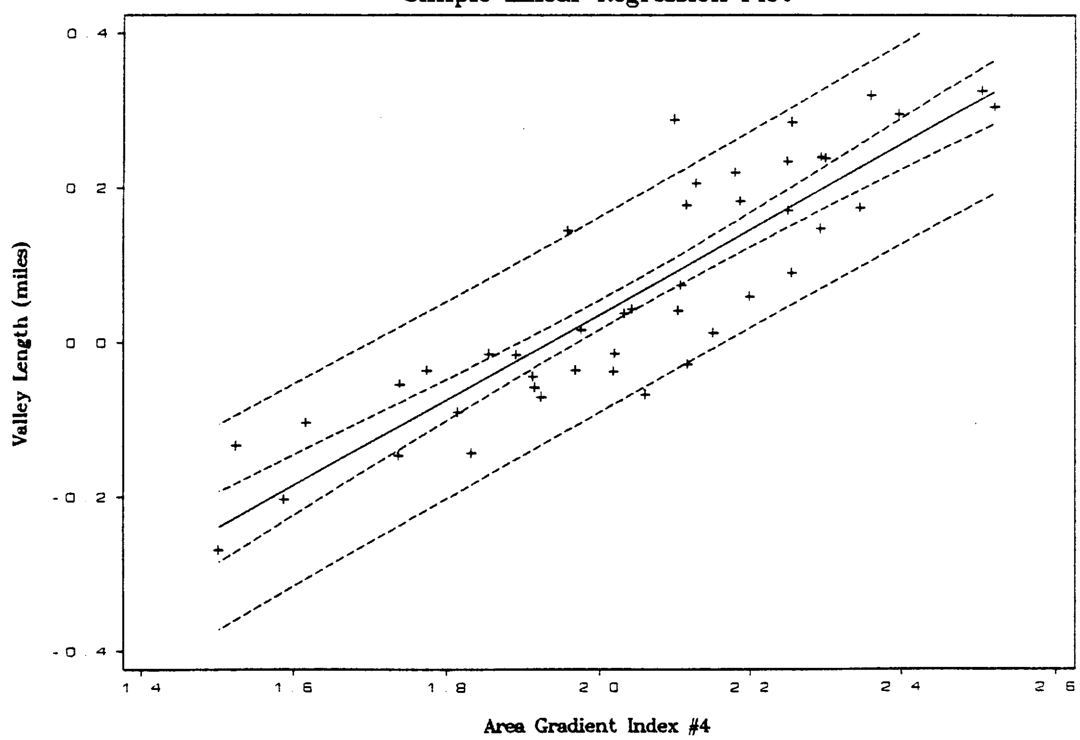
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-1.06986	0.09417	-11.36	0.0000
AGI4	0.55324	0.04567	12.11	0.0000

R-SQUARED	0.7775	RESID. MEAN SQUARE (MSE)	0.00553
ADJUSTED R-SQUARED	0.7722	STANDARD DEVIATION	0.07438

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.81190	0.81190	146.75	0.0000
RESIDUAL	42	0.23237	0.00553		
TOTAL	43	1.04427			

CASES INCLUDED 44   MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "B" second order regression output of basin relief versus basin length.

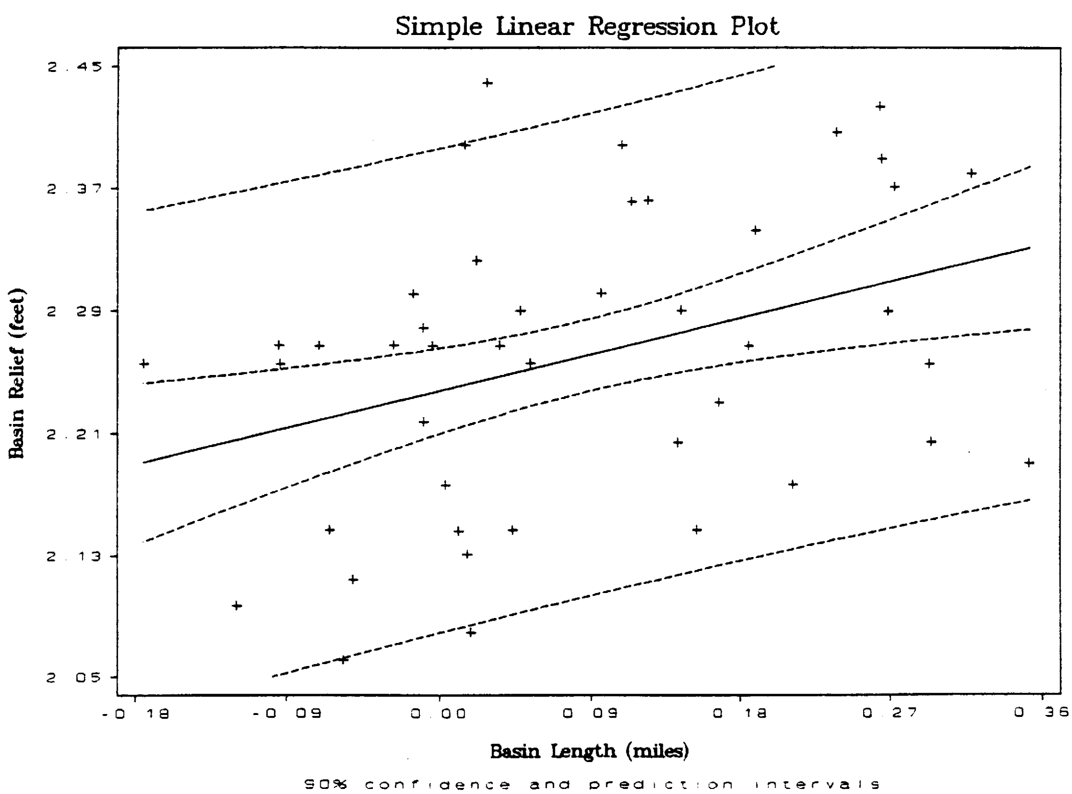
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BASIN RELIEF

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	2.23745	0.01658	134.93	0.0000
BL	0.26579	0.10551	2.52	0.0157

R-SQUARED	0.1313	RESID. MEAN SQUARE (MSE)	0.00862
ADJUSTED R-SQUARED	0.1106	STANDARD DEVIATION	0.09286

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.05472	0.05472	6.35	0.0157
RESIDUAL	42	0.36216	0.00862		
TOTAL	43	0.41688			

CASES INCLUDED 44   MISSING CASES 0



Strata "B" second order regression output for used relief versus basin area and channel slope.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF USED RELIEF

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	3.24234	0.31391	10.33	0.0000
BA	0.47309	0.11211	4.22	0.0001
CHS	0.69677	0.17127	4.07	0.0002

R-SQUARED	0.3188	RESID. MEAN SQUARE (MSE)	0.00912
ADJUSTED R-SQUARED	0.2855	STANDARD DEVIATION	0.09548

SOURCE	DF	SS	MS	F	P
REGRESSION	2	0.17490	0.08745	9.59	0.0004
RESIDUAL	41	0.37379	0.00912		
TOTAL	43	0.54869			

CASES INCLUDED 44 MISSING CASES 0

Strata "B" second order regression output for relief ratio versus basin area.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RELIEF RATIO

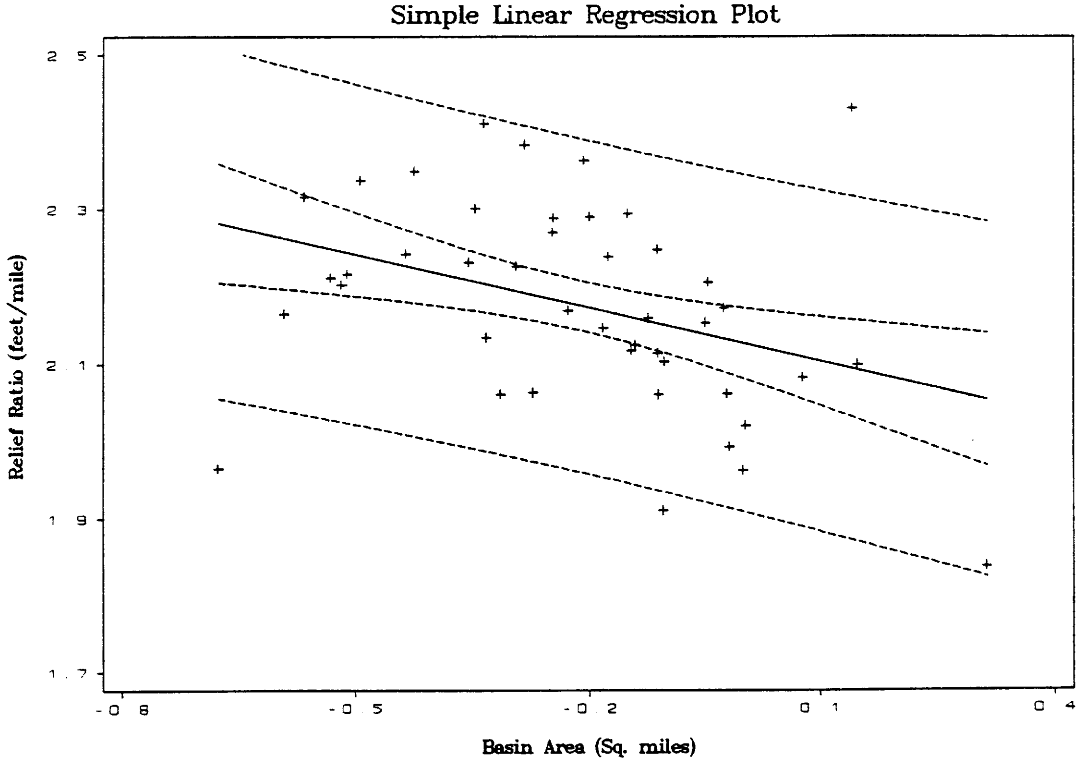
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	2.12669	0.02707	78.55	0.0000
BA	-0.23010	0.09020	-2.55	0.0145

R-SQUARED	0.1342	RESID. MEAN SQUARE (MSE)	0.01607
ADJUSTED R-SQUARED	0.1135	STANDARD DEVIATION	0.12679

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.10460	0.10460	6.51	0.0145
RESIDUAL	42	0.67513	0.01607		
TOTAL	43	0.77974			

CASES INCLUDED 44   MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "B" second order regression output for ruggedness number versus drainage density.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RUGGEDNESS NUMBER

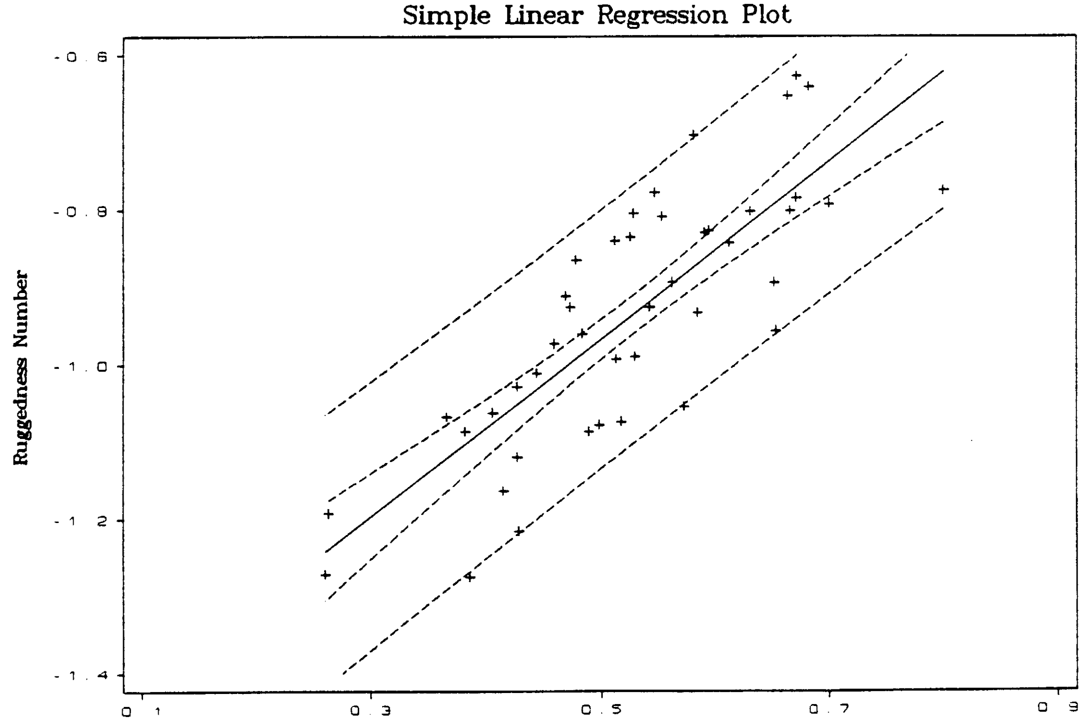
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-1.54027	0.07026	-21.92	0.0000
DD	1.14689	0.13023	8.81	0.0000

R-SQUARED	0.6487	RESID. MEAN SQUARE (MSE)	0.00963
ADJUSTED R-SQUARED	0.6404	STANDARD DEVIATION	0.09815

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.74722	0.74722	77.56	0.0000
RESIDUAL	42	0.40463	0.00963		
TOTAL	43	1.15184			

CASES INCLUDED 44   MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "B" second order regression output for channel slope versus basin area and main channel length.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF CHANNEL SLOPE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-1.77528	0.03522	-50.40	0.0000
BA	-0.37297	0.10263	-3.63	0.0008
MCHL	-0.23423	0.13230	-1.77	0.0841

R-SQUARED	0.6589	RESID. MEAN SQUARE (MSE)	0.00704
ADJUSTED R-SQUARED	0.6423	STANDARD DEVIATION	0.08392

SOURCE	DF	SS	MS	F	P
REGRESSION	2	0.55785	0.27893	39.61	0.0000
RESIDUAL	41	0.28873	0.00704		
TOTAL	43	0.84658			

CASES INCLUDED 44   MISSING CASES 0

Strata "B" second order regression output for sinuosity versus main channel length.

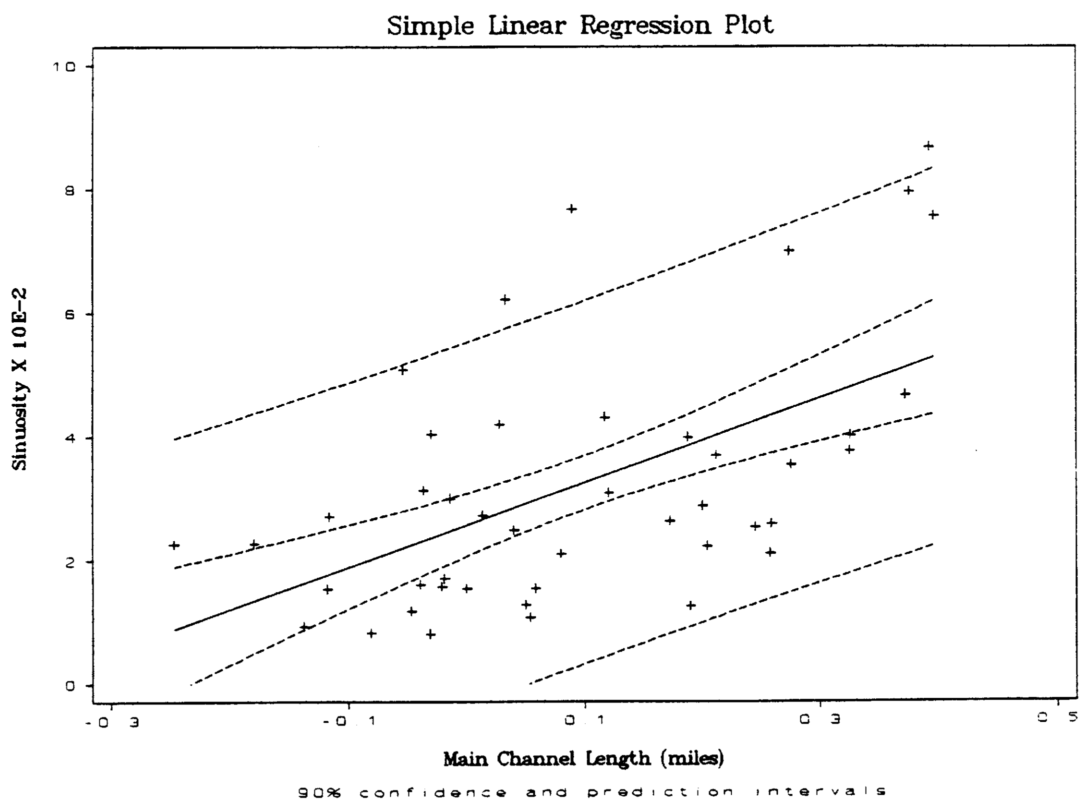
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF SINUOSITY

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.02579	0.00301	8.56	0.0000
MCHL	0.06848	0.01586	4.32	0.0001

R-SQUARED	0.3074	RESID. MEAN SQUARE (MSE)	2.991E-04
ADJUSTED R-SQUARED	0.2909	STANDARD DEVIATION	0.01729

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.00558	0.00558	18.64	0.0001
RESIDUAL	42	0.01256	2.991E-04		
TOTAL	43	0.01814			

CASES INCLUDED 44 MISSING CASES 0



Strata "B" second order regression output for valley area versus channel slope.

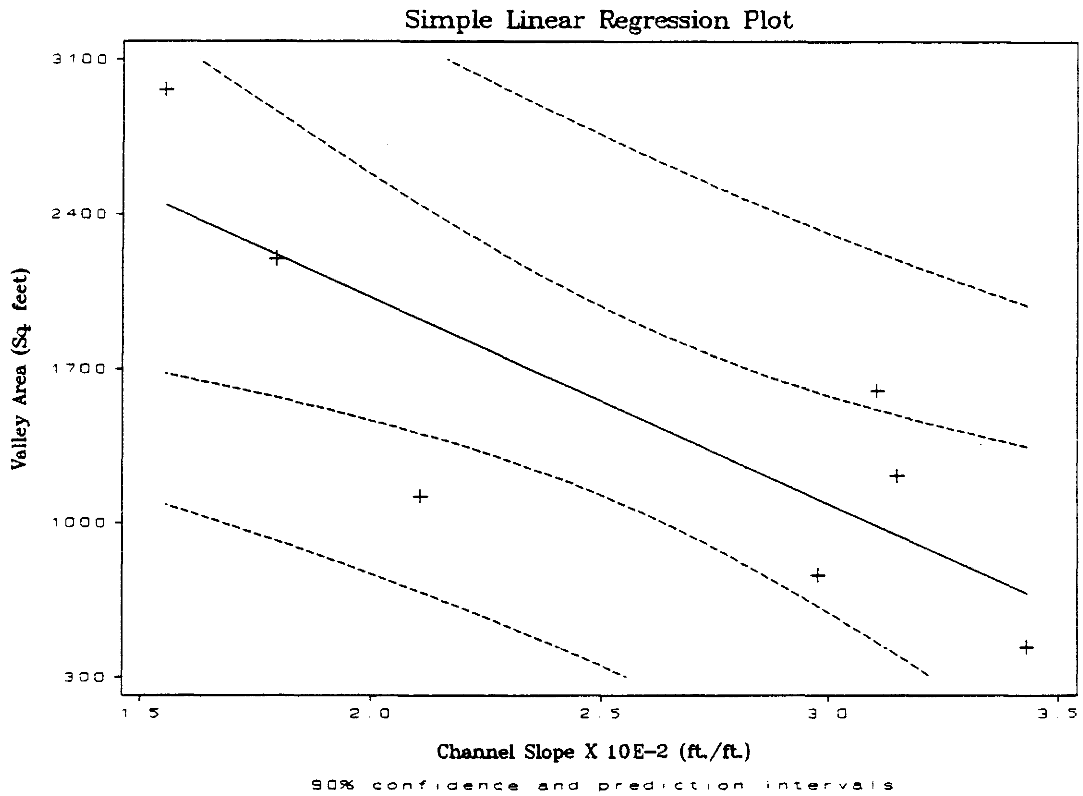
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF VALLEY AREA

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	3899.95	813.798	4.79	0.0049
CHS	-93832.6	30353.6	-3.09	0.0271

R-SQUARED	0.6565	RESID. MEAN SQUARE (MSE)	3.116E+05
ADJUSTED R-SQUARED	0.5878	STANDARD DEVIATION	558.169

SOURCE	DF	SS	MS	F	P
REGRESSION	1	2.977E+06	2.977E+06	9.56	0.0271
RESIDUAL	5	1.558E+06	3.116E+05		
TOTAL	6	4.535E+06			

CASES INCLUDED 7 MISSING CASES 0



Strata "B" second order regression output for top width versus valley area.

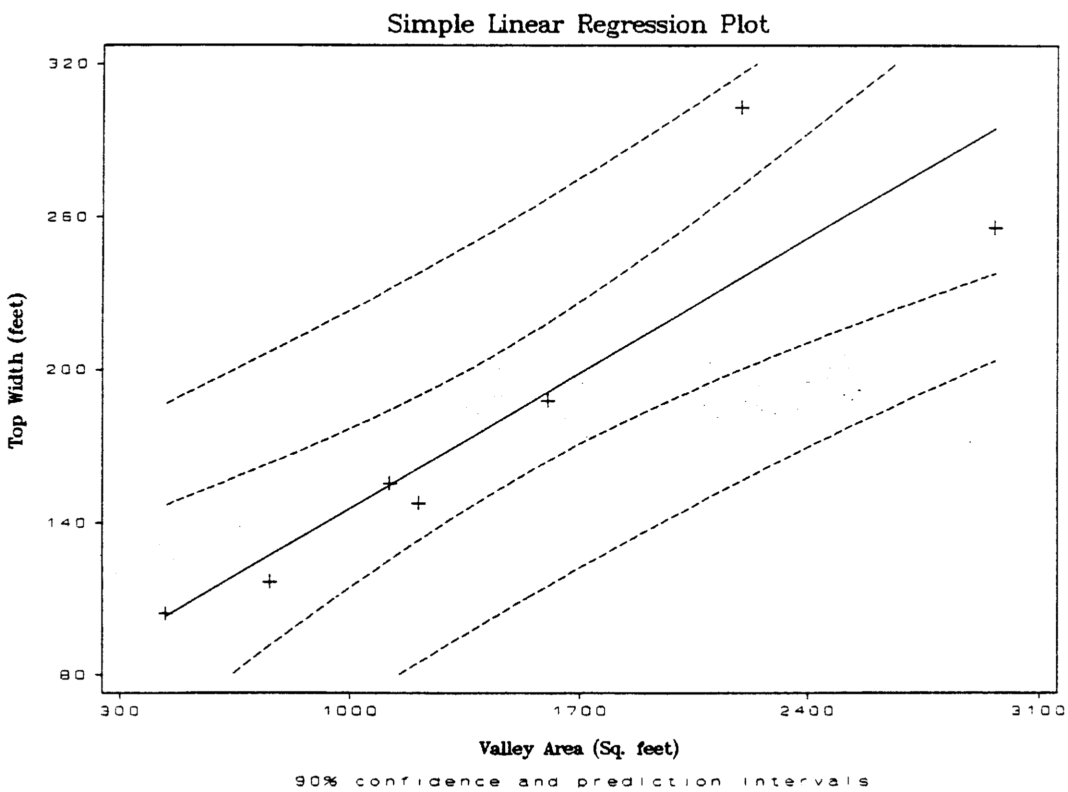
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOP WIDTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	69.9525	27.7992	2.52	0.0534
A	0.07581	0.01659	4.57	0.0060

R-SQUARED	0.8069	RESID. MEAN SQUARE (MSE)	1247.43
ADJUSTED R-SQUARED	0.7683	STANDARD DEVIATION	35.3189

SOURCE	DF	SS	MS	F	P
REGRESSION	1	26064.5	26064.5	20.89	0.0060
RESIDUAL	5	6237.14	1247.43		
TOTAL	6	32301.6			

CASES INCLUDED 7 MISSING CASES 0



Strata "B" second order regression output for average depth versus valley area.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AVERAGE DEPTH

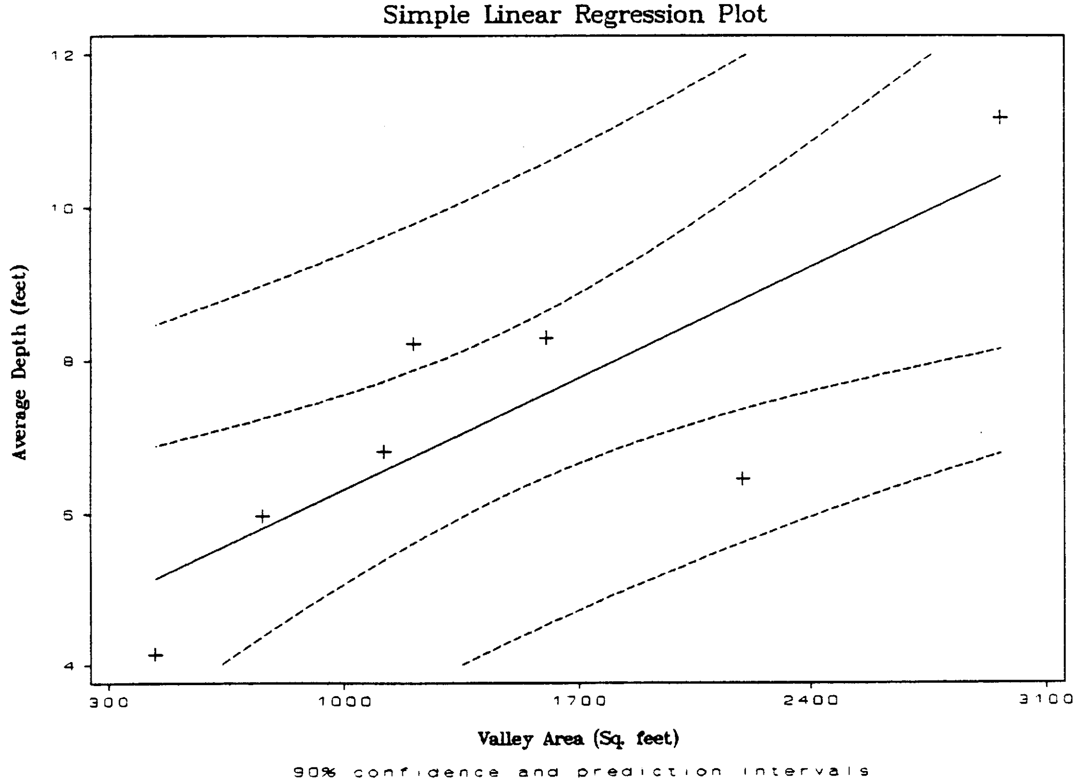
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	4.22396	1.10688	3.82	0.0124
A	0.00208	6.604E-04	3.15	0.0252

R-SQUARED	0.6656	RESID. MEAN SQUARE (MSE)	1.97767
ADJUSTED R-SQUARED	0.5987	STANDARD DEVIATION	1.40630

SOURCE	DF	SS	MS	F	P
REGRESSION	1	19.6822	19.6822	9.95	0.0252
RESIDUAL	5	9.88835	1.97767		
TOTAL	6	29.5706			

CASES INCLUDED 7 MISSING CASES 0

Simple Linear Regression Plot



Strata "B" second order regression output for ground slope versus area gradient index #2.

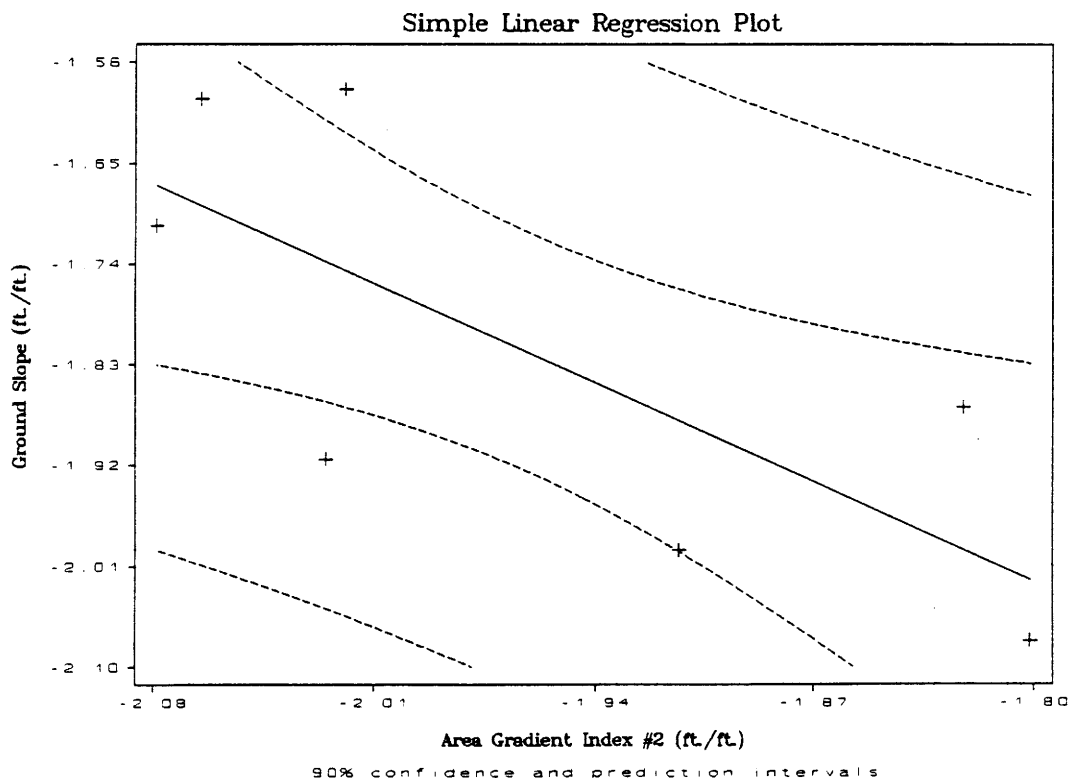
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF GROUND SLOPE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-4.30568	0.98342	-4.38	0.0072
AGI2	-1.26802	0.50089	-2.53	0.0524

R-SQUARED	0.5617	RESID. MEAN SQUARE (MSE)	0.01985
ADJUSTED R-SQUARED	0.4741	STANDARD DEVIATION	0.14089

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.12721	0.12721	6.41	0.0524
RESIDUAL	5	0.09925	0.01985		
TOTAL	6	0.22645			

CASES INCLUDED 7 MISSING CASES 0



Strata "B" second order regression output for bed width versus valley area.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BED WIDTH

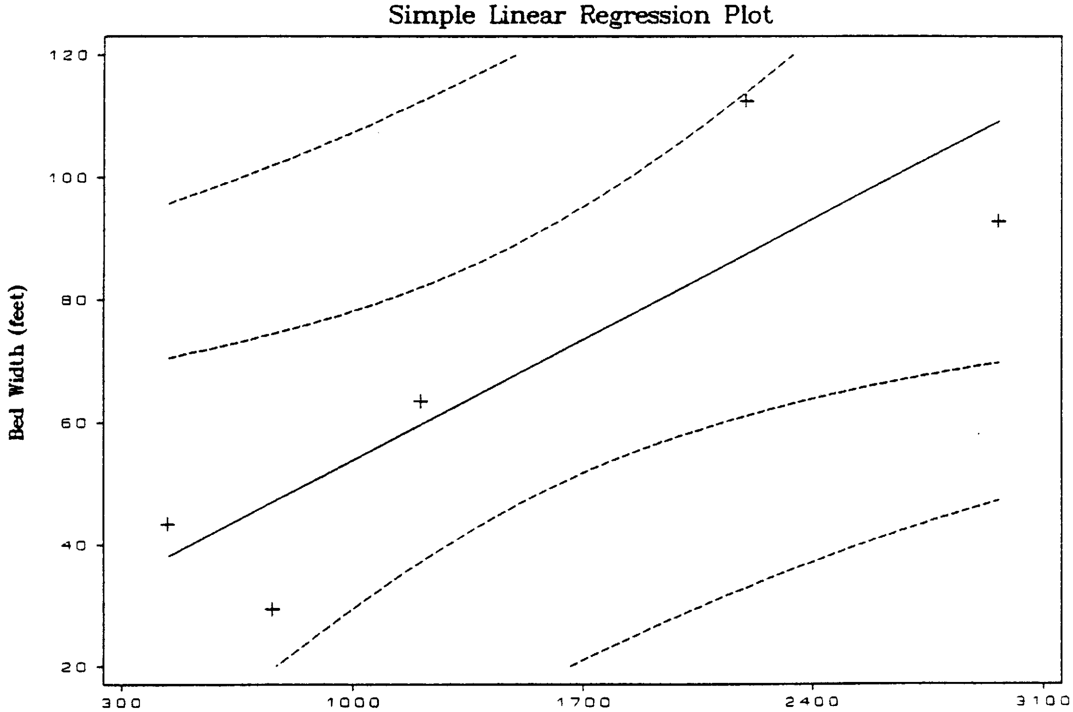
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	25.6475	17.2425	1.49	0.2336
A	0.02816	0.00969	2.91	0.0622

R-SQUARED	0.7379	RESID. MEAN SQUARE (MSE)	411.520
ADJUSTED R-SQUARED	0.6506	STANDARD DEVIATION	20.2860

SOURCE	DF	SS	MS	F	P
REGRESSION	1	3476.40	3476.40	8.45	0.0622
RESIDUAL	3	1234.56	411.520		
TOTAL	4	4710.96			

CASES INCLUDED 5   MISSING CASES 2

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "B" second order regression output of area #2 versus valley area.

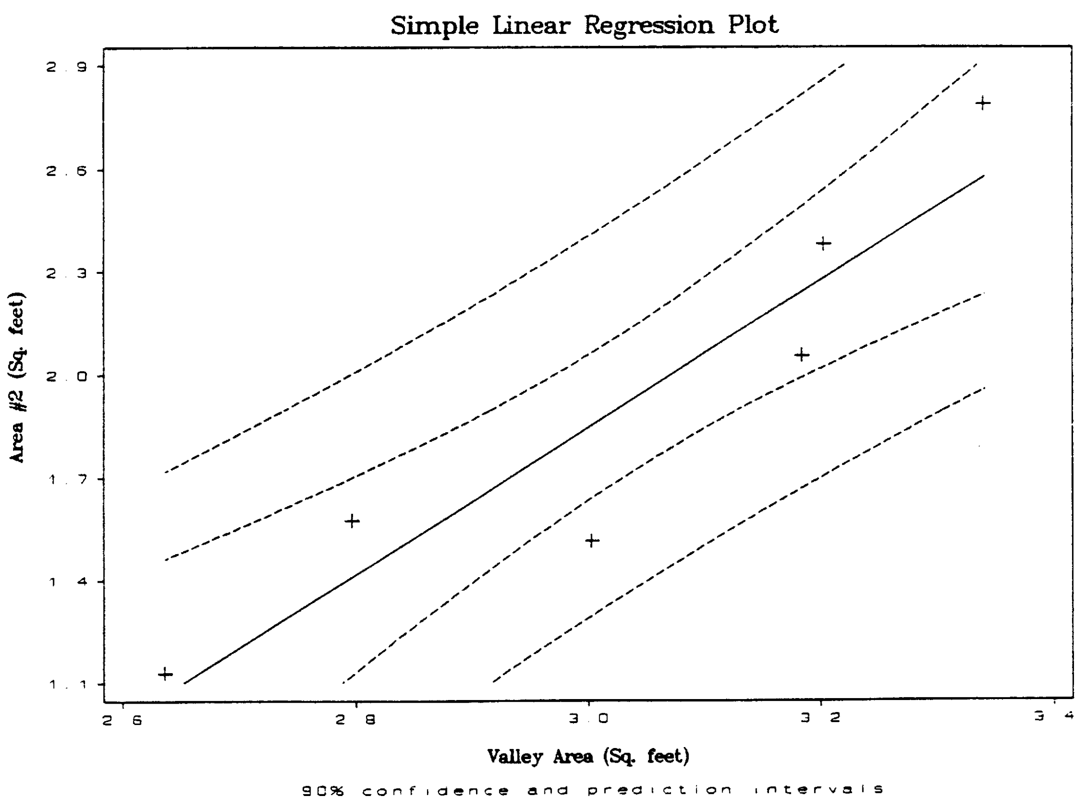
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AREA #2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-4.58585	1.22546	-3.74	0.0201
A	2.14418	0.40350	5.31	0.0060

R-SQUARED	0.8759	RESID. MEAN SQUARE (MSE)	0.05860
ADJUSTED R-SQUARED	0.8449	STANDARD DEVIATION	0.24207

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.65466	1.65466	28.24	0.0060
RESIDUAL	4	0.23438	0.05860		
TOTAL	5	1.88905			

CASES INCLUDED 6   MISSING CASES 1



Strata "B" second order regression output for top width #2 versus area #2.

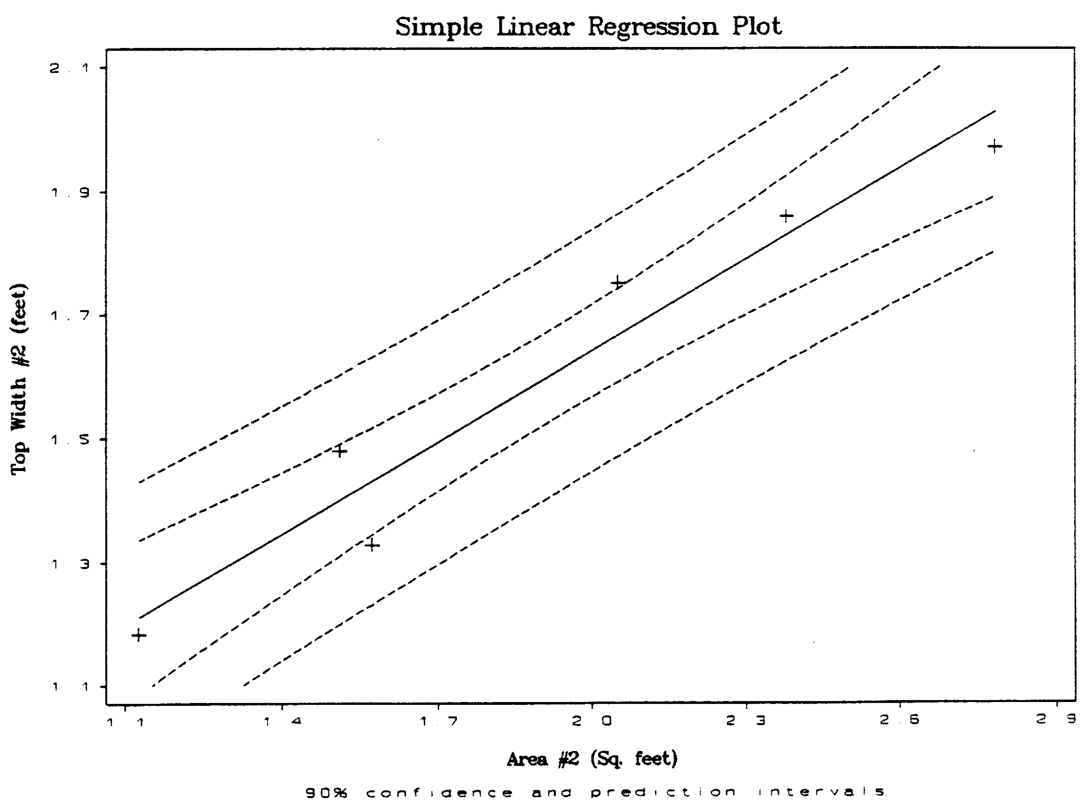
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOP WIDTH #2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.65466	0.12230	5.35	0.0059
A2	0.49333	0.06158	8.01	0.0013

R-SQUARED	0.9413	RESID. MEAN SQUARE (MSE)	0.00716
ADJUSTED R-SQUARED	0.9267	STANDARD DEVIATION	0.08464

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.45975	0.45975	64.17	0.0013
RESIDUAL	4	0.02866	0.00716		
TOTAL	5	0.48840			

CASES INCLUDED 6   MISSING CASES 1



Strata "B" second order regression output for average depth #2 versus area #2.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AVERAGE DEPTH #2

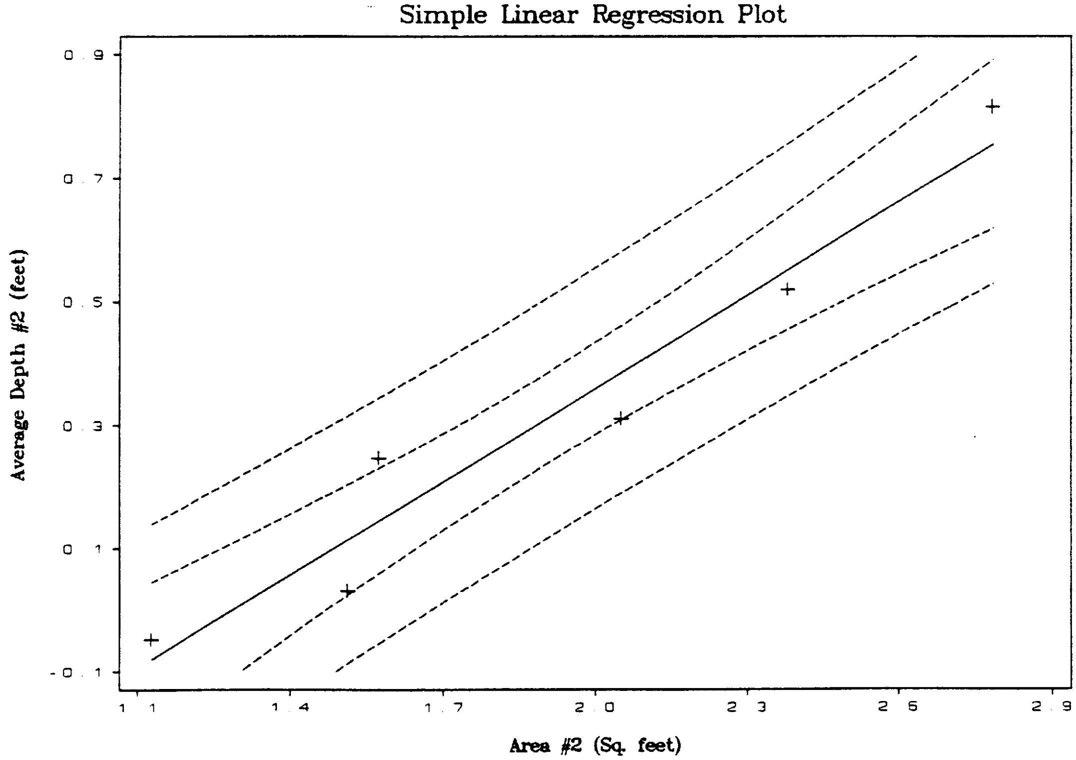
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.64990	0.12220	-5.32	0.0060
A2	0.50482	0.06153	8.20	0.0012

R-SQUARED	0.9439	RESID. MEAN SQUARE (MSE)	0.00715
ADJUSTED R-SQUARED	0.9299	STANDARD DEVIATION	0.08457

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.48141	0.48141	67.30	0.0012
RESIDUAL	4	0.02861	0.00715		
TOTAL	5	0.51002			

CASES INCLUDED 6 MISSING CASES 1

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "B" second order regression output for area #3 versus valley area.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AREA #3

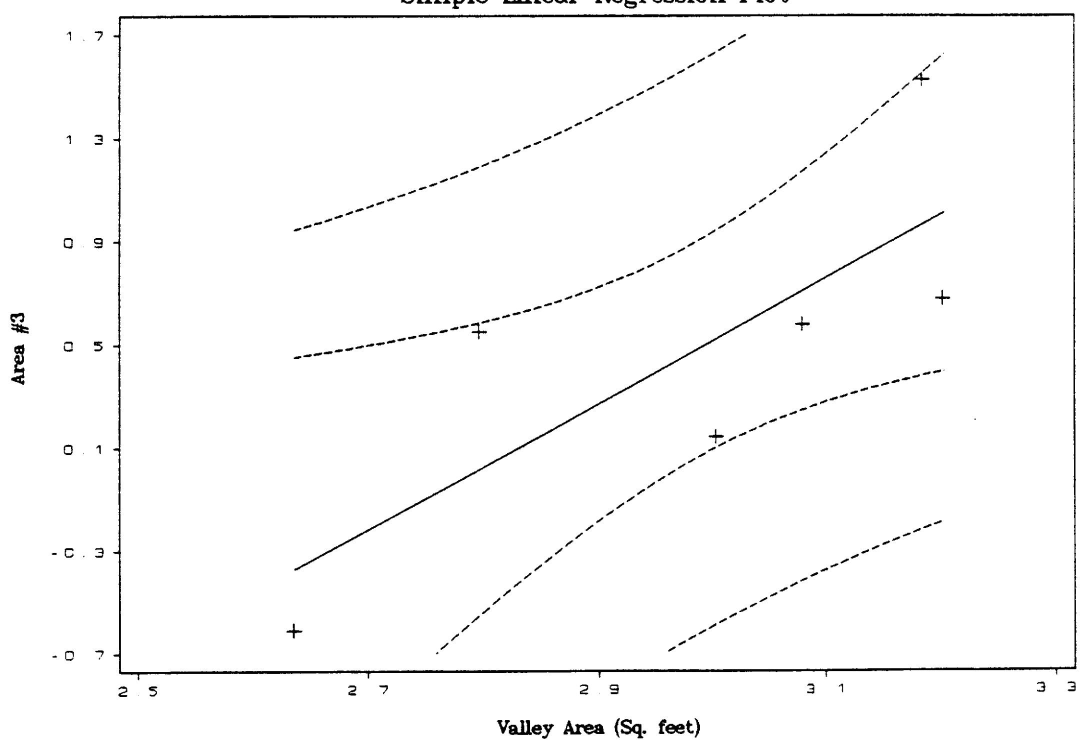
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-6.80646	2.86432	-2.38	0.0763
A	2.44015	0.95773	2.55	0.0635

R-SQUARED	0.6187	RESID. MEAN SQUARE (MSE)	0.23223
ADJUSTED R-SQUARED	0.5234	STANDARD DEVIATION	0.48191

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.50755	1.50755	6.49	0.0635
RESIDUAL	4	0.92894	0.23223		
TOTAL	5	2.43649			

CASES INCLUDED 6   MISSING CASES 1

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "B" second order regression output for top width #3 versus area #3.

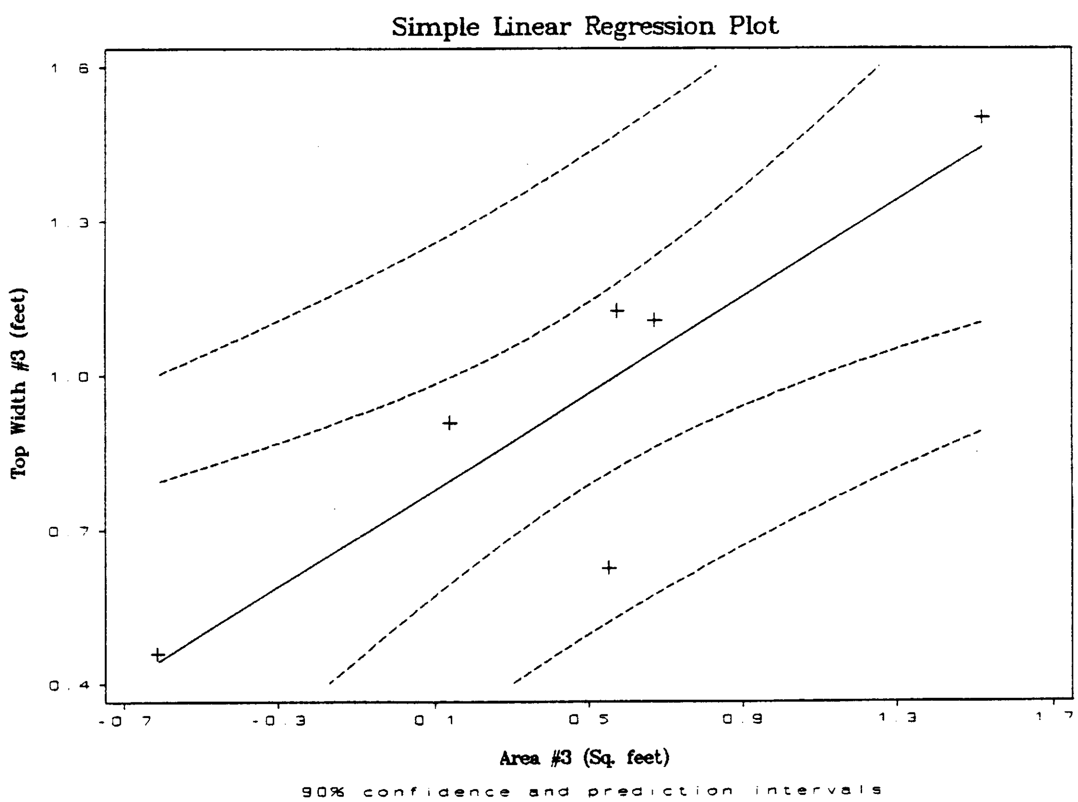
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOP WIDTH #3

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.73032	0.10363	7.05	0.0021
A3	0.46923	0.13047	3.60	0.0228

R-SQUARED	0.7638	RESID. MEAN SQUARE (MSE)	0.04148
ADJUSTED R-SQUARED	0.7047	STANDARD DEVIATION	0.20366

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.53647	0.53647	12.93	0.0228
RESIDUAL	4	0.16590	0.04148		
TOTAL	5	0.70237			

CASES INCLUDED 6   MISSING CASES 1



Strata "B" second order regression output for average depth #3 versus area #3.

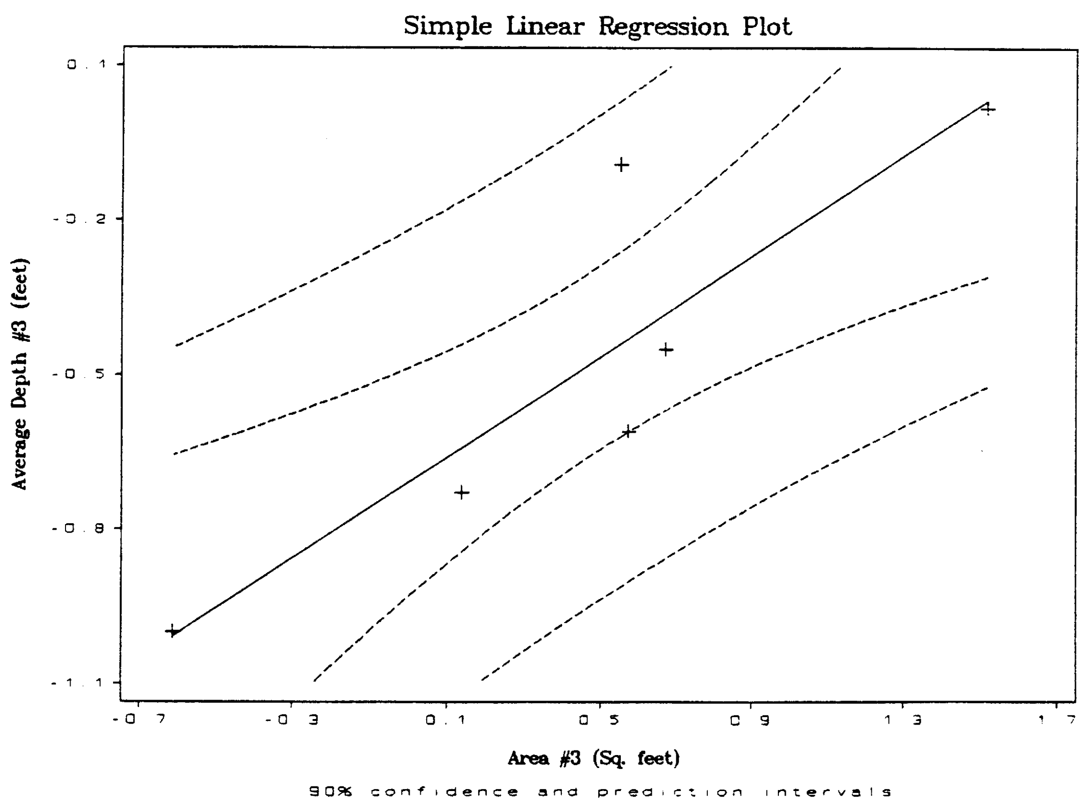
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AVGERAGE DEPTH #3

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.70938	0.10426	-6.80	0.0024
A3	0.48859	0.13126	3.72	0.0204

R-SQUARED	0.7760	RESID. MEAN SQUARE (MSE)	0.04198
ADJUSTED R-SQUARED	0.7200	STANDARD DEVIATION	0.20488

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.58165	0.58165	13.86	0.0204
RESIDUAL	4	0.16791	0.04198		
TOTAL	5	0.74956			

CASES INCLUDED 6 MISSING CASES 1



High bank reach means for **Strata "B"** second order

BASIN ID 19B0	AREA ($ft.^2$)	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	2.00	2.00	2.00	2.00	2.00	2.00	3.00	4.00
MEAN	439.80	105.90	104.40	4.15	4.15	25.14	43.30	0.009
S.D.	106.91	13.01	13.29	0.50	0.50	0.20	9.81	0.004
C.V. (%)	24.31	12.29	12.73	11.93	11.93	0.81	22.65	42.28
MINIMUM	364.20	96.70	95.00	3.80	3.80	25.00	37.00	0.006
MAXIMUM	515.40	115.10	113.80	4.50	4.50	25.29	54.60	0.014
RANGE	151.20	18.40	18.80	0.70	0.70	0.29	17.60	0.008

BASIN ID 30A0	AREA ($ft.^2$)	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	2.00	2.00	2.00	2.00	2.00	2.00	1.00	1.00
MEAN	1209.70	151.15	147.25	8.00	8.20	18.15	63.40	0.026
S.D.	221.47	4.03	3.04	1.27	1.27	2.45		
C.V. (%)	18.31	2.67	2.06	15.91	15.52	13.48		
MINIMUM	1053.10	148.30	145.10	7.10	7.30	16.42	63.40	0.026
MAXIMUM	1366.30	154.00	149.40	8.90	9.10	19.88	63.40	0.026
RANGE	313.20	5.70	4.30	1.80	1.80	3.46	0.00	0.000

BASIN ID 30B0	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	4.00	4.00	4.00	4.00	4.00	4.00	4.00	6.000
MEAN	759.17	120.17	116.25	5.75	5.95	19.66	29.35	0.033
S.D.	573.88	43.84	44.37	2.23	2.22	3.98	18.88	0.032
C.V. (%)	75.59	36.48	38.17	38.85	37.34	20.25	64.31	96.898
MINIMUM	333.90	74.50	69.60	4.10	4.30	14.50	6.30	0.014
MAXIMUM	1584.70	175.70	171.80	9.00	9.20	23.49	50.90	0.099
RANGE	1250.80	101.20	102.20	4.90	4.90	8.99	44.60	0.084

BASIN ID 36A0	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	3.00	3.00	3.00	3.00	3.00	3.00	2.00	6.00
MEAN	2193.60	306.50	302.50	6.37	6.43	59.57	112.30	0.021
S.D.	2188.70	74.95	74.08	4.89	5.00	24.39	12.59	0.020
C.V. (%)	99.78	24.45	24.49	76.73	77.73	40.93	11.21	97.13
MINIMUM	854.10	259.00	255.60	3.30	3.30	31.80	103.40	-0.003
MAXIMUM	4719.30	392.90	387.90	12.00	12.20	77.46	121.20	0.051
RANGE	3865.20	133.90	132.30	8.70	8.90	45.66	17.80	0.055

BASIN ID 36B0	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	4.00	4.00	4.00	4.00	4.00	4.00	4.00	5.00
MEAN	2965.40	262.08	256.02	10.78	11.18	37.74	92.98	0.010
S.D.	2275.00	56.65	55.49	7.33	7.75	31.11	71.26	0.002
C.V. (%)	76.72	21.61	21.67	68.02	69.33	82.44	76.64	21.11
MINIMUM	553.60	209.30	207.60	2.60	2.60	14.52	27.60	0.007
MAXIMUM	6014.40	312.30	311.10	19.40	20.30	80.35	162.50	0.012
RANGE	5460.80	103.00	103.50	16.80	17.70	65.83	134.90	0.005

BASIN ID 54A0	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	2.00	2.00	2.00	2.00	2.00	2.00		1.00
MEAN	1604.50	191.50	188.20	8.20	8.30	23.01		0.012
S.D.	690.77	32.67	31.40	2.26	2.26	2.49		
C.V. (%)	43.05	17.06	16.68	27.59	27.26	10.83		
MINIMUM	1116.10	168.40	166.00	6.60	6.70	21.25		0.012
MAXIMUM	2093.00	214.60	210.40	9.80	9.90	24.78		0.012
RANGE	976.90	46.20	44.40	3.20	3.20	3.52		

BASIN ID 54B0	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	4.00	4.00	4.00	4.00	4.00	4.00		4.00
MEAN	1119.60	158.60	155.28	6.70	6.80	23.31		0.014
S.D.	647.84	37.41	35.91	2.16	2.23	2.61		0.006
C.V. (%)	57.86	23.59	23.12	32.24	32.82	11.21		38.43
MINIMUM	630.70	119.70	117.90	5.30	5.30	20.21		0.008
MAXIMUM	2071.00	209.50	204.10	9.90	10.10	26.13		0.021
RANGE	1440.30	89.80	86.20	4.60	4.80	5.92		0.013

Medium bank reach means for **Strata "B"** second order

BASIN ID 19BO	**AREA** (ft.^{2})	**WETTED PERIMETER** (ft.)	**TOP WIDTH** (ft.)	**HYDRAULIC RADIUS**	**AVERAGE DEPTH** (ft.)	**W/D RATIO**
n	2.00	2.00	2.00	2.00	2.00	2.00
MEAN	48.30	31.55	31.10	1.00	1.05	22.19
S.D.	65.62	38.40	38.33	0.85	0.78	20.06
C.V. (%)	135.86	121.70	123.23	84.85	74.08	90.43
MINIMUM	1.90	4.40	4.00	0.40	0.50	8.00
MAXIMUM	94.70	58.70	58.20	1.60	1.60	36.38
RANGE	92.80	54.30	54.20	1.20	1.10	28.38

BASIN ID 30BO	**AREA** (ft.^{2})	**WETTED PERIMETER** (ft.)	**TOP WIDTH** (ft.)	**HYDRAULIC RADIUS**	**AVERAGE DEPTH** (ft.)	**W/D RATIO**
n	4.00	4.00	4.00	4.00	4.00	4.00
MEAN	56.10	29.55	27.78	1.63	1.80	14.03
S.D.	49.90	20.03	21.00	0.51	0.44	8.26
C.V. (%)	88.94	67.78	75.62	31.53	24.43	58.91
MINIMUM	12.80	12.10	9.50	1.10	1.30	6.50
MAXIMUM	114.90	51.40	50.70	2.20	2.30	22.04
RANGE	102.10	39.30	41.20	1.10	1.00	15.54

BASIN ID 36AO	AREA $(ft.^2)$	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	3.00	3.00	3.00	3.00	3.00	3.00
MEAN	275.73	95.00	93.40	3.27	3.37	32.42
S.D.	186.03	83.67	84.71	0.58	0.67	35.61
C.V. (%)	67.47	88.07	90.70	17.67	19.78	109.83
MINIMUM	161.60	45.30	43.10	2.60	2.60	11.65
MAXIMUM	490.40	191.60	191.20	3.60	3.80	73.54
RANGE	328.80	146.30	148.10	1.00	1.20	61.89

BASIN ID 36BO	AREA $(ft.^2)$	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	2.00	2.00	2.00	2.00	2.00	2.00
MEAN	608.95	97.45	93.35	6.25	6.55	14.48
S.D.	38.54	6.29	7.71	0.78	0.92	3.21
C.V. (%)	6.33	6.46	8.26	12.45	14.03	22.16
MINIMUM	581.70	93.00	87.90	5.70	5.90	12.21
MAXIMUM	636.20	101.90	98.80	6.80	7.20	16.75
RANGE	54.50	8.90	10.90	1.10	1.30	4.54

BASIN ID 54AO	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	2.00	2.00	2.00	2.00	2.00	2.00
MEAN	118.50	56.95	56.25	2.05	2.10	27.87
S.D.	51.90	6.29	6.15	0.64	0.71	6.46
C.V. (%)	43.80	11.05	10.94	31.04	33.67	23.16
MINIMUM	81.80	52.50	51.90	1.60	1.60	23.31
MAXIMUM	155.20	61.40	60.60	2.50	2.60	32.44
RANGE	73.40	8.90	8.70	0.90	1.00	9.13

BASIN ID 54BO	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	4.00	4.00	4.00	4.00	4.00	4.00
MEAN	51.20	33.15	32.60	1.28	1.30	29.05
S.D.	48.40	14.59	14.17	0.87	0.91	7.68
C.V. (%)	94.53	44.01	43.46	67.89	69.94	26.44
MINIMUM	9.30	17.90	17.70	0.50	0.50	18.16
MAXIMUM	113.00	46.80	45.40	2.40	2.50	35.40
RANGE	103.70	28.90	27.70	1.90	2.00	17.24

Low bank reach means for **Strata "B"** second order

BASIN ID 19B0	**AREA** (ft.^{2})	**WETTED PERIMETER** (ft.)	**TOP WIDTH** (ft.)	**HYDRAULIC RADIUS**	**AVERAGE DEPTH** (ft.)	**W/D RATIO**
n	2.00	2.00	2.00	2.00	2.00	2.00
MEAN	0.25	2.90	2.90	0.10	0.10	29.00
S.D.	0.07	0.57	0.57	0.00	0.00	5.66
C.V. (%)	28.28	19.51	19.51	0.00	0.00	19.51
MINIMUM	0.20	2.50	2.50	0.10	0.10	25.00
MAXIMUM	0.30	3.30	3.30	0.10	0.10	33.00
RANGE	0.10	0.80	0.80	0.00	0.00	8.00

BASIN ID 30B0	**AREA** (ft.^{2})	**WETTED PERIMETER** (ft.)	**TOP WIDTH** (ft.)	**HYDRAULIC RADIUS**	**AVERAGE DEPTH** (ft.)	**W/D RATIO**
n	2.00	2.00	2.00	2.00	2.00	2.00
MEAN	3.80	5.60	4.25	0.65	0.85	5.34
S.D.	1.84	0.71	0.50	0.21	0.35	1.64
C.V. (%)	48.38	12.63	11.65	32.64	41.60	30.69
MINIMUM	2.50	5.10	3.90	0.50	0.60	4.18
MAXIMUM	5.10	6.10	4.60	0.80	1.10	6.50
RANGE	2.60	1.00	0.70	0.30	0.50	2.32

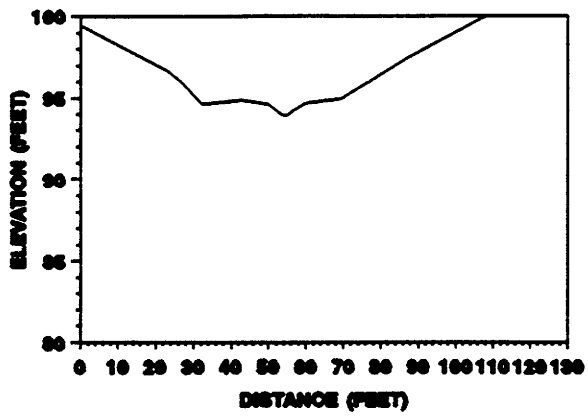
BASIN ID 36A0	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	4.00	4.00	4.00	4.00	4.00	4.00
MEAN	8.48	13.55	13.38	0.50	0.50	40.30
S.D.	10.93	5.00	4.79	0.54	0.54	17.88
C.V. (%)	128.92	36.89	35.82	107.08	107.08	44.38
MINIMUM	1.60	8.40	8.30	0.20	0.20	14.69
MAXIMUM	24.70	19.70	19.10	1.30	1.30	54.00
RANGE	23.10	11.30	10.80	1.10	1.10	39.31

BASIN ID 54A0	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	2.00	2.00	2.00	2.00	2.00	2.00
MEAN	33.25	31.80	31.50	1.05	1.05	30.63
S.D.	5.59	0.00	0.00	0.21	0.21	6.19
C.V. (%)	16.80	0.00	0.00	20.20	20.20	20.20
MINIMUM	29.30	31.80	31.50	0.90	0.90	26.25
MAXIMUM	37.20	31.80	31.50	1.20	1.20	35.00
RANGE	7.90	0.00	0.00	0.30	0.30	8.75

BASIN ID 54B0	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	4.00	4.00	4.00	4.00	4.00	4.00
MEAN	4.05	13.05	13.00	0.23	0.23	49.38
S.D.	4.30	11.39	11.33	0.15	0.15	24.31
C.V. (%)	106.19	87.27	87.16	66.67	66.67	49.23
MINIMUM	0.10	1.70	1.70	0.10	0.10	17.00
MAXIMUM	8.30	23.10	23.00	0.40	0.40	75.00
RANGE	8.20	21.40	21.30	0.30	0.30	58.00

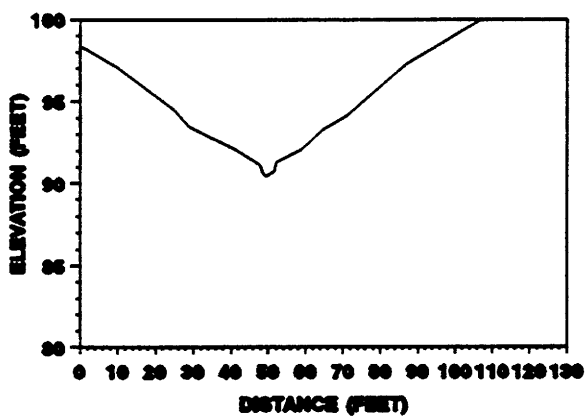
BONE PILE CREEK, 1980

CROSS SECTION 0+00.00



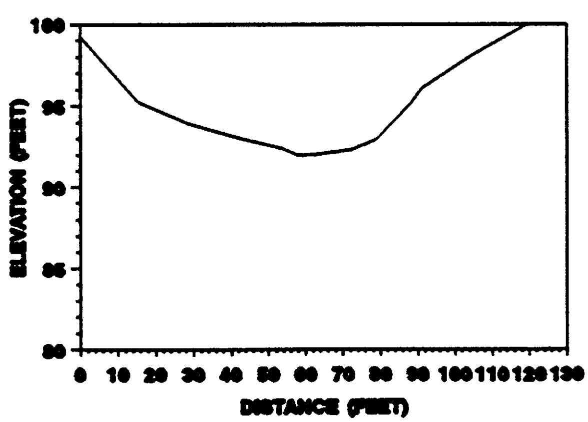
BONE PILE CREEK, 1980

CROSS SECTION 4+00.00



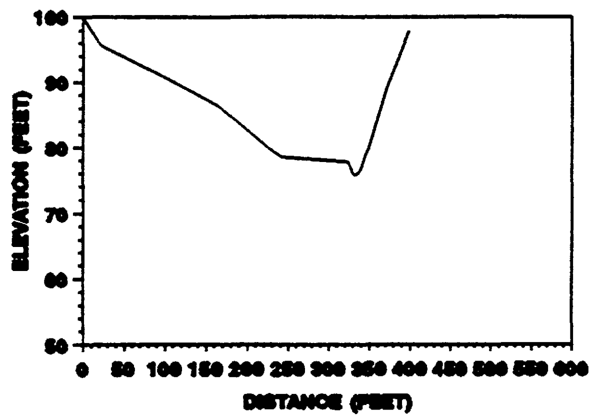
BONE PILE CREEK, 1980

CROSS SECTION 6+14.00



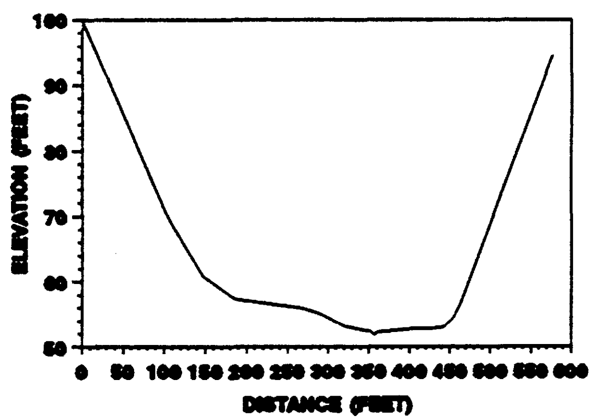
HAY CREEK, 36A0

CROSS SECTION 0+08.80



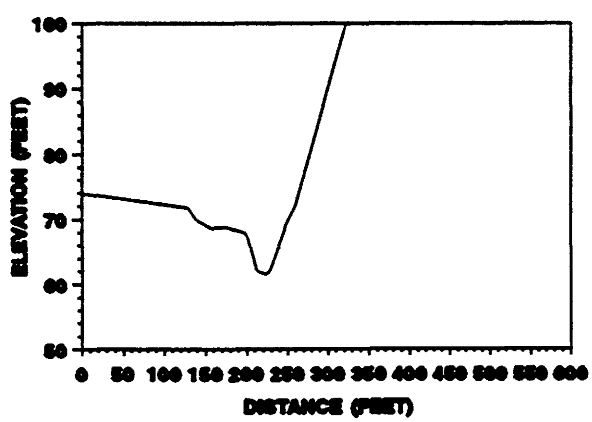
HAY CREEK, 36A0

CROSS SECTION 4+88.40



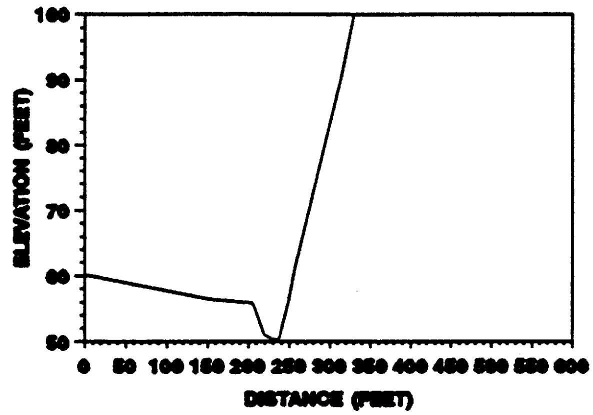
HAY CREEK, 36A0

CROSS SECTION 7+88.10



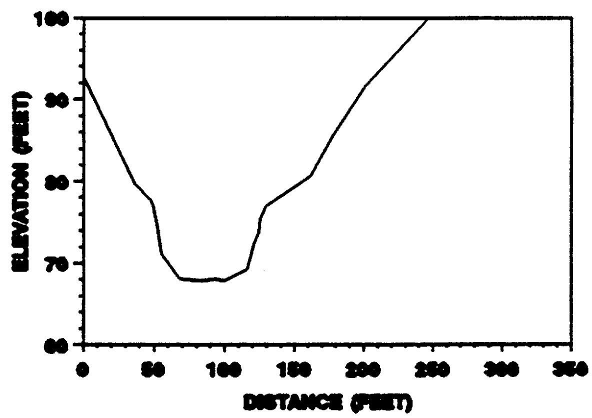
HAY CREEK, 36A0

CROSS SECTION 9+00.30



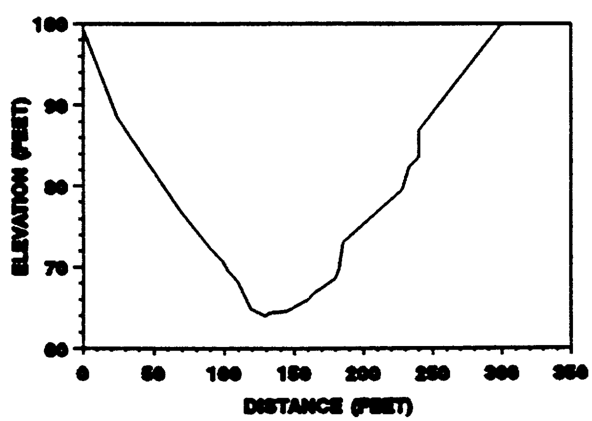
HAY CREEK, 36B0

CROSS SECTION 0+00.00

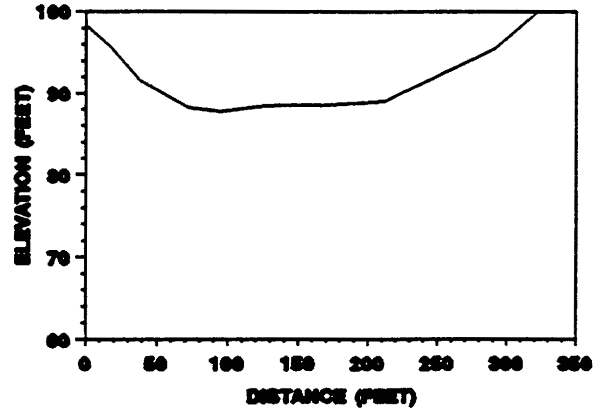


HAY CREEK, 36B0

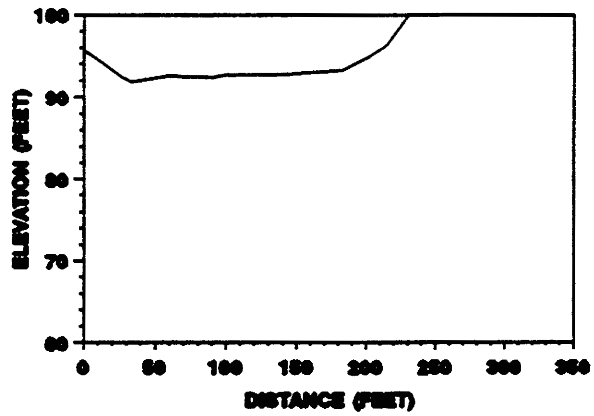
CROSS SECTION 2+21.80



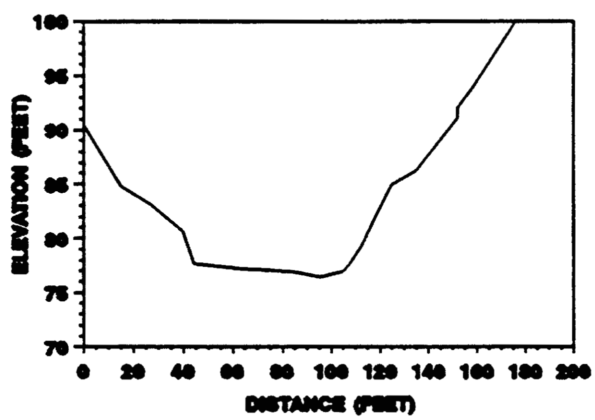
HAY CREEK, 36B0
CROSS SECTION 16+14.40



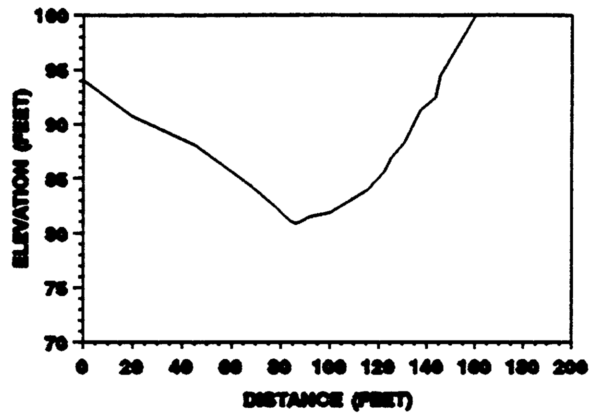
HAY CREEK, 36B0
CROSS SECTION 29+68.80



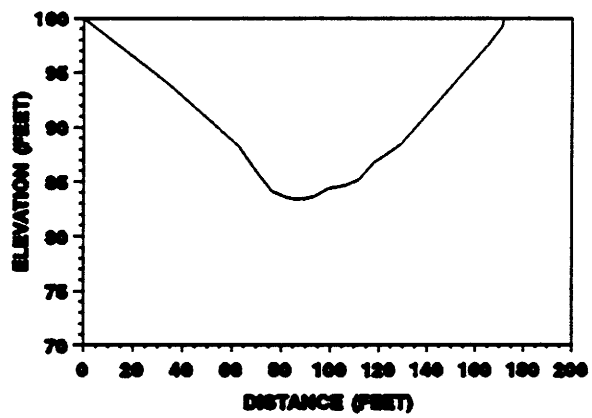
BELLE FOURCHE RIVER, 30A0
CROSS SECTION 0+08.80



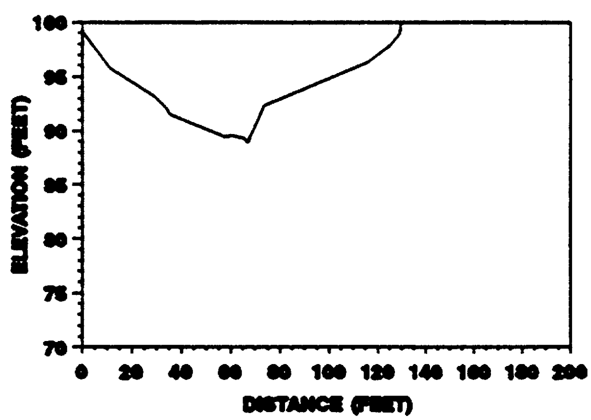
BELLE FOURCHE RIVER, 30A0
CROSS SECTION 0+73.00



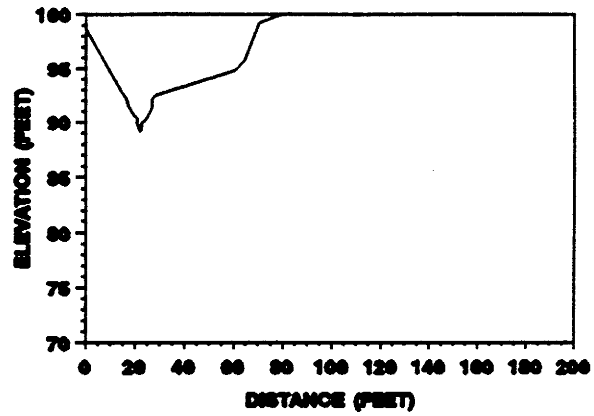
BELLE FOURCHE RIVER, 30B0
CROSS SECTION 0+00.00



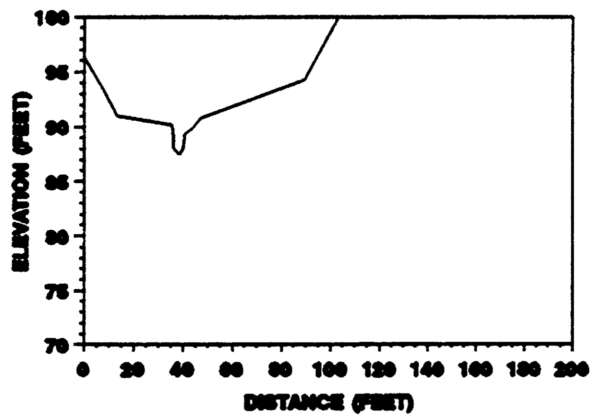
BELLE FOURCHE RIVER, 30B0
CROSS SECTION 1+00.00



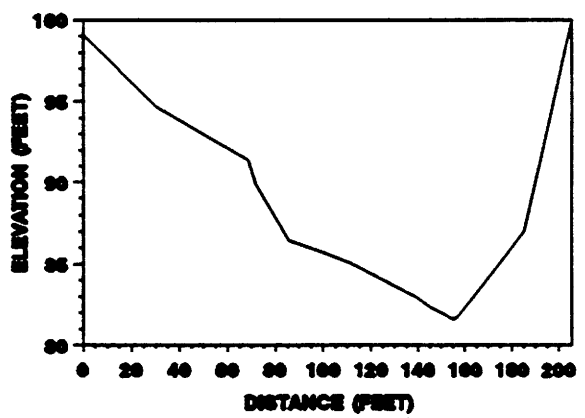
BELLE FOURCHE RIVER, 30B0
CROSS SECTION 11+72.00



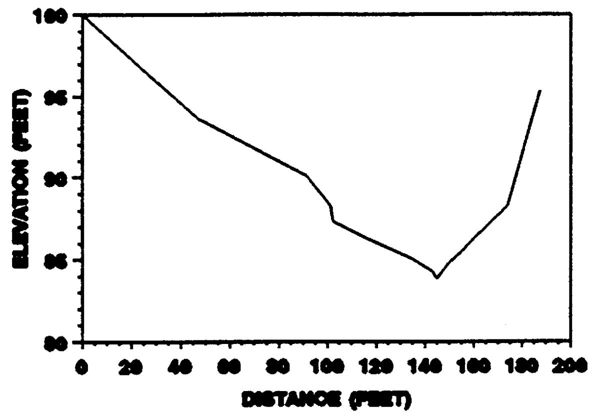
BELLE FOURCHE RIVER, 30B0
CROSS SECTION 12+12.00



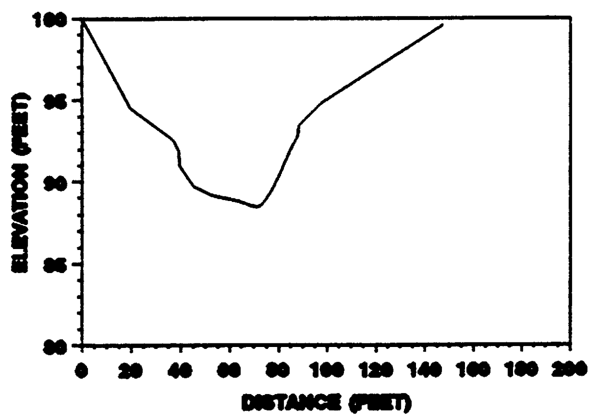
HORSE CREEK, 54B0
CROSS SECTION 0+00.00



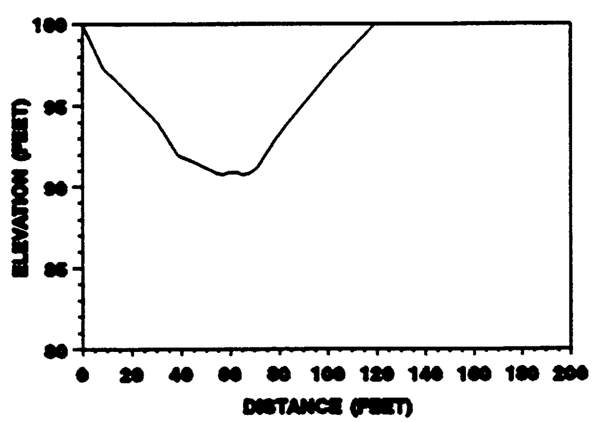
HORSE CREEK, 54B0
CROSS SECTION 1+13.00



HORSE CREEK, 54B0
CROSS SECTION 7+06.00

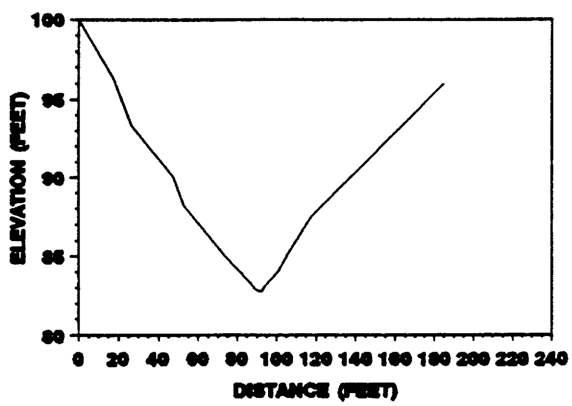


HORSE CREEK, 54B0
CROSS SECTION 9+44.50



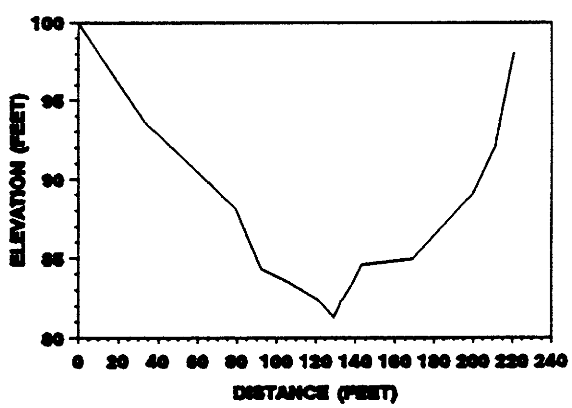
HORSE CREEK, 54A0

CROSS SECTION 0+00.00



HORSE CREEK, 54A0

CROSS SECTION 1+03.40

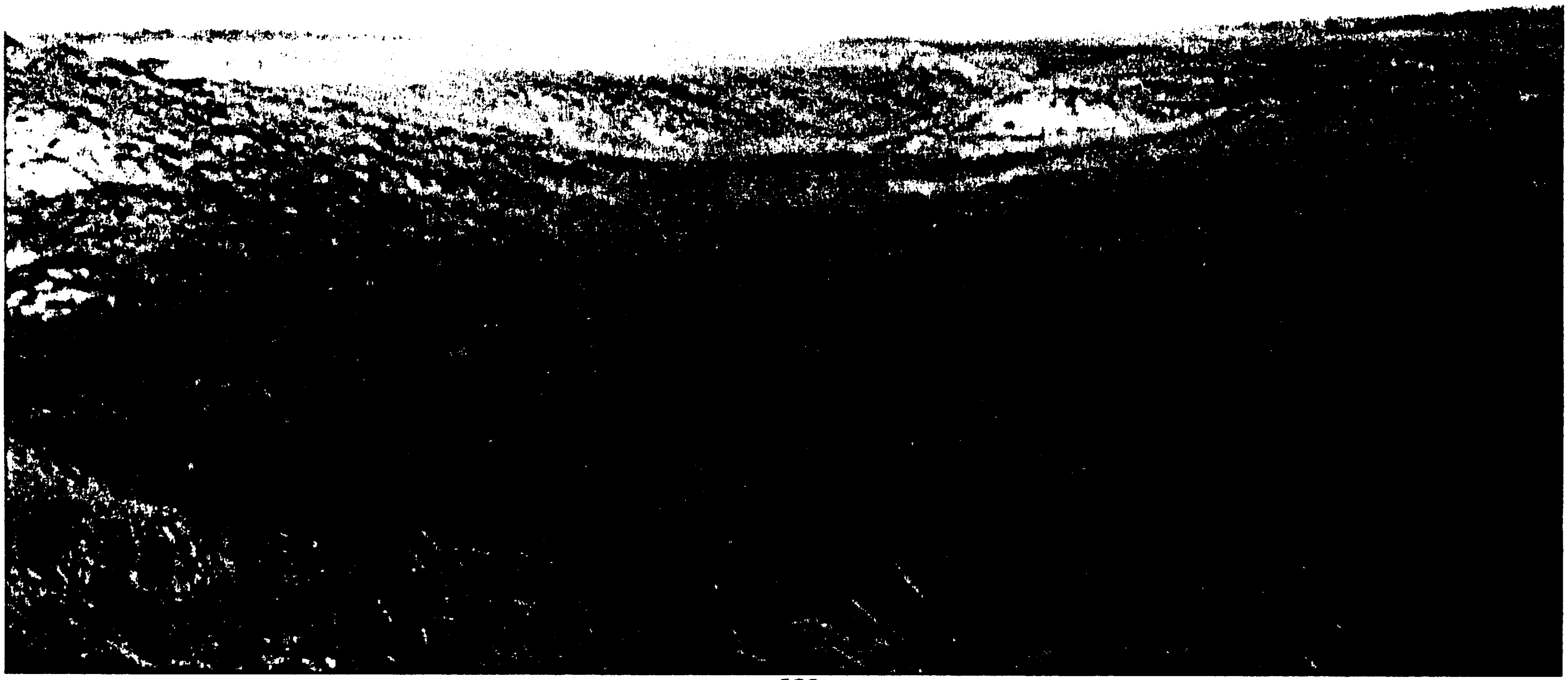


Strata "B" second order raw data by study reach, cross section, and bank identification.

