PAP-701

DEVELOPMENT AND TESTING

OF

GRAVEL SUBSTRATE SAMPLING TECHNIQUES

Submitted to:

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May 28, 1993

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Executive Summary

Techniques for sampling substrate material, armour layer, transport material, and bulk density are discussed. Experience in field testing these methods on the North Platte, Gunnison, Rio Chama, and Stanislaus rivers is discussed, and recommendations for improvement are presented.

Project objectives were to develop sampling techniques that are consistent with numerical modelling techniques, that may be used to determine the particle size distribution of the substrate and armour materials, to quantify and describe the material in transport over the stream surface, and to field test the developed techniques.

A drum sampling technique was developed to sample the armour and substrate material. A 30-gallon drum is placed on the streambed to isolate a portion of the bed from the flow. The armour layer material is removed from the area enclosed by the drum. Successive drum placements are made to obtain the desired sample size. Following excavation of the final armour layer sample, the substrate material is excavated from the area defined by the drum. The sampling process becomes more complex when the drum becomes submerged because of the washout of fine particles and the difficulty of working in high flows. When the sampler is used in conjunction with a filter cloth sampling bag placed over the top of the drum and an anchoring system, the sampling technique proved to be successful in retaining the fine material that was washed out while the drum sample was submerged. The method was tested in flow depths of up to four feet.

Bulk densities were measured at the test sites using a procedure devised by Dr. R. T. Milhous. Substrate material from the center of a rigid frame is excavated. The volume of the depression is determined by covering the frame with plastic sheeting and filling it with known volumes of water before and after the excavation of the depression. The weight of the material excavated is determined and the bulk density of the substrate material can be computed. Analyses were performed to determine the void ratios of the insitu substrate material but were found to be unreliable due to the magnitude of errors that ocurred during the bulk density determination process.

Samples were collected to characterize the surface material in transport applying several experimental techniques. Hydraulic dredging of surface fines with a drill operated pump were attempted but proved unsuccessful due to clogging of the pump. A swirl sampling technique was developed that suspended the surface material in a column of water isolated by the drum sampler while a vertically integrated sample was obtained. Conclusions regarding the results of the swirl technique are inconclusive. The dredging and swirl sampling techniques were used in situations where the surface material was so minimal that a grab sample could not be obtained by hand. When sufficient quantities of surface material allowed a grab sample to be obtained, the sample was taken from an area isolated by the drum or in the lee of a large roughness element.

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The drum sampling technique proved successful for sampling armour and substrate layers of cobble and gravel bed streams. Field studies demonstrated that the drum sampler can be practically used for sampling bed material sizes up to 315 mm (12.4 in) in diameter. Comparisons with results of previous freeze core sampling on the Rio Chama river in New Mexico showed the drum sampler and freeze core sampler to compare closely in sampling particle sizes less than 100 mm (3.9 in), but differed in sampling the larger particles. The samples obtained with the drum sampler on the Rio Chama ranged from 0.7 mm (0.03 in) to 315 mm (12.4 in), while the samples obtained previously with a freeze core sampler ranged from 0.6 mm (0.02 in) to 120 mm (4.7 in).

Results and analysis of the field sampling procedures performed at the four study sites are presented, including error analysis regarding sample size where applicable. Observations for improvement and refinement of the sampling techniques are also presented.

Introduction

The reported project was undertaken as part of an interagency study between the U.S. Bureau of Reclamation and the U.S. Fish and Wildlife Service, on the relationships between flow and river channel characteristics and the removal of fine material from coarse sediment substrates. Colorado State University was contracted to assist in the development and testing of substrate sampling techniques. The project involved the evaluation of numerical studies and data collection from laboratory and field study sites. The work described herein addresses the methodology for field substrate sampling to support future numerical model investigations. All work was conducted as directed by Dr. R. T. Milhous.

Goals and Objectives

The goals of this study are:

(1) To develop substrate sampling techniques that are consistent and compatible with numerical modeling.

(2) Provide specific field data that will allow the application and use of conventional numerical models.

The study objectives were to:

(1) Develop sampling techniques to map the particle size distribution on the stream substrate surface.

(2) Develop sampling techniques to quantitatively describe the material in transport over the stream substrate.

(3) Develop sampling techniques to quantitatively describe the particle size distribution of the stream substrate armor layer.

(4) Develop sampling techniques to quantitatively describe the particle size distribution below the stream substrate armor layer.

Alternative Approaches and Methods

Several substrate sampling techniques were identified and reviewed prior to the development of a new sampling technique that would meet the stated objectives. The substrate sampling techniques located in the literature are summarized in Table 1. Sampling techniques that are routinely used and that have been cited are reported.

Substrate Sampling Techniques

Many sampling devices haves been introduced throughout the development of bed material sampling techniques. However, the majority of these techniques are limited in their application to both fine and coarse bed materials. The search and review of substrate sampling techniques centered on sampling devices and techniques that are appropriate for use in sampling and differentiating substrate materiait and the armour layer. Specific focus was placed on sampling methods that are applicable to gravel and cobble bed streams. Schematics of the reviewed substrate sampling devices are presented in Appendix IV.

Freeze Core techniques use liquid CO_2 or N_2 to freeze the substrate material with a single probe or a three probe apparatus that is driven into the river or stream bed. The original single tube freeze core sampler, developed by Walkotten (1973), consisted of a copper tube and a brass tip. The apparatus was equipped with an injector composed of a series of equally spaced nozzles that uniformly injected liquid CO_2 to obtain a frozen core around the probe.

Following several improvements to the single tube freeze core device (Petts, 1989; Carling and Reader, 1981), Lotspeich and Reid (1980) introduced the tri-tube freeze core sampler, based on the same freeze core idea, but used three tubes arranged in a triangular fashion approximately 5-7.5 cm apart to obtain frozen cores that were larger and more representative than those obtained with the single tube technique. One advantage of freeze core techniques is that the potential exists to show vertical stratigraphy of the substrate if distinguishable layers are present (Walkotten, 1973; Everest, et al., 1982). .

The McNeil Core technique represents traditional attempts to sample substrates by means of cylindrical tubes or coring devices. The McNeil sampler, originally developed by McNeil and Ahnell (1964), was constructed of stainless steel and consisted of a tube that extended six inches from the bottom of a larger cylindrical basin. The tube diameter depends on the size of the gravel being sampled and varies from four to six inches. If the bed material is fine grained (e.g., sands and gravels) the tube portion of the sampler is driven into the stream bed to a depth of approximately six inches. Material from within the tube is excavated and retained in the basin. Once the sample has been extracted from the tube, a water tight cap is placed over the top of the tube to retain the suspended sediments in the basin. The suspended material is allowed to settle, and the water is decanted thereby retaining the material for gradation analysis.

Klingeman et al. (1982) developed a "Cookie-cutter" sampler to sample river beds consisting of predominantly large cobbles and when other types of sampling devices could not be used. The "Cookie-cutter" sampler consists of a US 55 gallon drum cut in half around the circumference. The section having two open ends is used. Teeth are cut around the

perimeter of one end of the sampler to enhance its placement into the streambed. To complement the drum, an underwater sample box is used to collect fines that are washed from the drum during excavation of the sample. The sample box is rectangular, with dimensions of 69 cm (27 in) long by 31 cm (12 in) high by 41 cm (16 in) wide, with one end open. The open end of the box is shaped to attach to the drum, while a #200 mesh screen is fastened across its downstream opening. The sampler may be operated by one or two persons and is driven into the bed. The armour and substrate layers are extracted from the area defined by the perimeter of the drum and retained for analysis.

One of the most common grid sampling methods is the pebble count technique (Wolman 1954). Approximately 100 stones are randomly selected from the surface of the streambed. The particle axes are measured and the dimensions are recorded under the appropriate size classifications. The particle analysis yields a frequency by number size distribution curve from which summary statistics, such as median grain size, can be directly determined. Individual particles can be selected using either a grid or transect method, where particles under grid points are measured. The particle selection can also be performed by pacing across the bed surface and measuring the first particle encountered under the toe of each step. Since the pebble count technique is random, the relative size frequency of any given particle size on the bed is approximated by the percentage of times it was encountered in the pebble count. According to Kellerhals and Bray (1971), pebble count results are theoretically equivalent to size distributions obtained from bulk samples.

Grab sampling techniques are the simplest and least expensive methods for sampling substrates. The most traditional grab sampling technique requires a shovel to excavate the

substrate material from river bed. Grab sampling methods have proven to be very reliable on dry river beds, banks, and under conditions where flow depths are less than 40 cm (1.3 ft.) and velocities are less than 80 cm/s (2.6 ft/s) (Grost. et al.. 1991). Outside these limits, the fine particles are often washed away in the process of excavating the sample (Petts, 1989).

Fripp and Diplas (1993) developed and tested a new technique for under water sampling. The Fripp and Diplas technique requires that the armour layer first be removed using conventional surface sampling methods. A cylindrical piston device, with clay on the piston, is then firmly pressed onto the streambed drawing the piston up into the cylinder to protect and retrieve the sample. The diameter of the cylinder holding the piston is 145 mm (6 in). According to Fripp and Diplas (1993), the sampler is applicable for material predominantly less than 40 mm (16 in) in size.

Development of New Methods

Drum Sampler

The particle size range found in gravel and cobble bed streams is usually quite variable, consisting of particles from fine sands and silts to large cobbles (i.e. ~0.001 mm to ~300 mm). Church et al. (1987) state that it is impractical to maintain a single method of measurement to characterize this large variability of grain size. To obtain an accurate measure of the entire range of particles sizes in a cobble bed stream, it often becomes necessary to remove large amounts of material to obtain a statistically representative sample. Sample sizes obtained with most conventional sampling devices are quite small (usually less

than 30 lbs (14 kg), and a large number of repetitions must be performed to obtain an adequate sample size.

Since the objective is to develop a simple sampling device applicable for obtaining large samples, yet portable enough for use in remote field applications. a drum type sampler consisting of an open ended 30 gallon steel drum, 18 in.(46 cm) in diameter, was selected. The closed end of the drum is cut off leaving a drum length of 24 in. (61 cm). A photograph of the sampler is presented in Appendix VI.

Spatial control in sampling the armour layer is provided by sampling the material within the area enclosed by the drum, approximately 244 in^2 (0.16 m^2). The drum sampler is placed on the stream bed and the armour layer is removed by hand from within the sampler. Particles lying under the edge of the sampler are discarded if less than 50 percent of the particle exists in the sampling area. The armour layer for this sampling procedure is defined as the particles that are exposed to the streambed surface. Field sampling experience has shown that biological growth, aufwuchs, commonly found on the surface material is useful in discerning the armour layer. The armour layer particles are removed and retained apart from the substrate layer sample. The drum sampler is placed at additional locations to obtain the desired sample size. Each consecutive drum placement is sequentially positioned upstream of the prior placement in order to minimize disturbance to the sampling area.

Following the removal of the armour layer at the final drum placement, the substrate material is excavated to a depth of 6-12 in (15-30 cm) and retained for particle size analysis. The excavation process involves removing larger particles by hand, digging to loosen the material, and removal of the finer material. The sampling tools used to aid in excavation of

the bed material include a stainless steel bowl (six inches in diameter (15 cm) and 2 inches deep (5 cm)) and a large prying device used to loosen and remove large particles.

Placement of the drum in less than 1.5 ft (46 cm) of water depth provides a column of water isolated from the current. The fine material suspended in the water column during sample excavation can be quantified by sampling the column and performing an appropriate laboratory test such as hydrometer or visual accumulation tube analysis. Under conditions where flow depths are in excess of 1.5 ft, a filter cloth sampling bag was designed for placement over the top of the drum sampler in order to contain the sample as it is excavated from the bed. The dimensions of the sample bag are approximately 32 inches (81 cm.) wide by 60 inches (152 cm.)long, with a filter mesh size of approximately 0.149 mm. The filter material used throughout the development phase was a Mirafi Fabric #180N.

The sampling bag is placed over the top end of the drum and secured with an adjustable shock cord. A six inch (15 cm) slot cut into the sample bag at the top of the sampler allows access for one arm and/or sampling tools that may be warranted. An anchoring system becomes necessary when the sampler is used in submerged conditions when flow currents exceed 2.5 ft/s (80 cm/s). Field applications have been tested in depths of up to four feet by divers equipped with wetsuits and snorkeling equipment. Sampling in depths greater than four feet would require certified SCUBA divers equipped with oxygen tanks and buoyancy control.

Stream Substrate Bulk Density

A technique proposed by Dr. R. T. Milhous was implemented at three of the four study sites. The technique utilizes a rigid frame that is placed on a dry section of the stream bed, such as an exposed cobble bar or bank, and is considered representative material. The frame has inner dimensions of 1 m x 1 m, and is constructed of 2 in (5 cm) x 4 in (10 cm) redwood. The armour layer is removed prior to placement of the frame. The frame is secured with rebar stakes, and any loose material on the surface of the site is smoothed into the gaps between the frame and the substrate material. Four mill plastic sheeting is placed over the frame and preweighed water is pored into the frame until incipient overflow occurs. While water is added to the frame, the plastic is smoothed onto the substrate material to minimize air bubbles and pockets of water underneath the plastic. The contained water is then removed after recording the total weight of water added.

Substrate material is excavated from the center of the area enclosed by the frame with shovels to form a depression approximately 2 ft (61 cm) in diameter and 1.5 ft (46 cm) deep. The material is retained for weighing and particle size analysis. After excavation, the plastic is replaced over the frame and water is added to the frame in a similar fashion until incipient overflow is achieved.

Care is taken during the placement of the plastic to minimize sampling errors. Potential measurement errors are:

1) Error in estimating the weight of water needed to fill the bulk density frame using a 1 kg graduated hook scale was $\pm$ 0.2 kg.

2) Error in estimating the weight of water needed to fill the bulk density frame using an Ohaus gram balance was $\pm$ 0.02 kg.

3) Error in the water volume estimate due to the surface roughness under the plastic is estimated at ± 0.25 kg.

4) Error in estimating the point at which the addition of water caused overflow of the bulk density frame. The estimated variability of the water surface at the point of overflow was ± 2 mm, which converts to ± 2000 ml or ± 2 kg for a 1 m^2 frame area.

The total potential cumulative errors that could occur are ± 2.45 kg (5.4 lb) and ± 2.27 kg (5.0 lb) for the hook scale and gram balance, respectively. These errors in weight estimation convert to volumetric errors of 2.5E-3 m^3 (8.7E-2 ft^3) and 2.3E-3 m^3 (8.0E-2 ft^3), respectively.

The volume of the excavated depression is determined by subtracting the initial weight of water required to fill the frame from the final weight, and then converting the weight to a volume. This procedure assumed the unit weight of water to be 62.4 lbs/ft^3 (1000 kgs/m^3). The resulting bulk density of the insitu material can then be calculated from:

$$\rho_b = \frac{W_d}{V} \tag{1}$$

where: ρ_b = bulk density of in situ material

W_d = dry weight of excavated material

V = volume of excavated depression

The dry weight of the excavated material is obtained from the laboratory analysis. Due to the potential errors in volume estimation, the bulk density for each study site is estimated within a specified range, which is dependent upon the magnitude of the estimated error.

Determination of bulk density at each study site is performed with the objective of defining an index that could be useful in studying the looseness of stream bed material. The potential for estimating density effects on the stability of bed material introduces a concept that may be useful in sediment transport studies. One means of estimating the streambed density is by determining the void ratio of the substrate material. The void ratio is calculated as:

$$e = \frac{\rho_b}{\gamma_w G_s} \tag{2}$$

where: e = void ratio

γ_w = unit weight of water. 62.4 lbs/ft^3 (1000 kgs/m^3)

G_s = specific gravity (determined from laboratory analysis)

Grid Sampling

Grid sampling involves the removal of stones, usually by hand, which are found at specific points defined by a grid or transect layout. The grid or transect layouts can be established by placing wire or string in perpendicular orientations at equal spacings and sampling the stone at each intersection point using predetermined distances on a surveying tape, or by simply pacing off a predetermined distance sampling the stone under the sampler's

toe after each pace.

Grid sampling is random and the relative frequency of any given particle size on the bed is approximated by its percentage of occurrence in the pebble count. According to Kellerhals and Bray (1971) pebble count results are theoretically equivalent to size distributions obtained from volumetric samples. Size distribution gradation curves for pebble count methods are developed by placing the particle median axis measurements into classes. The percentage of particles that are finer than each size class is determined by summing the total number of particles finer than each size class and dividing by the total number of particles sampled. The resulting gradation curves can then be plotted. Since volumetric sample analysis is usually based upon particle weights, it is desirable to convert these gradation curves to a weight distribution analysis for purpose of comparison to volumetric analysis results. The conversion from frequency to weight is accomplished by determining the weight of each sampled particle as well as the total sample weight. Knowing the specific gravity of the sample, determined from lab analysis, and the three axes. the weight of a particle can be estimated assuming an elliptical shape. The volume of a particle is then computed as:

$$V = \frac{4}{3}\pi abc \tag{3}$$

where: V = estimated volume of particle

a, b, c = lengths of the three particle axes

Furthermore, the weight of each particle is calculated as:

$$W = V\gamma_w G_s \tag{4}$$

where: W = estimated weight of particle

γ_w = unit weight of water

G_s = specific gravity of material (determined from lab analysis)

Therefore, the size gradations curves are generated by dividing the total weight of particles finer than each particle size, and dividing by the total calculated sample weight.

Surface Material Samples

A variety of surface sampling techniques were investigated at the test sites to determine a method that is successful in quantifying and characterizing the fine bed material that is transported by the flow. The methods examined are summarized.

1) Hydraulic dredging of the surface material was performed by using the drum sampler to isolate a portion of the bed from the stream flow, and removing the surface material from the area enclosed by the drum. The specific hydraulic dredging technique used consisted of an electric drill powered centrifugal pump, with a 5/8 in (1.59 cm) ID intake hose. However, the ports on the pump were only 2-3 mm in diameter. The drum was placed on a section of the stream bed. the intake hose was moved over the surface area defined by the drum. and a slurry sample was collected.

2) A swirl sampling technique was developed for conditions where minimal amounts of surface material are present and scoop techniques are not applicable. Swirl samples are obtained by placing the sampling drum on the streambed and then stirring and/or agitating the water column to force the surface material into suspension. A vertically integrated sample is obtained using a one quart Nalgene bottle. The suspended sample was retained for laboratory analysis.

3) The dredging and swirl sampling techniques were used in situations where the surface material was so minimal that a grab sample could not be obtained by hand. When sufficient amounts of surface material allowed a grab sample to be obtained, the sample was taken from an area isolated by the drum or in the lee of a large roughness element. The surface material was collected in ziplock bags and retained for laboratory analysis.

Photographic Sampling

Photographic sampling utilizes an under water camera which can be submerged to record the particle size distribution of the streambed. A grid or scale is required to quantify the particle sizes. Testing of photographic sampling techniques was performed at one study site. It was determined that further development of the technique is required for it to be adequately tested in the field.

Description of test sites

Four test sites were selected following a joint evaluation of candidate sites by the U.S. Bureau of Reclamation and the U. S. Fish and Wildlife Service. Criterion for potential test sites included the following:

1) Cooperation of river management organizations.

2) Applicability to developmental research (e.g. gravel and cobble bed rivers)

3) Availability of data from previous sampling studies (e.g., freeze core sampling)

The four test sites selected for sampling were;

1) North Plate River, downstream from Gray Reef Dam, Wyoming

2) Gunnison River, between Delta and the Redlands Dam, Colorado

3) Rio Chama River, between El Vado Dam and Abiquiu, New Mexico

4) Stanislaus River, between Knights Ferry and Oakdale, California

Prior to sampling at the four sites, a training session was conducted on the Poudre River, near Fort Collins, Colorado, by Dr. R. T. Milhous. Colorado State University representatives were familiarized with the drum sampling and the bulk density sampling concepts. Sampling procedures were conducted at the four test sites during the following time periods:

1)	North Platte River	August 17-20, 1992
2)	Gunnison River	January 19-22, 1993
3)	Rio Chama River	February 8-10, 1993
4)	Stanislaus River	March 15-19, 1993

A description of each test site follows.

North Platte

The North Platte test site is located near Casper. Wyoming, below the Grey Reef Dam. Three study locations were selected that correspond to three study sites being used for flushing flow studies by Dr. T. A. Wesche from the University of Wyoming. The three sites will be referenced as:

1. Upper or Grey Reef Site
2. Middle or Cottonwood Site
3. Lower or Boat Ramp site

Topographic maps showing the locations of each test site are presented in Figures 1-3. Additional information regarding exact sampling locations is included in Appendix I.

Flow conditions during field tests:

- Flow rate (8/18/92) = 541 cfs
- Flow rate (8/19/92) = 788 cfs
- Flow rate (8/20/92) = 800 cfs
- Maximum sampling depth = 3.7 ft. (8/18/92) (130 ft. south of gaging station)

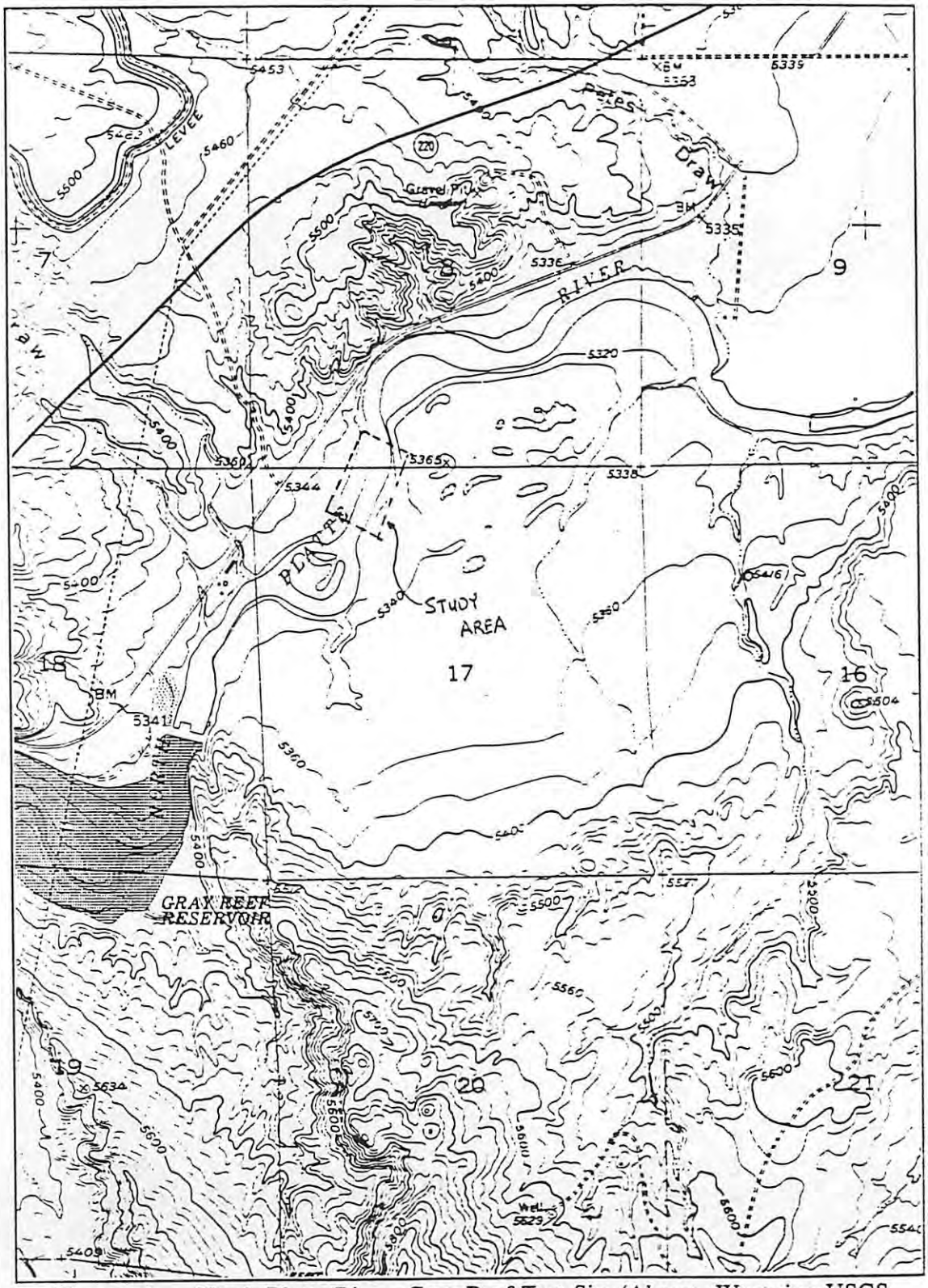


Figure 1. North Platte River, Grey Reef Test Site (Alcova, Wyoming USGS quadrangle map)

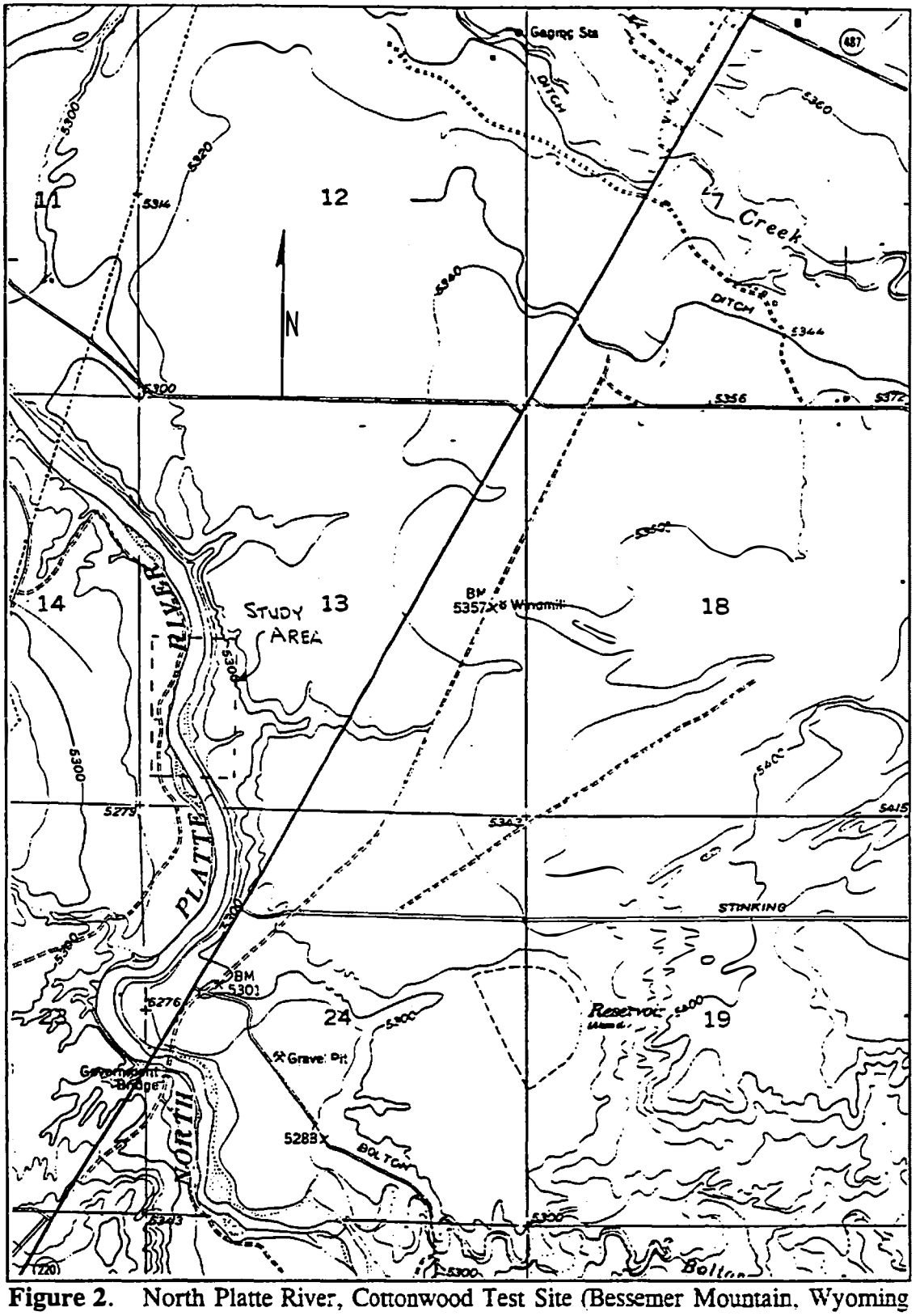


Figure 2. North Platte River, Cottonwood Test Site (Bessemer Mountain, Wyoming USGS quadrangle map)