BASIN I.D.	CROSS SECTION NUMBER	BANK I.D.	AREA (feet^2)	TOP WIDTH (feet)	AVERAGE DEPTH (feet)	BED WIDTH (feet)
19B0	4+69.90	HIGH	364.20	95.00	3.80	37.00
19B0	6+14.90	HIGH	515.40	113.80	4.50	54.60
30A0	0+00.00	HIGH	1366.30	149.40	9.10	63.40
30A0	0+73.00	HIGH	1053.10	145.10	7.30	
30B0	0+00.00	HIGH	1584.70	171.80	9.20	24.10
30B0	1+03.00	HIGH	710.00	129.20	5.50	6.30
30B0	11+72.00	HIGH	333.90	69.60	4.80	50.90
30B0	12+12.00	HIGH	408.10	94.40	4.30	36.10
36A0	0+00.00	HIGH	4719.30	387.90	12.20	103.40
36A0	7+89.10	HIGH	1007.40	264.00	3.80	
36A0	9+00.30	HIGH	854.10	255.60	3.30	
36B0	0+00.00	HIGH	2971.00	207.60	14.30	35.60
36B0	2+21.50	HIGH	6014.40	296.50	20.30	27.60
36B0	16+14.40	HIGH	2322.50	311.10	7.50	146.20
36B0	20+09.60	HIGH	553.60	208.90	2.60	162.50
54A0	0+00.00	HIGH	1116.10	166.00	6.70	
54A0	1+03.40	HIGH	2093.00	210.40	9.90	
54B0	0+00.00	HIGH	2071.00	204.10	10.10	96.60
54B0	1+13.00	HIGH	951.60	152.80	6.20	
54B0	7+66.00	HIGH	825.20	146.30	5.60	
54B0	9+44.50	HIGH	630.70	117.90	5.30	
19B0	0+00.00	MEDIUM	94.70	58.20	1.60	38.30
19B0	4+69.90	MEDIUM	1.90	4.00	0.50	
30B0	0+00.00	MEDIUM	114.90	50.70	2.30	
30B0	1+03.00	MEDIUM	80.10	40.50	2.00	
30B0	11+72.00	MEDIUM	16.60	10.40	1.60	

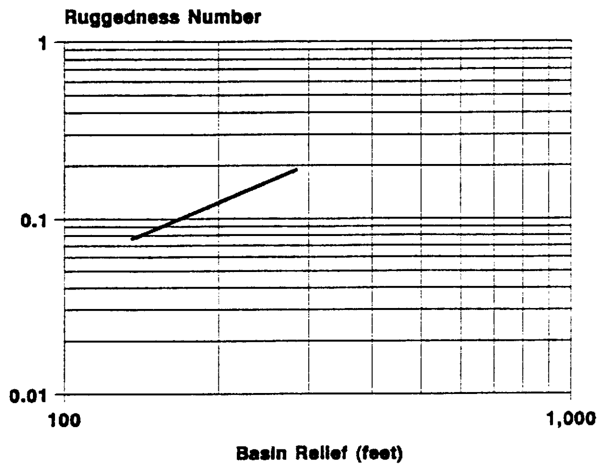
BASIN I.D.	CROSS SECTION NUMBER	BANK I.D.	AREA (feet^2)	TOP WIDTH (feet)	AVERAGE DEPTH (feet)	BED WIDTH (feet)
30B0	12+12.00	MEDIUM	12.80	9.50	1.30	
36A0	4+88.40	MEDIUM	490.40	191.20	2.60	121.20
36A0	7+89.10	MEDIUM	175.20	45.90	3.80	
36A0	9+00.30	MEDIUM	161.60	43.10	3.70	
36B0	0+00.00	MEDIUM	636.20	87.90	7.20	
36B0	2+21.50	MEDIUM	581.70	98.80	5.90	
54A0	0+00.00	MEDIUM	155.20	60.60	2.60	
54A0	1+03.40	MEDIUM	81.80	51.90	1.60	
54B0	0+00.00	MEDIUM	16.20	23.30	0.70	
54B0	1+13.00	MEDIUM	9.30	17.70	0.50	
54B0	7+66.00	MEDIUM	113.00	45.40	2.50	
54B0	9+44.50	MEDIUM	66.30	44.00	1.50	
19B0	0+00.00	LOW	0.30	3.30	0.10	
19B0	4+69.90	LOW	0.20	2.50	0.10	
30A0	0+00.00	LOW	4.50	18.50	0.20	
30A0	0+73.00	LOW	3.10	9.50	0.30	
30B0	11+72.00	LOW	2.50	3.90	0.60	
30B0	12+12.00	LOW	5.10	4.60	1.10	
36A0	0+00.00	LOW	24.70	19.10	1.30	
36A0	4+88.40	LOW	1.60	8.30	0.20	
36A0	7+89.10	LOW	5.20	15.30	0.30	
36A0	9+00.30	LOW	2.40	10.80	0.20	
54A0	0+00.00	LOW	37.20	31.50	1.20	
54A0	1+03.40	LOW	29.30	31.50	0.90	
54B0	0+00.00	LOW	0.60	4.80	0.10	
54B0	1+13.00	LOW	0.10	1.70	0.10	

BASIN I.D.	CROSS SECTION NUMBER	BANK I.D.	AREA (feet^2)	TOP WIDTH (feet)	AVERAGE DEPTH (feet)	BED WIDTH (feet)
54B0	7+66.00	LOW	8.30	23.00	0.40	
54B0	9+44.50	LOW	7.20	22.50	0.30	



APPENDIX B-3

STRATA "B" - THIRD ORDER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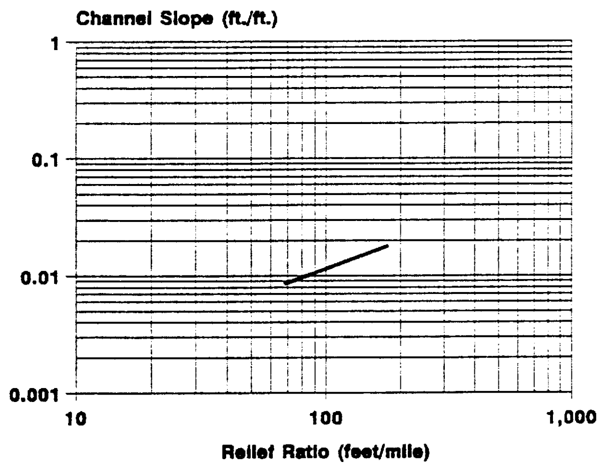
Basin Relief (feet)


Channel Slope (ft./ft.)
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10
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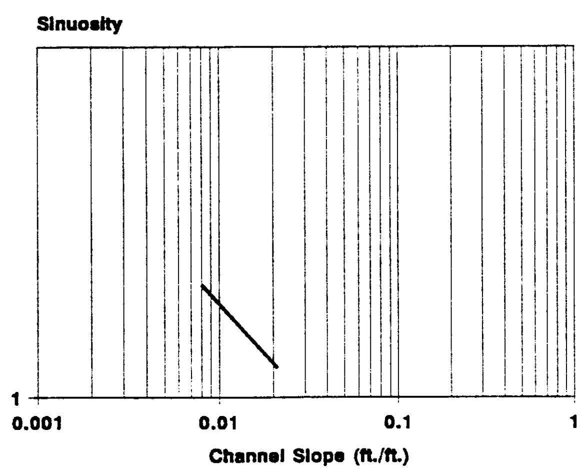
1,000
Relief Ratio (feet/mile)


Sinuosity
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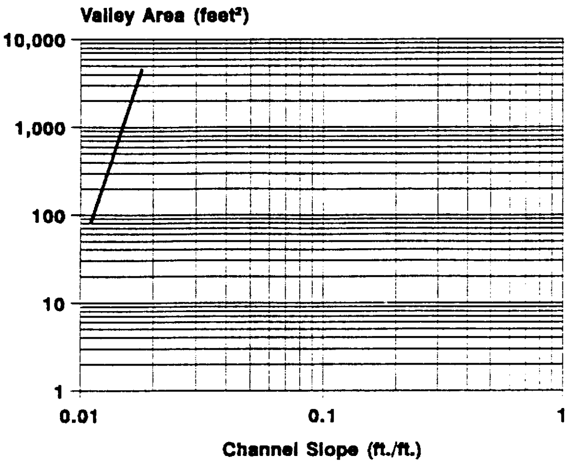
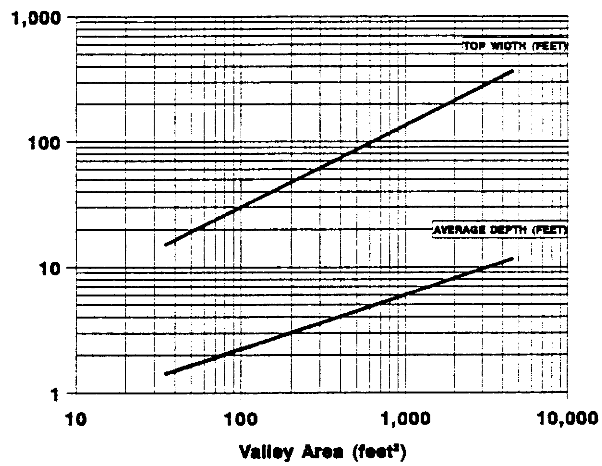
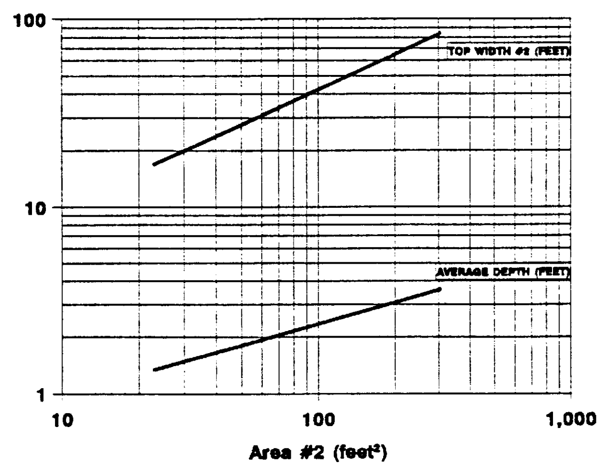
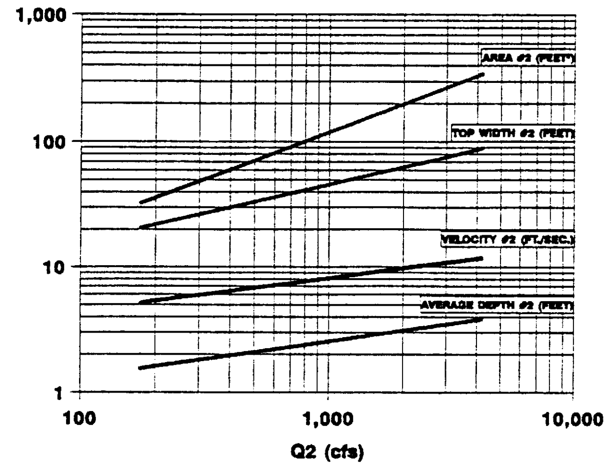
0.1
1
Channel Slope (ft./ft.)

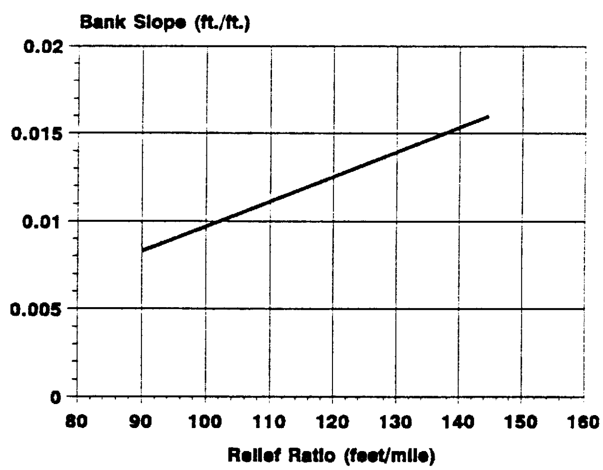

Valley Area (feet²)
10,000
1,000
100
10
1
0.01
0.1
1
Channel Slope (ft./ft.)


1,000
100
10
1
TOP WIDTH (FEET)
AVERAGE DEPTH (FEET)
10
100
1,000
10,000
Valley Area (feet²)

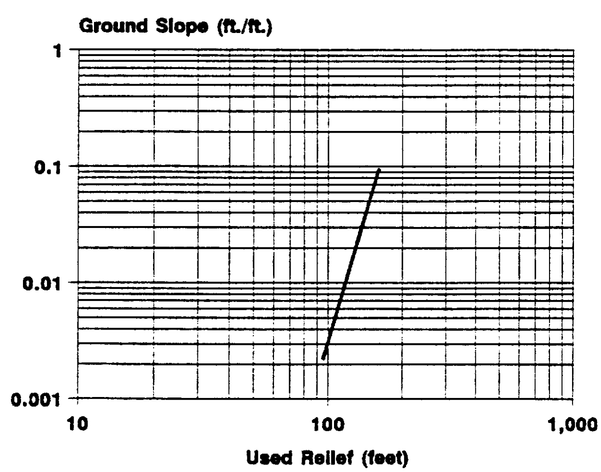

100
10
1
TOP WIDTH #2 (FEET)
AVERAGE DEPTH (FEET)
10
100
1,000
Area #2 (feet²)



1,000
100
10
1
AREA #2 (FEET²)
TOP WIDTH #2 (FEET)
VELOCITY #2 (FT./SEC.)
AVERAGE DEPTH #2 (FEET)
100
1,000
10,000
Q2 (cfs)



Bank Slope (ft./ft.)
0.02
0.015
0.01
0.005
0
80
90
100
110
120
130
140
150
160
Relief Ratio (feet/mile)



Ground Slope (ft./ft.)
1
0.1
0.01
0.001
10
100
1,000
Used Relief (feet)

Strata "B" third order regression output for basin perimeter versus basin area.

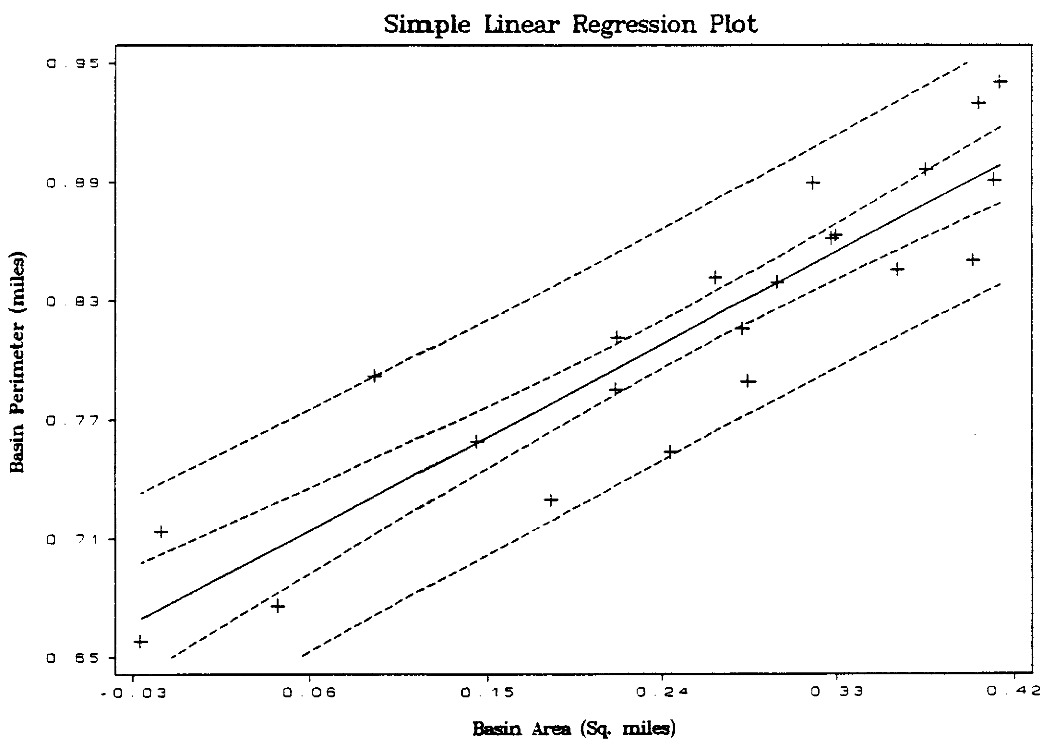
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BASIN PERIMETER

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.68283	0.01535	44.48	0.0000
BA	0.52254	0.05386	9.70	0.0000

R-SQUARED	0.8248	RESID. MEAN SQUARE (MSE)	0.00110
ADJUSTED R-SQUARED	0.8160	STANDARD DEVIATION	0.03317

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.10357	0.10357	94.13	0.0000
RESIDUAL	20	0.02200	0.00110		
TOTAL	21	0.12557			

CASES INCLUDED 22 MISSING CASES 0



90% confidence and prediction intervals

Strata "B" third order regression output for drainage density versus basin area.

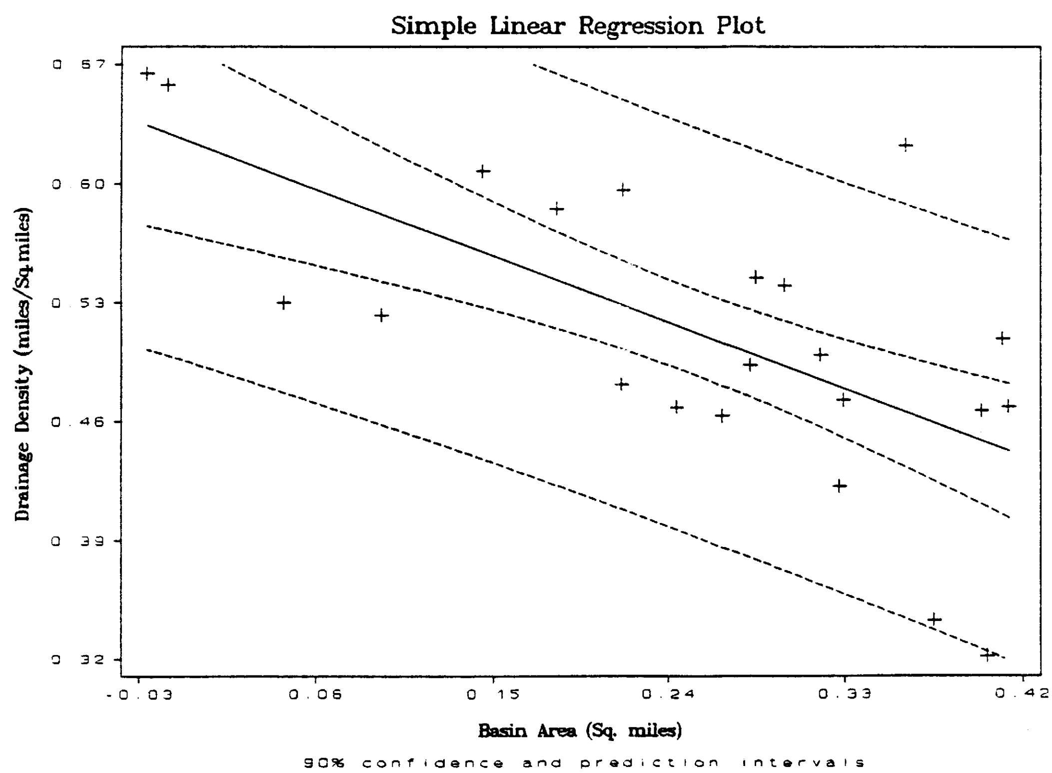
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF DRAINAGE DENSITY

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.62263	0.03157	19.72	0.0000
BA	-0.43489	0.11075	-3.93	0.0008

R-SQUARED	0.4353	RESID. MEAN SQUARE (MSE)	0.00465
ADJUSTED R-SQUARED	0.4071	STANDARD DEVIATION	0.06821

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.07174	0.07174	15.42	0.0008
RESIDUAL	20	0.09305	0.00465		
TOTAL	21	0.16479			

CASES INCLUDED 22 MISSING CASES 0



Strata "B" third order regression output for basin length versus basin area.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BASIN LENGTH

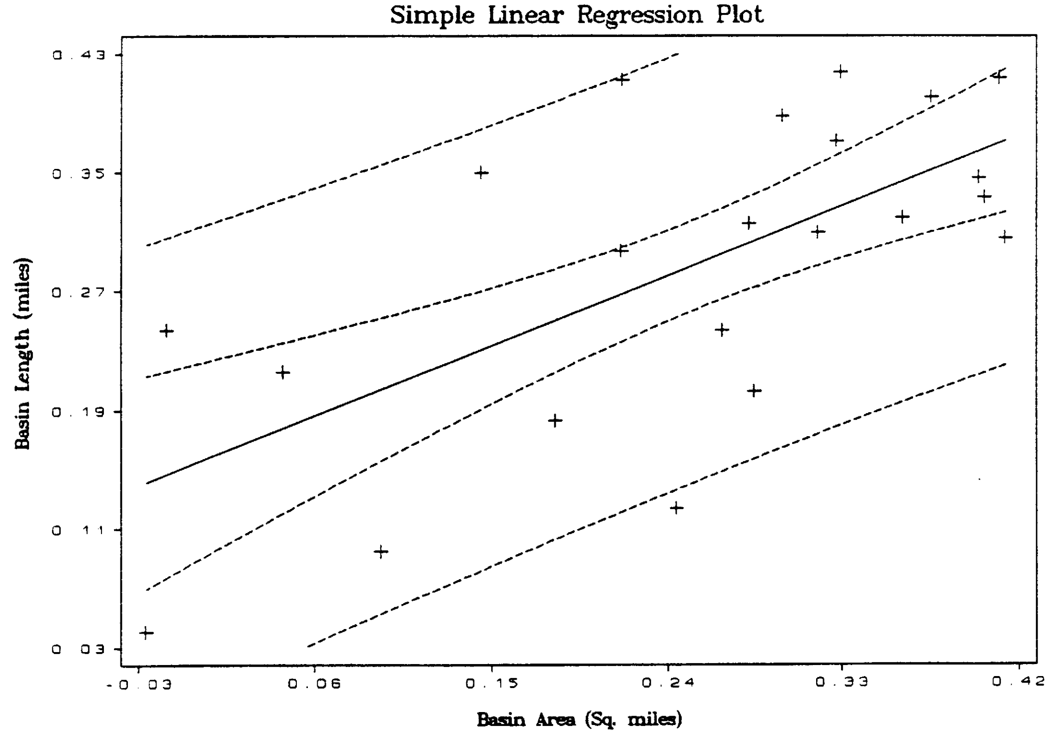
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.15505	0.03846	4.03	0.0007
BA	0.52445	0.13493	3.89	0.0009

R-SQUARED	0.4303	RESID. MEAN SQUARE (MSE)	0.00691
ADJUSTED R-SQUARED	0.4018	STANDARD DEVIATION	0.08310

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.10433	0.10433	15.11	0.0009
RESIDUAL	20	0.13812	0.00691		
TOTAL	21	0.24245			

CASES INCLUDED 22 MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "B" third order regression output for number of first orders versus relief ratio and total channel length.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF FIRSTS

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.53796	0.35625	-1.51	0.1475
RR	0.27255	0.14613	1.87	0.0777
TCHL	0.95362	0.15114	6.31	0.0000

R-SQUARED	0.6771	RESID. MEAN SQUARE (MSE)	0.00438
ADJUSTED R-SQUARED	0.6431	STANDARD DEVIATION	0.06621

SOURCE	DF	SS	MS	F	P
REGRESSION	2	0.17468	0.08734	19.92	0.0000
RESIDUAL	19	0.08330	0.00438		
TOTAL	21	0.25798			

CASES INCLUDED 22 MISSING CASES 0

Strata "B" third order regression output for number of second orders versus channel slope and total channel length.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF SECONDS

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.49704	0.12950	3.84	0.0011
CHS	0.22810	0.06695	3.41	0.0030
TCHL	0.33155	0.08011	4.14	0.0006

R-SQUARED	0.5570	RESID. MEAN SQUARE (MSE)	0.00131
ADJUSTED R-SQUARED	0.5103	STANDARD DEVIATION	0.03626

SOURCE	DF	SS	MS	F	P
REGRESSION	2	0.03140	0.01570	11.94	0.0004
RESIDUAL	19	0.02498	0.00131		
TOTAL	21	0.05638			

CASES INCLUDED 22   MISSING CASES 0

Strata "B" third order regression output for total channel length versus basin area.

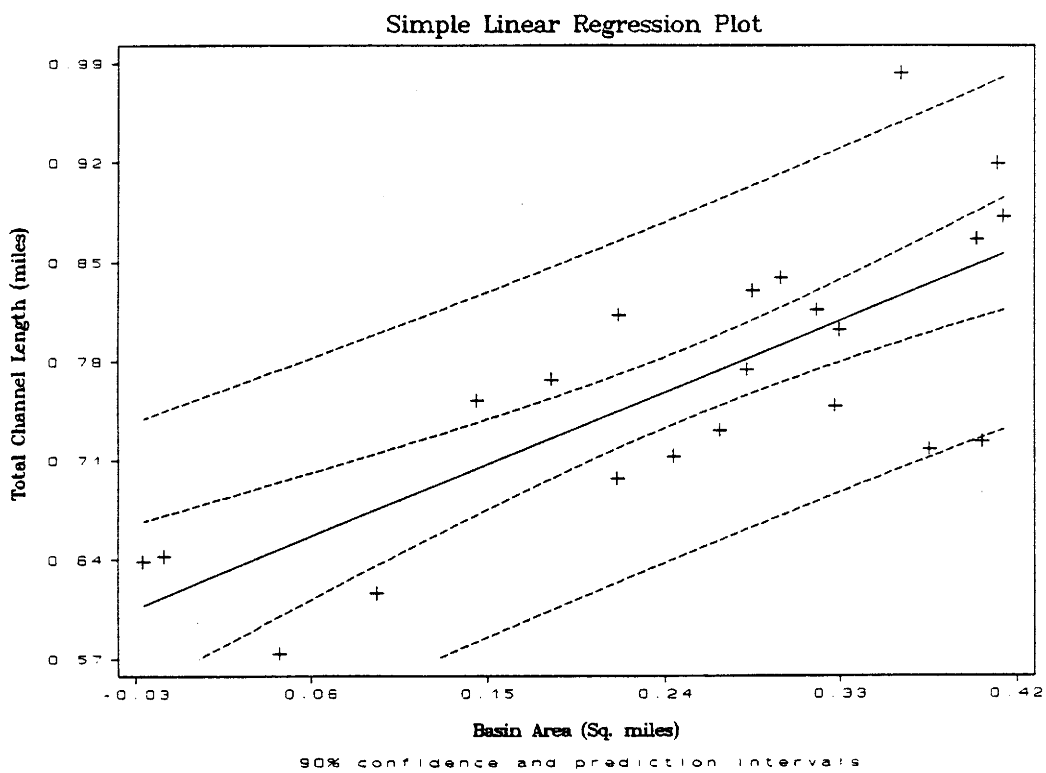
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOTAL CHANNEL LENGTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.62263	0.03157	19.72	0.0000
BA	0.56511	0.11075	5.10	0.0001

R-SQUARED	0.5656	RESID. MEAN SQUARE (MSE)	0.00465
ADJUSTED R-SQUARED	0.5438	STANDARD DEVIATION	0.06821

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.12113	0.12113	26.04	0.0001
RESIDUAL	20	0.09305	0.00465		
TOTAL	21	0.21418			

CASES INCLUDED 22 MISSING CASES 0



Strata "B" third order regression output for relief ratio versus basin area.

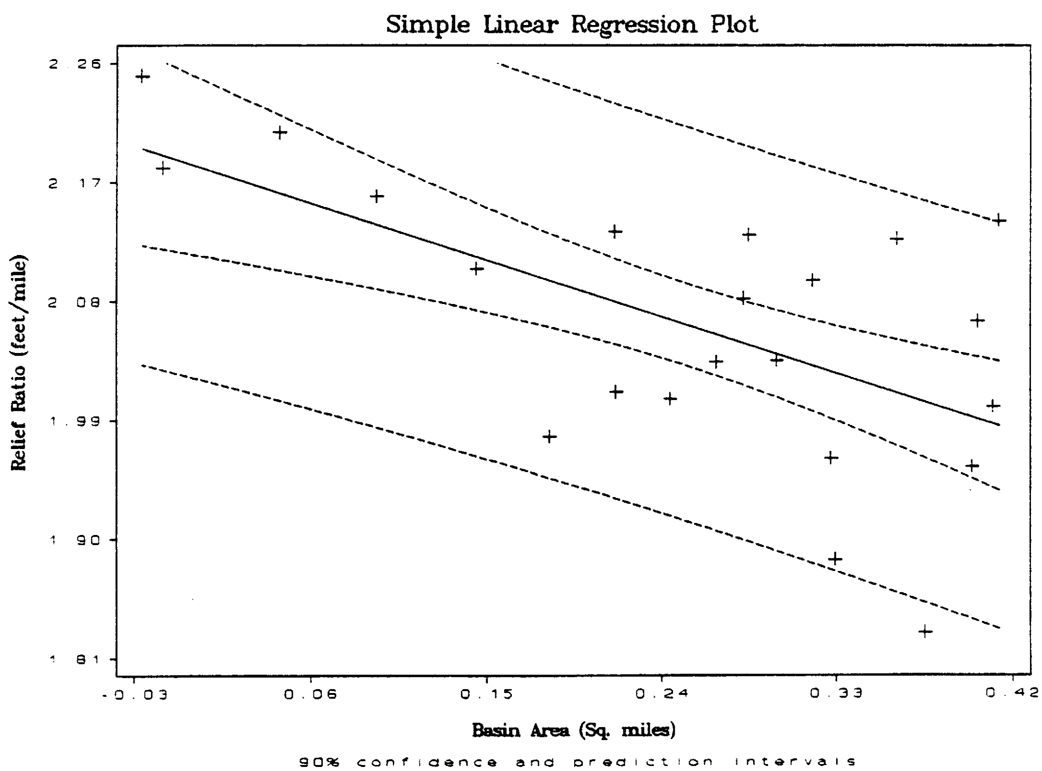
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RELIEF RATIO

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	2.18296	0.03914	55.78	0.0000
BA	-0.47635	0.13732	-3.47	0.0024

R-SQUARED	0.3757	RESID. MEAN SQUARE (MSE)	0.00715
ADJUSTED R-SQUARED	0.3444	STANDARD DEVIATION	0.08457

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.08607	0.08607	12.03	0.0024
RESIDUAL	20	0.14305	0.00715		
TOTAL	21	0.22912			

CASES INCLUDED 22   MISSING CASES 0



Strata "B" third order regression output for main channel length versus basin length.

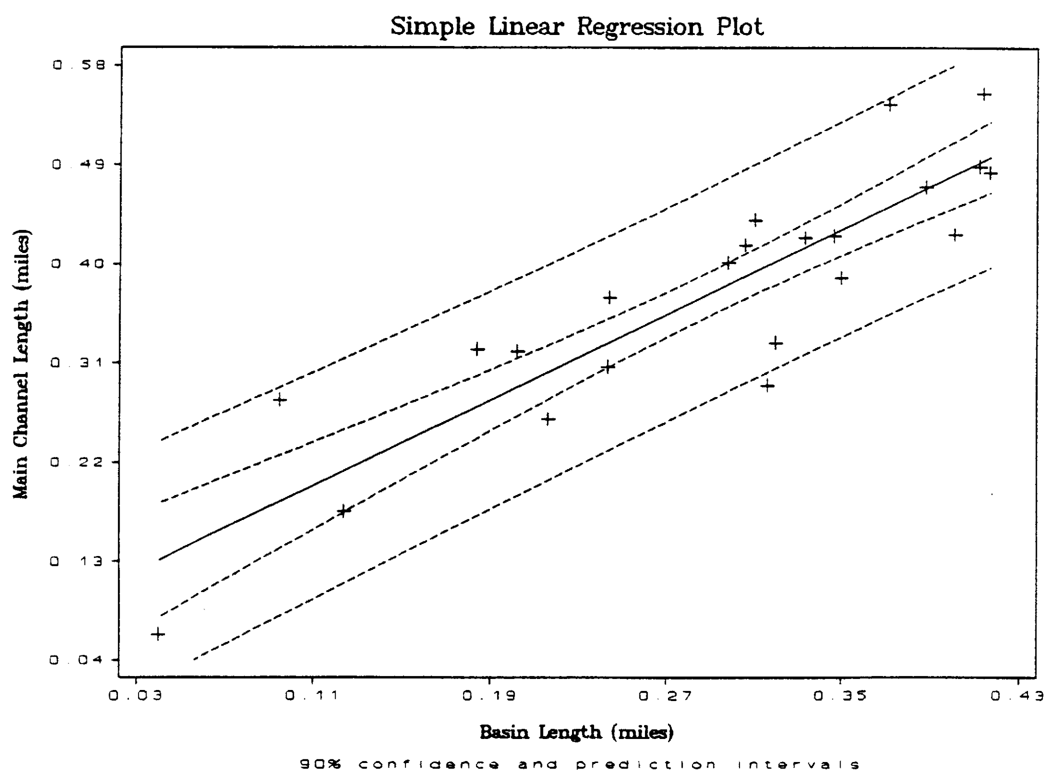
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF MAIN CHANNEL LENGTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.09201	0.03424	2.69	0.0142
BL	0.97144	0.11178	8.69	0.0000

R-SQUARED	0.7906	RESID. MEAN SQUARE (MSE)	0.00303
ADJUSTED R-SQUARED	0.7802	STANDARD DEVIATION	0.05504

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.22880	0.22880	75.53	0.0000
RESIDUAL	20	0.06059	0.00303		
TOTAL	21	0.28939			

CASES INCLUDED 22 MISSING CASES 0



Strata "B" third order regression output for valley length versus basin length.

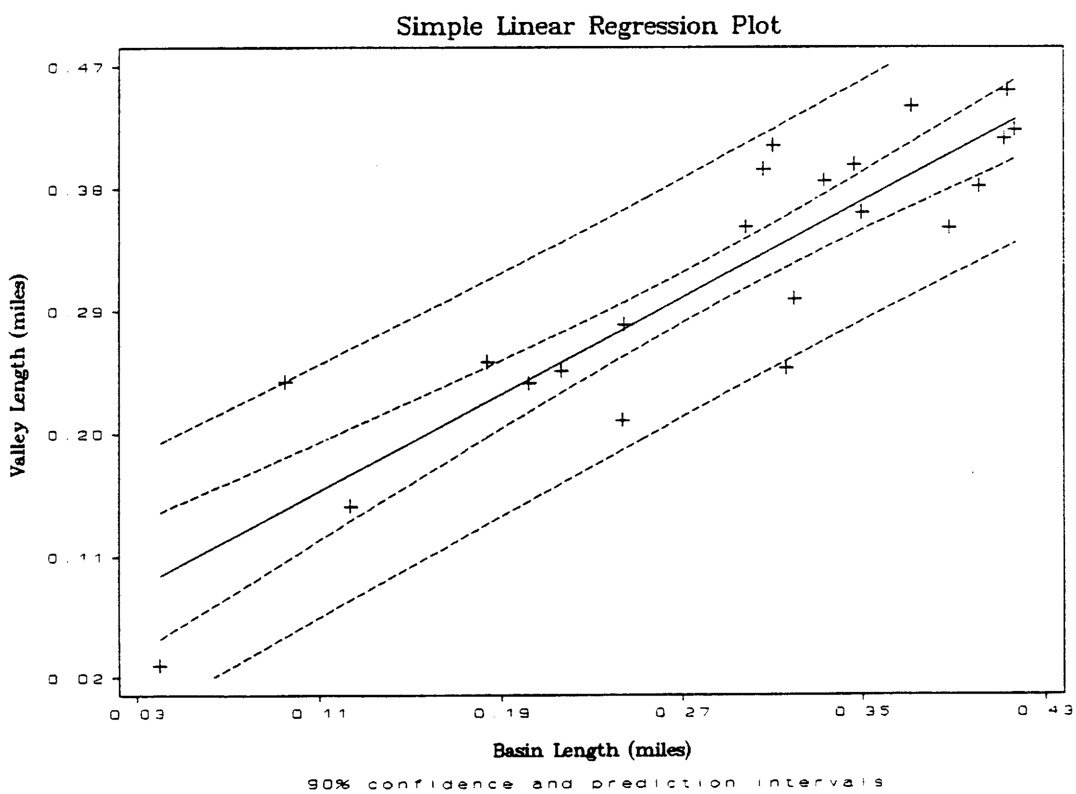
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF VALLEY LENGTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.05963	0.03096	1.93	0.0685
BL	0.89004	0.10110	8.80	0.0000

R-SQUARED	0.7949	RESID. MEAN SQUARE (MSE)	0.00248
ADJUSTED R-SQUARED	0.7846	STANDARD DEVIATION	0.04978

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.19206	0.19206	77.51	0.0000
RESIDUAL	20	0.04956	0.00248		
TOTAL	21	0.24162			

CASES INCLUDED 22 MISSING CASES 0



Strata "B" third order regression output of basin relief versus basin area and basin length.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BASIN RELIEF

PREDICTOR VARIABLES VIF	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	2.23398	0.05116	43.67	0.0000
BA	-0.30378	0.17663	-1.72	0.1017
BL	0.67096	0.22093	3.04	0.0068

R-SQUARED	0.3299	RESID. MEAN SQUARE (MSE)	0.00674
ADJUSTED R-SQUARED	0.2594	STANDARD DEVIATION	0.08211

SOURCE	DF	SS	MS	F	P
REGRESSION	2	0.06306	0.03153	4.68	0.0223
RESIDUAL	19	0.12809	0.00674		
TOTAL	21	0.19115			

CASES INCLUDED 22 MISSING CASES 0

Strata "B" third order regression output for used relief versus basin area and channel slope.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF USED RELIEF

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	3.04950	0.27759	10.99	0.0000
BA	0.45202	0.13588	3.33	0.0035
CHS	0.59231	0.15111	3.92	0.0009

R-SQUARED	0.5085	RESID. MEAN SQUARE (MSE)	0.00612
ADJUSTED R-SQUARED	0.4568	STANDARD DEVIATION	0.07826

SOURCE	DF	SS	MS	F	P
REGRESSION	2	0.12042	0.06021	9.83	0.0012
RESIDUAL	19	0.11637	0.00612		
TOTAL	21	0.23679			

CASES INCLUDED 22 MISSING CASES 0

Strata "B" third order regression output for ruggedness number versus basin relief.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RUGGEDNESS NUMBER

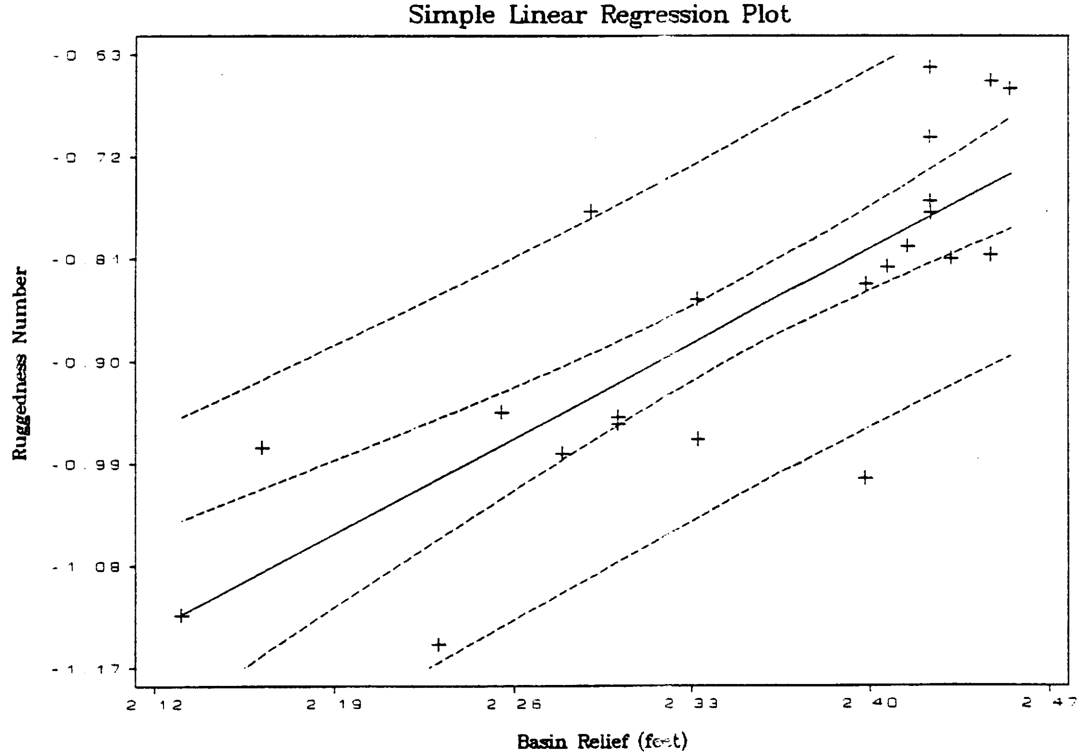
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-3.67468	0.47712	-7.70	0.0000
BR	1.19772	0.20285	5.90	0.0000

R-SQUARED	0.6354	RESID. MEAN SQUARE (MSE)	0.00787
ADJUSTED R-SQUARED	0.6172	STANDARD DEVIATION	0.08869

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.27421	0.27421	34.86	0.0000
RESIDUAL	20	0.15732	0.00787		
TOTAL	21	0.43153			

CASES INCLUDED 22 MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "B" third order regression output for channel slope versus relief ratio.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF CHANNEL SLOPE

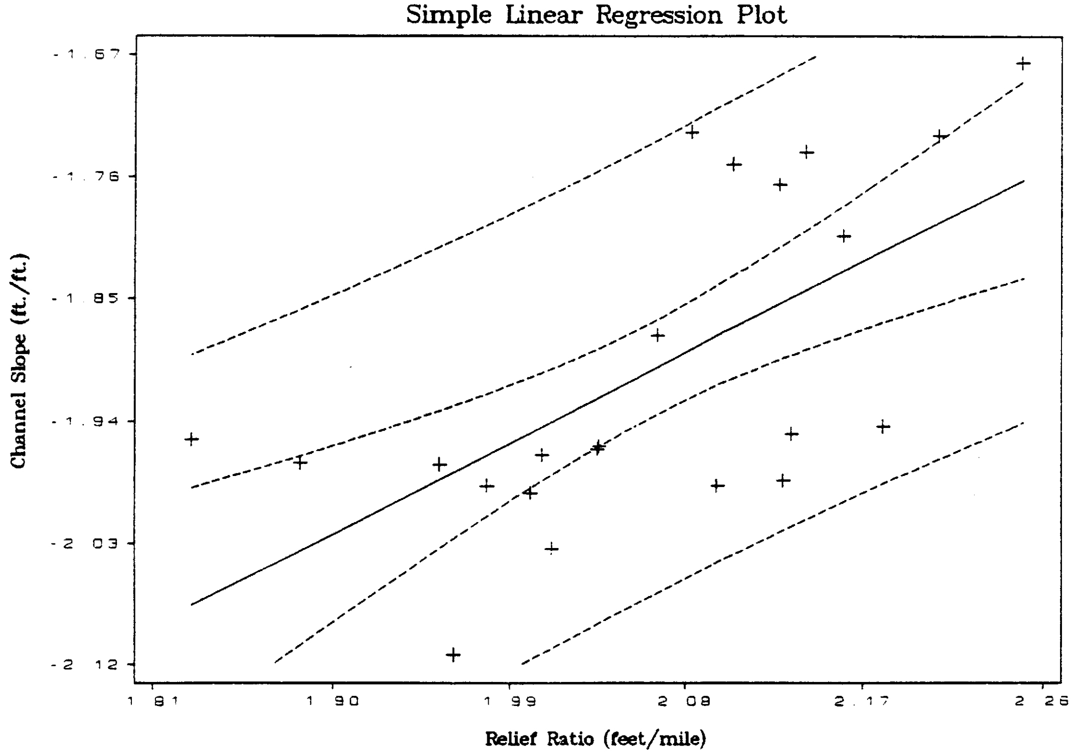
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-3.44115	0.40828	-8.43	0.0000
RR	0.74629	0.19771	3.77	0.0012

R-SQUARED	0.4160	RESID. MEAN SQUARE (MSE)	0.00896
ADJUSTED R-SQUARED	0.3868	STANDARD DEVIATION	0.09464

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.12761	0.12761	14.25	0.0012
RESIDUAL	20	0.17913	0.00896		
TOTAL	21	0.30673			

CASES INCLUDED 22 MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "B" third order regression output for sinuosity versus channel slope.

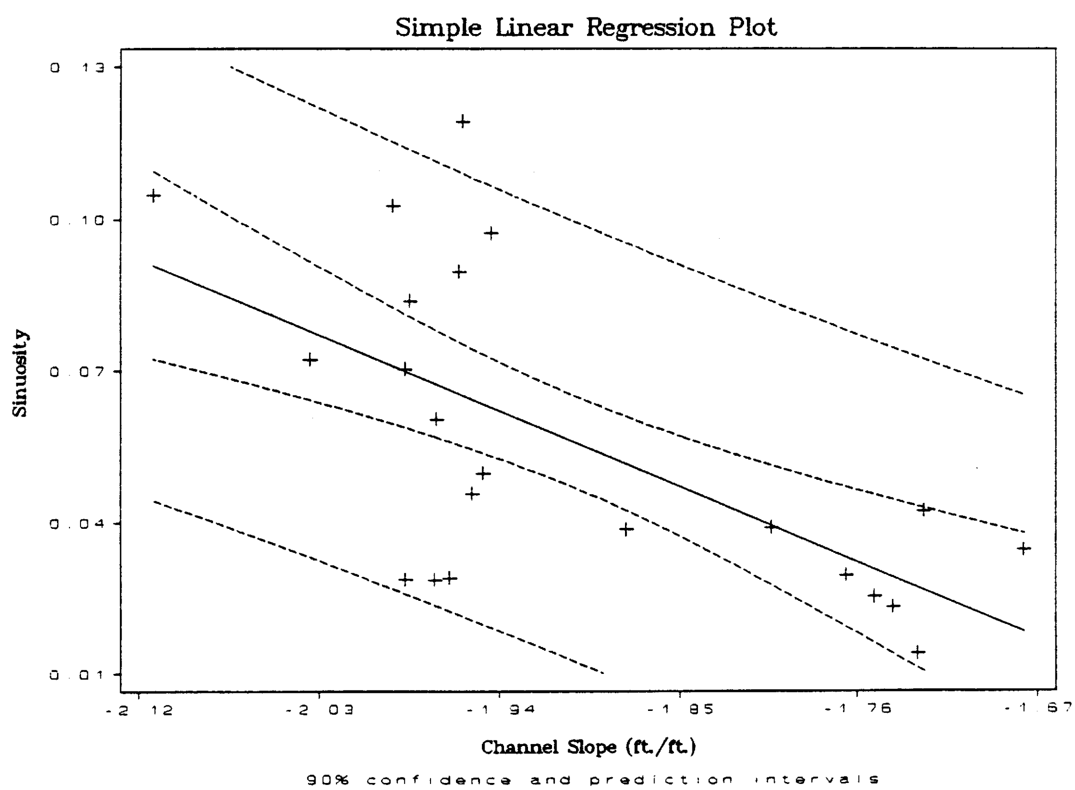
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF SINUOSITY

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.26065	0.08504	-3.07	0.0061
CHS	-0.16639	0.04462	-3.73	0.0013

R-SQUARED	0.4101	RESID. MEAN SQUARE (MSE)	6.108E-04
ADJUSTED R-SQUARED	0.3806	STANDARD DEVIATION	0.02471

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.00849	0.00849	13.90	0.0013
RESIDUAL	20	0.01222	6.108E-04		
TOTAL	21	0.02071			

CASES INCLUDED 22 MISSING CASES 0



Strata "B" third order regression output for valley area versus channel slope.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF VALLEY AREA

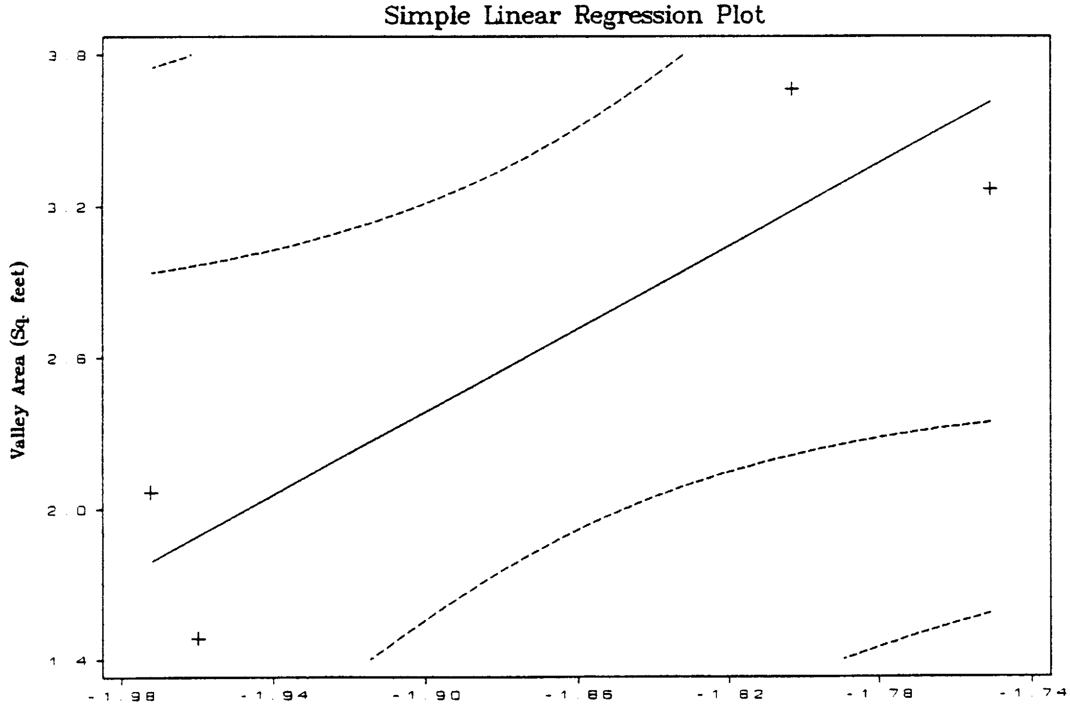
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	18.0295	5.28033	3.41	0.0761
CHS	8.23310	2.81770	2.92	0.0999

R-SQUARED	0.8102	RESID. MEAN SQUARE (MSE)	0.29462
ADJUSTED R-SQUARED	0.7153	STANDARD DEVIATION	0.54279

SOURCE	DF	SS	MS	F	P
REGRESSION	1	2.51540	2.51540	8.54	0.0999
RESIDUAL	2	0.58925	0.29462		
TOTAL	3	3.10465			

CASES INCLUDED 4 MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "B" third order regression output for top width versus valley area.

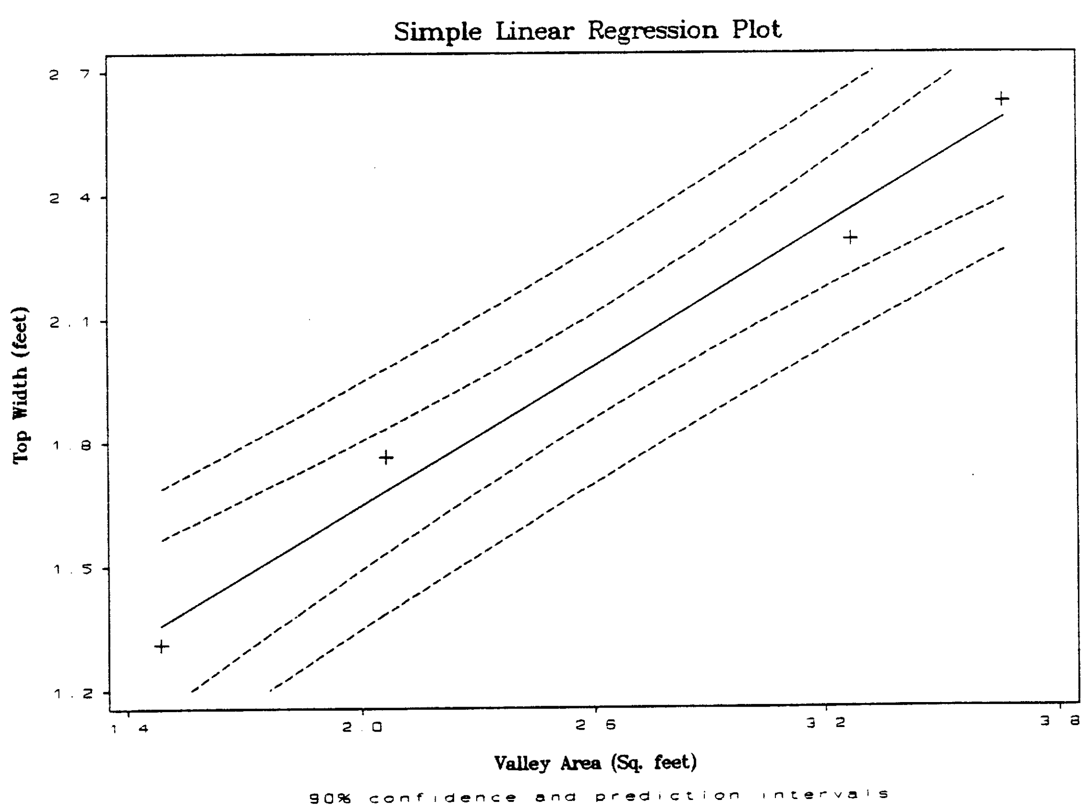
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOP WIDTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.51662	0.13740	3.76	0.0640
A	0.56485	0.04969	11.37	0.0076

R-SQUARED	0.9848	RESID. MEAN SQUARE (MSE)	0.00767
ADJUSTED R-SQUARED	0.9771	STANDARD DEVIATION	0.08755

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.99057	0.99057	129.23	0.0076
RESIDUAL	2	0.01533	0.00767		
TOTAL	3	1.00590			

CASES INCLUDED 4 MISSING CASES 0



Strata "B" third order regression output for average depth versus valley area.

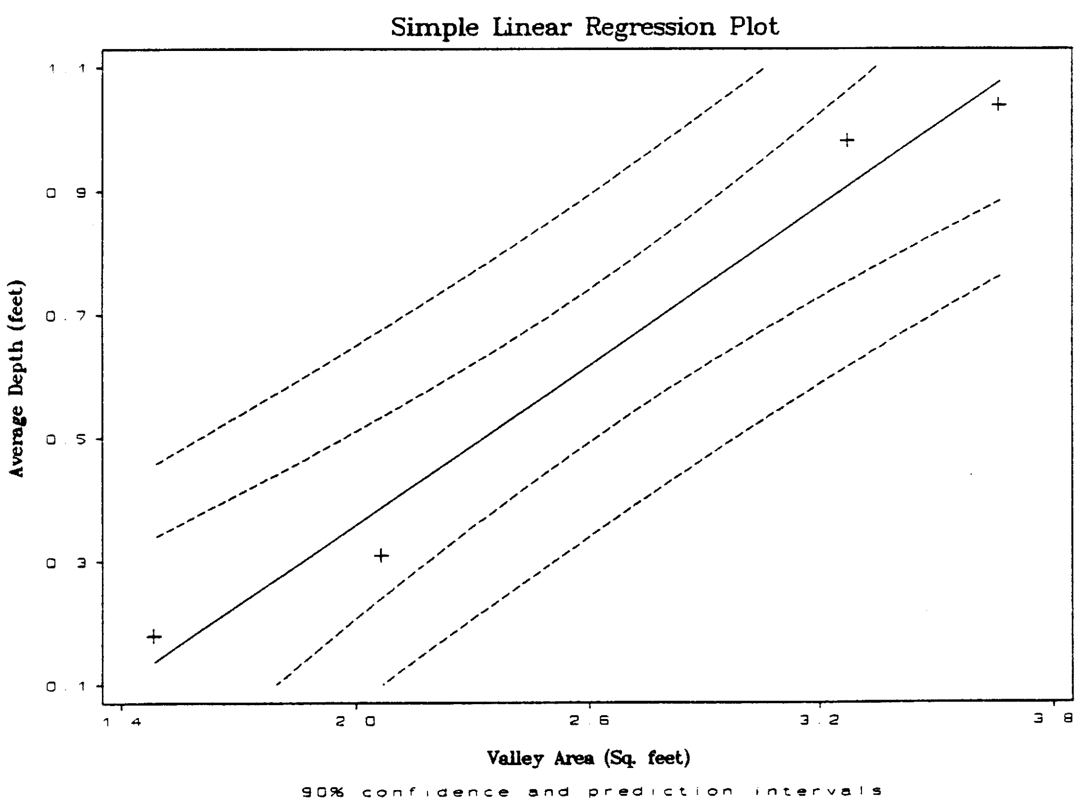
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AVERAGE DEPTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.50519	0.13338	-3.79	0.0632
A	0.43174	0.04824	8.95	0.0123

R-SQUARED	0.9756	RESID. MEAN SQUARE (MSE)	0.00722
ADJUSTED R-SQUARED	0.9635	STANDARD DEVIATION	0.08499

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.57870	0.57870	80.11	0.0123
RESIDUAL	2	0.01445	0.00722		
TOTAL	3	0.59315			

CASES INCLUDED 4 MISSING CASES 0



Strata "B" third order regression output for area #2 versus basin relief and sinuosity.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AREA #2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	15.9731	1.20870	13.22	0.0481
BR	-5.68428	0.50545	-11.25	0.0565
SIN	-19.6945	1.52286	-12.93	0.0491

R-SQUARED	0.9951	RESID. MEAN SQUARE (MSE)	0.00485
ADJUSTED R-SQUARED	0.9852	STANDARD DEVIATION	0.06965

SOURCE	DF	SS	MS	F	P
REGRESSION	2	0.97686	0.48843	100.68	0.0703
RESIDUAL	1	0.00485	0.00485		
TOTAL	3	0.98171			

CASES INCLUDED 4 MISSING CASES 0

Strata "B" third order regression output for area #2 versus Q2.

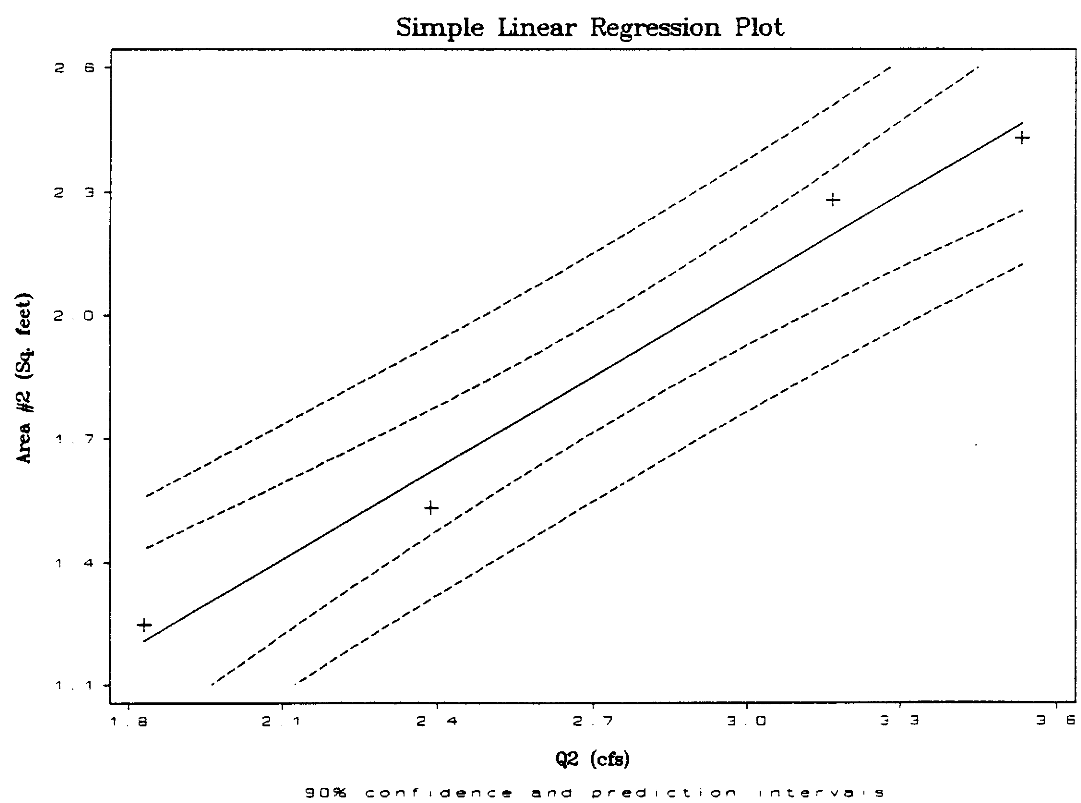
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AREA #2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.14397	0.19503	-0.74	0.5373
Q2	0.73871	0.06941	10.64	0.0087

R-SQUARED	0.9826	RESID. MEAN SQUARE (MSE)	0.00852
ADJUSTED R-SQUARED	0.9740	STANDARD DEVIATION	0.09228

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.96468	0.96468	113.27	0.0087
RESIDUAL	2	0.01703	0.00852		
TOTAL	3	0.98171			

CASES INCLUDED 4 MISSING CASES 0



Strata "B" third order regression output for top width #2 versus area #2.

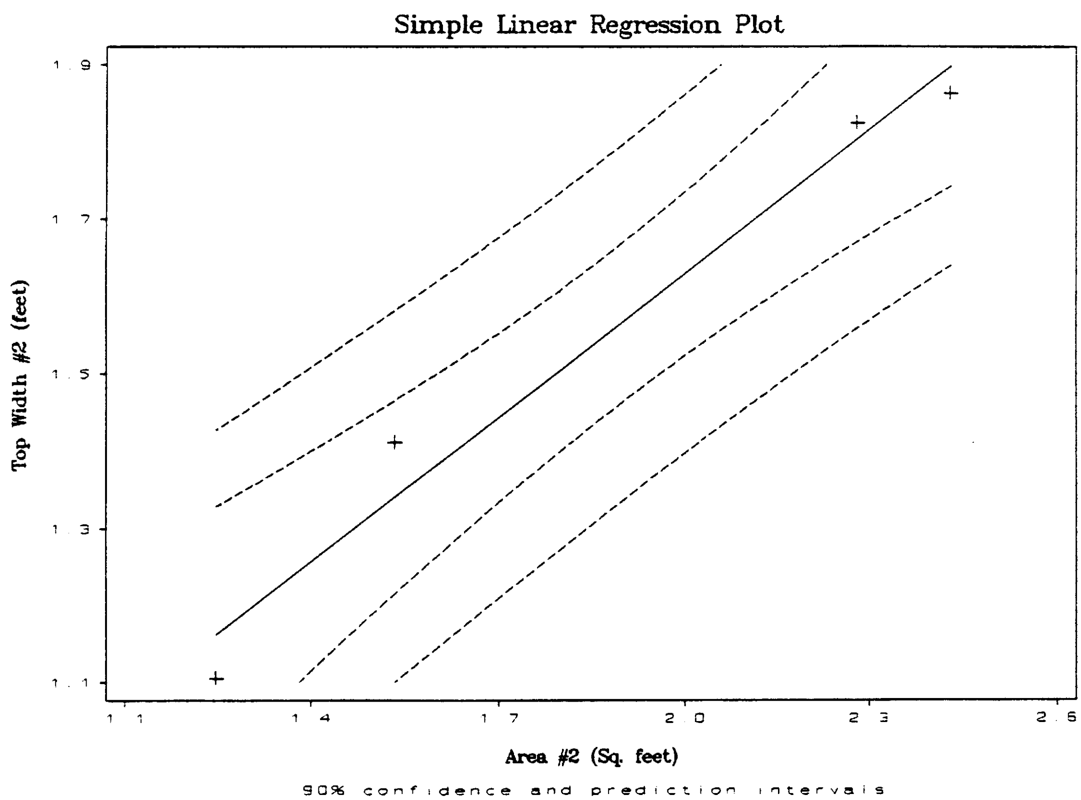
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOP WIDTH #2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.38516	0.13816	2.79	0.1082
A2	0.62271	0.07132	8.73	0.0129

R-SQUARED	0.9744	RESID. MEAN SQUARE (MSE)	0.00499
ADJUSTED R-SQUARED	0.9617	STANDARD DEVIATION	0.07066

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.38068	0.38068	76.24	0.0129
RESIDUAL	2	0.00999	0.00499		
TOTAL	3	0.39066			

CASES INCLUDED 4 MISSING CASES 0



Strata "B" third order regression output of top width #2 versus Q2.

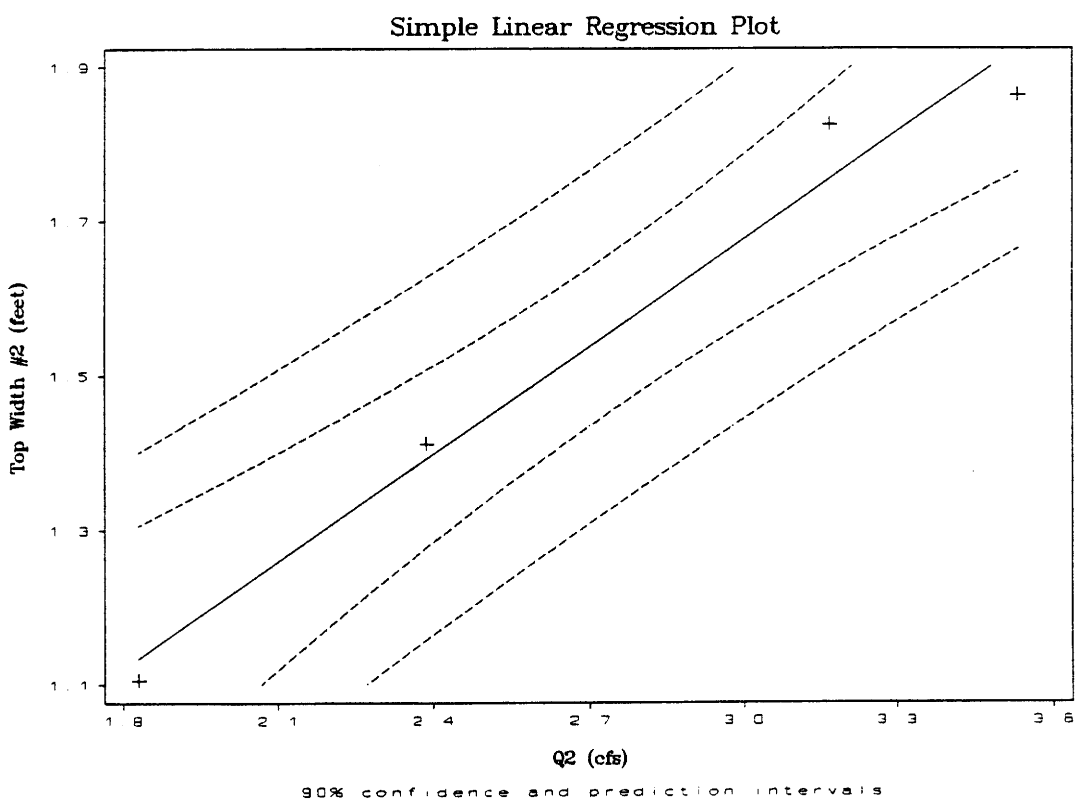
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOP WIDTH #2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.28417	0.14797	1.92	0.1948
Q2	0.46416	0.05266	8.81	0.0126

R-SQUARED	0.9749	RESID. MEAN SQUARE (MSE)	0.00490
ADJUSTED R-SQUARED	0.9624	STANDARD DEVIATION	0.07002

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.38086	0.38086	77.69	0.0126
RESIDUAL	2	0.00980	0.00490		
TOTAL	3	0.39066			

CASES INCLUDED 4 MISSING CASES 0



Strata "B" third order regression output for average depth #2 versus area #2.

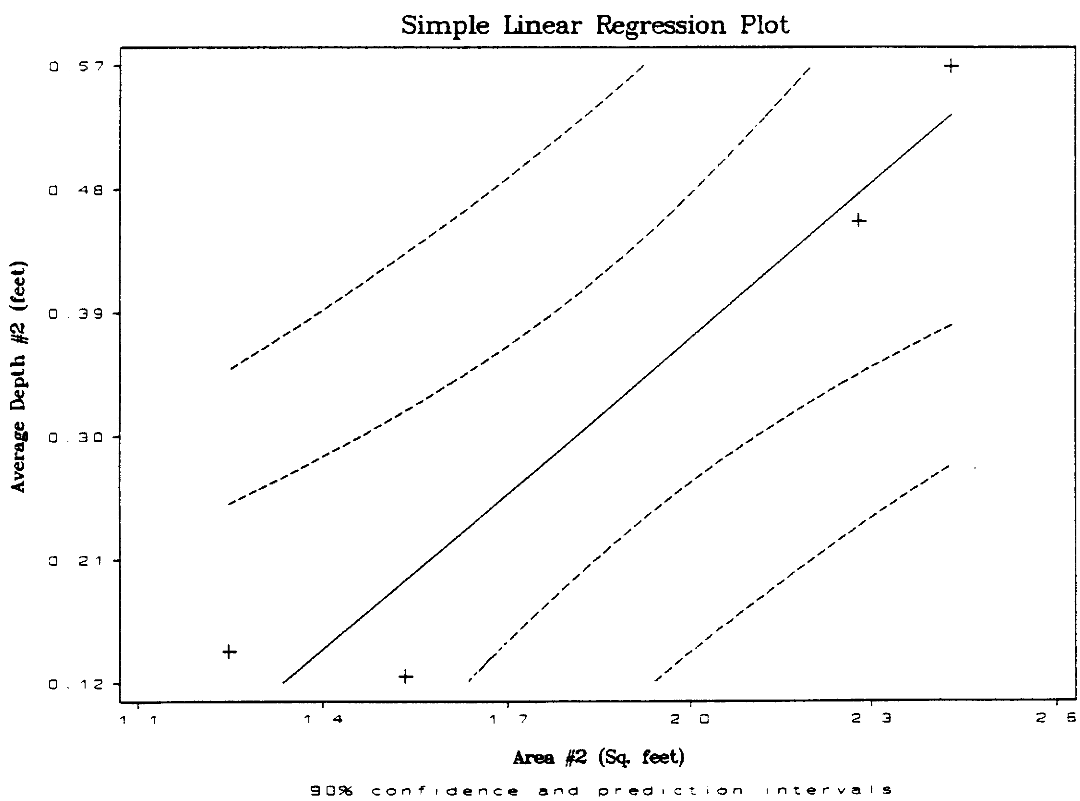
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AVERAGE DEPTH #2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.38498	0.13631	-2.82	0.1058
A2	0.37826	0.07036	5.38	0.0329

R-SQUARED	0.9353	RESID. MEAN SQUARE (MSE)	0.00486
ADJUSTED R-SQUARED	0.9029	STANDARD DEVIATION	0.06972

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.14046	0.14046	28.90	0.0329
RESIDUAL	2	0.00972	0.00486		
TOTAL	3	0.15019			

CASES INCLUDED 4 MISSING CASES 0



Strata "B" third order regression output for average depth #2 versus Q2.

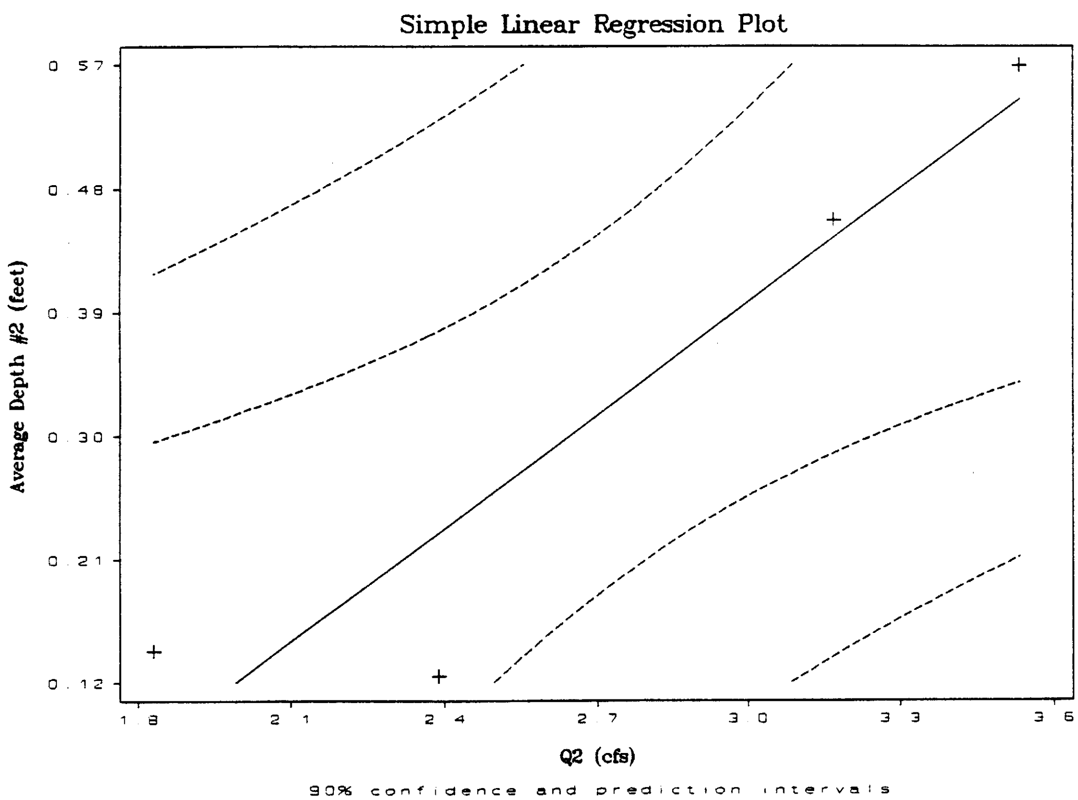
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AVERAGE DEPTH #2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.42843	0.18968	-2.26	0.1524
Q2	0.27540	0.06750	4.08	0.0552

R-SQUARED	0.8927	RESID. MEAN SQUARE (MSE)	0.00805
ADJUSTED R-SQUARED	0.8391	STANDARD DEVIATION	0.08975

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.13408	0.13408	16.65	0.0552
RESIDUAL	2	0.01611	0.00805		
TOTAL	3	0.15019			

CASES INCLUDED 4 MISSING CASES 0



Strata "B" third order regression output for velocity #2 versus Q2.

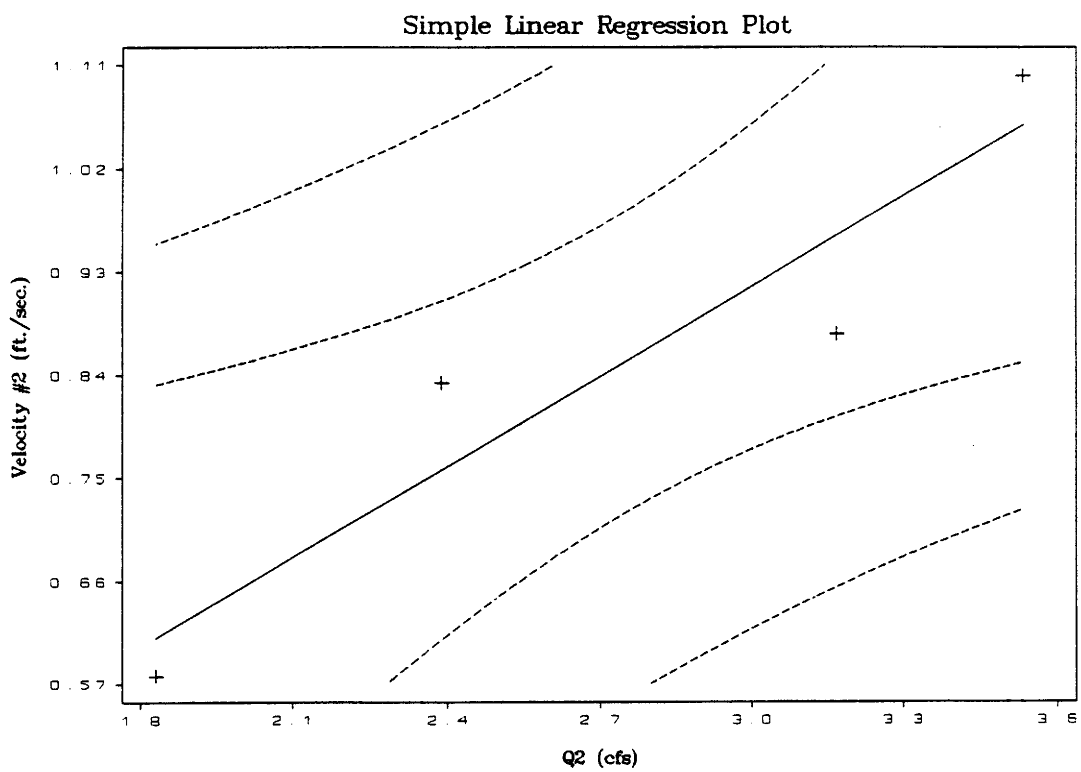
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF VELOCITY #2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.12946	0.19066	0.68	0.5672
Q2	0.26271	0.06785	3.87	0.0607

R-SQUARED	0.8823	RESID. MEAN SQUARE (MSE)	0.00814
ADJUSTED R-SQUARED	0.8234	STANDARD DEVIATION	0.09022

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.12200	0.12200	14.99	0.0607
RESIDUAL	2	0.01628	0.00814		
TOTAL	3	0.13828			

CASES INCLUDED 4   MISSING CASES 0



90% confidence and prediction intervals

Strata "B" third order regression output for bank slope versus relief ratio.

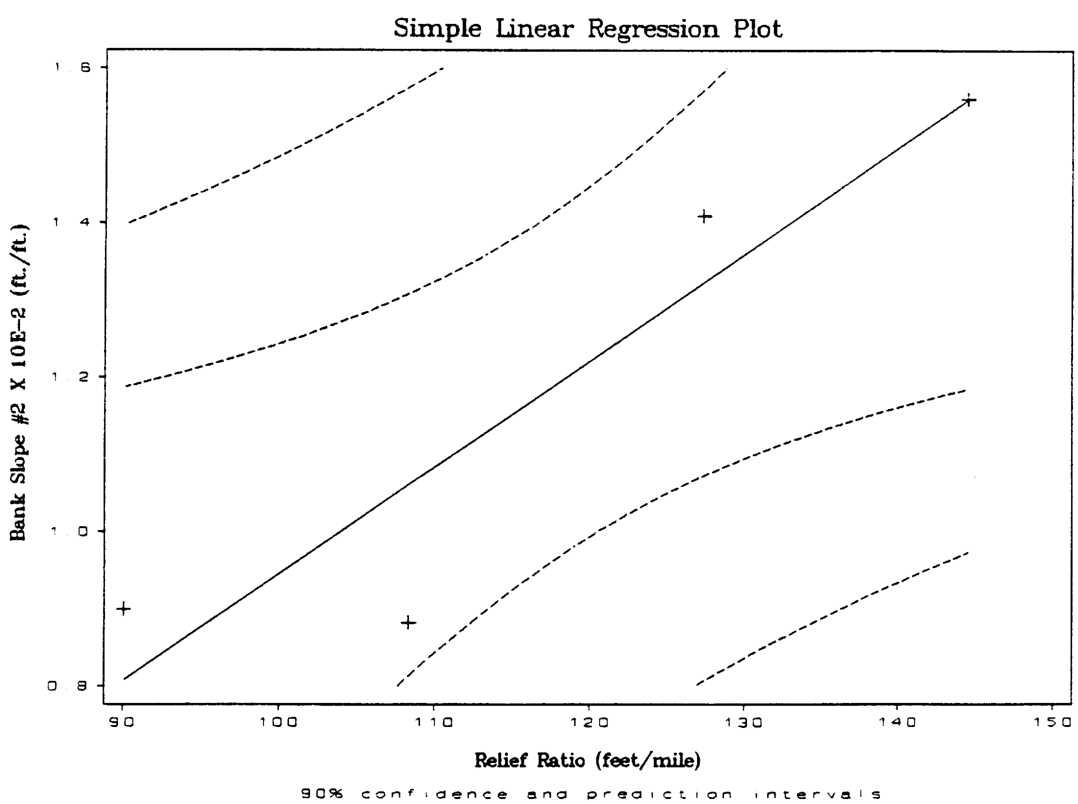
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BANK SLOPE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.00434	0.00452	-0.96	0.4382
RR	1.380E-04	3.790E-05	3.64	0.0679

R-SQUARED	0.8688	RESID. MEAN SQUARE (MSE)	2.392E-06
ADJUSTED R-SQUARED	0.8033	STANDARD DEVIATION	0.00155

SOURCE	DF	SS	MS	F	P
REGRESSION	1	3.169E-05	3.169E-05	13.25	0.0679
RESIDUAL	2	4.784E-06	2.392E-06		
TOTAL	3	3.648E-05			

CASES INCLUDED 4 MISSING CASES 0



Strata "B" third order regression output for ground slope #2 versus used relief.

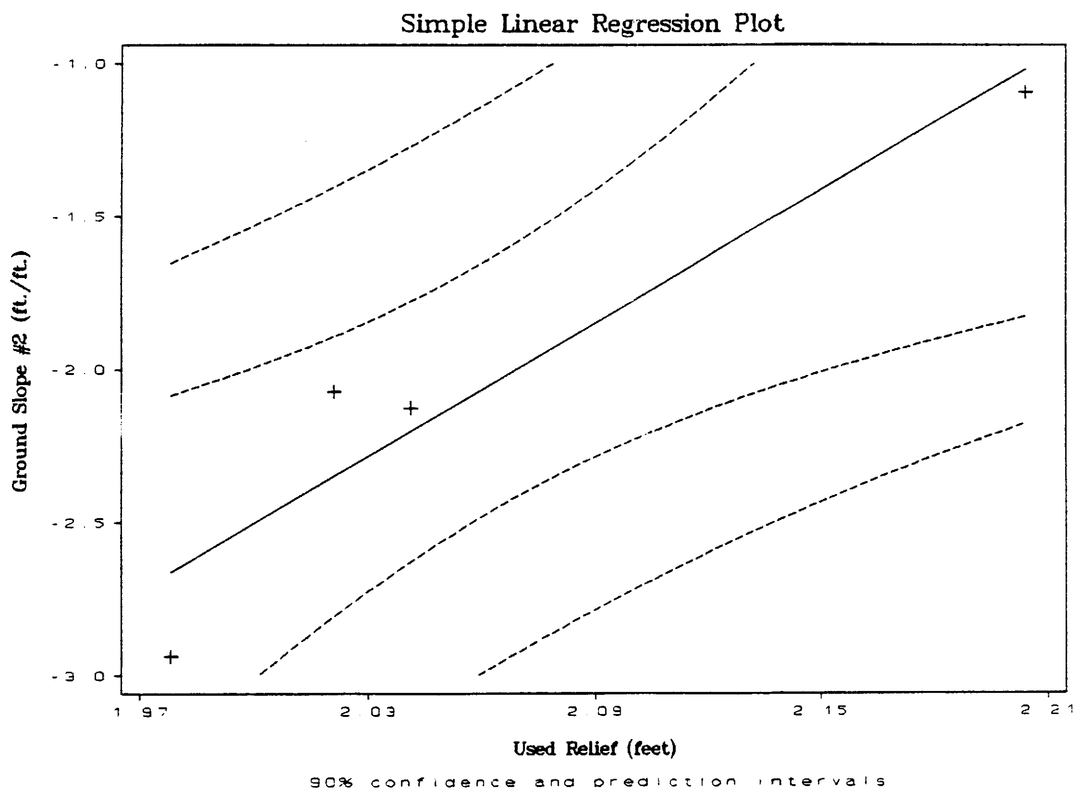
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF GROUND SLOPE #2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-17.0180	3.41616	-4.98	0.0380
UR	7.25842	1.65601	4.38	0.0483

R-SQUARED	0.9057	RESID. MEAN SQUARE (MSE)	0.08059
ADJUSTED R-SQUARED	0.8586	STANDARD DEVIATION	0.28389

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.54828	1.54828	19.21	0.0483
RESIDUAL	2	0.16118	0.08059		
TOTAL	3	1.70946			

CASES INCLUDED 4 MISSING CASES 0



High bank reach means for **Strata "B"** third order

Basin ID 1900	**Area** (ft^2)	**Wetted Perimeter** (ft)	**Top Width** (ft)	**Hydraulic Radius**	**Average Depth** (ft)	**W/D Ratio**	**Bed Slope** (ft/ft)
n	3	3	3	3	3	3	3
Mean	34.63	22.42	21.07	1.47	1.57	13.78	-0.001
S.D.	20.90	6.53	6.17	0.47	0.51	2.54	0.003
C.V. (%)	60.35	29.13	29.27	32.22	32.60	18.43	592.22
Minimum	16.95	15.55	14.45	1.10	1.20	12.14	-0.004
Maximum	57.70	28.55	26.65	2.00	2.15	16.70	0.002
Range	40.75	13.00	12.20	0.90	0.95	4.56	0.006

Basin ID 3000	**Area** (ft^2)	**Wetted Perimeter** (ft)	**Top Width** (ft)	**Hydraulic Radius**	**Average Depth** (ft)	**W/D Ratio**	**Bed Slope** (ft/ft)
n	2	2	2	2	2	2	2
Mean	1980.20	205.43	200.50	9.38	9.60	20.63	0.003
S.D.	902.13	59.36	60.95	1.66	1.48	3.14	0.005
C.V. (%)	45.56	28.90	30.40	17.73	15.47	15.20	141.42
Minimum	1342.30	163.45	157.40	8.20	8.55	18.42	0.000
Maximum	2618.10	247.40	243.60	10.55	10.65	22.85	0.007
Range	1275.80	83.95	86.20	2.35	2.10	4.44	0.007

Basin ID 3600	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)
n	1	1	1	1	1	1	1
Mean	117.00	58.95	58.15	1.95	2.05	28.52	0.016
S.D.	0.00	0.00	0.00	0.00	0.00	0.00	0.000
C.V. (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Minimum	117.00	58.95	58.15	1.95	2.05	28.52	0.016
Maximum	117.00	58.95	58.15	1.95	2.05	28.52	0.016
Range	0.00	0.00	0.00	0.00	0.00	0.00	0.000

Basin ID 5400	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)
n	1	1	1	1	1	1	1
Mean	4602.10	423.55	420.45	10.90	10.90	38.60	0.004
S.D.	0.00	0.00	0.00	0.00	0.00	0.00	0.000
C.V. (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Minimum	4602.10	423.55	420.45	10.90	10.90	38.60	0.004
Maximum	4602.10	423.55	420.45	10.90	10.90	38.60	0.004
Range	0.00	0.00	0.00	0.00	0.00	0.00	0.000

Medium bank reach means for **Strata "B"** third order

Basin ID 1900	Area (ft²)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velo-city (ft/s)	Q (cfs)
n	3	3.00	3.00	3.00	3.00	3.00	3	3	3	3	3
Mean	22.67	14.68	13.50	1.38	1.48	9.22	-0.001	0.009	0.033	5.06	172.43
S.D.	19.76	6.19	5.67	0.58	0.67	0.32	0.003	0.010	0.000	4.55	252.01
C.V. (%)	87.19	42.16	42.02	41.89	44.89	3.46	592.22	109.18	0.00	89.95	146.15
Minimum	10.15	10.55	9.55	1.00	1.05	9.00	-0.004	0.001	0.033	1.52	18.87
Maximum	45.45	21.80	20.00	2.05	2.25	9.59	0.002	0.020	0.033	10.19	463.28
Range	35.30	11.25	10.45	1.05	1.20	0.59	0.006	0.019	0.000	8.67	444.41

Basin ID 3000	Area (ft²)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	2	2	2	2	2	2	2	2	2	2	2
Mean	36.63	32.98	31.10	1.38	1.53	36.58	0.003	0.014	0.030	6.90	260.53
S.D.	10.64	14.11	16.12	0.74	0.95	39.13	0.005	0.005	0.000	1.47	127.33
C.V. (%)	29.06	42.78	51.84	54.00	62.60	106.98	141.42	32.27	0.00	21.33	48.87
Minimum	29.10	23.00	19.70	0.85	0.85	8.91	0.000	0.011	0.030	5.86	170.49
Maximum	44.15	42.95	42.50	1.90	2.20	64.24	0.007	0.017	0.030	7.94	350.56
Range	15.05	19.95	22.80	1.05	1.35	55.33	0.007	0.006	0.000	2.08	180.07

Basin ID 3600	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	3	3	3	3	3	3	3	3	3	3	3
Mean	305.23	81.53	80.08	3.03	3.08	24.28	0.010	0.009	0.033	8.90	4220.20
S.D.	339.85	60.71	59.91	1.37	1.37	8.11	0.006	0.008	0.000	6.66	6341.70
C.V. (%)	111.34	74.46	74.80	45.00	44.27	33.39	61.17	89.19	0.00	74.78	150.27
Minimum	75.70	42.20	41.55	1.80	1.85	17.23	0.005	0.003	0.033	4.95	374.71
Maximum	695.65	151.45	149.10	4.50	4.55	33.14	0.016	0.018	0.033	16.59	11540.00
Range	619.95	109.25	107.55	2.70	2.70	15.91	0.011	0.015	0.000	11.64	11165.29

Basin ID 5400	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	3	3	3	3	3	3	3	3	3	3	3
Mean	279.35	75.83	73.82	3.65	3.77	19.99	0.008	0.016	0.034	12.84	3685.10
S.D.	78.79	8.69	7.90	0.73	0.75	2.44	0.005	0.005	0.000	3.15	1791.50
C.V. (%)	28.20	11.45	10.71	19.90	19.93	12.19	55.58	33.23	0.00	24.54	48.62
Minimum	193.20	65.85	64.75	2.90	3.00	17.21	0.004	0.010	0.034	10.37	2273.80
Maximum	347.75	81.65	79.25	4.35	4.50	21.77	0.013	0.020	0.034	16.39	5700.50
Range	154.55	15.80	14.50	1.45	1.50	4.56	0.009	0.010	0.000	6.02	3426.70

Low bank reach means for Strata "B" third order

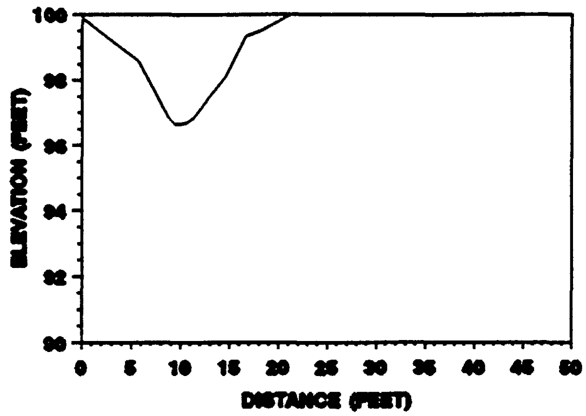
Basin ID 3000	Area (ft²)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	1	1	1	1	1	1	1	1	1	1	1
Mean	17.10	11.20	9.00	1.50	1.90	4.74	0.000	0.001	0.030	1.84	31.38
S.D.	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.00
C.V. (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Minimum	17.10	11.20	9.00	1.50	1.90	4.74	0.000	0.001	0.030	1.84	31.38
Maximum	17.10	11.20	9.00	1.50	1.90	4.74	0.000	0.001	0.030	1.84	31.38
Range	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.00

Basin ID 3600	Area (ft²)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	3	3	3	3	3	3	3	3	3	3	3
Mean	42.37	23.88	23.52	1.02	1.03	35.47	0.010	0.004	0.031	3.35	195.15
S.D.	51.86	18.40	18.11	0.85	0.88	20.84	0.006	0.010	0.000	1.67	261.91
C.V. (%)	122.42	77.05	77.02	83.66	84.69	58.76	61.17	287.52	0.00	49.86	134.21
Minimum	1.30	7.70	7.65	0.15	0.15	18.55	0.005	-0.007	0.031	1.58	2.05
Maximum	100.65	43.90	43.25	1.85	1.90	58.75	0.016	0.014	0.031	4.90	493.28
Range	99.35	36.20	35.60	1.70	1.75	40.20	0.011	0.021	0.000	3.32	491.23

Basin ID 5400	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	3	3	3	3	3	3	3	3	3	3	3
Mean	25.08	24.92	24.63	0.87	0.87	28.09	0.008	0.010	0.031	4.17	140.13
S.D.	22.92	13.10	13.04	0.34	0.34	4.34	0.005	0.007	0.000	2.60	190.87
C.V. (%)	91.35	52.57	52.95	39.27	39.27	15.46	55.58	70.37	0.00	62.33	136.20
Minimum	7.90	14.15	13.90	0.60	0.60	23.17	0.004	0.003	0.031	2.02	27.11
Maximum	51.10	39.50	39.15	1.25	1.25	31.36	0.013	0.016	0.031	7.05	360.51
Range	43.20	25.35	25.25	0.65	0.65	8.20	0.009	0.013	0.000	5.04	333.40

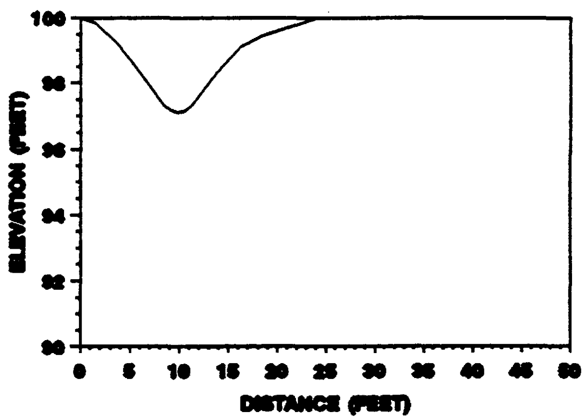
BONE PILE CREEK, 1900

CROSS SECTION 0+[illegible]



BONE PILE CREEK, 1900

CROSS SECTION 1+22.00



BONE PILE CREEK, 1900

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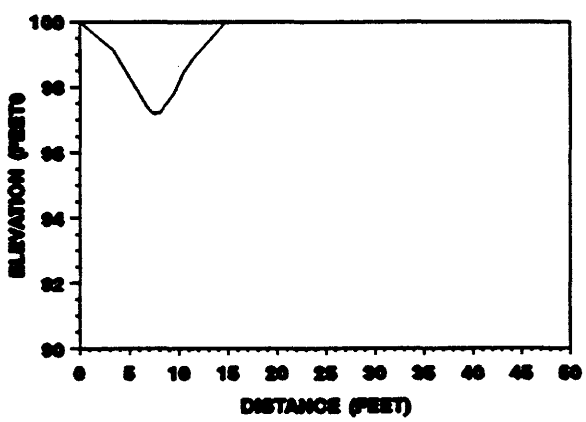

BONE PILE CREEK, 1900
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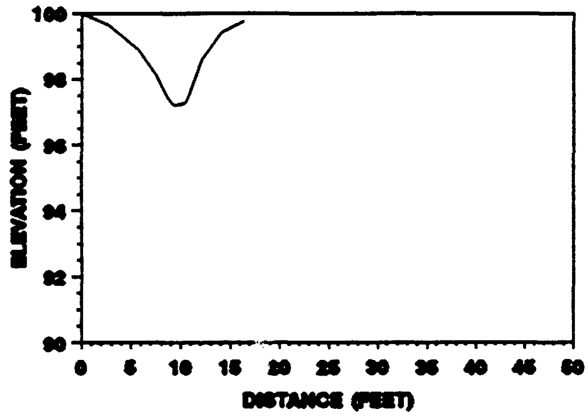

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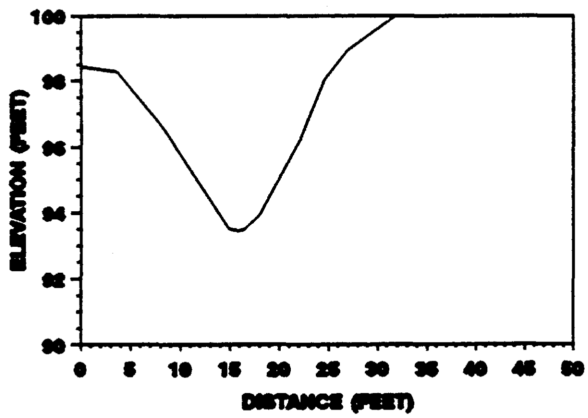

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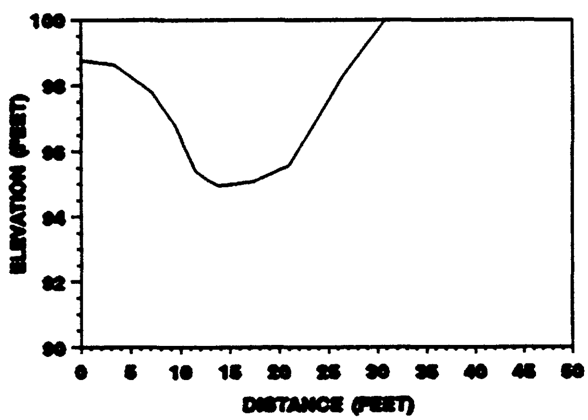

HAY CREEK, 3600
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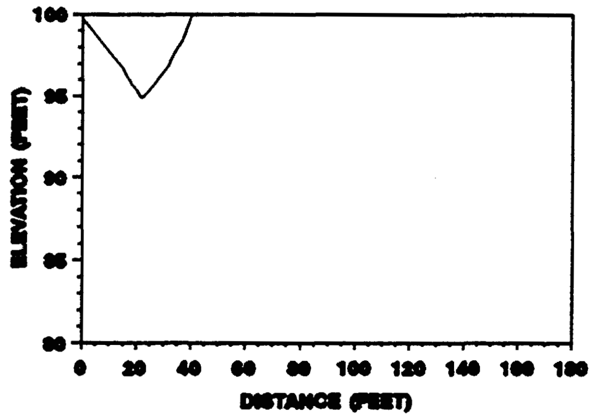

HAY CREEK, 3600
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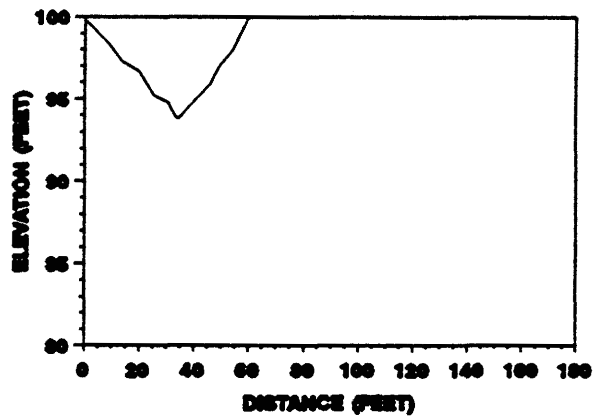

HAY CREEK, 3600
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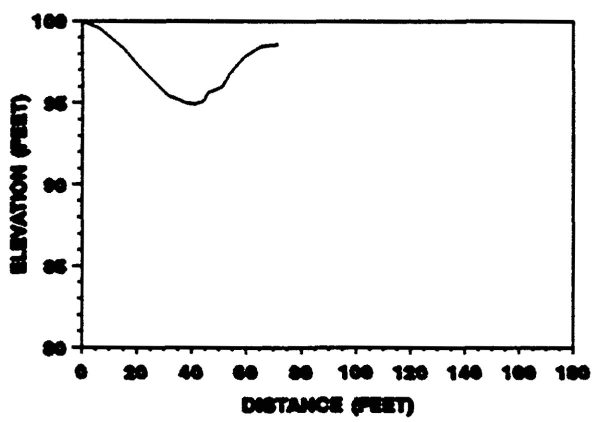
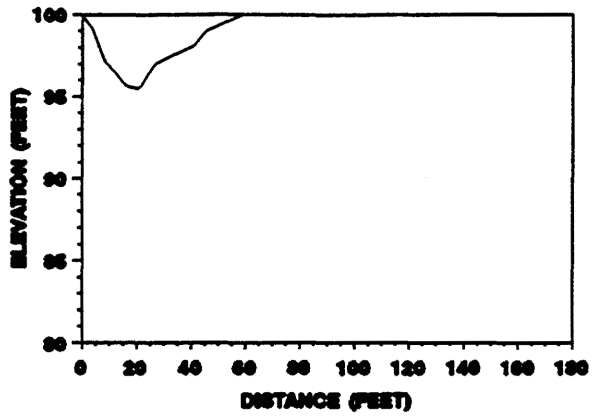


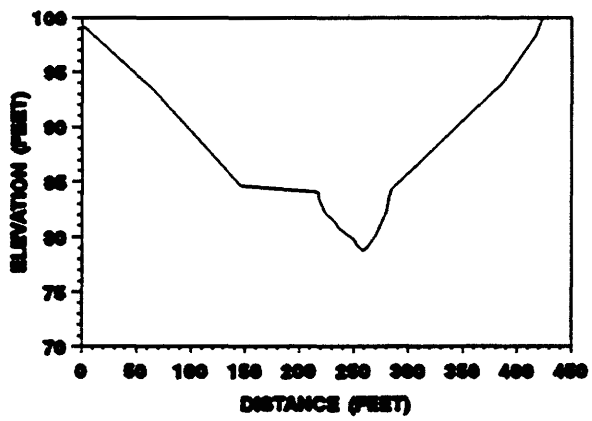
HAY CREEK, 3600

CROSS SECTION 0+58.20



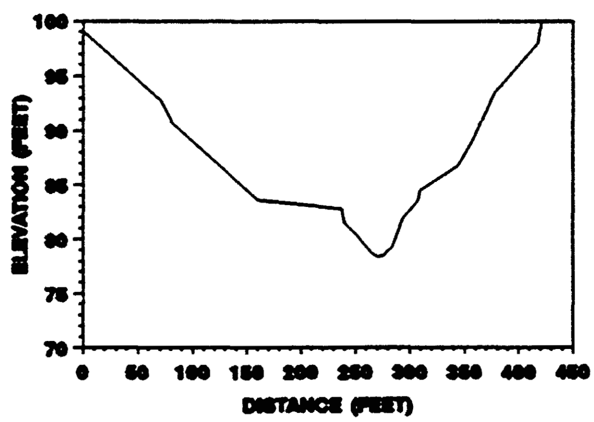
HORSE CREEK, 5400

CROSS SECTION 0+00.00



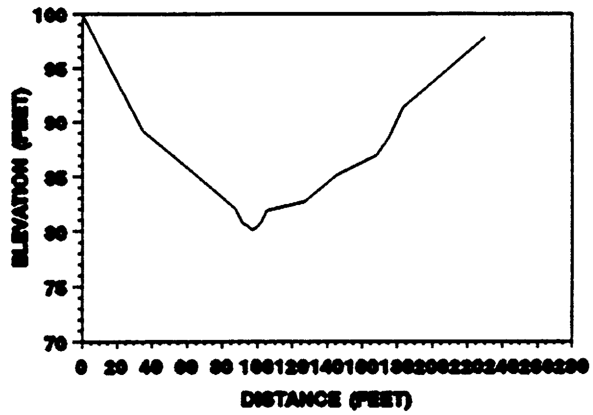
HORSE CREEK, 5400

CROSS SECTION 0+02.50



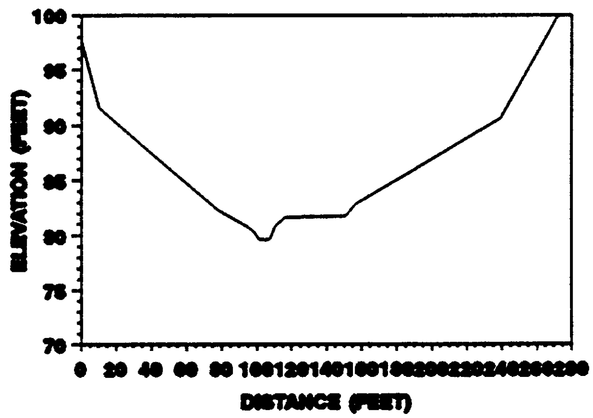
BELLE FOURCHE RIVER, 3000

CROSS SECTION 0+[illegible]



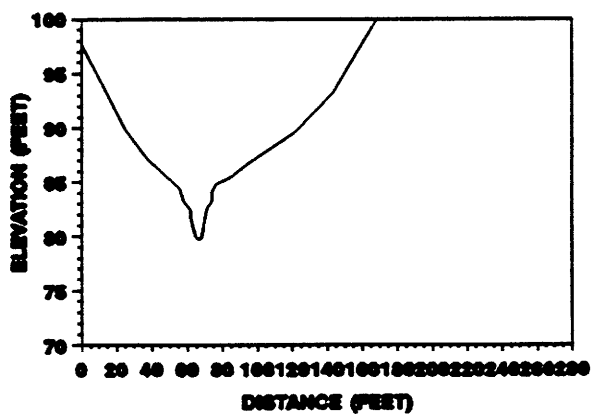
BELLE FOURCHE RIVER, 3000

CROSS SECTION 0+92.00

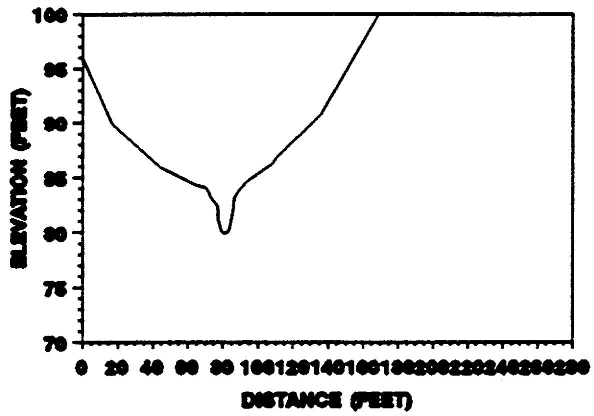


BELLE FOURCHE RIVER, 3000

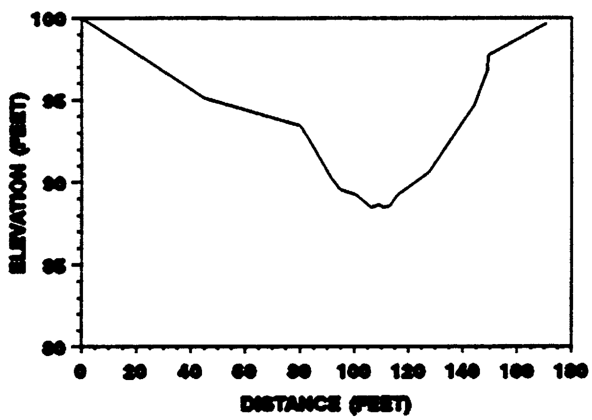
CROSS SECTION 0+[illegible]



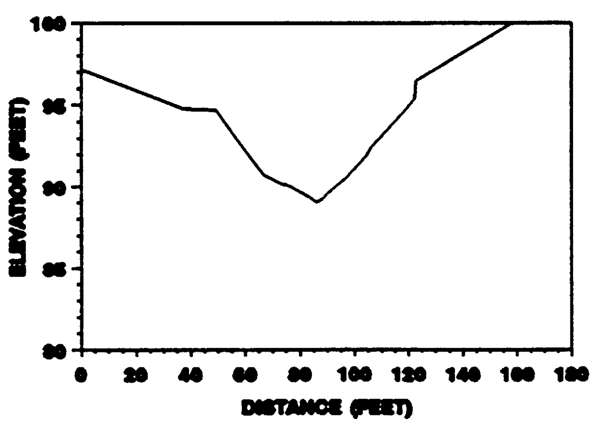
BELLE FOURCHE RIVER, 3000
CROSS SECTION B-2



HAY CREEK, 3600
CROSS SECTION 0+00.00

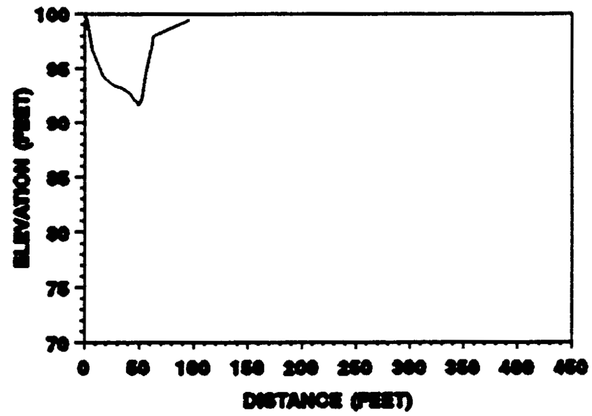


HAY CREEK, 3600
CROSS SECTION 2+70.00



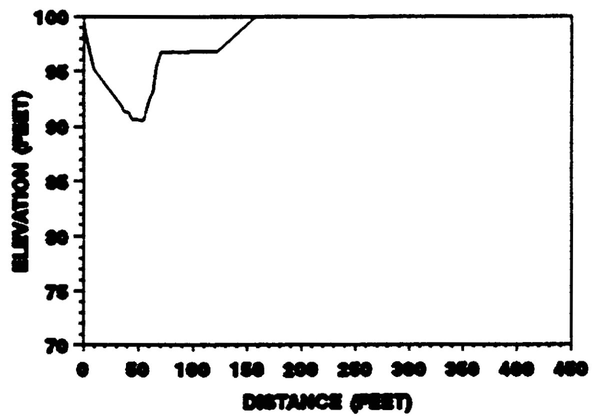
HORSE CREEK, 5400

CROSS SECTION 0+00.00



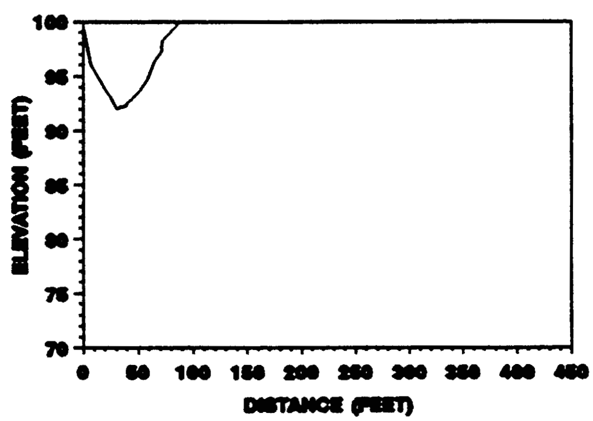
HORSE CREEK, 5400

CROSS SECTION 1+30.00



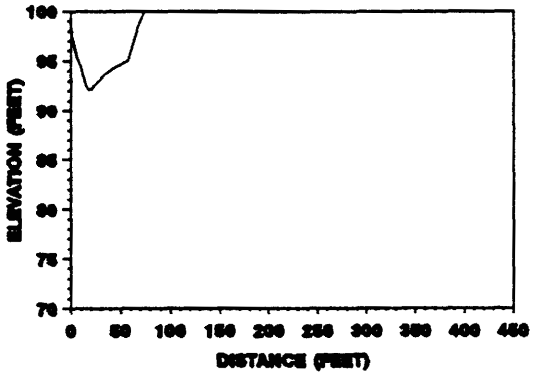
HORSE CREEK, 5400

CROSS SECTION 0+00.00



HORSE CREEK, 5400

CROSS SECTION 0+81.28

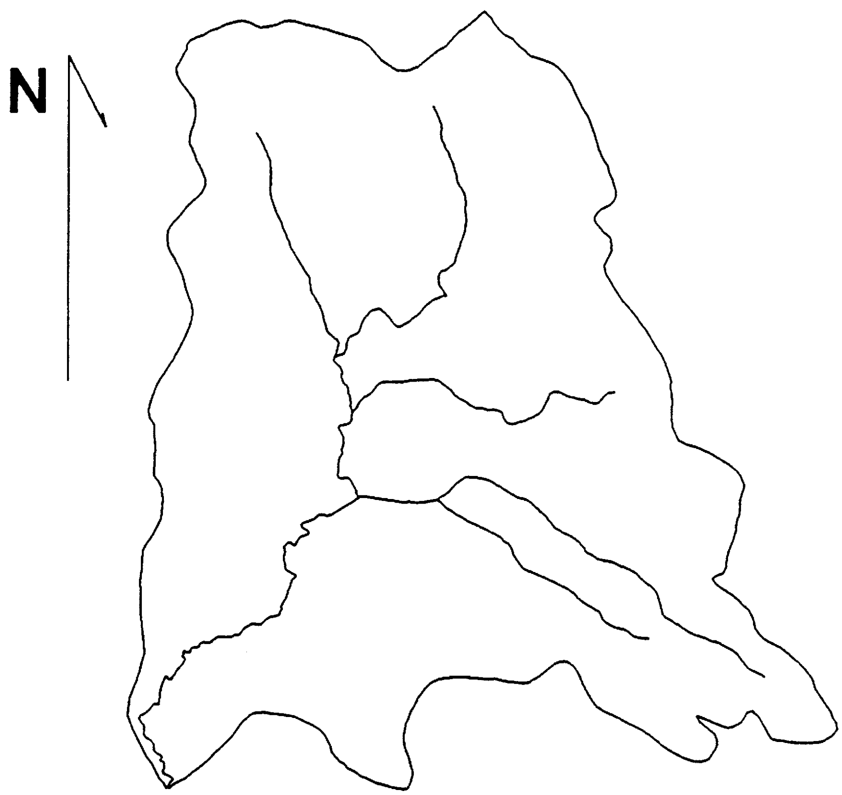


Strata "B" third order raw data by study reach, cross section, and bank identification.

BASIN I.D.	CROSS SECTION NUMBER	BANK I.D.	AREA ($feet^2$)	TOP WIDTH (feet)	AVERAGE DEPTH (feet)	FLOOD-PLAIN WIDTH (feet)
1900	0+00.00A	HIGH	30.00	20.60	1.50	
1900	1+23.00A	HIGH	28.50	23.60	1.20	
1900	13+47.30A	HIGH	15.60	14.60	1.10	69.40
1900	12+98.00A	HIGH	18.30	14.30	1.30	
1900	0+00.00B	HIGH	59.70	25.60	2.30	
1900	0+83.80B	HIGH	55.70	27.70	2.00	
3000	0+00.00A	HIGH	2212.60	223.10	9.90	44.90
3000	0+92.00A	HIGH	3023.70	264.10	11.40	15.90
3000	0+00.00B	HIGH	1404.20	160.20	8.80	
3000	0+75.50B	HIGH	1280.50	154.60	8.30	
3600	0+00.00C	HIGH	107.50	58.10	1.90	
3600	0+58.30C	HIGH	126.50	58.20	2.20	
5400	0+00.00A	HIGH	4482.30	420.90	10.60	
5400	0+62.50A	HIGH	4722.00	420.00	11.20	
1900	0+00.00A	MEDIUM	11.20	9.70	1.20	
1900	1+23.00A	MEDIUM	13.60	12.20	1.10	
1900	12+98.00A	MEDIUM	9.30	8.80	1.00	
1900	13+47.30A	MEDIUM	11.00	10.30	1.10	
1900	0+00.00B	MEDIUM	56.20	21.60	2.60	
1900	0+83.80B	MEDIUM	34.70	18.40	1.90	
3000	0+00.00A	MEDIUM	19.00	17.40	1.10	
3000	0+92.00A	MEDIUM	39.20	67.60	0.60	
3000	0+00.00B	MEDIUM	54.20	22.60	2.40	
3000	0+75.50B	MEDIUM	34.10	16.80	2.00	
3600	0+00.00A	MEDIUM	908.70	168.20	5.40	
3600	2+79.60A	MEDIUM	482.60	130.00	3.70	

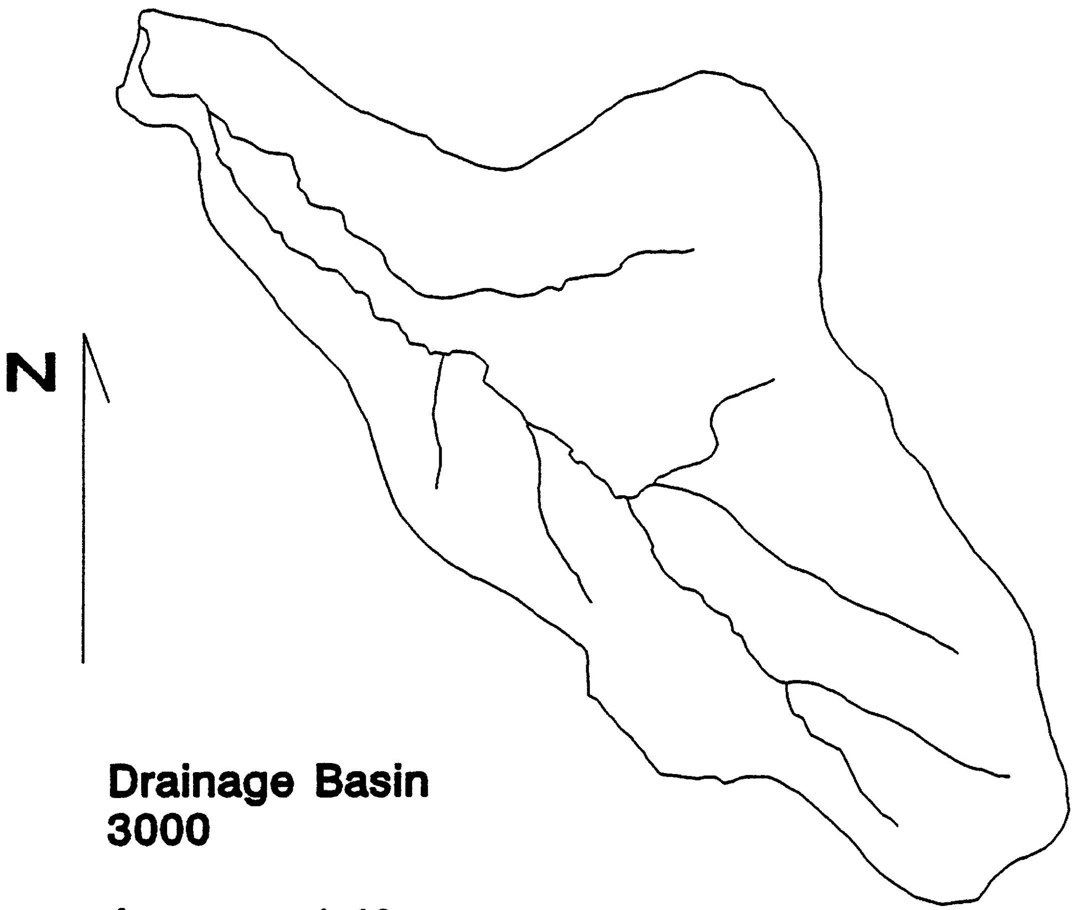
BASIN I.D.	CROSS SECTION NUMBER	BANK I.D.	AREA (feet²)	TOP WIDTH (feet)	AVERAGE DEPTH (feet)
3600	0+00.00B	MEDIUM	101.70	39.70	2.60
3600	1+32.50B	MEDIUM	187.00	59.50	3.10
3600	0+00.00C	MEDIUM	73.10	41.70	1.80
3600	0+58.30C	MEDIUM	78.30	41.40	1.90
5400	0+00.00A	MEDIUM	216.90	65.60	3.30
5400	0+62.50A	MEDIUM	169.50	63.90	2.70
5400	0+00.00B	MEDIUM	345.40	94.40	3.70
5400	1+39.00B	MEDIUM	248.80	64.10	3.90
5400	0+00.00C	MEDIUM	378.50	84.40	4.50
5400	0+81.20C	MEDIUM	317.00	70.50	4.50
3000	0+00.00B	LOW	16.50	8.80	1.90
3000	0+75.5B	LOW	17.70	9.20	1.90
3600	0+00.00A	LOW	182.00	59.10	3.10
3600	2+79.60A	LOW	19.30	27.40	0.70
3600	0+00.00B	LOW	6.80	10.90	0.60
3600	1+32.50B	LOW	43.50	28.40	1.50
3600	0+00.00C	LOW	1.00	8.20	0.10
3600	0+58.30C	LOW	1.60	7.10	0.20
5400	0+00.00A	LOW	62.60	43.40	1.40
5400	0+62.50A	LOW	39.60	34.90	1.10
5400	0+00.00B	LOW	6.60	11.60	0.60
5400	1+39.00B	LOW	9.20	16.20	0.60
5400	0+00.00C	LOW	8.80	17.80	0.50
5400	0+81.20C	LOW	23.70	23.90	1.00
1900	0+00.00A	LOW #2	0.30	2.50	0.10
1900	1+23.00A	LOW #2	0.30	2.70	0.10

BASIN I.D.	CROSS SECTION NUMBER	BANK I.D.	AREA ($feet^2$)	TOP WIDTH (feet)	AVERAGE DEPTH (feet)
1900	12+98.00A	LOW #2	0.20	1.80	0.10
1900	13+47.30A	LOW #2	0.30	2.00	0.10
1900	0+00.00B	LOW #2	0.10	1.50	0.07
1900	0+83.80B	LOW #2	0.30	4.50	0.10
3000	0+00.00B	LOW #2	11.50	8.00	1.40
3000	0+75.50B	LOW #2	12.80	8.70	1.50
3600	0+00.00A	LOW #2	14.70	24.20	0.60
3600	2+79.60A	LOW #2	0.80	5.00	0.20



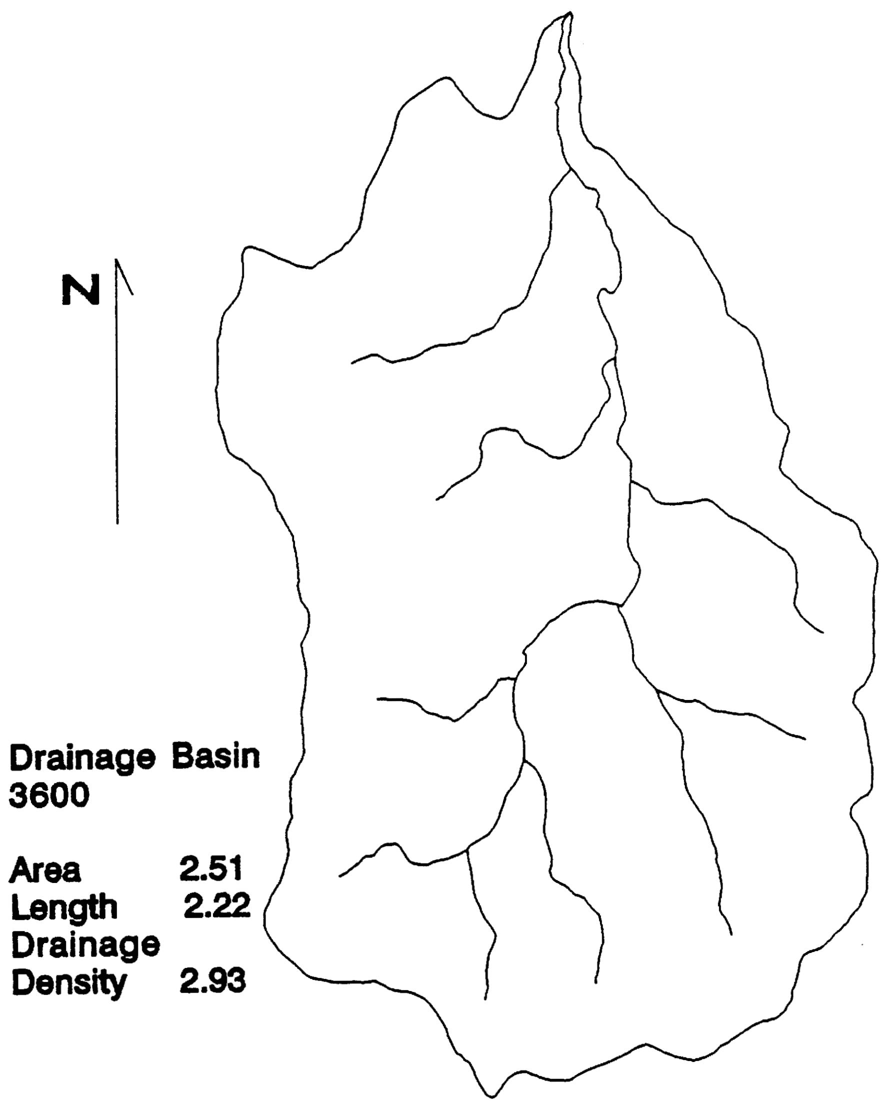
Drainage Basin
1900

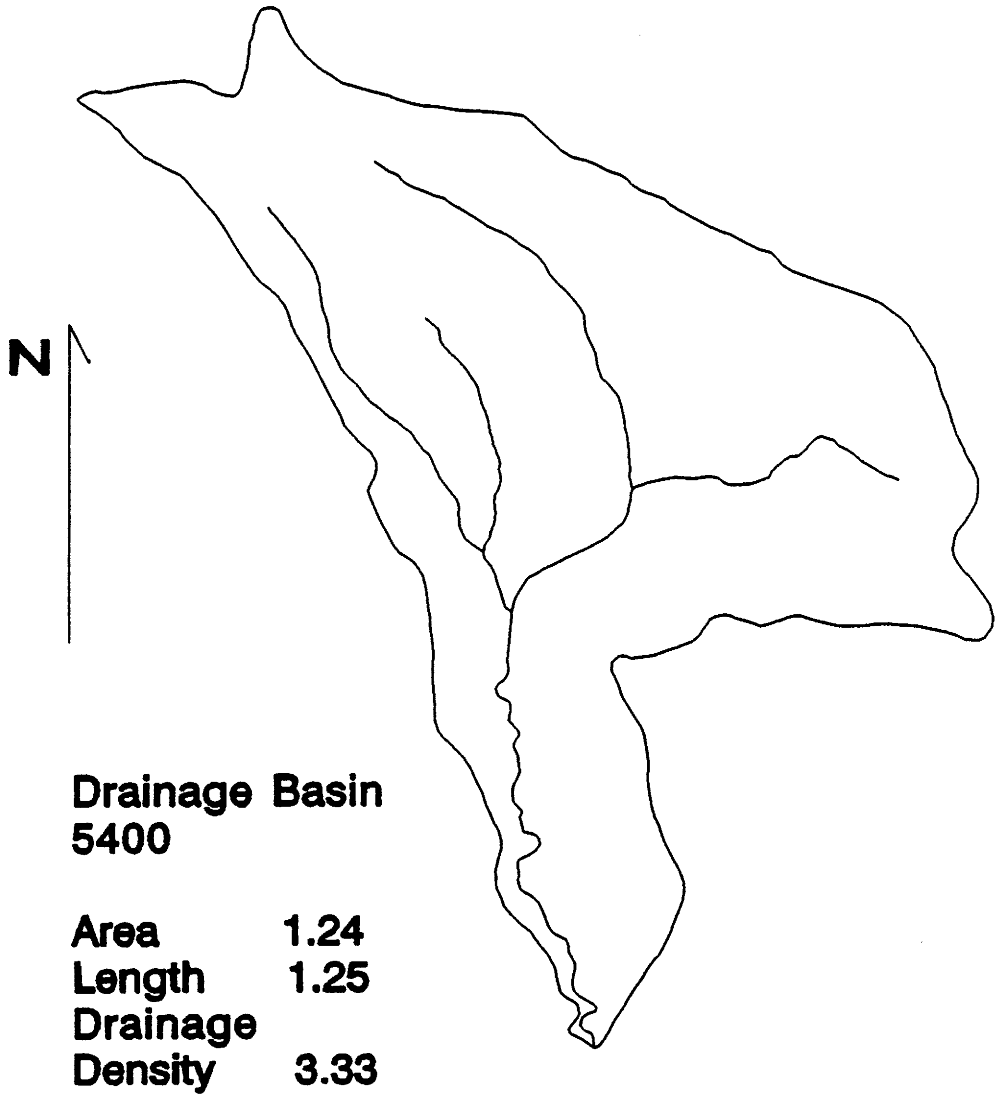
Area 1.85
Length 1.75
Drainage
Density 2.91



Drainage Basin
3000

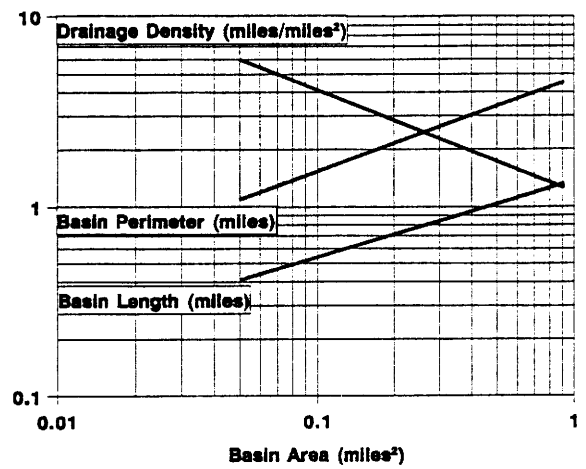
Area 1.40
Length 2.24
Drainage
Density 4.05

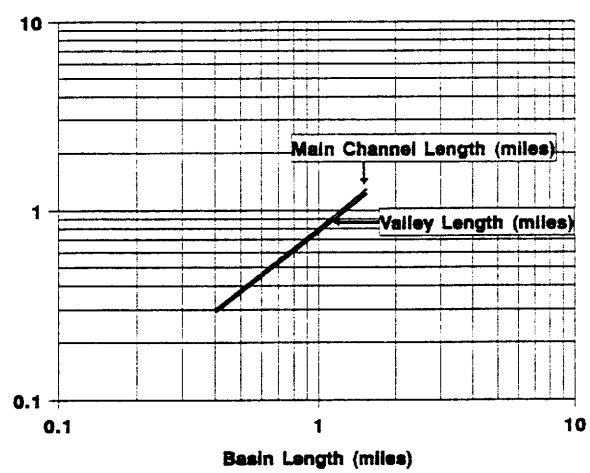

N
Drainage Basin
3600
Area 2.51
Length 2.22
Drainage
Density 2.93

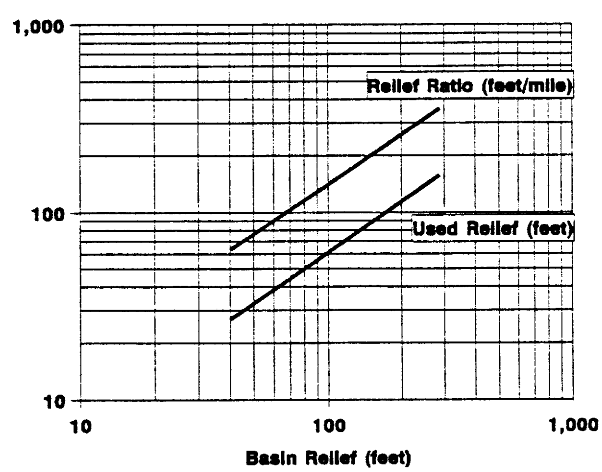

N
Drainage Basin
5400
Area 1.24
Length 1.25
Drainage
Density 3.33

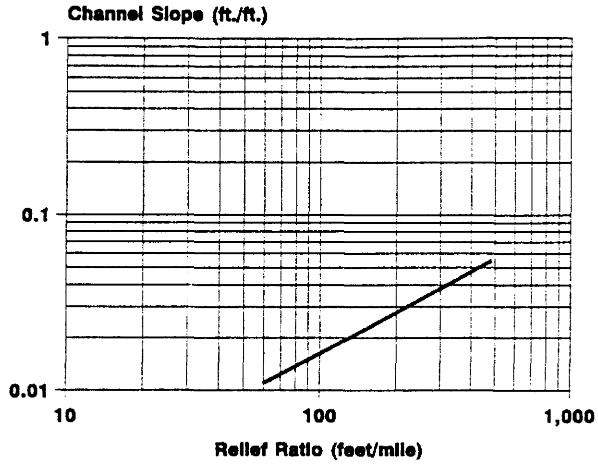
APPENDIX C-1

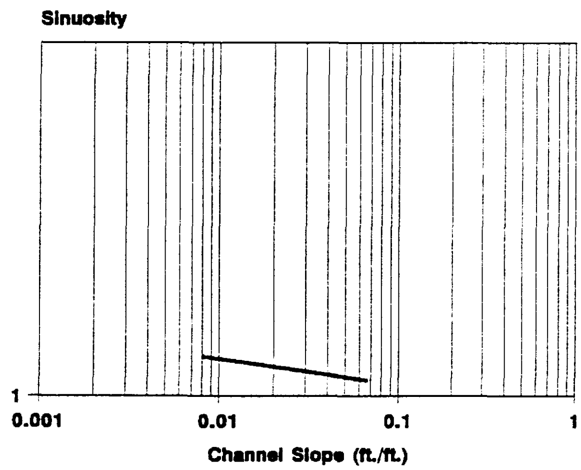
STRATA "C" - FIRST ORDER

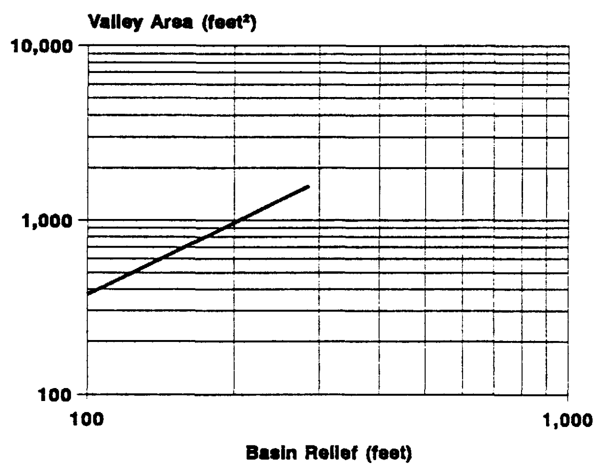

10
Drainage Density (miles/miles²)
1
Basin Perimeter (miles)
Basin Length (miles)
0.1
0.01
0.1
1
Basin Area (miles²)

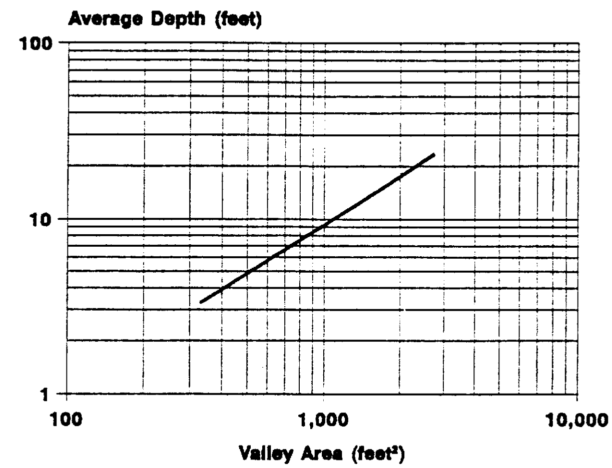

10
Main Channel Length (miles)
1
Valley Length (miles)
0.1
0.1
1
10
Basin Length (miles)

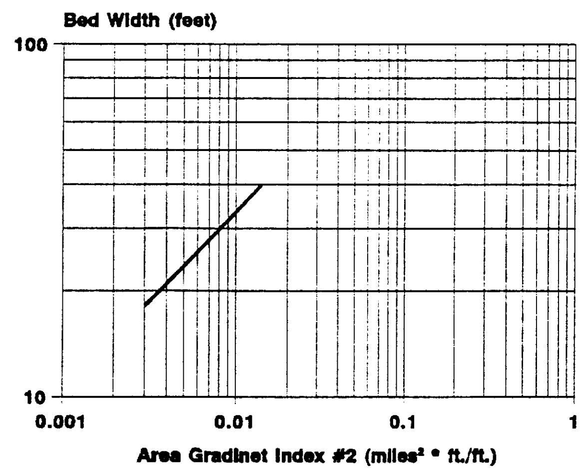

1,000
Relief Ratio (feet/mile)
100
Used Relief (feet)
10
10
100
1,000
Basin Relief (feet)

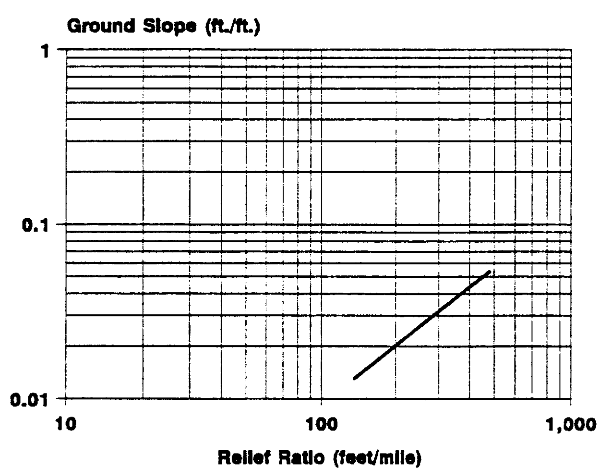

Channel Slope (ft./ft.)
1
0.1
0.01
10
100
1,000
Relief Ratio (feet/mile)


Sinuosity
1
0.001
0.01
0.1
1
Channel Slope (ft./ft.)


Valley Area (feet²)
10,000
1,000
100
100
1,000
Basin Relief (feet)


Average Depth (feet)
100
10
1
100
1,000
10,000
Valley Area (feet²)


Bed Width (feet)
100
10
0.001
0.01
0.1
1
Area Gradinet Index #2 (miles² * ft./ft.)


Ground Slope (ft./ft.)
1
0.1
0.01
10
100
1,000
Relief Ratio (feet/mile)

Strata "C" first order regression output for basin perimeter versus basin area.

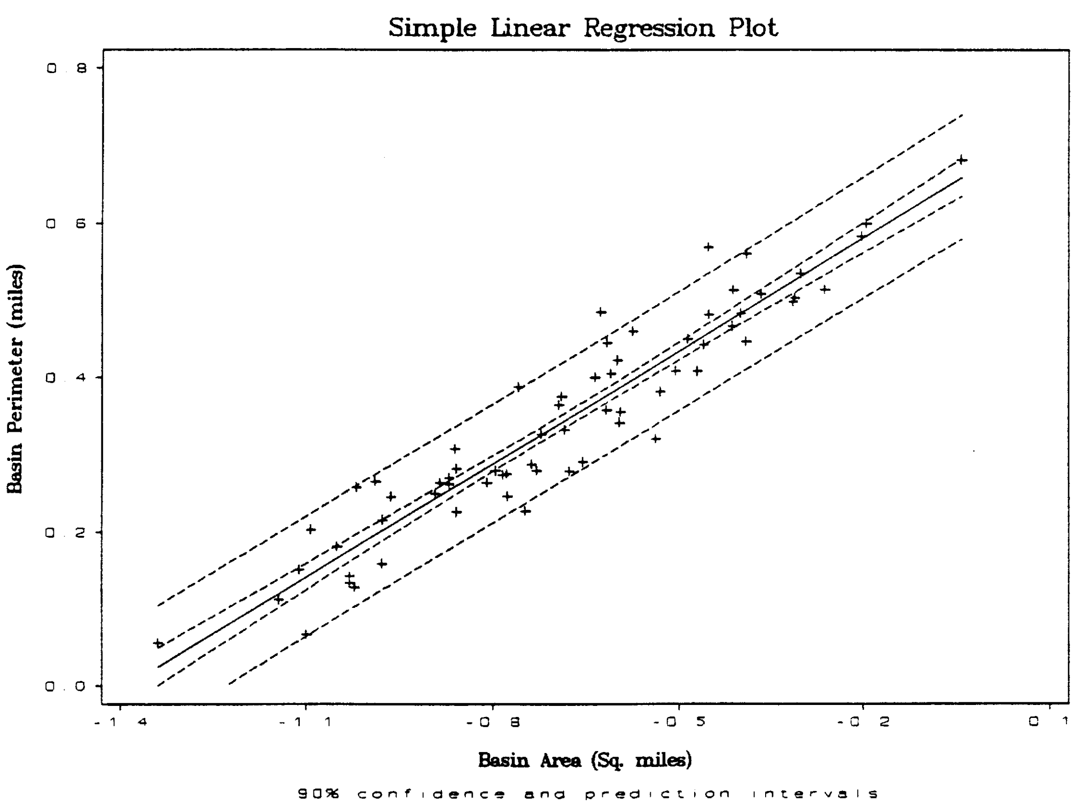
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BASIN PERIMETER

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.67920	0.01542	44.05	0.0000
BA	0.48858	0.02089	23.39	0.0000

R-SQUARED	0.8953	RESID. MEAN SQUARE (MSE)	0.00208
ADJUSTED R-SQUARED	0.8936	STANDARD DEVIATION	0.04560

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.13750	1.13750	547.03	0.0000
RESIDUAL	64	0.13308	0.00208		
TOTAL	65	1.27058			

CASES INCLUDED 66 MISSING CASES 0



Strata "C" first order regression output for drainage density versus basin area.

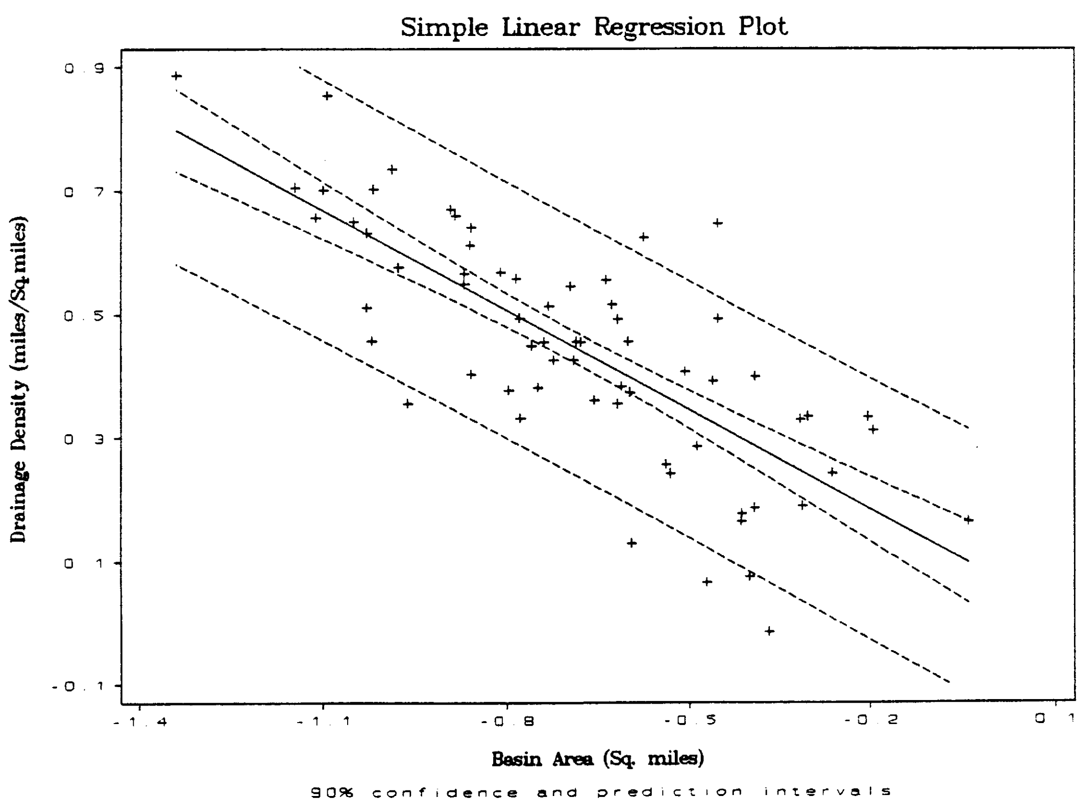
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF DRAINAGE DENSITY

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.07611	0.04165	1.83	0.0723
BA	-0.53820	0.05643	-9.54	0.0000

R-SQUARED	0.5870	RESID. MEAN SQUARE (MSE)	0.01517
ADJUSTED R-SQUARED	0.5806	STANDARD DEVIATION	0.12318

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.38030	1.38030	90.97	0.0000
RESIDUAL	64	0.97110	0.01517		
TOTAL	65	2.35140			

CASES INCLUDED 66 MISSING CASES 0



Strata "C" first order regression output for basin length versus basin area.

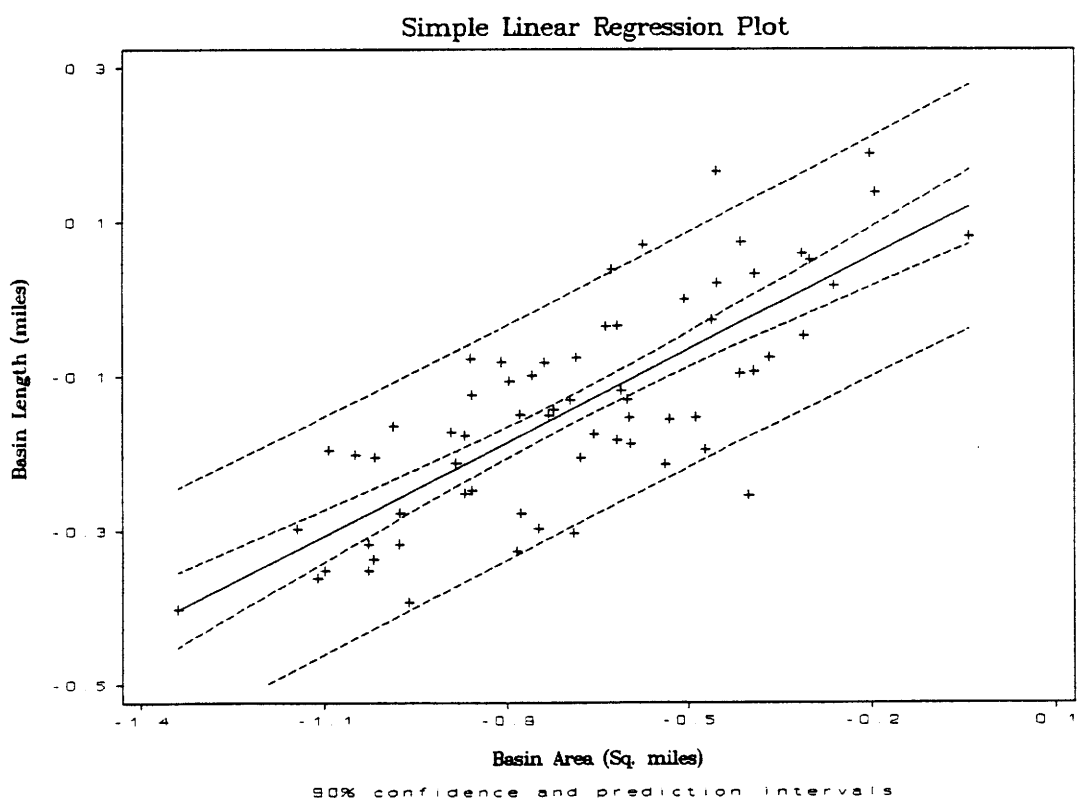
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BASIN LENGTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.13596	0.03054	4.45	0.0000
BA	0.40208	0.04137	9.72	0.0000

R-SQUARED	0.5961	RESID. MEAN SQUARE (MSE)	0.00815
ADJUSTED R-SQUARED	0.5898	STANDARD DEVIATION	0.09030

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.77036	0.77036	94.47	0.0000
RESIDUAL	64	0.52189	0.00815		
TOTAL	65	1.29225			

CASES INCLUDED 66 MISSING CASES 0



Strata "C" first order regression output for main channel length versus basin length.

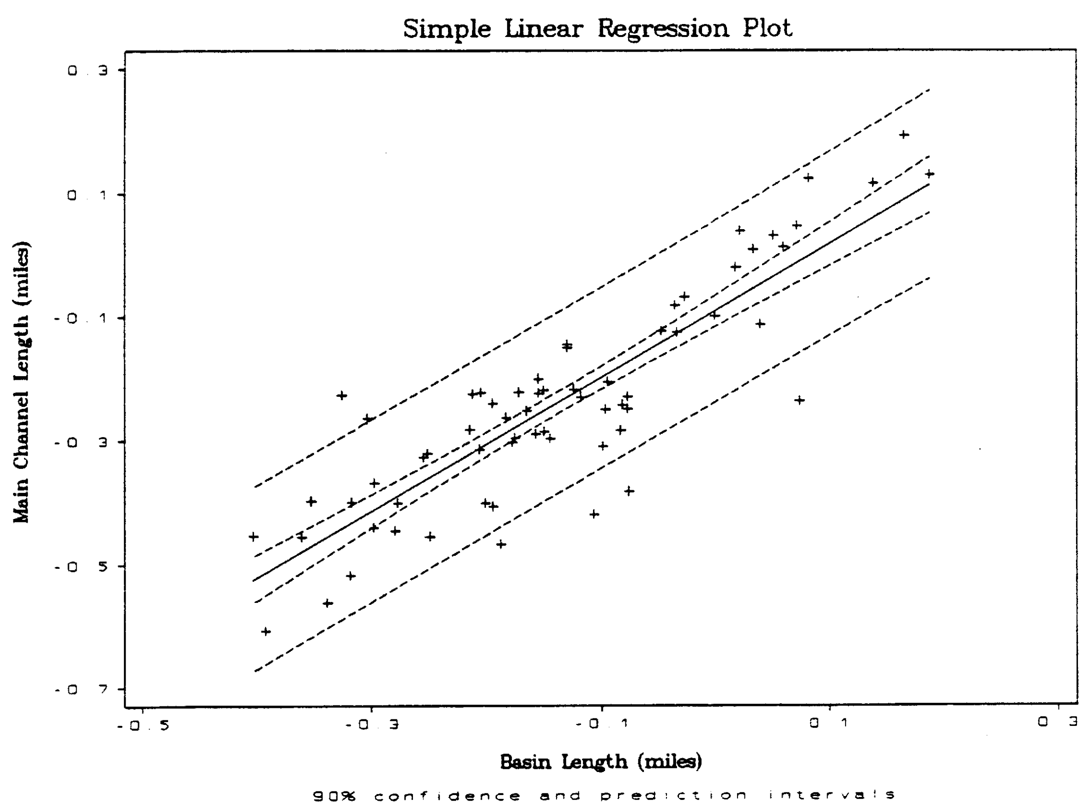
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF MAIN CHANNEL LENGTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.08979	0.01514	-5.93	0.0000
BL	1.07919	0.07636	14.13	0.0000

R-SQUARED	0.7573	RESID. MEAN SQUARE (MSE)	0.00754
ADJUSTED R-SQUARED	0.7535	STANDARD DEVIATION	0.08681

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.50501	1.50501	199.71	0.0000
RESIDUAL	64	0.48229	0.00754		
TOTAL	65	1.98730			

CASES INCLUDED 66   MISSING CASES 0



Strata "C" first order regression output for valley length versus basin length.