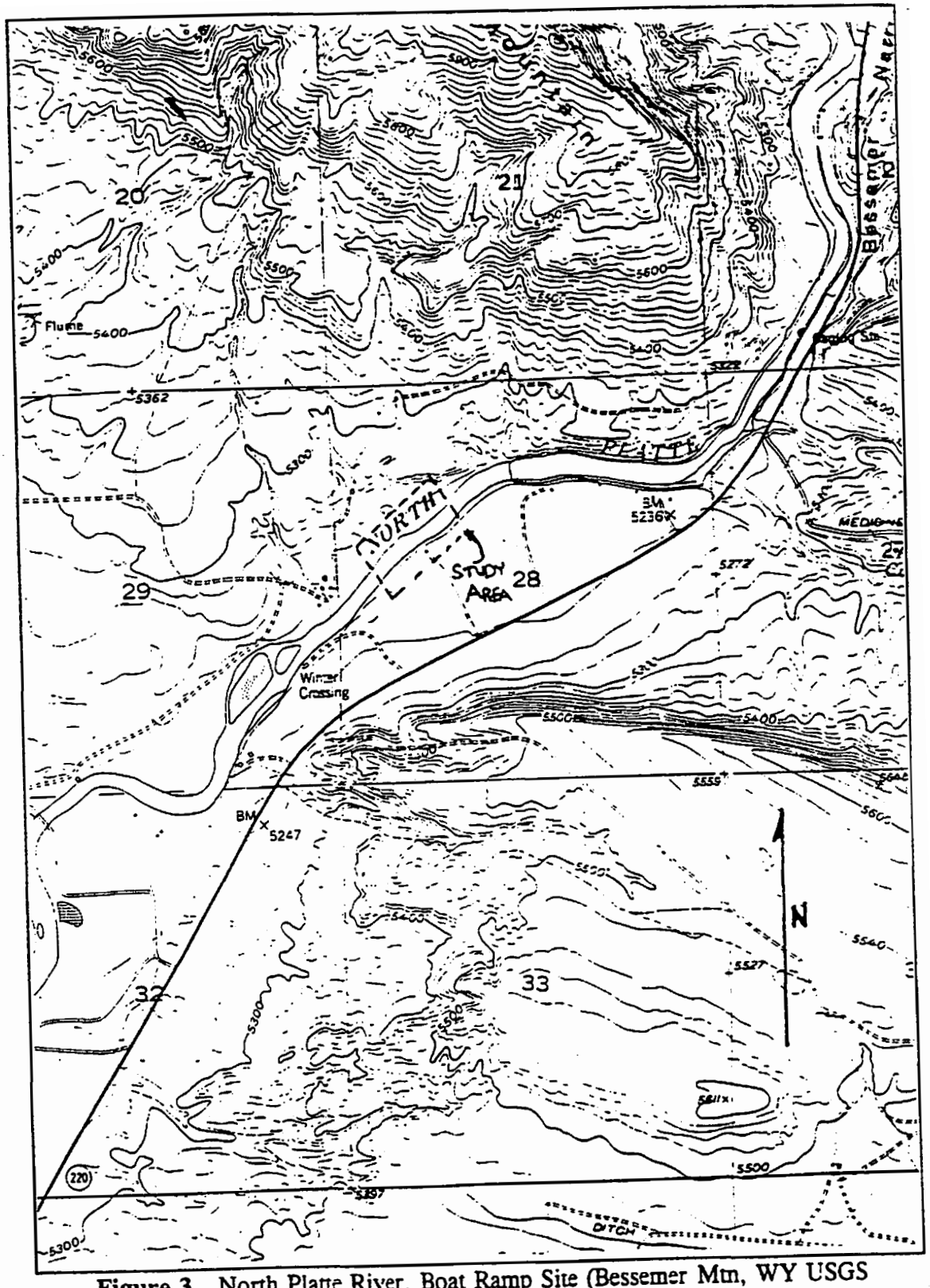


Figure 3. North Platte River, Boat Ramp Site (Bessemer Mtn, WY USGS guadrangle map)

Gunnison River

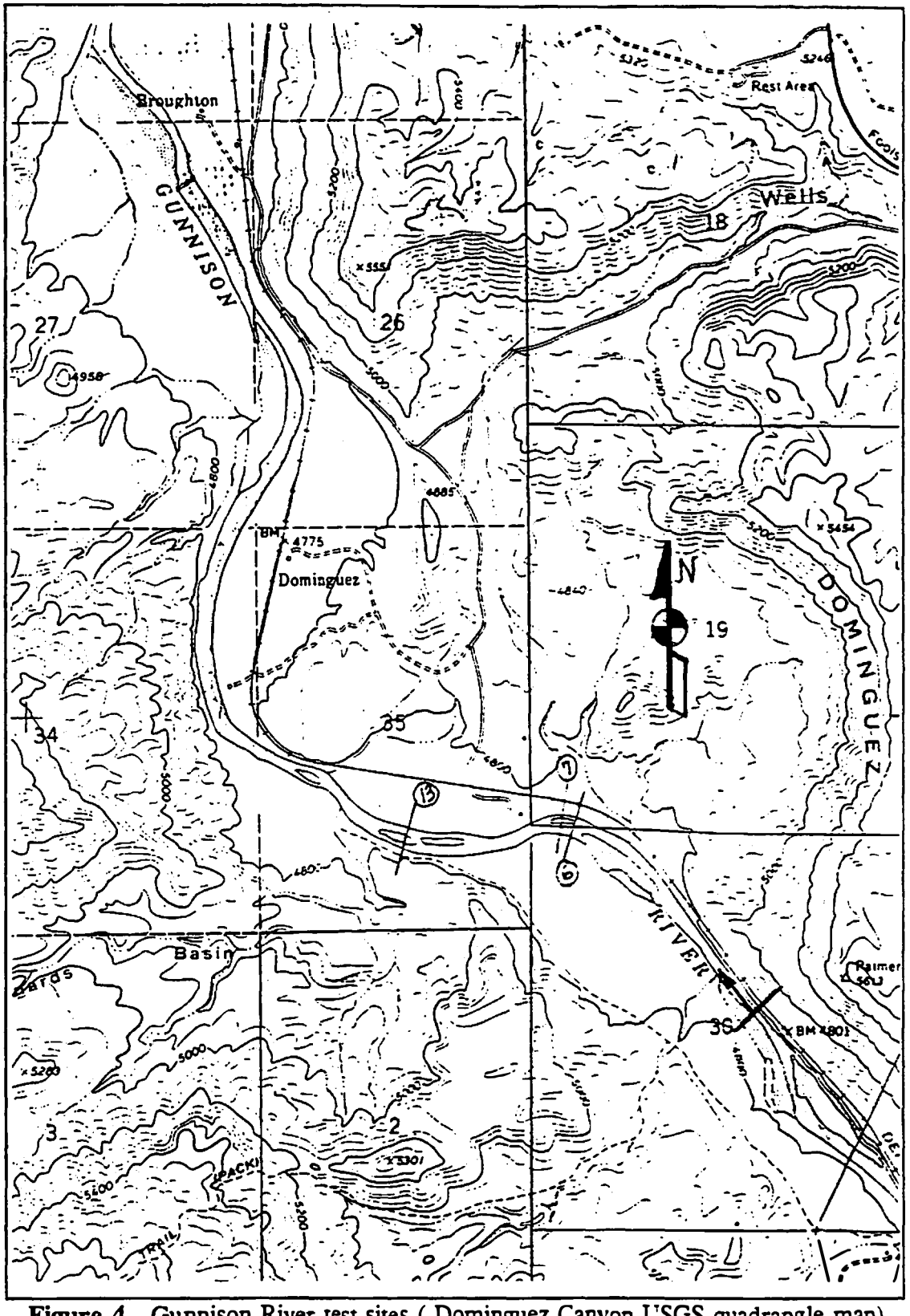
The test site on the Gunnision River is located approximately 20 miles south of Grand Junction, Colorado along U.S. Highway 50. A topographic map of the study reach is presented in Figure 4. The reach is divided into 19 cross sections, displayed in Figure 5, which were established by the U.S. Bureau of Reclamation.

River bed samples were taken at cross sections 6, 7, and 13. The river is accessible by vehicle near cross section 8, from which the other cross sections can only be accessed by boat or foot. A 14 ft. aluminum boat was used to transport sampling equipment to the study locations as well as hauling the bed material samples back to the vehicle.

For additional information regarding specific sampling locations refer to Appendix I.

Flow Conditions during field tests:

- Flow Rate (Jan.20) = 1140 cfs (32 cms) (gaging station at Whitewater)
- Flow Rate (Jan. 21) = 1050 cfs (30 cms) (gaging station at Whitewater)
- Maximum flow depth at sampling locations = 3.5 ft. (1.1 m) (X-Section 13)
- Water temperature = 36°F
- The turbidity was mild with water visibility around 1 foot (0.3 m).


Broughton
GUNNISON
Rest Area
Wells
18
26
27
4958
4685
BM
4775
Dominguez
N
19
DOMINGUEZ
35
34
13
9
RIVER
Basin
Raimer
35
BM 4801
3
2
5301
5200
5000
5600
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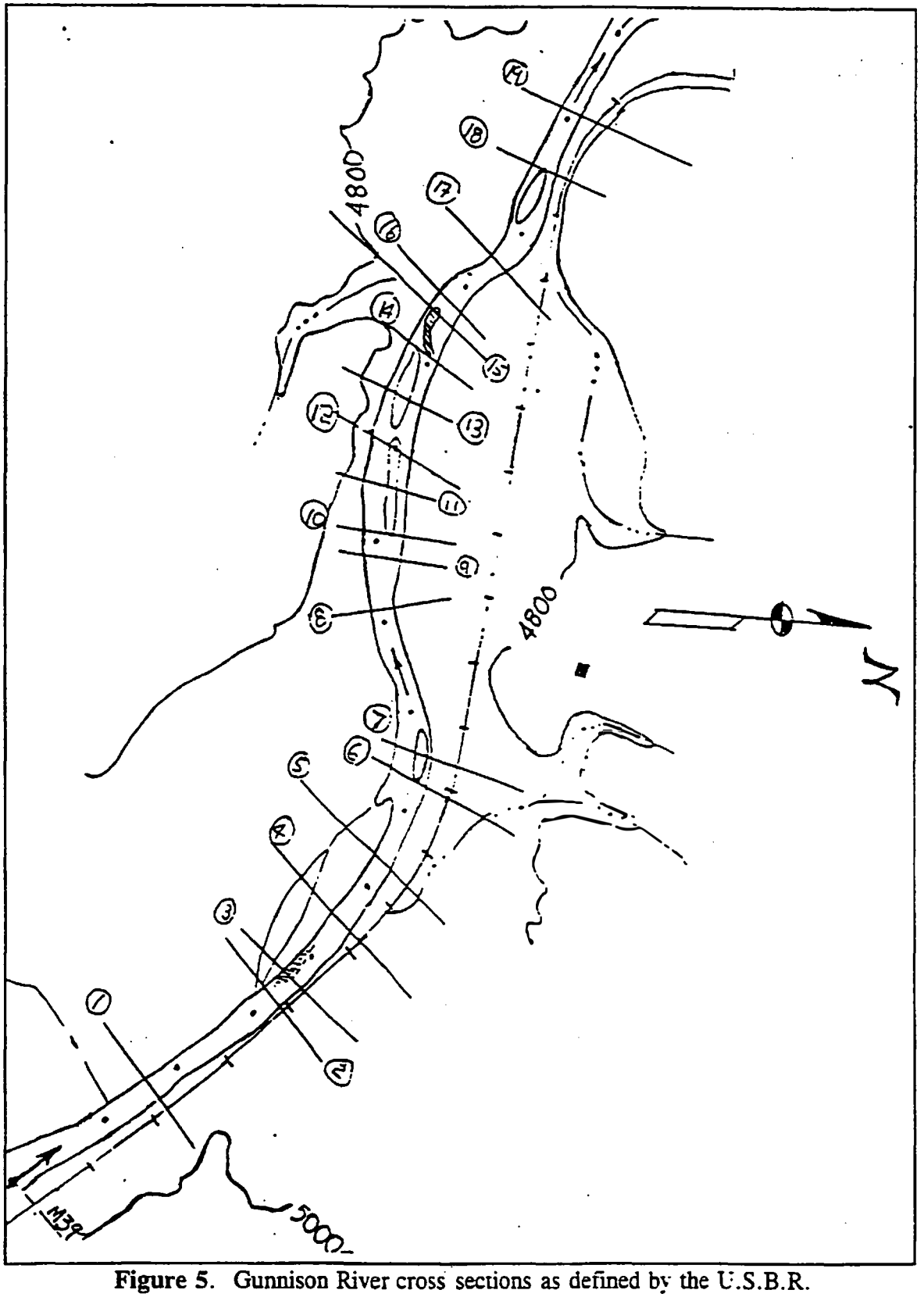

Figure 5. Gunnison River cross sections as defined by the U.S.B.R.

Rio Chama

The Rio Chama River is located in northern New Mexico approximately 60 miles south of Alamosa, Colorado. Flows in the Rio Chama are governed by controlled releases from El Vado dam. Minimum flows of 150 cfs are generally maintained from mid-September to mid March to support the reproduction of the brown trout and maintain the overall aquatic habitat stability. The two study sites selected for sampling were located 1.2 and 30.3 river miles downstream from El Vado dam. The section at mile 1.2 was selected for study to compare results with earlier studies that had been performed using freeze core and Hubble sampling devices. Data from one prior study, performed in 1992, was obtained from Mr. James L. Fogg of the Bureau of Land Management and is included in Appendix V.

The downstream section at river mile 30.3 was selected to study the variation in river bed characteristics between the upstream and downstream reaches. Previous freeze core and Hubble sampling had been performed at other sites that were of interest, but those sites could not be accessed due to impassible road conditions resulting from snowmelt. Figure 6 presents a plan view of the Rio Chama study area while Figures 7 and 8 display more detailed topographic maps of the specific test sites.

Flow Conditions during field tests:

- Flow Rate (Feb. 9) = 285 cfs (8.1 cms)
- Maximum flow depth at sampling locations = 2 ft. (0.6 m) (River mile 1.2)
- Water temperature = 38°F
- Turbidity at mile 1.2 was very low (river bed was clearly visible)
- Turbidity at mile 30.3 was high due to siltation from tributaries.

Figure 6. Plan view of Rio Chama study area

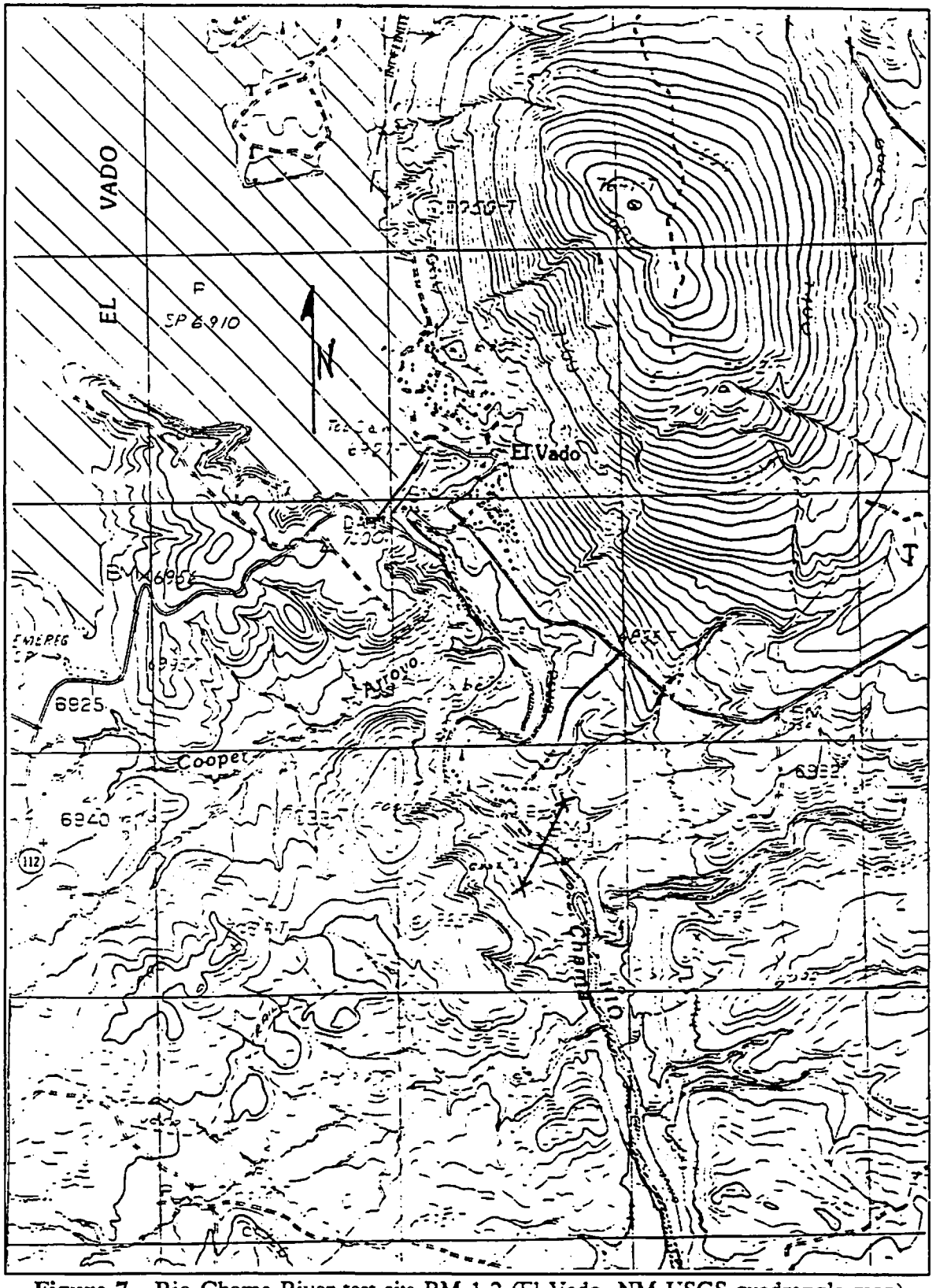

Figure 7. Rio Chama River test site RM 1.2 (El Vado, NM USGS quadrangle map)

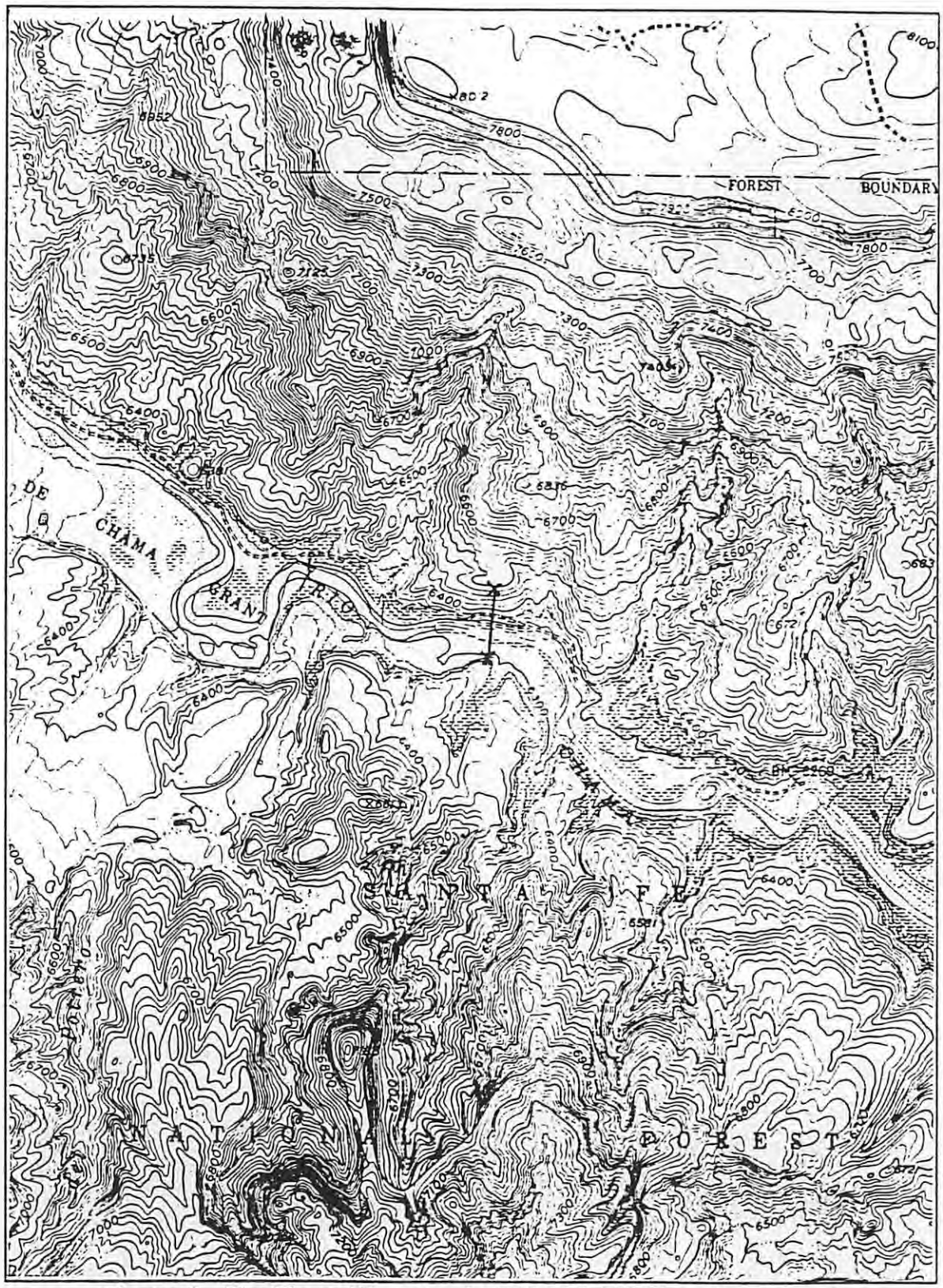

Figure 8. Rio Chama River test site RM 30.3 (USGS quadrangle map)

Stanislaus

The study area on the Stanislaus river is located between Knights Ferry and Oakdale, California. The study area, shown in Figure 9, is included in the Stanislaus River park system which is managed and regulated by the U. S. Army Corps of Engineers. Sampling procedures were performed at three locations along the study reach. Two substrate sampling procedures were performed, one pebble count was conducted and one bulk density determination was performed. Each of the sampling locations was selected by Dr. R. T. Milhous. A topographic map of the specific test sites is presented in Figure 10. The three sampling sites are located in an area known as Honolulu Bar, and were accessed by foot from the Honolulu Bar picnic area. Transect locations across the study reach were previously established by the U. S. Fish and Wildlife Service. The substrate sampling test sites were located and referenced according to the transect locations. Specific locations of the three test sites, bulk density sample, and the transects established by the U. S. Fish and Wildlife Service are included in Appendix I.

Flow Conditions during field tests:

- Flow Rate (March 16) = 200 cfs (5.7 cms)
- Maximum flow depth at sampling locations = 3.5 ft. (0.9 m)
- Water temperature = 40°F
- The turbidity was low, water visibility was approximately 2-3 feet (0.6-0.9 m).

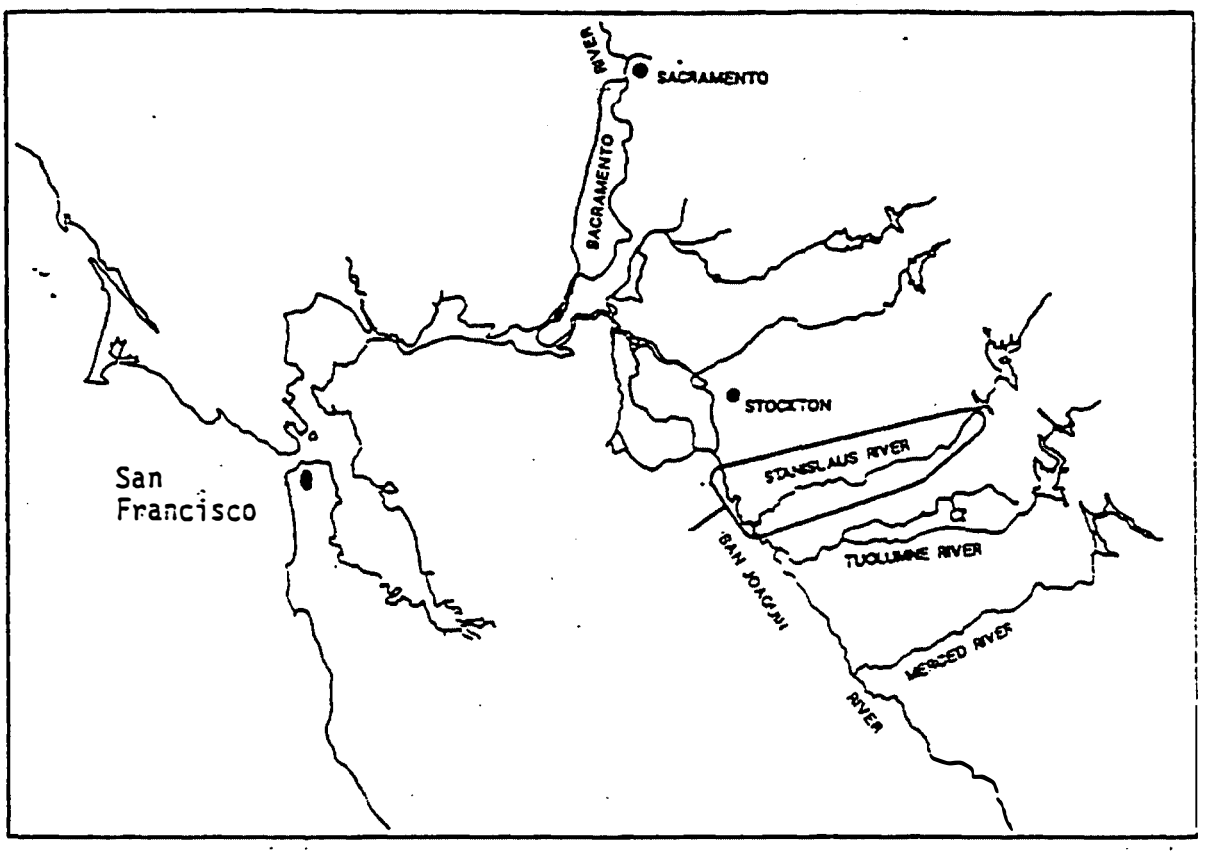

Figure 9. Plan view of the Stanislaus River study area

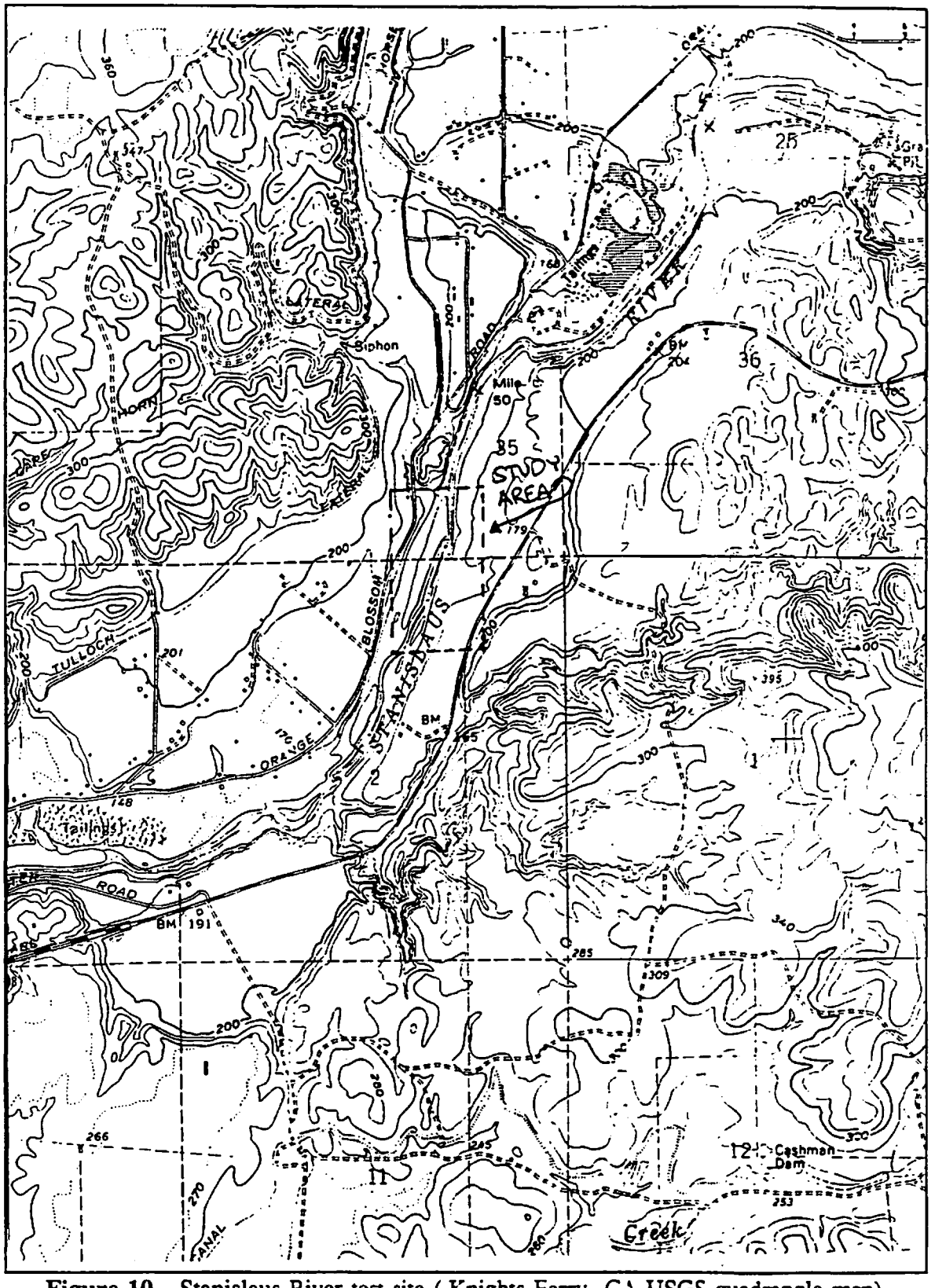

Figure 10. Stanislaus River test site (Knights Ferry, CA USGS quadrangle map)

Analysis and Results

Throughout the field testing program the armour. substrate and surface material samples collected at each test site were retained and delivered to soils laboratories for analysis. Particle size analysis for all the size fractions as well as specific gravity analyses were requested. The dry weight for each sample was recorded, including the bulk density sample weight.