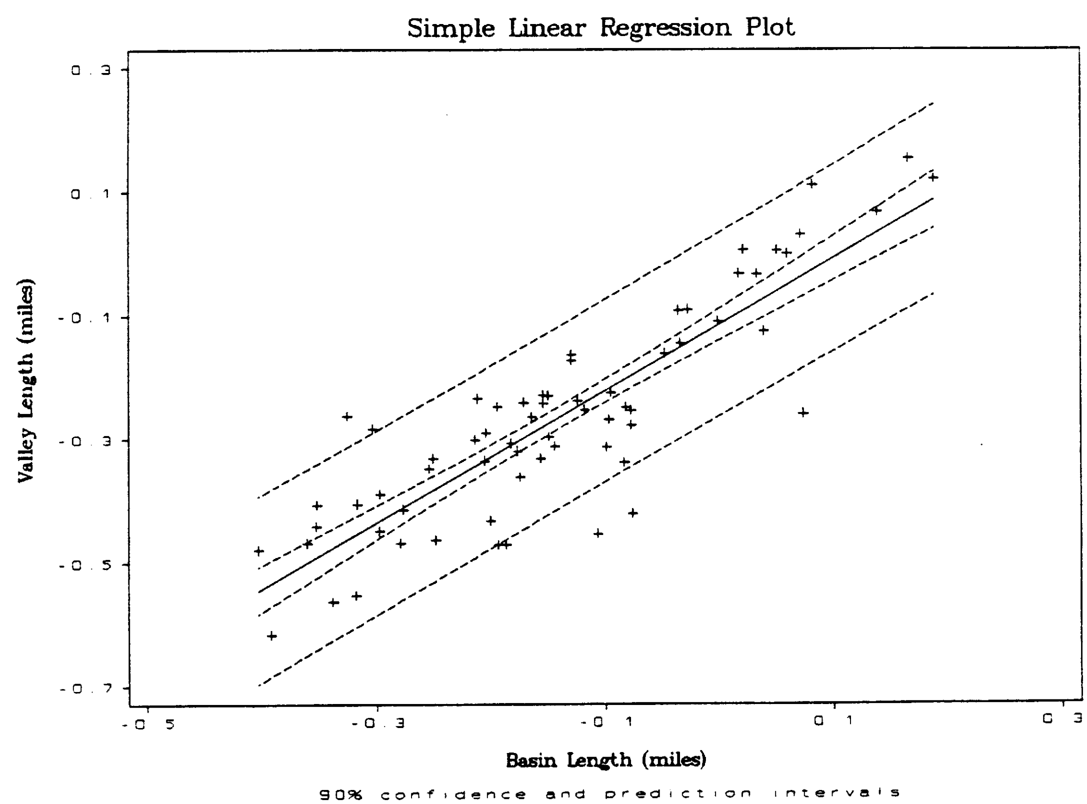
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF VALLEY LENGTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.11452	0.01531	-7.48	0.0000
BL	1.06960	0.07721	13.85	0.0000

R-SQUARED	0.7499	RESID. MEAN SQUARE (MSE)	0.00770
ADJUSTED R-SQUARED	0.7460	STANDARD DEVIATION	0.08777

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.47839	1.47839	191.91	0.0000
RESIDUAL	64	0.49302	0.00770		
TOTAL	65	1.97141			

CASES INCLUDED 66 MISSING CASES 0



Strata "C" first order regression output of basin relief versus basin area and basin length.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BASIN RELIEF

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	1.94289	0.06851	28.36	0.0000
BA	-0.36611	0.12761	-2.87	0.0056
BL	0.75569	0.24505	3.08	0.0030

R-SQUARED	0.1382	RESID. MEAN SQUARE (MSE)	0.03134
ADJUSTED R-SQUARED	0.1108	STANDARD DEVIATION	0.17703

SOURCE	DF	SS	MS	F	P
REGRESSION	2	0.31651	0.15826	5.05	0.0093
RESIDUAL	63	1.97429	0.03134		
TOTAL	65	2.29080			

CASES INCLUDED 66 MISSING CASES 0

Strata "C" first order regression output for used relief versus basin relief.

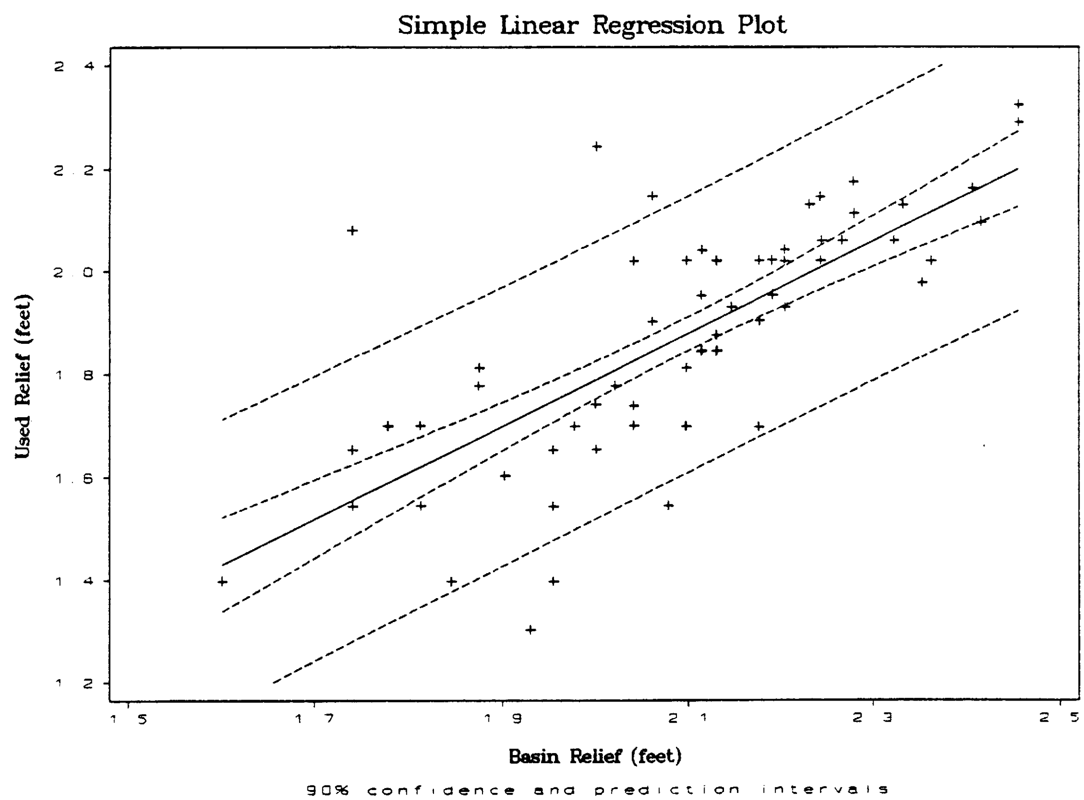
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF USED RELIEF

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.01480	0.22168	-0.07	0.9470
BR	0.90205	0.10572	8.53	0.0000

R-SQUARED	0.5322	RESID. MEAN SQUARE (MSE)	0.02561
ADJUSTED R-SQUARED	0.5248	STANDARD DEVIATION	0.16002

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.86401	1.86401	72.80	0.0000
RESIDUAL	64	1.63878	0.02561		
TOTAL	65	3.50279			

CASES INCLUDED 66 MISSING CASES 0



Strata "C" first order regression output for relief ratio versus basin relief.

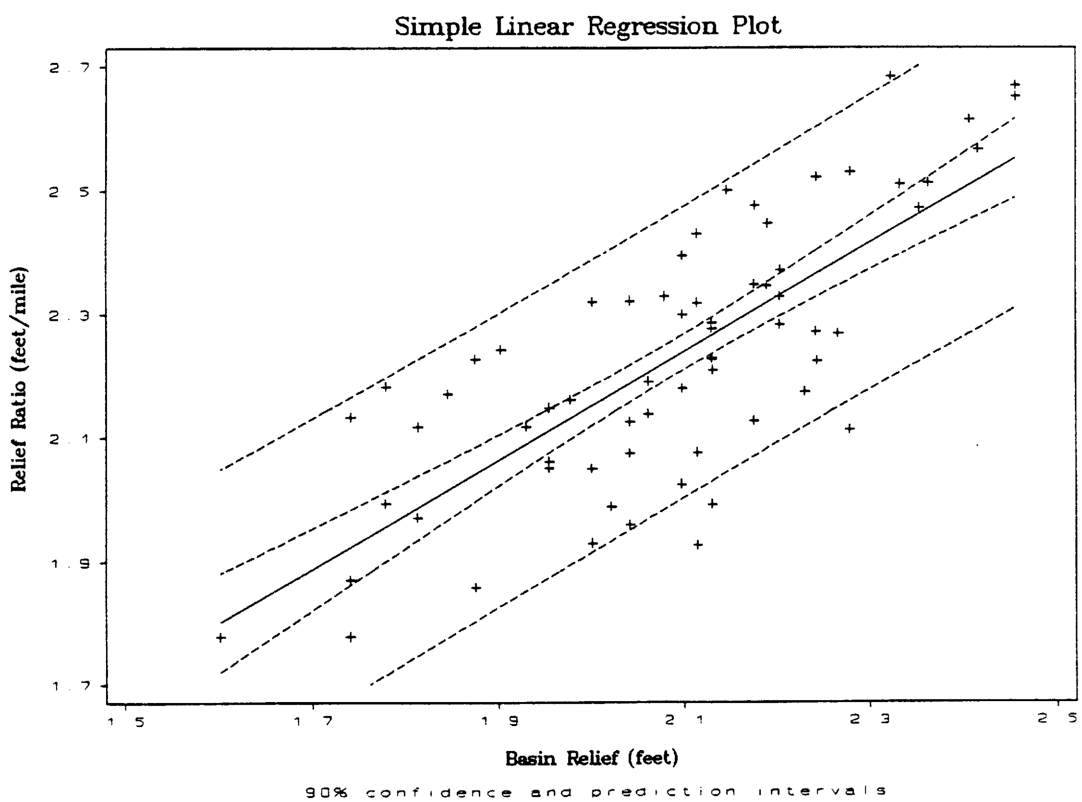
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RELIEF RATIO

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.39125	0.19432	2.01	0.0483
BR	0.87992	0.09268	9.49	0.0000

R-SQUARED	0.5848	RESID. MEAN SQUARE (MSE)	0.01968
ADJUSTED R-SQUARED	0.5783	STANDARD DEVIATION	0.14027

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.77366	1.77366	90.15	0.0000
RESIDUAL	64	1.25922	0.01968		
TOTAL	65	3.03288			

CASES INCLUDED 66 MISSING CASES 0



Strata "C" first order regression output for ruggedness number versus basin relief.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RUGGEDNESS NUMBER

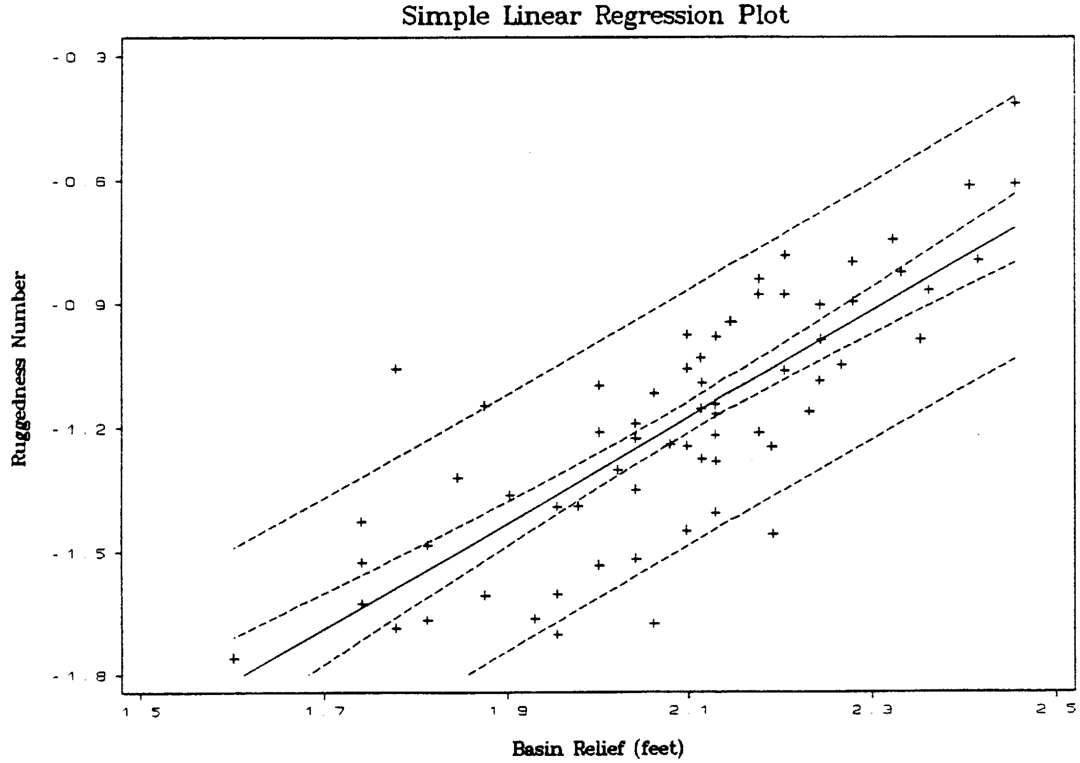
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-3.87701	0.25462	-15.23	0.0000
BR	1.28753	0.12144	10.60	0.0000

R-SQUARED	0.6372	RESID. MEAN SQUARE (MSE)	0.03378
ADJUSTED R-SQUARED	0.6316	STANDARD DEVIATION	0.18380

SOURCE	DF	SS	MS	F	P
REGRESSION	1	3.79756	3.79756	112.42	0.0000
RESIDUAL	64	2.16201	0.03378		
TOTAL	65	5.95957			

CASES INCLUDED 66 MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "C" first order regression output for channel slope versus relief ratio.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF CHANNEL SLOPE

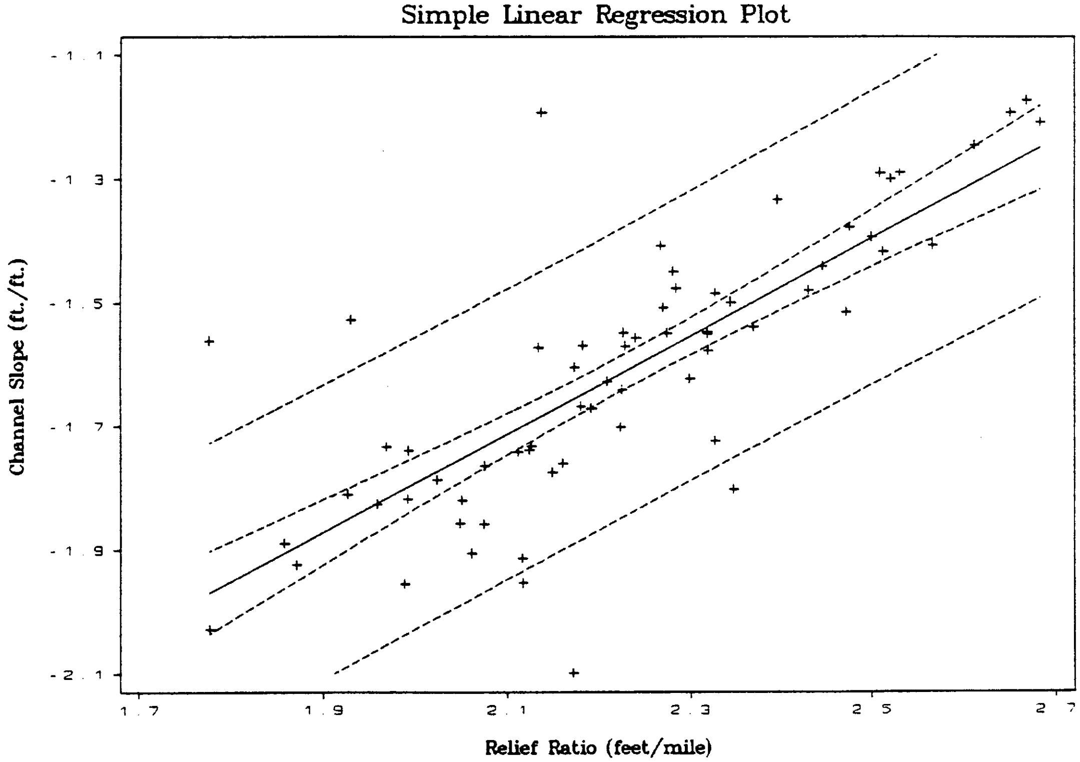
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-3.38048	0.17927	-18.86	0.0000
RR	0.79440	0.08006	9.92	0.0000

R-SQUARED	0.6061	RESID. MEAN SQUARE (MSE)	0.01944
ADJUSTED R-SQUARED	0.5999	STANDARD DEVIATION	0.13943

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.91397	1.91397	98.46	0.0000
RESIDUAL	64	1.24413	0.01944		
TOTAL	65	3.15810			

CASES INCLUDED 66 MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "C" first order regression output for sinuosity versus channel slope.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF SINUOSITY

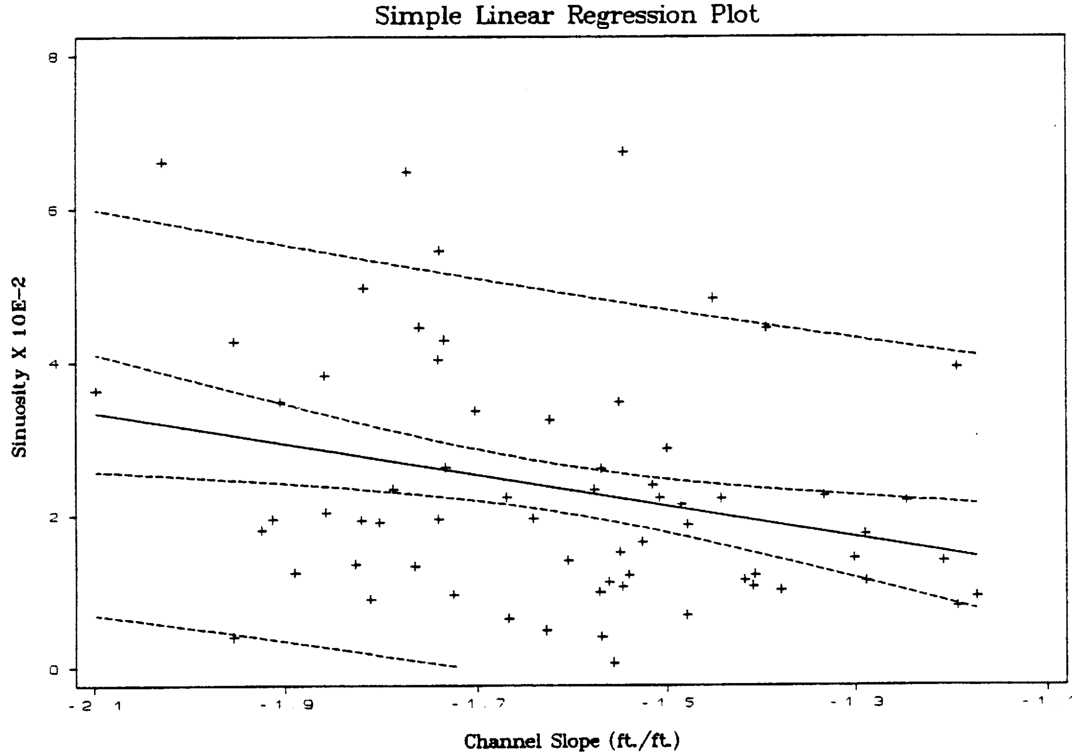
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.00934	0.01390	-0.67	0.5043
CHS	-0.02032	0.00856	-2.37	0.0206

R-SQUARED	0.0810	RESID. MEAN SQUARE (MSE)	2.313E-04
ADJUSTED R-SQUARED	0.0666	STANDARD DEVIATION	0.01521

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.00130	0.00130	5.64	0.0206
RESIDUAL	64	0.01480	2.313E-04		
TOTAL	65	0.01611			

CASES INCLUDED 66 MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "C" first order regression output for valley area versus basin relief.

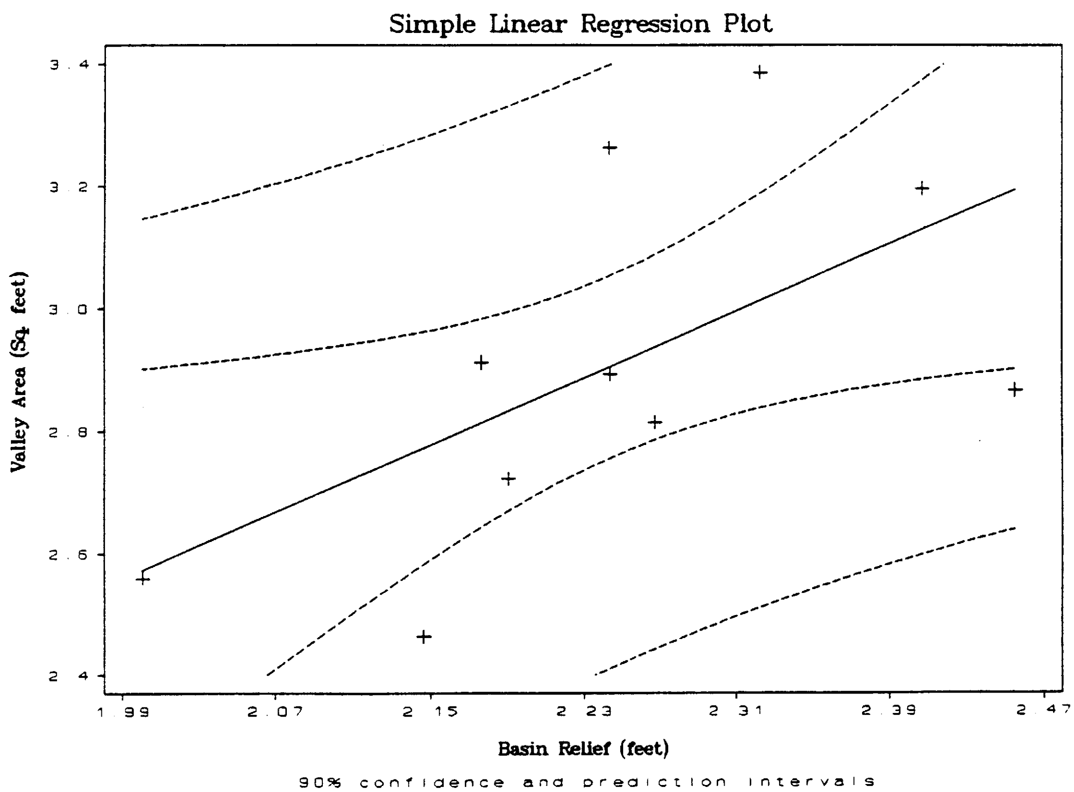
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF VALLEY AREA

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.16923	1.45106	-0.12	0.9100
BR	1.37051	0.64538	2.12	0.0665

R-SQUARED	0.3605	RESID. MEAN SQUARE (MSE)	0.06420
ADJUSTED R-SQUARED	0.2805	STANDARD DEVIATION	0.25337

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.28950	0.28950	4.51	0.0665
RESIDUAL	8	0.51358	0.06420		
TOTAL	9	0.80308			

CASES INCLUDED 10   MISSING CASES 0



Strata "C" first order regression output for average depth versus valley area.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AVERAGE DEPTH

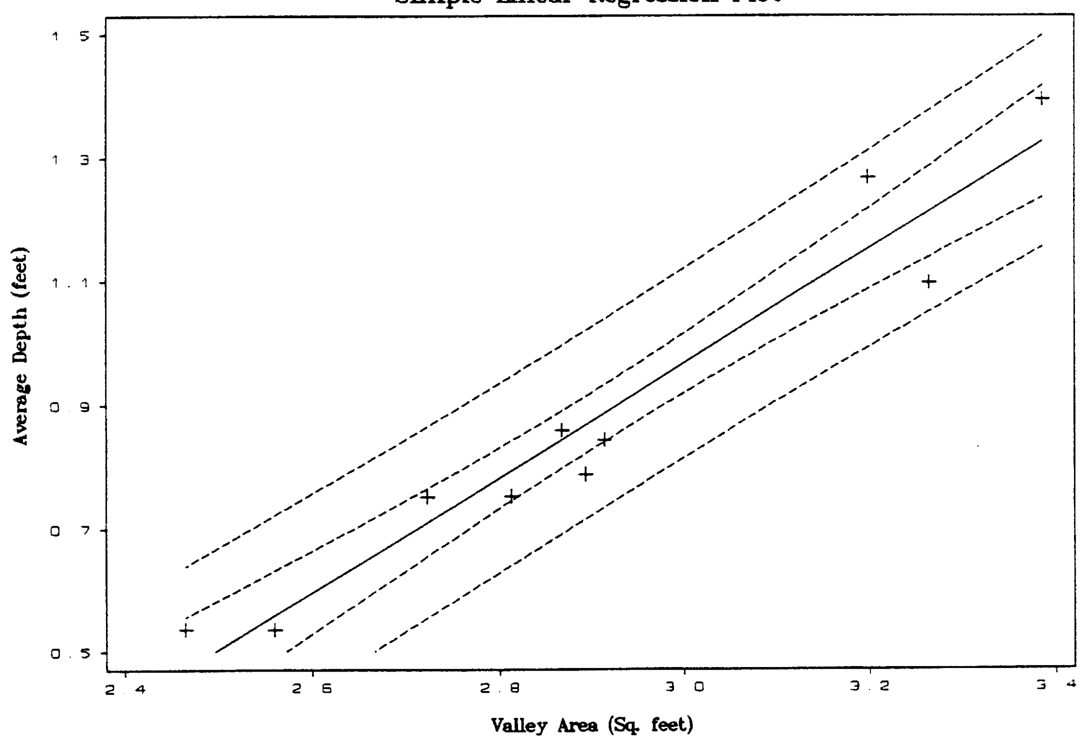
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-1.81967	0.25494	-7.14	0.0001
A	0.92922	0.08727	10.65	0.0000

R-SQUARED	0.9341	RESID. MEAN SQUARE (MSE)	0.00612
ADJUSTED R-SQUARED	0.9258	STANDARD DEVIATION	0.07821

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.69342	0.69342	113.37	0.0000
RESIDUAL	8	0.04893	0.00612		
TOTAL	9	0.74235			

CASES INCLUDED 10 MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "C" first order regression output for ground slope versus relief ratio.

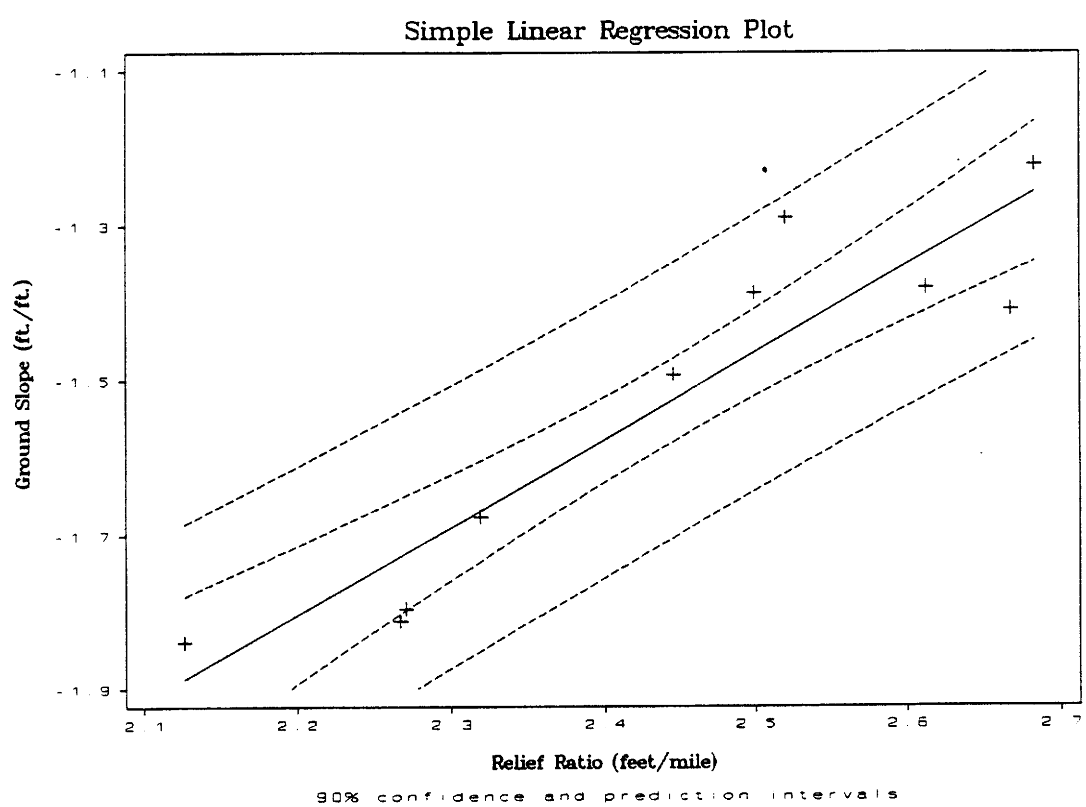
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF GROUND SLOPE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-4.29766	0.39423	-10.90	0.0000
RR	1.13347	0.16108	7.04	0.0001

R-SQUARED	0.8609	RESID. MEAN SQUARE (MSE)	0.00836
ADJUSTED R-SQUARED	0.8435	STANDARD DEVIATION	0.09142

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.41380	0.41380	49.52	0.0001
RESIDUAL	8	0.06685	0.00836		
TOTAL	9	0.48065			

CASES INCLUDED 10 MISSING CASES 0



Strata "C" first order regression output for bed width versus area gradient index #2.

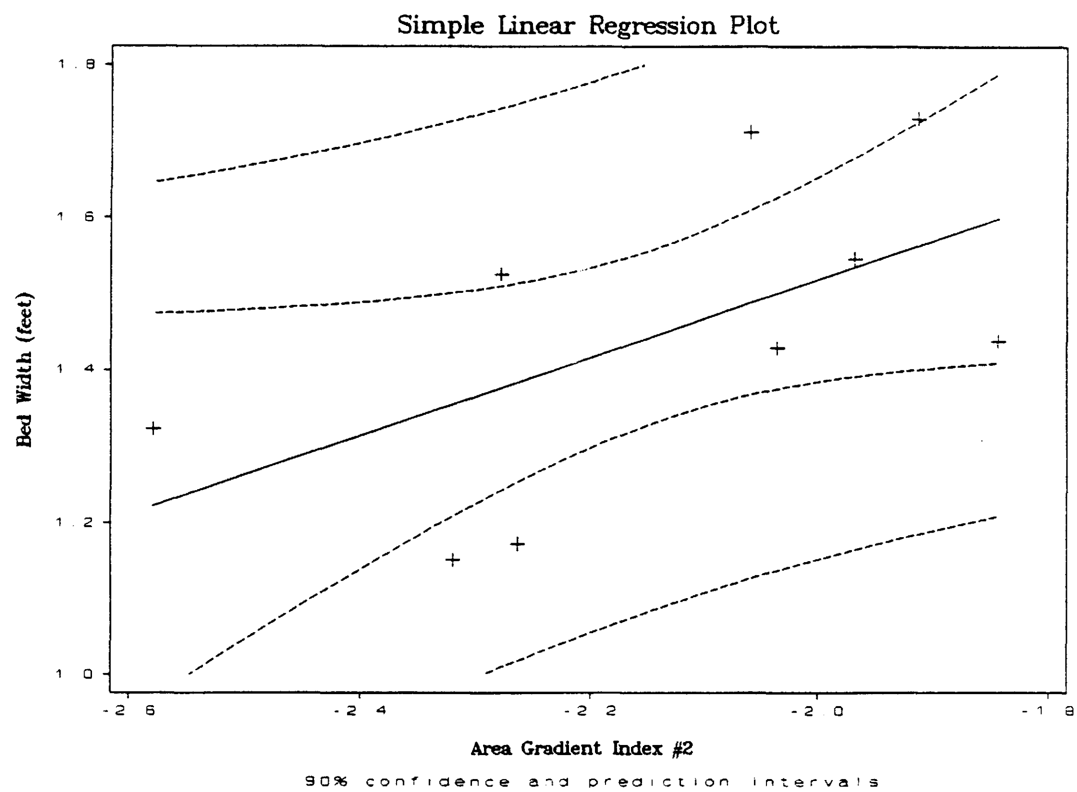
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BED WIDTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	2.54381	0.58080	4.38	0.0032
AGI2	0.51246	0.26997	1.90	0.0995

R-SQUARED	0.3398	RESID. MEAN SQUARE (MSE)	0.03249
ADJUSTED R-SQUARED	0.2455	STANDARD DEVIATION	0.18025

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.11707	0.11707	3.60	0.0995
RESIDUAL	7	0.22742	0.03249		
TOTAL	8	0.34449			

CASES INCLUDED 9 MISSING CASES 1



Strata "C" first order regression output for top width versus basin relief and sinuosity.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOP WIDTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	3.24727	0.54408	5.97	0.0006
BR	-0.47815	0.22322	-2.14	0.0694
SIN	-6.74661	2.64399	-2.55	0.0380

R-SQUARED	0.4905	RESID. MEAN SQUARE (MSE)	0.00384
ADJUSTED R-SQUARED	0.3449	STANDARD DEVIATION	0.06195

SOURCE	DF	SS	MS	F	P
REGRESSION	2	0.02586	0.01293	3.37	0.0944
RESIDUAL	7	0.02686	0.00384		
TOTAL	9	0.05272			

CASES INCLUDED 10   MISSING CASES 0

Strata "C" first order regression output for top width versus relief ratio and sinuosity.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TW

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	2.68680	0.29758	9.03	0.0000
RR	-0.23622	0.11556	-2.04	0.0802
SIN	-3.84833	1.97863	-1.94	0.0929

R-SQUARED	0.4718	RESID. MEAN SQUARE (MSE)	0.00398
ADJUSTED R-SQUARED	0.3209	STANDARD DEVIATION	0.06307

SOURCE	DF	SS	MS	F	P
REGRESSION	2	0.02488	0.01244	3.13	0.1071
RESIDUAL	7	0.02785	0.00398		
TOTAL	9	0.05272			

CASES INCLUDED 10 MISSING CASES 0

High bank reach means for **Strata "C"** first orders.

BASIN ID 05B4	**AREA** (ft.^{2})	**WETTED PERIMETER** (ft.)	**TOP WIDTH** (ft.)	**HYDRAULIC RADIUS**	**AVERAGE DEPTH** (ft.)	**W/D RATIO**	**BED WIDTH** (ft.)	**AVERAGE SLOPE** (ft/ft)
n	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.00
MEAN	2735.90	145.42	100.83	17.68	25.85	4.12	19.35	0.064
S.D.	1721.10	46.93	26.81	4.72	9.36	1.37	14.77	0.026
C.V. (%)	62.91	32.27	26.59	26.72	36.23	33.13	76.32	41.18
MINIMUM	1709.00	114.50	71.70	14.90	17.30	3.01	4.25	0.037
MAXIMUM	5305.50	215.20	135.30	24.70	39.20	6.09	34.72	0.090
RANGE	3596.50	100.70	63.60	9.80	21.90	3.08	30.47	0.053

BASIN ID 07D3	**AREA** (ft.^{2})	**WETTED PERIMETER** (ft.)	**TOP WIDTH** (ft.)	**HYDRAULIC RADIUS**	**AVERAGE DEPTH** (ft.)	**W/D RATIO**	**BED WIDTH** (ft.)	**AVERAGE SLOPE** (ft/ft)
n	3.00	3.00	3.00	3.00	3.00	3.00	3.00	5.00
MEAN	1896.60	156.07	148.50	11.97	12.60	11.76	35.62	0.053
S.D.	608.00	26.50	26.46	1.68	1.74	0.78	13.41	0.011
C.V. (%)	32.06	16.98	17.82	14.02	13.84	6.63	37.65	21.58
MINIMUM	1512.70	136.40	128.10	10.90	11.40	10.86	20.21	0.034
MAXIMUM	2597.60	186.20	178.40	13.90	14.60	12.22	44.67	0.064
RANGE	1084.90	49.80	50.30	3.00	3.20	1.36	24.46	0.030

BASIN ID 07D4	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
MEAN	828.87	132.17	127.97	6.13	6.33	21.27	38.53	0.017
S.D.	353.15	17.28	15.12	1.86	2.00	5.46	20.66	0.008
C.V. (%)	42.61	13.07	11.82	30.26	31.59	25.66	53.63	47.07
MINIMUM	509.60	121.50	118.40	4.20	4.30	17.52	21.97	0.010
MAXIMUM	1208.20	152.10	145.40	7.90	8.30	27.54	61.68	0.026
RANGE	698.60	30.60	27.00	3.70	4.00	10.02	39.71	0.016

BASIN ID 07E3	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
MEAN	1589.00	110.70	86.30	14.30	18.60	4.69	15.16	0.046
S.D.	288.92	14.85	21.50	0.71	1.27	1.48	3.94	0.027
C.V. (%)	18.18	13.41	24.91	4.94	6.84	31.48	25.99	58.02
MINIMUM	1384.70	100.20	71.10	13.80	17.70	3.65	12.37	0.027
MAXIMUM	1793.30	121.20	101.50	14.80	19.50	5.73	17.94	0.065
RANGE	408.60	21.00	30.40	1.00	1.80	2.09	5.57	0.038

BASIN ID 12B1	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	4.00	4.00	4.00	4.00	4.00	4.00	4.00	7.00
MEAN	689.43	117.83	115.50	5.80	5.93	21.31	54.40	0.016
S.D.	296.69	8.90	8.40	2.24	2.35	6.47	11.57	0.007
C.V. (%)	43.04	7.55	7.27	38.63	39.69	30.38	21.27	40.67
MINIMUM	488.50	105.00	103.20	4.10	4.20	12.70	44.90	0.009
MAXIMUM	1126.20	123.90	121.90	9.10	9.40	27.98	70.90	0.028
RANGE	637.70	18.90	18.70	5.00	5.20	15.27	26.00	0.019

BASIN ID 12B2	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	5.00	5.00	5.00	5.00	5.00	5.00	5.00	7.00
MEAN	788.18	107.98	103.68	7.16	7.52	14.90	53.42	0.042
S.D.	305.88	19.74	19.89	2.16	2.39	5.47	15.64	0.016
C.V. (%)	38.81	18.28	19.18	30.11	31.75	36.70	29.27	39.01
MINIMUM	435.50	76.90	73.10	4.40	4.50	9.37	33.90	0.021
MAXIMUM	1054.90	128.50	125.20	9.70	10.50	23.49	77.20	0.063
RANGE	619.40	51.60	52.10	5.30	6.00	14.12	43.30	0.042

BASIN ID 16C2	AREA (ft.²)	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	4.00	4.00	4.00	4.00	4.00	4.00	4.00	6.00
MEAN	552.13	100.10	96.75	5.45	5.70	17.26	27.93	0.034
S.D.	169.54	24.86	26.63	1.06	1.04	5.38	6.81	0.015
C.V. (%)	30.71	24.84	27.53	19.45	18.23	31.18	24.40	43.06
MINIMUM	300.00	71.20	65.80	4.20	4.60	12.43	23.00	0.020
MAXIMUM	665.50	129.70	128.20	6.70	7.00	24.65	38.00	0.061
RANGE	365.50	58.50	62.40	2.50	2.40	12.23	15.00	0.041

BASIN ID 22B1	AREA (ft.²)	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	6.00	6.00	6.00	6.00	6.00	6.00	0.00	13.00
MEAN	328.32	90.53	88.67	3.47	3.55	25.22		0.043
S.D.	172.35	31.42	31.43	0.82	0.88	6.15		0.013
C.V. (%)	52.50	34.70	35.45	23.62	24.67	24.39		29.72
MINIMUM	138.40	63.40	62.70	2.20	2.20	16.63		0.024
MAXIMUM	569.50	135.60	133.90	4.20	4.30	31.14		0.065
RANGE	431.10	72.20	71.20	2.00	2.10	14.51	0.00	0.040

BASIN ID 22B2	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	5.00	5.00	5.00	5.00	5.00	5.00	3.00	8.00
MEAN	364.26	108.80	107.62	3.42	3.46	32.27	24.37	0.027
S.D.	40.76	20.10	20.24	0.51	0.53	10.05	15.10	0.012
C.V. (%)	11.19	18.47	18.81	14.82	15.38	31.14	61.96	42.42
MINIMUM	318.00	81.40	79.80	2.90	2.90	19.46	10.00	0.002
MAXIMUM	406.20	136.80	135.60	4.00	4.10	45.20	40.10	0.038
RANGE	88.20	55.40	55.80	1.10	1.20	25.74	30.10	0.037

BASIN ID 22C2	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	6.00	6.00	6.00	6.00	6.00	6.00	5.00	8.000
MEAN	1039.10	125.67	122.27	7.50	7.68	17.06	28.20	0.015
S.D.	640.16	38.64	37.10	3.19	3.31	3.60	9.07	0.005
C.V. (%)	61.61	30.74	30.34	42.50	43.08	21.09	32.15	32.207
MINIMUM	266.90	71.80	70.00	3.60	3.60	13.66	14.90	0.007
MAXIMUM	1732.10	163.60	159.10	10.80	11.10	23.33	37.60	0.022
RANGE	1465.20	91.80	89.10	7.20	7.50	9.67	22.70	0.015

Medium bank reach means for **Strata "C"** first orders.

BASIN ID 07D4	**AREA** (ft.^{2})	**WETTED PERIMETER** (ft.)	**TOP WIDTH** (ft.)	**HYDRAULIC RADIUS**	**AVERAGE DEPTH** (ft.)	**W/D RATIO**
n	2.00	2.00	2.00	2.00	2.00	2.00
MEAN	246.50	57.05	54.15	4.30	4.55	11.91
S.D.	6.79	3.18	3.04	0.14	0.07	0.85
C.V. (%)	2.75	5.58	5.62	3.29	1.55	7.17
MINIMUM	241.70	54.80	52.00	4.20	4.50	11.30
MAXIMUM	251.30	59.30	56.30	4.40	4.60	12.51
RANGE	9.60	4.50	4.30	0.20	0.10	1.21

BASIN ID 16C2	**AREA** (ft.^{2})	**WETTED PERIMETER** (ft.)	**TOP WIDTH** (ft.)	**HYDRAULIC RADIUS**	**AVERAGE DEPTH** (ft.)	**W/D RATIO**
n	3.00	3.00	3.00	3.00	3.00	3.00
MEAN	120.87	43.40	42.50	2.07	2.13	39.03
S.D.	109.09	32.38	31.85	1.95	2.05	30.37
C.V. (%)	90.25	74.61	74.95	94.37	96.10	77.81
MINIMUM	0.90	7.20	7.20	0.10	0.10	12.19
MAXIMUM	214.10	69.60	69.10	4.00	4.20	72.00
RANGE	213.20	62.40	61.90	3.90	4.10	59.81

BASIN ID 22B1	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	6.00	6.00	6.00	6.00	6.00	6.00
MEAN	19.03	19.93	19.63	0.87	0.88	22.67
S.D.	13.22	8.26	8.26	0.37	0.35	7.77
C.V. (%)	69.48	41.42	42.08	42.34	39.49	34.27
MINIMUM	5.50	10.20	9.90	0.50	0.50	16.50
MAXIMUM	36.00	28.60	28.30	1.30	1.30	38.00
RANGE	30.50	18.40	18.40	0.80	0.80	21.50

BASIN ID 22B2	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	5.00	5.00	5.00	5.00	5.00	5.00
MEAN	14.26	20.62	20.32	0.68	0.70	39.86
S.D.	10.20	14.68	14.68	0.48	0.49	40.15
C.V. (%)	71.51	71.21	72.25	70.07	69.99	100.73
MINIMUM	1.10	6.20	6.10	0.20	0.20	12.36
MAXIMUM	24.40	44.50	44.30	1.40	1.40	110.75
RANGE	23.30	38.30	38.20	1.20	1.20	98.39

BASIN ID 22C2	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	3.00	3.00	3.00	3.00	3.00	3.00
MEAN	6.17	13.80	13.70	0.43	0.43	30.87
S.D.	3.12	5.96	5.96	0.06	0.06	9.44
C.V. (%)	50.57	43.21	43.53	13.32	13.32	30.58
MINIMUM	3.80	8.80	8.70	0.40	0.40	21.75
MAXIMUM	9.70	20.40	20.30	0.50	0.50	40.60
RANGE	5.90	11.60	11.60	0.10	0.10	18.85

Low bank reach means for **Strata "C"** first orders.

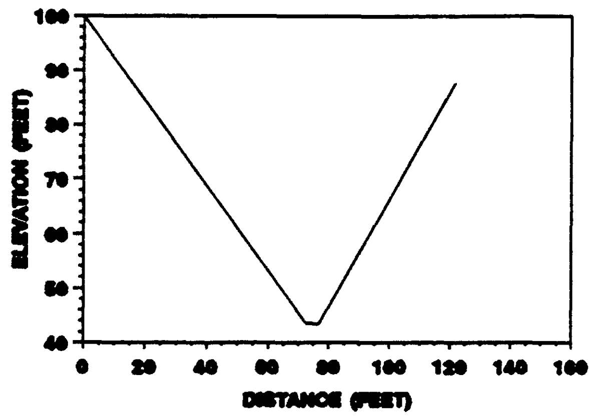
BASIN ID **12B1**	**AREA (ft.^{2})**	**WETTED PERIMETER (ft.)**	**TOP WIDTH (ft.)**	**HYDRAULIC RADIUS**	**AVERAGE DEPTH (ft.)**	**W/D RATIO**
n	4.00	4.00	4.00	2.00	2.00	2.00
MEAN	1.13	10.65	10.65	0.15	0.15	75.00
S.D.	1.13	5.33	5.33	0.07	0.07	14.14
C.V. (%)	100.66	50.03	50.03	47.14	47.14	18.86
MINIMUM	0.30	6.00	6.00	0.10	0.10	65.00
MAXIMUM	2.80	17.00	17.00	0.20	0.20	85.00
RANGE	2.50	11.00	11.00	0.10	0.10	20.00

BASIN ID **22B1**	**AREA (ft.^{2})**	**WETTED PERIMETER (ft.)**	**TOP WIDTH (ft.)**	**HYDRAULIC RADIUS**	**AVERAGE DEPTH (ft.)**	**W/D RATIO**
n	6.00	6.00	3.00	3.00	3.00	
MEAN	0.23	3.90	3.90	0.10	0.10	39.00
S.D.	0.15	1.46	1.46	0.00	0.00	11.53
C.V. (%)	64.52	37.33	37.33	0.00	0.00	29.57
MINIMUM	0.10	2.70	2.70	0.10	0.10	30.00
MAXIMUM	0.50	6.20	6.20	0.10	0.10	52.00
RANGE	0.40	3.50	3.50	0.00	0.00	22.00

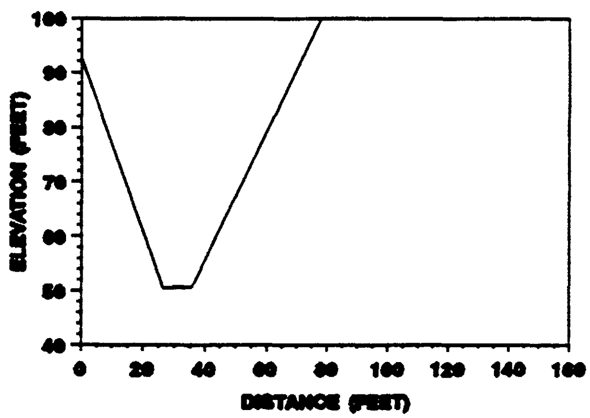
BASIN ID 22B2	AREA ($ft.^2$)	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	2.00	2.00	2.00	2.00	2.00	2.00
MEAN	0.40	4.10	4.05	0.10	0.10	40.50
S.D.	0.14	0.99	0.92	0.00	0.00	9.19
C.V. (%)	35.36	24.15	22.70	0.00	0.00	22.70
MINIMUM	0.30	3.40	3.40	0.10	0.10	34.00
MAXIMUM	0.50	4.80	4.70	0.10	0.10	47.00
RANGE	0.20	1.40	1.30	0.00	0.00	13.00

BASIN ID 22C2	AREA ($ft.^2$)	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	3.00	3.00	3.00	2.00	2.00	2.00
MEAN	1.03	7.93	7.93	0.10	0.10	103.50
S.D.	1.12	6.79	6.79	0.00	0.00	75.66
C.V. (%)	107.91	85.63	85.63	0.00	0.00	73.10
MINIMUM	0.20	3.10	3.10	0.10	0.10	50.00
MAXIMUM	2.30	15.70	15.70	0.10	0.10	157.00
RANGE	2.10	12.60	12.60	0.00	0.00	107.00

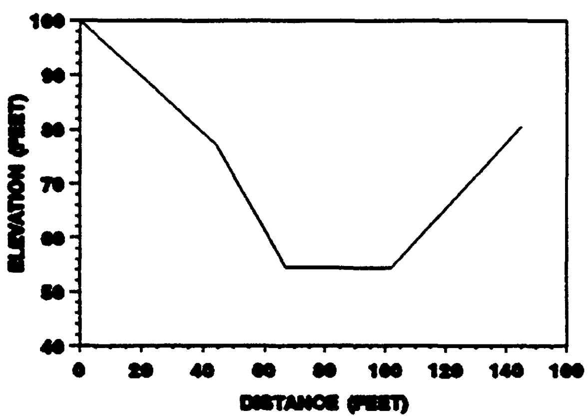
RUSSELL DRAW, 05B4
CROSS SECTION 0+60.60



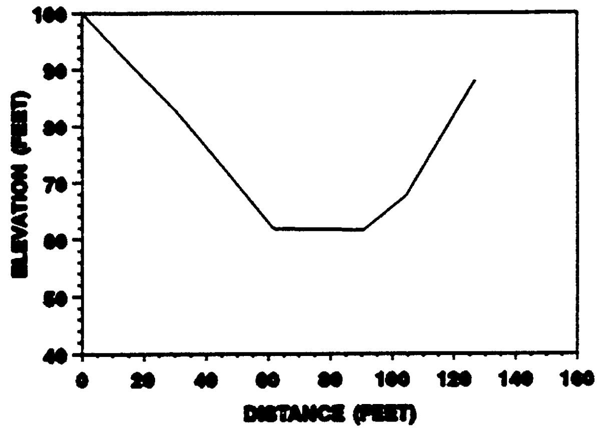
RUSSELL DRAW, 05B4
CROSS SECTION 2+37.80



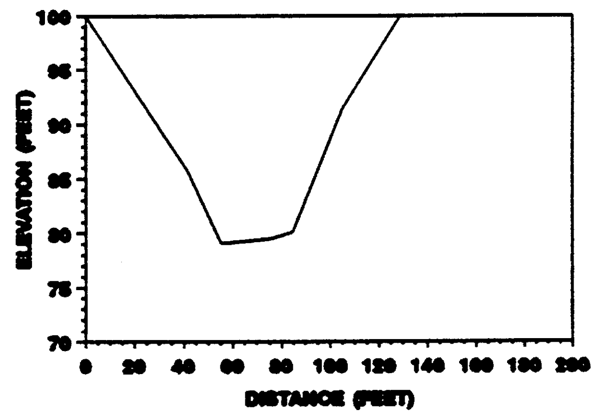
RUSSELL DRAW, 05B4
CROSS SECTION 6+40.75



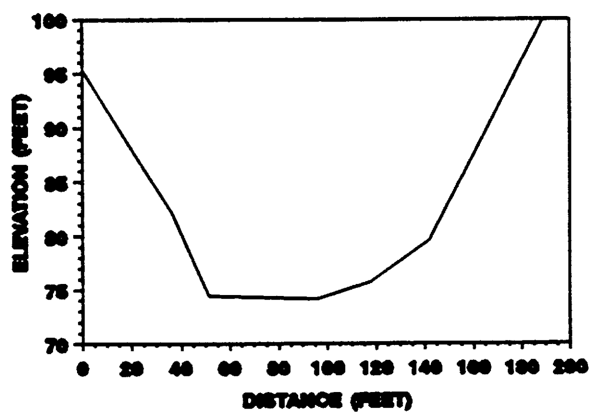
RUSSELL DRAW, 05B4
CROSS SECTION 9+14.75



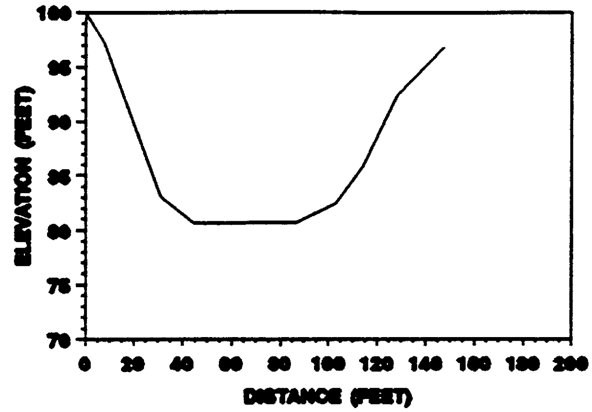
RAWHIDE CREEK, 07D3
CROSS SECTION 6+66.80



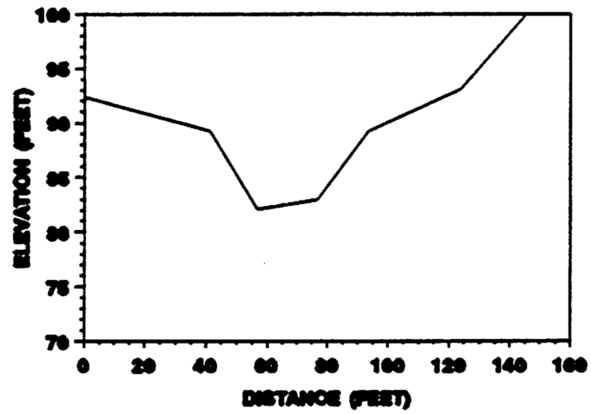
RAWHIDE CREEK, 07D3
CROSS SECTION 11+71.80



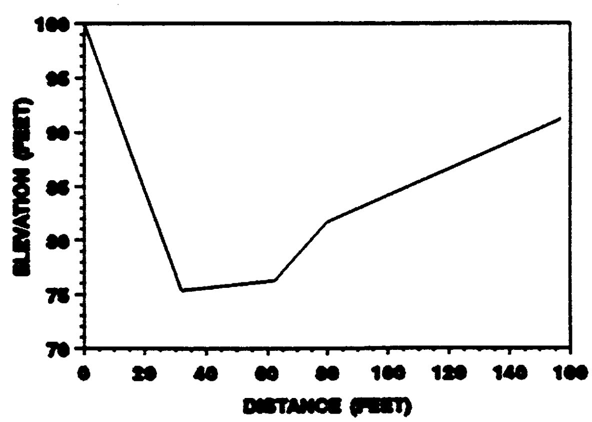
RAWHIDE CREEK, 07D3
CROSS SECTION 13+30.80



RAWHIDE CREEK, 07D4
CROSS SECTION 0+00.00

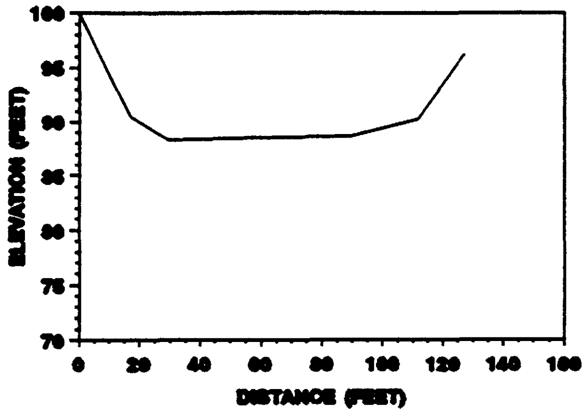


RAWHIDE CREEK, 07D4
CROSS SECTION 4+28.00



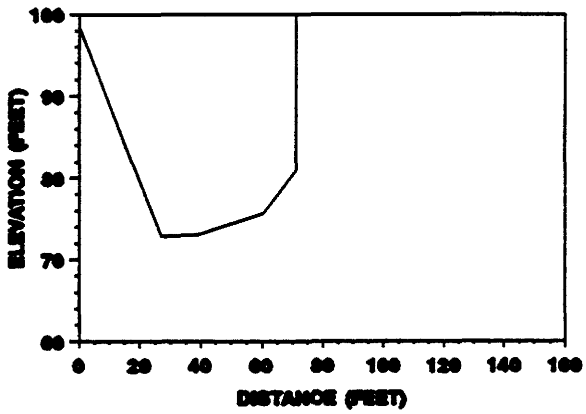
RAWHIDE CREEK, 07D4

CROSS SECTION 11+65.00



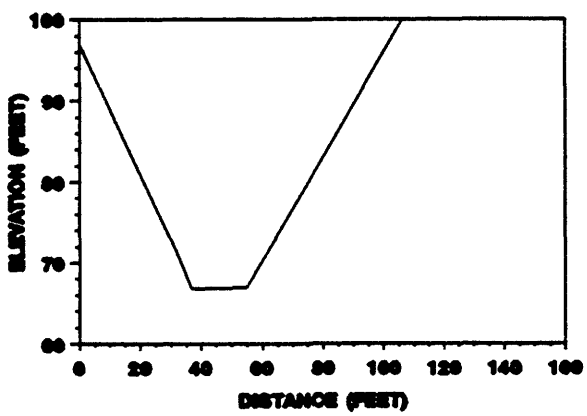
RAWHIDE CREEK, 07E3

CROSS SECTION 0+00.00

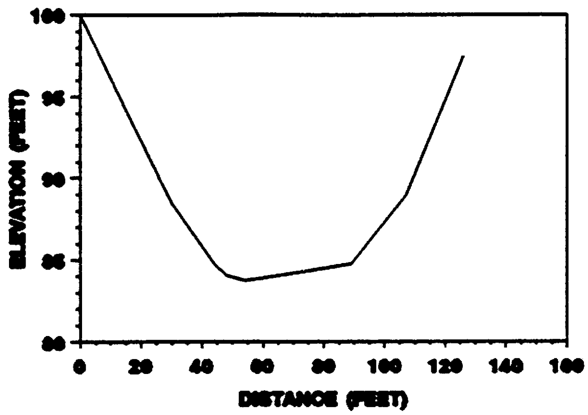


RAWHIDE CREEK, 07E3

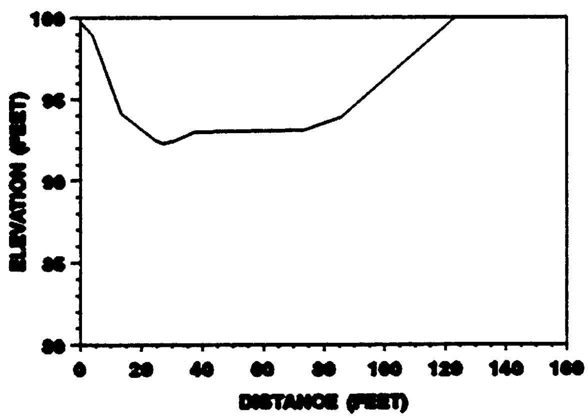
CROSS SECTION 3+00.00



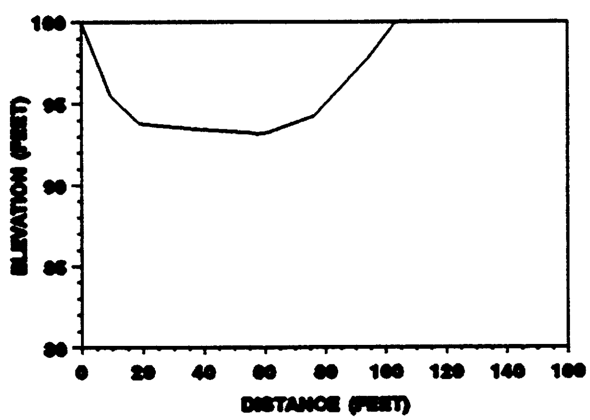
LONE TREE PRONG, 12B1
CROSS SECTION 0+00.00



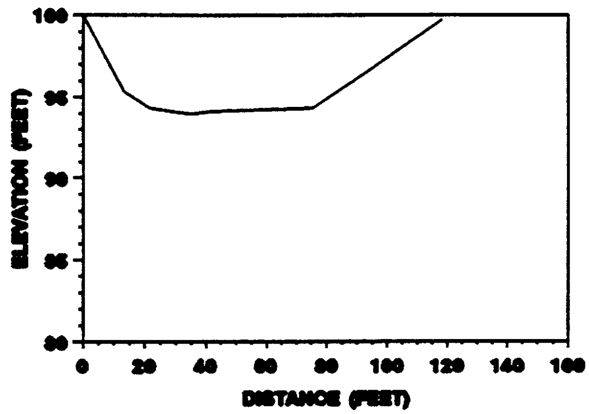
LONE TREE PRONG, 12B1
CROSS SECTION 4+00.00



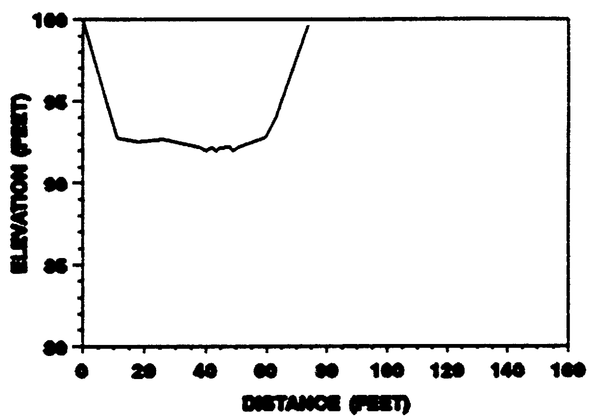
LONE TREE PRONG, 12B1
CROSS SECTION 13+21.00



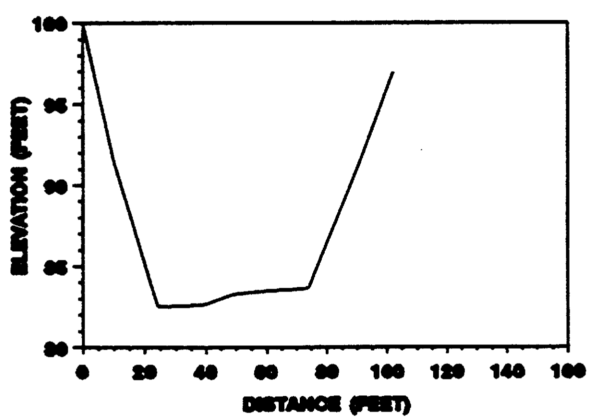
LONE TREE PRONG, 12B1
CROSS SECTION 15+62.80



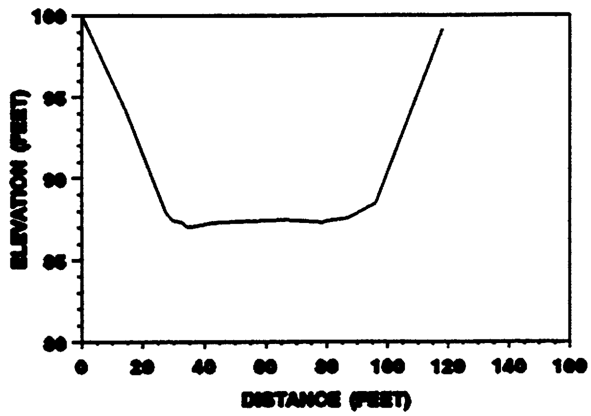
LONE TREE PRONG, 12B2
CROSS SECTION 0+60.00



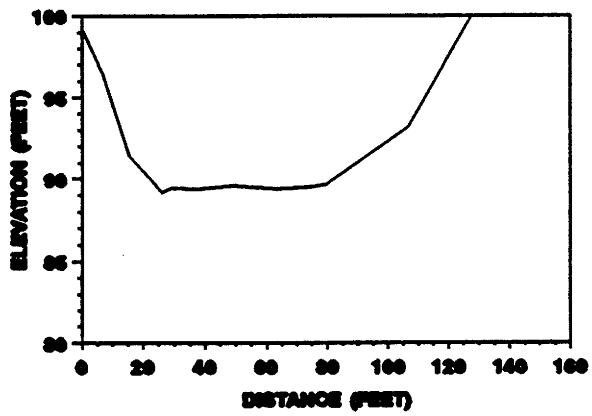
LONE TREE PRONG, 12B2
CROSS SECTION 2+13.00



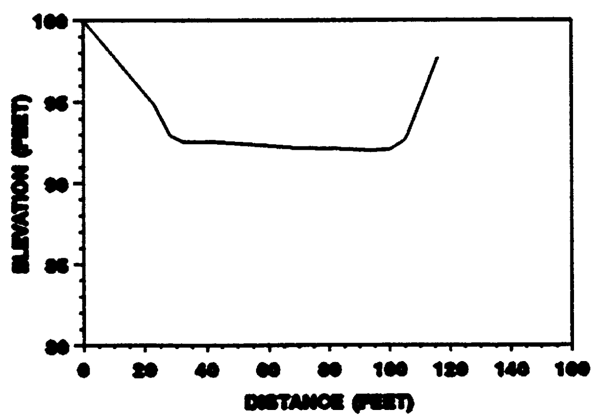
LONE TREE PRONG, 12B2
CROSS SECTION 4+76.00



LONE TREE PRONG, 12B2
CROSS SECTION 13+66.00

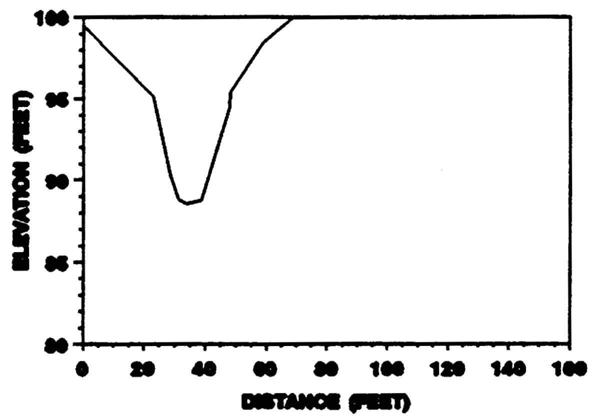


LONE TREE PRONG, 12B2
CROSS SECTION 16+57.00



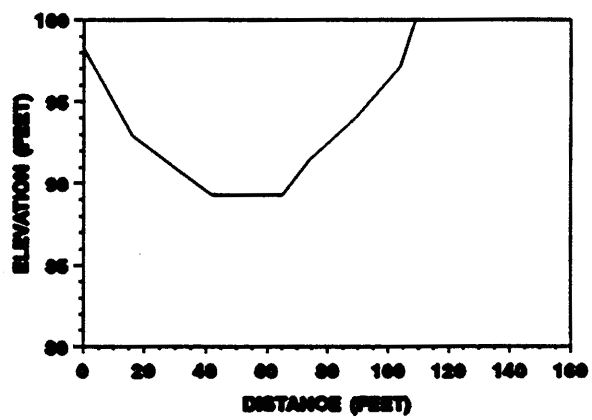
SHEARING PEN DRAW, 16C2

CROSS SECTION 6+60.00



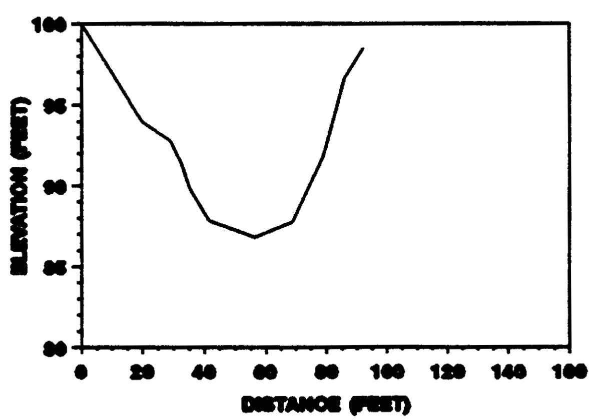
SHEARING PEN DRAW, 16C2

CROSS SECTION 6+57.20

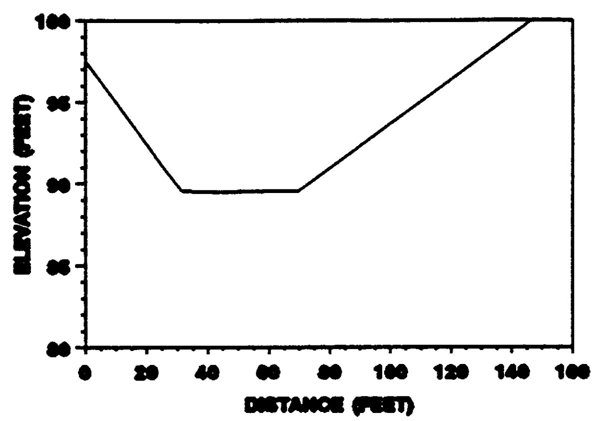


SHEARING PEN DRAW, 16C2

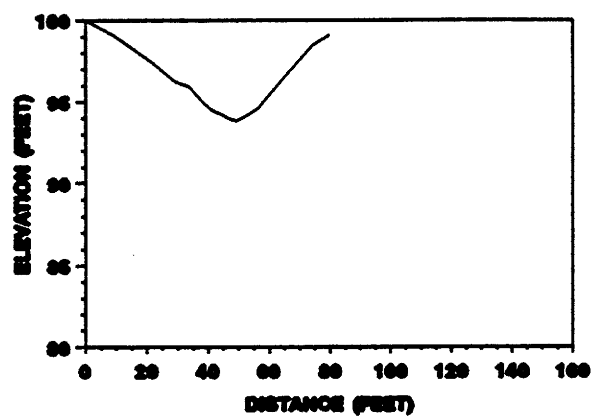
CROSS SECTION 1+48.00



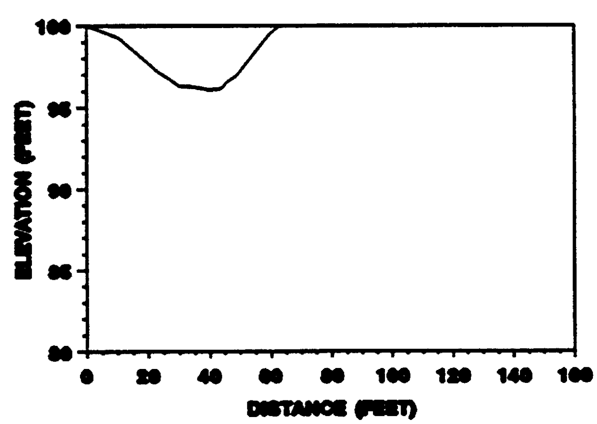
SHEARING PEN DRAW, 16C2
CROSS SECTION 15+24.00



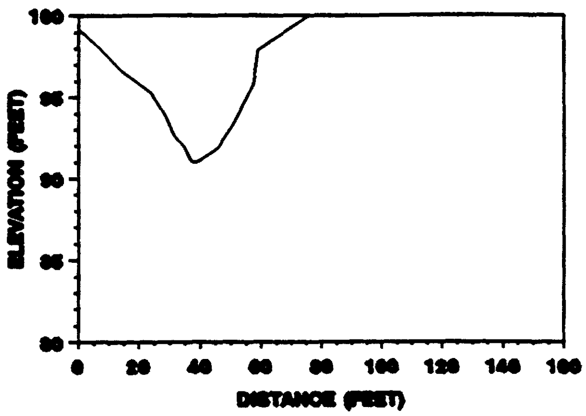
THIELEN DRAW, 22B1
CROSS SECTION 0+60.00



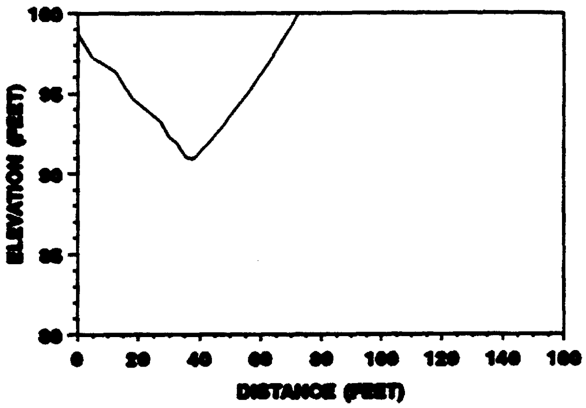
THIELEN DRAW, 22B1
CROSS SECTION 0+90.00



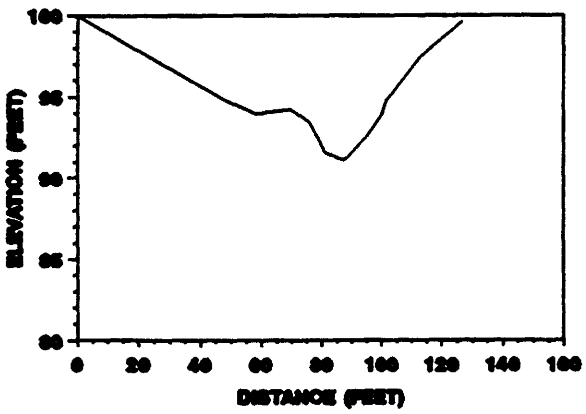
THIELEN DRAW, 22B1
CROSS SECTION 7+57.90



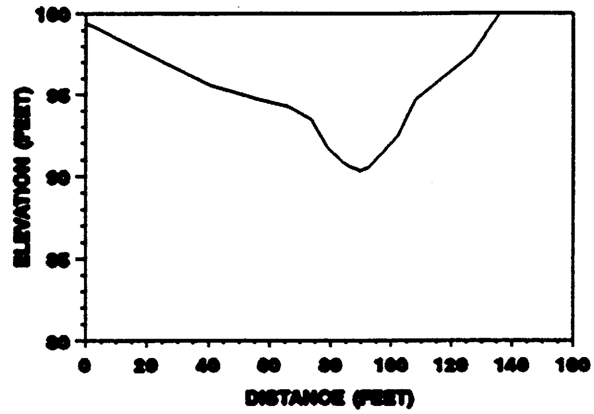
THIELEN DRAW, 22B1
CROSS SECTION 8+15.00



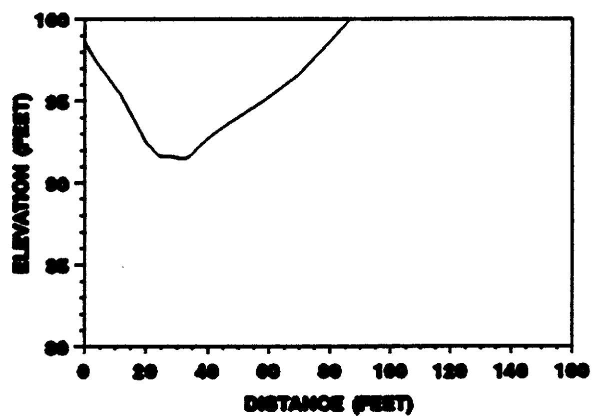
THIELEN DRAW, 22B1
CROSS SECTION 15+57.60



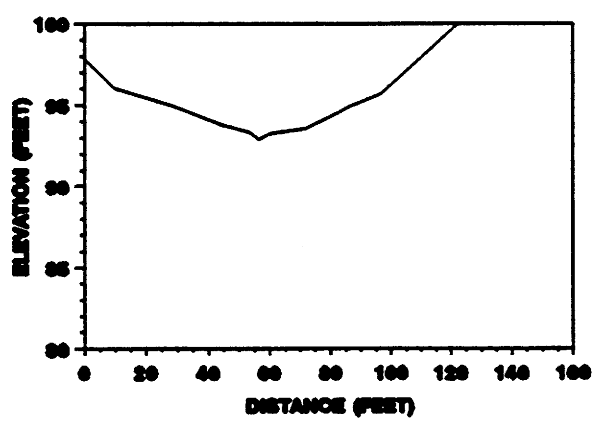
THIELEN DRAW, 22B1
CROSS SECTION 16+25.50



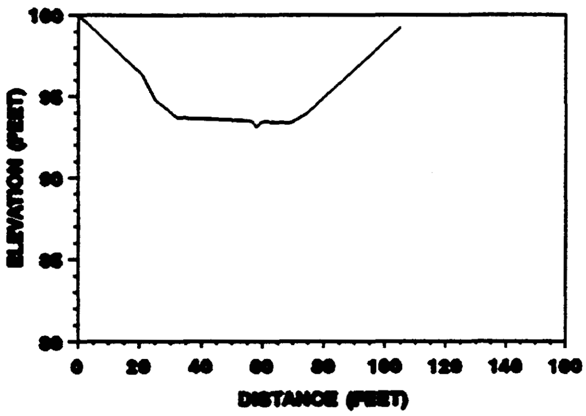
THIELEN DRAW, 22B2
CROSS SECTION 6+60.00



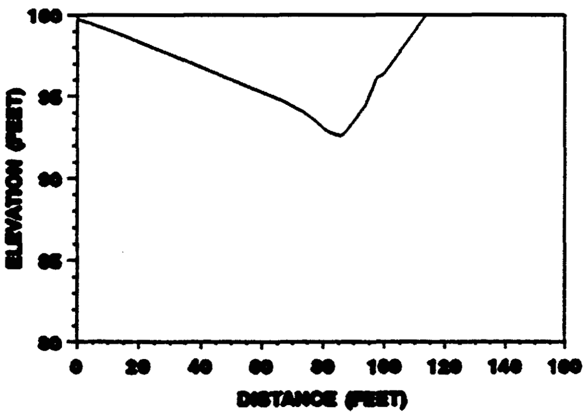
THIELEN DRAW, 22B2
CROSS SECTION 5+16.00



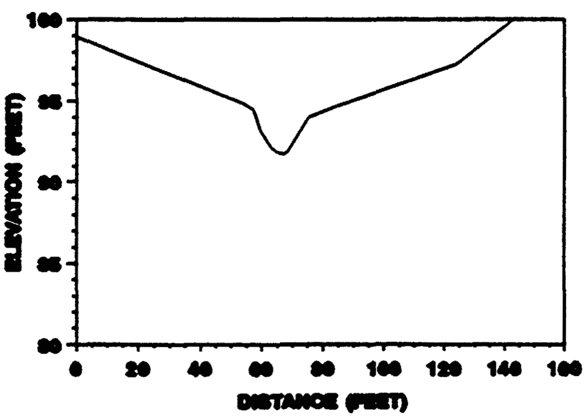
THIELEN DRAW, 22B2
CROSS SECTION 6+19.60