The weight of each collected sample is important with regard to statistical error analysis. Adequate sample weights are directly proportional to the size of the largest particles occurring in the bed material being sampled. The greater the particle sizes present in a river bed, the larger the sample size needed to obtain a representative sample of the large particle size fractions. Researchers have conducted empirical investigations to quantify adequate sample weights and determine errors that result when adequate sample sizes cannot be obtained. Comparisons of the results from each field site are presented in the following sections, including suggested sample sizes and error analysis. bulk density comparisons, grid sampling results, and surface material sampling results. In addition. results from the drum sampling method are compared to results from previous tests performed with a tri-tube freeze core sampler. Results from the field sites, as received from each laboratory, are presented in Appendix II. The range of particle sizes sampled varied from less than 0.001mm (0.004 in) to 315 mm (12.4 in)

Comparison of test sites

Size distribution characteristics D10, D16, D35, D50, D65, and D84 are summarized for the armour layer and substrate gradation analysis results in Tables 2 and 3 respectively. The Rio Chama River armour layer samples displayed the largest overall particle size distribution, while the Stanislaus armour layer samples resulted in the smallest particle sizes. The substrate sample results varied widely for each river ranging from a D10 of 0.22 mm to a D85 of 105 mm.

Table 2. Armour layer size distributions

River	North Platte River			Gunnsion River				Rio Chama River		Stanislaus River	
Location	Upper Grey Reef Site (mm)	Middle Cottonwood Site (mm)	Lower Boat Ramp Site (mm)	Cross Section 6 (mm)	Cross Section 7 (mm)	Cross Section 13 (mm)	Cross Section 13 (mm)	River Mile 1.2 #1 (mm)	River Mile 1.2 #2 (mm)	Near Cross Section 1 (mm)	Island Cross Section (mm)
D10	60	52	38	56	35	37	43	54	21	48	8.4
D16	62	63	42	72	49	42	51	63	31	64	11
D35	71	81	70	93	82	56	78	110	58	117	16
D50	80	88	83	108	96	71	98	120	290	155	21
D65	89	92	102	123	109	87	118	150	300	175	29
D85	98	105	105	141	126	110	144	180	320	197	45

Table 3. Substrate size distributions

River	North Platte River			Gunnsion River				Rio Chama River		Stanislaus River	
Location	Upper Grey Reef Site (mm)	Middle Cottonwood Site (mm)	Lower Boat Ramp Site (mm)	Cross Section 6 (mm)	Cross Section 7 (mm)	Cross Section 13 (mm)	Cross Section 13 (mm)	River Mile 1.2 #1 (mm)	River Mile 30.3 #2 (mm)	Near Cross Section 1	Island Cross Section
D10	0.22	0.46	0.81	0.47	0.94	0.31	0.49	0.70	0.63	1.0	0.54
D16	0.31	0.90	1.2	0.79	3	0.84	1.0	1.0	1.0	9.5	1.0
D35	4.0	4.2	5.2	7.4	12	5.4	12	6.7	4.3	13	8.6
D50	14	11	11	15	25	12	23	14	12	22	16
D65	35	21	23	28	51	22	43	21	33	36	27
D85	62	90	54	64	105	43	89	45	73	105	58

Sample Size and Error Analysis

The sizes of substrate and armour layer samples obtained from each test site were determined by the amount of material that could practically be extracted and transported from the sampling site. The volume of material sampled is an important factor in determining statistically significant conclusions. Recommendations addressing minimum sample size have been presented by several authors. De Vries (1970) conducted experiments using natural sand mixtures to derive empirical functions for use in estimating relative errors with respect to sample size. De Vries' analysis, based upon statistical theory, leads to an empirical analysis that determines several frequency by number to volumetric conversion constants. The required sample mass, according to his analysis. can be derived from:

$$M = \frac{\beta \rho_s D_i^3}{r_{pi}^2 p_i} \tag{5}$$

where: β = 0.8 volumetric conversion constant

ρ_s = density of sand (2650 kg/m^3)

D_i^3 = median particle size between sieves bounding size fraction (mm)

r_{pi}^2 = relative error

p_i = error of the probability

The design of the required mass is based upon the composition of the bed and the particle fraction of interest. For characterization of the coarse end of the grain-size distribution, De Vries defined D_{84} as an appropriate large size upon which to base an estimate of required sample size. Figure 11 presents design guidelines used by DeVries (1970) for natural

sand. considering three levels of accuracy. The three levels of accuracy are:

high accuracy - $r_{p_i} = 1\%$. $r_{p_i}\bar{p}_i = 10^{-5}$

normal accuracy - $r_{p_i} = 3\%$. $r_{p_i}\bar{p}_i = 10^{-4}$

low accuracy - $r_{p_i} = 10\%$, $r_{p_i}\bar{p}_i = 10^{-3}$

DeVries's analysis is based upon studies with fine gravel mixtures, with density, $\rho_s = 2650$ kg/m^3. Extrapolation of De Vries's analysis for application to larger gravels and cobbles requires that very large quantities of material be collected. For example, to obtain a representative sample at an intermediate level of precision of a material with a D_{84} equal to 100 mm (3.9 in), a sample size of approximately 2000 kg (4409 lbs) is suggested. Table 4 summarizes suggested sample sizes and relative errors for the four project study sites according to DeVries (1970).

Church et al. (1987) provided alternative recommendations for determining minimum sample weight based on an empirical investigation. Replicate analyses were performed with a single gravel mixture, to study sampling variability and stability of the standard deviations. Proposed estimates for recommended minimum sample sizes are based on the percent of sample weight in the largest stone, as presented in Figure 12. Corresponding coefficients of variations for variations in sample size with size of the largest particle size are presented in Figure 13.

Sample sizes collected at each project test site were based on the amount of material that could be practically carried from the site. and according to estimates by Dr. R. T. Milhous of adequate sample sizes. The sample weights and corresponding particle

characteristics were evaluated according to sample size standards suggested by DeVries (1970) and Church et al. (1987). Summaries of suggested sample sizes and the corresponding errors are presented in Tables 4 and 5. Suggested sample sizes ranged from 4 to 10,000 kg.

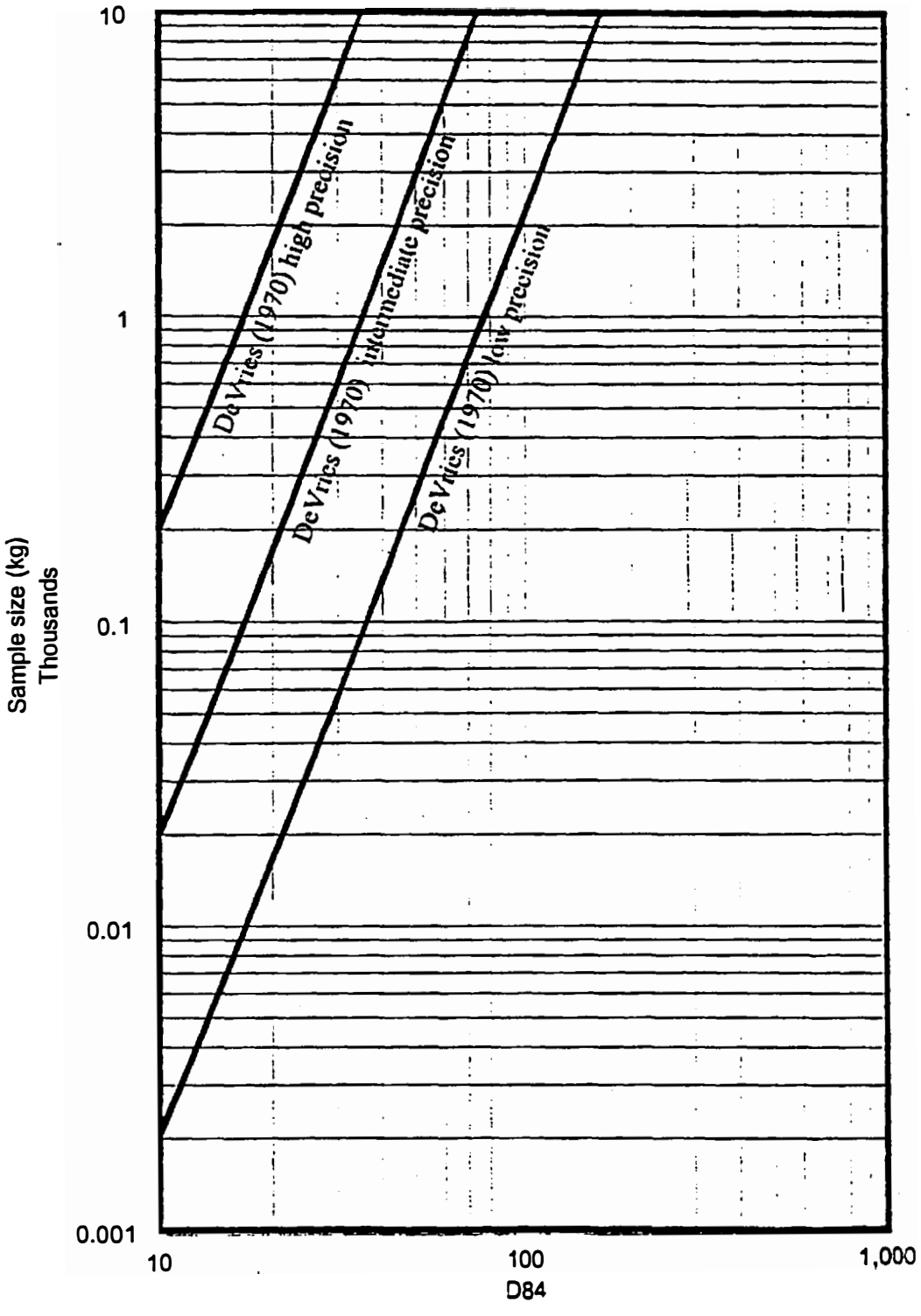

Figure 11. Determination of sample size according to DeVries (1970)

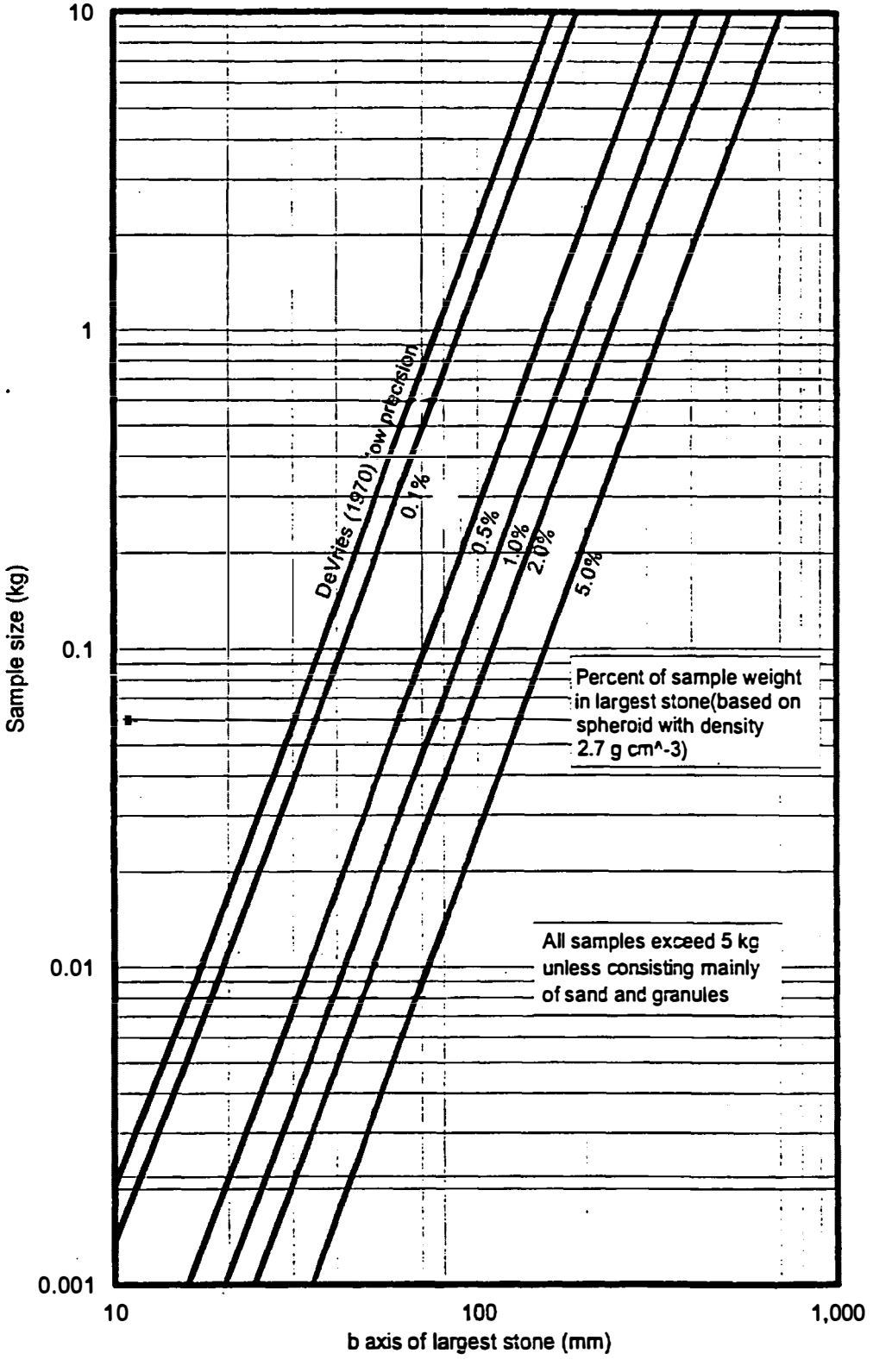

Figure 12. Determination of sample size according to Church et al. (1987)

Table 4. Suggested sample sizes and relative errors for samples collected at project test sites, according to DeVries (1970)

Test Site	Location	Sample Type	Sample Weight (lbs)	Sample Weight (kg)	D50 (mm)	Relative Error in D50	D84 (mm)	Relative Error in (D84)	Required Sample Mass low accuracy (kg)	Required Sample Mass normal accuracy (kg)	Required Sample Mass High accuracy (kg)
North Platte	Grey reef	Armour	121.2	54.98	80	0.020	98	0.191	200	2217	19953
North Platte	Cottonwood	Armour	122.7	55.67	88	0.026	105	0.210	245	2727	24542
North Platte	Boat Ramp	Armour	92.4	41.92	83	0.029	105	0.242	245	2727	24542
North Platte	Grey reef	Substrate	163.5	74.15	14	0.000	62	0.083	51	561	5053
North Platte	Cottonwood	Substrate	109.1	49.48	11	0.000	90	0.177	155	1717	15455
North Platte	Boat Ramp	Substrate	114.8	52.06	11	0.000	54	0.080	33	371	3338
Gunnison	X-Section 6	Armour	173.6	78.74	108	0.034	141	0.275	594	6603	59428
Gunnison	X-Section 7	Armour	118.0	53.54	96	0.035	126	0.281	424	4712	42408
Gunnison	X-Section 13	Armour	123.7	56.12	71	0.014	110	0.224	282	3135	28217
Gunnison	X-Section 13	Armour	157.5	71.43	98	0.028	144	0.298	633	7034	63303
Gunnison	X-Section 6	Substrate	174.5	79.17	15	0.000	64	0.084	56	617	5557
Gunnison	X-Section 7	Substrate	165.7	75.18	25	0.000	105	0.181	245	2727	24542
Gunnison	X-Section 13	Substrate	148.5	67.36	12	0.000	43	0.050	17	187	1686
Gunnison	X-Section 13	Substrate	73.6	33.40	23	0.001	88	0.208	144	1605	14447
Rio Chama	River mile 1.2	Armour 1	141.3	64.09	120	0.057	180	0.439	1236	13738	123638
Rio Chama	River mile 1.2	Armour 2	121.1	54.93	290	0.941	320	1.125	6947	77187	694682
Rio Chama	River mile 1.2	Substrate 1	108.8	49.35	14	0.000	45	0.063	19	215	1932
Rio Chama	River mile 1.2	Substrate 1	102.2	46.36	12	0.000	73	0.133	82	916	8247
Stanislaus	X-Section 1	Armour	176.2	79.90	155	0.099	175	0.377	1136	12624	113619
Stanislaus	Island XS	Armour	28.6	12.96	21	0.002	29	0.063	5	57	517
Stanislaus	X-Section 1	Substrate	287.7	130.51	13	0.000	36	0.028	10	110	989
Stanislaus	Island XS	Substrate	218.4	99.07	8.6	0.000	27	0.021	4	46	417

Table 5. Suggested sample sizes for samples collected at project test sites, according to Church et al.(1987)

Test Site	Location	Sample Type	Sample Weight (lbs)	Sample Weight (kg)	Axis of largest particle (mm)	Suggested Sample size[1] (kg)
North Platte	Grey reef	Armour	121.2	54.98	139.7	4000
North Platte	Cottonwood	Armour	122.7	55.67	152.4	4800
North Platte	Boat Ramp	Armour	92.4	41.92	127.0	2800
North Platte	Grey reef	Substrate	163.5	74.15	101.6	1400
North Platte	Cottonwood	Substrate	109.1	49.48	127.0	2800
North Platte	Boat Ramp	Substrate	114.8	52.06	101.6	1400
Gunnison	X-Section 6	Armour	173.6	78.74	177.8	8000
Gunnison	X-Section 7	Armour	118.0	53.54	139.7	4000
Gunnison	X-Section 13	Armour	123.7	56.12	127.0	2800
Gunnison	X-Section 13	Armour	157.5	71.43	152.4	4800
Gunnison	X-Section 6	Substrate	174.5	79.17	76.2	600
Gunnison	X-Section 7	Substrate	165.7	75.18	127.0	2800
Gunnison	X-Section 13	Substrate	148.5	67.36	88.9	950
Gunnison	X-Section 13	Substrate	73.6	33.40	120.7	2400
Rio Chama	River mile 1.2	Armour 1	141.3	64.09	213.4	>10000
Rio Chama	River mile 1.2	Armour 2	121.1	54.93	313.9	>10000
Rio Chama	River mile 1.2	Substrate 1	108.8	49.35	101.6	1400
Rio Chama	River mile 1.2	Substrate 2	102.2	46.36	152.4	4800
Stanislaus	X-Section 1	Armour	176.2	79.90	228.6	>10000
Stanislaus	Island XS	Armour	28.6	12.96	76.2	600
Stanislaus	X-Section 1	Substrate	287.7	130.51	177.8	8000
Stanislaus	Island XS	Substrate	218.4	99.07	152.4	4800

[1] Sample size suggested to obtain a coefficient of variation of 0.1

Bulk Densities and Void Ratios

The bulk density sampling process was performed at three of the four river study sites; the North Platte, Gunnison and Stanislaus rivers. The lack of an exposed bar or bank resembling the bed material under study restricted the field crew from obtaining a bulk density sample from the Rio Chama test sites. The locations of the bulk density sampling sites are presented in Appendix I, and photographs of the application of the bulk density technique at each site is presented in Appendix VI. The resulting bulk density ranges computed from the sample weights, hole volumes, and error estimations for the North Platte, Gunnison, and Stanislaus rivers were 138-167 lbs\ft^3(2.2-2.7 g/cm^3), 135-207 lbs/ft^3 (2.2-3.3 g/cm^3), and 111-137 lbs/ft^3 (1.8-2.2 g/cm^3), respectively.

Void ratio ranges were calculated from the resulting bulk density ranges and the specific gravities of the samples determined from the laboratory analyses. A summary of the bulk densities and void ratios for the project study sites are presented in Table 6. The bulk densities were determined for the coarse and fine particle size fractions which were differentiated by the material passing and retained on a US Standard Series #4 sieve. It should be noted that two calculated lower bound values of the void ratio ranges resulted in negative numbers, as indicated in Table 6. These results denote that the potential sampling errors in measuring bulk density exceed the sensitivity required to measure the void ratios of the substrate material.

Table 6. Summary of bulk densities and void ratios for test sites

River	Volume of depression (ft^3)	Sample Weight (lbs)	Possible Error in Volume Estimation	Lower bound of bulk density pcf	Upper bound of bulk density pcf	Bulk Specific Gravity - #4[1]	Bulk Specific Gravity + #4[1]	Lower bound of void ratio	Upper bound of void ratio
North Platte	0.89	134.3	0.09	137.46	167.25	2.52[2]	2.52[2]	-0.0598	0.1439
Gunnison	0.38	62.07	0.08	134.93	206.90	2.54	2.59	-0.2339	0.1746
Stanislaus	0.75	92.11	0.08	110.98	137.48	2.70	2.67	0.2255	0.5182
Rio Chama[3]						2.50	2.51		

[1] Specific gravities were determined for material both retained on and passing a US Standard series #4 sieve
[2] Laboratory analysis not performed, value estimated by Dr. R. T. Milhous
[3] Bulk density determination was not performed during the Rio Chama field trip

Grid Samples

Grid sampling techniques were performed during the study at two test sites to determine the gradation of the armour layer. The pacing technique. Wolman walk method (Wolman, 1954), was used on the Rio Chama River, at the test site located 30.3 miles downstream of El Vado dam. The sampling area was approximately forty feet long and encompassed the entire river width of about sixty feet; the reach was classified as a riffle zone. The average depth across the section was approximately two feet. High turbidity limited visibility of the bed. One hundred particles were sampled by pacing across the section. The sampler retrieved each particle that was found beneath their toe after each pace. A hand tape was used to measure the three axes of each particle once it was removed from the bed. When large particles, which could not be removed from the bed, were encountered, the two exposed axes of the particle were measured in place.

The second of two grid sampling techniques was performed along the secondary channel of the Stanislaus River study location. A 100-foot fiberglass tape was stretched diagonally across the dry channel bed. The major, intermediate. and minor axes of each particle lying under an even foot mark of the tape were measured. A total of 100 particles were measured. To allow comparison of the frequency by number and frequency by weight distribution, both are presented for each grid sample in Figures 14 and 15.

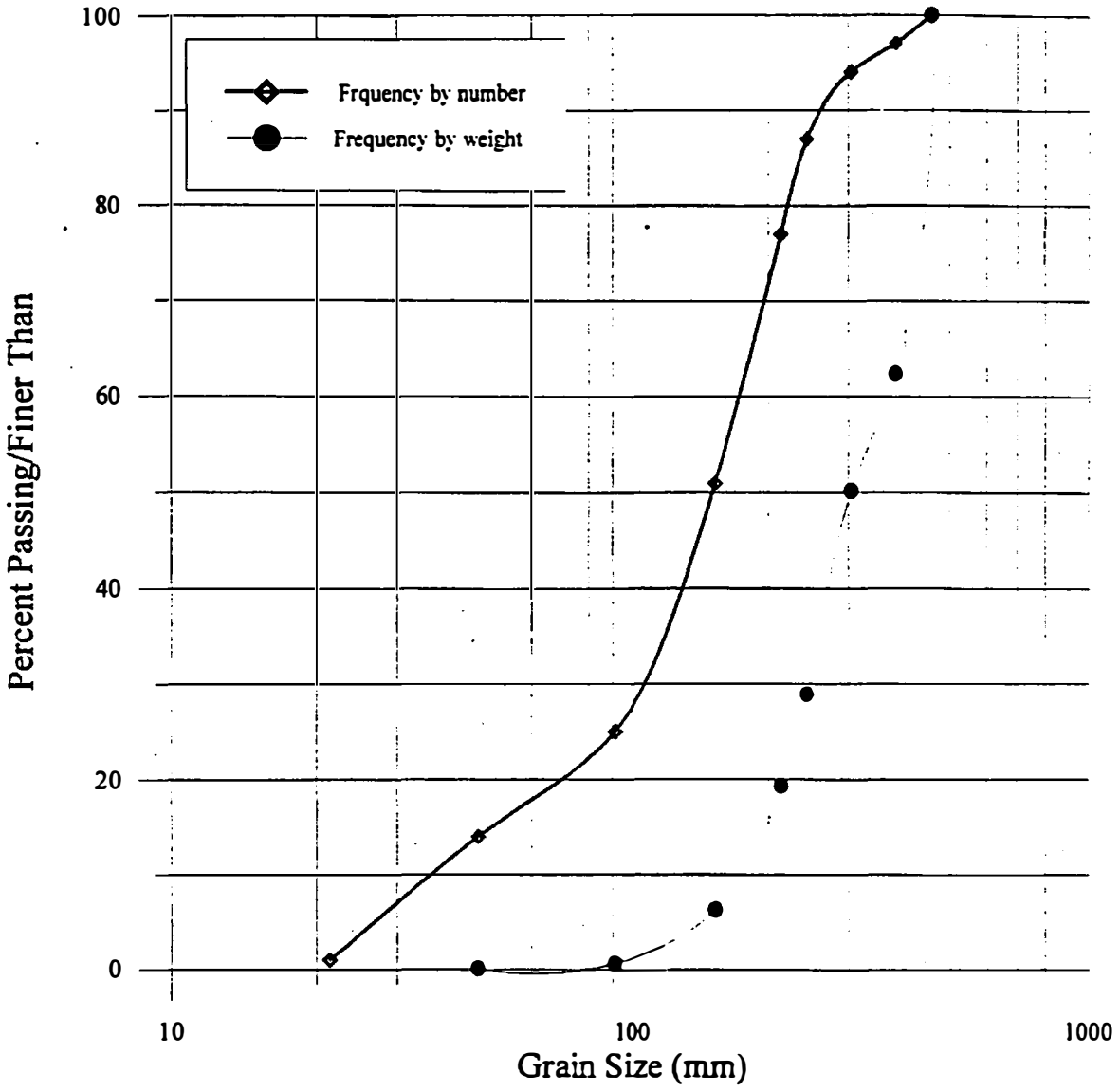

Figure 14. Rio Chama grid sampling gradation results

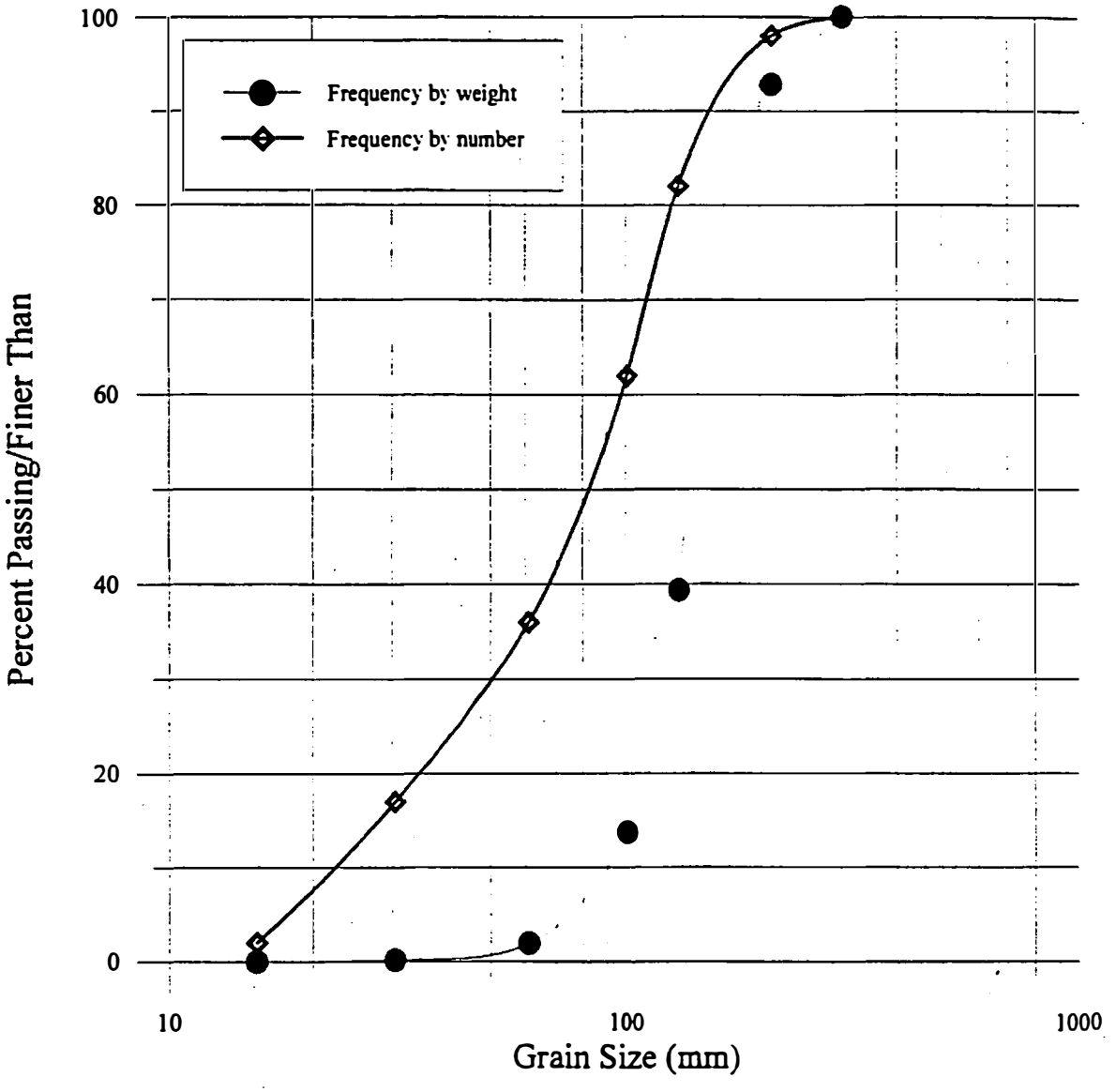

Figure 15. Stanislaus grid sampling gradation results

Surface Material Samples

At each test site, one of the three surface material sampling techniques described above was investigated. For the test sites at which the sampling procedures were successful. samples were retained for particle size analysis, otherwise observations concerning problems with the technique were recorded.

The hydraulic dredging technique was tested at one of the North Platte test sites. The apparatus appeared to perform adequately in removing the material from the bed surface, but due to the small opening of the pump (2-3 mm), the intake manifold was easily obstructed. Observations noted that a pump with a larger intake would improve the technique, but the suction power of the pump would need to be regulated so that only the fine surface material was collected. Due to the problems experienced with the dredging device samples could not be collected for particle size determination.

Swirl sampling techniques were tested at several locations along the Gunnison, Rio Chama, and Stanislaus rivers. The testing of this technique was limited to flow conditions where the drum sampler was not submerged. The water column isolated by the drum was generally agitated by hand by swirling and stirring the water for several seconds before collecting a sample. Vertically integrated samples were collected from the drum using 1 quart Nalgene bottles, having an opening diameter of approximately one inch (2.5 cm). The swirl samples were retained and delivered to the U. S. Bureau of Reclamation Soils Laboratory in Denver, Colorado, for future analysis.

Grab samples of the fine surface material were taken at the test sites where enough material was present to collect a sample, either with a small bowl or scoop. Table 7 presents the results for the grab samples that were obtained.

Table 7. Summary of surface material sample results

River	North Platte River			Gunnison River		Rio Chama River	Stanislaus River	
Location	Upper Grey Reef Site (mm)	Middle Cottonwood Site (mm)	Lower Boat Ramp Site (mm)	Cross Section 13 Main Channel (mm)	Cross Section 13 Secondary Channel (mm)	River Mile 30.3 #2 (mm)	Island Cross Section (mm)	Near Cross Section 1 (mm)
D10	0.40	NA	NA	0.001	NA	0.15	0.18	0.18
D16	0.50	NA	NA	0.004	NA	0.17	0.21	0.19
D35	0.69	NA	0.10	0.021	0.004	0.32	0.40	0.30
D50	0.86	0.003	0.12	0.05	0.009	0.50	0.72	0.38
D65	1.1	0.006	0.18	0.07	0.047	0.60	6.2	0.47
D85	1.4	0.014	0.21	0.27	0.072	0.90	10.3	0.56

NA = not available from laboratory analysis

Comparison With Freeze Core Sampling

One test site location along the Rio Chama river was selected from previous freeze core sampling locations established approximately one year prior to the Rio Chama field study. The site was selected to allow comparison of the drum and freeze core sampling methods. The freeze core sampling was performed by the U.S. Bureau of Land Management in October of 1991. Although the testing procedures were not performed at the same time, the results can be viewed in order to compare the sampling range of each sampler. The gradation analysis results for the armour and substrate layers for each sampler are presented in Figures 15 and 16. It should be noted that the freeze core sampling procedure separated the bed material in 10 cm increments instead of differentiating between the armour and substrate layers. For comparison purposes the results from the upper 10 cm sampled with the freeze core sampler are plotted against the armour layer sampled with the drum sampler (Figure 16). Similarly, the 10-20 and 20-30 cm increments sampled with the freeze core sampler are plotted against the substrate material sampled with the drum sampler (Figure 17).

As observed in Figure 16. the drum sampler obtained particles much larger than those obtained with the freeze core sampler. Although these samples were taken approximately one year apart and the bed characteristics may have changed over time, the possibility that the large particles sampled by the drum sampler were not present along the sampled reach a year earlier is not likely. The differences observed appear to support conclusions made from previous studies with freeze core samplers. Several authors observed that large particles are often under sampled with the freeze core samplers (Petts, 1989; Thomas, 1992; Young et al., 1991).

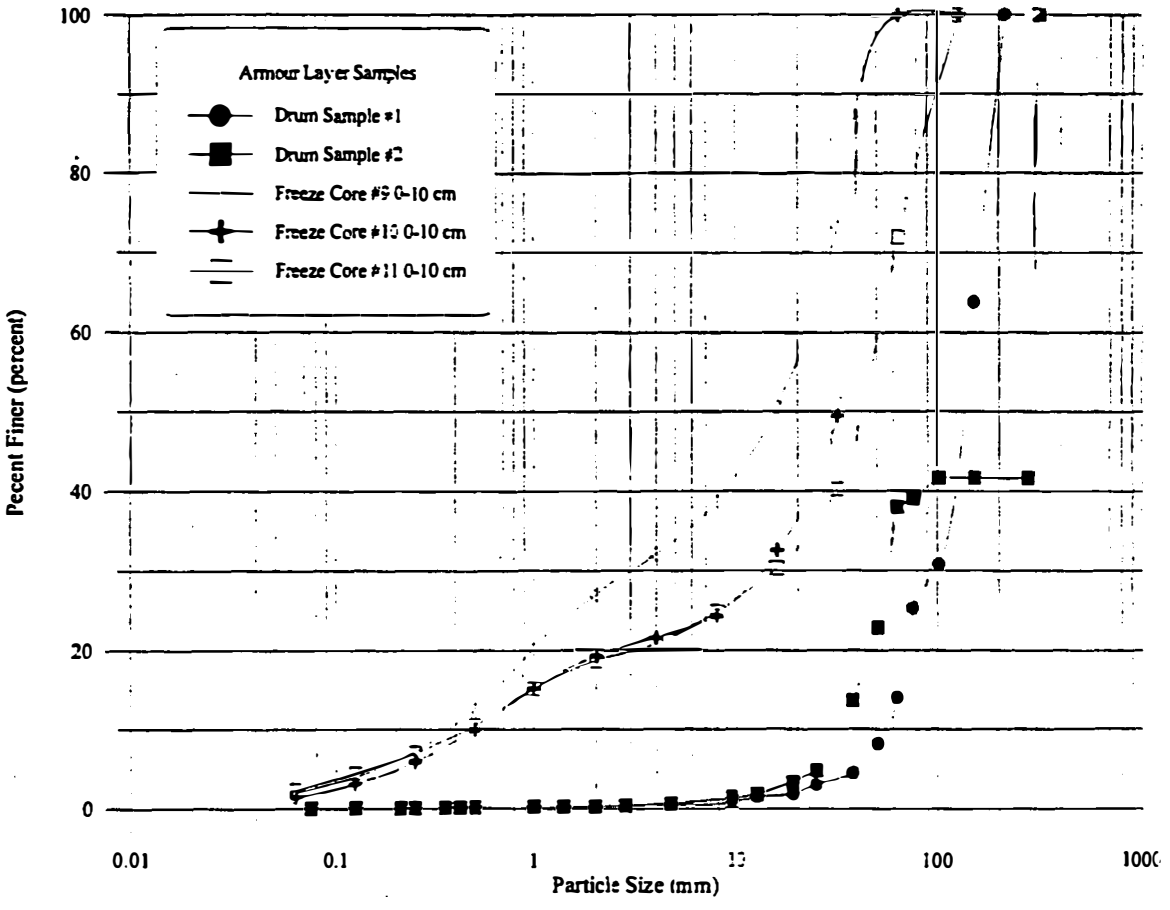

Figure 16. Comparison of armour layer drum samples taken in February 1993 and freeze core samples taken in October 1991 on the Rio Chama river

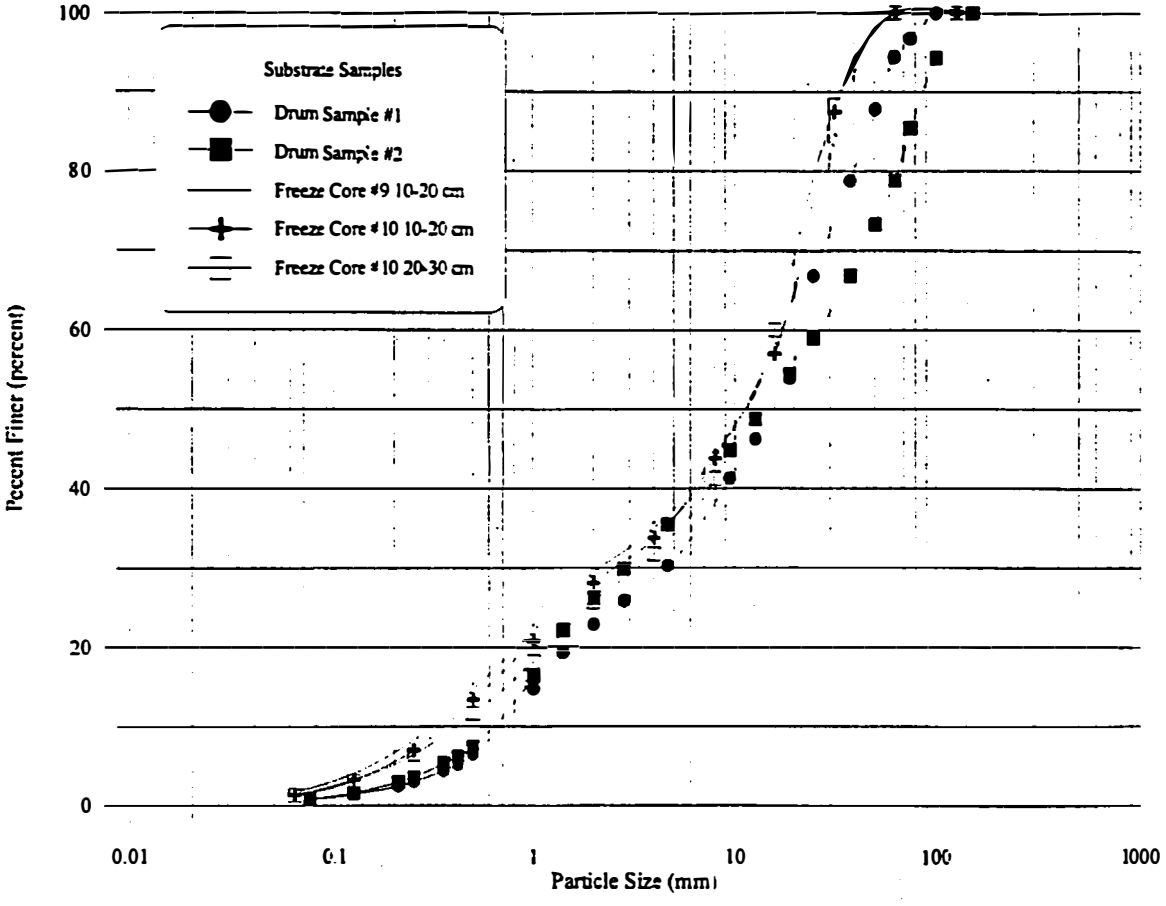

Figure 17. Comparison of substrate layer drum samples taken in February 1993 and freeze core samples taken in October 1991 on the Rio Chama river

Figure 17 illustrates very close correlation between the substrate sampling results obtained from the drum and freeze core samplers. The differences in median grain size, D_{50}, among the samples is approximately 5 mm, while the variation in D_{84} is approximately 60 mm. The freeze core laboratory analysis data is included in Appendix V.

Observations

Throughout the procedures performed during the field studies, observations were made regarding each sampling device and technique. The comments are summarized according to each sampling technique and summarized.

Drum Sampling

1) An adequate anchoring system must be designed to stabilize the drum for sampling in velocities greater than 2 ft/s and/or flow depths greater than 2 ft.
2) The filter cloth sampling bag functioned well in retaining most of the fines of the sampled material, but further investigation should be performed to quantify the amount and particle size of the fines that may be lost.
3) The drum sampling technique proved to be applicable for sampling in flow depths less than four feet. Drum sampling in depths greater than four feet without the assistance of certified SCUBA divers is not advised.
4) A crew of three persons is recommended for sampling in unsubmerged conditions, while an additional person is required when sampling in flows where the sampling drum

becomes submerged.

5) Full wetsuits are necessary for sampling in water temperatures greater than 38 degrees Fahrenheit (3.3°C). Dry suits are recommended for sampling in water temperatures lower than 38°F.

Bulk Density Determination

1) The error potential that exists during the bulk density determination process is excessive. The method used to determine the volume of the excavated depression requires refinement to minimize errors.

2) Transporting a balance to the field sites proved to be difficult and potentially dangerous when traversing a river. Other means of determining the water volumes, such as a calibrated volumetric container, should be investigated.

Surface Sampling

1) The swirl sampling technique has potential, but a standardized method of inducing a known shear stress on the bed requires development. The technique of agitating the water is variable and cannot be consistently reproduced.

Summary

The development and testing of sampling techniques was performed at test sites along the North Platte, Gunnison, Rio Chama, and Stanislaus rivers. The objectives were to develop techniques to map the particle size distribution on the stream substrate surface, to quantify material in transport over the stream surface, and to describe the particle size distributions of the stream armour and substrate layers.

The drum sampling technique uses a 24 inch length of a 30-gallon drum, with both ends cut out, to sample the armour layer and substrate layers in rivers where large gravels and cobbles are predominant. The sampling method is applicable for both submerged and unsubmerged conditions. Approximately three to four field crew members were required to carry out the sampling operations. Normally, one crew member performed the sampling, while the others stabilized drum sampler and transported the samples to the shore.

Experimental modifications were added to the drum sampler, to attempt to trap the fine particles that are washed away during sample excavation when the drum sampler is submerged. The modification demonstrating the most potential was a filter cloth sampling bag designed to slip over the top drum sampler, allowing one arm and any needed sampling tools to be inserted into a six inch slot cut in the bag at the top of the drum. The material is transferred into the bag as it is excavated. Following each sample, the filter cloth bag is carried to shore and the sample is transferred into storage sacks. The filter cloth sampling bag was evaluated in flow depths up to four feet and exhibited great potential as an under water sampling aid. However, additional testing is recommended, to evaluate the amount or percentage of the fine material that is lost or that becomes entrained in the filter fabric mesh.

The drum sampling technique was tested at a total of 10 locations, along four river study reaches. Submerged sampling was experimented with at 3 of the 10 test sites. A maximum of two samples were obtained from each test site, therefore conclusions concerning the accuracy of the sampler cannot be made. It is recommended that subsequent testing be performed.

In comparison of collected sample sizes and recommended sample sizes, it may be noted that the samples collected during the project field studies were in most cases below the suggested sample sizes. It is important for each researcher to evaluate and optimize the sample sizes obtained, with regard to sample error and practical sample size.

The drum sampling technique proved successful for sampling armour and substrate layers of cobble and gravel bed streams. Field studies demonstrated that the drum sampler can be practically used for sampling bed material sizes up to 315 mm (12.4 in) in diameter. Comparisons with results of previous freeze core sampling on the Rio Chama river in New Mexico showed the drum sampler and freeze core sampler to compare closely in sampling particle sizes less than 100 mm (3.9 in), but differed in sampling the larger particles. The samples obtained with the drum sampler on the Rio Chama ranged from 0.7 mm (0.03 in) to 315 mm (12.4 in), while the samples obtained previously with a freeze core sampler ranged from 0.6 mm (0.02 in) to 120 mm (4.7 in).

A method to determine the bulk density of stream substrate material, developed by Dr. R. T. Milhous, was tested at three of the four study sites. The method utilizes a wooden frame, with inner dimensions of 1 m x 1m, to isolate a portion of a dry stream bank or bar that is selected to represent the material under study. The volume of a depression excavated

from the center portion of the frame is determined by lining the frame with plastic sheeting and filling the frame with water, both prior to and after the excavation of the depression. The volume of the depression is estimated by the differential amount of water needed to fill the frame. The resulting bulk density is then computed from the dry weight of the material removed from the depression and the volumetric determination. Analyses were performed to determine the void ratios of the in situ substrate material but were found to be unreliable due to the magnitude of errors that incurred during the bulk density determination process.

Surface sampling methods were investigated to characterize the surface material in transport. Techniques including hydraulic dredging, swirl sampling, and grab sampling were studied. Attempts of hydraulic dredging of the surface fines with a small drill operated pump proved unsuccessful due to clogging of the pump. A swirl sampling technique was developed that suspended the surface material in a column of water isolated by the drum sampler while a vertically integrated sample of the suspended material was obtained. The swirl sampling method proved successful in collecting surface fines where minimal traces of material were present. Additional development of this technique is recommended. A standard method of exerting a shear force on the stream bed to suspend the material is needed. Research under controlled conditions regarding the accuracy and reliability of the method would also be useful.

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APPENDIX I
Test Site Sampling Locations

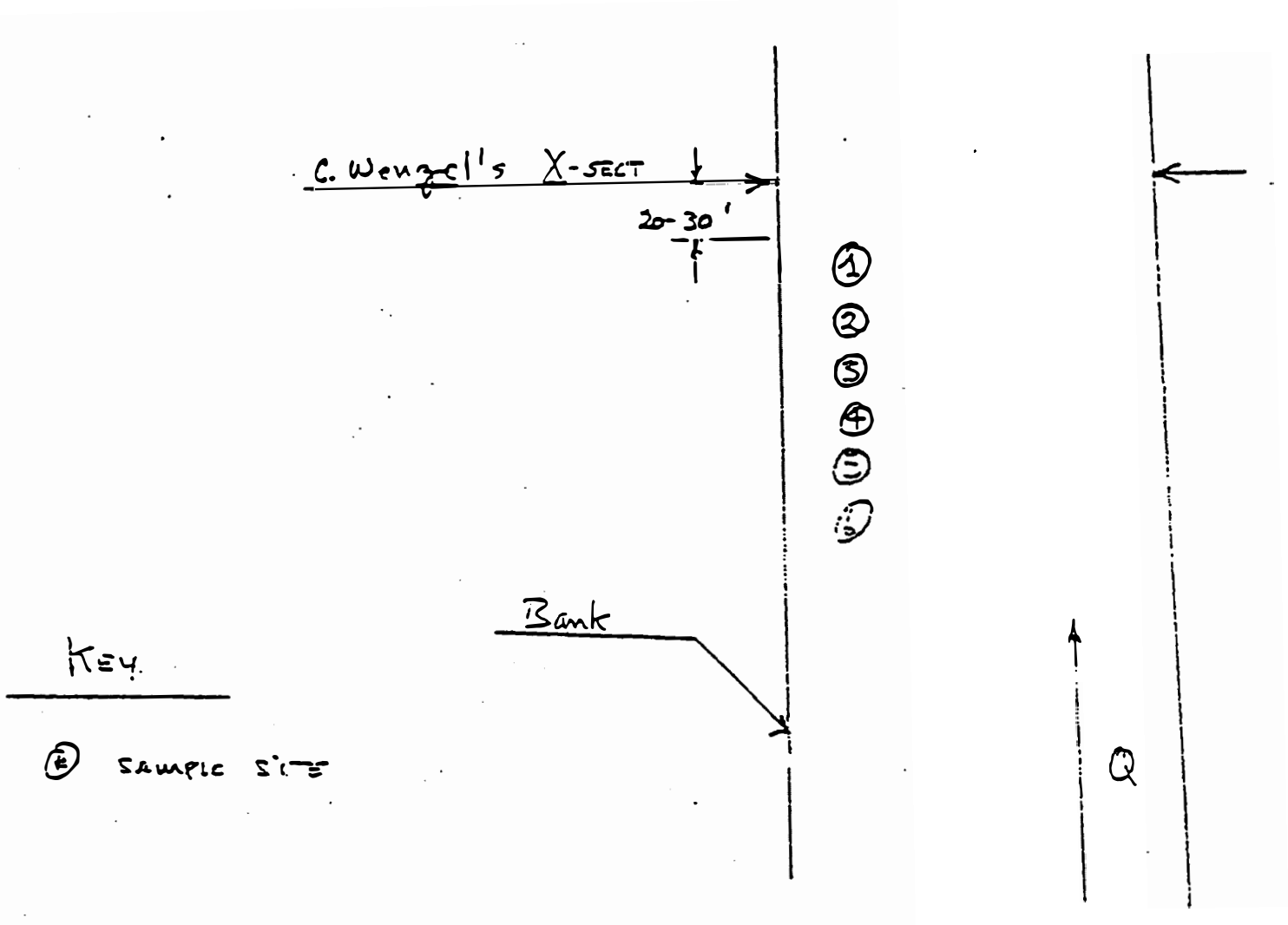

Figure I Sampling locations - Upper/Grey Reef Site, North Platte River, Wyoming

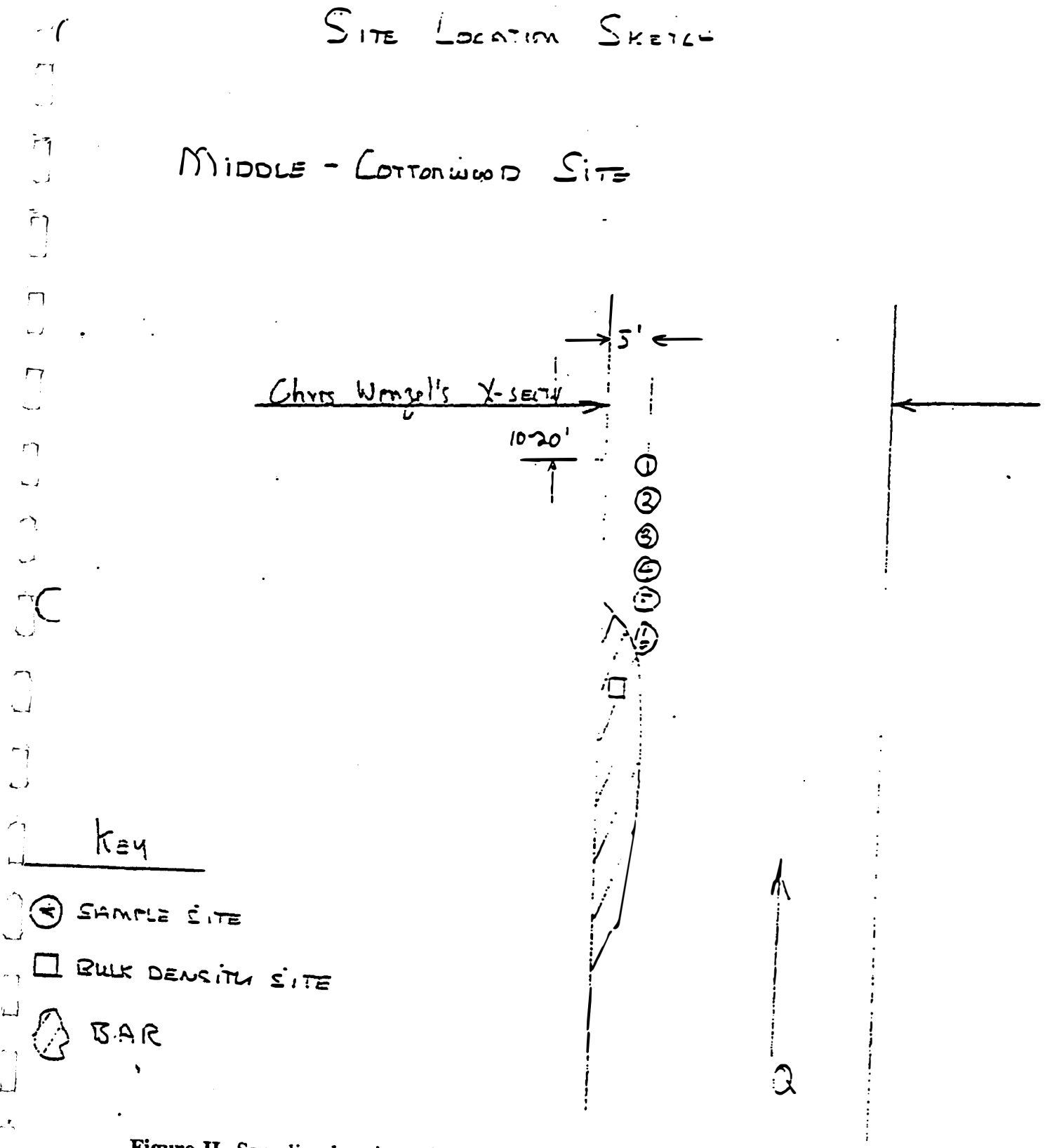

Figure II Sampling locations - Middle/ Cottonwood Site, North Platte River, Wyoming