THIELEN DRAW, 22B2
CROSS SECTION 13+11.60

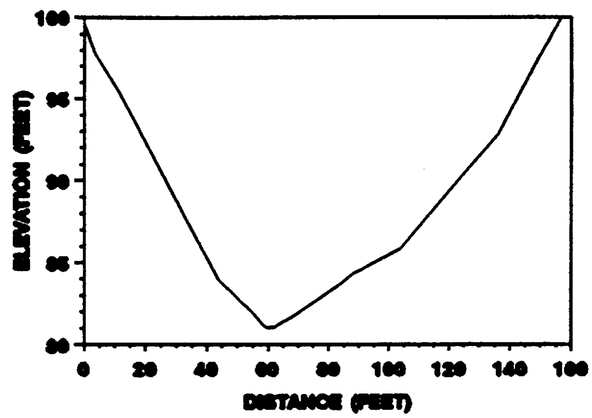


THIELEN DRAW, 22B2
CROSS SECTION 13+65.10



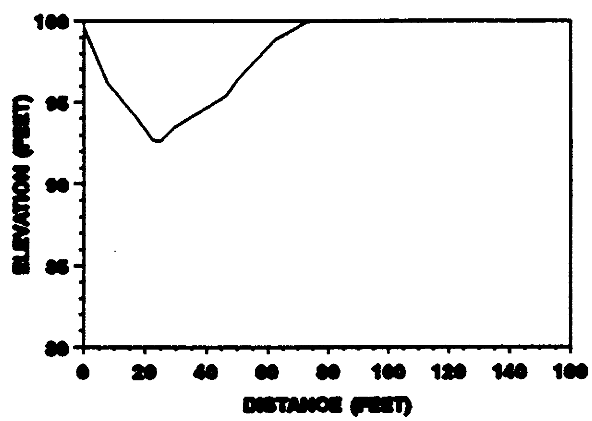
THIELEN DRAW, 22C2

CROSS SECTION 0+00.00



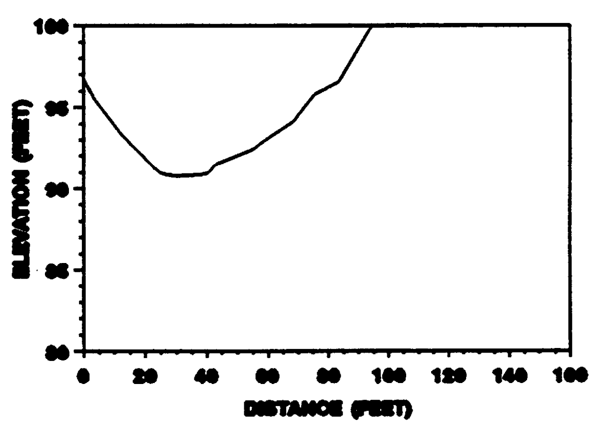
THIELEN DRAW, 22C2

CROSS SECTION 1+34.00



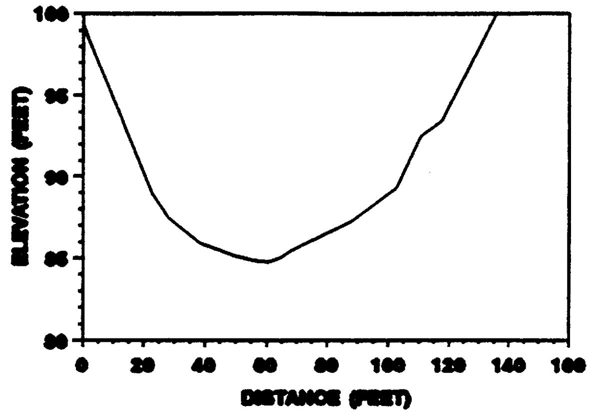
THIELEN DRAW, 22C2

CROSS SECTION 6+62.50



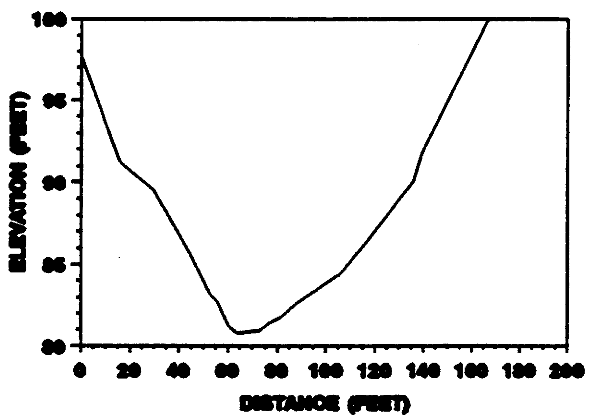
THIELEN DRAW, 22C2

CROSS SECTION 3+26.80



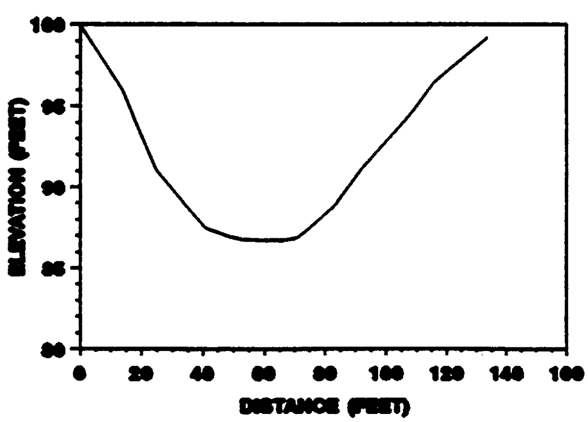
THIELEN DRAW, 22C2

CROSS SECTION 13+10.70

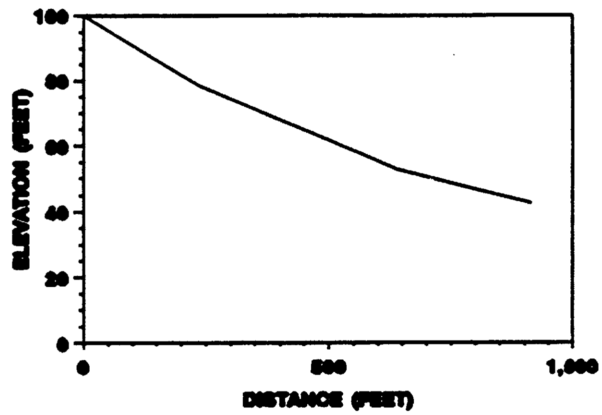


THIELEN DRAW, 22C2

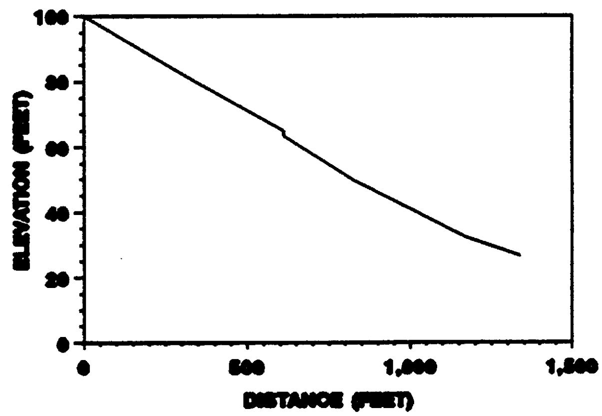
CROSS SECTION 14+36.80



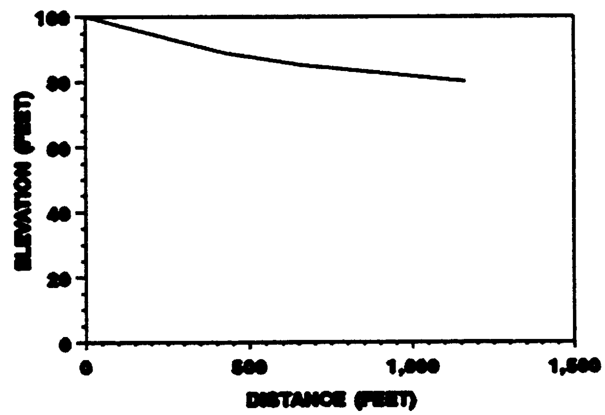
RUSSELL DRAW, 05B4
LONGITUDINAL PROFILE



RAWHIDE CREEK, 07D3
LONGITUDINAL PROFILE

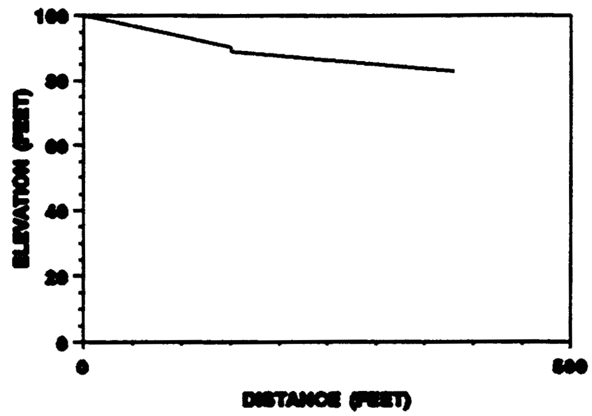


RAWHIDE CREEK, 07D4
LONGITUDINAL PROFILE



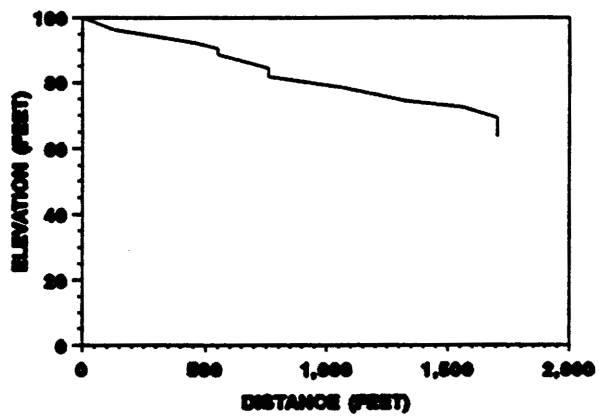
RAWHIDE CREEK, 07E3

LONGITUDINAL PROFILE



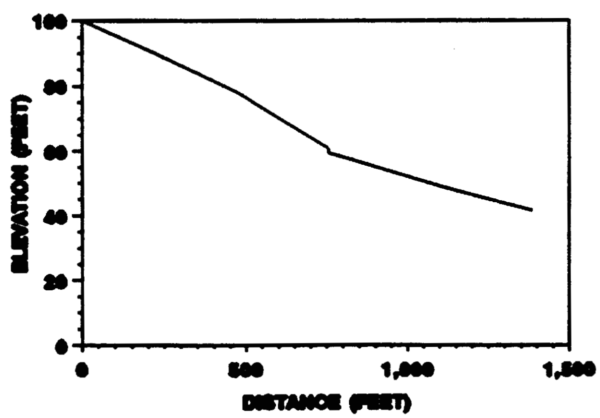
LONE TREE PRONG, 12B1

LONGITUDINAL PROFILE

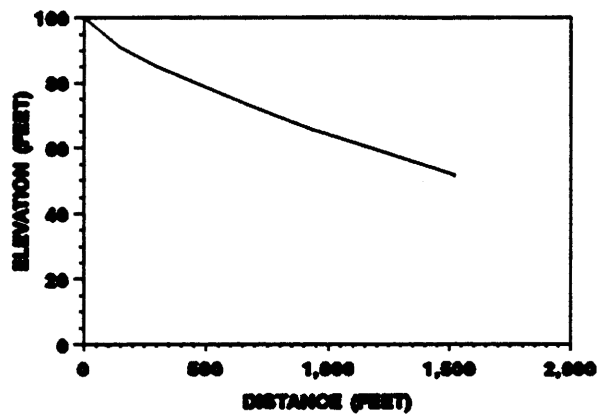


LONE TREE PRONG, 12B2

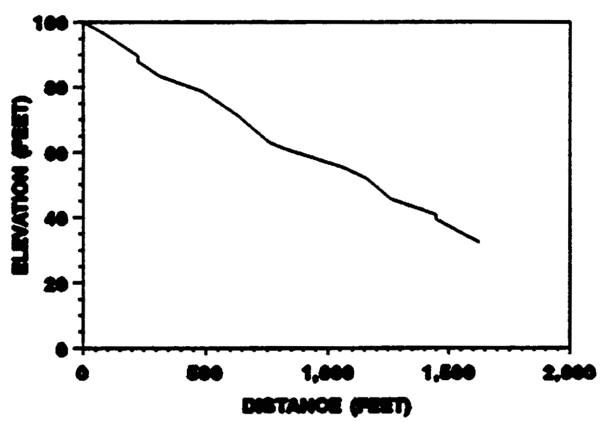
LONGITUDINAL PROFILE



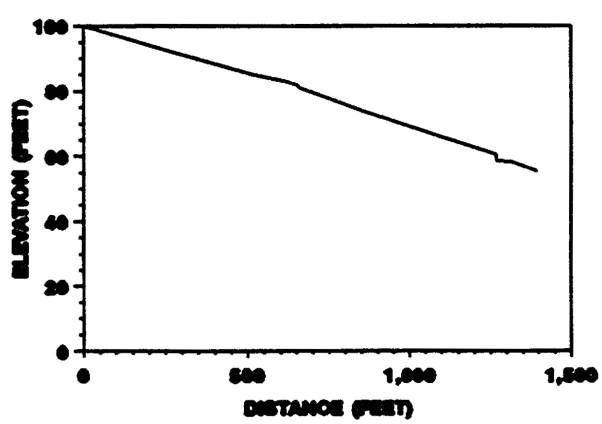
SHEARING PEN DRAW, 16C2
LONGITUDINAL PROFILE



THIELEN DRAW, 22B1
LONGITUDINAL PROFILE

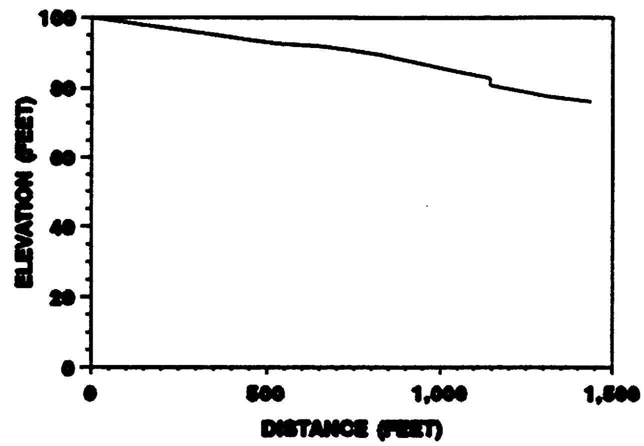


THIELEN DRAW, 22B2
LONGITUDINAL PROFILE



THIELEN DRAW, 22C2

LONGITUDINAL PROFILE

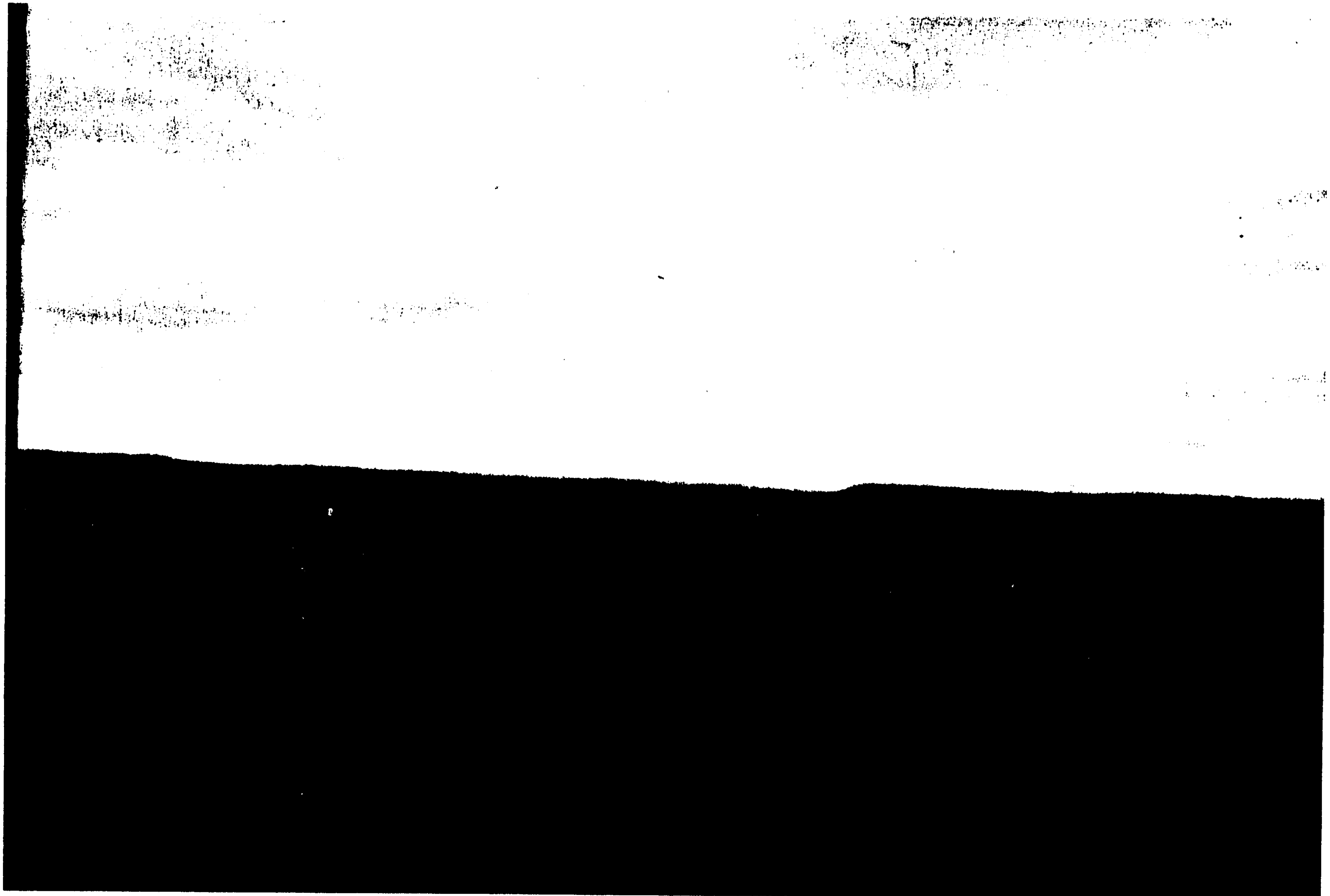


Strata "C" first order raw data by study reach, cross section, and bank identification.

BASIN I.D.	CROSS SECTION NUMBER	BANK I.D.	AREA ($feet^2$)	TOP WIDTH (feet)	AVERAGE DEPTH (feet)	BED WIDTH (feet)
05B4	0+00.00	HIGH	2104.80	90.90	23.10	4.25
05B4	2+37.00	HIGH	1709.00	71.70	23.80	9.47
05B4	6+40.75	HIGH	5305.50	135.30	39.20	34.72
05B4	9+14.75	HIGH	1824.20	105.40	17.30	28.97
07D3	0+00.00	HIGH	1512.70	128.10	11.80	20.21
07D3	11+71.50	HIGH	2597.60	178.40	14.60	44.67
07D3	13+39.50	HIGH	1579.50	139.00	11.40	41.97
07D4	0+00.00	HIGH	509.60	118.40	4.30	21.97
07D4	4+29.00	HIGH	1208.20	145.40	8.30	31.93
07D4	11+65.00	HIGH	768.80	120.10	6.40	61.68
07E3	0+00.00	HIGH	1384.70	71.10	19.50	12.37
07E3	3+80.00	HIGH	1793.30	101.50	17.70	17.94
12B1	0+00.00	HIGH	1126.20	119.40	9.40	44.90
12B1	4+60.00	HIGH	622.10	121.90	5.10	70.90
12B1	13+21.00	HIGH	520.90	103.20	5.00	48.20
12B1	15+62.00	HIGH	488.50	117.50	4.20	53.60
12B2	0+00.00	HIGH	435.50	73.10	6.00	48.60
12B2	2+13.00	HIGH	1033.30	98.40	10.50	51.70
12B2	4+76.00	HIGH	1054.90	116.00	9.10	33.90
12B2	13+86.00	HIGH	938.80	125.20	7.50	55.70
12B2	16+57.00	HIGH	478.40	105.70	4.50	77.20
16C2	0+00.00	HIGH	300.00	65.80	4.60	25.00
16C2	1+48.00	HIGH	612.00	87.00	7.00	25.70
16C2	6+57.80	HIGH	631.00	106.00	6.00	23.00
16C2	15+24.80	HIGH	665.50	128.20	5.20	38.00
22B1	0+00.00	HIGH	192.40	71.00	2.70	

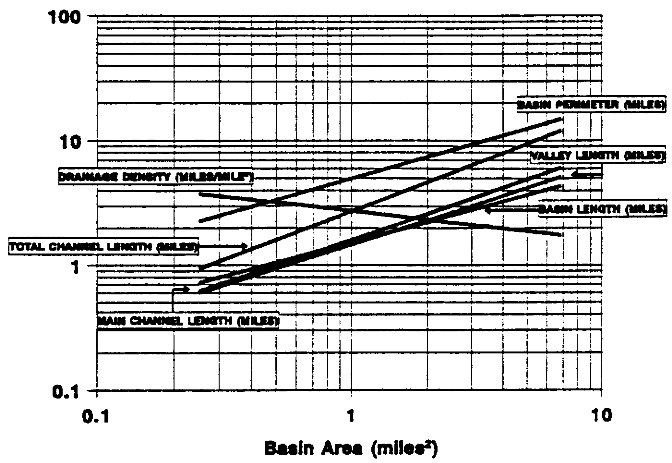
BASIN I.D.	CROSS SECTION NUMBER	BANK I.D.	AREA (feet^2)	TOP WIDTH (feet)	AVERAGE DEPTH (feet)	BED WIDTH (feet)
22B1	0+90.00	HIGH	138.40	62.70	2.20	
22B1	7+57.90	HIGH	281.10	72.50	3.90	
22B1	8+15.00	HIGH	282.70	68.20	4.10	
22B1	15+57.60	HIGH	505.80	123.70	4.10	
22B1	16+25.50	HIGH	569.50	133.90	4.30	
22B2	0+00.00	HIGH	323.80	79.80	4.10	10.00
22B2	5+16.00	HIGH	318.00	109.30	2.90	23.00
22B2	6+19.00	HIGH	394.00	100.50	3.90	40.10
22B2	13+11.60	HIGH	379.30	112.90	3.40	
22B2	13+95.10	HIGH	406.20	135.60	3.00	
22C2	0+00.00	HIGH	1732.10	155.70	11.10	37.60
22C2	1+34.90	HIGH	266.90	70.00	3.80	35.00
22C2	6+62.50	HIGH	303.20	84.00	3.60	
22C2	8+26.60	HIGH	1311.10	133.90	9.80	24.20
22C2	13+10.70	HIGH	1634.30	159.10	10.30	14.90
22C2	14+36.60	HIGH	987.20	130.90	7.50	29.30
07D4	0+00.00	MEDIUM	241.70	52.00	4.60	
07D4	4+29.00	MEDIUM	251.30	56.30	4.50	
16C2	0+00.00	MEDIUM	0.90	7.20	0.10	
16C2	1+48.00	MEDIUM	214.10	51.20	4.20	
16C2	15+24.80	MEDIUM	147.60	69.10	2.10	
22B1	0+00.00	MEDIUM	36.00	28.30	1.30	
22B1	0+90.00	MEDIUM	18.70	26.60	0.70	
22B1	7+57.90	MEDIUM	5.80	10.80	0.50	
22B1	8+15.00	MEDIUM	5.50	9.90	0.60	
22B1	15+57.60	MEDIUM	14.70	16.60	0.90	

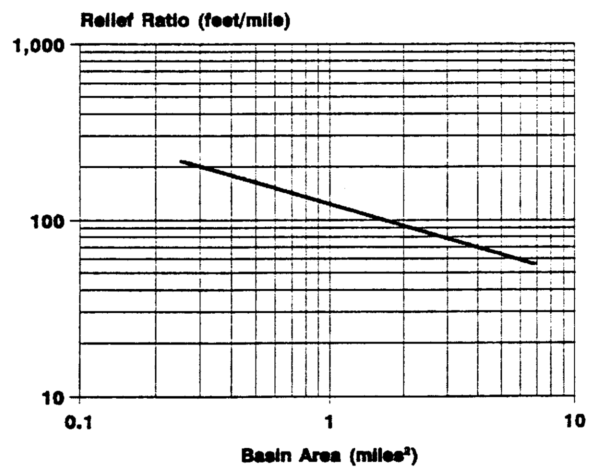
BASIN I.D.	CROSS SECTION NUMBER	BANK I.D.	AREA (feet^2)	TOP WIDTH (feet)	AVERAGE DEPTH (feet)
22B1	16+25.50	MEDIUM	33.50	25.60	1.30
22B2	0+00.00	MEDIUM	21.10	22.10	1.00
22B2	5+16.00	MEDIUM	1.10	6.10	0.20
22B2	6+19.00	MEDIUM	18.90	44.30	0.40
22B2	13+11.60	MEDIUM	5.80	11.80	0.50
22B2	13+95.10	MEDIUM	24.40	17.30	1.40
22C2	0+00.00	MEDIUM	5.00	12.10	0.40
22C2	1+34.90	MEDIUM	3.80	8.70	0.40
22C2	6+62.50	MEDIUM	9.70	20.30	0.50
12B1	0+00.00	LOW	2.80	17.00	0.20
12B1	4+60.00	LOW	0.70	6.50	0.10
12B1	13+21.00	LOW	0.30	6.00	0.05
12B1	15+62.00	LOW	0.70	13.10	0.05
22B1	0+00.00	LOW	0.20	3.50	0.10
22B1	0+90.00	LOW	0.30	6.20	0.05
22B1	7+57.90	LOW	0.10	2.70	0.04
22B1	8+15.00	LOW	0.10	2.80	0.04
22B1	15+57.60	LOW	0.20	3.00	0.10
22B1	16+25.50	LOW	0.50	5.20	0.10
22B2	13+11.60	LOW	0.50	4.70	0.10
22B2	13+95.10	LOW	0.30	3.40	0.10
22C2	0+00.00	LOW	0.60	5.00	0.10
22C2	1+34.90	LOW	0.20	3.10	0.06
22C2	6+62.50	LOW	2.30	15.70	0.10

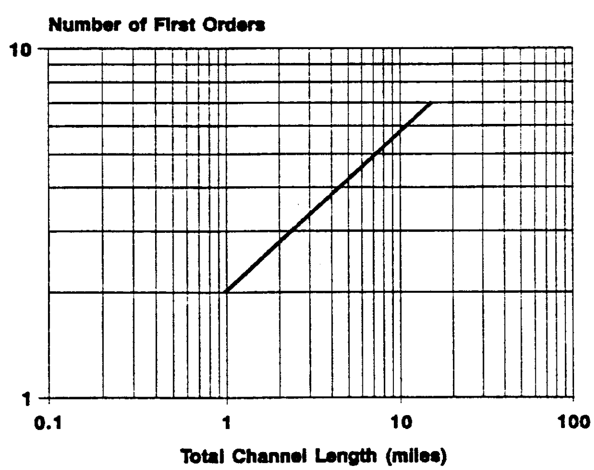


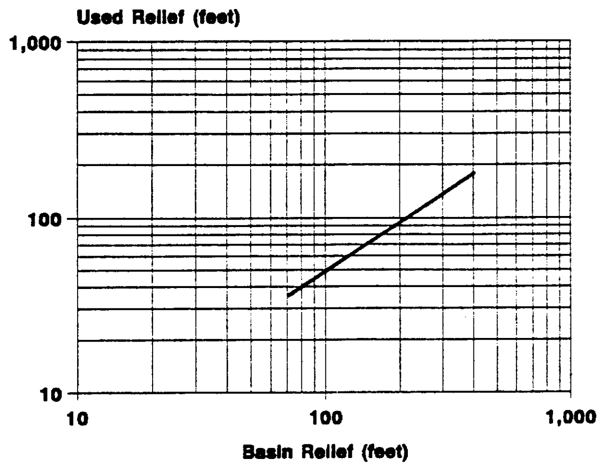
APPENDIX C-2

STRATA "C" - SECOND ORDER

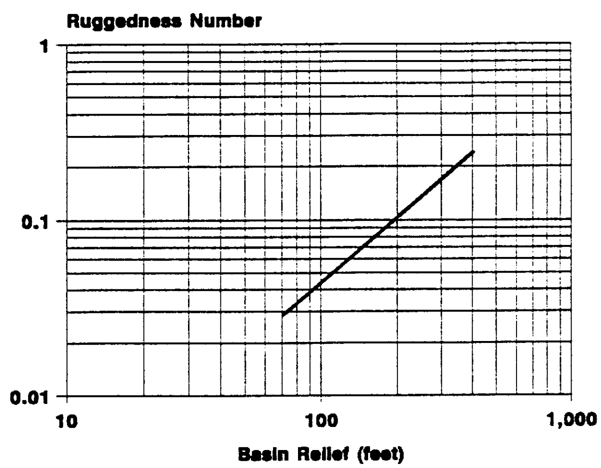

100
10
1
0.1
0.1
1
10
BASIN PERIMETER (MILES)
VALLEY LENGTH (MILES)
DRAINAGE DENSITY (MILES/MILE²)
BASIN LENGTH (MILES)
TOTAL CHANNEL LENGTH (MILES)
MAIN CHANNEL LENGTH (MILES)
Basin Area (miles²)


Relief Ratio (feet/mile)
1,000
100
10
0.1
1
10
Basin Area (miles²)

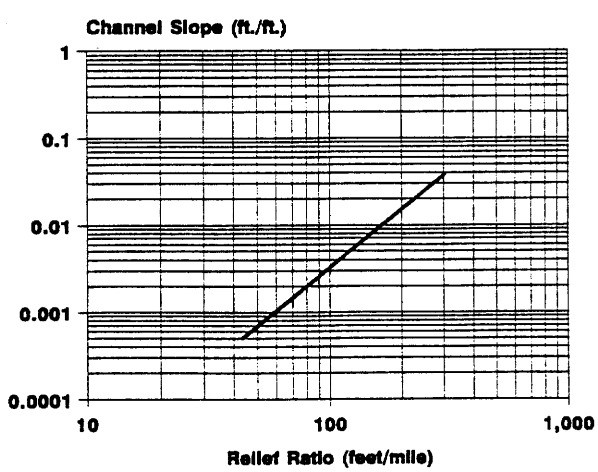

Number of First Orders
10
1
0.1
1
10
100
Total Channel Length (miles)



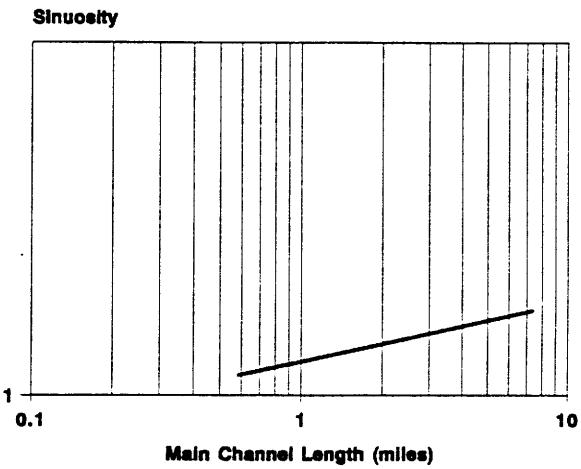
Used Relief (feet)
1,000
100
10
10
100
1,000
Basin Relief (feet)



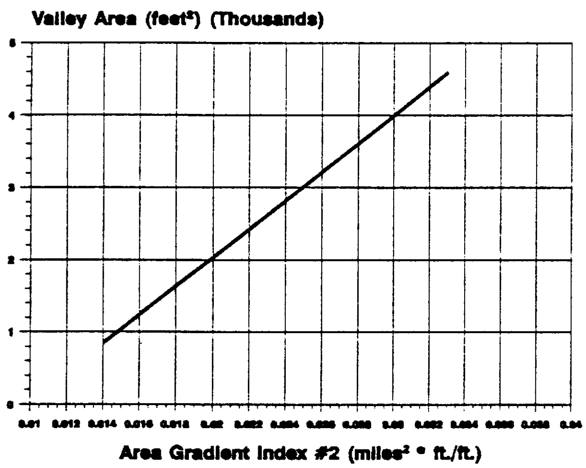
Ruggedness Number
1
0.1
0.01
10
100
1,000
Basin Relief (feet)



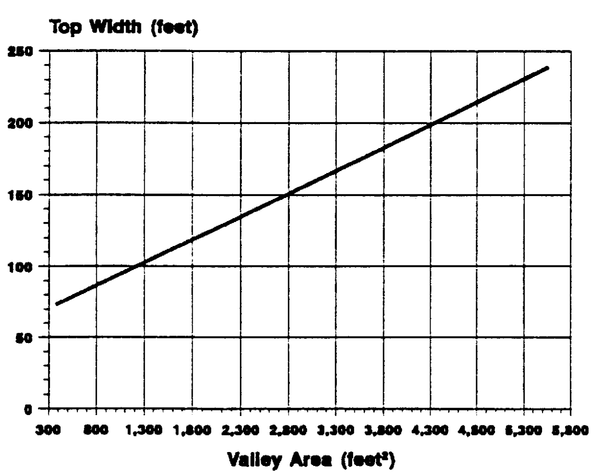
Channel Slope (ft./ft.)
1
0.1
0.01
0.001
0.0001
10
100
1,000
Relief Ratio (feet/mile)



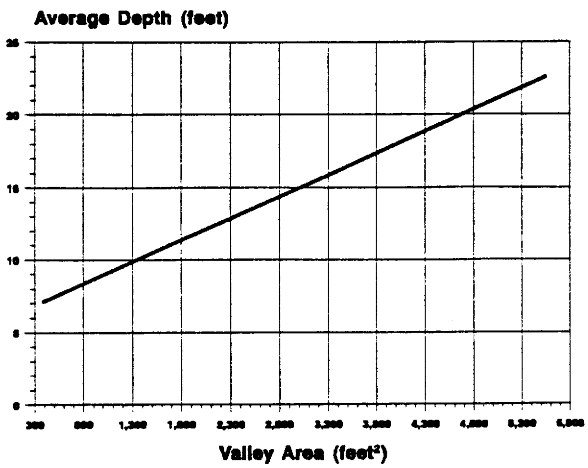
Sinuosity
1
0.1
1
10
Main Channel Length (miles)

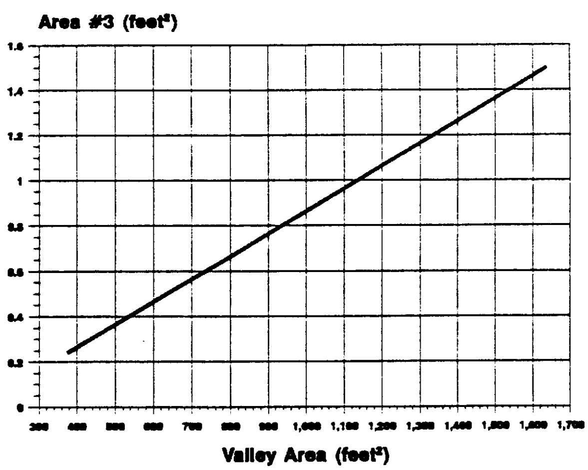


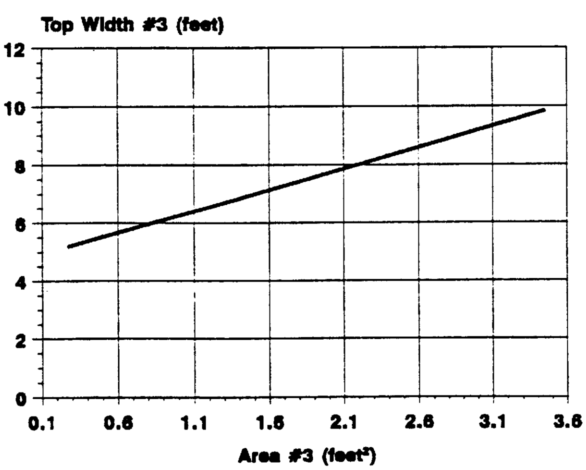
Valley Area (feet²) (Thousands)
4
3
2
1
0
Area Gradient Index #2 (miles² * ft./ft.)

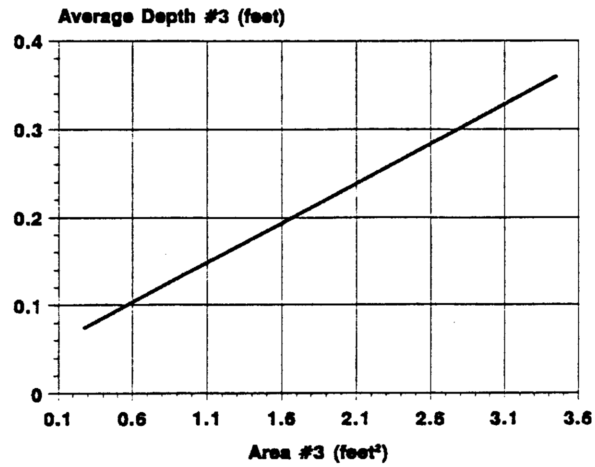


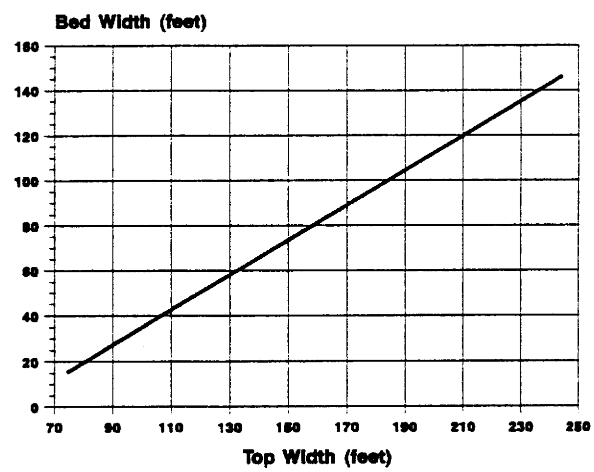
Top Width (feet)
250
200
150
100
50
0
300
800
1,300
1,800
2,300
2,800
3,300
3,800
4,300
4,800
5,300
5,800
Valley Area (feet²)


Average Depth (feet)
Valley Area (feet²)


Area #3 (feet²)
Valley Area (feet²)


Top Width #3 (feet)
12
10
8
6
4
2
0
0.1
0.6
1.1
1.6
2.1
2.6
3.1
3.6
Area #3 (feet²)


Average Depth #3 (feet)
0.4
0.3
0.2
0.1
0
0.1
0.6
1.1
1.6
2.1
2.6
3.1
3.6
Area #3 (feet²)


Bed Width (feet)
160
140
120
100
80
60
40
20
0
70
90
110
130
150
170
190
210
230
250
Top Width (feet)

Strata "C" second order regression output for basin perimeter versus basin area.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BASIN PERIMETER

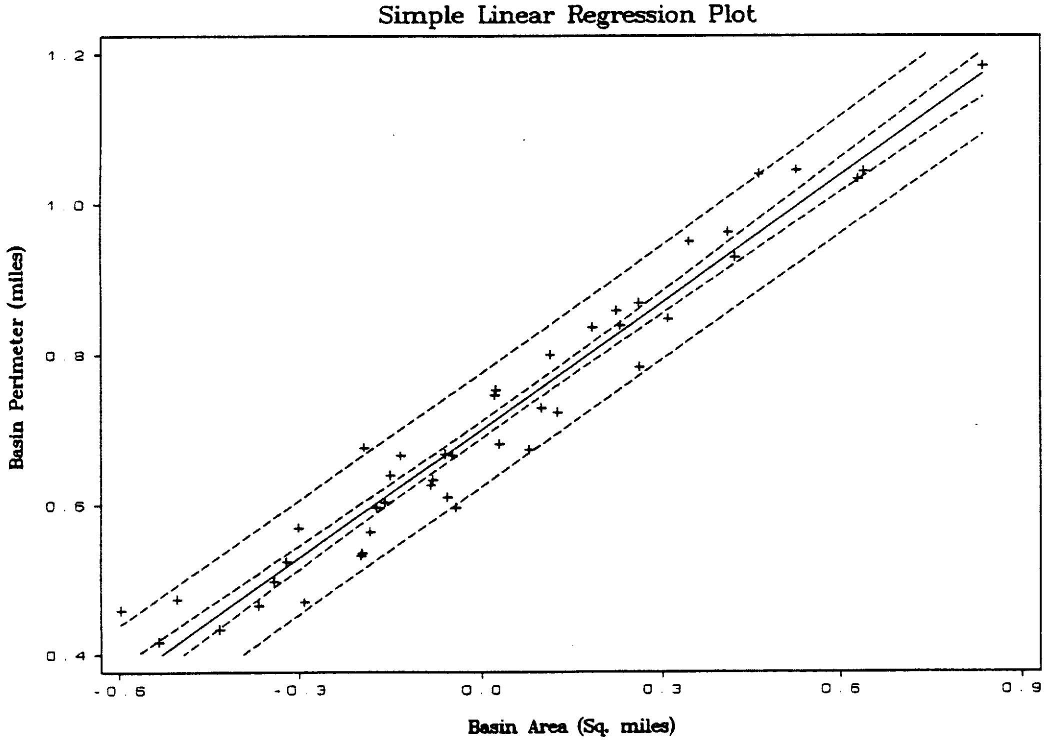
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.69993	0.00671	104.38	0.0000
BA	0.56684	0.02041	27.77	0.0000

R-SQUARED	0.9483	RESID. MEAN SQUARE (MSE)	0.00197
ADJUSTED R-SQUARED	0.9471	STANDARD DEVIATION	0.04441

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.52094	1.52094	771.12	0.0000
RESIDUAL	42	0.08284	0.00197		
TOTAL	43	1.60378			

CASES INCLUDED 44 MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "C" second order regression output for drainage density versus basin area.

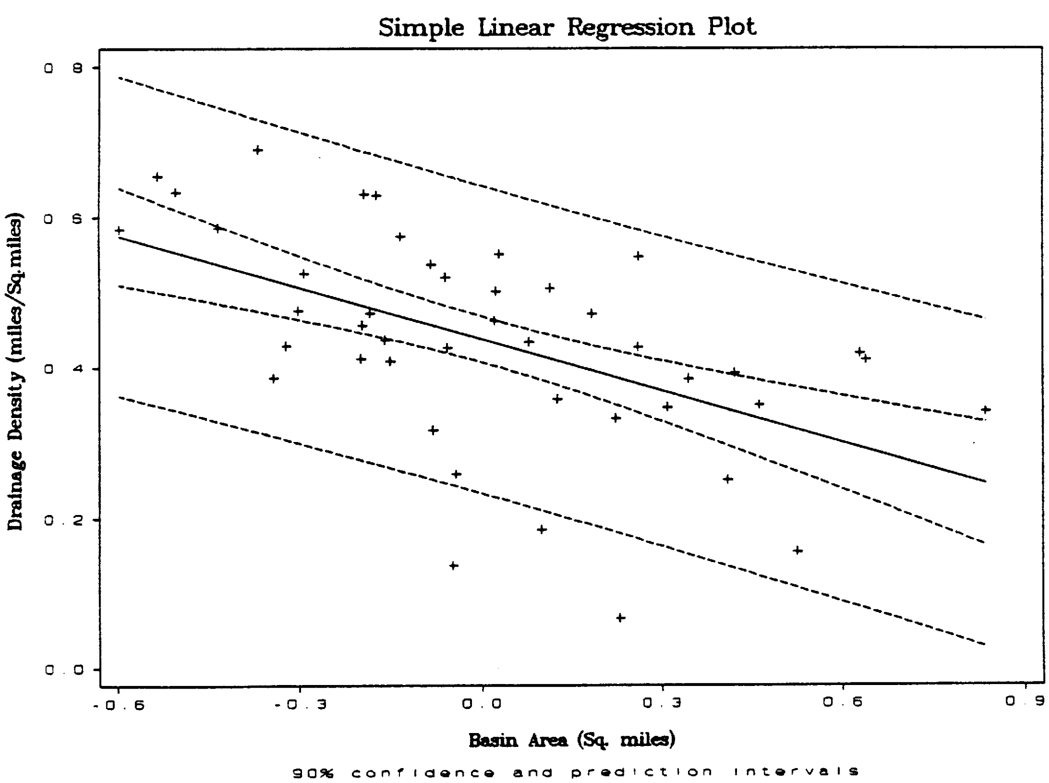
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF DRAINAGE DENSITY

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.43742	0.01816	24.08	0.0000
BA	-0.22940	0.05530	-4.15	0.0002

R-SQUARED	0.2906	RESID. MEAN SQUARE (MSE)	0.01447
ADJUSTED R-SQUARED	0.2738	STANDARD DEVIATION	0.12031

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.24909	0.24909	17.21	0.0002
RESIDUAL	42	0.60793	0.01447		
TOTAL	43	0.85702			

CASES INCLUDED 44 MISSING CASES 0



Strata "C" second order regression output for basin length versus basin area.

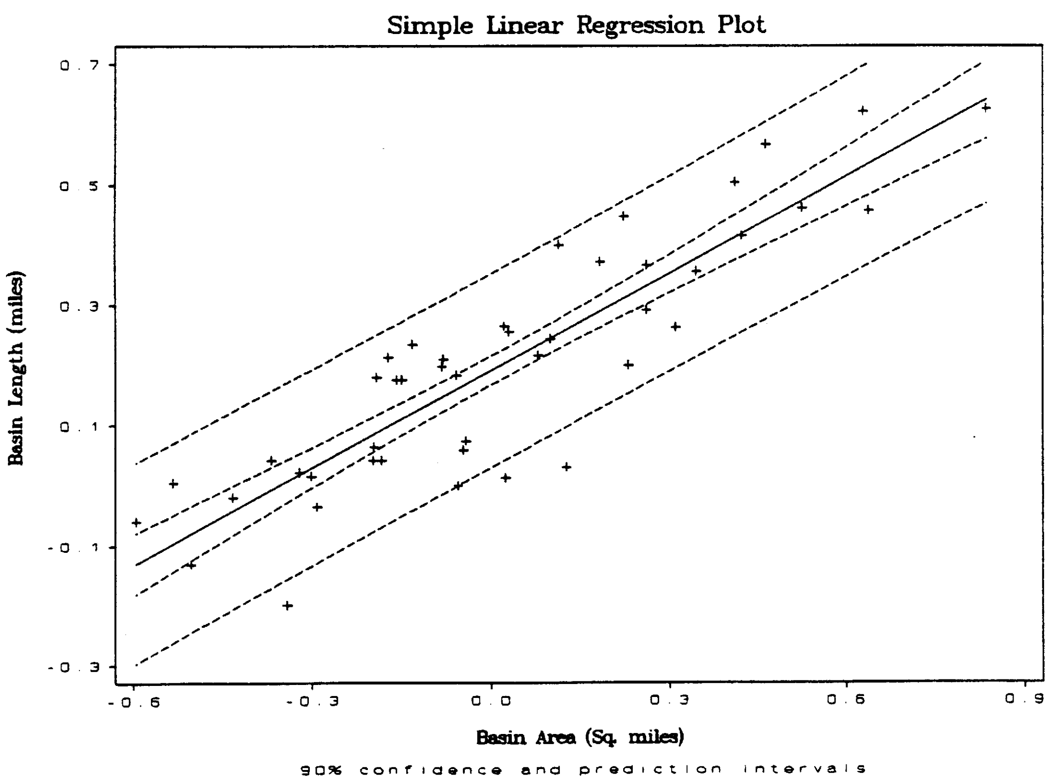
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BASIN LENGTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.19118	0.01431	13.36	0.0000
BA	0.53828	0.04356	12.36	0.0000

R-SQUARED	0.7843	RESID. MEAN SQUARE (MSE)	0.00898
ADJUSTED R-SQUARED	0.7792	STANDARD DEVIATION	0.09476

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.37152	1.37152	152.73	0.0000
RESIDUAL	42	0.37717	0.00898		
TOTAL	43	1.74869			

CASES INCLUDED 44 MISSING CASES 0



Strata "C" second order regression output for main channel length versus basin area.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF MAIN CHANNEL LENGTH

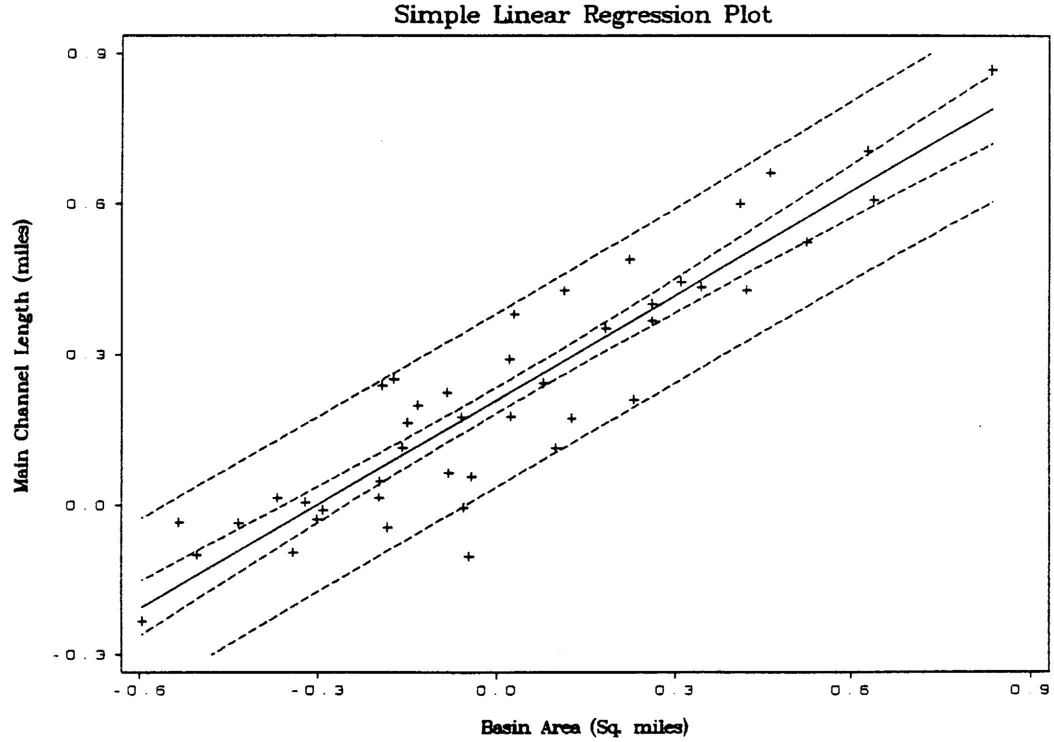
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.20930	0.01534	13.64	0.0000
BA	0.69469	0.04671	14.87	0.0000

R-SQUARED	0.8404	RESID. MEAN SQUARE (MSE)	0.01033
ADJUSTED R-SQUARED	0.8366	STANDARD DEVIATION	0.10163

SOURCE	DF	SS	MS	F	P
REGRESSION	1	2.28440	2.28440	221.18	0.0000
RESIDUAL	42	0.43379	0.01033		
TOTAL	43	2.71819			

CASES INCLUDED 44 MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "C" second order regression output for total channel length versus basin area.

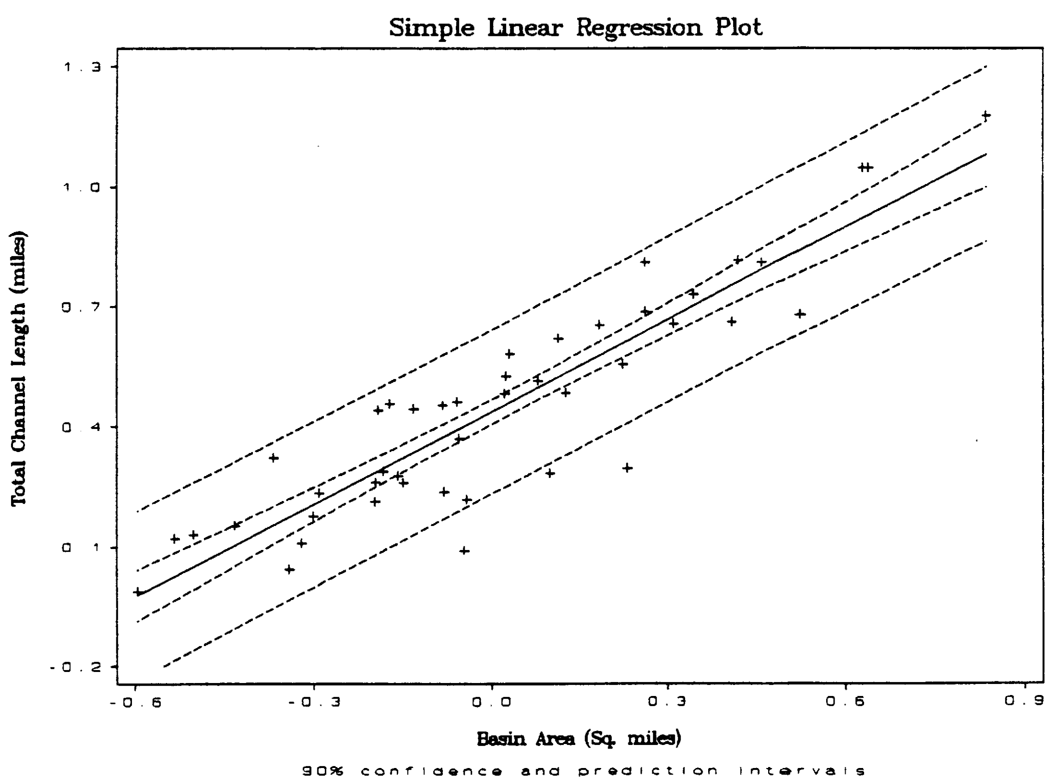
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOTAL CHANNEL LENGTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.43742	0.01816	24.08	0.0000
BA	0.77060	0.05530	13.94	0.0000

R-SQUARED	0.8222	RESID. MEAN SQUARE (MSE)	0.01447
ADJUSTED R-SQUARED	0.8179	STANDARD DEVIATION	0.12031

SOURCE	DF	SS	MS	F	P
REGRESSION	1	2.81092	2.81092	194.20	0.0000
RESIDUAL	42	0.60793	0.01447		
TOTAL	43	3.41885			

CASES INCLUDED 44 MISSING CASES 0



Strata "C" second order regression output for number of first orders versus total channel length.

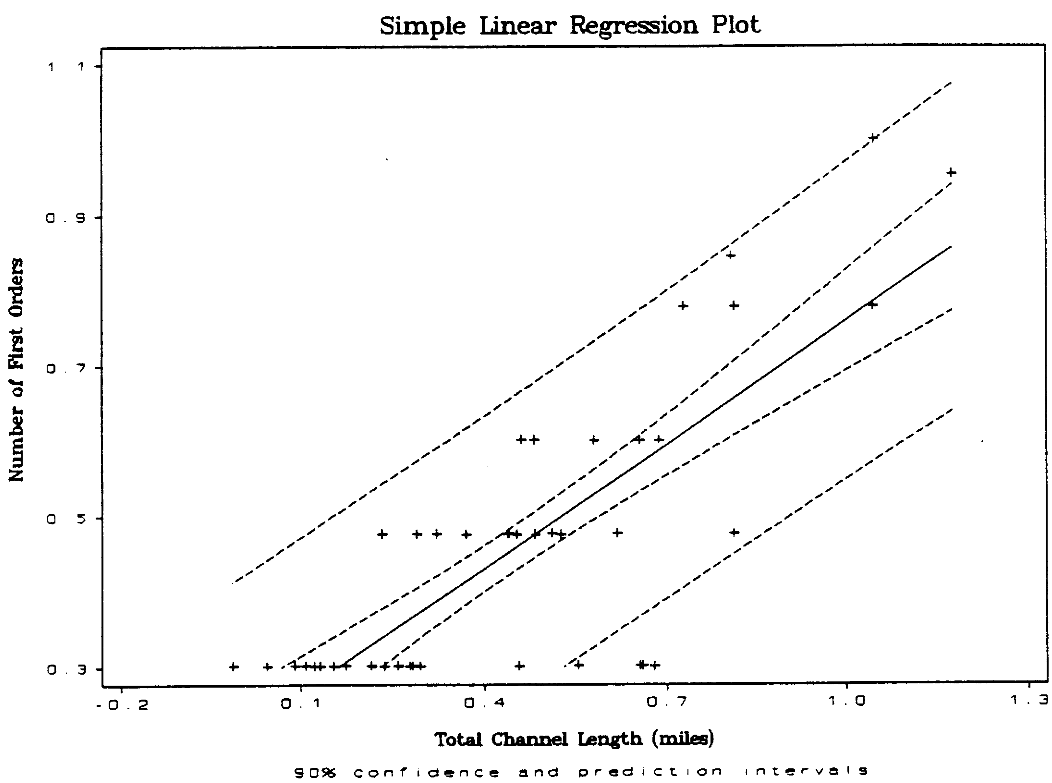
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF NUMBER OF FIRST ORDERS

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.21148	0.03416	6.19	0.0000
TCHL	0.54820	0.06440	8.51	0.0000

R-SQUARED	0.6331	RESID. MEAN SQUARE (MSE)	0.01418
ADJUSTED R-SQUARED	0.6244	STANDARD DEVIATION	0.11907

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.02745	1.02745	72.47	0.0000
RESIDUAL	42	0.59546	0.01418		
TOTAL	43	1.62291			

CASES INCLUDED 44   MISSING CASES 0



Strata "C" second order regression output for valley length versus basin area.

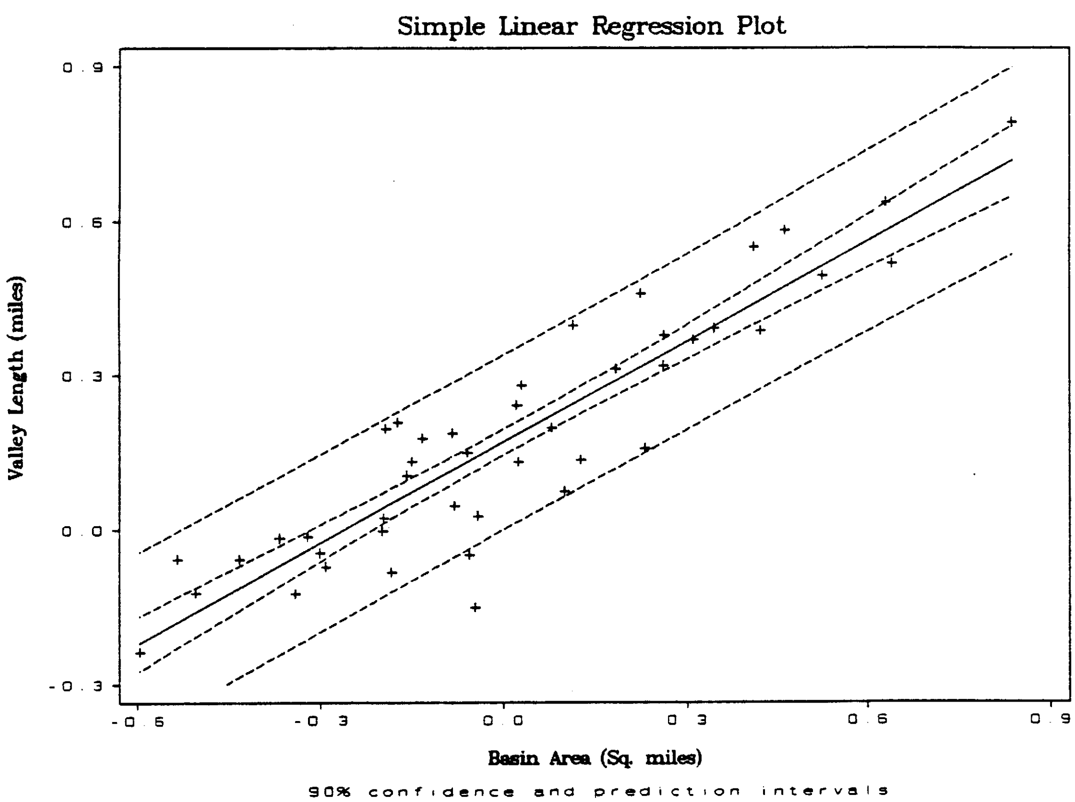
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF VALLEY LENGTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.17043	0.01509	11.30	0.0000
BA	0.65389	0.04593	14.24	0.0000

R-SQUARED 0.8283 RESID. MEAN SQUARE (MSE) 0.00999
ADJUSTED R-SQUARED 0.8242 STANDARD DEVIATION 0.09994

SOURCE	DF	SS	MS	F	P
REGRESSION	1	2.02396	2.02396	202.65	0.0000
RESIDUAL	42	0.41947	0.00999		
TOTAL	43	2.44343			

CASES INCLUDED 44 MISSING CASES 0



Strata "C" second order regression output of basin relief versus basin area and basin length.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BASIN RELIEF

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	2.13084	0.04490	47.46	0.0000
BA	-0.29944	0.12844	-2.33	0.0247
BL	0.79045	0.21132	3.74	0.0006

R-SQUARED	0.3104	RESID. MEAN SQUARE (MSE)	0.01684
ADJUSTED R-SQUARED	0.2768	STANDARD DEVIATION	0.12978

SOURCE	DF	SS	MS	F	P
REGRESSION	2	0.31085	0.15543	9.23	0.0005
RESIDUAL	41	0.69059	0.01684		
TOTAL	43	1.00144			

CASES INCLUDED 44 MISSING CASES 0

Strata "C" second order regression output for used relief versus basin relief.

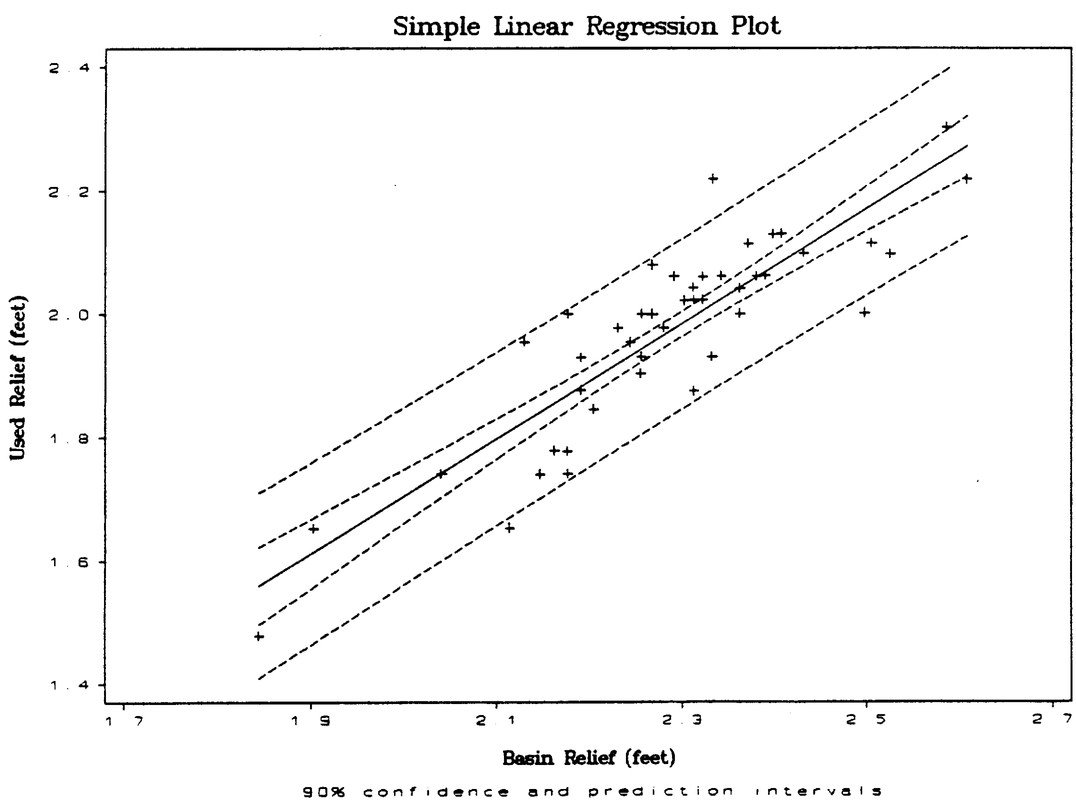
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF USED RELIEF

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.16568	0.18571	-0.89	0.3774
BR	0.93476	0.08113	11.52	0.0000

R-SQUARED	0.7597	RESID. MEAN SQUARE (MSE)	0.00659
ADJUSTED R-SQUARED	0.7540	STANDARD DEVIATION	0.08118

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.87503	0.87503	132.76	0.0000
RESIDUAL	42	0.27682	0.00659		
TOTAL	43	1.15185			

CASES INCLUDED 44 MISSING CASES 0



Strata "C" second order regression output for relief ratio versus basin area.

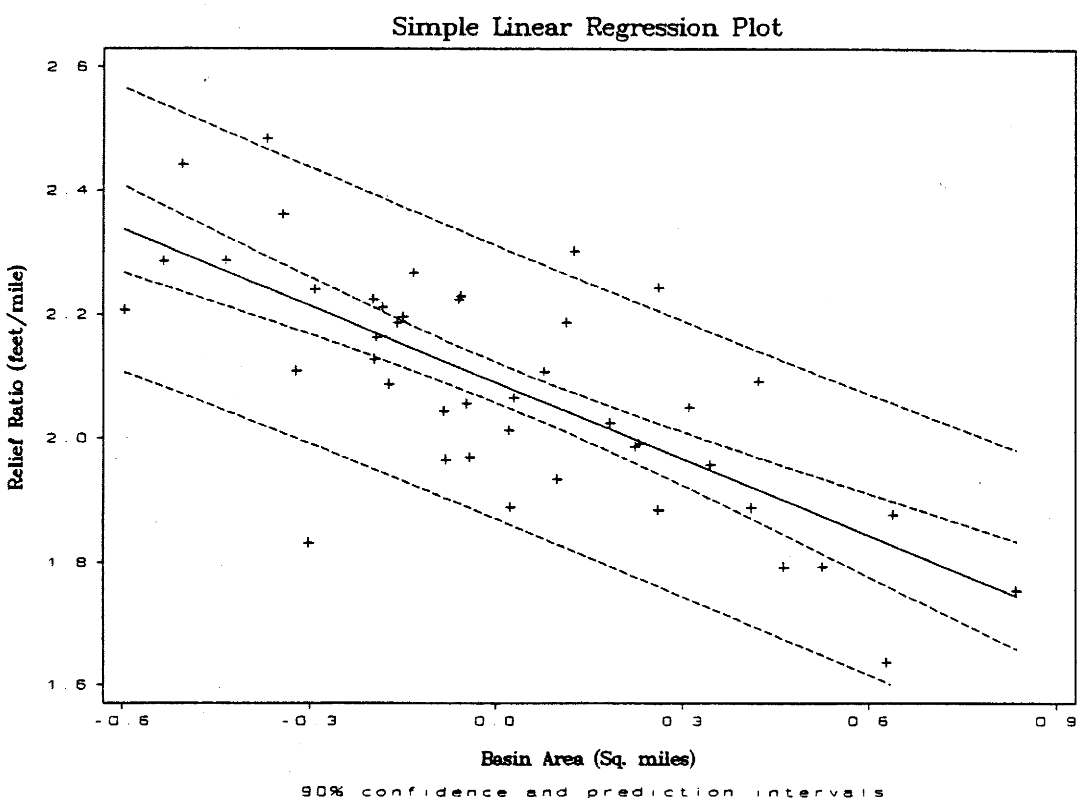
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RELIEF RATIO

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	2.09078	0.01959	106.72	0.0000
BA	-0.41224	0.05964	-6.91	0.0000

R-SQUARED	0.5322	RESID. MEAN SQUARE (MSE)	0.01684
ADJUSTED R-SQUARED	0.5210	STANDARD DEVIATION	0.12976

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.80443	0.80443	47.78	0.0000
RESIDUAL	42	0.70715	0.01684		
TOTAL	43	1.51157			

CASES INCLUDED 44 MISSING CASES 0



Strata "C" second order regression output for ruggedness number versus basin relief.

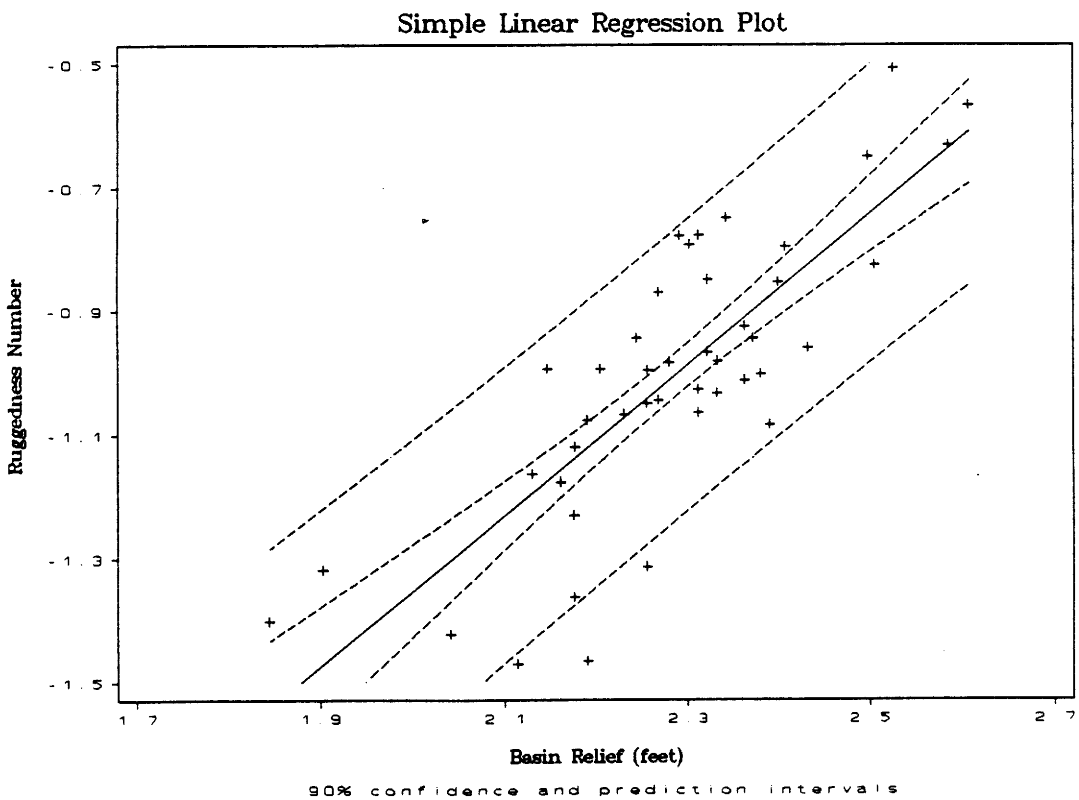
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RUGGEDNESS NUMBER

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-3.79592	0.31724	-11.97	0.0000
BR	1.22177	0.13858	8.82	0.0000

R-SQUARED	0.6492	RESID. MEAN SQUARE (MSE)	0.01923
ADJUSTED R-SQUARED	0.6408	STANDARD DEVIATION	0.13868

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.49487	1.49487	77.73	0.0000
RESIDUAL	42	0.80777	0.01923		
TOTAL	43	2.30264			

CASES INCLUDED 44 MISSING CASES 0



Strata "C" second order regression output for channel slope versus relief ratio.

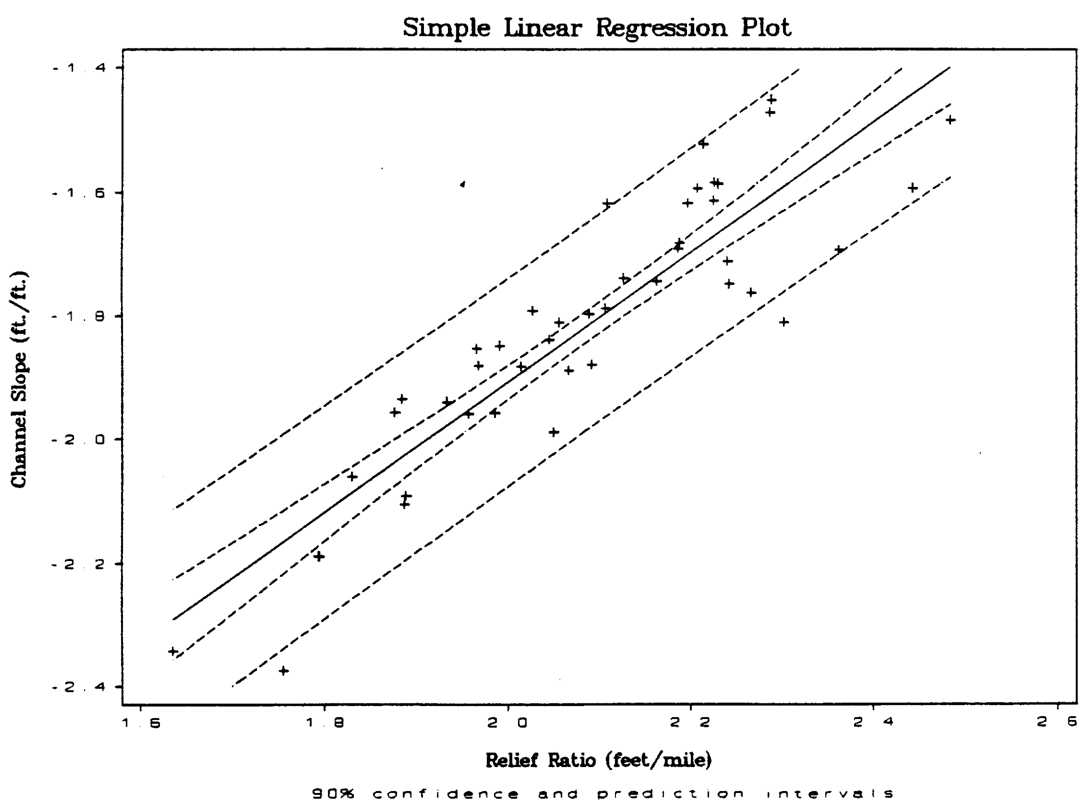
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF CHANNEL SLOPE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-4.01161	0.16795	-23.89	0.0000
RR	1.05195	0.08030	13.10	0.0000

R-SQUARED	0.8034	RESID. MEAN SQUARE (MSE)	0.00975
ADJUSTED R-SQUARED	0.7987	STANDARD DEVIATION	0.09873

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.67270	1.67270	171.62	0.0000
RESIDUAL	42	0.40936	0.00975		
TOTAL	43	2.08206			

CASES INCLUDED 44 MISSING CASES 0



Strata "C" second order regression output for sinuosity versus main channel length.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF SINUOSITY

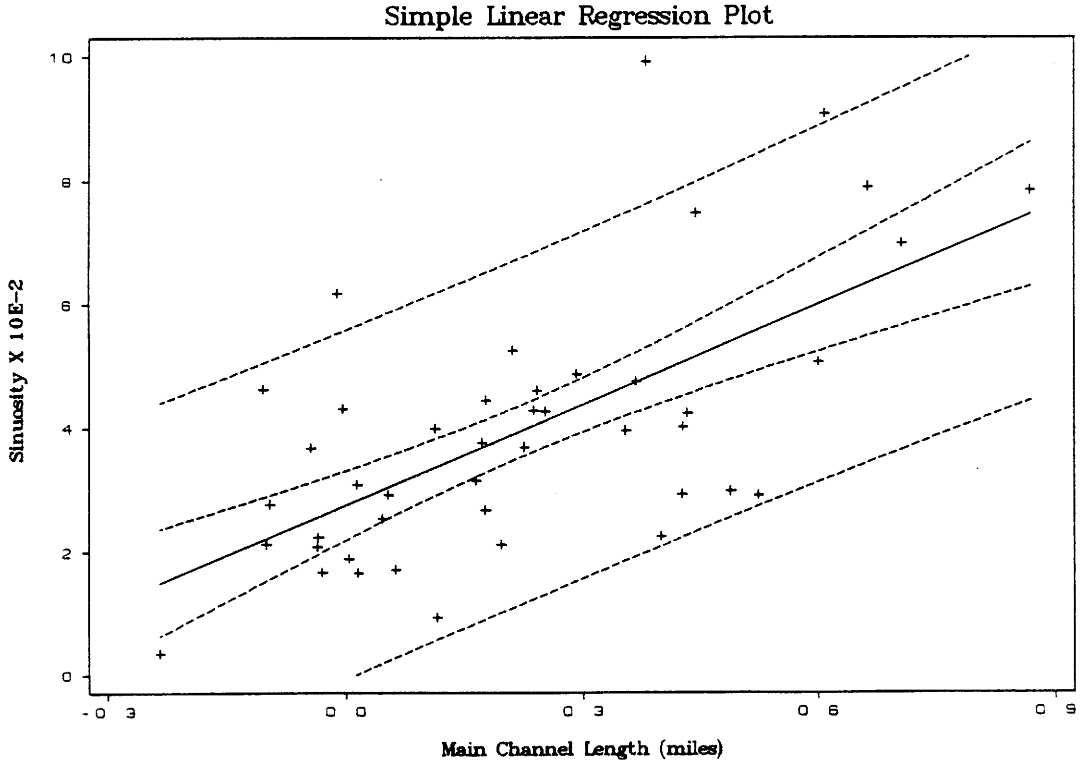
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.02760	0.00333	8.29	0.0000
MCHL	0.05410	0.01000	5.41	0.0000

R-SQUARED	0.4107	RESID. MEAN SQUARE (MSE)	2.718E-04
ADJUSTED R-SQUARED	0.3967	STANDARD DEVIATION	0.01649

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.00796	0.00796	29.27	0.0000
RESIDUAL	42	0.01142	2.718E-04		
TOTAL	43	0.01937			

CASES INCLUDED 44 MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "C" second order regression output for valley area versus area gradient index #2.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF VALLEY AREA

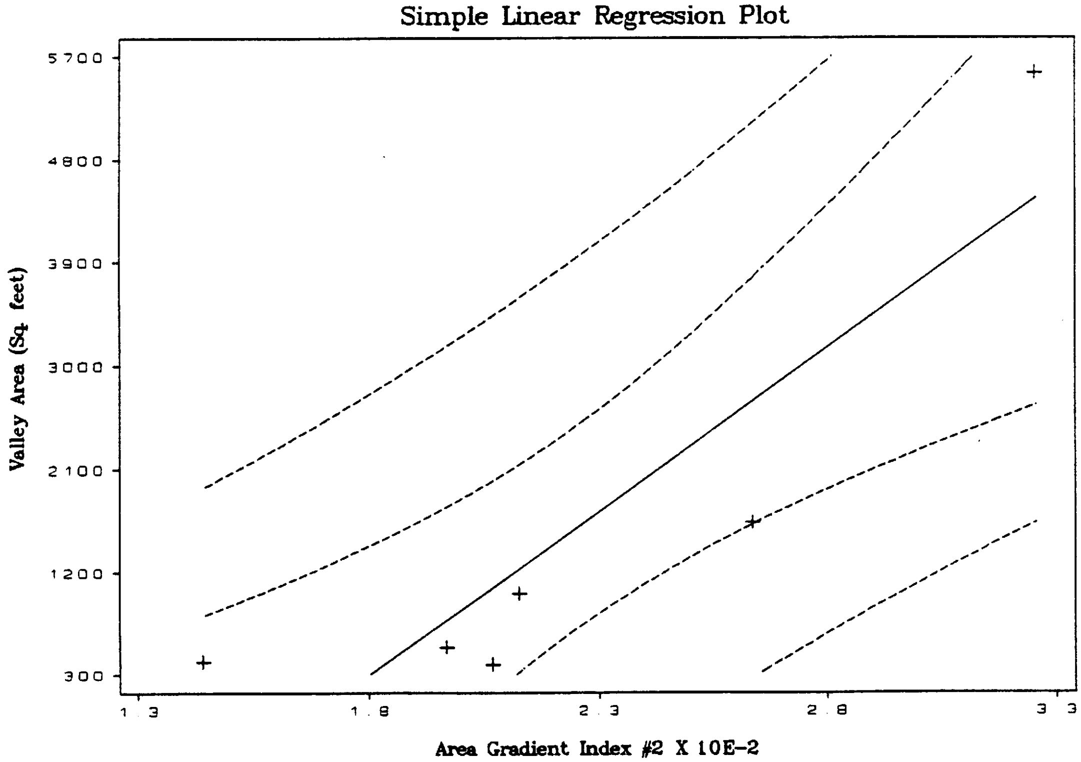
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-4853.85	1700.50	-2.85	0.0462
AGI2	2.862E+05	73291.5	3.90	0.0175

R-SQUARED	0.7922	RESID. MEAN SQUARE (MSE)	1.043E+06
ADJUSTED R-SQUARED	0.7402	STANDARD DEVIATION	1021.32

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.590E+07	1.590E+07	15.25	0.0175
RESIDUAL	4	4.172E+06	1.043E+06		
TOTAL	5	2.008E+07			

CASES INCLUDED 6 MISSING CASES 1

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "C" second order regression output for top width versus valley area.