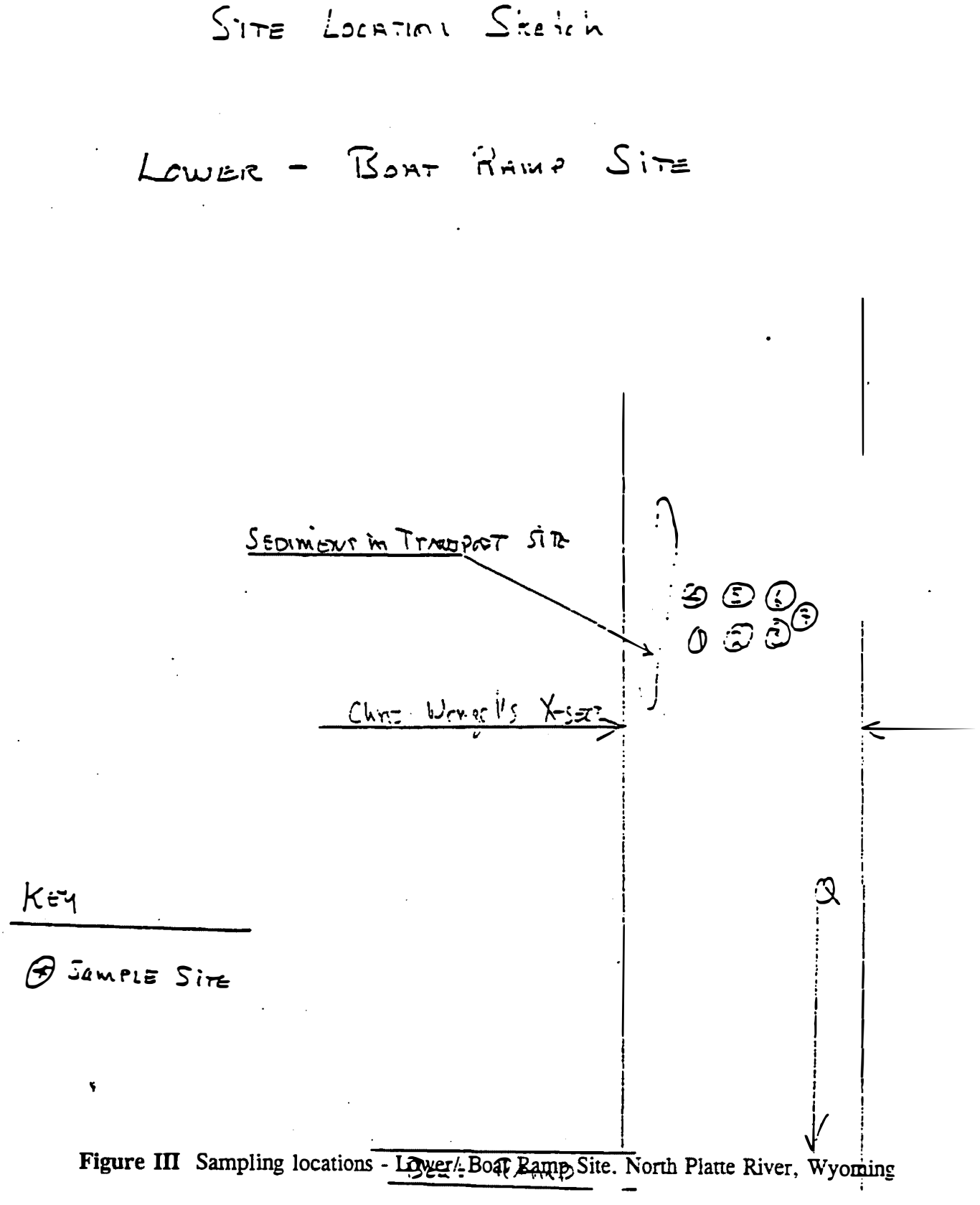

Figure III Sampling locations - Lower Boat Ramp Site. North Platte River, Wyoming

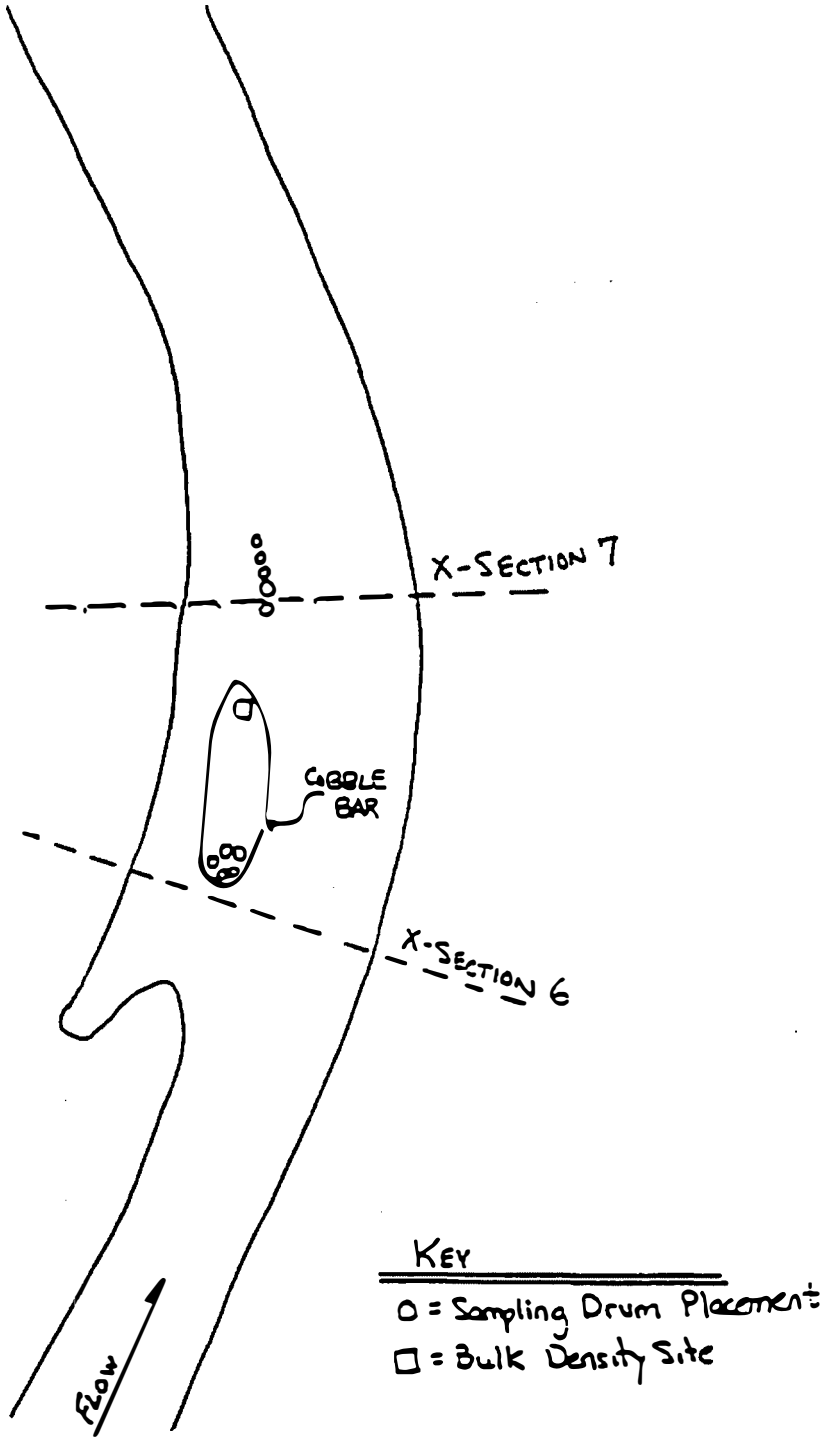

Figure IV Sampling locations - Cross sections 6 and 7, Gunnison River, Colorado

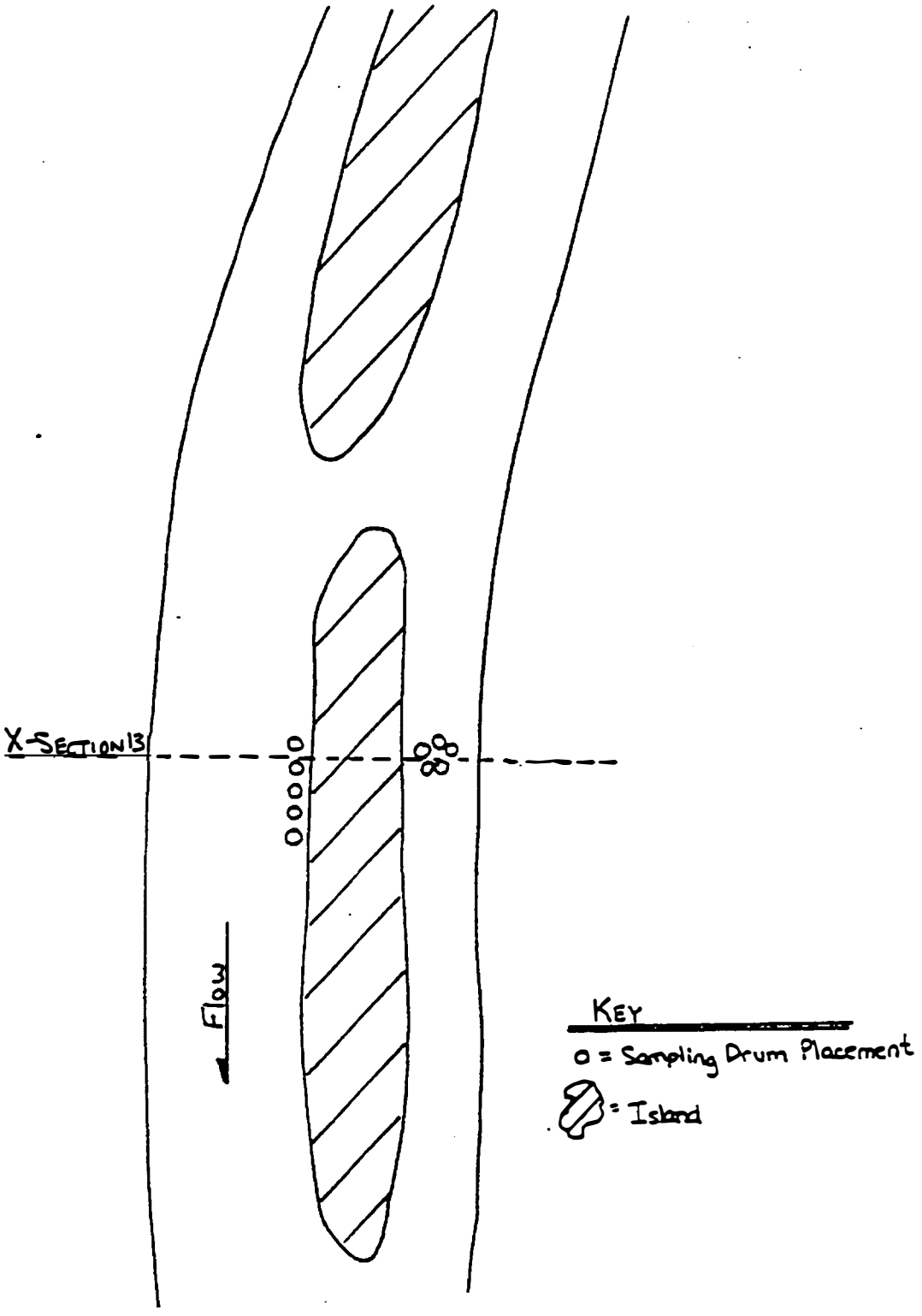

Figure V Sampling locations - Cross sections 13, Gunnison River, Colorado

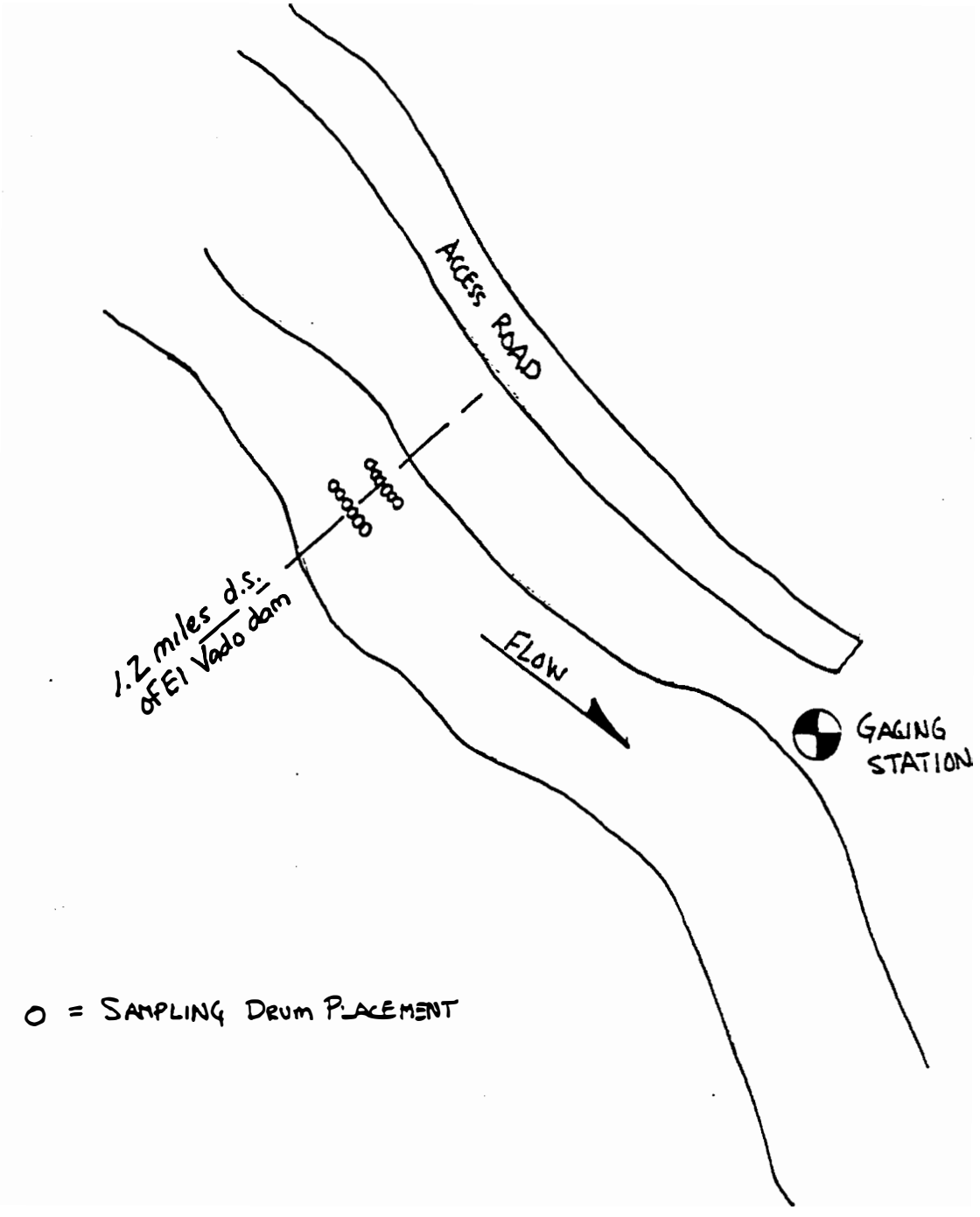

Figure VI Sampling locations - Cross section 1.2 miles downstream of El Vado Dam. Rio Chama, New Mexico

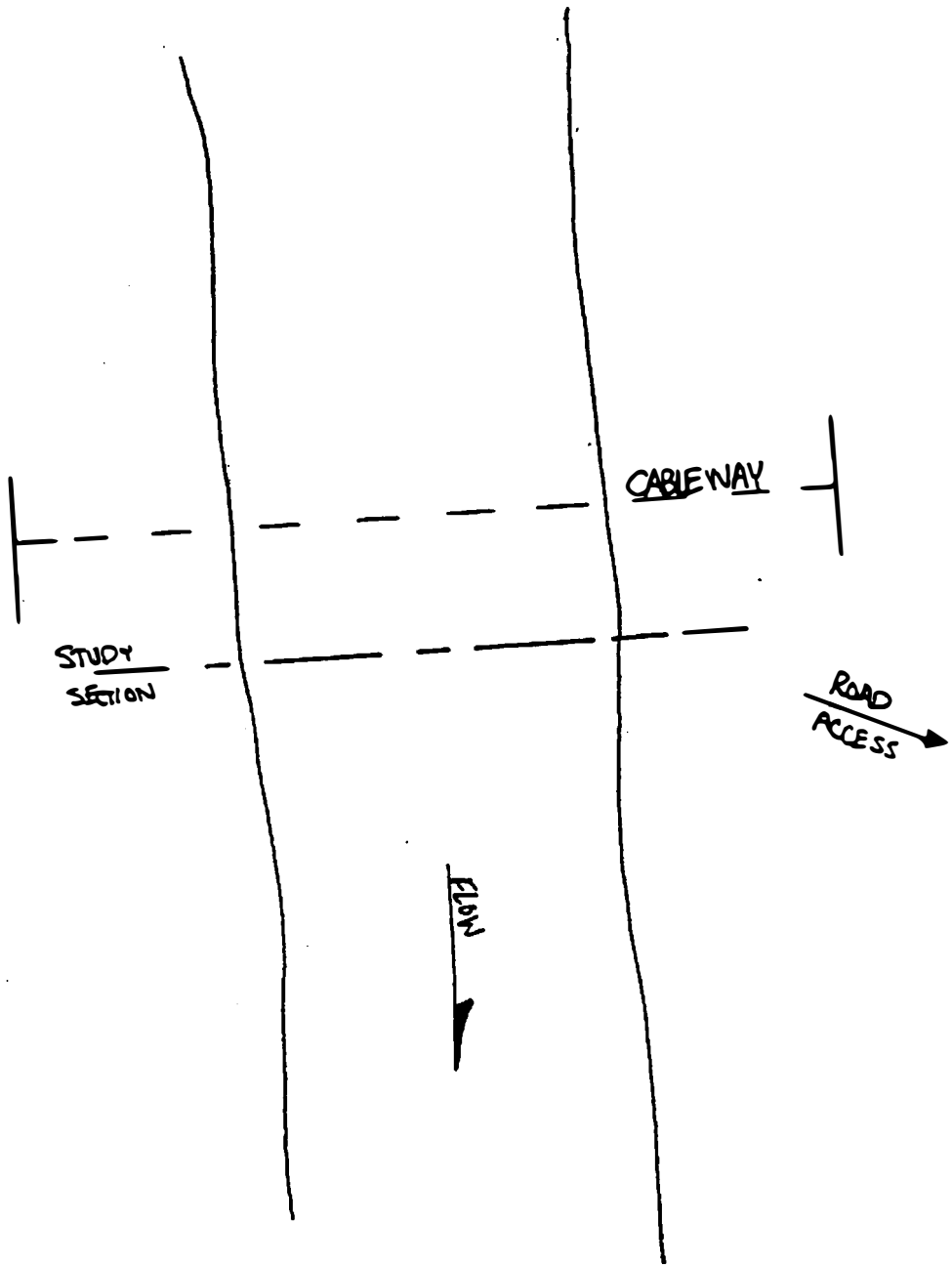

Figure VII Sampling locations - Cross section 30.0 miles downstream of El Vado Dam, Rio Chama, New Mexico

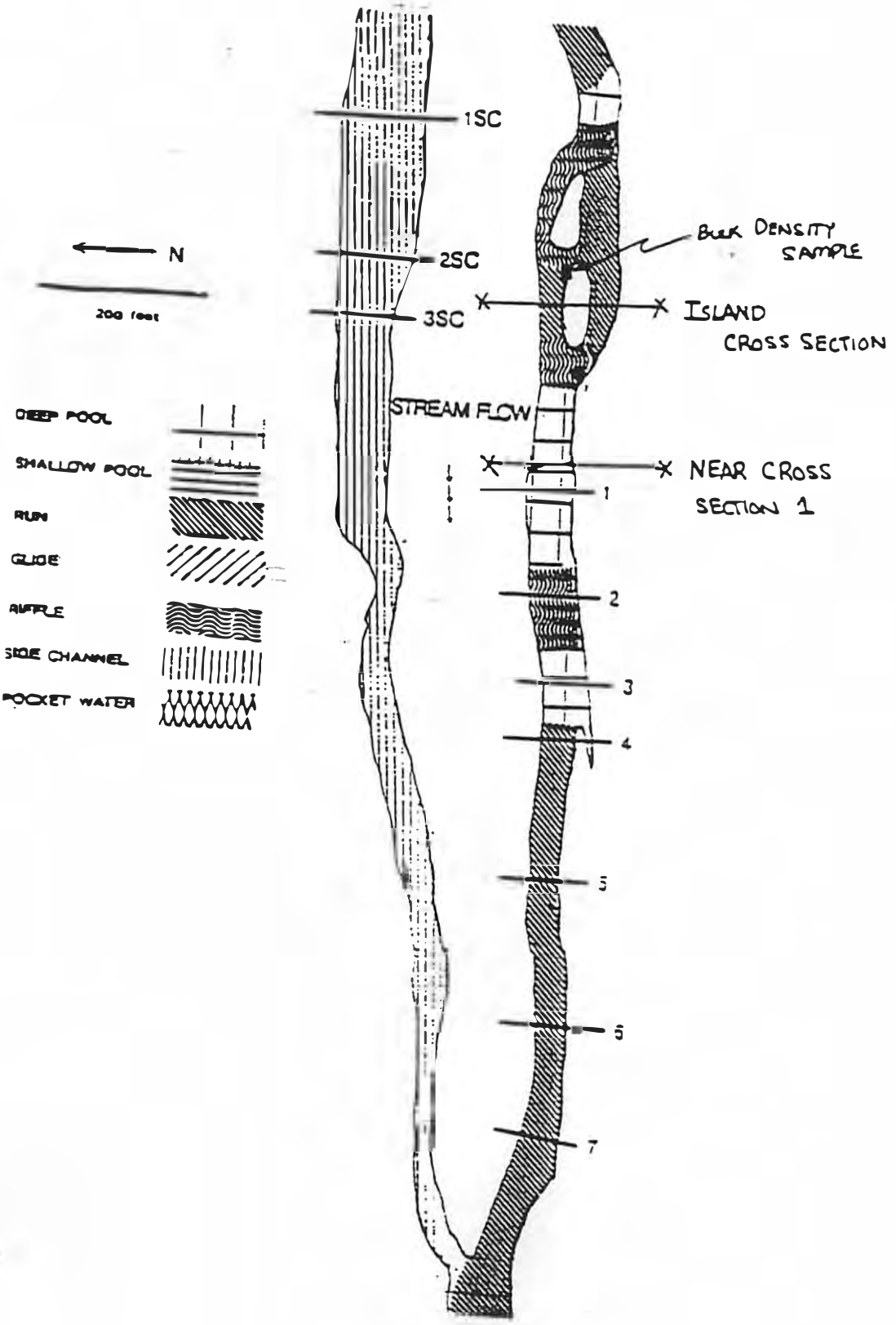

Figure VIII Sampling locations - Stanislaus River, California

APPENDIX II
Laboratory Analysis Results

North Platte River

Wyoming

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Sample: 7

Source of Material: North Platte - Armor Upper Station

Date Sampled: August 19, 1992

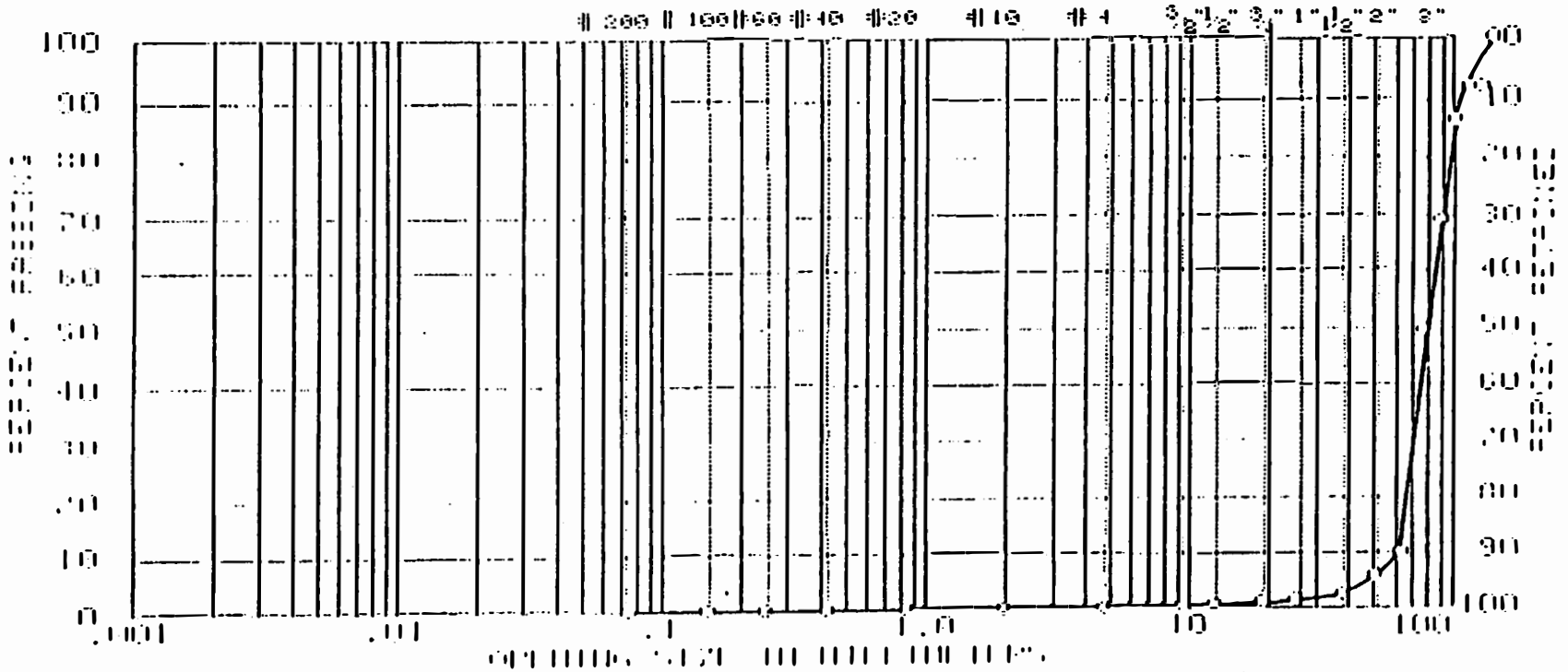
WASH SIEVE ANALYSIS

121.20 lbs

Sieve Size	% Passing
5½"	100.0
5"	91.9
4½"	91.3
4"	86.4
3½"	69.5
3"	49.6
2½"	10.0
2"	5.9
1½"	2.4
1"	1.5
3/4"	0.9
1/2"	0.4
3/8"	0.3
#4	0.2
#10	0.1
#20	0.1
#40	0.1
#60	0.1
#100	0.1
#200	0.0

GRAIN SIZE DISTRIBUTION CURVE

PROJECT: U.S. FISH & WILDLIFE SERVICE AUGUST 19, 1992
LOCATION OF SAMPLE: NORTH PLATTE ARMOR UPPER STATION
SAMPLE No. 7



% CLAY	% SILT	% SAND			% GRAVEL
		FINE	MEDIUM	COARSE	
0.0		.1	0.0	.1	99.8

D10=63.100mm D30=[illegible] D60=81.28mm Cc= .9 Cu= 1.3

Sample: 8

Source of Material: North Platte - Sub Armor Upper Station

Date Sampled: August 19, 1992

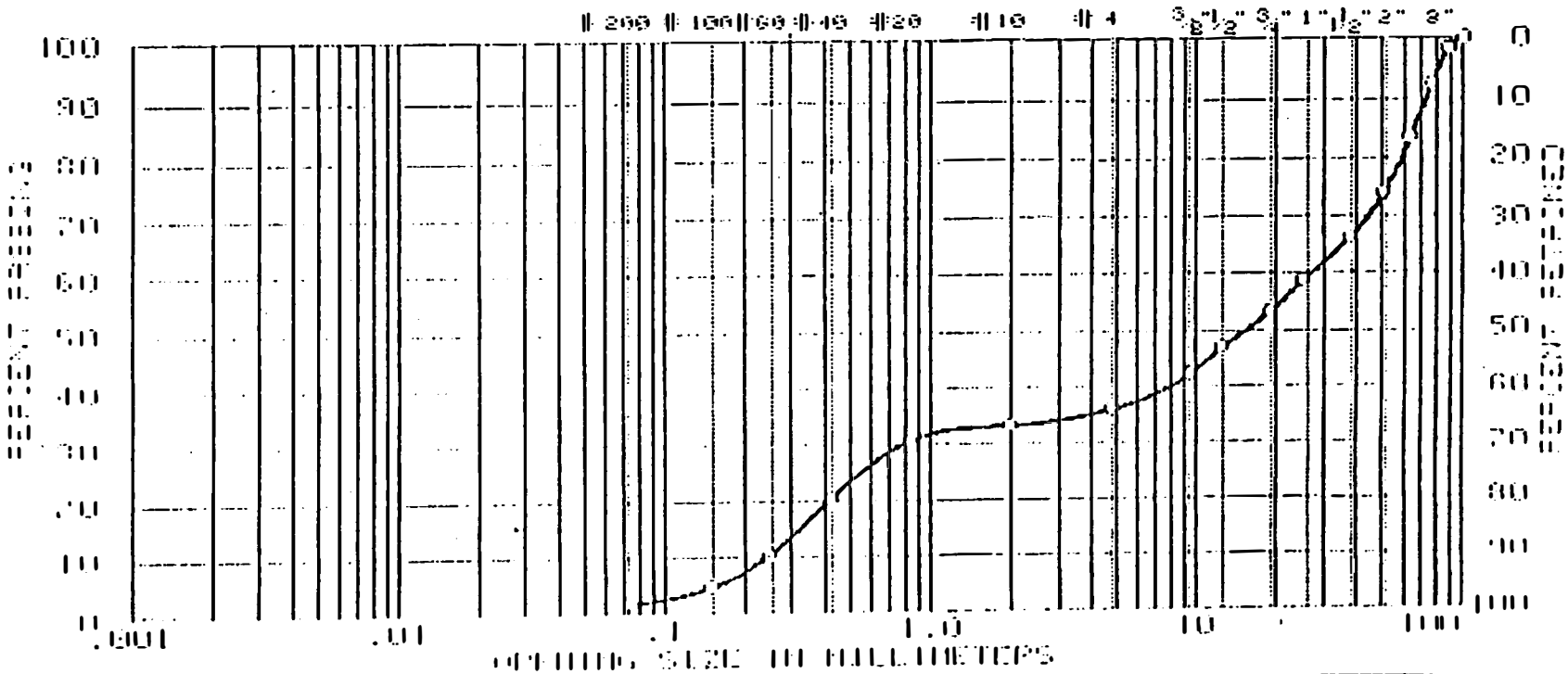
WASH SIEVE ANALYSIS

Sieve Size	% Passing
4"	100.0
3½"	98.5
3"	92.4
2½"	83.4
2"	74.0
1½"	66.4
1"	58.8
3/4"	53.2
1/2"	46.9
3/8"	42.2
#4	35.9
#10	33.2
#20	30.7
#40	20.4
#60	10.3
#100	4.5
#200	1.7