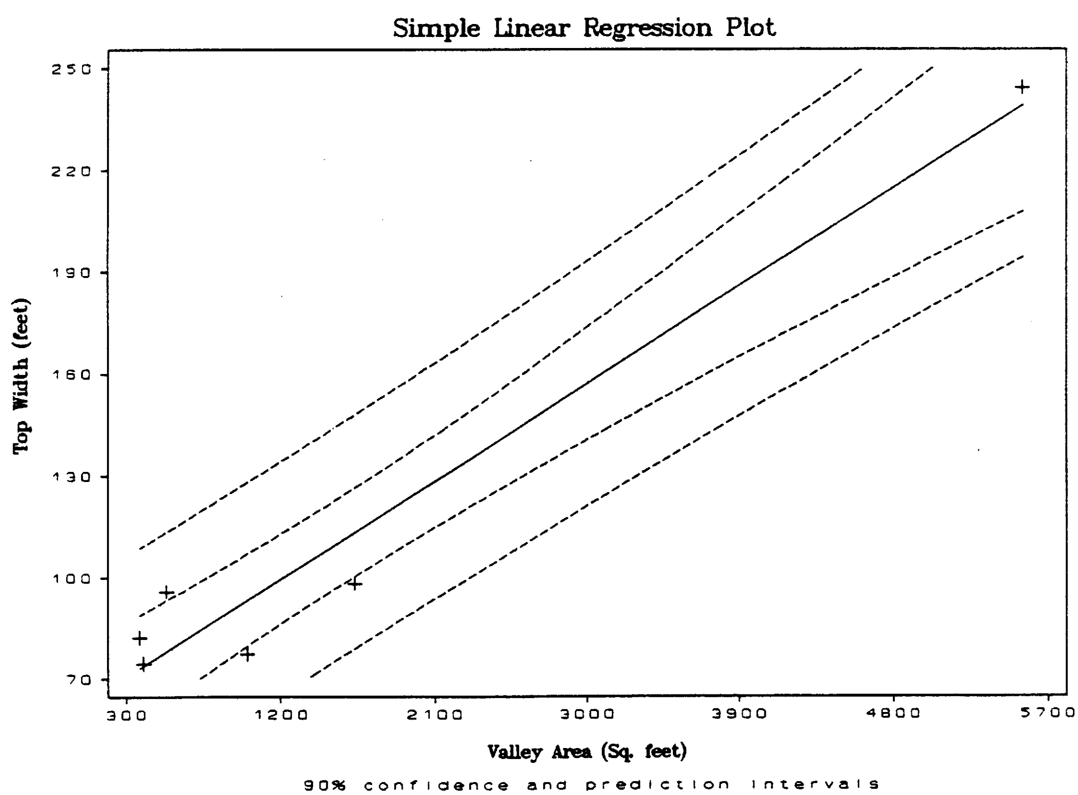
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOP WIDTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	61.1342	8.10079	7.55	0.0017
A	0.03203	0.00335	9.57	0.0007

R-SQUARED	0.9581	RESID. MEAN SQUARE (MSE)	225.087
ADJUSTED R-SQUARED	0.9476	STANDARD DEVIATION	15.0029

SOURCE	DF	SS	MS	F	P
REGRESSION	1	20595.1	20595.1	91.50	0.0007
RESIDUAL	4	900.347	225.087		
TOTAL	5	21495.5			

CASES INCLUDED 6   MISSING CASES 1



Strata "C" second order regression output for average depth versus valley area.

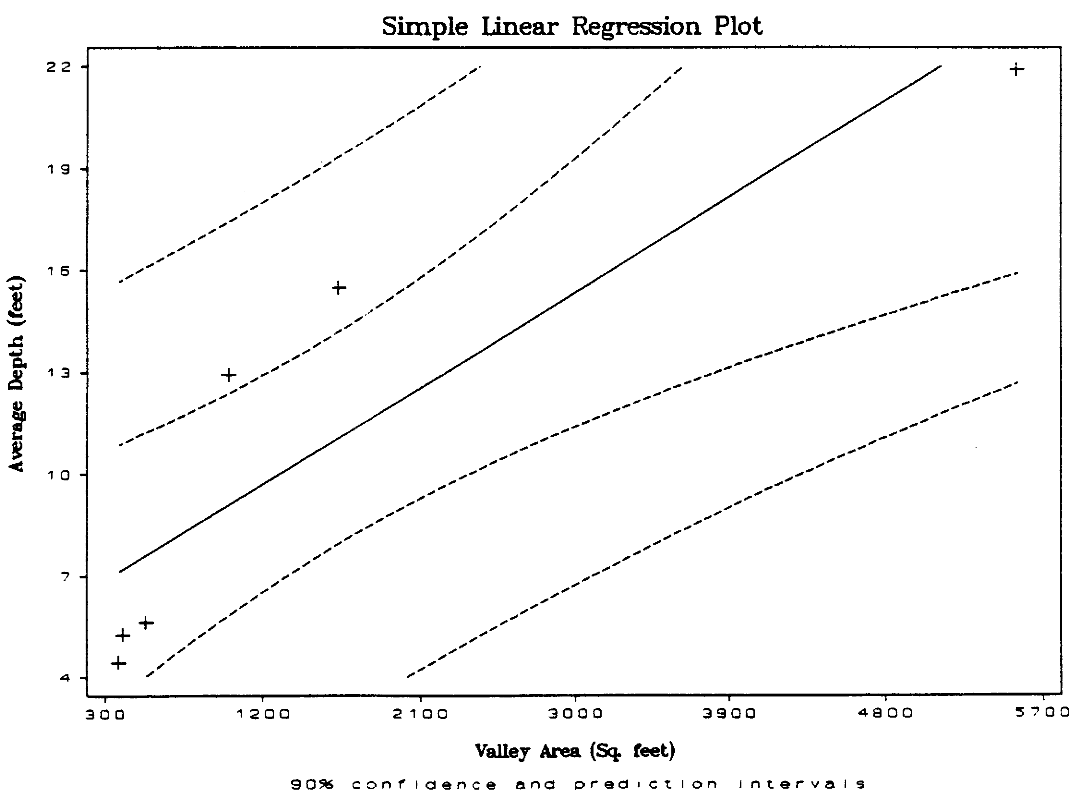
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AVERAGE DEPTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	5.96674	1.93624	3.08	0.0369
A	0.00313	8.003E-04	3.91	0.0173

R-SQUARED	0.7929	RESID. MEAN SQUARE (MSE)	12.8592
ADJUSTED R-SQUARED	0.7411	STANDARD DEVIATION	3.58597

SOURCE	DF	SS	MS	F	P
REGRESSION	1	196.911	196.911	15.31	0.0173
RESIDUAL	4	51.4368	12.8592		
TOTAL	5	248.348			

CASES INCLUDED 6 MISSING CASES 1



Strata "C" second order regression output for bed width versus top width.

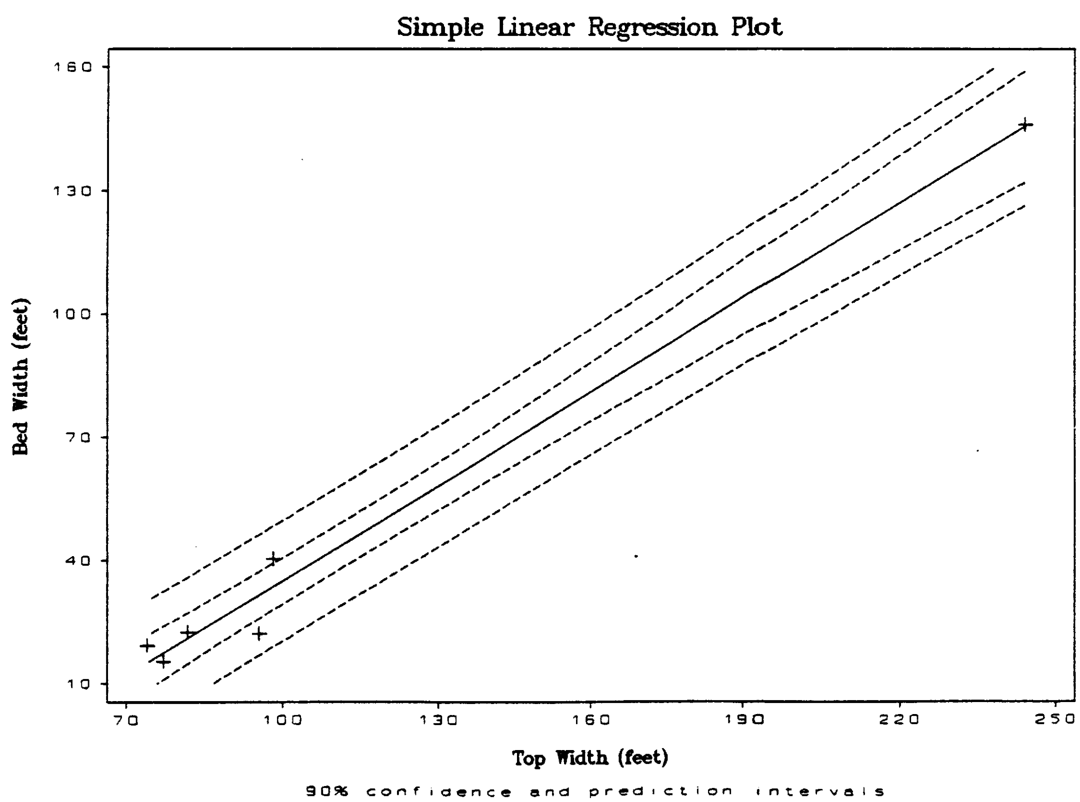
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BED WIDTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-41.7931	5.51304	-7.58	0.0016
TW	0.76842	0.04346	17.68	0.0001

R-SQUARED	0.9874	RESID. MEAN SQUARE (MSE)	40.5982
ADJUSTED R-SQUARED	0.9842	STANDARD DEVIATION	6.37167

SOURCE	DF	SS	MS	F	P
REGRESSION	1	12692.5	12692.5	312.64	0.0001
RESIDUAL	4	162.393	40.5982		
TOTAL	5	12854.9			

CASES INCLUDED 6 MISSING CASES 1



Strata "C" second order regression output for area #3 versus valley area.

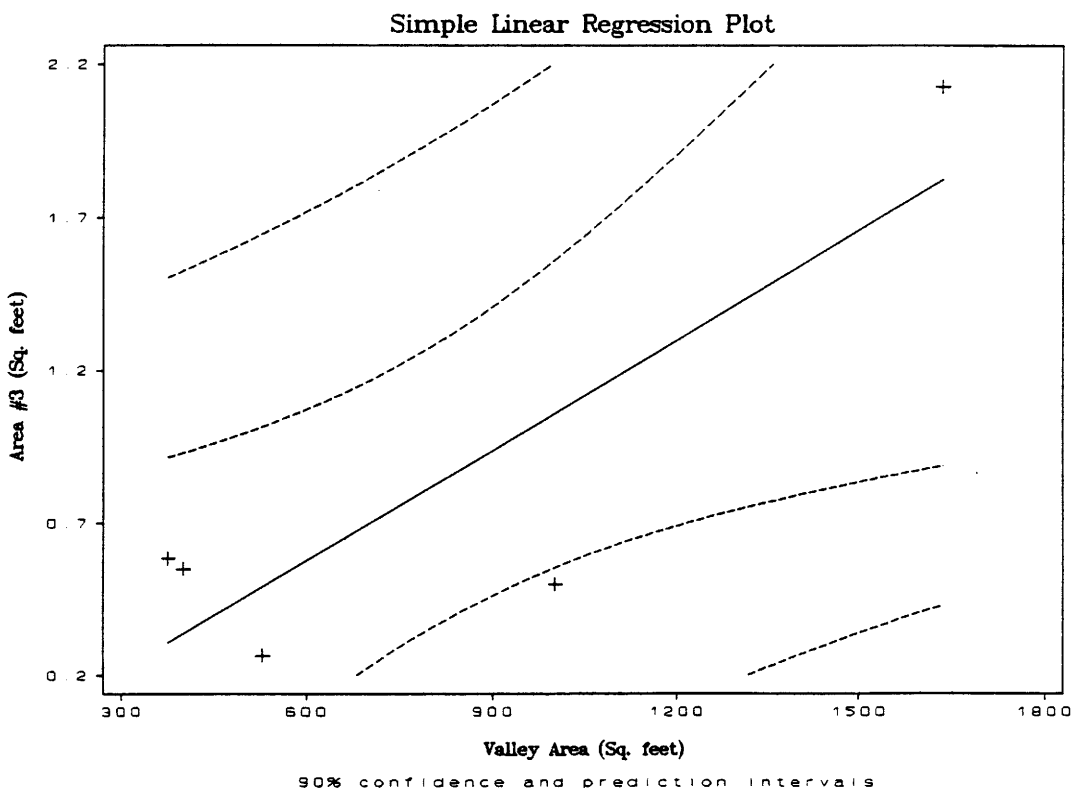
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AREA #3

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.14425	0.37675	-0.38	0.7273
A	0.00120	4.079E-04	2.95	0.0602

R-SQUARED	0.7433	RESID. MEAN SQUARE (MSE)	0.19175
ADJUSTED R-SQUARED	0.6577	STANDARD DEVIATION	0.43789

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.66559	1.66559	8.69	0.0602
RESIDUAL	3	0.57525	0.19175		
TOTAL	4	2.24084			

CASES INCLUDED 5 MISSING CASES 2



Strata "C" second order regression output for top width #3 versus area #3.

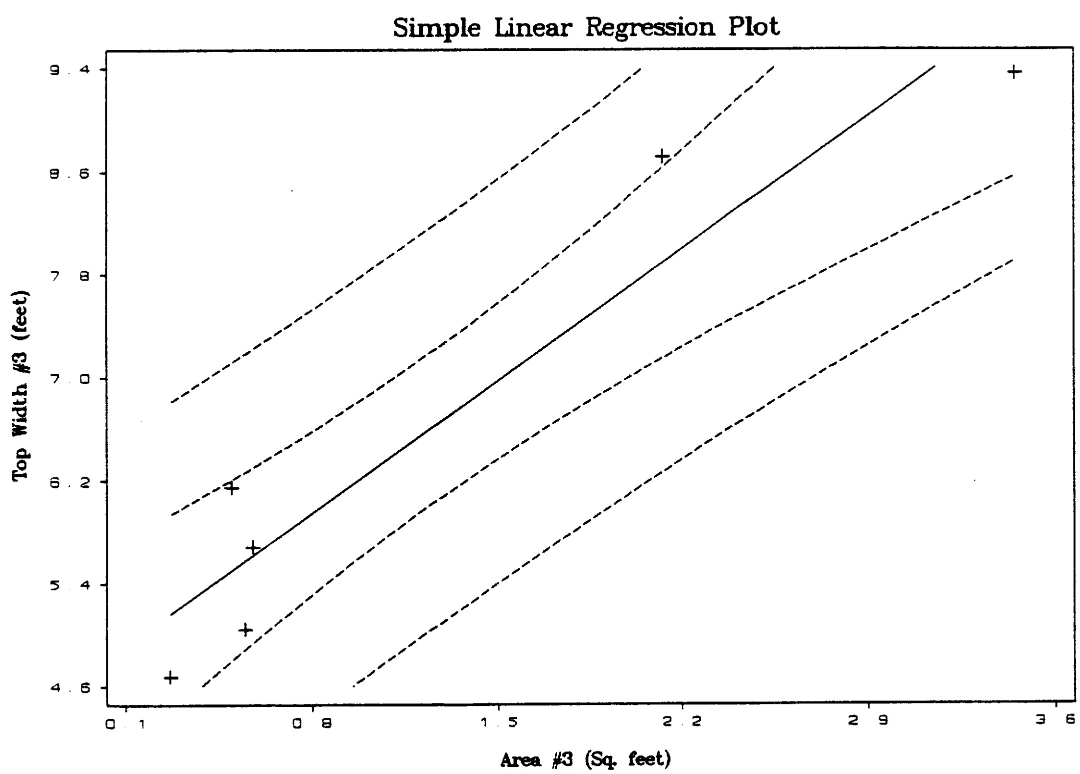
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOP WIDTH #3

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	4.77545	0.40707	11.73	0.0003
A3	1.46573	0.23919	6.13	0.0036

R-SQUARED	0.9037	RESID. MEAN SQUARE (MSE)	0.46190
ADJUSTED R-SQUARED	0.8797	STANDARD DEVIATION	0.67964

SOURCE	DF	SS	MS	F	P
REGRESSION	1	17.3455	17.3455	37.55	0.0036
RESIDUAL	4	1.84762	0.46190		
TOTAL	5	19.1931			

CASES INCLUDED 6   MISSING CASES 1



90% confidence and prediction intervals

Strata "C" second order regression output for average depth #3 versus area #3.

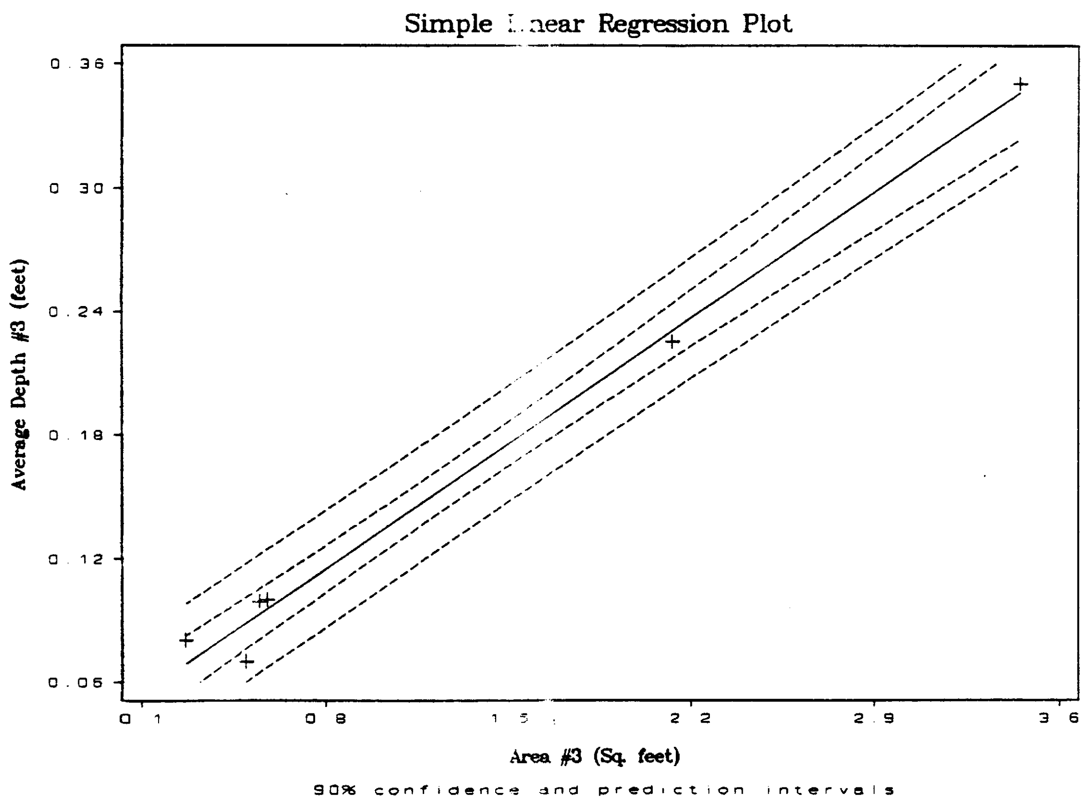
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AVGERAGE DEPTH #3

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.04573	0.00731	6.25	0.0033
A3	0.08708	0.00430	20.27	0.0000

R-SQUARED	0.9904	RESID. MEAN SQUARE (MSE)	1.491E-04
ADJUSTED R-SQUARED	0.9879	STANDARD DEVIATION	0.01221

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.06122	0.06122	410.71	0.0000
RESIDUAL	4	5.963E-04	1.491E-04		
TOTAL	5	0.06182			

CASES INCLUDED 6 MISSING CASES 0



High bank reach means for **Strata "C"** second order

BASIN ID 05B0	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	3.00	3.00	3.00	3.00	3.00	3.00	3.00	1.00
MEAN	5554.40	259.20	244.17	20.63	21.90	11.07	146.07	0.011
S.D.	2690.40	72.48	69.18	4.97	5.23	0.53	43.38	
C.V. (%)	48.44	27.96	28.34	24.11	23.86	4.80	29.70	
MINIMUM	2846.30	184.80	173.10	15.40	16.40	10.56	103.70	0.011
MAXIMUM	8226.80	329.60	311.30	25.30	26.80	11.62	190.40	0.011
RANGE	5380.50	144.80	138.20	9.90	10.40	1.06	86.70	0.000

BASIN ID 07D0	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	3.00	3.00	3.00	3.00	3.00	3.00	3.00	5.00
MEAN	1002.10	89.97	76.93	11.03	12.90	5.97	15.07	0.021
S.D.	237.66	10.04	8.75	1.37	1.57	0.11	6.01	0.009
C.V. (%)	23.72	11.16	11.38	12.37	12.18	1.78	39.90	42.94
MINIMUM	826.90	81.60	69.80	10.10	11.80	5.90	11.30	0.013
MAXIMUM	1272.60	101.10	86.70	12.60	14.70	6.09	22.00	0.036
RANGE	445.70	19.50	16.90	2.50	2.90	0.19	10.70	0.023

BASIN ID 07E0	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	6.00	6.00	6.00	6.00	6.00	6.00	6.00	5.00
MEAN	1636.90	113.02	98.45	13.48	15.50	6.41	40.68	0.016
S.D.	1047.20	34.40	30.44	4.10	4.73	0.73	22.95	0.006
C.V. (%)	63.97	30.44	30.92	30.44	30.51	11.35	56.40	40.57
MINIMUM	819.30	84.90	73.60	9.70	10.90	5.36	22.60	0.009
MAXIMUM	3605.40	177.10	156.50	20.40	23.00	7.30	85.70	0.023
RANGE	2786.10	92.20	82.90	10.70	12.10	1.94	63.10	0.014

BASIN ID 12B0	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	3.00	3.00	3.00	3.00	3.00	3.00	3.00	2.00
MEAN	402.00	77.03	74.17	5.03	5.23	13.99	19.00	0.009
S.D.	193.69	23.57	22.74	0.91	0.91	1.91	7.61	0.002
C.V. (%)	48.18	30.59	30.66	18.03	17.34	13.68	40.05	23.19
MINIMUM	254.70	60.40	58.20	4.20	4.40	12.57	12.00	0.007
MAXIMUM	621.40	104.00	100.20	6.00	6.20	16.16	27.10	0.010
RANGE	366.70	43.60	42.00	1.80	1.80	3.59	15.10	0.003

BASIN ID 16C0	AREA ($ft.^2$)	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	5.00	5.00	5.00	5.00	5.00	5.00	3.00	7.00
MEAN	375.00	84.22	81.80	4.30	4.42	20.65	22.20	0.011
S.D.	191.04	17.79	17.16	1.65	1.72	7.97	10.08	0.002
C.V. (%)	50.95	21.12	20.98	38.39	38.84	38.58	45.41	17.15
MINIMUM	149.80	61.20	60.00	2.40	2.50	13.74	11.20	0.008
MAXIMUM	629.10	110.90	107.50	5.70	5.90	32.89	31.00	0.014
RANGE	479.30	49.70	47.50	3.30	3.40	19.15	19.80	0.005

BASIN ID 22B0	AREA ($ft.^2$)	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO	BED WIDTH (ft.)	AVERAGE SLOPE (ft/ft)
n	3.00	3.00	3.00	3.00	3.00	3.00	2.00	2.00
MEAN	529.73	98.07	95.57	5.43	5.60	17.68	21.90	0.017
S.D.	58.46	11.51	12.09	0.91	0.96	5.53	2.97	0.007
C.V. (%)	11.04	11.74	12.65	16.70	17.22	31.28	13.56	43.32
MINIMUM	486.30	86.90	84.10	4.40	4.50	14.02	19.80	0.012
MAXIMUM	596.20	109.90	108.20	6.10	6.30	24.04	24.00	0.022
RANGE	109.90	23.00	24.10	1.70	1.80	10.03	4.20	0.010

Medium bank reach means for **Strata "C"** second order

BASIN ID 16C0	**AREA** (ft.^{2})	**WETTED PERIMETER** (ft.)	**TOP WIDTH** (ft.)	**HYDRAULIC RADIUS**	**AVERAGE DEPTH** (ft.)	**W/D RATIO**
n	3.00	3.00	3.00	3.00	3.00	3.00
MEAN	9.63	15.13	14.87	0.53	0.53	32.82
S.D.	9.26	6.62	6.41	0.35	0.35	13.17
C.V. (%)	96.08	43.71	43.10	65.85	65.85	40.15
MINIMUM	2.20	9.70	9.60	0.20	0.20	24.44
MAXIMUM	20.00	22.50	22.00	0.90	0.90	48.00
RANGE	17.80	12.80	12.40	0.70	0.70	23.56

BASIN ID 22B0	**AREA** (ft.^{2})	**WETTED PERIMETER** (ft.)	**TOP WIDTH** (ft.)	**HYDRAULIC RADIUS**	**AVERAGE DEPTH** (ft.)	**W/D RATIO**
n	3.00	3.00	3.00	3.00	3.00	3.00
MEAN	2.60	10.13	10.10	0.23	0.23	42.00
S.D.	1.87	5.20	5.20	0.06	0.06	15.16
C.V. (%)	72.06	51.32	51.49	24.74	24.74	36.09
MINIMUM	1.10	4.90	4.90	0.20	0.20	24.50
MAXIMUM	4.70	15.30	15.30	0.30	0.30	51.00
RANGE	3.60	10.40	10.40	0.10	0.10	26.50

BASIN ID 22C0	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	2.00	2.00	2.00	2.00	2.00	2.00
MEAN	29.80	19.30	18.30	1.55	1.65	11.15
S.D.	5.66	1.13	0.85	0.21	0.21	0.92
C.V. (%)	18.98	5.86	4.64	13.69	12.86	8.24
MINIMUM	25.80	18.50	17.70	1.40	1.50	10.50
MAXIMUM	33.80	20.10	18.90	1.70	1.80	11.80
RANGE	8.00	1.60	1.20	0.30	0.30	1.30

Low bank reach means for **Strata "C"** second order

BASIN ID 07D0	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	2.00	2.00	2.00	2.00	2.00	2.00
MEAN	0.50	6.15	6.15	0.07	0.07	127.50
S.D.	0.42	0.92	0.92	0.04	0.04	84.15
C.V. (%)	84.85	14.95	14.95	60.61	60.61	66.00
MINIMUM	0.20	5.50	5.50	0.04	0.04	68.00
MAXIMUM	0.80	6.80	6.80	0.10	0.10	187.00
RANGE	0.60	1.30	1.30	0.06	0.06	119.00

BASIN ID 07E0	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	4.00	4.00	4.00	4.00	4.00	4.00
MEAN	2.13	8.71	8.71	0.23	0.23	53.37
S.D.	2.38	2.03	2.03	0.19	0.19	25.80
C.V. (%)	111.98	23.36	23.36	84.13	84.13	48.34
MINIMUM	0.40	6.30	6.30	0.10	0.10	22.46
MAXIMUM	5.60	11.23	11.23	0.50	0.50	83.00
RANGE	5.20	4.93	4.93	0.40	0.40	60.54

BASIN ID 12B0	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	2.00	2.00	2.00	2.00	2.00	2.00
MEAN	0.55	5.05	5.05	0.10	0.10	50.50
S.D.	0.21	0.92	0.92	0.00	0.00	9.19
C.V. (%)	38.57	18.20	18.20	0.00	0.00	18.20
MINIMUM	0.40	4.40	4.40	0.10	0.10	44.00
MAXIMUM	0.70	5.70	5.70	0.10	0.10	57.00
RANGE	0.30	1.30	1.30	0.00	0.00	13.00

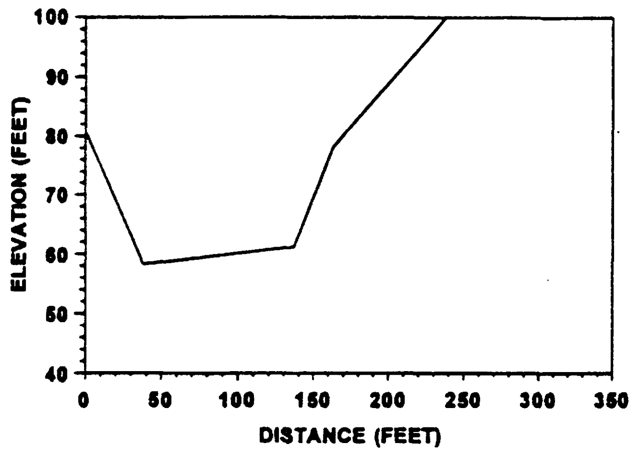
BASIN ID 16C0	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	5.00	5.00	5.00	5.00	5.00	5.00
MEAN	0.58	5.70	5.68	0.10	0.10	56.80
S.D.	0.60	4.32	4.33	0.00	0.00	43.34
C.V. (%)	103.02	75.88	76.31	0.00	0.00	76.31
MINIMUM	0.10	2.10	2.10	0.10	0.10	21.00
MAXIMUM	1.60	13.20	13.20	0.10	0.10	132.00
RANGE	1.50	11.10	11.10	0.00	0.00	111.00

BASIN ID 22B0	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	3.00	3.00	3.00	3.00	3.00	3.00
MEAN	0.27	4.67	4.67	0.08	0.08	97.07
S.D.	0.06	3.24	3.24	0.03	0.03	119.64
C.V. (%)	21.65	69.41	69.41	43.30	43.30	123.26
MINIMUM	0.20	2.60	2.60	0.04	0.04	26.00
MAXIMUM	0.30	8.40	8.40	0.10	0.10	235.20
RANGE	0.10	5.80	5.80	0.06	0.06	209.20

BASIN ID 22C0	AREA (ft.^{2})	WETTED PERIMETER (ft.)	TOP WIDTH (ft.)	HYDRAULIC RADIUS	AVERAGE DEPTH (ft.)	W/D RATIO
n	2.00	2.00	2.00	2.00	2.00	2.00
MEAN	3.45	9.55	9.35	0.35	0.35	32.20
S.D.	2.33	0.64	0.50	0.21	0.21	18.10
C.V. (%)	67.64	6.66	5.29	60.61	60.61	56.22
MINIMUM	1.80	9.10	9.00	0.20	0.20	19.40
MAXIMUM	5.10	10.00	9.70	0.50	0.50	45.00
RANGE	3.30	0.90	0.70	0.30	0.30	25.60

RUSSELL DRAW, 05B0

CROSS SECTION 0+00.00



RUSSELL DRAW, 05B0

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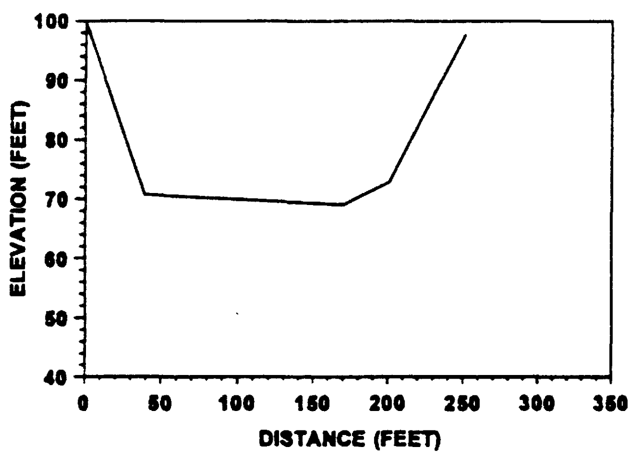

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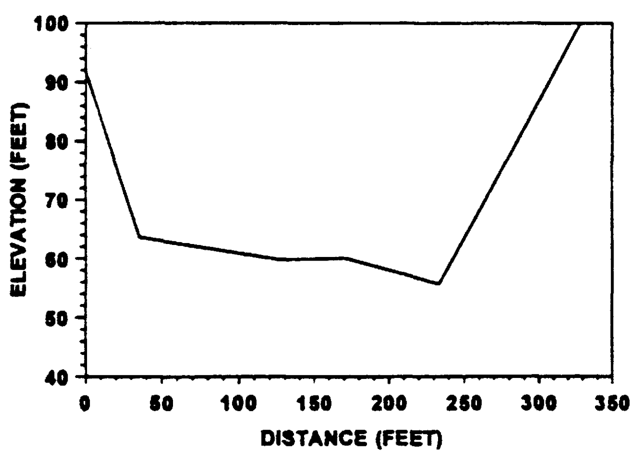
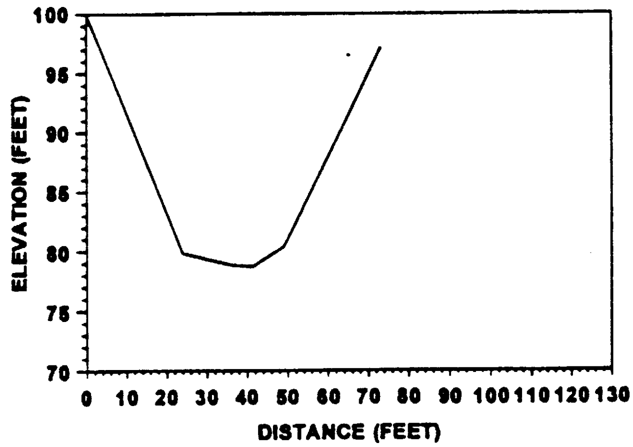


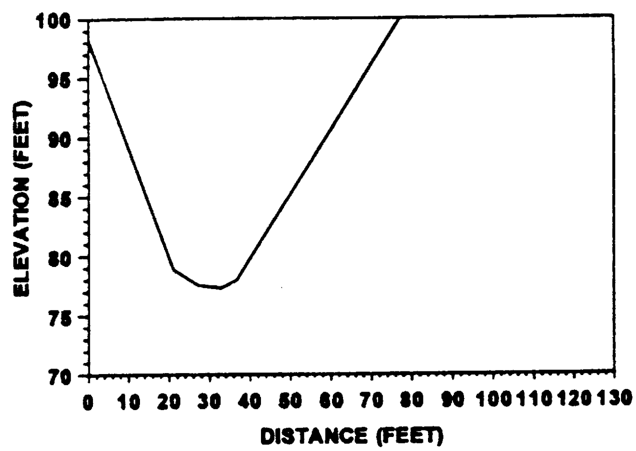
RAWHIDE CREEK, 07D0

CROSS SECTION 0+00.00



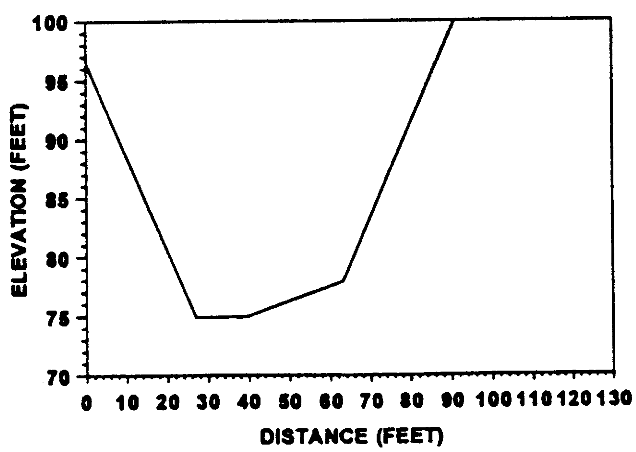
RAWHIDE CREEK, 07D0

CROSS SECTION 1+03.50

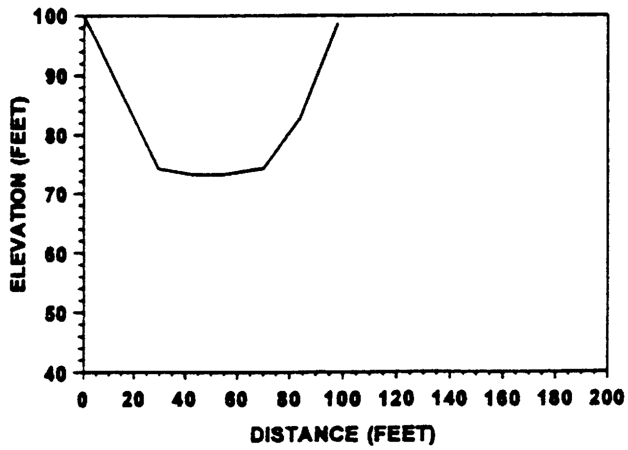


RAWHIDE CREEK, 07D0

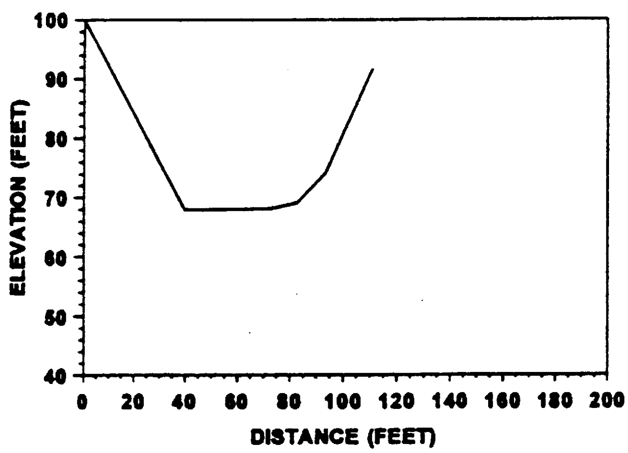
CROSS SECTION 11+14.95



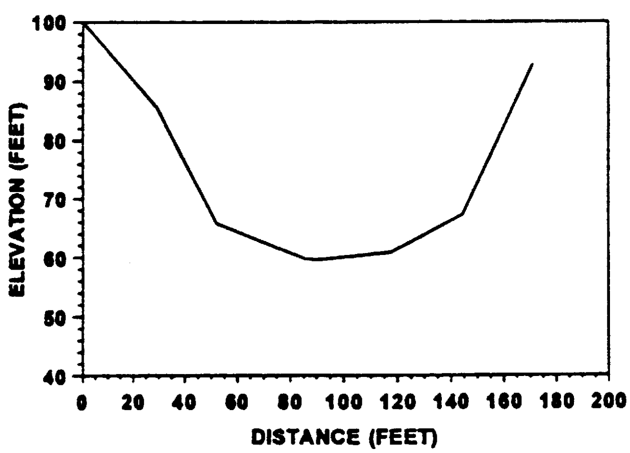
RAWHIDE CREEK, 07E0
CROSS SECTION 0+00.00



RAWHIDE CREEK, 07E0
CROSS SECTION 2+20.00

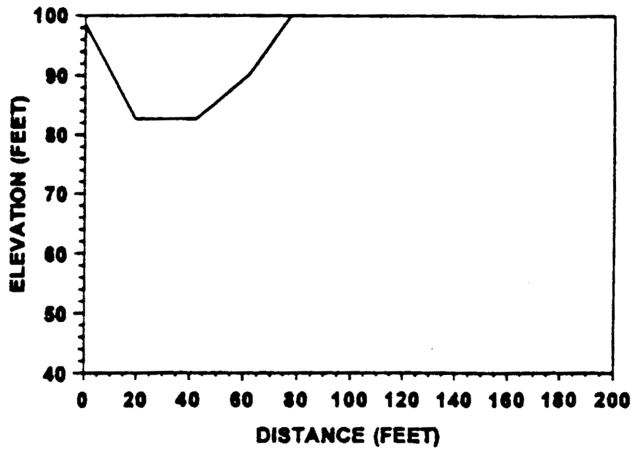


RAWHIDE CREEK, 07E0
CROSS SECTION 5+78.70



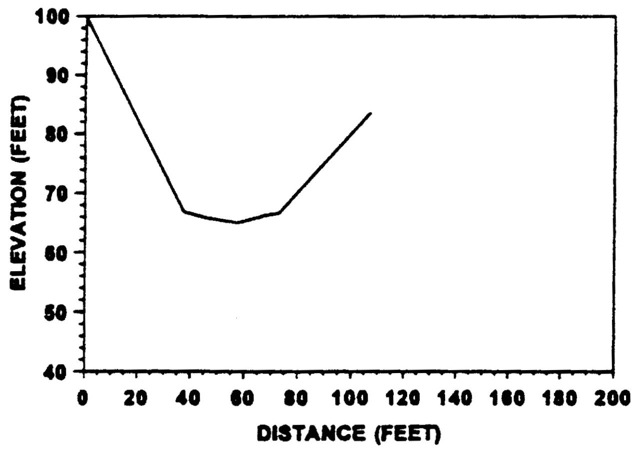
RAWHIDE CREEK, 07E0

CROSS SECTION 0+00.00



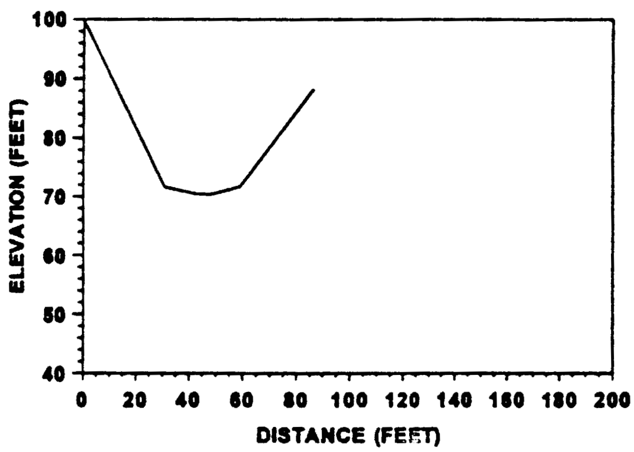
RAWHIDE CREEK, 07E0

CROSS SECTION 3+82.00

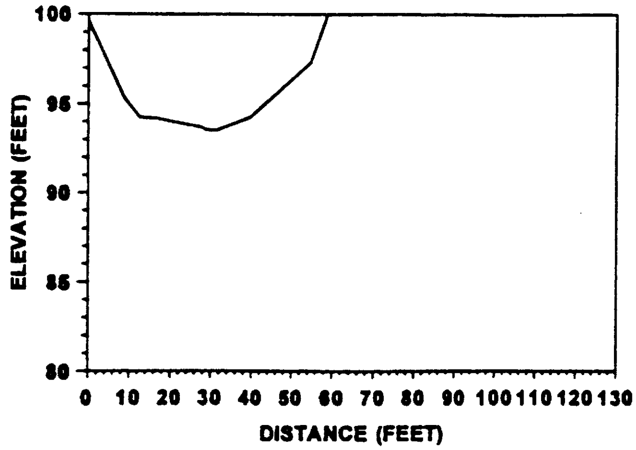


RAWHIDE CREEK, 07E0

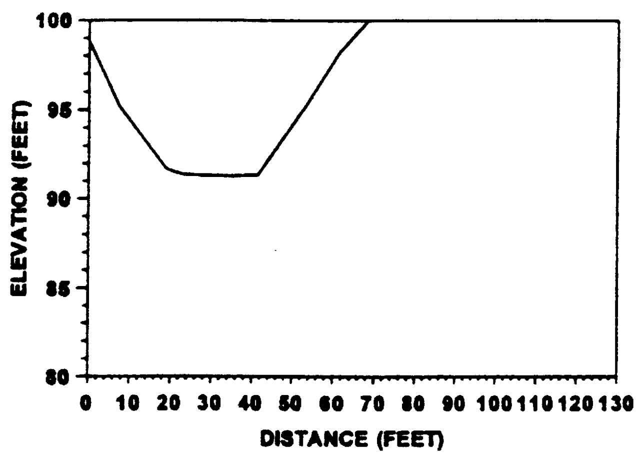
CROSS SECTION 5+86.00



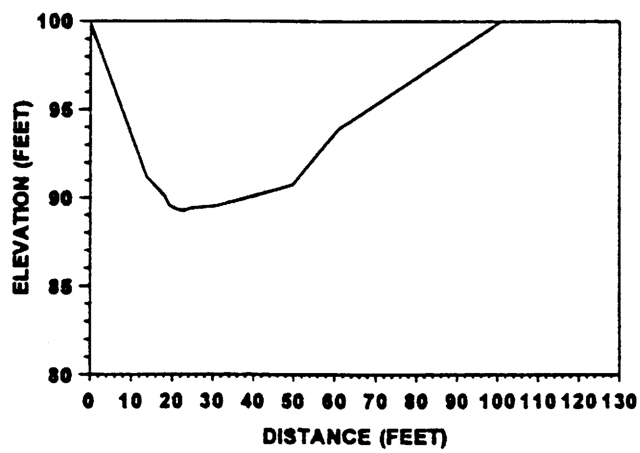
LONE TREE PRONG, 12B0
CROSS SECTION 0+00.00



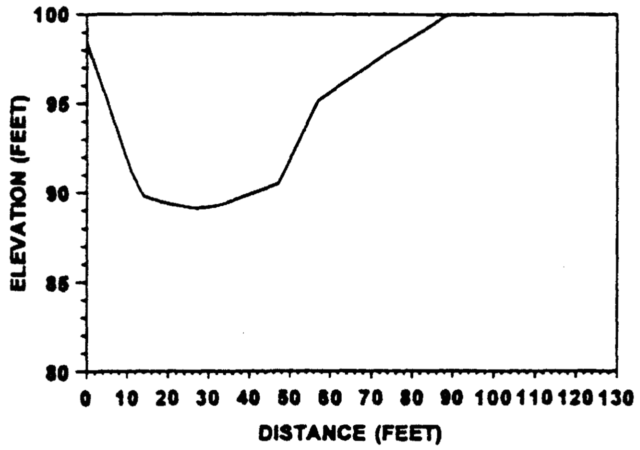
LONE TREE PRONG, 12B0
CROSS SECTION 3+21.00



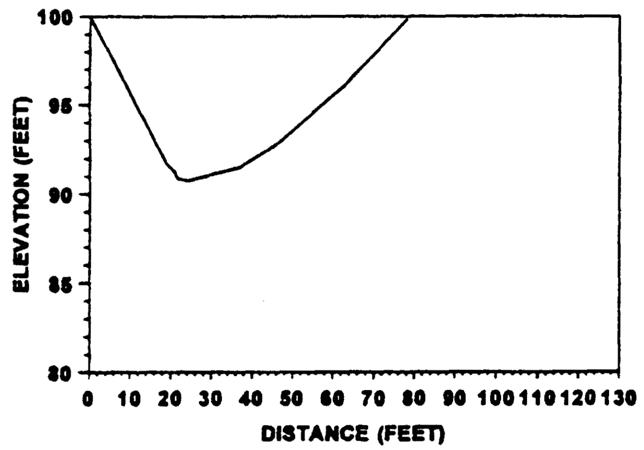
LONE TREE PRONG, 12B0
CROSS SECTION 6+41.00



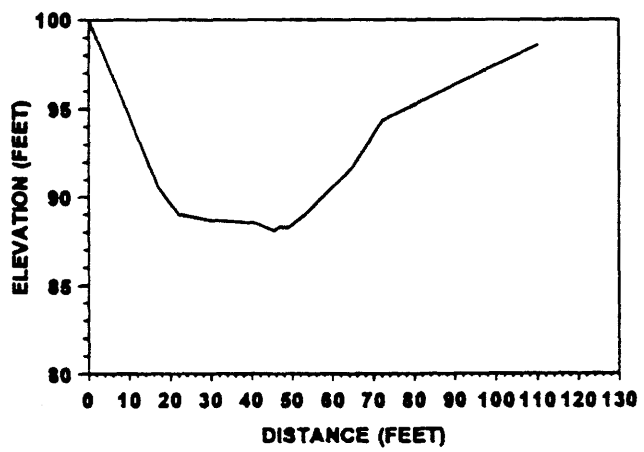
SHEARING PEN DRAW, 16C0
CROSS SECTION 0+00.00



SHEARING PEN DRAW, 16C0
CROSS SECTION 3+20.00

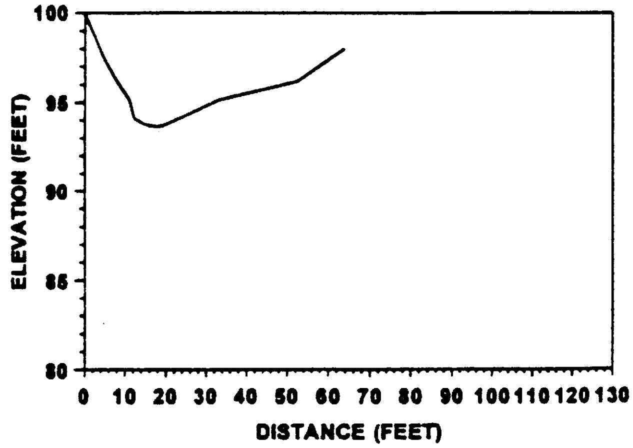


SHEARING PEN DRAW, 16C0
CROSS SECTION 8+40.00



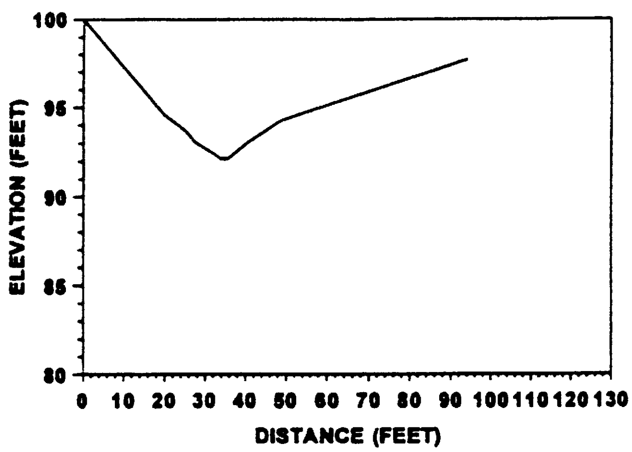
SHEARING PEN DRAW, 16C0

CROSS SECTION 31+69.00



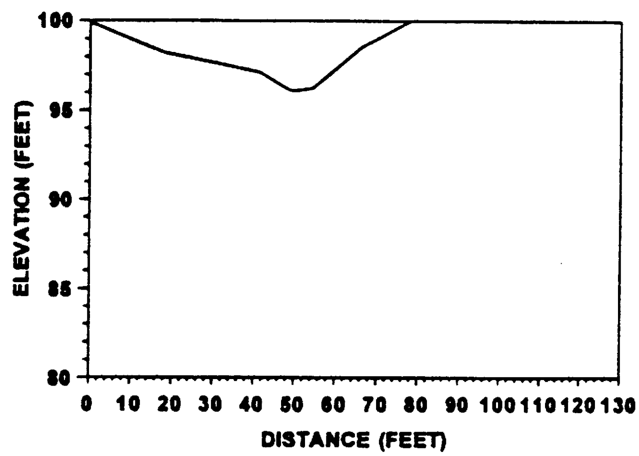
SHEARING PEN DRAW, 16C0

CROSS SECTION 32+94.00



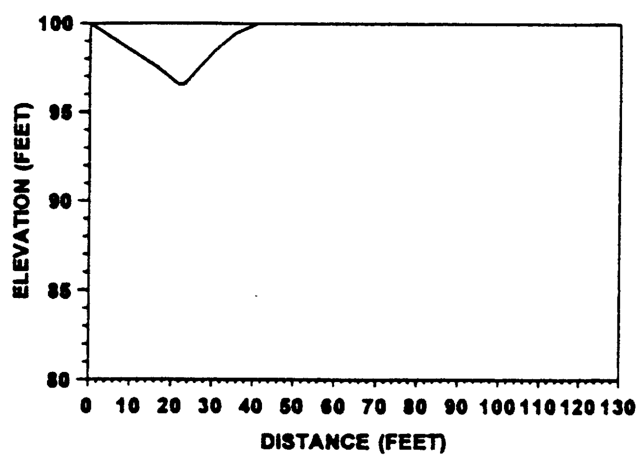
SHEARING PEN DRAW, 16D0

CROSS SECTION 0+00.00



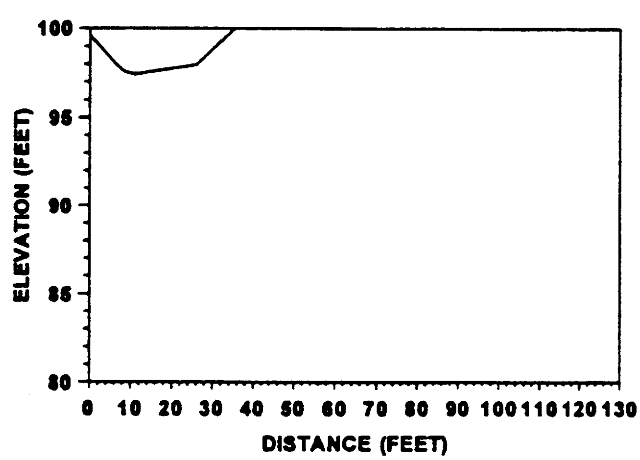
SHEARING PEN DRAW, 16D0

CROSS SECTION 1+64.20



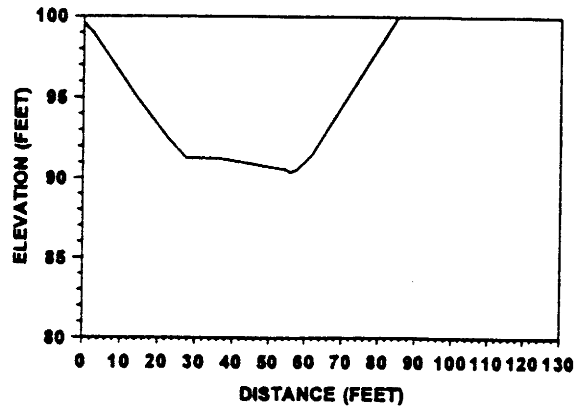
SHEARING PEN DRAW, 16D0

CROSS SECTION 2+70.80



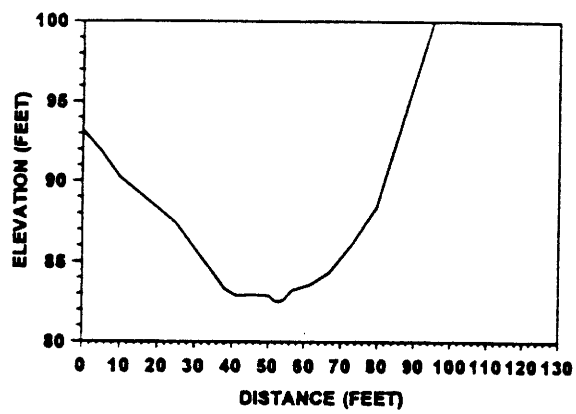
THIELEN DRAW, 22B0

CROSS SECTION 0+00.00



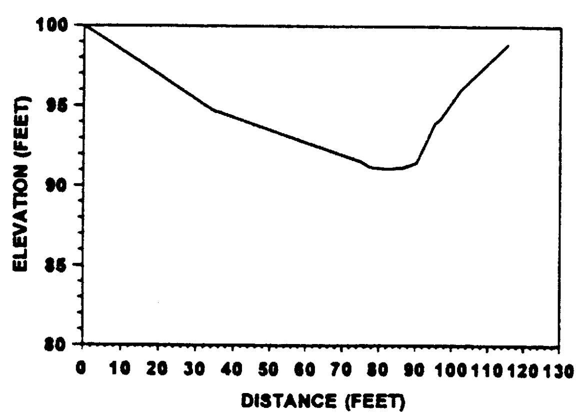
THIELEN DRAW, 22B0

CROSS SECTION 3+29.00



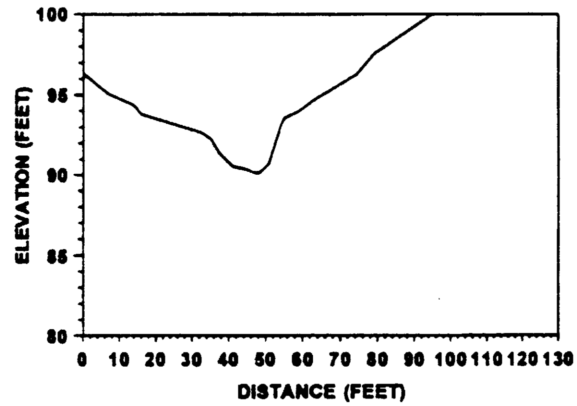
THIELEN DRAW, 22B0

CROSS SECTION 5+29.00



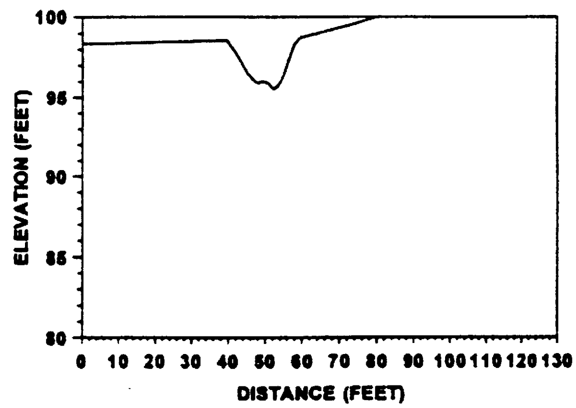
THIELEN DRAW, 22C0

CROSS SECTION 0+00.00



THIELEN DRAW, 22C0

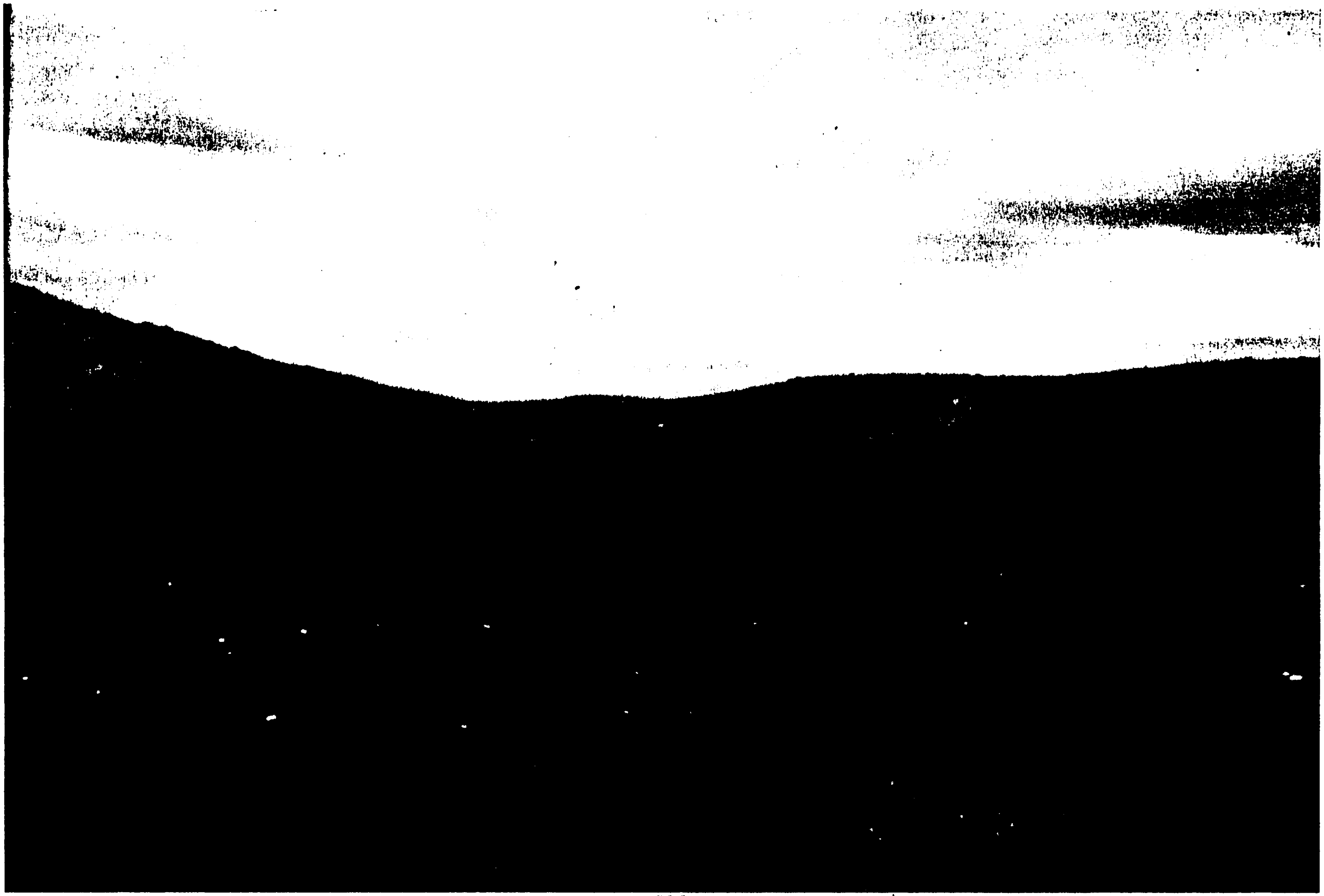
CROSS SECTION 0+35.50



Strata "C" second order raw data by study reach, cross section, and bank identification.

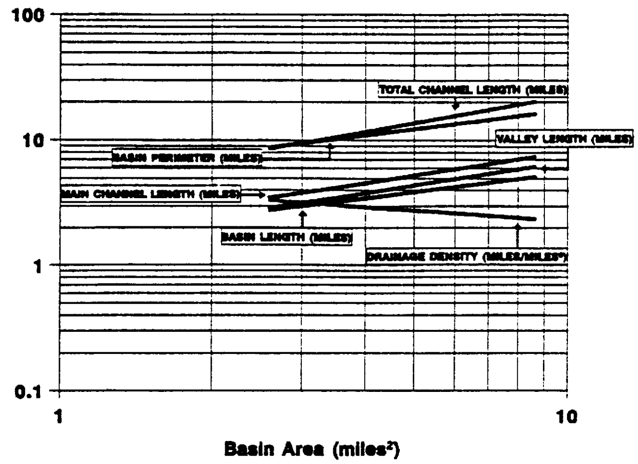
BASIN I.D.	CROSS SECTION NUMBER	BANK I.D.	AREA (feet²)	TOP WIDTH (feet)	AVERAGE DEPTH (feet)	BED WIDTH (feet)
05B0	0+00.00	HIGH	2846.30	173.10	16.40	103.70
05B0	6+65.00	HIGH	5590.00	248.10	22.50	144.10
05B0	14+83.25	HIGH	8226.80	311.30	26.80	190.40
07D0	0+00.00	HIGH	826.90	69.80	11.80	22.00
07D0	1+03.50	HIGH	906.70	74.30	12.20	11.90
07D0	11+14.95	HIGH	1272.60	86.70	14.70	11.30
07E0	0+00.00	HIGH	1739.50	96.50	18.00	40.80
07E0	2+20.00	HIGH	1725.90	100.50	17.20	32.60
07E0	5+78.70	HIGH	3605.40	156.50	23.00	85.70
07E0	0+00.00	HIGH	819.30	75.30	10.90	22.60
07E0	3+82.00	HIGH	1066.00	88.30	12.10	35.30
07E0	5+86.00	HIGH	865.40	73.60	11.80	27.10
12B0	0+00.00	HIGH	254.70	58.20	4.40	27.10
12B0	3+21.00	HIGH	329.90	64.10	5.10	17.90
12B0	6+41.00	HIGH	621.40	100.20	6.20	12.00
16C0	0+00.00	HIGH	449.70	78.30	5.70	24.40
16C0	3+20.00	HIGH	422.60	77.70	5.40	11.20
16C0	8+40.00	HIGH	629.10	107.50	5.90	31.00
16C0	31+69.00	HIGH	149.80	60.00	2.50	
16C0	32+94.00	HIGH	223.80	85.50	2.60	
22B0	0+00.00	HIGH	506.70	84.10	6.00	24.00
22B0	3+29.00	HIGH	596.20	94.40	6.30	19.80
22B0	5+29.00	HIGH	486.30	108.20	4.50	
22C0	0+00.00	HIGH	213.90	74.50	2.90	

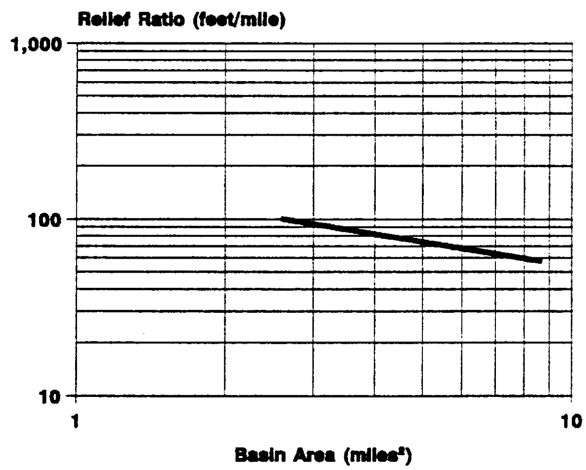
BASIN I.D.	CROSS SECTION NUMBER	BANK I.D.	AREA (feet²)	TOP WIDTH (feet)	AVERAGE DEPTH (feet)	BED WIDTH (feet)
16C0	8+40.00	MEDIUM	2.20	9.60	0.20	31.00
16C0	31+69.00	MEDIUM	20.00	22.00	0.90	
16C0	32+94.00	MEDIUM	6.70	13.00	0.50	
22B0	0+00.00	MEDIUM	2.00	10.10	0.20	24.00
22B0	3+29.00	MEDIUM	1.10	4.90	0.20	19.80
22B0	5+29.00	MEDIUM	4.70	15.30	0.30	
22C0	0+00.00	MEDIUM	25.80	17.70	1.50	
22C0	0+35.50	MEDIUM	33.80	18.90	1.80	
07D0	0+00.00	LOW	0.20	5.50	0.04	
07D0	1+03.50	LOW	0.80	6.80	0.10	
07E0	0+00.00	LOW	5.60	11.23	0.50	
07E0	3+82.00	LOW	1.70	9.00	0.20	
07E0	5+78.70	LOW	0.80	8.30	0.10	
07E0	5+86.00	LOW	0.40	6.30	0.10	
12B0	0+00.00	LOW	0.70	5.70	0.10	
12B0	6+41.00	LOW	0.40	4.40	0.10	
16C0	0+00.00	LOW	1.60	13.20	0.10	
16C0	3+20.00	LOW	0.30	4.10	0.10	
16C0	8+40.00	LOW	0.10	2.10	0.10	
16C0	31+69.00	LOW	0.30	5.00	0.10	
16C0	32+94.00	LOW	0.60	4.00	0.10	
22B0	0+00.00	LOW	0.30	3.00	0.10	
22B0	3+29.00	LOW	0.20	2.60	0.10	
22B0	5+29.00	LOW	0.30	8.40	0.04	
22C0	0+00.00	LOW	1.80	9.00	0.20	
22C0	0+35.50	LOW	5.10	9.70	0.50	

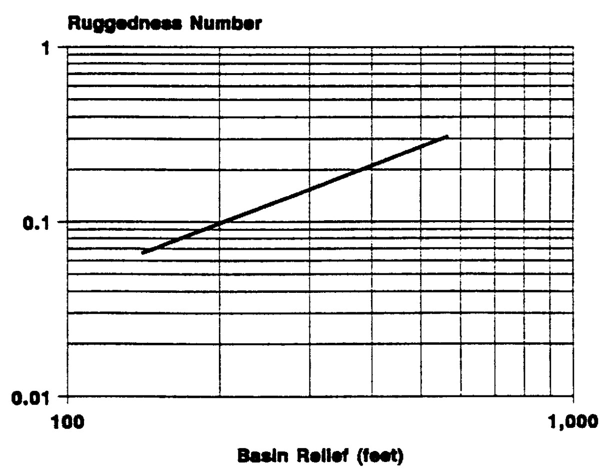


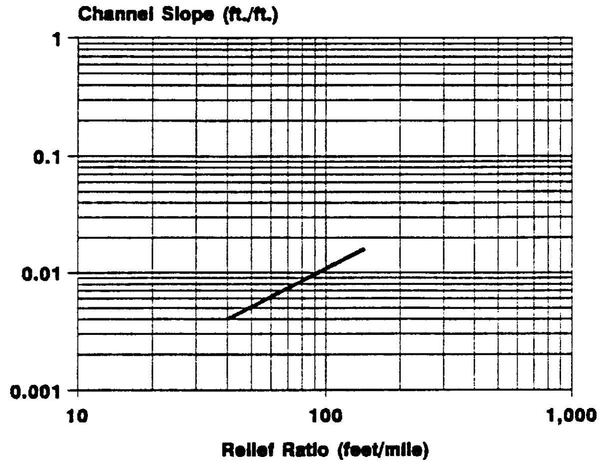
APPENDIX C-3

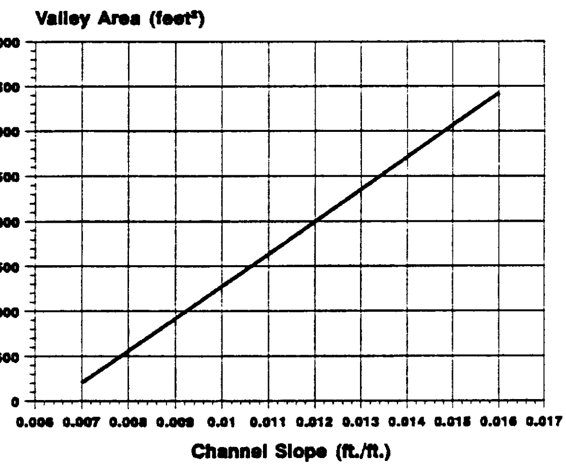
STRATA "C" - THIRD ORDER

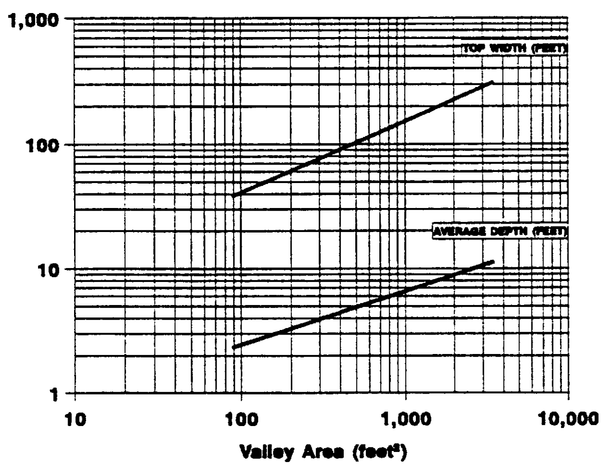

100
10
1
0.1
1
10
TOTAL CHANNEL LENGTH (MILES)
VALLEY LENGTH (MILES)
BASIN PERIMETER (MILES)
MAIN CHANNEL LENGTH (MILES)
BASIN LENGTH (MILES)
DRAINAGE DENSITY (MILES/MILES²)
Basin Area (miles²)

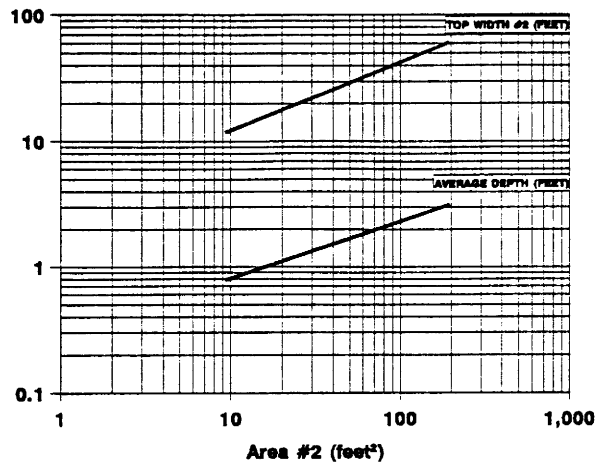

Relief Ratio (feet/mile)
1,000
100
10
1
10
Basin Area (miles²)

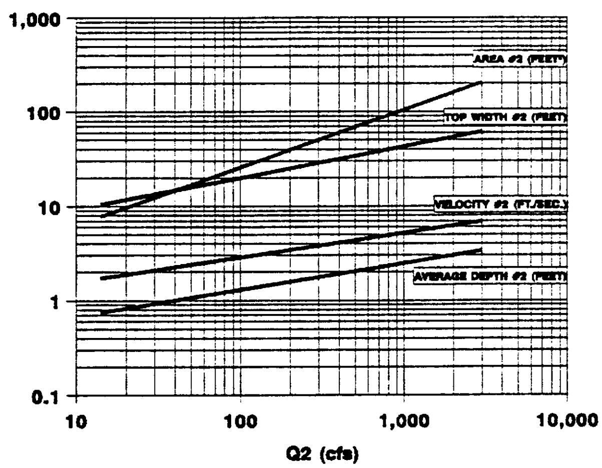

Ruggedness Number
1
0.1
0.01
100
1,000
Basin Relief (feet)

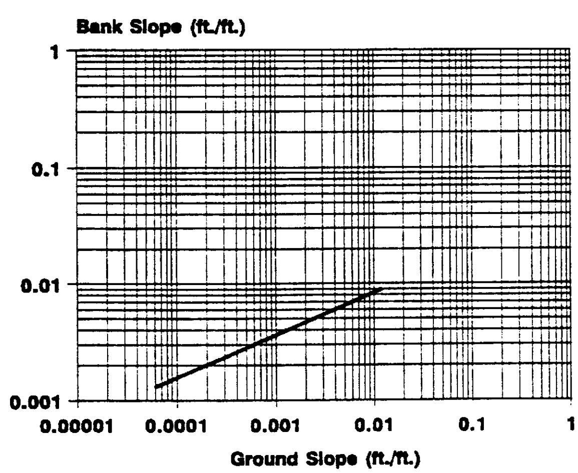

Channel Slope (ft./ft.)
1
0.1
0.01
0.001
10
100
1,000
Relief Ratio (feet/mile)

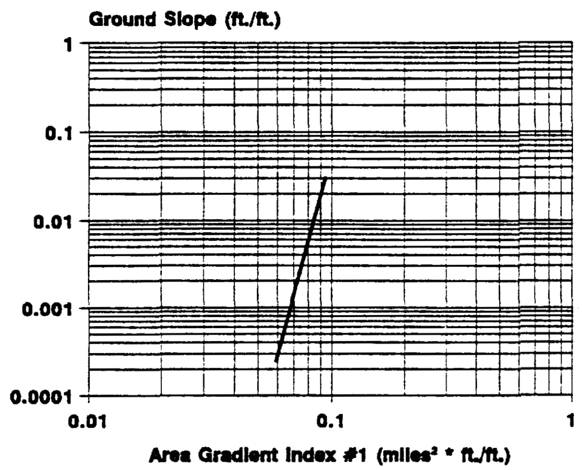

Valley Area (feet²)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0.006 0.007 0.008 0.009 0.01 0.011 0.012 0.013 0.014 0.015 0.016 0.017
Channel Slope (ft./ft.)


1,000
100
10
1
TOP WIDTH (FEET)
AVERAGE DEPTH (FEET)
10
100
1,000
10,000
Valley Area (feet²)

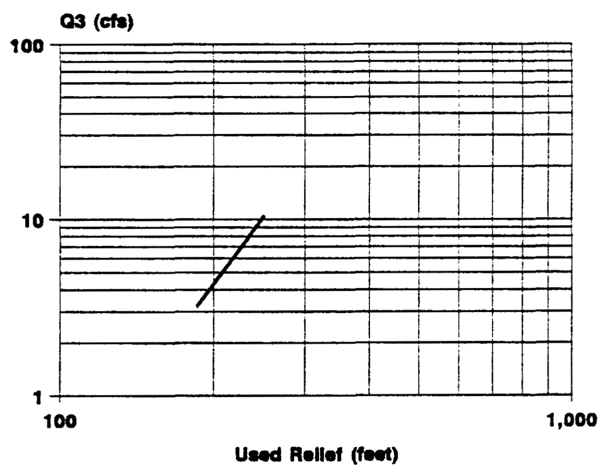

100
10
1
0.1
TOP WIDTH #2 (FEET)
AVERAGE DEPTH (FEET)
1
10
100
1,000
Area #2 (feet²)


1,000
100
10
1
0.1
AREA #2 (FEET²)
TOP WIDTH #2 (FEET)
VELOCITY #2 (FT./SEC.)
AVERAGE DEPTH #2 (FEET)
10
100
1,000
10,000
Q2 (cfs)

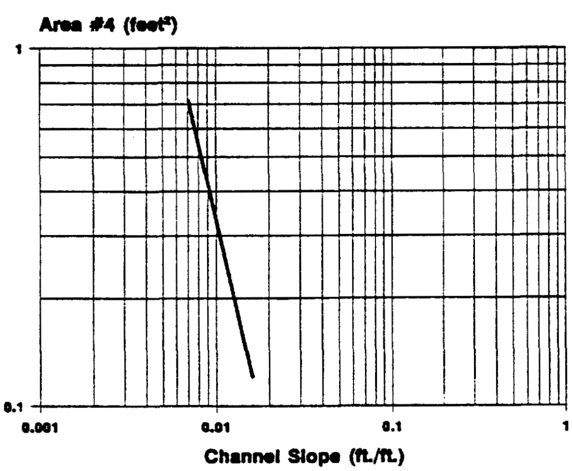

Bank Slope (ft./ft.)
1
0.1
0.01
0.001
0.00001
0.0001
0.001
0.01
0.1
1
Ground Slope (ft./ft.)



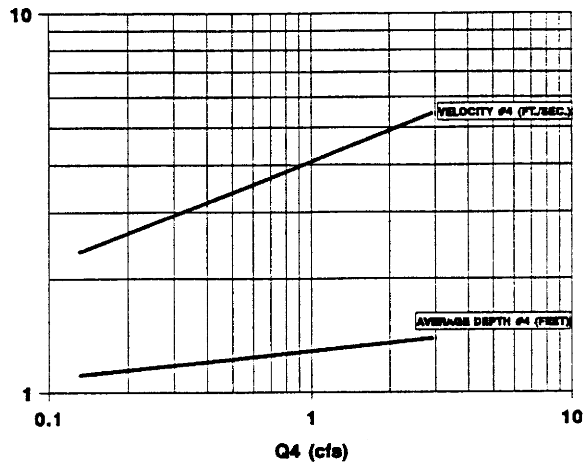
Ground Slope (ft./ft.)
1
0.1
0.01
0.001
0.0001
0.01
0.1
1
Area Gradient Index #1 (miles² * ft./ft.)

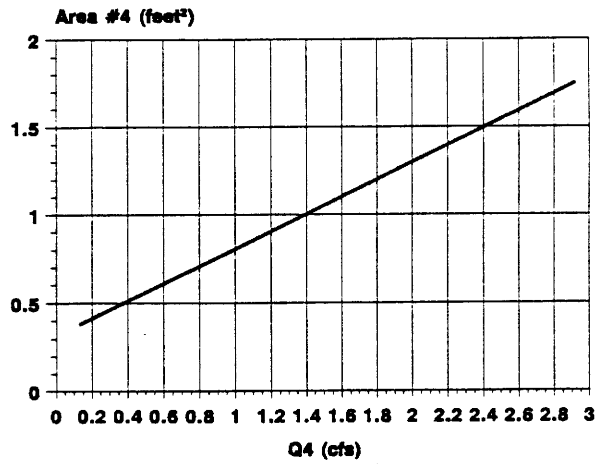


Q3 (cfs)
100
10
1
100
1,000
Used Relief (feet)



Area #4 (feet²)
1
0.1
0.001
0.01
0.1
1
Channel Slope (ft./ft.)