163.46

GRAIN SIZE DISTRIBUTION CURVE

PROJECT: U.S. FISH & WILDLIFE SERVICE AUGUST 19, 1992
LOCATION OF SAMPLE: NORTH PLATTE SUB ARMOR UPPER STATION
SAMPLE No.8



% CLAY	% SILT	% SAND			% GRAVEL
		FINE	MEDIUM	COARSE	
1.2		11.2	12.8	7.2	64.1

D10= .245mm D30= .7944mm D60=26.92mm Cc= .1 Cu= 109.6

Sample: 9

Source of Material: North Platte - Bank Material in Transport Upper Station

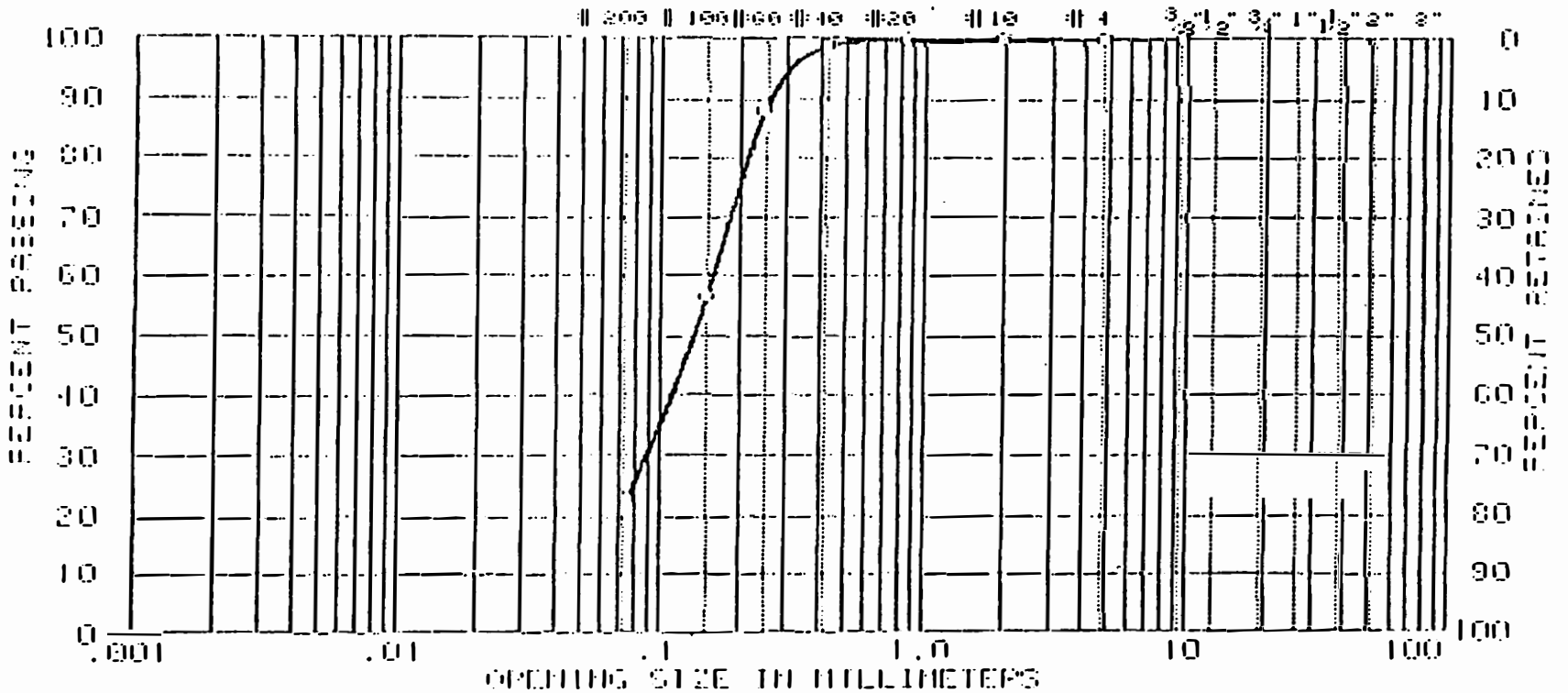
Date Sampled: August 19, 1992

WASH SIEVE ANALYSIS

Sieve Size	% Passing
3/8"	100.0
#4	99.9
#10	99.8
#20	99.6
#40	98.6
#60	88.0
#100	56.3
#200	22.7

GRAIN SIZE DISTRIBUTION CURVE

PROJECT: U.S. FISH & WILDLIFE SERVICE AUGUST 19, 1992
LOCATION OF SAMPLE: NORTH PLATTE-BANK MAT'L IN TRANSPORT-UPPER STA.
SAMPLE No.1



% CLAY	% SILT	% SAND			% GRAVEL
		FINE	MEDIUM	COARSE	
23.7		75.0	1.2	.1	.1

Sample: 10

Source of Material: North Platte - Armor Mid Cottonwood Site

Date Sampled: August 19, 1992

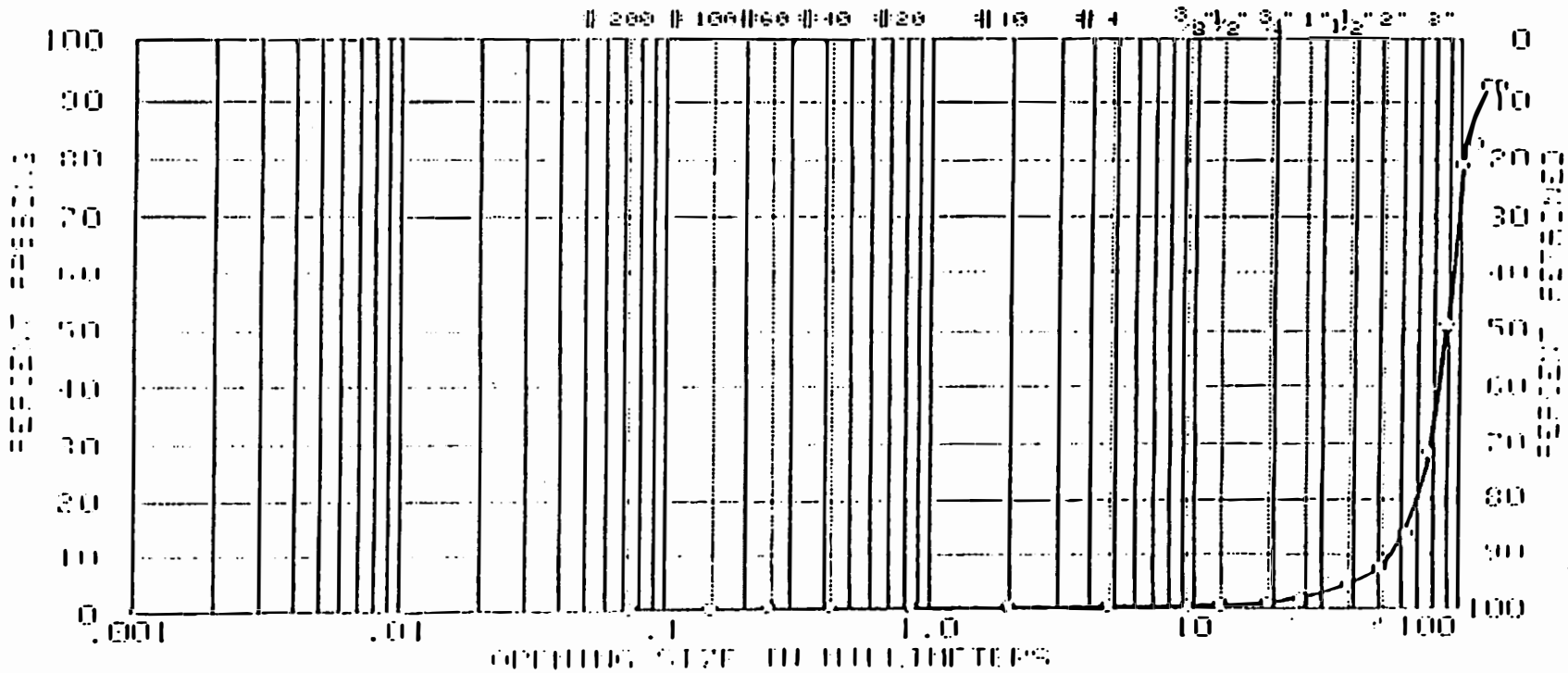
WASH SIEVE ANALYSIS

122.74 lb

Sieve Size	% Passing
6"	100.0
5½"	92.7
5"	92.7
4½"	82.7
4"	78.9
3½"	50.9
3"	28.4
2½"	13.8
2"	7.3
1½"	3.9
1"	1.5
3/4"	0.9
1/2"	0.7
3/8"	0.6
#4	0.6
#10	0.6
#20	0.5
#40	0.4
#60	0.4
#100	0.3
#200	0.3

GRAIN SIZE DISTRIBUTION CURVE

PROJECT: U.S. FISH & WILDLIFE SERVICE AUGUST 19, 1992
LOCATION OF SAMPLE: NORTH PLATTE DAMOR MID COTTONWOOD SITE
SAMPLE No. 10



% CLAY	% SILT	% SAND			% GRAVEL
		FINE	MEDIUM	COARSE	
.3		.1	.2	0.0	99.4

D10=57.544mm D30=75.858mm D60=91.20mm Cc= 1.1 Cu= 1.6

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Sample: 11

Source of Material: North Platte - Sub Arnor Mid Cottonwood Site

Date Sampled: August 19, 1992

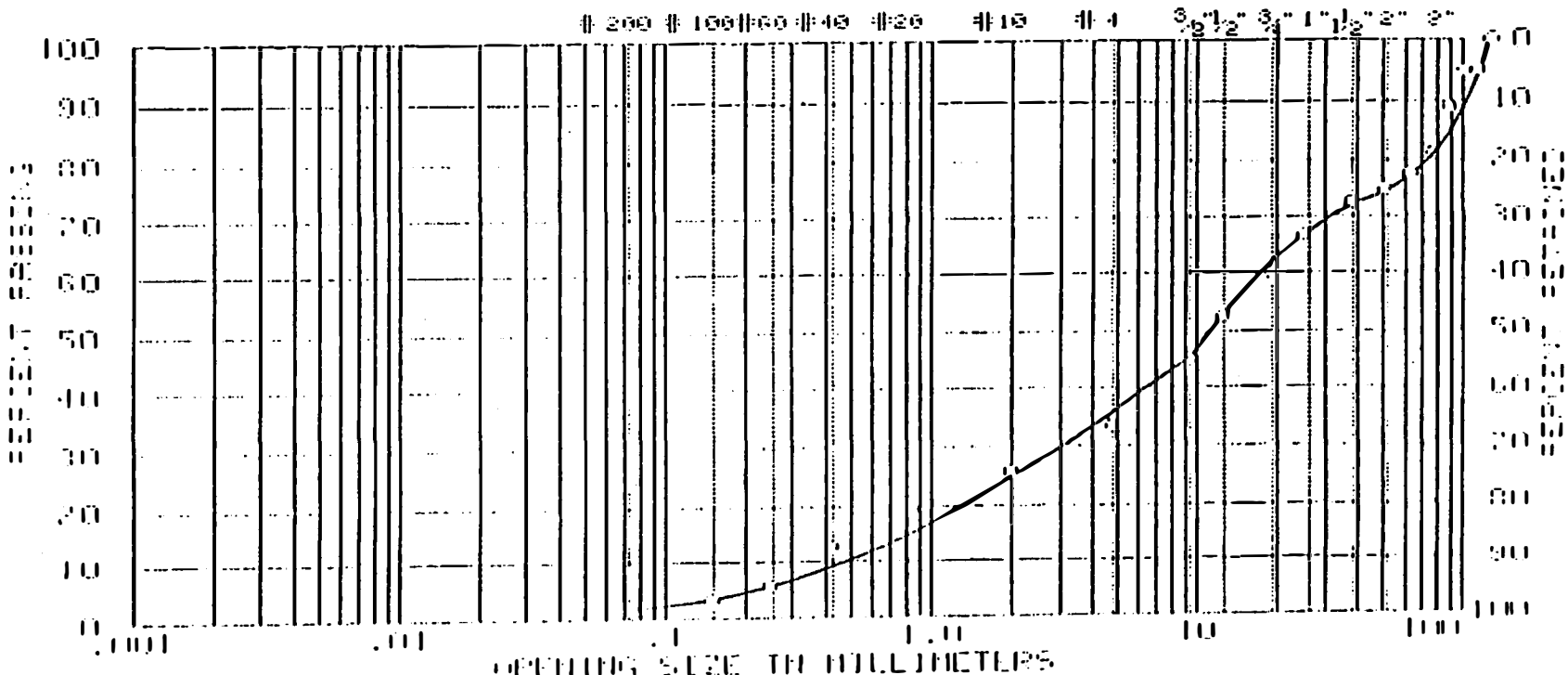
WASH SIEVE ANALYSIS

109.03 lb

Sieve Size	% Passing
5"	100.0
4½"	95.0
4"	95.0
3½"	88.9
3"	81.0
2½"	77.4
2"	74.6
1½"	72.5
1"	66.6
3/4"	60.0
1/2"	52.5
3/8"	45.1
#4	33.5
#10	25.7
#20	19.4
#40	12.6
#60	5.5
#100	3.0
#200	1.9

GRAIN SIZE DISTRIBUTION CURVE

PROJECT: U.S. FISH & WILDLIFE SERVICE AUGUST 19, 1992
LOCATION OF SAMPLE: NORTH PLATTE SUB ARMOR MID COTTONWOOD SITE
SAMPLE No. 11



% CLAY	% SILT	% SAND			% GRAVEL
		FINE	MEDIUM	COARSE	
1.0		10.7	13.1	7.8	66.5

D10= .355mm D30= 3.888mm D60=19.05mm Cc= 1.7 Cu= 53.7

Sample: 12

Source of Material: North Platte - Material in Transport Mid Cottonwood Site

Date Sampled: August 19, 1992

WASH SIEVE ANALYSIS

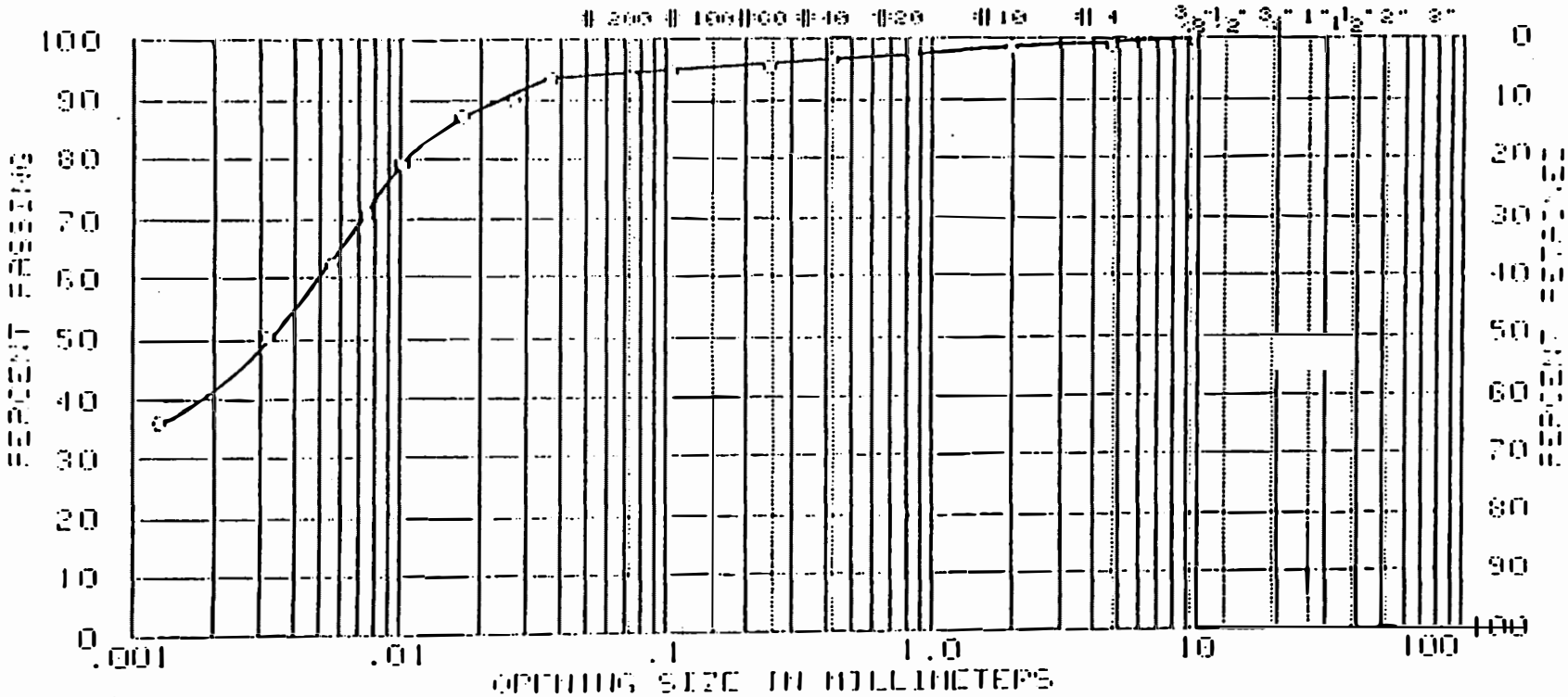
Sieve Size	% Passing
3/8"	100.0
#4	98.6
#10	98.5
#20	97.6
#40	96.3
#60	95.2
#100	94.3
#200	93.3

Hydrometer Analysis

Particle Size	% Passing
0.0372 mm	93.2
0.0268 mm	89.7
0.0173 mm	87.1
0.0103 mm	78.8
0.0076 mm	70.9
0.0056 mm	62.4
0.0032 mm	50.3
0.0013 mm	36.1

GRAIN SIZE DISTRIBUTION CURVE

PROJECT: U.S. FISH & WILDLIFE SERVICE AUGUST 19, 1992
LOCATION OF SAMPLE: N.PLATTE-NAT'L IN TRANS. MID COTTONWOOD SITE
SAMPLE No.12



% CLAY	% SILT	% SAND			% GRAVEL
		FINE	MEDIUM	COARSE	
59.0	34.1	3.0	2.2	.1	1.4

Sample: 13

Source of Material: North Platte - Mid Cottonwood Site

Date Sampled: August 19, 1992

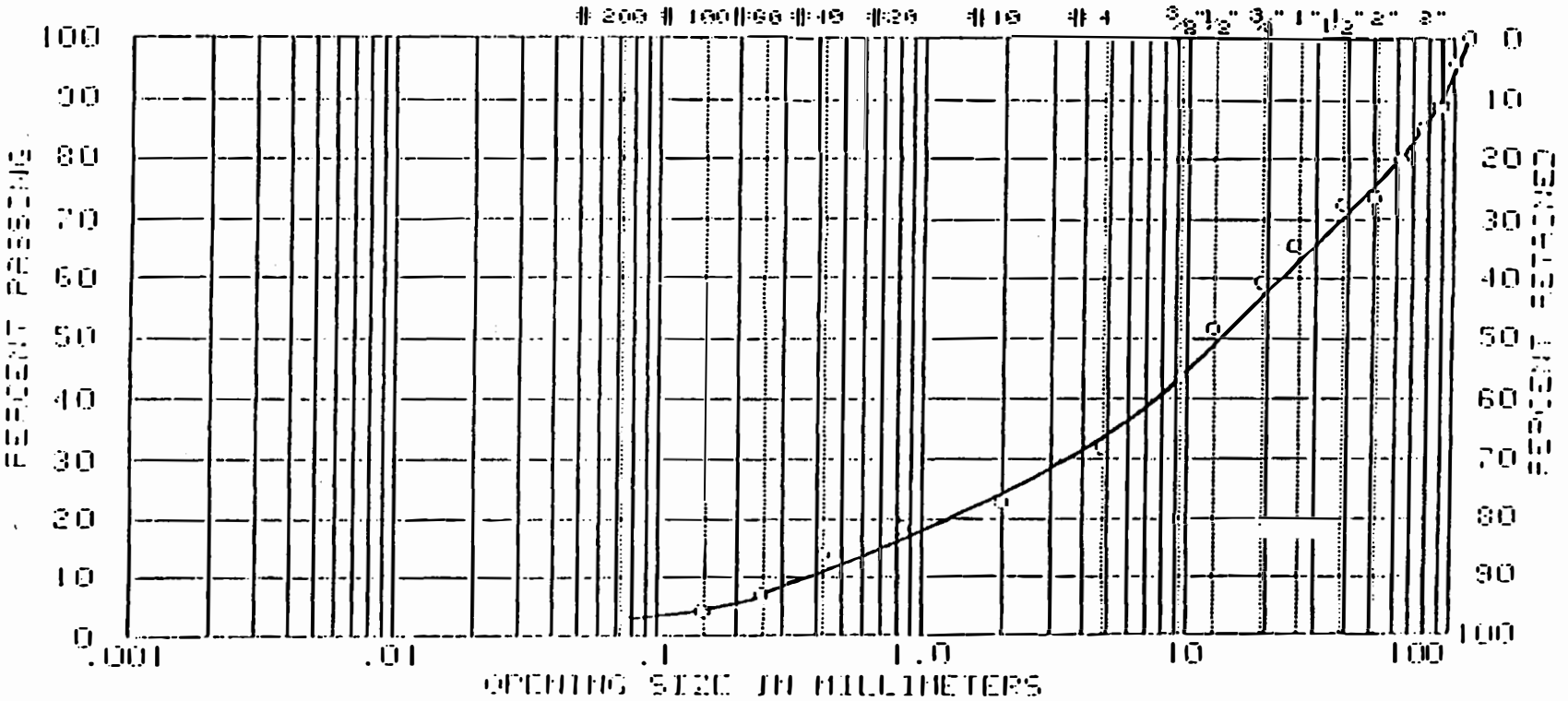
WASH SIEVE ANALYSIS

Sieve Size	% Passing
4½"	100.0
4"	95.9
3½"	88.8
3"	84.8
2½"	79.8
2"	73.5
1½"	72.3
1"	65.5
3/4"	59.3
1/2"	51.4
3/8"	43.4
#4	31.9
#10	22.7
#20	18.2
#40	13.7
#60	6.8
#100	4.0
#200	3.0

Total Sample Dry Weight for Bulk Density = 134.30#

GRAIN SIZE DISTRIBUTION CURVE

PROJECT: U.S. FISH & WILDLIFE SERVICE AUGUST 10, 1992
LOCATION OF SAMPLE: MID COTTONWOOD SITE
SAMPLE No. 13



% CLAY	% SILT	% SAND			% GRAVEL
		FINE	MEDIUM	COARSE	
3.0		10.2	9.0	9.2	68.1

D10= .324mm D30= 4.074mm D60=19.50mm Cc= 2.6 Cu= 60.3

Sample: 14

Source of Material: North Platte - Armor Boat Ramp

Date Sampled: August 18, 1992

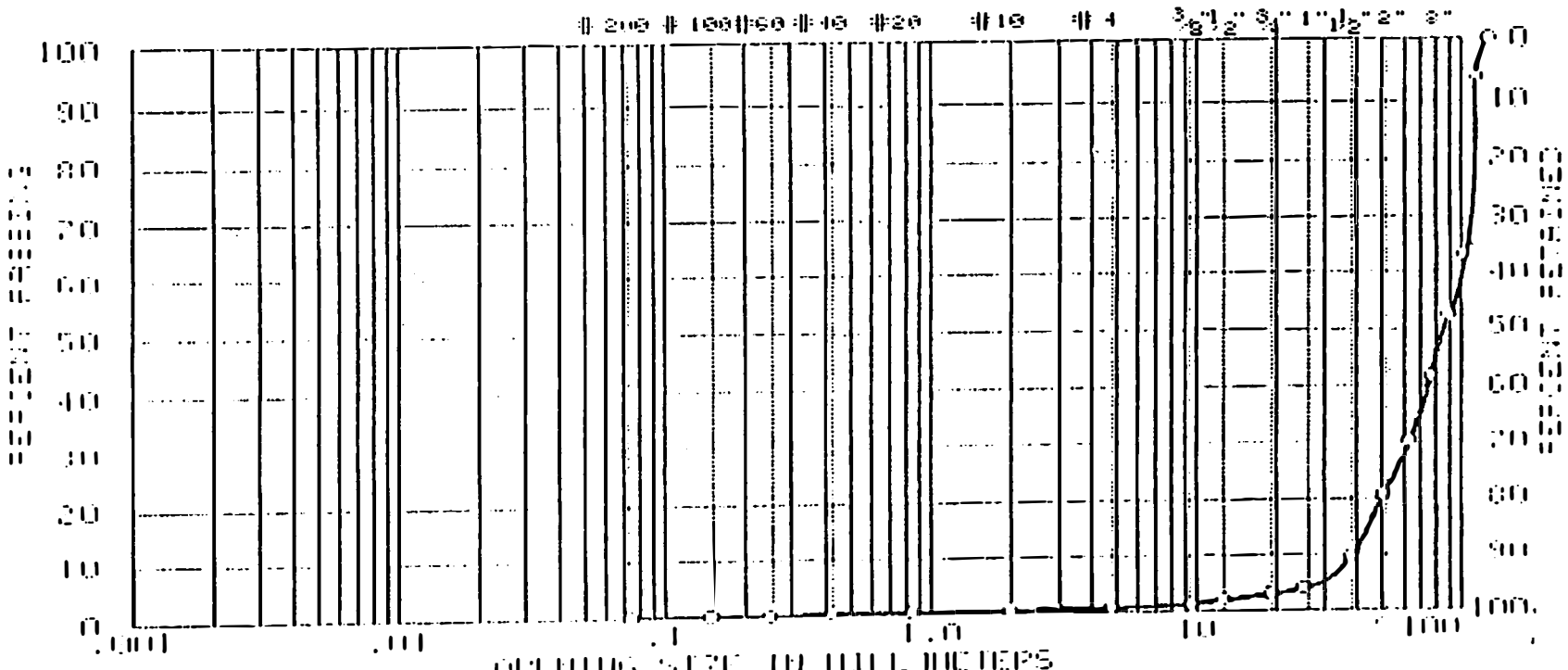
WASH SIEVE ANALYSIS

92.42 -

Sieve Size	% Passing
5"	100.0
4½"	93.6
4"	63.2
3½"	52.3
3"	41.6
2½"	30.1
2"	20.7
1½"	9.5
1"	3.9
3/4"	3.0
1/2"	1.9
3/8"	1.4
#4	0.9
#10	0.7
#20	0.6
#40	0.4
#60	0.3
#100	0.2
#200	0.2

GRAIN SIZE DISTRIBUTION CURVE

PROJECT: U.S. FISH & WILDLIFE SERVICE AUGUST 18, 1992
LOCATION OF SAMPLE: NOR III PLATTE ARMOR BOAT RAMP
SAMPLE No. 14



% CLAY	% SILT	% SAND			% GRAVEL
		FINE	MEDIUM	COARSE	
		.2	.3	.2	99.1

D10=38.0119mm D30=[illegible]mm D60=97.22mm Cc= 1.1 Cu= [illegible]

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Sample: 15

Source of Material: North Platte - Sub Armor Boat Ramp

Date Sampled: August 18, 1992

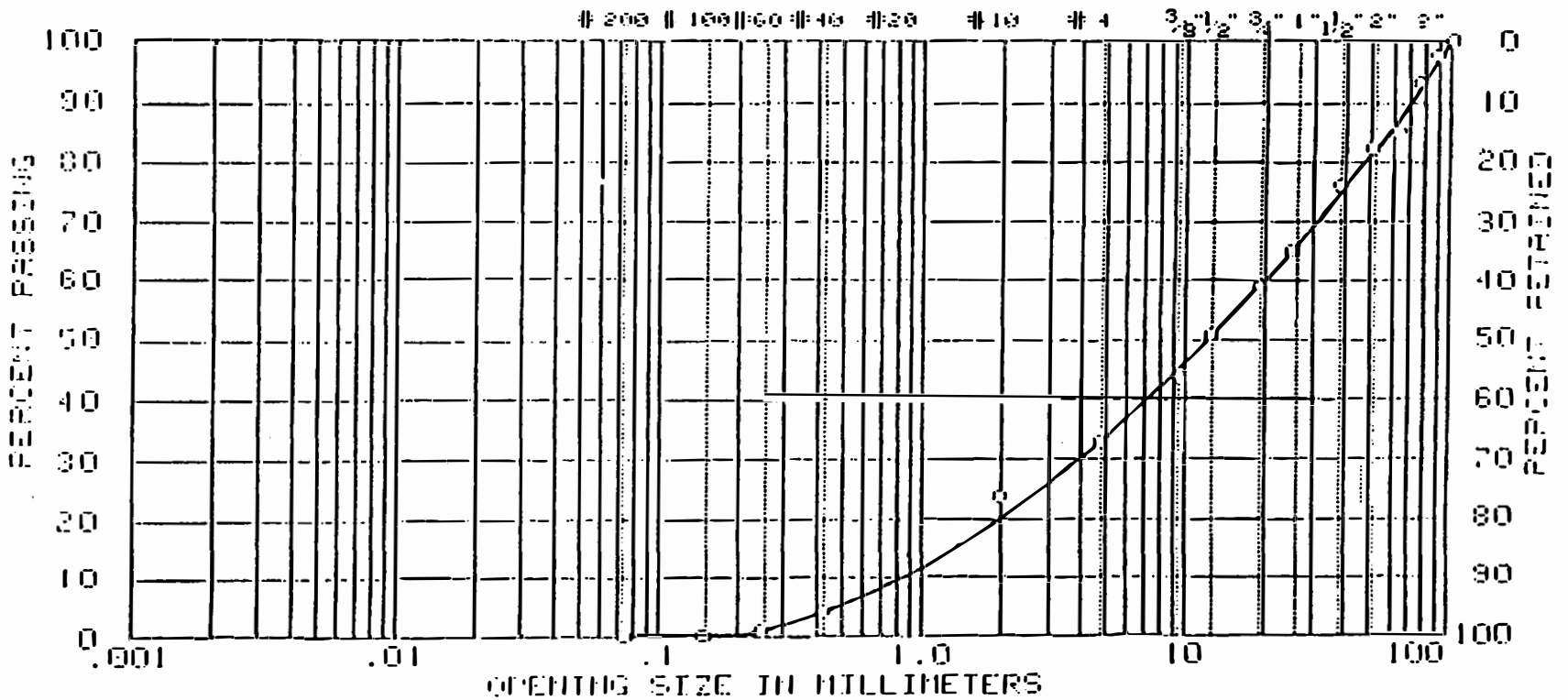
WASH SIEVE ANALYSIS

Sieve Size	% Passing
4"	100.0
3½"	97.4
3"	92.9
2½"	85.1
2"	82.4
1½"	76.0
1"	65.3
3/4"	59.0
1/2"	50.7
3/8"	43.7
#4	32.9
#10	23.7
#20	14.1
#40	3.9
#60	0.8
#100	0.2
#200	0.1

119.76

GRAIN SIZE DISTRIBUTION CURVE

PROJECT: U.S. FISH & WILDLIFE SERVICE AUGUST 18, 1992
LOCATION OF SAMPLE: NORTH PLATTE SUB ARMOR BOAT RAMP
SAMPLE No. K5



% CLAY	% SILT	% SAND			% GRAVEL
		FINE	MEDIUM	COARSE	
.1		3.8	19.8	9.2	67.1

D10= .646mm D30= 3.631mm D60=19.95mm Cc= 1.0 Cu= 30.9

CMF-FEE LABORATORIES INC.