10
1
0.1
1
10
VELOCITY #4 (FT./SEC.)
AVERAGE DEPTH #4 (FEET)
Q4 (cfs)


Area #4 (feet²)
2
1.5
1
0.5
0
0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2 2.2 2.4 2.6 2.8 3
Q4 (cfs)

Strata "C" third order regression output for basin perimeter versus basin area.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BASIN PERIMETER

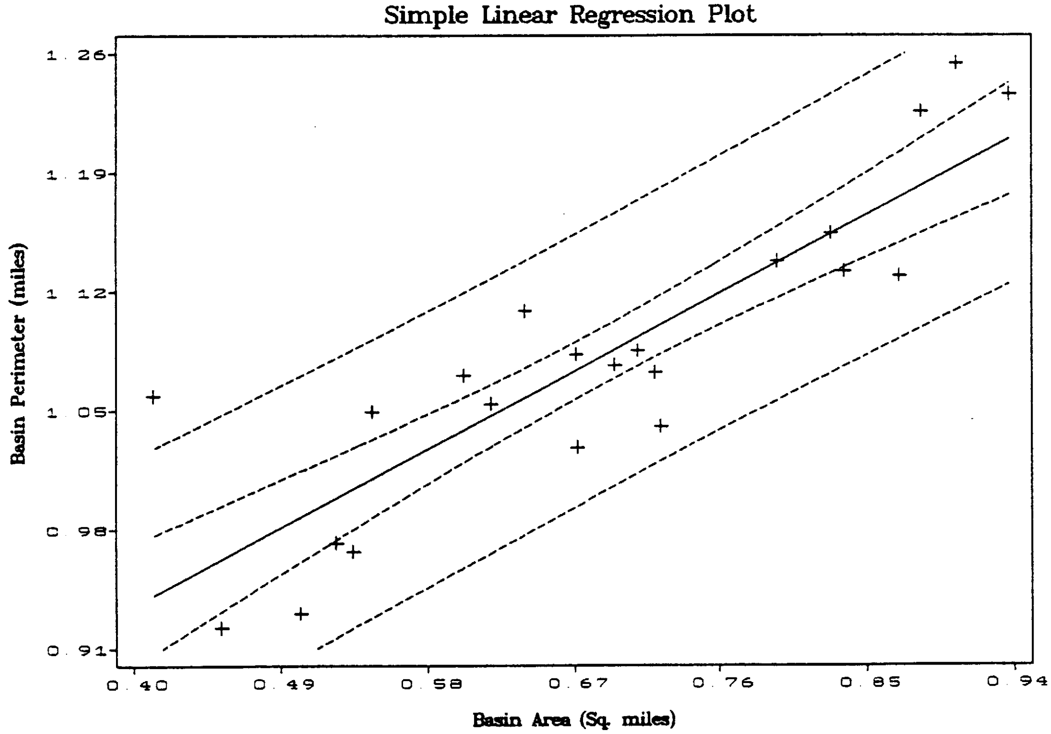
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.73149	0.04573	16.00	0.0000
BA	0.51022	0.06520	7.83	0.0000

R-SQUARED	0.7538	RESID. MEAN SQUARE (MSE)	0.00207
ADJUSTED R-SQUARED	0.7415	STANDARD DEVIATION	0.04553

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.12695	0.12695	61.24	0.0000
RESIDUAL	20	0.04146	0.00207		
TOTAL	21	0.16842			

CASES INCLUDED 22   MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "C" third order regression output for drainage density versus basin area.

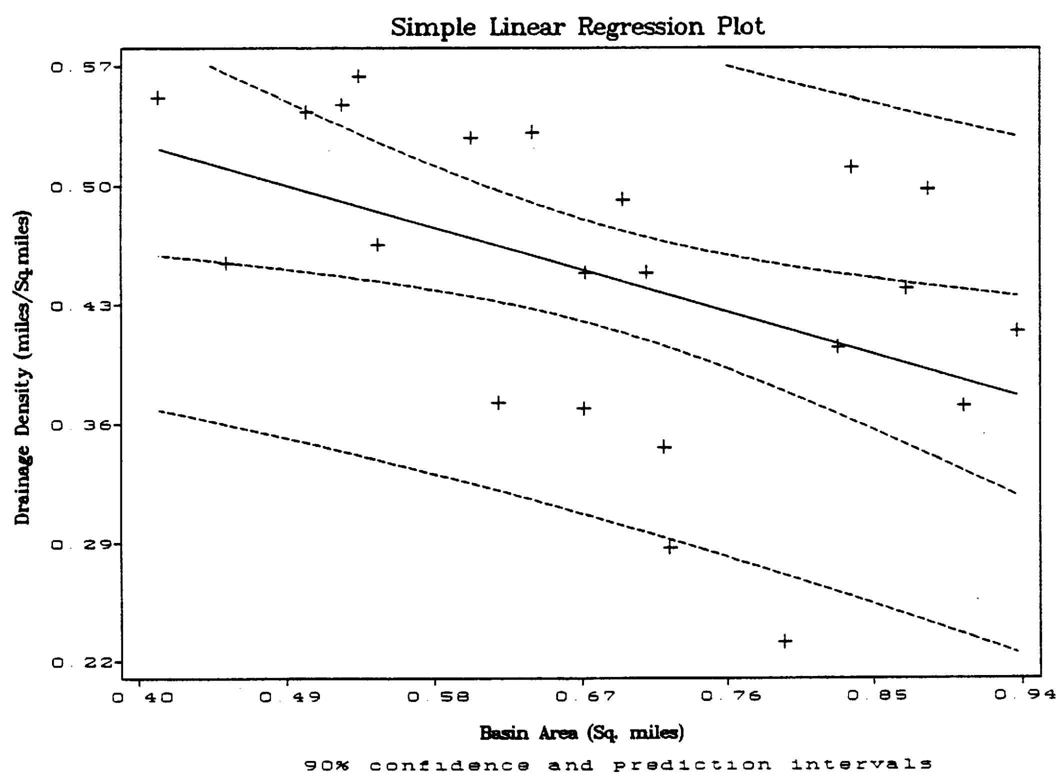
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF DRAINAGE DENSITY

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.63489	0.08158	7.78	0.0000
BA	-0.27539	0.11633	-2.37	0.0281

R-SQUARED	0.2189	RESID. MEAN SQUARE (MSE)	0.00660
ADJUSTED R-SQUARED	0.1798	STANDARD DEVIATION	0.08123

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.03698	0.03698	5.60	0.0281
RESIDUAL	20	0.13198	0.00660		
TOTAL	21	0.16896			

CASES INCLUDED 22 MISSING CASES 0



Strata "C" third order regression output for basin length versus basin area.

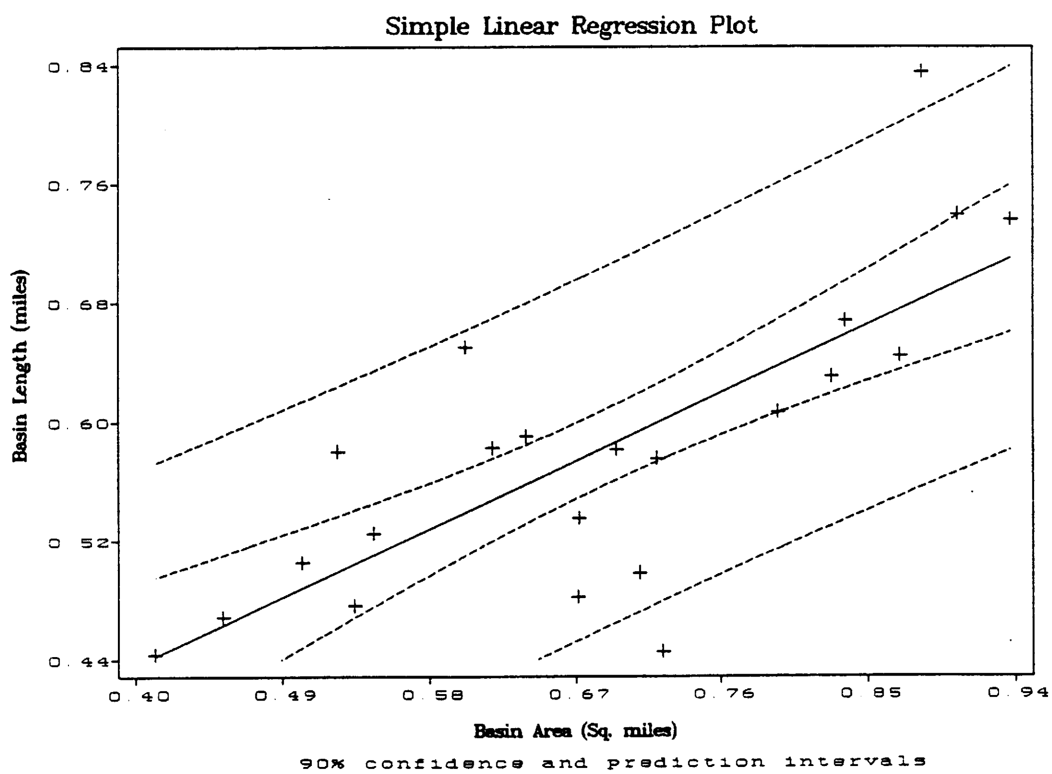
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BASIN LENGTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.23246	0.06927	3.36	0.0031
BA	0.50957	0.09876	5.16	0.0000

R-SQUARED	0.5710	RESID. MEAN SQUARE (MSE)	0.00476
ADJUSTED R-SQUARED	0.5496	STANDARD DEVIATION	0.06897

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.12663	0.12663	26.62	0.0000
RESIDUAL	20	0.09514	0.00476		
TOTAL	21	0.22177			

CASES INCLUDED 22 MISSING CASES 0



Strata "C" third order regression output for number of first orders versus total channel length and channel slope.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF NUMBER OF FIRST ORDERS

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	1.00231	0.26244	3.82	0.0012
TCHL	1.21361	0.16801	7.22	0.0000
CHS	0.64087	0.14491	4.42	0.0003

R-SQUARED	0.7355	RESID. MEAN SQUARE (MSE)	0.00802
ADJUSTED R-SQUARED	0.7076	STANDARD DEVIATION	0.08957

SOURCE	DF	SS	MS	F	P
REGRESSION	2	0.42381	0.21190	26.41	0.0000
RESIDUAL	19	0.15244	0.00802		
TOTAL	21	0.57625			

CASES INCLUDED 22 MISSING CASES 0

Strata "C" third order regression output for number of second orders versus total channel length and channel slope.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF SECONDS

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.54809	0.28199	1.94	0.0669
TCHL	0.73828	0.18053	4.09	0.0006
CHS	0.44787	0.15571	2.88	0.0097

R-SQUARED	0.4797	RESID. MEAN SQUARE (MSE)	0.00926
ADJUSTED R-SQUARED	0.4249	STANDARD DEVIATION	0.09625

SOURCE	DF	SS	MS	F	P
REGRESSION	2	0.16225	0.08113	8.76	0.0020
RESIDUAL	19	0.17600	0.00926		
TOTAL	21	0.33826			

CASES INCLUDED 22 MISSING CASES 0

Strata "C" third order regression output for total channel length versus basin area.

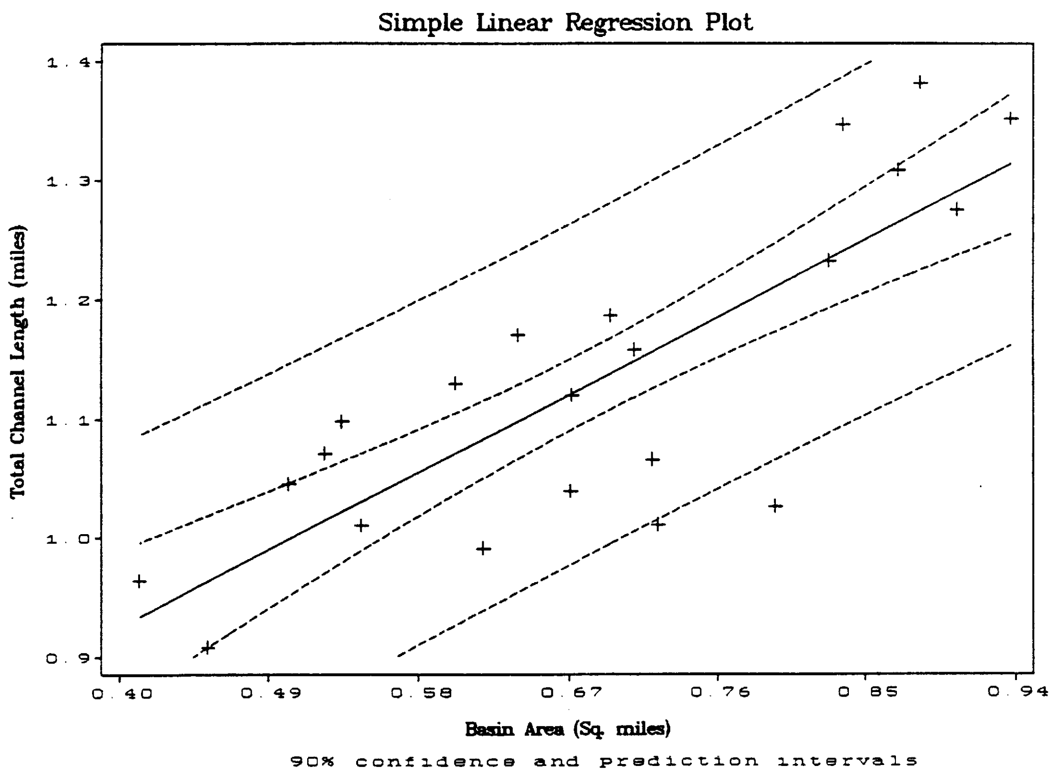
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOTAL CHANNEL LENGTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.63489	0.08158	7.78	0.0000
BA	0.72461	0.11633	6.23	0.0000

R-SQUARED	0.6599	RESID. MEAN SQUARE (MSE)	0.00660
ADJUSTED R-SQUARED	0.6429	STANDARD DEVIATION	0.08123

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.25606	0.25606	38.80	0.0000
RESIDUAL	20	0.13198	0.00660		
TOTAL	21	0.38804			

CASES INCLUDED 22   MISSING CASES 0



Strata "C" third order regression output for relief ratio versus basin area.

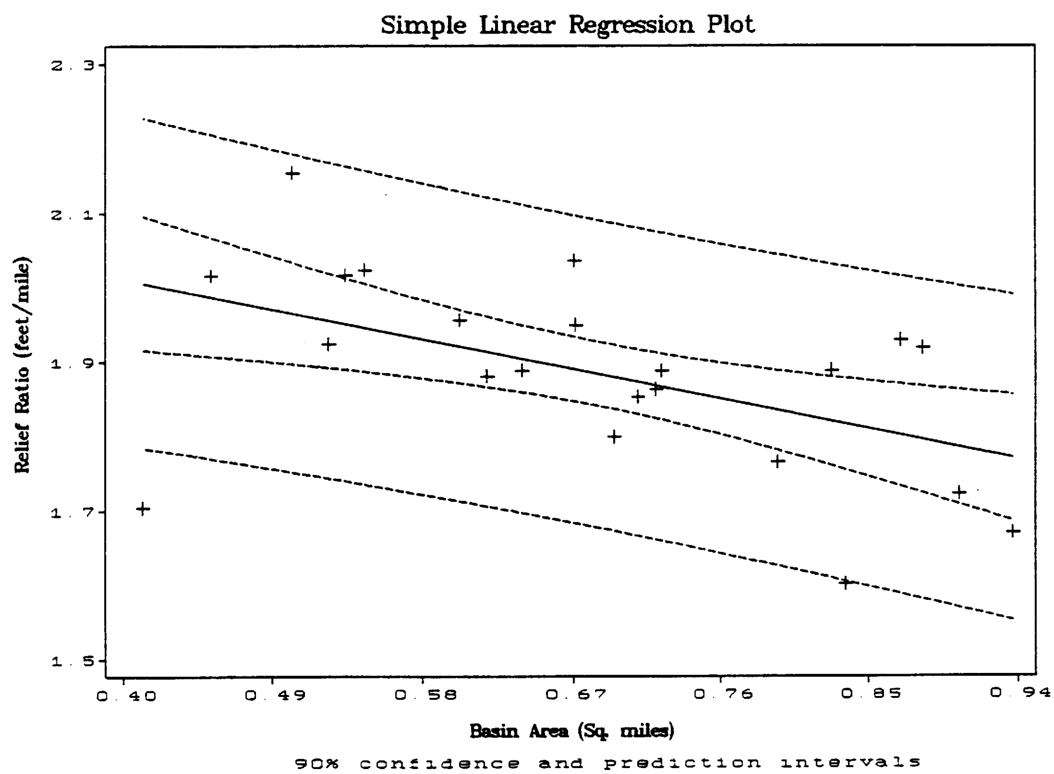
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RELIEF RATIO

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	2.18925	0.11787	18.57	0.0000
BA	-0.44569	0.16806	-2.65	0.0153

R-SQUARED	0.2602	RESID. MEAN SQUARE (MSE)	0.01377
ADJUSTED R-SQUARED	0.2232	STANDARD DEVIATION	0.11736

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.09687	0.09687	7.03	0.0153
RESIDUAL	20	0.27547	0.01377		
TOTAL	21	0.37234			

CASES INCLUDED 22   MISSING CASES 0



Strata "C" third order regression output for main channel length versus basin area.

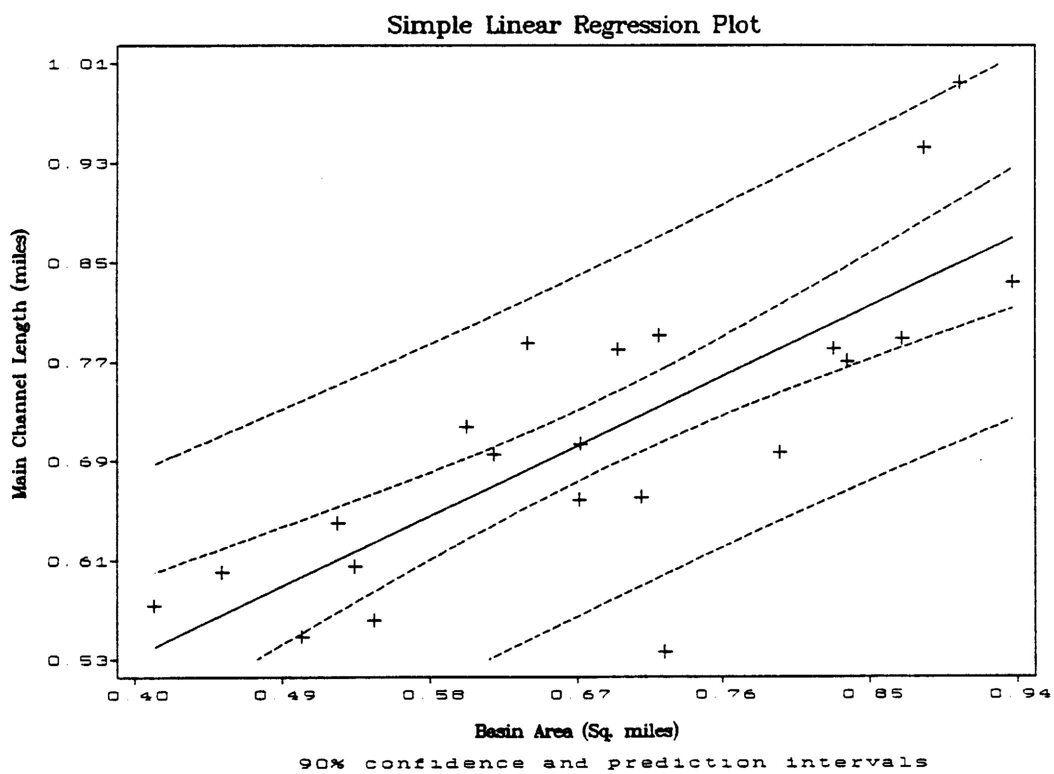
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF MAIN CHANNEL LENGTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.28208	0.07822	3.61	0.0018
BA	0.62711	0.11153	5.62	0.0000

R-SQUARED	0.6125	RESID. MEAN SQUARE (MSE)	0.00607
ADJUSTED R-SQUARED	0.5932	STANDARD DEVIATION	0.07788

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.19179	0.19179	31.62	0.0000
RESIDUAL	20	0.12131	0.00607		
TOTAL	21	0.31310			

CASES INCLUDED 22 MISSING CASES 0



Strata "C" third order regression output for valley length versus basin area.

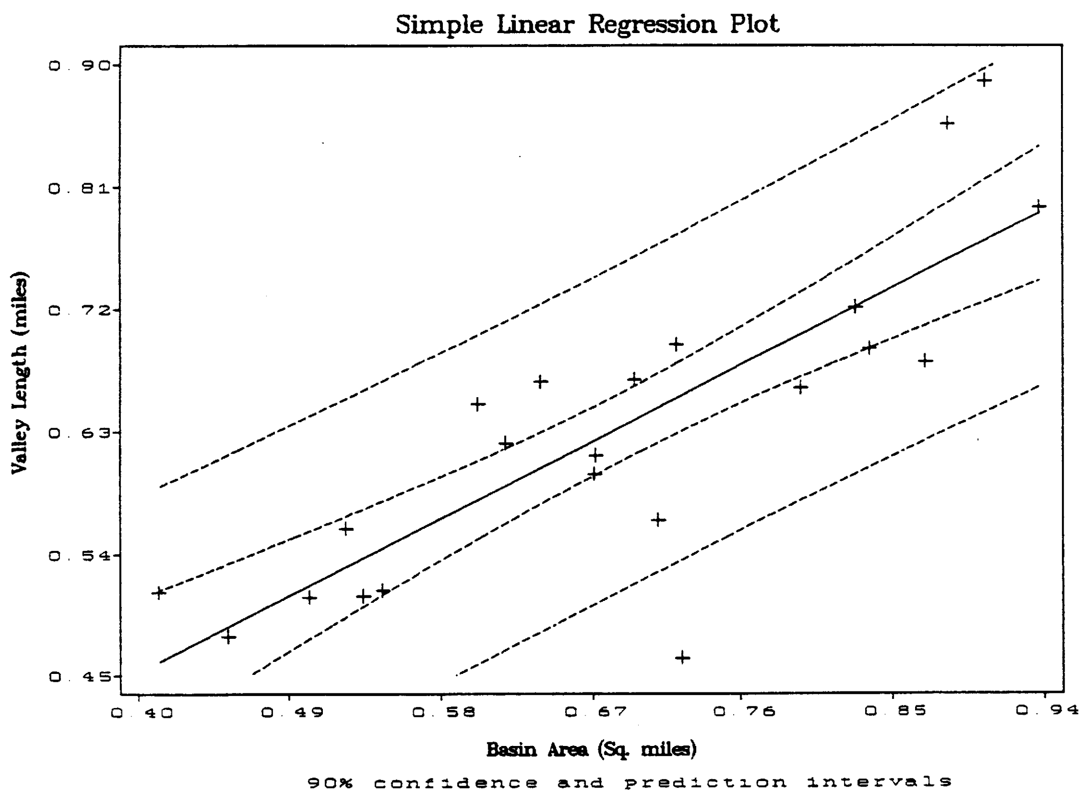
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF VALLEY LENGTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.20159	0.06860	2.94	0.0081
BA	0.62856	0.09782	6.43	0.0000

R-SQUARED	0.6737	RESID. MEAN SQUARE (MSE)	0.00467
ADJUSTED R-SQUARED	0.6574	STANDARD DEVIATION	0.06831

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.19267	0.19267	41.29	0.0000
RESIDUAL	20	0.09333	0.00467		
TOTAL	21	0.28600			

CASES INCLUDED 22 MISSING CASES 0



Strata "C" third order regression output of basin relief versus basin area and basin length.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BASIN RELIEF

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	2.20558	0.15106	14.60	0.0000
BA	-0.40991	0.26303	-1.56	0.1356
BL	0.92978	0.39005	2.38	0.0277

R-SQUARED	0.2345	RESID. MEAN SQUARE (MSE)	0.01447
ADJUSTED R-SQUARED	0.1539	STANDARD DEVIATION	0.12031

SOURCE	DF	SS	MS	F	P
REGRESSION	2	0.08423	0.04212	2.91	0.0790
RESIDUAL	19	0.27500	0.01447		
TOTAL	21	0.35923			

CASES INCLUDED 22 MISSING CASES 0

Strata "C" third order regression output for used relief versus basin area and channel slope.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF USED RELIEF

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	3.54286	0.23861	14.85	0.0000
BA	0.50226	0.14276	3.52	0.0023
CHS	0.81249	0.13804	5.89	0.0000

R-SQUARED	0.6466	RESID. MEAN SQUARE (MSE)	0.00582
ADJUSTED R-SQUARED	0.6095	STANDARD DEVIATION	0.07629

SOURCE	DF	SS	MS	F	P
REGRESSION	2	0.20236	0.10118	17.39	0.0001
RESIDUAL	19	0.11057	0.00582		
TOTAL	21	0.31293			

CASES INCLUDED 22 MISSING CASES 0

Strata "C" third order regression output for ruggedness number versus basin relief.

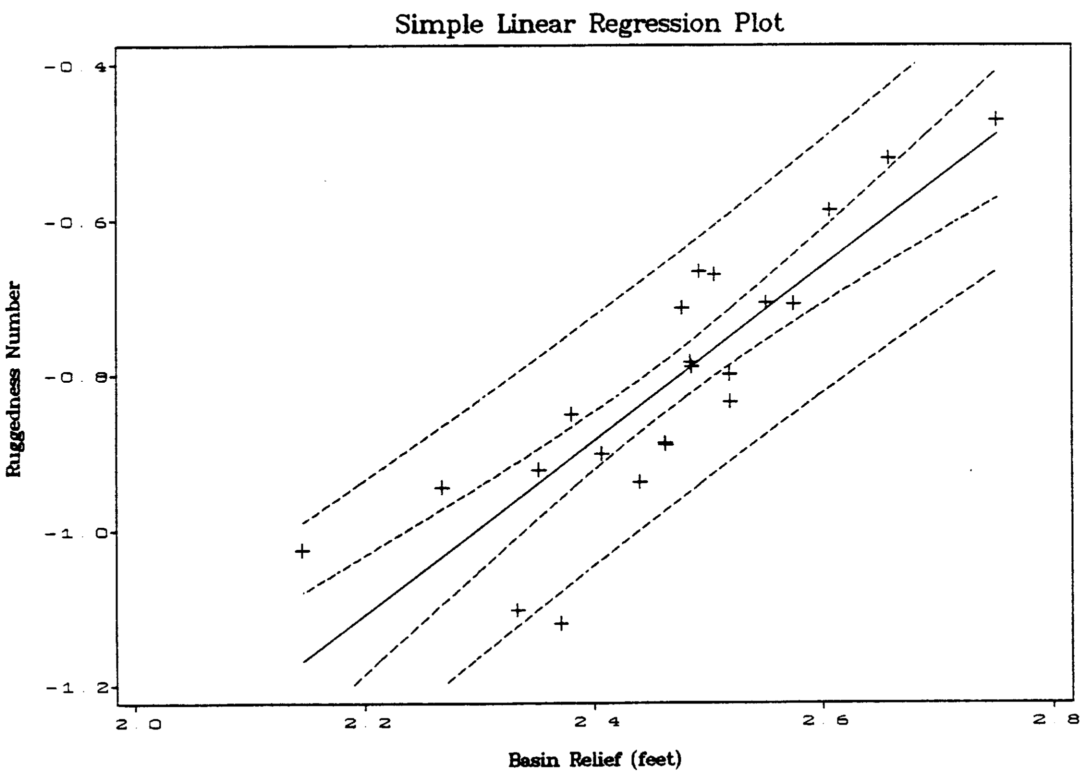
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF RUGGEDNESS NUMBER

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-3.57706	0.37257	-9.60	0.0000
BR	1.12191	0.15091	7.43	0.0000

R-SQUARED	0.7343	RESID. MEAN SQUARE (MSE)	0.00818
ADJUSTED R-SQUARED	0.7210	STANDARD DEVIATION	0.09045

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.45216	0.45216	55.27	0.0000
RESIDUAL	20	0.16363	0.00818		
TOTAL	21	0.61579			

CASES INCLUDED 22 MISSING CASES 0



90% confidence and prediction intervals

Strata "C" third order regression output for channel slope versus relief ratio.

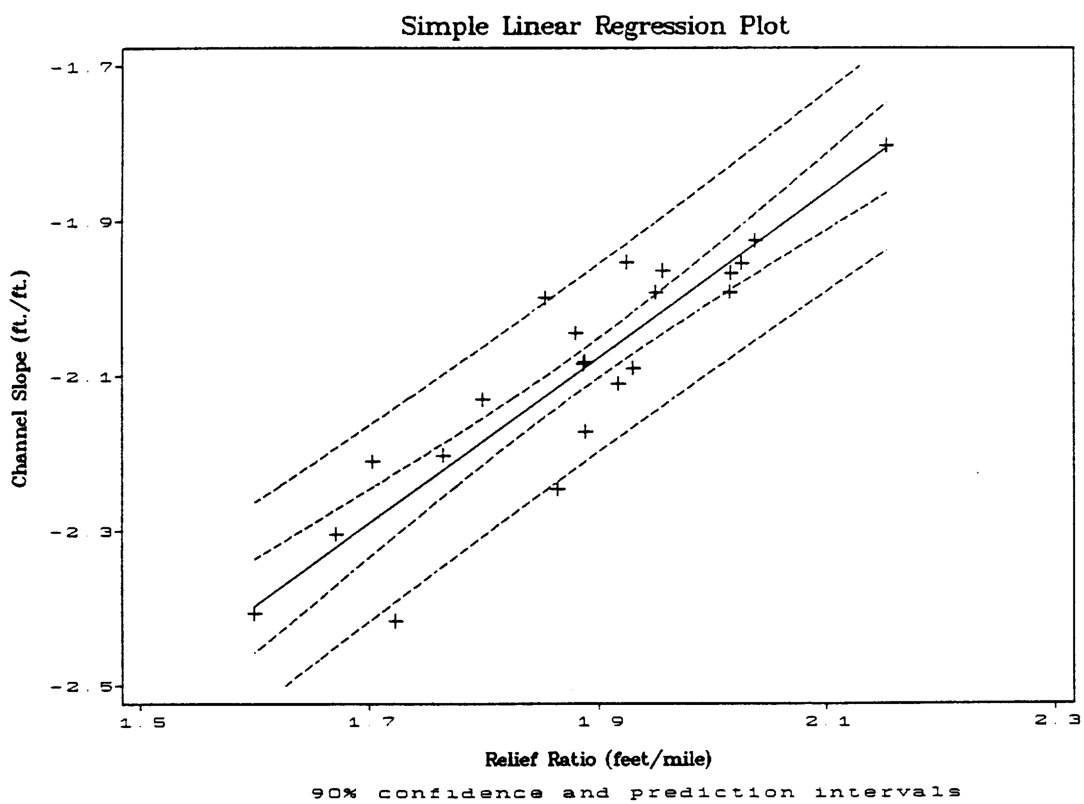
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF CHANNEL SLOPE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-4.10982	0.21327	-19.27	0.0000
RR	1.07041	0.11294	9.48	0.0000

R-SQUARED	0.8179	RESID. MEAN SQUARE (MSE)	0.00475
ADJUSTED R-SQUARED	0.8088	STANDARD DEVIATION	0.06892

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.42662	0.42662	89.82	0.0000
RESIDUAL	20	0.09500	0.00475		
TOTAL	21	0.52161			

CASES INCLUDED 22 MISSING CASES 0



Strata "C" third order regression output for valley area versus channel slope.

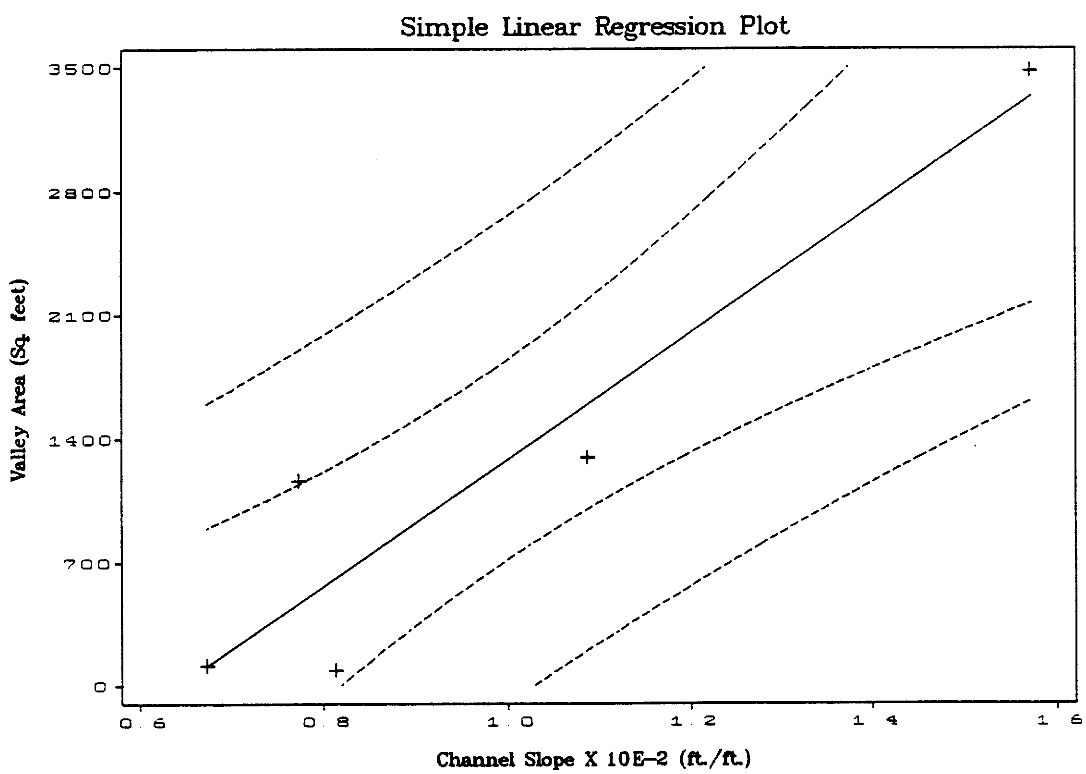
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF VALLEY AREA

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-2300.32	765.955	-3.00	0.0575
CHS	3.583E+05	73920.8	4.85	0.0168

R-SQUARED	0.8868	RESID. MEAN SQUARE (MSE)	2.879E+05
ADJUSTED R-SQUARED	0.8490	STANDARD DEVIATION	536.561

SOURCE	DF	SS	MS	F	P
REGRESSION	1	6.764E+06	6.764E+06	23.49	0.0168
RESIDUAL	3	8.637E+05	2.879E+05		
TOTAL	4	7.628E+06			

CASES INCLUDED 5 MISSING CASES 0



90% confidence and prediction intervals

Strata "C" third order regression output for top width versus valley area.

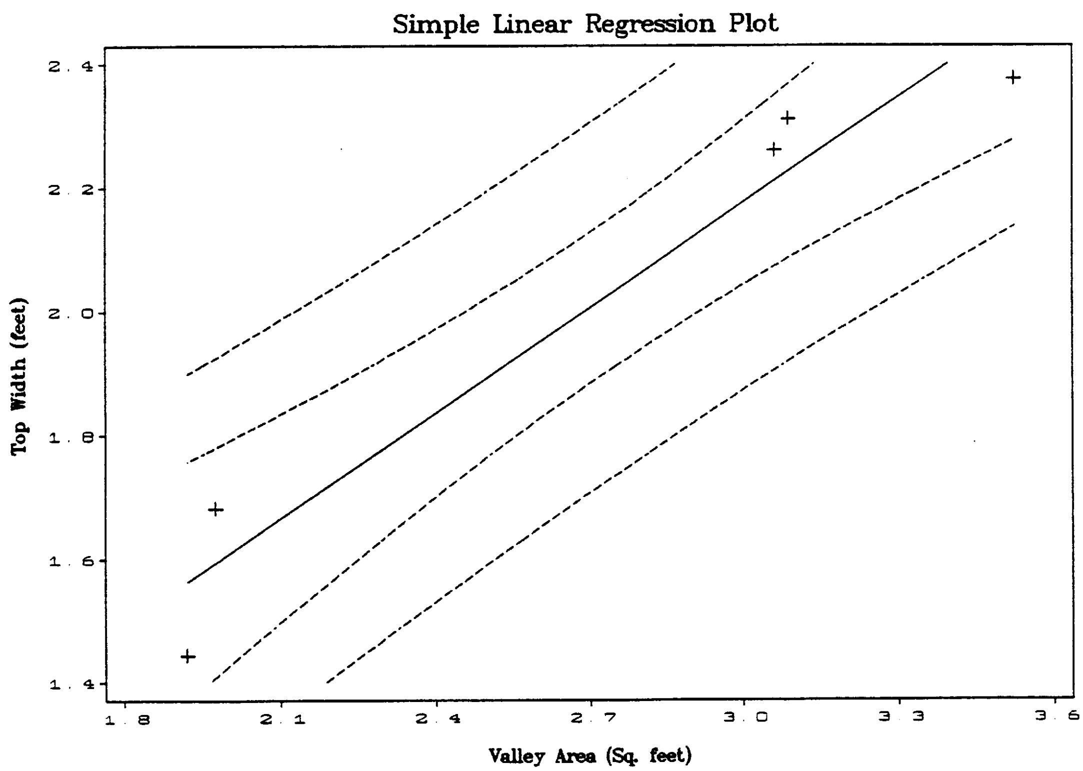
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOP WIDTH

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.47455	0.22359	2.12	0.1239
A	0.56715	0.08012	7.08	0.0058

R-SQUARED	0.9435	RESID. MEAN SQUARE (MSE)	0.01346
ADJUSTED R-SQUARED	0.9247	STANDARD DEVIATION	0.11600

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.67423	0.67423	50.10	0.0058
RESIDUAL	3	0.04037	0.01346		
TOTAL	4	0.71460			

CASES INCLUDED 5   MISSING CASES 0



90% confidence and prediction intervals

Strata "C" third order regression output for average depth versus valley area.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AVERAGE DEPTH

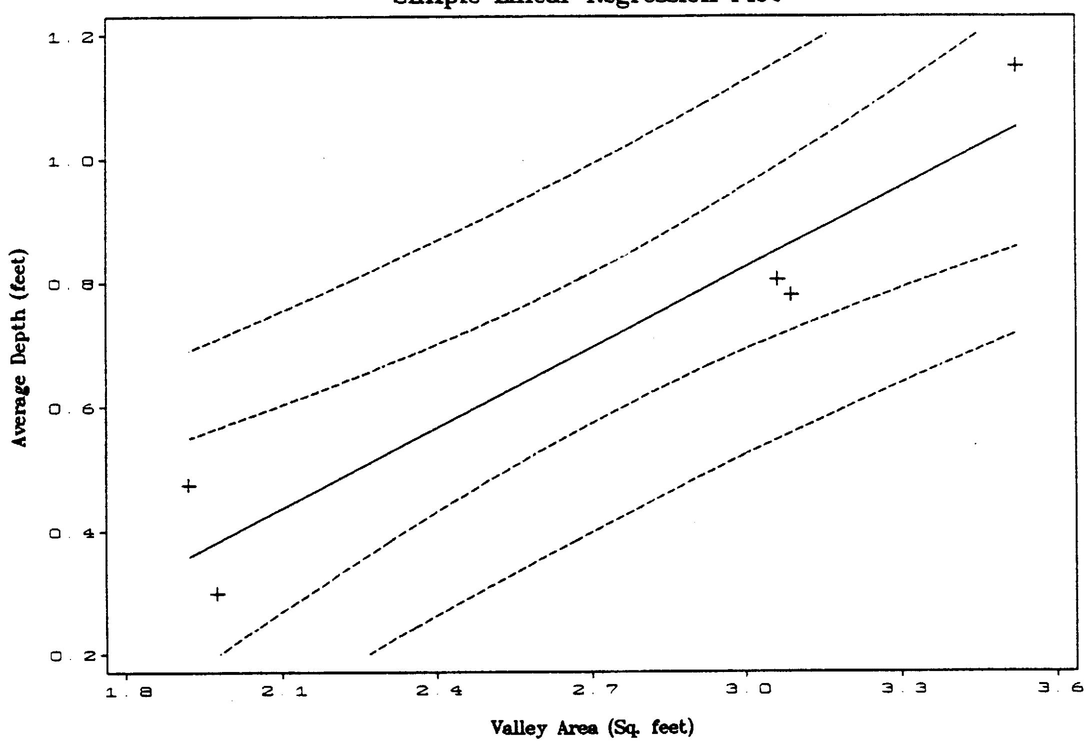
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.47217	0.22194	-2.13	0.1233
A	0.43208	0.07953	5.43	0.0122

R-SQUARED	0.9077	RESID. MEAN SQUARE (MSE)	0.01326
ADJUSTED R-SQUARED	0.8770	STANDARD DEVIATION	0.11515

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.39133	0.39133	29.51	0.0122
RESIDUAL	3	0.03978	0.01326		
TOTAL	4	0.43111			

CASES INCLUDED 5 MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "C" third order regression output for area #2 versus basin area and relief ratio.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AREA #2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-20.4609	3.79684	-5.39	0.0328
BA	4.53417	0.98157	4.62	0.0438
RR	9.50366	1.60889	5.91	0.0275

R-SQUARED	0.9464	RESID. MEAN SQUARE (MSE)	0.03419
ADJUSTED R-SQUARED	0.8927	STANDARD DEVIATION	0.18490

SOURCE	DF	SS	MS	F	P
REGRESSION	2	1.20647	0.60324	17.64	0.0536
RESIDUAL	2	0.06838	0.03419		
TOTAL	4	1.27485			

CASES INCLUDED 5 MISSING CASES 0

Strata "C" third order regression output for Q2 versus basin area and relief ratio.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF Q2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-34.5121	2.90737	-11.87	0.0070
BA	7.60039	0.75162	10.11	0.0096
RR	15.8567	1.23198	12.87	0.0060

R-SQUARED	0.9882	RESID. MEAN SQUARE (MSE)	0.02005
ADJUSTED R-SQUARED	0.9764	STANDARD DEVIATION	0.14158

SOURCE	DF	SS	MS	F	P
REGRESSION	2	3.35405	1.67702	83.66	0.0118
RESIDUAL	2	0.04009	0.02005		
TOTAL	4	3.39414			

CASES INCLUDED 5 MISSING CASES 0

Strata "C" third order regression output for area #2 versus Q2.

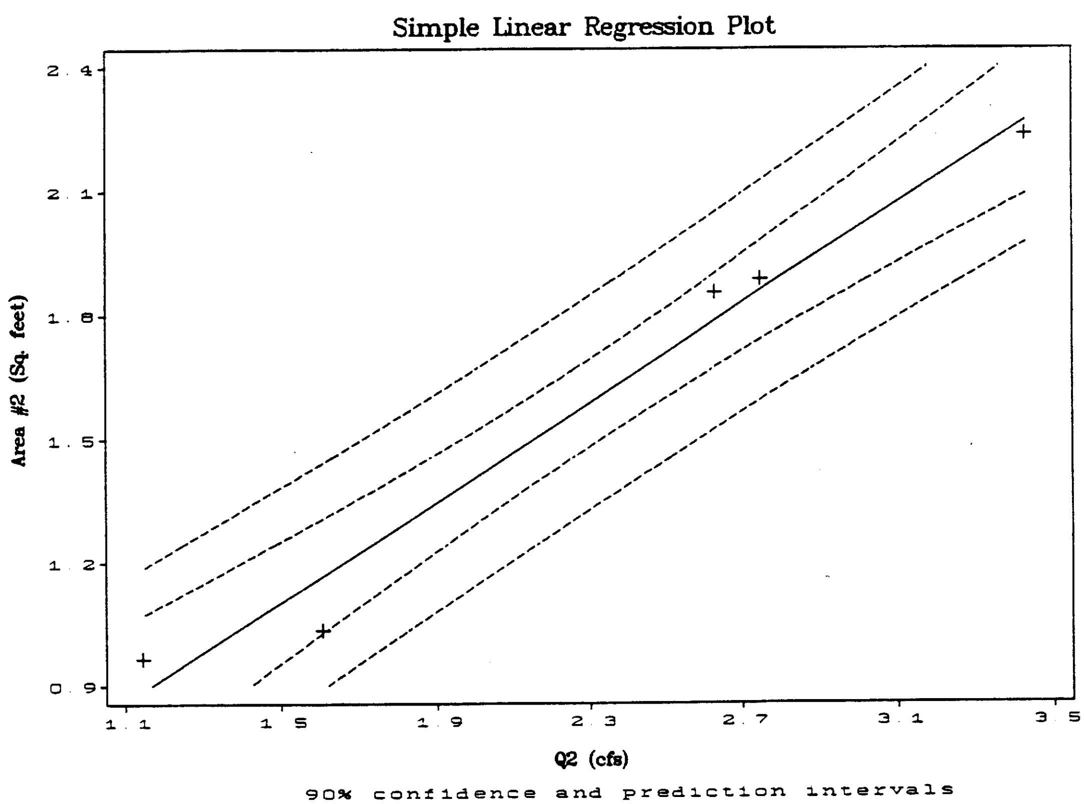
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AREA #2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.19396	0.13402	1.45	0.2436
Q2	0.60552	0.05460	11.09	0.0016

R-SQUARED	0.9762	RESID. MEAN SQUARE (MSE)	0.01012
ADJUSTED R-SQUARED	0.9682	STANDARD DEVIATION	0.10060

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.24449	1.24449	122.97	0.0016
RESIDUAL	3	0.03036	0.01012		
TOTAL	4	1.27485			

CASES INCLUDED 5 MISSING CASES 0



Strata "C" third order regression output for top width #2 versus area #2.

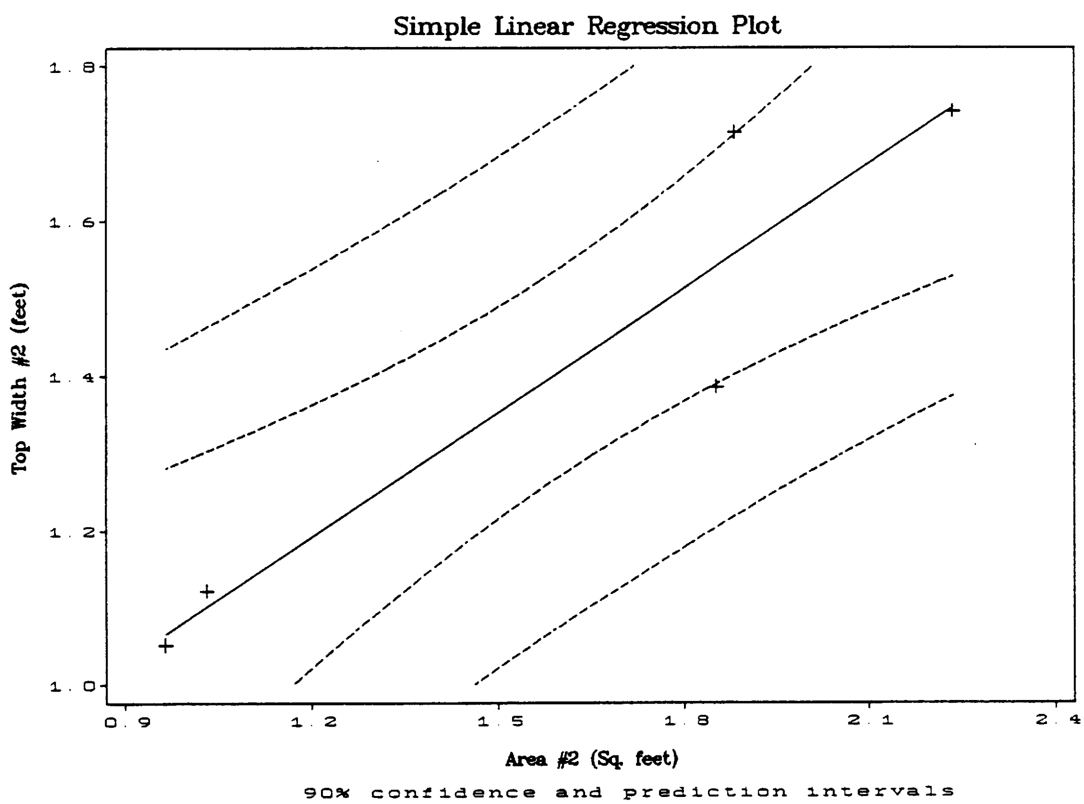
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOP WIDTH #2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.54946	0.18931	2.90	0.0624
A2	0.53517	0.11323	4.73	0.0179

R-SQUARED	0.8816	RESID. MEAN SQUARE (MSE)	0.01634
ADJUSTED R-SQUARED	0.8421	STANDARD DEVIATION	0.12784

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.36513	0.36513	22.34	0.0179
RESIDUAL	3	0.04903	0.01634		
TOTAL	4	0.41416			

CASES INCLUDED 5   MISSING CASES 0



Strata "C" third order regression output of top width #2 versus Q2.

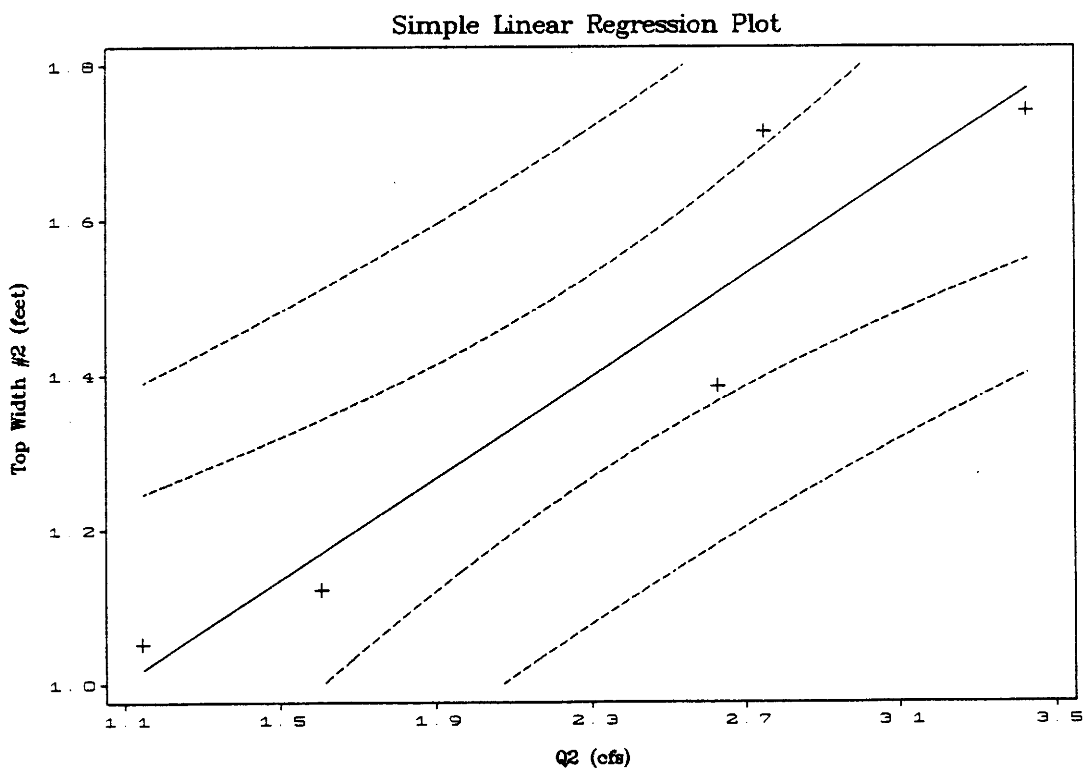
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOP WIDTH #2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.64157	0.16589	3.87	0.0306
Q2	0.32912	0.06759	4.87	0.0165

R-SQUARED	0.8877	RESID. MEAN SQUARE (MSE)	0.01551
ADJUSTED R-SQUARED	0.8502	STANDARD DEVIATION	0.12452

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.36765	0.36765	23.71	0.0165
RESIDUAL	3	0.04652	0.01551		
TOTAL	4	0.41416			

CASES INCLUDED 5 MISSING CASES 0



90% confidence and prediction intervals

Strata "B" third order regression output for average depth #2 versus area #2.

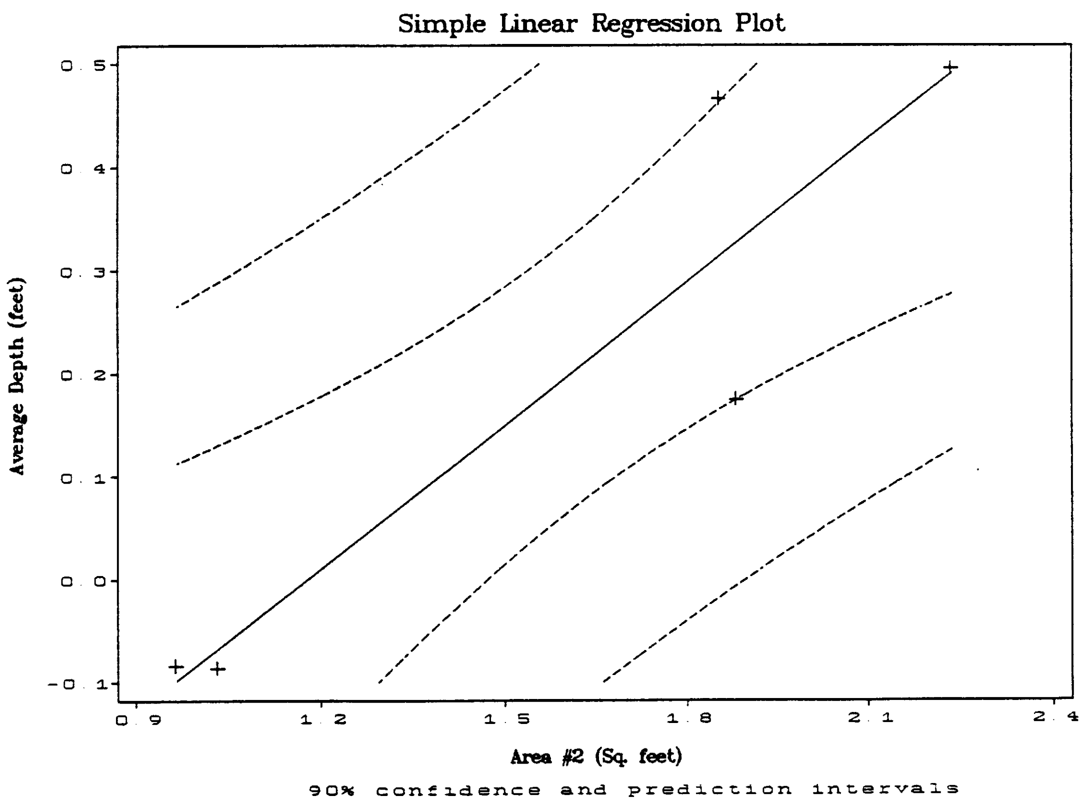
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AVERAGE DEPTH #2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.54626	0.18605	-2.94	0.0607
A2	0.46384	0.11128	4.17	0.0251

R-SQUARED	0.8528	RESID. MEAN SQUARE (MSE)	0.01579
ADJUSTED R-SQUARED	0.8037	STANDARD DEVIATION	0.12564

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.27428	0.27428	17.37	0.0251
RESIDUAL	3	0.04736	0.01579		
TOTAL	4	0.32164			

CASES INCLUDED 5 MISSING CASES 0



Strata "C" third order regression output for average depth #2 versus Q2.

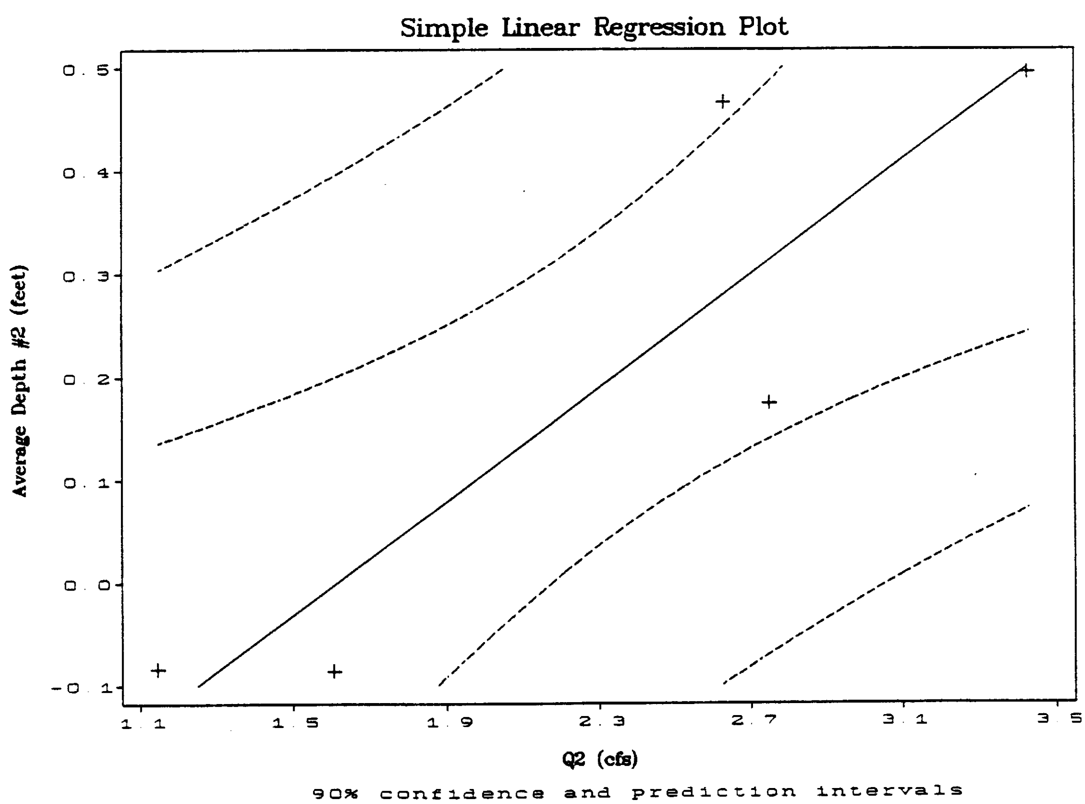
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AVERAGE DEPTH #2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.44473	0.19359	-2.30	0.1052
Q2	0.27586	0.07888	3.50	0.0396

R-SQUARED	0.8030	RESID. MEAN SQUARE (MSE)	0.02112
ADJUSTED R-SQUARED	0.7374	STANDARD DEVIATION	0.14531

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.25829	0.25829	12.23	0.0396
RESIDUAL	3	0.06335	0.02112		
TOTAL	4	0.32164			

CASES INCLUDED 5 MISSING CASES 0



Strata "C" third order regression output for velocity #2 versus Q2.

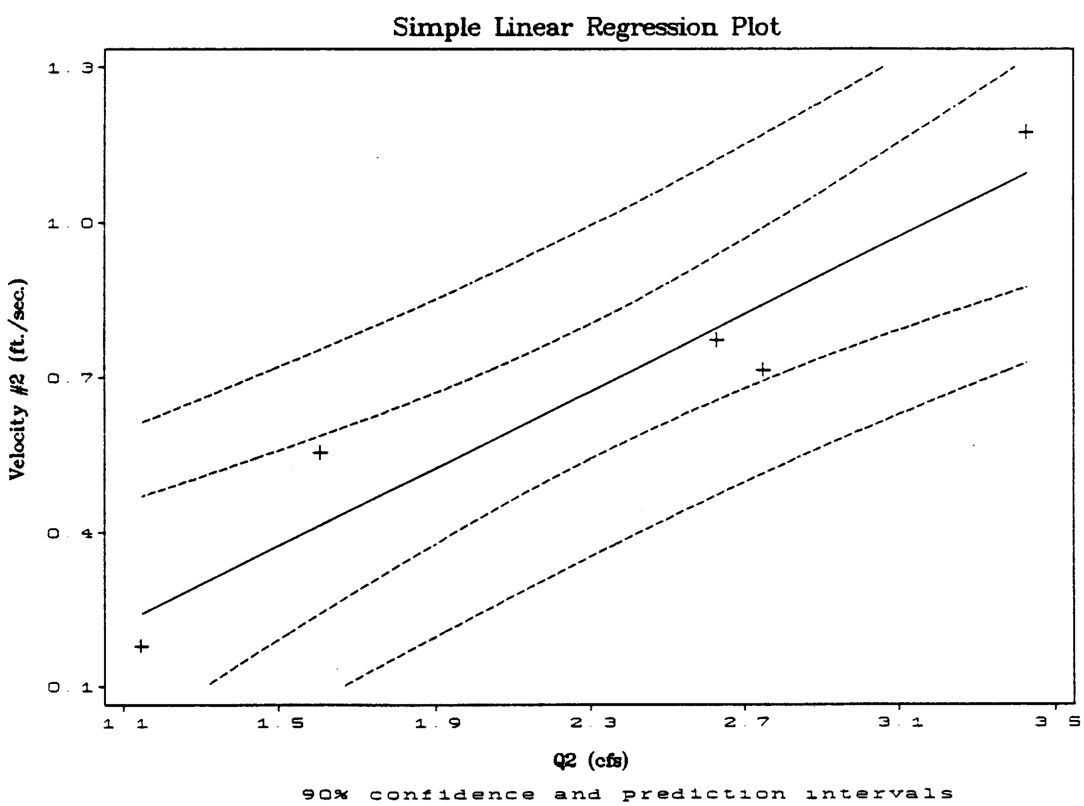
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF VELOCITY #2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-0.18548	0.16574	-1.12	0.3446
Q2	0.37368	0.06753	5.53	0.0116

R-SQUARED	0.9108	RESID. MEAN SQUARE (MSE)	0.01548
ADJUSTED R-SQUARED	0.8810	STANDARD DEVIATION	0.12441

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.47395	0.47395	30.62	0.0116
RESIDUAL	3	0.04643	0.01548		
TOTAL	4	0.52038			

CASES INCLUDED 5 MISSING CASES 0



Strata "C" third order regression output for bank slope versus ground slope.

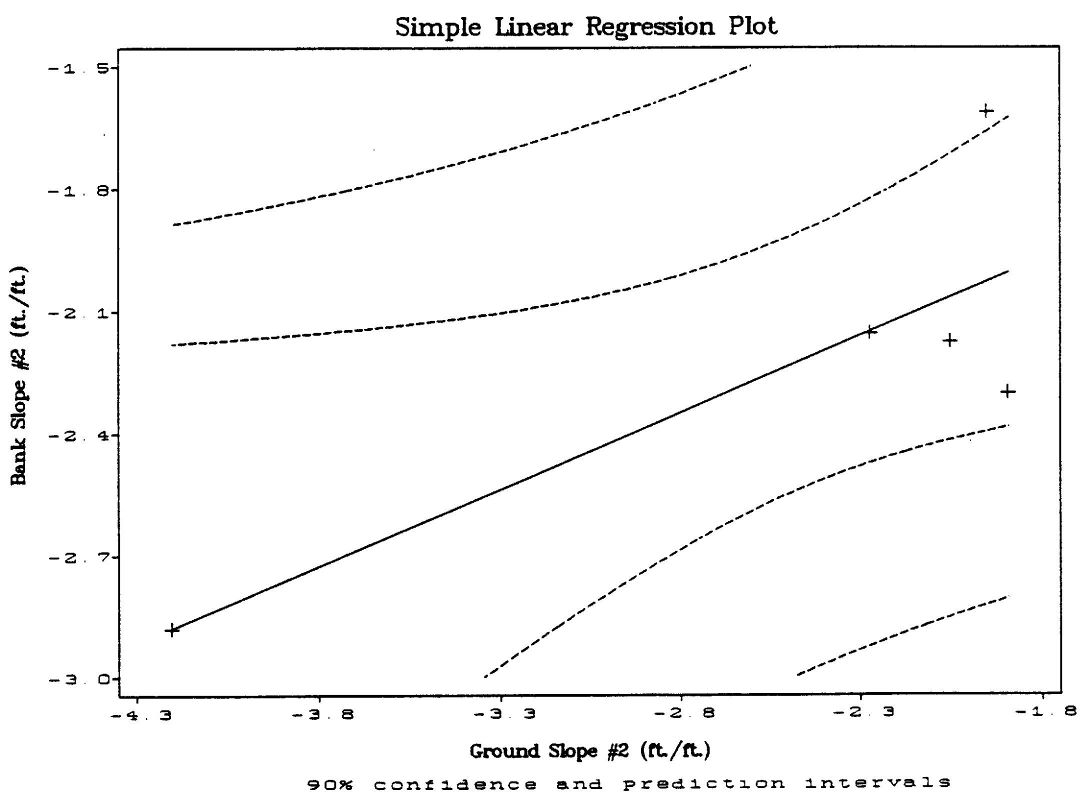
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF BANK SLOPE

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-1.28909	0.40206	-3.21	0.0491
GS2	0.37829	0.15325	2.47	0.0902

R-SQUARED	0.6701	RESID. MEAN SQUARE (MSE)	0.08975
ADJUSTED R-SQUARED	0.5601	STANDARD DEVIATION	0.29959

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.54693	0.54693	6.09	0.0902
RESIDUAL	3	0.26926	0.08975		
TOTAL	4	0.81619			

CASES INCLUDED 5 MISSING CASES 0



Strata "C" third order regression output for ground slope #2 versus area gradient index #1.

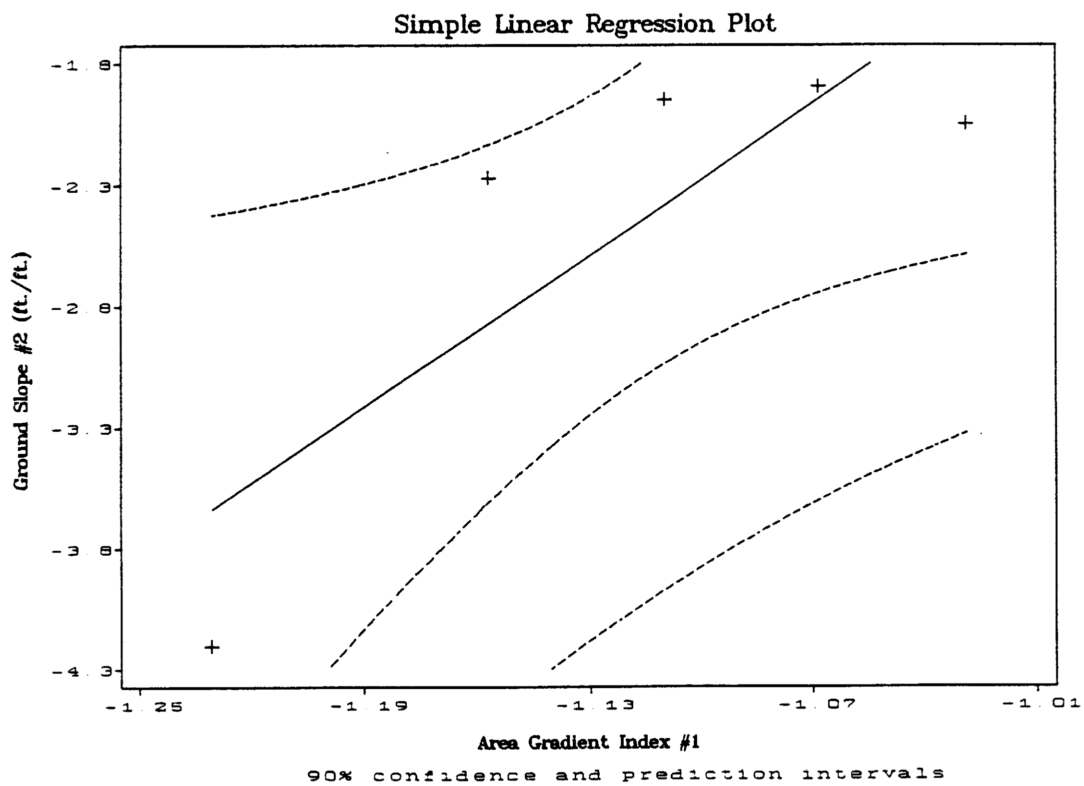
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF GROUND SLOPE #2

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	9.18584	4.38583	2.09	0.1272
AGI1	10.4208	3.91214	2.66	0.0761

R-SQUARED	0.7028	RESID. MEAN SQUARE (MSE)	0.37857
ADJUSTED R-SQUARED	0.6038	STANDARD DEVIATION	0.61528

SOURCE	DF	SS	MS	F	P
REGRESSION	1	2.68611	2.68611	7.10	0.0761
RESIDUAL	3	1.13572	0.37857		
TOTAL	4	3.82183			

CASES INCLUDED 5 MISSING CASES 0



Strata "C" third order regression output for Q3 versus used relief.

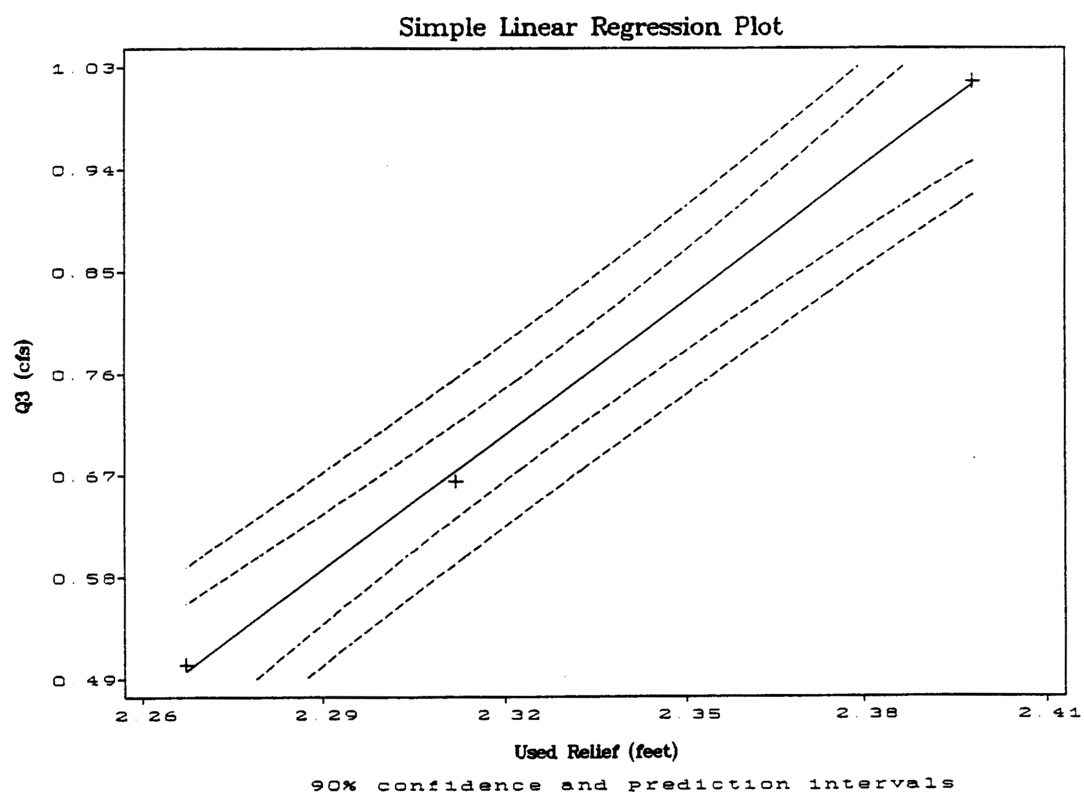
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF Q3

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-8.47410	0.27501	-30.81	0.0207
UR	3.95692	0.11822	33.47	0.0190

R-SQUARED	0.9991	RESID. MEAN SQUARE (MSE)	1.235E-04
ADJUSTED R-SQUARED	0.9982	STANDARD DEVIATION	0.01111

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.13839	0.13839	1120.32	0.0190
RESIDUAL	1	1.235E-04	1.235E-04		
TOTAL	2	0.13851			

CASES INCLUDED 3 MISSING CASES 2



Strata "C" third order regression output for area #4 versus channel slope.

UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AREA #4

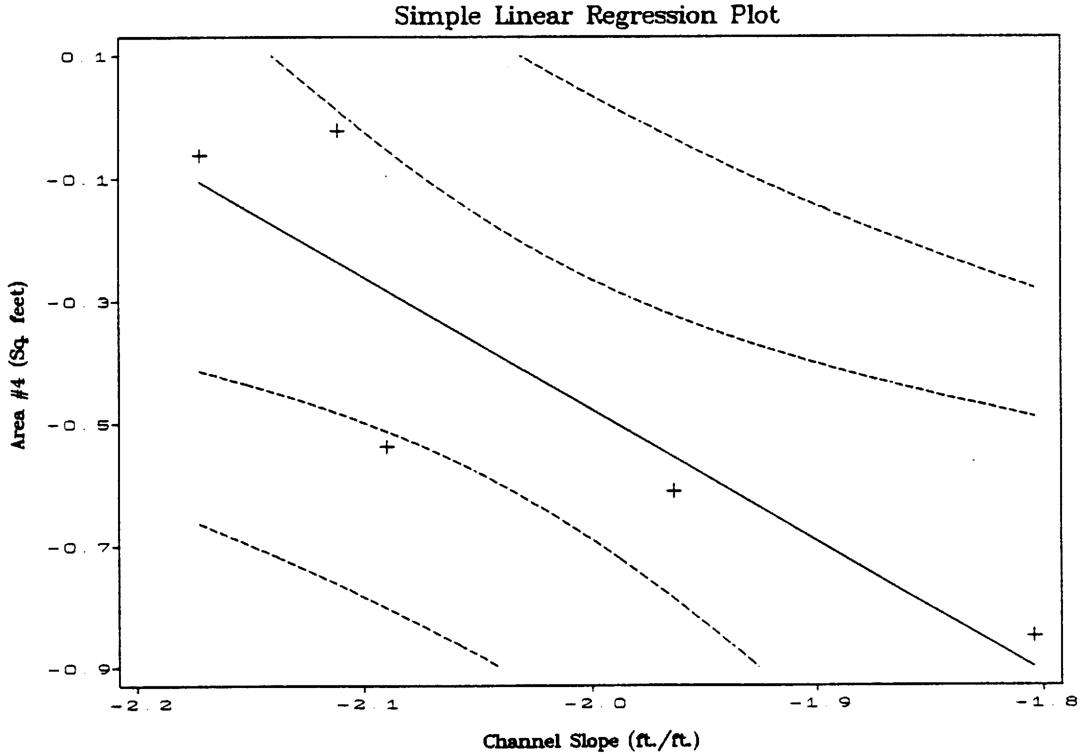
PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-4.79668	1.36974	-3.50	0.0394
CHS	-2.15967	0.67400	-3.20	0.0492

R-SQUARED	0.7739	RESID. MEAN SQUARE (MSE)	0.03913
ADJUSTED R-SQUARED	0.6985	STANDARD DEVIATION	0.19781

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.40174	0.40174	10.27	0.0492
RESIDUAL	3	0.11738	0.03913		
TOTAL	4	0.51912			

CASES INCLUDED 5 MISSING CASES 0

Simple Linear Regression Plot



90% confidence and prediction intervals

Strata "C" third order regression output for Q4 versus area gradient index #4.

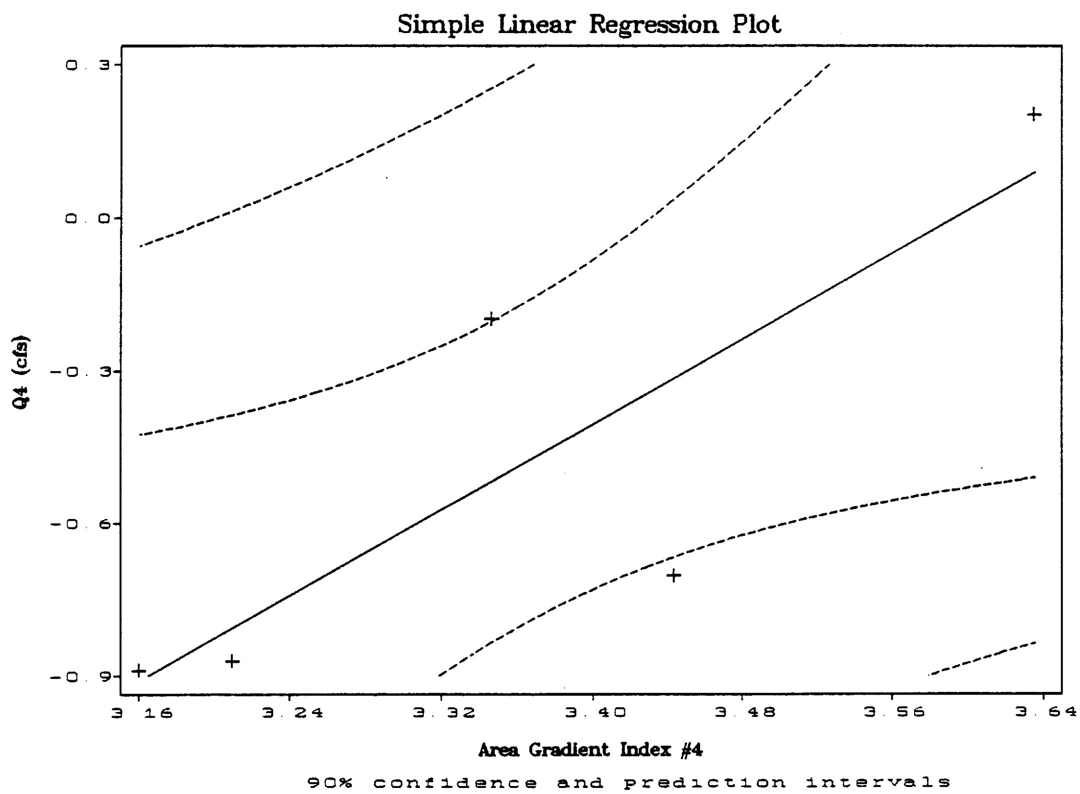
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF Q4

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	-7.55050	2.63769	-2.86	0.0644
AGI4	2.10144	0.78423	2.68	0.0751

R-SQUARED	0.7053	RESID. MEAN SQUARE (MSE)	0.08949
ADJUSTED R-SQUARED	0.6071	STANDARD DEVIATION	0.29915

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.64255	0.64255	7.18	0.0751
RESIDUAL	3	0.26846	0.08949		
TOTAL	4	0.91102			

CASES INCLUDED 5 MISSING CASES 0



Strata "C" third order regression output for top width #4 versus area #4.