Sample: 16

Source of Material: North Platte - X-Section Surface Material in Transport - Boat Ramp

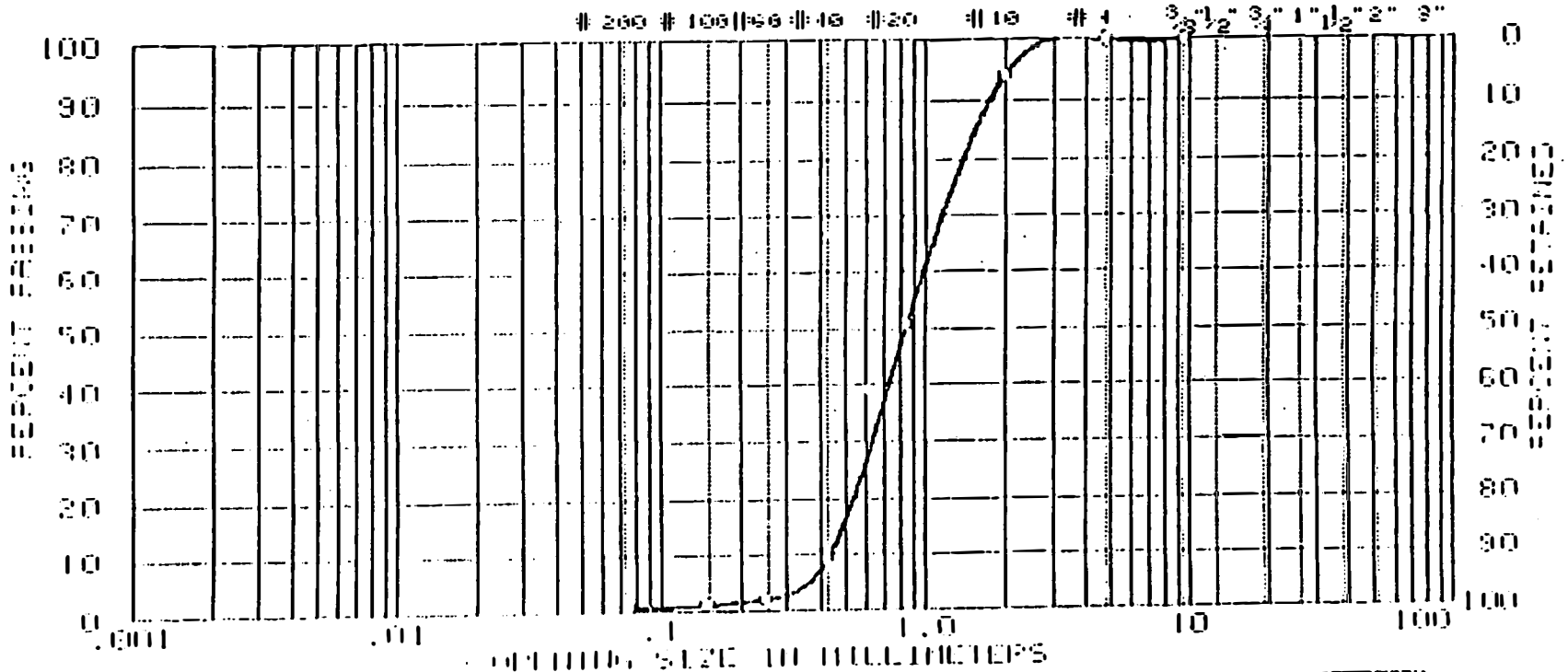
Date Sampled: August 18, 1992

WASH SIEVE ANALYSIS

Sieve Size	% Passing
3/8"	100.0
#4	99.9
#10	94.2
#20	50.6
#40	9.1
#60	2.1
#100	1.2
#200	0.8

GRAIN SIZE DISTRIBUTION CURVE

PROJECT: U.S. FISH & WILDLIFE SERVICE AUGUST 18, 1992
LOCATION OF SAMPLE: N.PLATTE-X-SEC. SURF. MAT'L. IN TRANS. BOAT RAMP
SAMPLE No.10



% CLAY	% SILT	% SAND			% GRAVEL
		FINE	MEDIUM	COARSE	
.0		8.3	85.1	5.8	0.0

D10= .43mm D30= .61mm D60= .93mm Cc= .9 Cu= 2.2

Gunnison River

Colorado

SAMPLE NO. X-SECTION-13	GRADATION AND SOILS CLASSIFICATION ANALYSIS			DEPTH SUBSTRATE	
TEST BY	BG & JD			CHECK BY	COMP
RIGHT BANK MAIN CHANNEL SUBSTRATE			FEATURE GUNNISON RIVER	EXC. NO.	
PERCENT OF TEST PIT OR AUGER HOLE OVERSIZE BY VOLUME					0%
MAX SIZE	3 1/2"	PLUS 12" 0.0%	5" TO 12" 0.0%	3" TO 5"	0.0%
P. INDEX		CLASS OF FINES =		+ OR - A LINE	

GRADATION OF GRAVEL SIZE

%MOIST+4	0.00%	SAMP WT.	148.51	%MOIST-4	0.00%	DRY SAMP 148.51
SIEVE SIZE		(75 MM) 3"	(37.5 MM) 1 1/2"	(19.0 MM) 3/4"	(9.5 MM) 3/8"	(4.75 MM) NO.4
WET MATL & PAN ACC		2.83	27.60	56.23	80.56	98.93
MASS OF PAN		0.00	0.00	0.00	0.00	0.00
WET MASS RET		2.83	27.60	56.23	80.56	98.93
DRY MASS RET		2.83	27.60	56.23	80.56	98.93
DRY MASS PASSING		145.68	120.91	92.28	67.95	49.58
% OF TOTAL PASSING		98.09%	81.42%	62.14%	45.75%	33.38%

SAMPLE WEIGHED IN POUNDS KILOGRAM GRAMS WT.IN PAN 49.58

GRADATION OF SAND SIZE

DRY WT MATL GRAMS BEFORE WASHING =	338.5	FACTOR = % TOT PASS NO#4 / TOTAL WT =	0.099
DISH NO.	PAN #G	DRY MASS OF SAMPLE (SIEVED) AFTER WASHING =	315.6
SIEVING TIME	10 MIN	DATE	1-21-93

SIEVE NO.	MASS RET (GR)	MASS PASS (GR)	FACTOR X MASS PASS = % OF TOTAL PASSING	% TOTAL PASSING	PARTICAL DIAMETER	REMARKS	
8	77.00	261.50		25.8%	2.36 MM		
16	153.20	185.30		18.3%	1.18 MM	GRAVEL	66.6%
30	192.50	146.00		14.4%	.600 MM	SAND	31.1%
50	239.40	99.10		9.8%	.300 MM	-200	2.3%
100	291.10	47.40		4.7%	.150 MM	.075 TO	
200	315.10	23.40		2.3%	.075 MM	.005 =	2.3%
PAN	315.60	TESTED BY		DATE 1-21-93		CU =	56.44
TOTAL	338.50	BG & JD				CC =	2.43

HYDROMETER ANALYSIS

HYDRO				DISPERSING AGENT		SODIUM HEX	
START		DATE				AMOUNT 125 ML	
TIME	TEMP C	HYD READ	HYD CORR	COR READ	% TOT PAS	PART DIA.	REMARKS
1 MIN	0.00	0.0	0.00	0.00	0.00%	.037 MM	
4 MIN	0.00	0.0	0.00	0.00	0.00%	.019 MM	
19 MIN	0.00	0.0	0.00	0.00	0.00%	.009 MM	
60 MIN	0.00	0.0	0.00	0.00	0.00%	.005 MM	
7HR 15MIN	0.00	0.00	0.00	0.00	0.00%	.002 MM	
25H 45MIN	0.00	0.00	0.00	0.00	0.00%	.001 MM	

SOILS CLASSIFICATION AND COMMON NAME

SAMPLE NO. X-SECTION-6		GRADATION AND SOILS CLASSIFICATION ANALYSIS				DEPTH ARMOUR LAYER	
TEST BY	BG & JD					CHECK BY	COMP
COBBLE BAR ARMOUR LAYER				FEATURE GUNNISON RIVER		EXC. NO.	
PERCENT OF TEST PIT OR AUGER HOLE OVERSIZE BY VOLUME							0%
MAX SIZE	7"	PLUS 12"	0.0%		0.0%		0.0%
P. INDEX		CLASS OF FINES =			+ OR - A LINE		

GRADATION OF GRAVEL SIZE

%MOIST+4	0.00%	SAMP WT.	173.58	%MOIST-4	0.00%	DRY SAMP	173.58
SIEVE SIZE		(150 MM) 6"	(75 MM) 3"	(37.5 MM) 1 1/2"	(19.0 MM) 3/4"	(9.5 MM) 3/8"	(4.75 MM) NO.4
WET MATL & PAN ACC		12.77	143.63	168.04	172.54	173.03	173.16
MASS OF PAN		0.00	0.00	0.00	0.00	0.00	0.00
WET MASS RET		12.77	143.63	168.04	172.54	173.03	173.16
DRY MASS RET		12.77	143.63	168.04	172.54	173.03	173.16
DRY MASS PASSING		160.81	29.95	5.54	1.04	0.55	0.42
% OF TOTAL PASSING		92.64%	17.25%	3.19%	0.60%	0.32%	0.24%

GRADATION AGGREGATE SIZE

DRY WT MATL GRAMS BEFORE WASHING =	178.7	FACTOR = %TOT PASS NO#4 / TOTAL WT =	0.001
DISH NO. PAN #0		DRY MASS OF SAMPLE (SIEVED) AFTER WASHING =	98.8
SIEVING TIME	10 MIN	DATE	1-20-93

SIEVE NO.	MASS RET (GR)	MASS PASS (GR)	FACTOR X MASS PASS	% TOTAL PASSING	PARTICAL DIAMETER	REMARKS	
8	17.40	161.30	= % OF	0.2%	2.36 MM		
16	27.90	150.80	TOTAL	0.2%	1.18 MM	GRAVEL	99.8%
30	41.80	136.90	PASSING	0.2%	.600 MM	SAND	0.1%
50	69.20	109.50		0.1%	.300 MM	-200	0.1%
100	86.10	92.60		0.1%	.150 MM	.075 TO	
200	97.40	81.30		0.1%	.075 MM	.005 =	0.1%
PAN	98.50	TESTED BY	JD	DATE	1-20-93	CU =	0.45
TOTAL	178.70					CC =	8.13

HYDROMETER ANALYSIS

HYDRO				DISPERSING AGENT		SODIUM HEX	
START		DATE				AMOUNT	125 ML
TIME	TEMP C	HYD READ	HYD CORR	COR READ	% TOT PAS	PART DIA.	REMARKS
1 MIN	0.00	0.0	0.00	0.00	0.00%	.037 MM	
4 MIN	0.00	0.0	0.00	0.00	0.00%	.019 MM	
19 MIN	0.00	0.0	0.00	0.00	0.00%	.009 MM	
60 MIN	0.00	0.0	0.00	0.00	0.00%	.005 MM	
7HR 15MIN	0.00	0.00	0.00	0.00	0.00%	.002 MM	
25H 45MIN	0.00	0.00	0.00	0.00	0.00%	.001 MM	

SOILS CLASSIFICATION AND COMMON NAME

SAMPLE NO. X-SECTION-7	GRADATION AND SOILS CLASSIFICATION ANALYSIS		DEPTH ARMOUR LAYER
TEST BY JD			CHECK BY COMP
MIDDLE OF CHANNEL ARMOUR LAYER		FEATURE GUNNISON RIVER	EXC. NO. / HELP ALT H

PERCENT OF TEST PIT OR AUGER HOLE OVERSIZE BY VOLUME

MAX SIZE	5 1/2"	PLUS 12"	0.0%		0.0%	0.0%
P. INDEX		CLASS OF FINES =			+ OR - A LINE	

GRADATION OF GRAVEL SIZE

MOIST+4	0.00%	SAMP WT.	118.03	MOIST-4	0.00%	DRY SAMP 118.03

SIEVE SIZE	(75 MM) 3"	(37.5 MM) 1 1/2"	(19.0 MM) 3/4"	(9.5 MM) 3/8"	(4.75 MM) NO.4	SAMPLE WEIGHED IN POUNDS KILOGRAM GRAMS WT.IN PAN
WET MATL & PAN ACC	86.43	104.85	115.82	117.19	117.46	
MASS OF PAN	0.00	0.00	0.00	0.00	0.00	
WET MASS RET	86.43	104.85	115.82	117.19	117.46	
DRY MASS RET	86.43	104.85	115.82	117.19	117.46	
DRY MASS PASSING	31.60	13.18	2.21	0.84	0.57	
% OF TOTAL PASSING	26.77%	11.17%	1.87%	0.71%	0.48%	0.57

GRADATION OF SAND SIZE

DRY WT MATL GRAMS BEFORE WASHING =	259.8	FACTOR=%TOT PASS NO#4 / TOTAL WT =	0.0019
DISH NO. pan #1		DRY MASS OF SAMPLE (SIEVED) AFTER WASHING =	171.9
SIEVING TIME	10 MIN	DATE	1-22-93

SIEVE NO.	MASS RET (GR)	MASS PASS (GR)	FACTOR X MASS PASS = % OF TOTAL PASSING	% TOTAL PASSING	PARTICAL DIAMETER	REMARKS
8	30.00	229.80		0.4%	2.36 MM	
16	50.20	209.60		0.4%	1.18 MM	GRAVEL 99.5%
30	80.20	179.60		0.3%	.600 MM	SAND 0.3%
50	115.70	144.10		0.3%	.300 MM	-200 0.2%
100	146.30	113.50		0.2%	.150 MM	.075 TO
200	169.70	90.10		0.2%	.075 MM	.005 = 0.2%
PAN	171.90	TESTED BY	BG	DATE	1-22-93	CU = 0.33
TOTAL	259.80					CC = 6.86

HYDROMETER ANALYSIS

HYDRO NO. N/A		DISPERSING AGENT	SODIUM HEX
START	DATE		AMOUNT M125 ML

TIME	TEMP C	HYD READ	HYD CORR	COR READ	% TOT PASS	PART DIA.	REMARKS
1 MIN	0.00	0.0	0.00	0.00	0.00%	.037 MM	
4 MIN	0.00	0.0	0.00	0.00	0.00%	.019 MM	
19 MIN	0.00	0.0	0.00	0.00	0.00%	.009 MM	
60 MIN	0.00	0.0	0.00	0.00	0.00%	.005 MM	
7HR 15MIN				0.00	0.00%	.002 MM	
25H 45MIN				0.00	0.00%	.001 MM	

SOILS CLASSIFICATION AND COMMON NAME

CL-ML GRAVELLY SILTY CLAY

SAMPLE NO. X-SECTION-7	GRADATION AND SOILS CLASSIFICATION ANALYSIS			DEPTH SUBSTRATE	
TEST BY	BG & JD			CHECK BY	COMP
MIDDLE OF CHANNEL SUBSTRATE			FEATURE GUNNISON RIVER	EXC. NO.	

PERCENT OF TEST PIT OR AUGER HOLE OVERSIZE BY VOLUME 0%

MAX SIZE	5"	PLUS 12"	0.0%		0.0%		0.0%
P. INDEX		CLASS OF FINES =			+ OR - A LINE		

GRADATION OF GRAVEL SIZE

%MOIST+4	0.00%	SAMP WT.	165.74	%MOIST-4	0.00%	DRY SAMP	165.74
SIEVE SIZE		(150 MM) 6"	(75 MM) 3"	(37.5 MM) 1 1/2"	(19.0 MM) 3/4"	(9.5 MM) 3/8"	(4.75 MM) NO.4
WET MATL & PAN ACC		0.00	44.32	65.75	90.84	115.39	132.47
MASS OF PAN		0.00	0.00	0.00	0.00	0.00	0.00
WET MASS RET		0.00	44.32	65.75	90.84	115.39	132.47
DRY MASS RET		0.00	44.32	65.75	90.84	115.39	132.47
DRY MASS PASSING		165.74	121.42	99.99	74.90	50.35	33.27
% OF TOTAL PASSING		100.00%	73.26%	60.33%	45.19%	30.38%	20.07%

GRADATION OF SAND SIZE

DRY WT MATL GRAMS BEFORE WASHING =	449.8	FACTOR=%TOT PASS NO#4 / TOTAL WT =	0.045
DISH NO. PAN #1		DRY MASS OF SAMPLE (SIEVED) AFTER WASHING =	446.4
SIEVING TIME	10 MIN	DATE	1-20-93

SIEVE NO.	MASS RET (GR)	MASS PASS (GR)	FACTOR X MASS PASS = % OF TOTAL PASSING	% TOTAL PASSING	PARTICAL DIAMETER	REMARKS	
8	122.30	327.50		14.6%	2.36 MM		
16	191.30	258.50		11.5%	1.18 MM	GRAVEL	79.9%
30	275.20	174.60		7.8%	.600 MM	SAND	19.9%
50	404.90	44.90		2.0%	.300 MM	-200	0.2%
100	441.20	8.60		0.4%	.150 MM	.075 TO	
200	446.30	3.50		0.2%	.075 MM	.005 =	0.2%
PAN	446.40	TESTED BY	BG	DATE	1-20-93	CU =	39.38
TOTAL	449.80					CC =	2.49

HYDROMETER ANALYSIS

HYDRO				DISPERSING AGENT		SODIUM HEX	
START		DATE				AMOUNT	125 ML
TIME	TEMP C	HYD READ	HYD CORR	COR READ	% TOT PAS	PART DIA.	REMARKS
1 MIN	0.00	0.0	0.00	0.00	0.00%	.037 MM	
4 MIN	0.00	0.0	0.00	0.00	0.00%	.019 MM	
19 MIN	0.00	0.0	0.00	0.00	0.00%	.009 MM	
60 MIN	0.00	0.0	0.00	0.00	0.00%	.005 MM	
7HR 15MIN	0.00	0.00	0.00	0.00	0.00%	.002 MM	
25H 45MIN	0.00	0.00	0.00	0.00	0.00%	.001 MM	

SOILS CLASSIFICATION AND COMMON NAME

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SAMPLE NO. X-SECTION-7	GRADATION ANALYSIS CLASSIFICATION ANALYSIS			DEPTH ARMOUR LAYER	
TEST BY	JD			CHECK BY	COMP
MIDDLE OF CHANNEL ARMOUR LAYER			FEATURE GUNNISON RIVER	EXC. NO.	HELP ALT H

PERCENT OF TEST PIT OR AUGER HOLE OVERSIZE BY VOLUME

MAX SIZE	5 1/2"	PLUS 12"	0.0%	0.0%		0.0%
P. INDEX		CLASS OF FINES =		+ OR - A LINE		

GRADATION OF GRAVEL SIZE

MOIST+4	0.00%	SAMP WT.	118.03	MOIST-4	0.00%	DRY SAMP	118.03
SIEVE SIZE		(75 MM) 3"	(37.5 MM) 1 1/2"	(19.0 MM) 3/4"	(9.5 MM) 3/8"	(4.75 MM) NO.4	SAMPLE WEIGHED
WET MATL & PAN ACC		86.43	104.85	115.82	117.19	117.46	IN
MASS OF PAN		0.00	0.00	0.00	0.00	0.00	POUNDS
WET MASS RET		86.43	104.85	115.82	117.19	117.46	KILOGRAM
DRY MASS RET		86.43	104.85	115.82	117.19	117.46	GRAMS
DRY MASS PASSING		31.60	13.18	2.21	0.84	0.57	WT.IN PAN
% OF TOTAL PASSING		26.77%	11.17%	1.87%	0.71%	0.48%	0.57

GRADATION OF SAND SIZE

DRY WT MATL GRAMS BEFORE WASHING =	259.8	FACTOR=%TOT PASS NO#4 / TOTAL WT	= 0.0019
DISH NO.	pan #1	DRY MASS OF SAMPLE (SIEVED) AFTER WASHING =	171.9
SIEVING TIME	10 MIN	DATE	1-22-93

SIEVE NO.	MASS RET (GR)	MASS PASS (GR)	FACTOR X MASS PASS	% TOTAL PASSING	PARTICAL DIAMETER	REMARKS	
8	30.00	229.80	= % OF	0.4%	2.36 MM		
16	50.20	209.60	TOTAL	0.4%	1.18 MM	GRAVEL	99.5%
30	80.20	179.60	PASSING	0.3%	.600 MM	SAND	0.3%
50	115.70	144.10		0.3%	.300 MM	-200	0.2%
100	146.30	113.50		0.2%	.150 MM	.075 TO	
200	169.70	90.10		0.2%	.075 MM	.005 =	0.2%
PAN	171.90	TESTED BY	BG	DATE	1-22-93	CU =	0.33
TOTAL	259.80					CC =	6.86

HYDROMETER ANALYSIS

HYDRO NO	N/A			DISPERSING AGENT		SODIUM HEX	
START		DATE				AMOUNT M25 ML	
TIME	TEMP C	HYD READ	HYD CORR	COR READ	% TOT PAS	PART DIA.	REMARKS
1 MIN	0.00	0.0	0.00	0.00	0.00%	.037 MM	
4 MIN	0.00	0.0	0.00	0.00	0.00%	.019 MM	
19 MIN	0.00	0.0	0.00	0.00	0.00%	.009 MM	
60 MIN	0.00	0.0	0.00	0.00	0.00%	.005 MM	
7HR 15MIN				0.00	0.00%	.002 MM	
25H 45MIN				0.00	0.00%	.001 MM	

SOILS CLASSIFICATION AND COMMON NAME

CL-ML GRAVELLY SILTY CLAY.

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SAMPLE NO. X-SECTION-6		GRADATION AND SOILS CLASSIFICATION ANALYSIS				DEPTH SUBSTRATE	
TEST BY	J.D.					CHECK BY	COMP
COBBLE BAR SUBSTRATE				FEATURE GUNNISON RIVER		EXC. NO.	
PERCENT OF TEST PIT OR AUGER HOLE OVERSIZE BY VOLUME 0%							
MAX SIZE	3"	PLUS 12"	0.0%	5" TO 12"	0.0%	3" TO 5"	0.0%
P. INDEX		CLASS OF FINES =			+ OR - A LINE		

GRADATION OF GRAVEL SIZE

%MOIST+4	0.00%	SAMP WT.	174.54	%MOIST-4	0.00%	DRY SAMP	174.54
SIEVE SIZE		(75 MM) 3"	(37.5 MM) 1 1/2"	(19.0 MM) 3/4"	(9.5 MM) 3/8"	(4.75 MM) NO.4	SAMPLE WEIGHED IN POUNDS KILOGRAM GRAMS
WET MATL & PAN ACC		18.46	45.56	75.67	104.98	123.92	
MASS OF PAN		0.00	0.00	0.00	0.00	0.00	
WET MASS RET		18.46	45.56	75.67	104.98	123.92	
DRY MASS RET		18.46	45.56	75.67	104.98	123.92	
DRY MASS PASSING		156.08	128.98	98.87	69.56	50.62	WT.IN PAN
% OF TOTAL PASSING		89.42%	73.90%	56.65%	39.85%	29.00%	50.62

GRADATION OF SAND SIZE

DRY WT MATL GRAMS BEFORE WASHING =	576.4	FACTOR=%TOT PASS NO#4 / TOTAL WT =	0.050
DISH NO. PAN #Q		DRY MASS OF SAMPLE (SIEVED) AFTER WASHING =	567.3
SIEVING TIME	10 MIN	DATE	1-21-93

SIEVE NO.	MASS RET (GR)	MASS PASS (GR)	FACTOR X MASS PASS = % OF TOTAL PASSING	% TOTAL PASSING	PARTICAL DIAMETER	REMARKS	
8	98.90	477.50		24.0%	2.36 MM		
16	187.70	388.70		19.6%	1.18 MM	GRAVEL	71.0%
30	294.30	282.10		14.2%	.600 MM	SAND	28.5%
50	481.00	95.40		4.8%	.300 MM	-200	0.5%
100	550.50	25.90		1.3%	.150 MM	.075 TO	
200	566.90	9.50		0.5%	.075 MM	.005 =	0.5%
PAN	567.30	TESTED BY		DATE	1-21-93	CU =	48.48
TOTAL	576.40	BG & JD				CC =	2.55

HYDROMETER ANALYSIS

HYDRO				DISPERSING AGENT		SODIUM HEX	
START		DATE				AMOUNT	125 ML
TIME	TEMP C	HYD READ	HYD CORR	COR READ	% TOT PAS	PART DIA.	REMARKS
1 MIN	0.00	0.0	0.00	0.00	0.00%	.037 MM	
4 MIN	0.00	0.0	0.00	0.00	0.00%	.019 MM	
19 MIN	0.00	0.0	0.00	0.00	0.00%	.009 MM	
60 MIN	0.00	0.0	0.00	0.00	0.00%	.005 MM	
7HR 15MIN	0.00	0.00	0.00	0.00	0.00%	.002 MM	
25H 45MIN	0.00	0.00	0.00	0.00	0.00%	.001 MM	

SOILS CLASSIFICATION AND COMMON NAME

6

SAMPLE NO.	GRADATION ANALYSIS	DEPTH	
X-SECTION-6	CLASSIFICATION ANALYSIS	COBBLE BAR	
TEST BY J.D.		CHECK BY	COMP
COBBLE BAR BULK DENSITY	FEATURE GUNNISON RIVER	EXC. NO.	