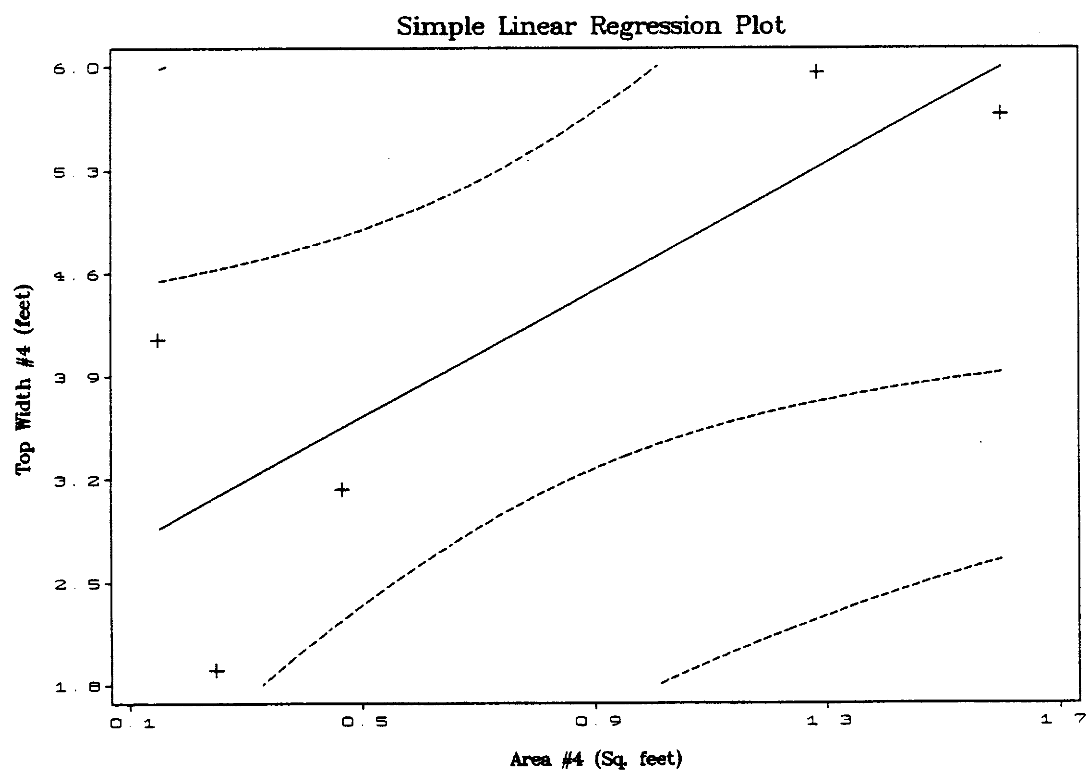
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF TOP WIDTH #4

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	2.54018	0.81269	3.13	0.0522
A4	2.16197	0.85573	2.53	0.0857

R-SQUARED	0.6803	RESID. MEAN SQUARE (MSE)	1.24280
ADJUSTED R-SQUARED	0.5737	STANDARD DEVIATION	1.11481

SOURCE	DF	SS	MS	F	P
REGRESSION	1	7.93274	7.93274	6.38	0.0857
RESIDUAL	3	3.72839	1.24280		
TOTAL	4	11.6611			

CASES INCLUDED 5 MISSING CASES 0



90% confidence and prediction intervals

Strata "C" third order regression output for average depth #4 versus area #4.

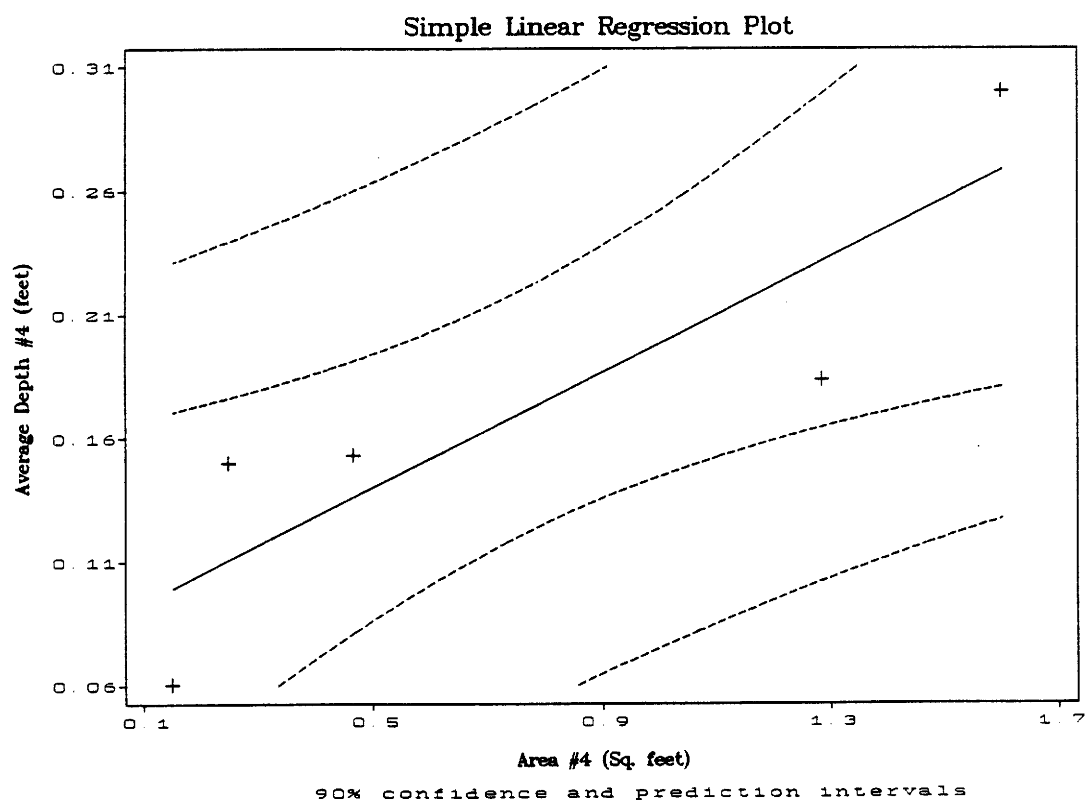
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AVERAGE DEPTH #4

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.08193	0.03433	2.39	0.0971
A4	0.11668	0.03615	3.23	0.0483

R-SQUARED	0.7764	RESID. MEAN SQUARE (MSE)	0.00222
ADJUSTED R-SQUARED	0.7019	STANDARD DEVIATION	0.04709

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.02311	0.02311	10.42	0.0483
RESIDUAL	3	0.00665	0.00222		
TOTAL	4	0.02976			

CASES INCLUDED 5 MISSING CASES 0



Strata "C" third order regression output for area #4 versus Q4.

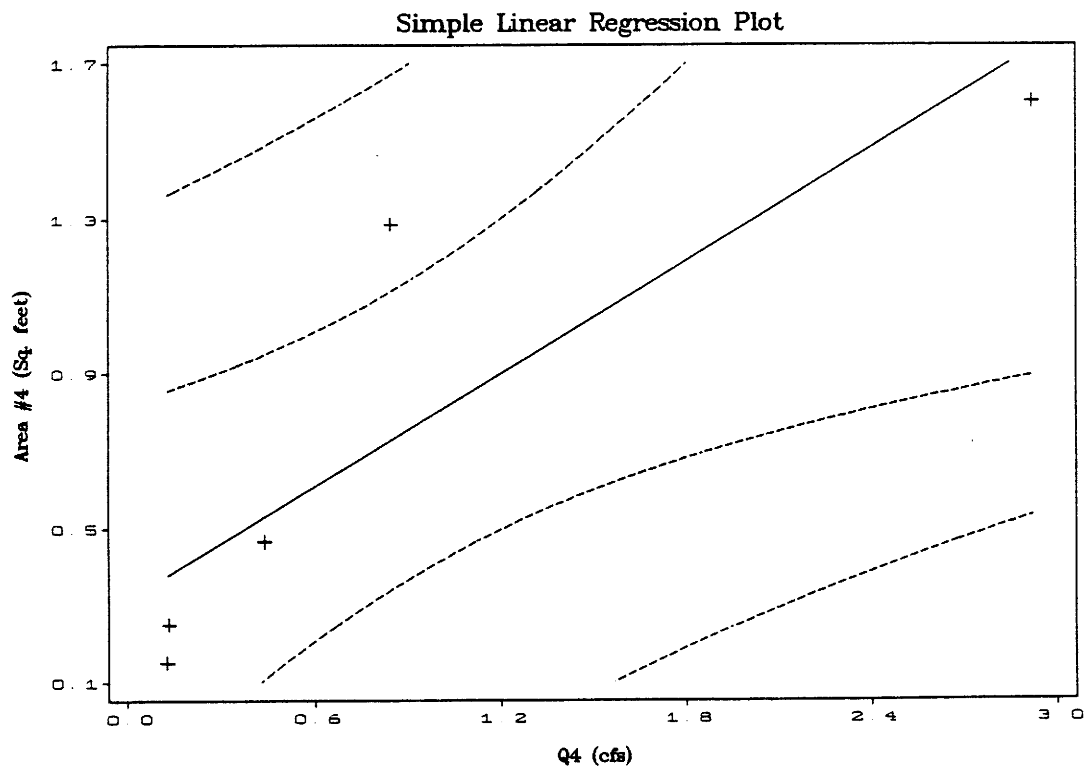
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AREA #4

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.31555	0.21544	1.46	0.2392
Q4	0.48610	0.15653	3.11	0.0531

R-SQUARED	0.7627	RESID. MEAN SQUARE (MSE)	0.13422
ADJUSTED R-SQUARED	0.6837	STANDARD DEVIATION	0.36637

SOURCE	DF	SS	MS	F	P
REGRESSION	1	1.29449	1.29449	9.64	0.0531
RESIDUAL	3	0.40267	0.13422		
TOTAL	4	1.69717			

CASES INCLUDED 5 MISSING CASES 0



90% confidence and prediction intervals

Strata "C" third order regression output for average depth #4 versus Q4.

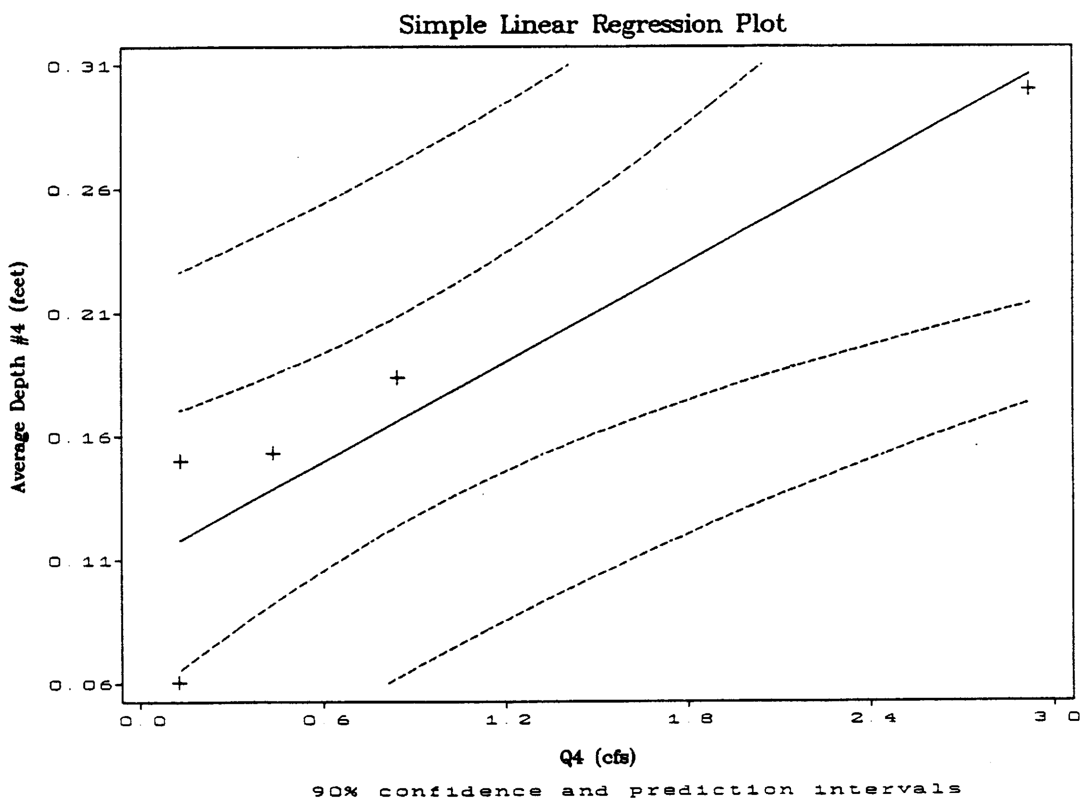
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF AVERAGE DEPTH #4

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.10919	0.02367	4.61	0.0192
Q4	0.06742	0.01720	3.92	0.0295

R-SQUARED	0.8367	RESID. MEAN SQUARE (MSE)	0.00162
ADJUSTED R-SQUARED	0.7823	STANDARD DEVIATION	0.04025

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.02490	0.02490	15.37	0.0295
RESIDUAL	3	0.00486	0.00162		
TOTAL	4	0.02976			

CASES INCLUDED 5 MISSING CASES 0



Strata "C" third order regression output for velocity #4 versus Q4.

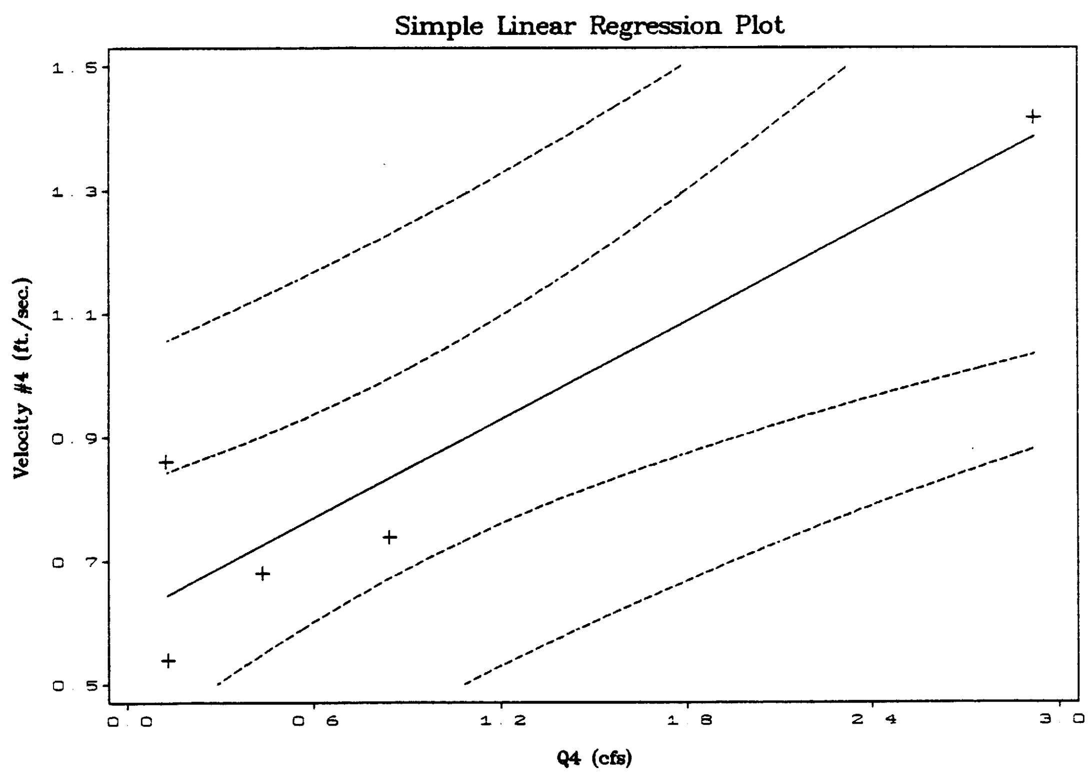
UNWEIGHTED LEAST SQUARES LINEAR REGRESSION OF VELOCITY #4

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
CONSTANT	0.60916	0.09023	6.75	0.0066
Q4	0.26589	0.06555	4.06	0.0270

R-SQUARED	0.8458	RESID. MEAN SQUARE (MSE)	0.02354
ADJUSTED R-SQUARED	0.7944	STANDARD DEVIATION	0.15343

SOURCE	DF	SS	MS	F	P
REGRESSION	1	0.38732	0.38732	16.45	0.0270
RESIDUAL	3	0.07063	0.02354		
TOTAL	4	0.45795			

CASES INCLUDED 5 MISSING CASES 0



90% confidence and prediction intervals

High bank reach means for **Strata "C"** third order

Basin ID **0500**	**Area** **(ft^2)**	**Wetted Perimeter (ft)**	**Top Width (ft)**	**Hydraulic Radius**	**Average Depth (ft)**	**W/D Ratio**	**Floodplain Width (ft)**	**Bed Slope (ft/ft)**
n	2	2	2	2	2	2	1	2
Mean	3477.40	249.77	239.90	14.58	15.40	19.83	21.95	0.012
S.D.	1353.90	42.32	49.07	7.88	8.77	14.61	0.004	0.005
C.V. (%)	38.93	16.94	20.46	54.09	56.94	73.67	32.64	21.98
Minimum	2520.10	219.85	205.20	9.00	9.20	9.50	21.95	0.009
Maximum	4434.80	279.70	27[illegible].60	20.15	21.60	30.16	21.95	0.014
Range	1914.70	59.85	69.40	11.15	12.40	20.66	0.00	0.005

Basin ID **0700**	**Area** **(ft^2)**	**Wetted Perimeter (ft)**	**Top Width (ft)**	**Hydraulic Radius**	**Average Depth (ft)**	**W/D Ratio**	**Floodplain Width (ft)**	**Bed Slope (ft/ft)**
n	2	2	2	2	2	2	2	2
Mean	1161.40	185.65	183.40	6.35	6.43	29.54	117.65	0.005
S.D.	23.55	33.09	33.87	0.99	1.03	10.17	41.58	0.002
C.V. (%)	2.03	17.83	18.47	15.59	15.96	34.41	35.34	39.22
Minimum	1144.80	162.25	159.45	5.65	5.70	22.35	88.25	0.004
Maximum	1178.10	209.05	207.35	7.05	7.15	36.73	147.05	0.007
Range	33.30	46.80	47.90	1.40	1.45	14.38	58.80	0.003

Basin ID 1200	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Floodplain Width (ft)	Bed Slope (ft/ft)
n	2	2	2	2	2	2	2	2
Mean	1294.90	211.57	209.45	6.03	6.08	34.64	125.25	0.004
S.D.	448.91	56.68	57.63	0.46	0.39	7.67	42.99	0.006
C.V. (%)	34.67	26.79	27.52	7.63	6.40	22.13	34.33	133.29
Minimum	977.45	171.50	168.70	5.70	5.80	29.22	94.85	0.000
Maximum	1612.30	251.65	250.20	6.35	6.35	40.07	155.65	0.009
Range	634.85	80.15	81.50	0.65	0.55	10.84	60.80	0.008

Basin ID 1600	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Floodplain Width (ft)	Bed Slope (ft/ft)
n	3	3	3	3	3	3	0	3
Mean	105.52	55.92	54.57	1.98	2.10	30.08	0.00	0.005
S.D.	48.52	31.86	32.54	0.68	0.79	20.99	0.00	0.003
C.V. (%)	45.99	56.97	59.63	34.32	37.80	69.76	0.00	66.80
Minimum	69.30	31.50	28.85	1.45	1.50	9.66	0.00	0.003
Maximum	160.65	91.95	91.15	2.75	3.00	51.59	0.00	0.008
Range	91.35	60.45	62.30	1.30	1.50	41.93	0.00	0.006

Basin ID 2200	Area (ft²)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Floodplain Width (ft)	Bed Slope (ft/ft)
n	3	3	3	3	3	3	1	3
Mean	88.20	32.10	28.45	2.73	3.13	10.19	10.15	0.008
S.D.	33.90	4.08	4.10	0.81	1.06	4.62	0.01	0.007
C.V. (%)	38.43	12.70	14.40	29.74	33.86	45.39	116.60	73.37
Minimum	57.45	28.55	23.90	1.85	1.95	6.94	10.15	-0.002
Maximum	124.55	36.55	31.85	3.45	4.00	15.48	10.15	0.016
Range	67.10	8.00	7.95	1.60	2.05	8.54	0.00	0.017

Medium bank reach means for Strata "C" third order

Basin ID 0500	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	2	2	2	2	2	2	2	2	2	2	2
Mean	194.10	57.25	55.80	3.23	3.33	18.06	0.012	0.025	0.033	14.94	2982.30
S.D.	104.09	8.27	7.21	1.38	1.45	5.59	0.004	0.009	0.000	1.59	1863.30
C.V. (%)	53.63	14.45	12.93	42.76	43.60	30.98	32.64	36.68	0.00	10.63	62.48
Minimum	120.50	51.40	50.70	2.25	2.30	14.10	0.009	0.019	0.033	13.82	1664.80
Maximum	267.70	63.10	60.90	4.20	4.35	22.01	0.014	0.032	0.033	16.06	4299.90
Range	147.20	11.70	10.20	1.95	2.05	7.91	0.005	0.013	0.000	2.25	2635.10

Basin ID 0700	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	2	2	2	2	2	2	2	2	2	2	2
Mean	131.92	58.10	57.25	1.75	1.78	35.58	0.012	0.008	0.033	5.19	658.88
S.D.	105.39	14.35	14.28	0.78	0.74	6.02	0.012	0.006	0.000	0.48	482.86
C.V. (%)	79.89	24.71	24.95	44.45	41.83	16.92	95.32	72.46	0.00	9.34	73.29
Minimum	57.40	47.95	47.15	1.20	1.25	31.32	0.004	0.004	0.033	4.85	317.44
Maximum	206.45	68.25	67.35	2.30	2.30	39.83	0.020	0.012	0.033	5.53	1000.30
Range	149.05	20.30	20.20	1.10	1.05	8.51	0.016	0.008	0.000	0.69	682.86

Basin ID 1200	Area (ft²)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	1	1	1	1	1	1	1	1	1	1	1
Mean	9.30	12.23	11.33	0.77	0.83	14.09	0.0001	0.001	0.030	1.51	14.04
S.D.	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.00
C.V. (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00	0.00
Minimum	9.30	12.23	11.33	0.77	0.83	14.09	0.0001	0.001	0.030	1.51	14.04
Maximum	9.30	12.23	11.33	0.77	0.83	14.09	0.0001	0.001	0.030	1.51	14.04
Range	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.00

Basin ID 1600	Area (ft²)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	2	2	2	2	2	2	2	2	2	2	2
Mean	11.28	14.05	13.70	0.80	0.83	16.79	0.006	0.008	0.030	3.63	41.04
S.D.	0.32	1.41	1.48	0.07	0.11	3.53	0.004	0.005	0.000	0.91	11.47
C.V. (%)	2.82	10.07	10.84	8.84	12.86	21.00	61.02	58.96	0.00	25.22	27.94
Minimum	11.05	13.05	12.65	0.75	0.75	14.30	0.003	0.004	0.030	2.98	32.94
Maximum	11.50	15.05	14.75	0.85	0.90	19.29	0.008	0.011	0.030	4.27	49.15
Range	0.45	2.00	2.10	0.10	0.15	4.99	0.005	0.006	0.000	1.29	16.22

Basin ID 2200	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	4	4	4	4	4	4	4	4	4	4	4
Mean	89.18	30.13	27.21	2.75	3.13	9.13	0.010	0.008	0.034	7.14	821.02
S.D.	59.31	15.39	15.92	0.89	1.09	4.57	0.008	0.007	0.001	4.66	901.84
C.V. (%)	66.50	51.09	58.48	32.22	35.02	49.99	86.36	91.93	1.48	65.35	109.84
Minimum	23.05	15.95	14.80	1.45	1.55	5.64	-0.002	0.001	0.033	3.19	74.42
Maximum	166.00	51.95	50.50	3.40	4.05	15.33	0.016	0.017	0.034	12.39	2057.30
Range	142.95	36.00	35.70	1.95	2.50	9.69	0.018	0.016	0.001	9.20	1982.88

Low bank reach means for **Strata "C"** third order

Basin ID 0500	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	1	1	1	1	1	1	1	1	1	1	1
Mean	2.20	10.35	10.30	0.20	0.20	64.33	0.014	0.015	0.030	2.10	4.62
S.D.	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.00
C.V. (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Minimum	2.20	10.35	10.30	0.20	0.20	64.33	0.014	0.015	0.030	2.10	4.62
Maximum	2.20	10.35	10.30	0.20	0.20	64.33	0.014	0.015	0.030	2.10	4.62
Range	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.00

Basin ID 0700	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	3	3	3	3	3	3	3	3	3	3	3
Mean	5.83	16.60	16.37	0.47	0.48	89.11	0.010	0.005	0.033	1.88	11.37
S.D.	1.21	9.20	9.40	0.24	0.26	115.37	0.009	0.001	0.000	0.58	5.31
C.V. (%)	20.67	55.44	57.45	50.63	53.09	129.47	83.50	22.92	0.00	30.74	46.75
Minimum	4.70	9.70	9.15	0.20	0.20	21.65	0.004	0.004	0.033	1.22	5.73
Maximum	7.10	27.05	27.00	0.65	0.70	222.33	0.020	0.006	0.033	2.29	16.28
Range	2.40	17.35	17.85	0.45	0.50	200.68	0.016	0.002	0.000	1.07	10.55

Basin ID 2200	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	2	2	2	2	2	2	2	2	2	2	2
Mean	5.05	7.15	6.65	0.55	0.60	15.67	0.003	0.001	0.030	0.91	6.03
S.D.	3.82	0.57	0.07	0.28	0.35	5.42	0.007	0.001	0.000	0.74	7.24
C.V. (%)	75.61	7.91	1.06	51.43	58.93	34.61	209.32	94.28	0.00	81.45	120.09
Minimum	2.35	6.75	6.60	0.35	0.35	11.83	-0.002	0.000	0.030	0.39	0.91
Maximum	7.75	7.55	6.70	0.75	0.85	19.50	0.008	0.001	0.030	1.44	11.14
Range	5.40	0.80	0.10	0.40	0.50	7.67	0.010	0.001	0.000	1.05	10.23

Low bank # 2 reach means for Strata "C" third order

Basin ID 0500	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	1	1	1	1	1	1	1	1	1	1	1
Mean	0.15	4.15	4.15	0.06	0.06	132.70	0.014	0.013	0.030	0.86	0.13
S.D.	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.00
C.V. (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Minimum	0.15	4.15	4.15	0.06	0.06	132.70	0.014	0.013	0.030	0.86	0.13
Maximum	0.15	4.15	4.15	0.06	0.06	132.70	0.014	0.013	0.030	0.86	0.13
Range	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.00

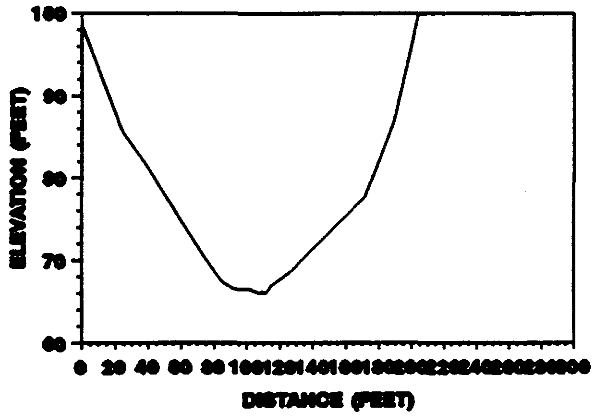
Basin ID 0700	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	2	2	2	2	2	2	2	2	2	2	2
Mean	1.60	5.83	5.68	0.28	0.30	36.09	0.012	0.005	0.033	1.42	2.92
S.D.	1.34	1.17	0.95	0.18	0.21	2.25	0.012	0.003	0.000	0.98	3.46
C.V. (%)	83.97	20.03	16.82	64.28	70.71	6.25	95.32	55.12	0.00	68.93	118.58
Minimum	0.65	5.00	5.00	0.15	0.15	34.50	0.004	0.003	0.033	0.73	0.47
Maximum	2.55	6.65	6.35	0.40	0.45	37.69	0.020	0.007	0.033	2.11	5.37
Range	1.90	1.65	1.35	0.25	0.30	3.19	0.016	0.004	0.000	1.38	4.90

Basin ID 1200	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	1	1	1	1	1	1	1	1	1	1	1
Mean	0.25	2.10	1.90	0.15	0.15	15.00	0.0004	0.0015	0.030	0.54	0.13
S.D.	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.00
C.V. (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Minimum	0.25	2.10	1.90	0.15	0.15	15.00	0.0004	0.0015	0.0300	0.54	0.13
Maximum	0.25	2.10	1.90	0.15	0.15	15.00	0.0004	0.0015	0.0300	0.54	0.13
Range	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.0000	0.000	0.00	0.00

Basin ID 1600	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	3	3	3	3	3	3	3	3	3	3	3
Mean	1.28	6.00	5.95	0.18	0.18	37.25	0.005	0.005	0.032	0.74	0.84
S.D.	0.93	2.30	2.27	0.10	0.10	16.94	0.003	0.004	0.002	0.40	0.70
C.V. (%)	72.51	38.25	38.07	56.77	56.77	45.48	66.80	85.97	5.41	54.89	82.60
Minimum	0.30	3.55	3.55	0.10	0.10	21.25	0.003	0.000	0.030	0.33	0.22
Maximum	2.15	8.10	8.05	0.30	0.30	55.00	0.008	0.008	0.033	1.14	1.60
Range	1.85	4.55	4.50	0.20	0.20	33.75	0.006	0.008	0.003	0.81	1.38

Basin ID 2200	Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Hydraulic Radius	Average Depth (ft)	W/D Ratio	Bed Slope (ft/ft)	Bank Slope (ft/ft)	Manning's "n"	Velocity (ft/s)	Q (cfs)
n	3	3	3	3	3	3	3	3	3	3	3
Mean	0.47	3.18	3.13	0.14	0.15	54.44	0.008	0.004	0.031	0.68	0.44
S.D.	0.29	1.37	1.33	0.03	0.06	57.85	0.009	0.006	0.001	0.65	0.60
C.V. (%)	61.86	42.88	42.59	23.61	36.02	106.26	116.60	141.98	3.69	95.73	136.47
Minimum	0.30	1.95	1.90	0.10	0.10	13.25	-0.002	0.000	0.030	0.17	0.05
Maximum	0.80	4.65	4.55	0.16	0.21	120.58	0.016	0.011	0.032	1.42	1.13
Range	0.50	2.70	2.65	0.06	0.11	107.33	0.017	0.010	0.002	1.25	1.08

RUSSELL DRAW, 0500
CROSS SECTION 0+[illegible]



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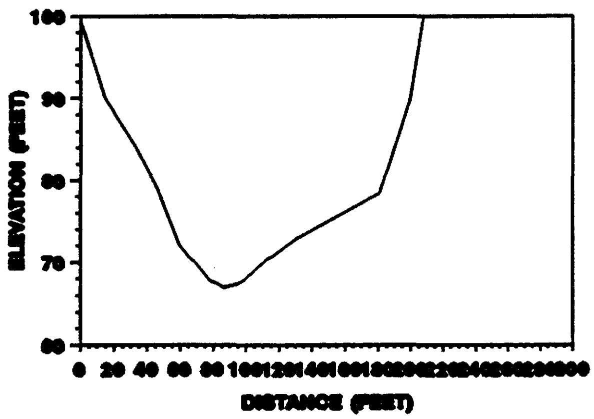

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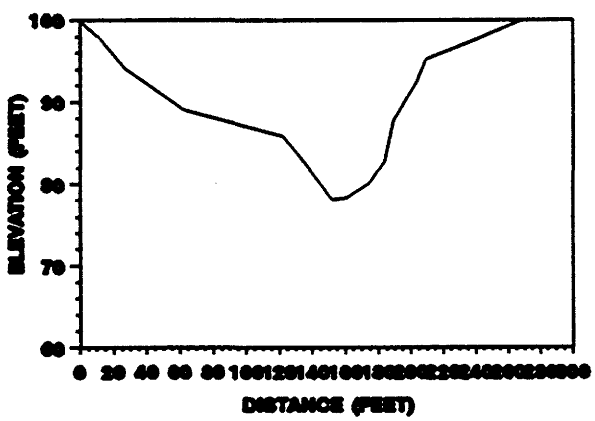
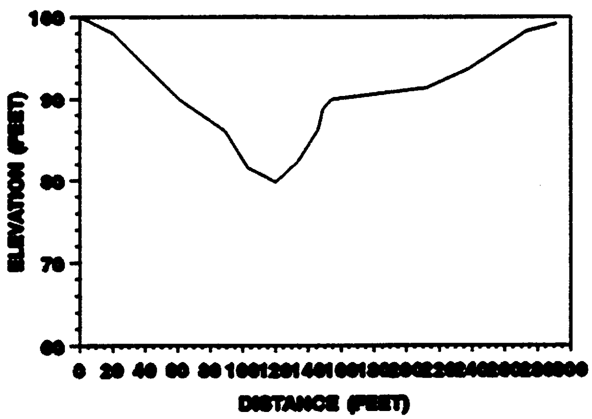


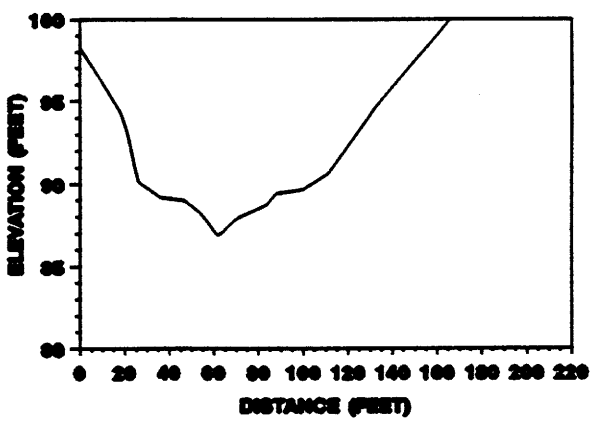
RUSSELL DRAW, 0500

CROSS SECTION 1+51.00



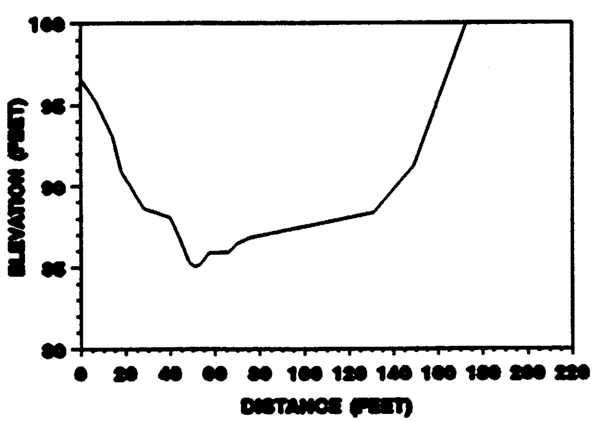
RAWHIDE CREEK, 0700

CROSS SECTION 0+00.00



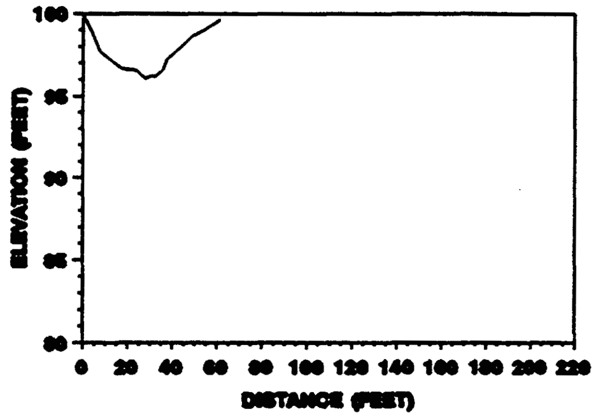
RAWHIDE CREEK, 0700

CROSS SECTION 1+45.00



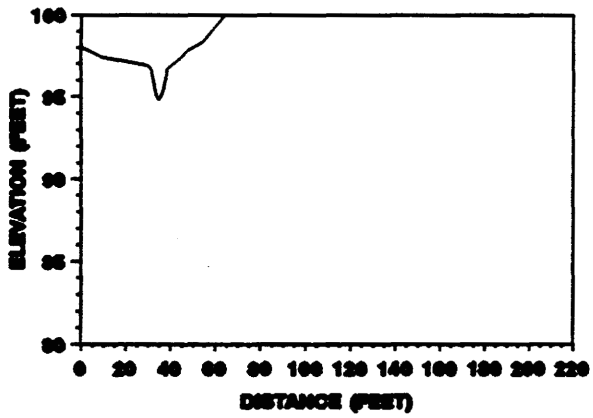
RAWHIDE CREEK, 0700

CROSS SECTION 0+[illegible]



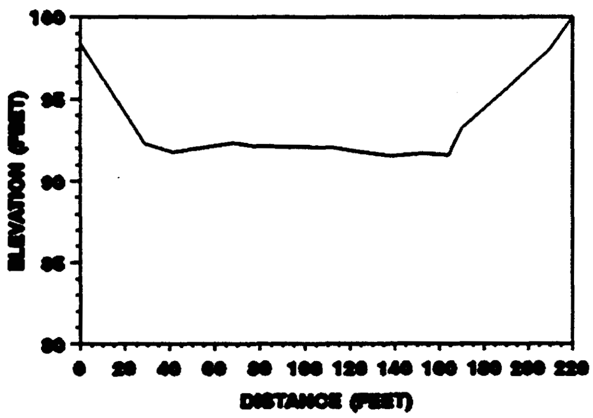
RAWHIDE CREEK, 0700

CROSS SECTION 0+[illegible].70

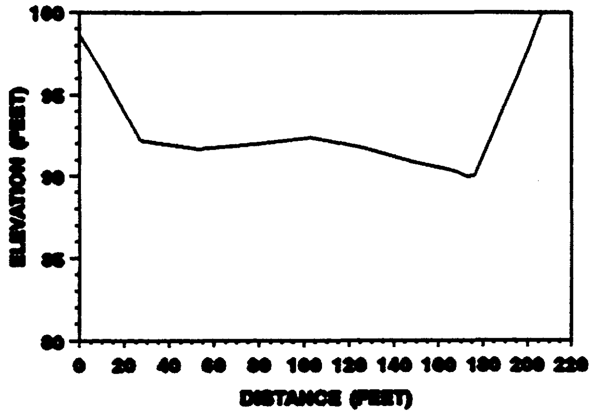


RAWHIDE CREEK, 0700

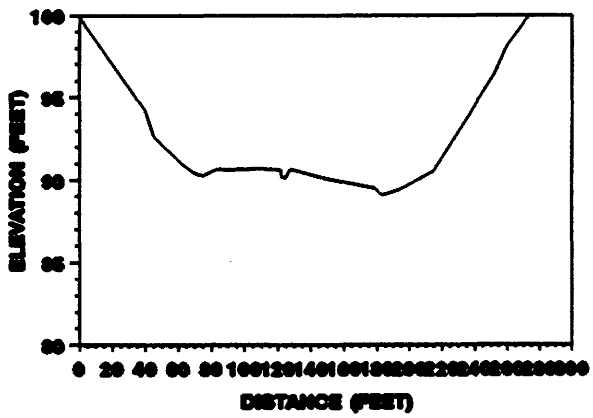
CROSS SECTION 0+[illegible]



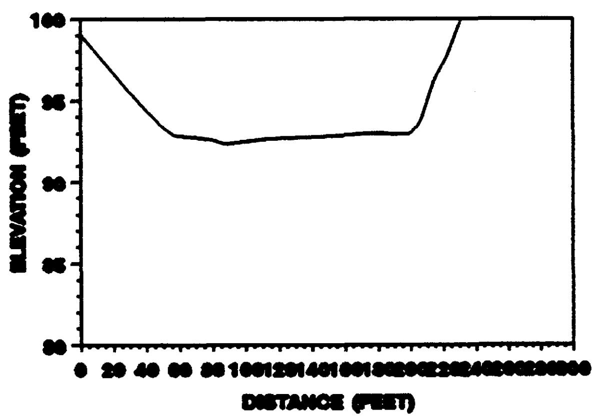
RAWHIDE CREEK, 0700
CROSS SECTION 6+30.00



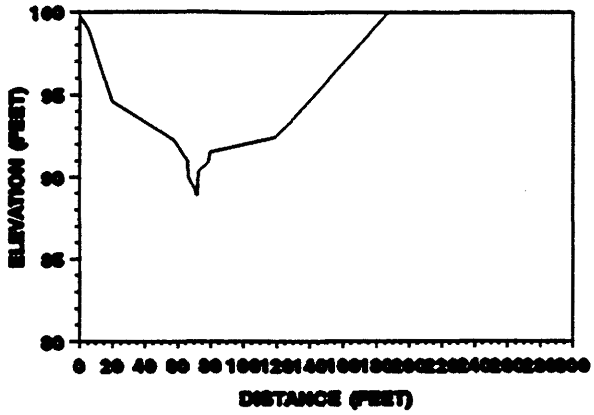
LONE TREE PRONG, 1200
CROSS SECTION 0+60.00



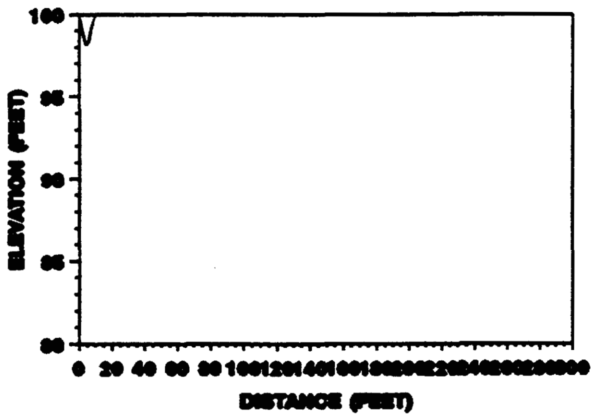
LONE TREE PRONG, 1200
CROSS SECTION 14+63.00



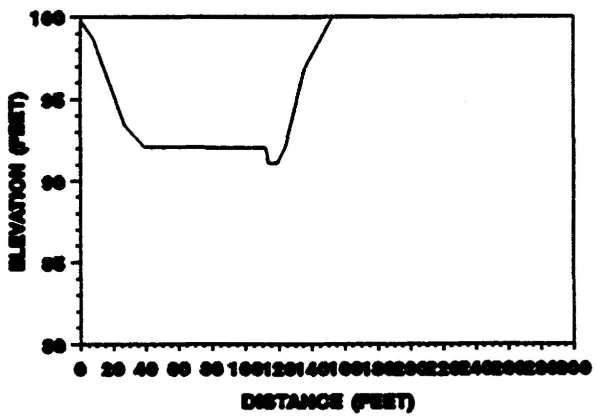
LONE TREE PRONG, 1200
CROSS SECTION 0+00.00



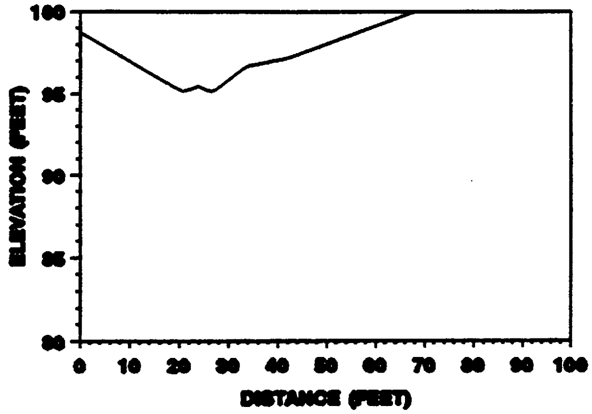
LONE TREE PRONG, 1200
CROSS SECTION 1+35.00



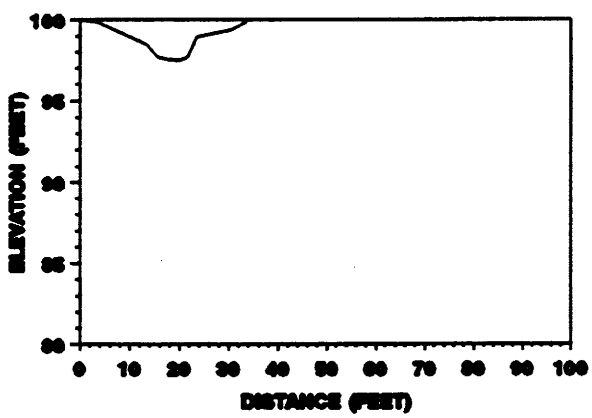
LONE TREE PRONG, 1200
CROSS SECTION 4+54.00



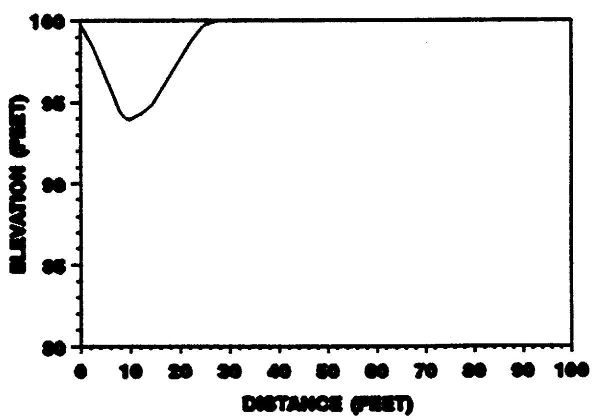
SHEARING PEN DRAW, 1600
CROSS SECTION [illegible]



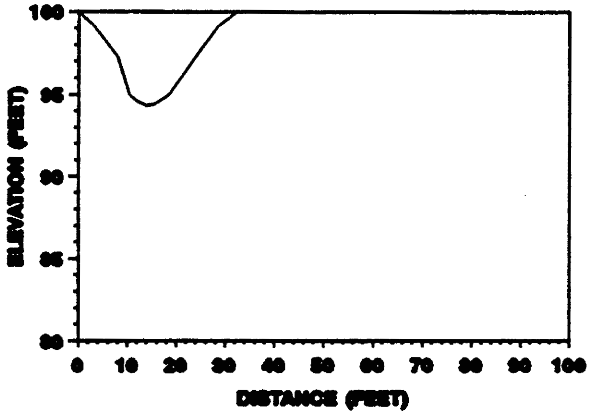
SHEARING PEN DRAW, 1600
CROSS SECTION 1+32.50



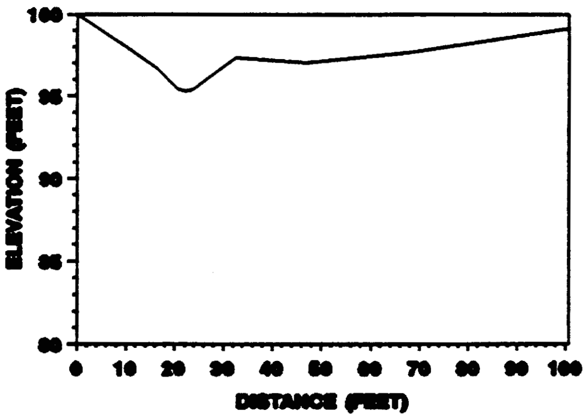
SHEARING PEN DRAW, 1600
CROSS SECTION [illegible]



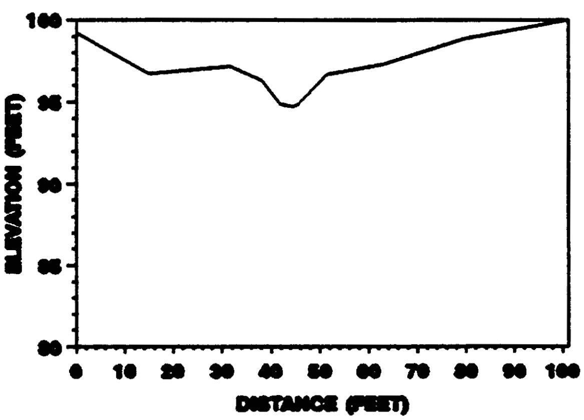
SHEARING PEN DRAW, 1600
CROSS SECTION 0+98.00



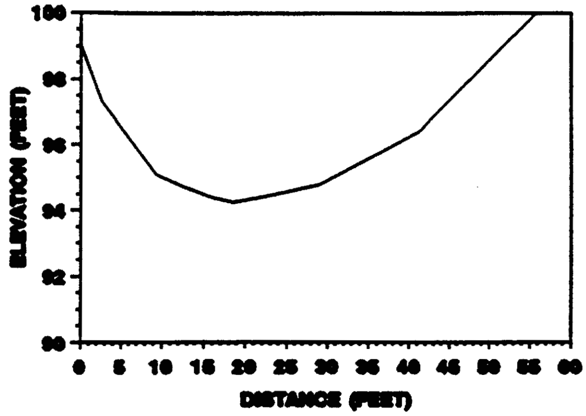
SHEARING PEN DRAW, 1600
CROSS SECTION 13+18.30



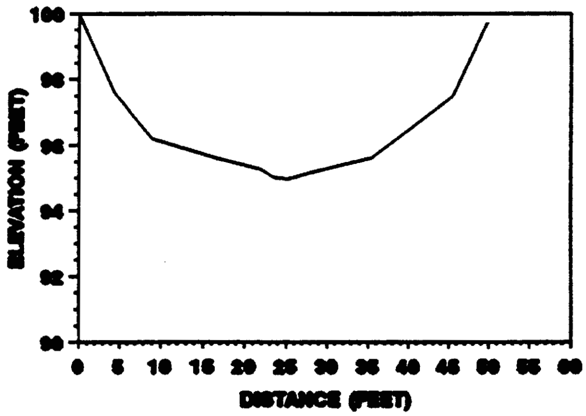
SHEARING PEN DRAW, 1600
CROSS SECTION 14+36.90



THIELEN DRAW, 2200
CROSS SECTION 0+60.00



THIELEN DRAW, 2200
CROSS SECTION 0+70.00



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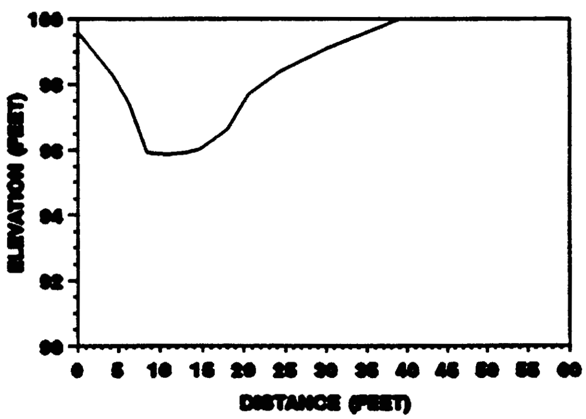

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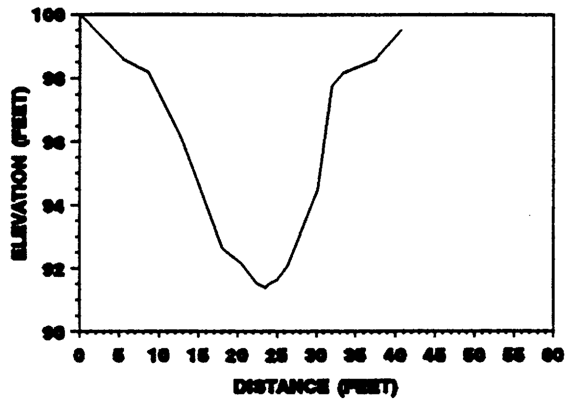
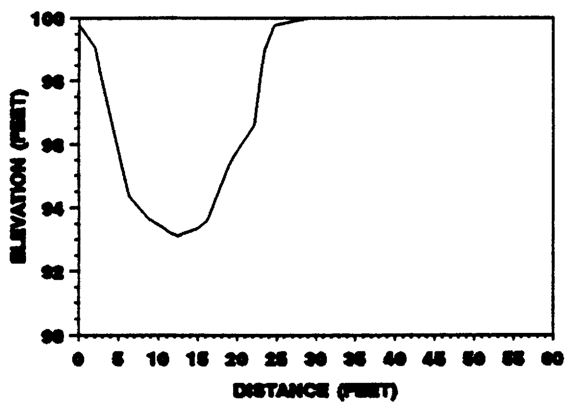
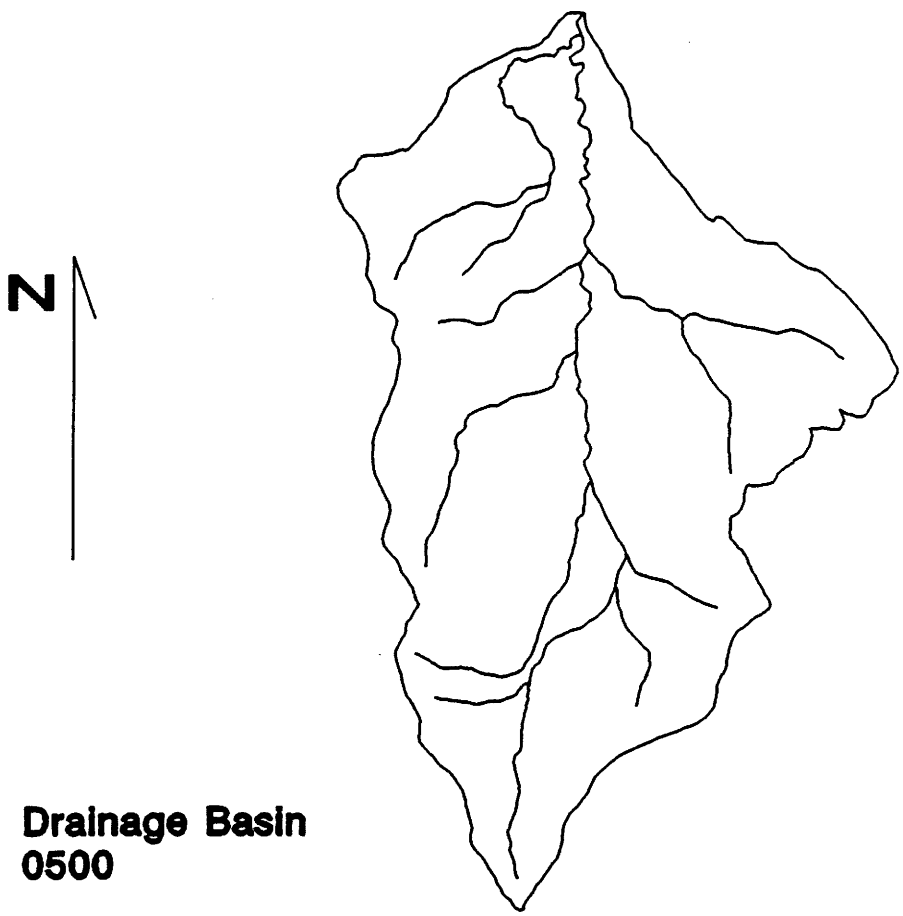
CROSS SECTION 0+60.00



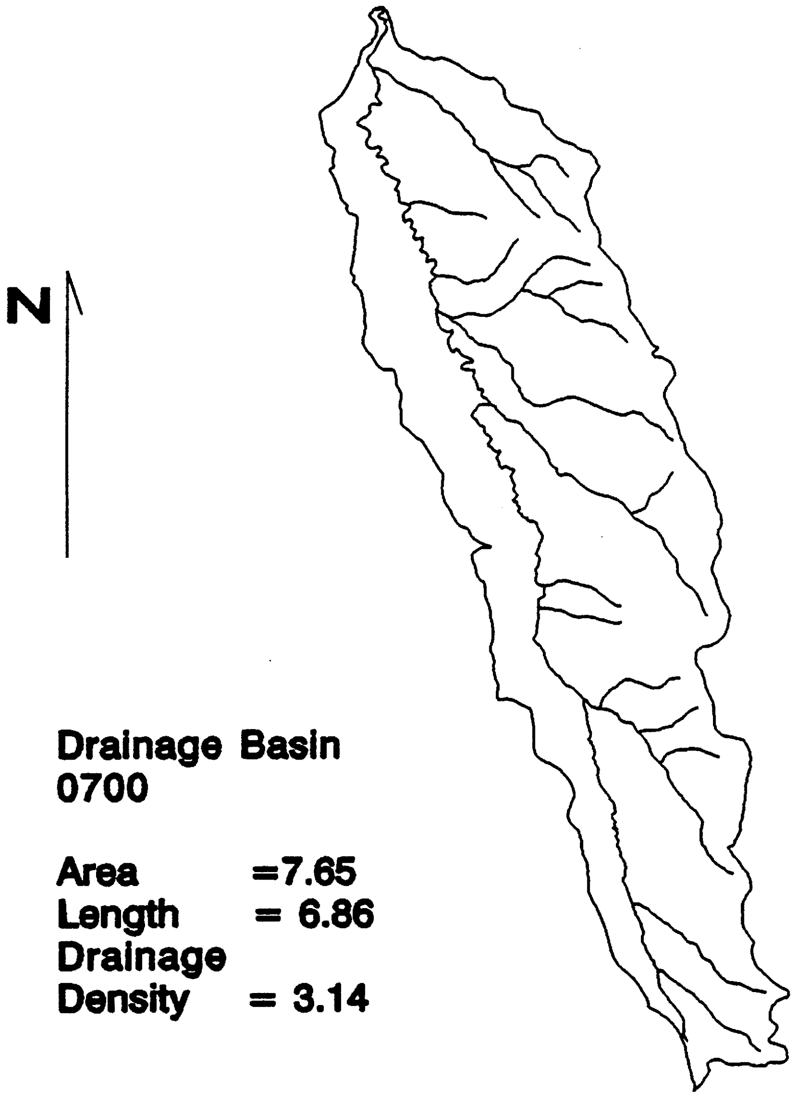
THIELEN DRAW, 2200
CROSS SECTION 0+81.30

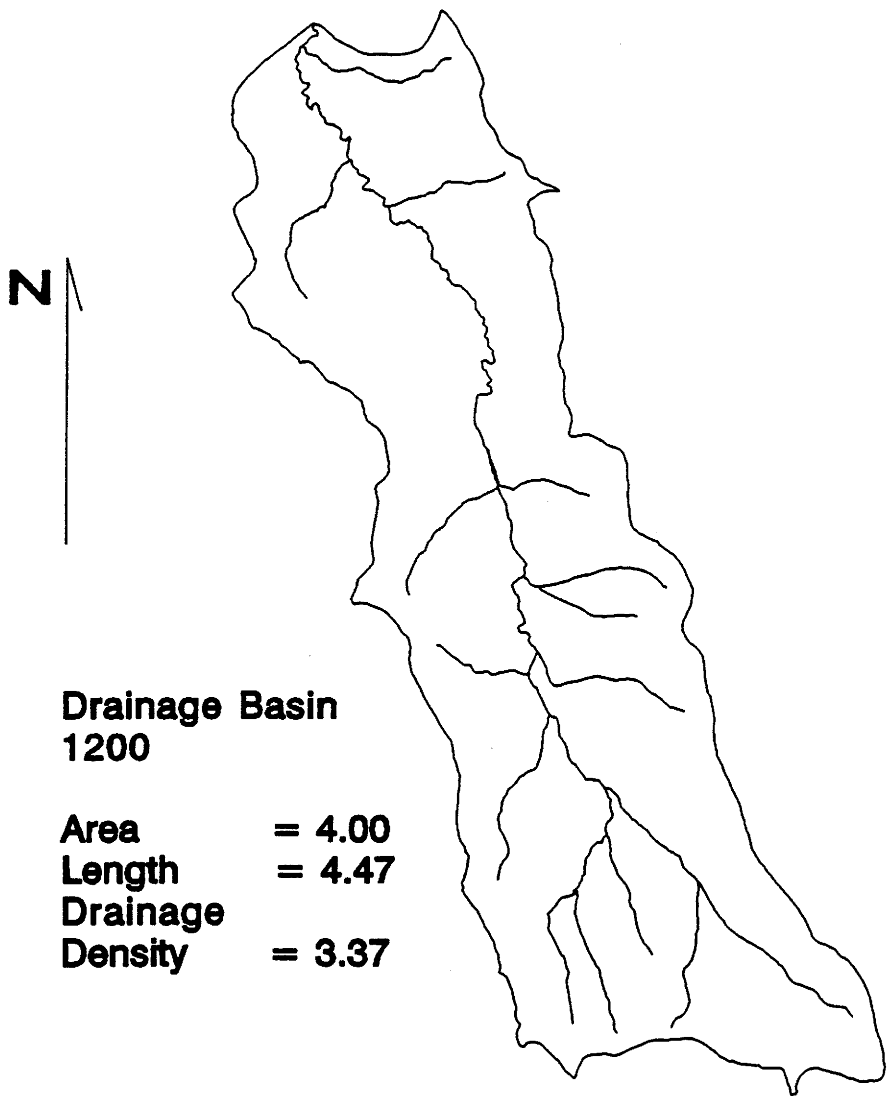




Drainage Basin
0500

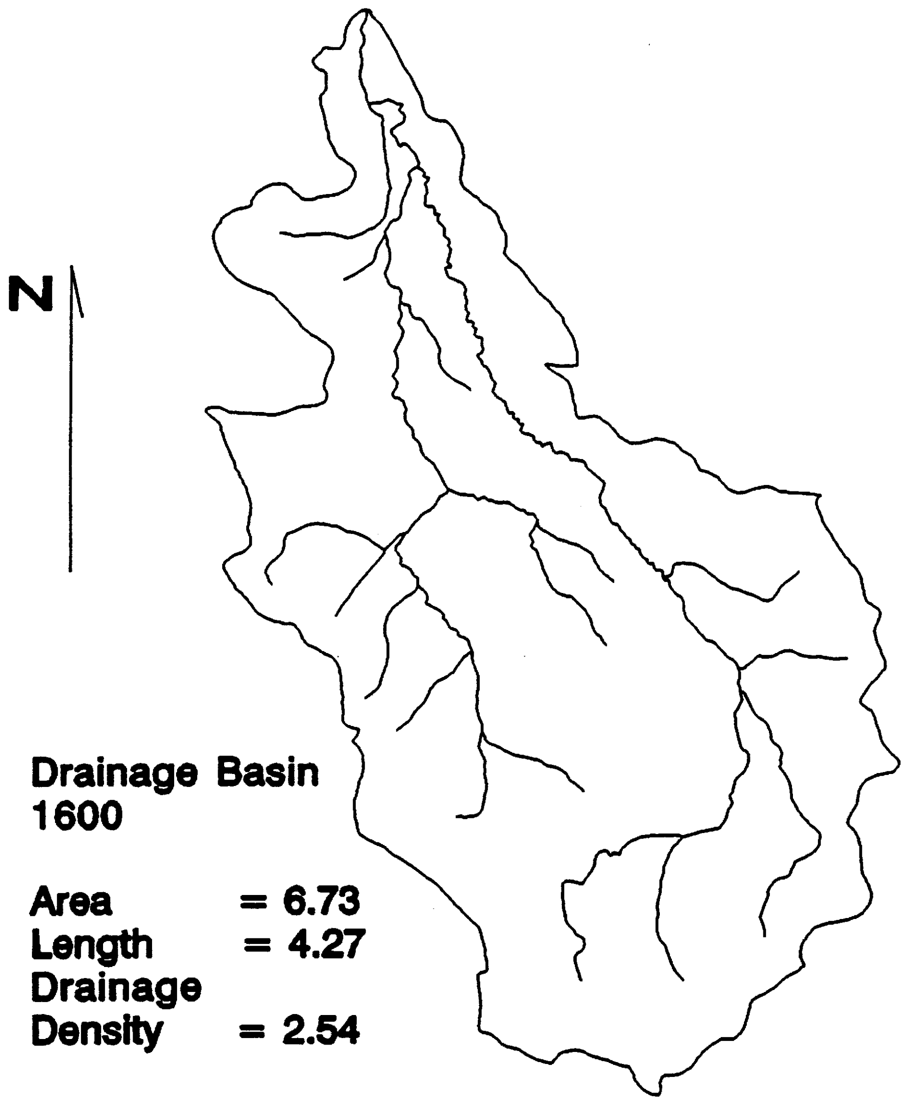
Area = 3.18
Basin Length = 3.20
Drainage Density = 3.49

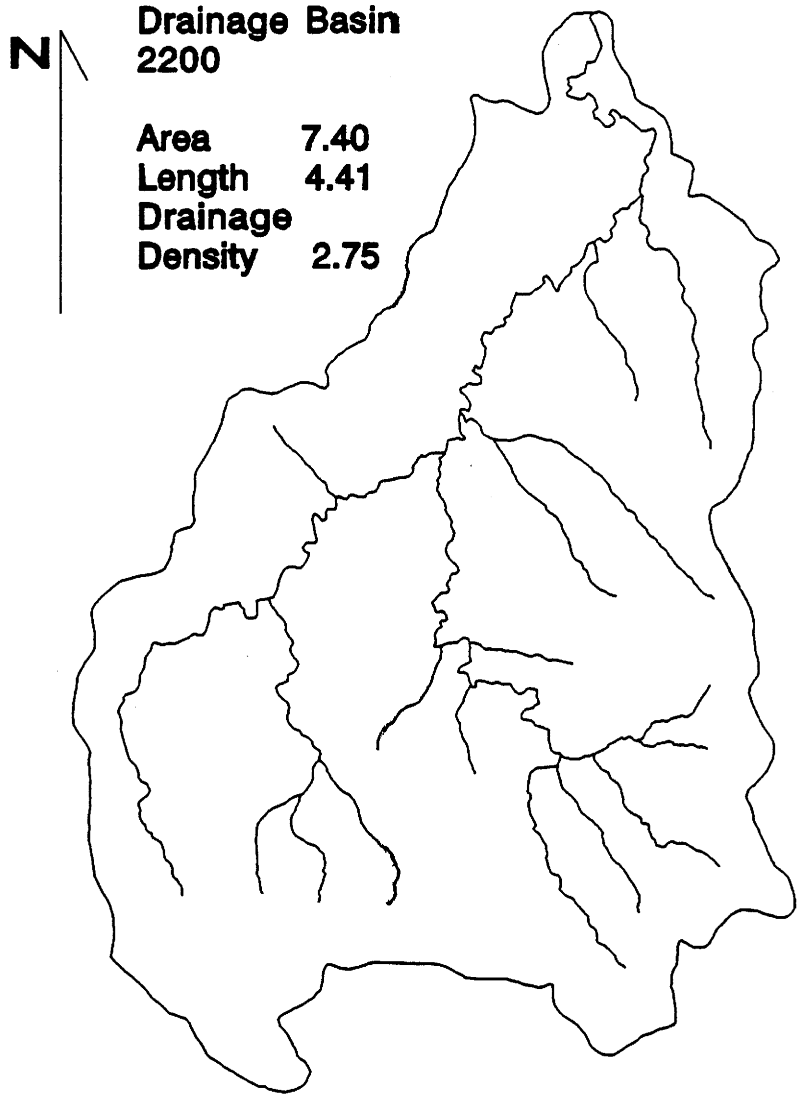

N
Drainage Basin
0700
Area =7.65
Length = 6.86
Drainage
Density = 3.14



Drainage Basin
1200

Area = 4.00
Length = 4.47
Drainage
Density = 3.37

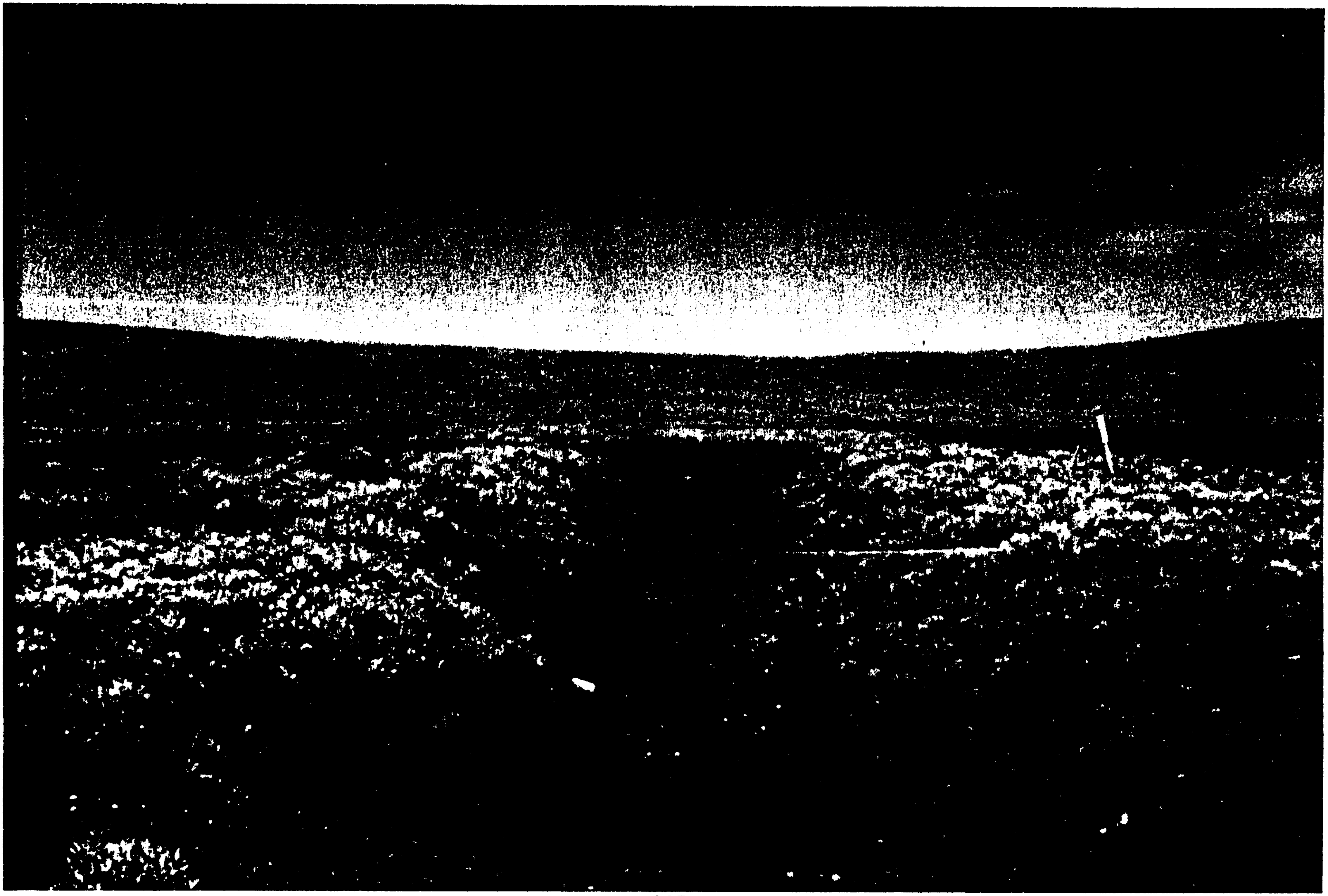

N
Drainage Basin
1600
Area = 6.73
Length = 4.27
Drainage
Density = 2.54

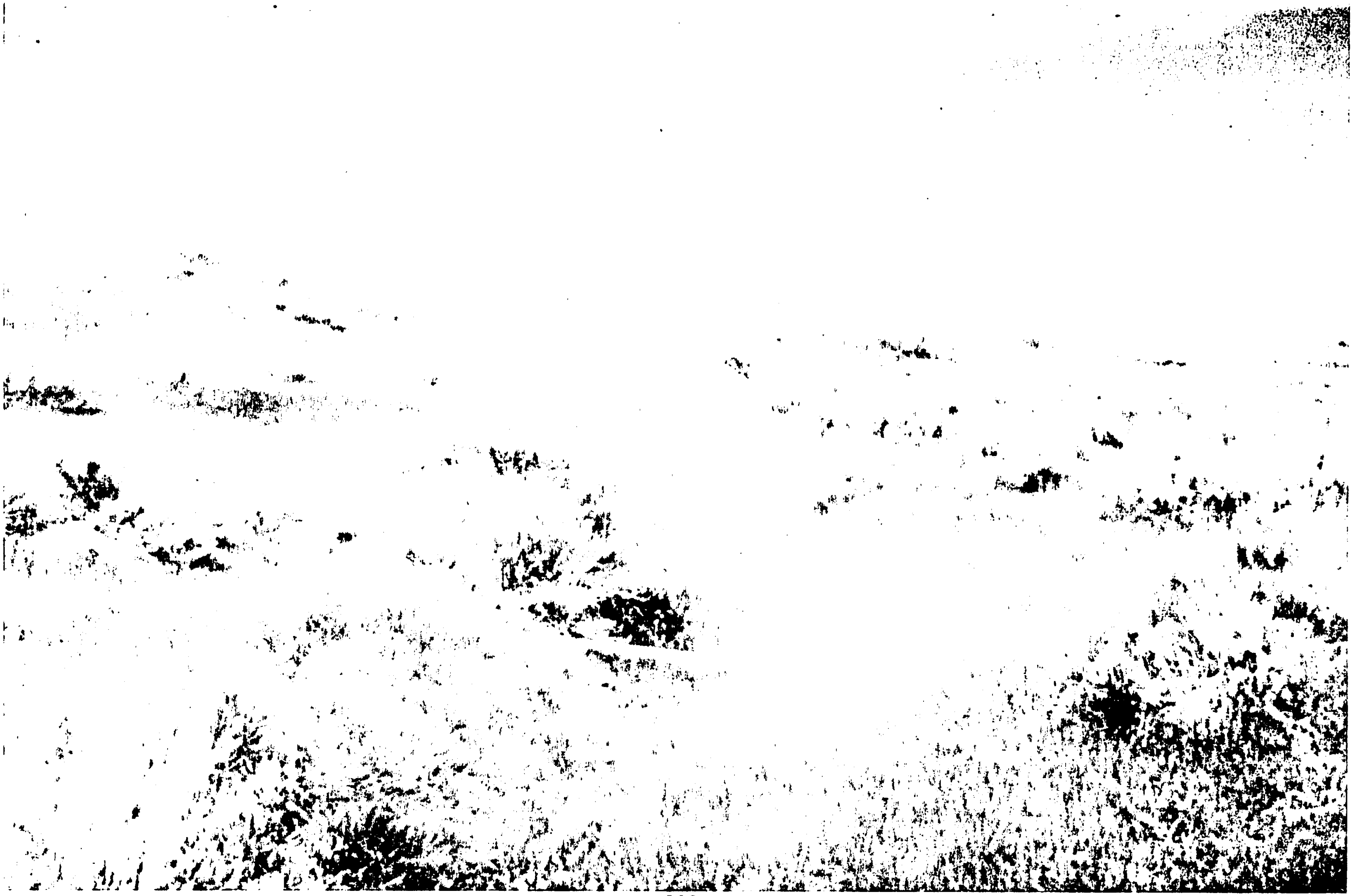

N
Drainage Basin
2200
Area 7.40
Length 4.41
Drainage
Density 2.75

Strata "C" third order raw data by study reach, cross section, and bank identification.

BASIN I.D.	CROSS SECTION NUMBER	BANK I.D.	AREA (feet²)	TOP WIDTH (feet)	AVERAGE DEPTH (feet)	FLOOD-PLAIN WIDTH (feet)
0500	0+00.00A	HIGH	2670.90	265.90	10.00	
0500	1+51.00A	HIGH	2369.20	283.30	8.40	
0500	0+00.00B	HIGH	4364.20	202.80	21.50	25.20
0500	0+65.50B	HIGH	4505.30	207.60	21.70	18.70
0700	0+00.00A	HIGH	1041.80	155.10	6.70	79.20
0700	1+45.00A	HIGH	1247.70	163.80	7.60	97..30
0700	0+00.00C	HIGH	1100.10	211.70	5.20	136.50
0700	6+39.00C	HIGH	1256.10	203.00	6.20	157.60
1200	0+00.00A	HIGH	2047.60	273.00	7.50	155.80
1200	14+63.00A	HIGH	1177.10	227.40	5.20	155.50
1200	0+00.00B	HIGH	1043.20	185.50	5.60	89.30
1200	4+54.00B	HIGH	911.70	151.90	6.00	100.40
1600	0+00.00A	HIGH	103.80	56.10	1.90	
1600	1+32.50A	HIGH	34.80	31.30	1.10	
1600	0+00.00B	HIGH	80.60	25.60	3.10	
1600	0+90.00B	HIGH	92.60	32.10	2.90	
1600	13+18.30B	HIGH	153.60	96.30	1.60	
1600	14+36.80B	HIGH	167.70	86.00	2.00	
2200	0+00.00B	HIGH	64.40	35.00	1.80	
2200	1+02.80B	HIGH	50.50	24.20	2.10	
2200	0+00.00C	HIGH	80.20	24.10	3.30	
2200	0+79.90C	HIGH	85.00	23.70	3.60	
2200	0+00.00D	HIGH	143.10	38.80	3.70	9.20
2200	0+81.30D	HIGH	106.00	24.90	4.30	11.10
0500	0+00.00A	MEDIUM	319.70	65.10	4.90	
0500	1+51.00A	MEDIUM	215.70	56.70	3.80	

BASIN I.D.	CROSS SECTION NUMBER	BANK I.D.	AREA ($feet^2$)	TOP WIDTH (feet)	AVERAGE DEPTH (feet)
0500	0+00.00B	MEDIUM	163.30	59.90	2.70
0500	0+65.50B	MEDIUM	77.70	41.50	1.90
0700	0+00.00A	MEDIUM	385.30	103.50	3.70
0700	1+45.00A	MEDIUM	27.60	31.20	0.90
0700	0+00.00B	MEDIUM	66.30	43.90	1.50
0700	0+86.70B	MEDIUM	48.50	50.40	1.00
1200	0+00.00B	MEDIUM	10.60	12.50	0.80
1200	1+35.00B	MEDIUM	9.30	9.50	1.00
1200	4+54.00B	MEDIUM	8.00	12.00	0.70
1600	0+00.00A	MEDIUM	16.30	20.00	0.80
1600	1+32.50A	MEDIUM	6.70	9.50	0.70
1600	13+18.30B	MEDIUM	10.50	13.20	0.80
1600	14+36.80B	MEDIUM	11.60	12.10	1.00
2200	0+00.00A	MEDIUM	166.40	51.80	3.20
2200	0+79.60A	MEDIUM	165.60	49.20	3.40
2200	0+00.00B	MEDIUM	19.30	14.90	1.30
2200	1+02.80B	MEDIUM	26.80	14.70	1.80
2200	0+00.00C	MEDIUM	70.00	19.50	3.60
2200	0+79.90C	MEDIUM	76.70	21.10	3.60
2200	0+00.00D	MEDIUM	99.50	25.00	4.00
2200	0+81.30D	MEDIUM	89.10	21.50	4.10
0500	0+00.00B	LOW	3.10	11.60	0.30
0500	0+65.50B	LOW	1.30	9.00	0.10
0700	0+00.00A	LOW	8.60	15.30	0.60
0700	1+45.00A	LOW	5.60	10.60	0.50
0700	0+00.00B	LOW	3.10	11.00	0.30





APPENDIX VI

ABSTRACTS OF RESULTING THESES AND PUBLICATIONS

Jensen, Lee E., <u>Characterization of Drainage Networks for Mine Land Reclamation in the Eastern Powder River Basin, Wyoming</u>, M.S., Department of Range Management / Wyoming Water Resources Center, July 1994.

There are 15 active and several proposed and discontinued coal mining operations in the Eastern Powder River Basin, Basin. The accessibility and quality of coal in the basin lend to its economic desirability. The current life-of-mine estimates indicate that each mine will disturb and then reclaim between 959 to 13,217 acres before completion of mining activities.

An alternative to current engineering approaches, the Geomorphic Approach, was applied in this study. A total of 384 drainage basins were selected and analyzed. There were 25 or more geomorphic characteristics delineated and measured for each basin from U.S.G.S. 1:24,000 quadrangles. Additionally, field investigations were conducted to quantify cross-sectional and longitudinal profile characteristics of 58 drainage networks.

The geomorphic characteristics measured from U.S.G.S. 1:24,000 quadrangles were utilized to classify third order drainage basins into three separate strata. The geomorphic characteristics were then used to develop design equations for the reconstruction of drainage basins and networks within each strata by order. Approximately 200 significant design equations were developed for reclamation in the Eastern Powder River Basin.

Anderson, Anthony J., A Classification of Drainage Basins in the Eastern Powder River Basin Coal Field of Wyoming. M.S., Department of Range Management/Wyoming Water Resources Center, July 1994.

Current and potential coal mining operations in the Powder River Basin have increased the need for knowledge regarding drainage basin form and function in that region. Quantitative analysis of erosional landforms has derived and defined variables that can distinguish drainage basins. This study combined quantitative morphometric, substrate, and surface cover variables with multivariate statistics to develop a classification system for low order watersheds in the Powder River Basin Coal Field in Campbell County Wyoming.

Three hundred eighty-four low order drainage basins were selected from USGS, 1:24000, 7.5 minute, topographic quadrangles. Fifteen quantitative and six categorical variables were used to characterize and describe each basin. Principal components analysis, cluster analysis, and discriminant function analysis were used to categorize the basins in each order. The resulting categories were altered as necessary after correlation key parameters were analyzed.

The resulting classification has three strata defined by geology, basin area, and gross basin slope of the third order drainage basin. Second and first order basins were classified by the third order stream to which they are tributary.