PERCENT OF TEST PIT OR AUGER HOLE OVERSIZE BY VOLUME 0%

MAX SIZE	3"	PLUS 12"	0.0%	5" TO 12"	0.0%	3" TO 5"	0.0%
P. INDEX		CLASS OF FINES =			+ OR - 4 INDE	

GRADATION OF GRAVEL SIZE

%MOIST +4	0.00%	SAMP WT.	62.07	%MOIST -4	0.00%	DRY SAMP	62.07

SIEVE SIZE	(75 MM) 3"	(37.5 MM) 1 1/2"	(19.0 MM) 3/4"	(9.5 MM) 3/8"	(4.75 MM) NO.4	SAMPLE WEIGHED IN POUNDS KILOGRAM GRAMS WT.IN PAN
WET MATL. & PAN ACC	16.77	24.00	33.89	42.06	47.27	
MASS OF PAN	0.00	0.00	0.00	0.00	0.00	
WET MASS RET	16.77	24.00	33.89	42.06	47.27	
DRY MASS RET	16.77	24.00	33.89	42.06	47.27	
DRY MASS PASSING	45.30	38.07	28.18	20.01	14.80	
% OF TOTAL PASSING	72.98%	61.33%	45.40%	32.24%	23.84%	14.80

GRADATION OF SAND SIZE

DRY WT MATL GRAMS BEFORE WASHING =	481.6	FACTOR=%TOT PASS NO#4 / TOTAL WT =	0.050
DISH NO. PAN #0		DRY MASS OF SAMPLE (SIEVED) AFTER WASHING =	449.5
SIEVING TIME	10 MIN	DATE	1-21-93

SIEVE NO.	MASS RET (GR)	MASS PASS (GR)	FACTOR X MASS PASS = % OF TOTAL PASSING	% TOTAL PASSING	PARTICAL DIAMETER	REMARKS	
8	95.90	385.70		19.1%	2.36 MM		
16	152.50	329.10		16.3%	1.18 MM	GRAVEL	76.2%
30	228.60	253.00		12.5%	.600 MM	SAND	22.2%
50	366.20	115.40		5.7%	.300 MM	-200	1.6%
100	431.50	50.10		2.5%	.150 MM	.075 TO	
200	448.80	32.80		1.6%	.075 MM	.005 =	1.6%
PAN	449.50	TESTED BY		DATE	1-21-93	CU =	73.56
TOTAL	481.60	BG & JD				CC =	3.86

HYDROMETER ANALYSIS

HYDRO		DISPERSING AGENT	SODIUM HEX
START	DATE		AMOUNT 125 ML

TIME	TEMP C	HYD READ	HYD CORR	COR READ	% TOT PAS	PART DIA	REMARKS
1 MIN	0.00	0.0	0.00	0.00	0.00%	.037 MM	
4 MIN	0.00	0.0	0.00	0.00	0.00%	.019 MM	
19 MIN	0.00	0.0	0.00	0.00	0.00%	.009 MM	
60 MIN	0.00	0.0	0.00	0.00	0.00%	.005 MM	
7HR 15MIN	0.00	0.00	0.00	0.00	0.00%	.002 MM	
25H 45MIN	0.00	0.00	0.00	0.00	0.00%	.001 MM	

SOILS CLASSIFICATION AND COMMON NAME

7

7-1589 (10-86)
Bureau of Reclamation

SPECIFIC GRAVITY DETERMINATION
(VOLUME METHOD)

Designation USBR 5320-__

SAMPLE NO. X-SECTION	PROJECT GUNNISON RIVER	FEATURE COBBLE BAR BULK DENSITY	
SPECIMEN NO.	HOLE NO.	DEPTH ft ☐ m ☐	
TESTED BY J. DALEIDEN — DATE 1-21-93	COMPUTED BY J.D. — DATE 1-21-93	CHECKED BY	DATE

	TRIAL NO. 1	TRIAL NO. 2
1. FLASK NO.	#17	#3-2
2. MASS OF FLASK * (g)	112.27	118.17
3. VOLUME OF FLASK * (cm³)	249.70	249.80
4. MASS OF SPECIMEN (g)	74.32	75.22
5. MASS OF FLASK + SPECIMEN + WATER (g)	406.66	413.19
6. TEMPERATURE OF WATER (°C)	19°	19°
7. MASS OF FLASK + WATER = (5) - (4) (g)	332.34	337.97
8. MASS OF WATER IN FLASK = (7) - (2) (g)	220.06	219.75
9. ABSOLUTE DENSITY OF WATER AT TEMP (6) (g/cm³)	0.998405	0.998405
10. VOLUME OF WATER IN FLASK = (8) / (9) (cm³)	220.21	220.08
11. VOLUME OF SOIL = (3) - (10) (cm³)	29.49	29.72
12. SPECIFIC GRAVITY = (4) / (11) **	2.54	2.53
13. AVERAGE	2.54	

*Calibration data from USBR 1030
**Implies that for water 1 g = 1 mL = 1 cm³

SSD

W = 242.1
D = 256.5
P = 142.9
#93
5.6
113.6
4.9

W = 239.0
D = 234.0
P = 130.1
#T304
5.0
103.9
4.8

GPO 552-303

7-2336 (1-86)
Bureau of Reclamation

BULK SPECIFIC GRAVITY AND PERCENT ABSORPTION OF THE PLUS NO. 4 FRACTION

Designation USBR 5320-

SAMPLE NO.	PROJECT	FEATURE
X-SECTION 6	GUNNISON RIVER	COBBLE BAR BULK ~~[illegible]~~ DENSITY
HOLE NO.	DEPTH	n☐ m☐
TESTED BY: J. DAVENPORT, DATE: 1-21-93	COMPUTED BY: J.J., DATE: 1-21-93	CHECKED: DATE:

SUSPENSION METHOD

		TRIAL NO. 1	TRIAL NO. 2
1. Mass of basket in water	(g)	TARED	
2. Mass of basket in air	(g)	TARED	
3. Mass of SSD* specimen + basket in air	(g)	—	
4. Mass of SSD specimen + basket in water	(g)	—	
5. Mass of ovendry specimen	(g)	20.68	
6. Mass of SSD specimen in air (3) - (2)	(g)	20.88	
7. Mass of SSD specimen in water (4) - (1)	(g)	12.91	
8. Apparent specific gravity (5)/[(5) - (7)]		2.66	
9. Average apparent specific gravity			
10. Bulk specific gravity (SSD) (6)/[redacted]		[redacted]	
11. Average bulk specific gravity (SSD)			
12. Bulk specific gravity (ovendry) (5)/[(6) - (7)]		2.59	
13. Average bulk specific gravity (ovendry)			
14. Absorption [(6) - (5)]/(5)] x 100	(%)	1.0	
15. Average absorption	(%)		

SIPHON METHOD

1. Mass of specimen (SSD)	(g)		
2. Volume of water displaced	(mL)		
3. Mass of ovendry specimen	(g)		
4. Mass of water (1) - (3)	(g)		
5. Bulk specific gravity (SSD) (1)/(2)			
6. Average bulk specific gravity (SSD)			
7. Bulk specific gravity (ovendry) (3)/(2)			
8. Average bulk specific gravity (ovendry)			
9. Absorption [(4)/(3)] x 100	(%)		
10. Average absorption	(%)		

*SSD (Saturated surface-dry)

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SAMPLE NO. X-SECTION 13	GRADATION AND SOILS CLASSIFICATION ANALYSIS		DEPTH ARMOUR LAYER
TEST BY JD			CHECK BY COMP
RIGHT BANK MAIN CHANNEL ARMOUR LAYER		FEATURE GUNNISON RIVER	EXC. NO.

PERCENT OF TEST PIT OR AUGER HOLE OVERSIZE BY VOLUME 0%

MAX SIZE	5"	PLUS 12"	0.0%	5" TO 12"	0.0%	3" TO 5"	0.0%
P. INDEX		CLASS OF FINES =			+ OR - A LINE		

GRADATION OF GRAVEL SIZE

%MOIST +4	0.00%	SAMP WT.	123.72	%MOIST -4	0.00%	DRY SAMP	123.72

SIEVE SIZE	(75 MM) 3"	(37.5 MM) 1 1/2"	(19.0 MM) 3/4"	(9.5 MM) 3/8"	(4.75 MM) NO.4	SAMPLE WEIGHED IN POUNDS KILOGRAM GRAMS
WET MATL & PAN ACC	56.57	110.84	121.39	122.94	123.24	
MASS OF PAN	0.00	0.00	0.00	0.00	0.00	
WET MASS RET	56.57	110.84	121.39	122.94	123.24	
DRY MASS RET	56.57	110.84	121.39	122.94	123.24	
DRY MASS PASSING	67.15	12.88	2.33	0.78	0.48	WT.IN PAN
% OF TOTAL PASSING	54.28%	10.41%	1.88%	0.63%	0.39%	0.48

GRADATION OF SAND SIZE

DRY WT MATL GRAMS BEFORE WASHING =	219.8	FACTOR=%TOT PASS NO#4 / TOTAL WT =	0.002
DISH NO. PAN #C		DRY MASS OF SAMPLE (SIEVED) AFTER WASHING =	126.5
SIEVING TIME	10 MIN	DATE	1-20-93

SIEVE NO.	MASS RET (GR)	MASS PASS (GR)	FACTOR X MASS PASS = % OF TOTAL PASSING	% TOTAL PASSING	PARTICAL DIAMETER	REMARKS	
8	28.80	191.00		0.3%	2.36 MM		
16	37.70	182.10		0.3%	1.18 MM	GRAVEL	99.6%
30	42.50	177.30		0.3%	.600 MM	SAND	0.2%
50	55.80	164.00		0.3%	.300 MM	-200	0.2%
100	82.30	137.50		0.2%	.150 MM	.075 TO	
200	122.30	97.50		0.2%	.075 MM	.005 =	0.2%
PAN	126.50	TESTED BY	JD	DATE	1-20-93	CU =	0.32
TOTAL	126.50					CC =	5.16

HYDROMETER ANALYSIS

HYDRO	N/A			DISPERSING AGENT		SODIUM HEX	
START		DATE				AMOUNT	125 ML

TIME	TEMP C	HYD READ	HYD CORR	COR READ	% TOT PAS	PART DIA	REMARKS
1 MIN	0.00	0.0	0.00	0.00	0.00%	.037 MM	
4 MIN	0.00	0.0	0.00	0.00	0.00%	.019 MM	
19 MIN	0.00	0.0	0.00	0.00	0.00%	.009 MM	
60 MIN	0.00	0.0	0.00	0.00	0.00%	.005 MM	
7HR 15MIN				0.00	0.00%	.002 MM	
25H 45MIN				0.00	0.00%	.001 MM	

SOILS CLASSIFICATION AND COMMON NAME

SAMPLE NO.	GRADATION AND SOILS CLASSIFICATION ANALYSIS		DEPTH
X-SECTION-13			ARMOUR LAYER
TEST BY JD			CHECK BY COMP
LEFT BANK SECONDARY CHANNEL ARMOUR LAYER		FEATURE GUNNISON RIVER	EXC. NO.

PERCENT OF TEST PIT OR AUGER HOLE OVERSIZE BY VOLUME 0%

MAX SIZE	6"	PLUS 12"	0.0%	5" TO 12"	0.0%	3" TO 5"	0.0%
P. INDEX		CLASS OF FINES =			+ OR - A LINE		

GRADATION OF GRAVEL SIZE

%MOIST+4	0.00%	SAMP WT.	157.47	%MOIST-4	0.00%	DRY SAMP	157.47
SIEVE SIZE		(150 MM) 6"	(75 MM) 3"	(37.5 MM) 1 1/2"	(19.0 MM) 3/4"	(9.5 MM) 3/8"	(4.75 MM) NO.4
WET MATL & PAN ACC		17.07	105.75	147.45	155.56	156.44	156.55
MASS OF PAN		0.00	0.00	0.00	0.00	0.00	0.00
WET MASS RET		17.07	105.75	147.45	155.56	156.44	156.55
DRY MASS RET		17.07	105.75	147.45	155.56	156.44	156.55
DRY MASS PASSING		140.40	51.72	10.02	1.91	1.03	0.92
% OF TOTAL PASSING		89.16%	32.84%	6.36%	1.21%	0.65%	0.58%

GRADATION OF SAND SIZE

DRY WT MATL GRAMS BEFORE WASHING =	412.7	FACTOR = %TOT PASS NO# 4 / TOTAL WT =	0.001
DISH NO. PAN #10		DRY MASS OF SAMPLE (SIEVED) AFTER WASHING =	341.6
SIEVING TIME	10 MIN	DATE	1-20-93

SIEVE NO.	MASS RET (GR)	MASS PASS (GR)	FACTOR X MASS PASS = % OF TOTAL PASSING	% TOTAL PASSING	PARTICAL DIAMETER	REMARKS	
8	9.60	403.10		0.6%	2.36 MM		
16	13.10	399.60		0.6%	1.18 MM	GRAVEL	99.4%
30	20.70	392.00		0.6%	.600 MM	SAND	0.5%
50	89.80	322.90		0.5%	.300 MM	-200	0.1%
100	260.70	152.00		0.2%	.150 MM	.075 TO	
200	339.00	73.70		0.1%	.075 MM	.005 =	0.1%
PAN	341.60	TESTED BY	JD	DATE	1-20-93	CU =	0.14
TOTAL	412.70					CC =	10.52

HYDROMETER ANALYSIS

HYDRO				DISPERSING AGENT		SODIUM HEX	
START		DATE				AMOUNT	125 ML
TIME	TEMP C	HYD READ	HYD CORR	COR READ	% TOT PAS	PART DIA.	REMARKS
1 MIN	0.00	0.0	0.00	0.00	0.00%	.037 MM	
4 MIN	0.00	0.0	0.00	0.00	0.00%	.019 MM	
19 MIN	0.00	0.0	0.00	0.00	0.00%	.009 MM	
60 MIN	0.00	0.0	0.00	0.00	0.00%	.005 MM	
7HR 15MIN	0.00	0.00	0.00	0.00	0.00%	.002 MM	
25H 45MIN	0.00	0.00	0.00	0.00	0.00%	.001 MM	

SOILS CLASSIFICATION AND COMMON NAME

SAMPLE NO. X-SECTION-13	GRADATION AND SOILS CLASSIFICATION ANALYSIS		DEPTH SURFACE LAYER
TEST BY BG			CHECK BY COMP
RIGHT BANK MAIN CHANNEL SURFACE LAYER 1-20-93		FEATURE GUNNISON RIVER	EXC. NO.

PERCENT OF TEST PIT OR AUGER HOLE OVERSIZE BY VOLUME 0%

MAX SIZE	3/4"	PLUS 12"	0.0%	5" TO 12"	0.0%	3" TO 5"	0.0%
P. INDEX		CLASS OF FINES =			+ OR - A LINE		

GRADATION OF GRAVEL SIZE

%MOIST+4	0.00%	SAMP WT.	3.65	%MOIST-4	0.00%	DRY SAMP	3.65

SIEVE SIZE	(75 MM) 3"	(37.5 MM) 1 1/2"	(19.0 MM) 3/4"	(9.5 MM) 3/8"	(4.75 MM) NO.4	SAMPLE WEIGHED IN POUNDS KILOGRAM GRAMS WT.IN PAN
WET MATL & PAN ACC	0.00	0.00	0.03	0.20	0.33	
MASS OF PAN	0.00	0.00	0.00	0.00	0.00	
WET MASS RET	0.00	0.00	0.03	0.20	0.33	
DRY MASS RET	0.00	0.00	0.03	0.20	0.33	
DRY MASS PASSING	3.65	3.65	3.62	3.45	3.32	3.32
% OF TOTAL PASSING	100.00%	100.00%	99.18%	94.52%	90.96%	

GRADATION OF SAND SIZE

DRY WT MATL GRAMS BEFORE WASHING =	50.3	FACTOR=%TOT PASS NO#4 / TOTAL WT =	1.810
DISH NO. #10		DRY MASS OF SAMPLE (SIEVED) AFTER WASHING =	16.7
SIEVING TIME	10 MIN	DATE	1-20-93

SIEVE NO.	MASS RET (GR)	MASS PASS (GR)	FACTOR X MASS PASS = % OF TOTAL PASSING	% TOTAL PASSING	PARTICAL DIAMETER	REMARKS
8	1.60	48.66		88.1%	2.36 MM	
16	2.00	48.26		87.3%	1.18 MM	GRAVEL 9.0%
30	2.40	47.86		86.6%	.600 MM	SAND 23.7%
50	3.00	47.26		85.5%	.300 MM	-200 67.3%
100	4.30	45.96		83.2%	.150 MM	.075 TO
200	13.10	37.16		67.3%	.075 MM	.005 = 47.7%
PAN	16.70	TESTED BY	BG	DATE	1-20-93	CU = 0.00
TOTAL	50.25					CC = 0.00

HYDROMETER ANALYSIS

HYDRO	#25625		DISPERSING AGENT	SODIUM HEX	
START	7:48	DATE	1-20-93	AMOUNT	125 ML

TIME	TEMP C	HYD READ	HYD CORR	COR READ	% TOT PAS	PART DIA.	REMARKS
1 MIN	21.00	28.0	6.04	21.96	39.74%	.037 MM	
4 MIN	21.00	25.0	6.04	18.96	34.31%	.019 MM	
19 MIN	21.00	21.0	6.04	14.96	27.07%	.009 MM	
60 MIN	20.50	17.0	6.17	10.83	19.60%	.005 MM	
7HR 15MIN	20.00	13.00	6.30	6.70	12.13%	.002 MM	
25H 45MIN	19.00	11.00	6.43	4.57	8.27%	.001 MM	

SOILS CLASSIFICATION AND COMMON NAME

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7-1589 (10-86)
Bureau of Reclamation

SPECIFIC GRAVITY DETERMINATION
(VOLUME METHOD)

Designation USBR 5320-___

SAMPLE NO. 1/20/93	PROJECT Gunnison River		FEATURE
SPECIMEN NO. X-Section 13	HOLE NO. Right bank Main channel	DEPTH Surface layer	ft ☐ m ☐
TESTED BY BG	DATE 1-26-93	COMPUTED BY	DATE
		CHECKED BY	DATE

	TRIAL NO. 1	TRIAL NO. 2
1. FLASK NO.	3	
2. MASS OF FLASK * (g)	118.63	
3. VOLUME OF FLASK * (cm³)	249.67	
4. MASS OF SPECIMEN (g)	107.4	
5. MASS OF FLASK + SPECIMEN + WATER (g)	433.52	
6. TEMPERATURE OF WATER (°C)	24.0	
7. MASS OF FLASK + WATER = (5) - (4) (g)	326.12	
8. MASS OF WATER IN FLASK = (7) - (2) (g)	207.49	
9. ABSOLUTE DENSITY OF WATER AT TEMP (6) .997296 (g/cm³)	.997296	
10. VOLUME OF WATER IN FLASK = (8) / (9) (cm³)	208.05	
11. VOLUME OF SOIL = (3) - (10) (cm³)	41.62	
12. SPECIFIC GRAVITY = (4) / (11) **	2.58	
13. AVERAGE		

*Calibration data from USBR 1030
**Implies that for water 1 g = 1 mL = 1 cm³

62.428

GPO 852-303

13

Bureau of Reclamation	SOIL CONSISTENCY TEST (THREE-POINT LIQUID LIMIT METHOD)	USBR 5300 - 19

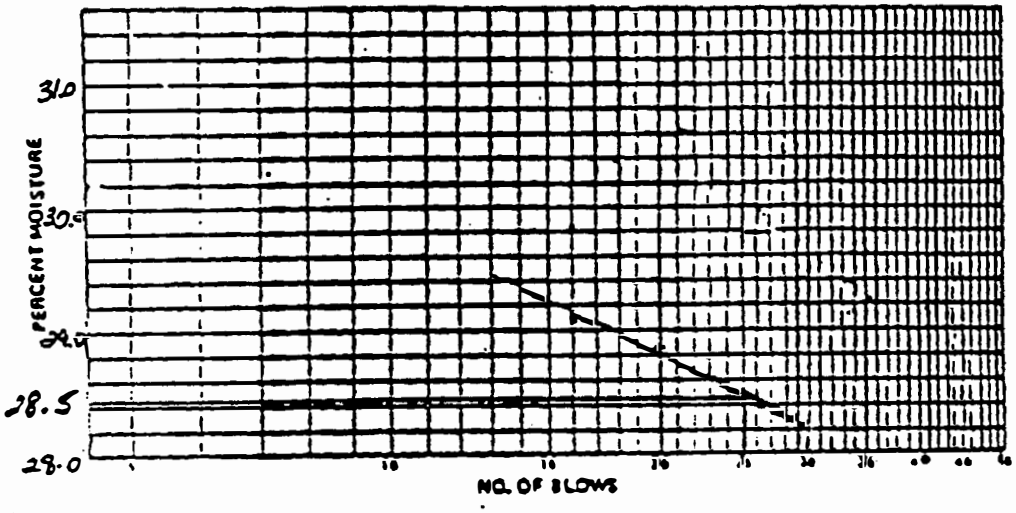
Sample No. X-SECTION 13 RIGHT ABUTMENT - SURFACE MATERIAL Project GUNNISON RIVER

Air dried [ ]
Oven dried [X]
Natural [ ]

Tested by J. DALEIDEN Date 2-5-83
Computed by J. DALEIDEN Date 2-6-83
Checked by B. Gerlanics Date 2-6-83

	Plastic Limit		Liquid Limit		
Trial No.	1	2	1	2	3
Dish No.	7G	4F	7E	8E	0H
No. of blows			16	20	26
Mass of dish + wet soil (g)	29.3028	29.4428	26.5207	25.5182	27.3394
Mass of dish + dry soil (g)	25.0916	25.7188	22.1715	23.3110	25.9140
Mass of dish (g)	14.6888	14.6219	14.5294	13.5500	14.4561
Mass of water (g)	2.2145	2.6239	2.3573	2.1972	2.4254
Mass of dry soil (g)	10.4028	12.3770	7.6421	9.7610	11.4579
% moisture	21.3	21.3	28.1	28.7	28.4
Average plastic limit	21.3				

FLOW CURVE



Liquid Limit (LL)	28.5	Plastic Limit (PL)	21.3	Plasticity Index (PI = LL - PL)	7.2

SHRINKAGE TEST

Shrinkage dish no.		Vol. of shrinkage dish (V)	
Mass of dish + wet soil (g)		Vol. of dry soil (Vo)	
Mass of dish + dry soil (g)		V - Vo	
Mass of water (g)			
Mass of dish (g)		$\frac{V - V_o}{W_o}$	
Mass of dry soil (Wo) (g)			
% moisture		Shrinkage limit	
		Shrinkage ratio	

Auxiliary tests: USBR 5200 - 19
USBR 5300 - 19
USBR 5300 -
USBR 5365 -

Remarks:

Soil consistency test (three-point liquid limit method)

14

SAMPLE NO. 1-20-93	GRADATION AND SOILS CLASSIFICATION ANALYSIS	DEPTH	
TEST BY BG		CHECK BY	COMP
TOP (MIDDLE) OF ISLAND SAMPLE CROSS SECTION 13	FEATURE GUNNISON RIVER	EXC. NO.	HELP ALT H

PERCENT OF TEST PIT OR AUGER HOLE OVERSIZE BY VOLUME

MAX SIZE	SAND	PLUS 12"	0.0%	5" TO 12"	0.0%	3" TO 5"	0.0%
P. INDEX		CLASS OF FINES =			+ OR - A LINE		

GRADATION OF GRAVEL SIZE

MOIST+4	0.00%	SAMP WT.	0.00	MOIST-4	0.00%	DRY SAMP	1782.20
SIEVE SIZE		(75 MM) 3"	(37.5 MM) 1 1/2"	(19.0 MM) 3/4"	(9.5 MM) 3/8"	(4.75 MM) NO.4	SAMPLE WEIGHED IN POUNDS KILOGRM GRAMS
WET MATL & PAN ACC		0.00	0.00	0.00	0.00	0.00	
MASS OF PAN		0.00	0.00	0.00	0.00	0.00	
WET MASS RET		0.00	0.00	0.00	0.00	0.00	
DRY MASS RET		0.00	0.00	0.00	0.00	0.00	
DRY MASS PASSING		1782.20	1782.20	1782.20	1782.20	1782.20	WT.IN PAN
% OF TOTAL PASSING		100.00%	100.00%	100.00%	100.00%	100.00%	1782.20

GRADATION OF SAND SIZE

DRY WT MATL GRAMS BEFORE WASHING =	500.0	FACTOR=%TOT PASS NO#4 / TOTAL WT =	0.2000
DISH NO. pan #1		DRY MASS OF SAMPLE (SIEVED) AFTER WASHING =	500.0
SIEVING TIME	10 MIN	DATE	1-20-93

SIEVE NO.	MASS RET (GR)	MASS PASS (GR)	FACTOR X MASS PASS	% TOTAL PASSING	PARTICAL DIAMETER	REMARKS	
8	0.20	499.80	= % OF	100.0%	2.36 MM		
16	0.70	499.30	TOTAL	99.9%	1.18 MM	GRAVEL	0.0%
30	9.30	490.70	PASSING	98.1%	.600 MM	SAND	92.6%
50	120.60	379.40		75.9%	.300 MM	-200	7.4%
100	354.40	145.60		29.1%	.150 MM	.075 TO	
200	463.20	36.80		7.4%	.075 MM	.005 =	7.4%
PAN	500.00	TESTED BY BG		DATE	1-20-93	CU =	0.00
TOTAL	500.00					CC =	0.00

HYDROMETER ANALYSIS

HYDRO NO	N/A		DISPERSING AGENT	SODIUM HEX
START		DATE		AMOUNT M125 ML

TIME	TEMP C	HYD READ	HYD CORR	COR READ	% TOT PAS	PART DIA	REMARKS
1 MIN	0.00	0.0	0.00	0.00	0.00%	.037 MM	
4 MIN	0.00	0.0	0.00	0.00	0.00%	.019 MM	
19 MIN	0.00	0.0	0.00	0.00	0.00%	.009 MM	
60 MIN	0.00	0.0	0.00	0.00	0.00%	.005 MM	
7HR 15MIN				0.00	0.00%	.002 MM	
25H 45MIN				0.00	0.00%	.001 MM	

SOILS CLASSIFICATION AND COMMON NAME

15

SAMPLE NO. X-SECTION 13	GRADATION AND SOILS CLASSIFICATION ANALYSIS		DEPTH SURFACE MATERIAL
TEST BY JD			CHECK BY COMP
LEFT BANK SECONDARY CHANNEL SURFACE MATERIAL		FEATURE GUNNISON RIVER	EXC. NO.

PERCENT OF TEST PIT OR AUGER HOLE OVERSIZE BY VOLUME 0%

MAX SIZE	0.00	PLUS 12"	0.0%	5" TO 12"	0.0%	3" TO 5"	0.0%
P. INDEX		CLASS OF FINES =			+ OR - A LINE		

GRADATION OF GRAVEL SIZE

%MOIST+4	0.00%	SAMP WT.	6.72	%MOIST-4	0.00%	DRY SAMP	6.72
SIEVE SIZE		(75 MM) 3"	(37.5 MM) 1 1/2"	(19.0 MM) 3/4"	(9.5 MM) 3/8"	(4.75 MM) NO.4	SAMPLE WEIGHED IN POUNDS, KILOGRAM GRAMS
WET MATL & PAN ACC		0.00	0.00	0.00	0.00	0.00	
MASS OF PAN		0.00	0.00	0.00	0.00	0.00	
WET MASS RET		0.00	0.00	0.00	0.00	0.00	
DRY MASS RET		0.00	0.00	0.00	0.00	0.00	
DRY MASS PASSING		6.72	6.72	6.72	6.72	6.72	WT.IN PAN
% OF TOTAL PASSING		100.00%	100.00%	100.00%	100.00%	100.00%	6.72

GRADATION OF SAND SIZE

DRY WT MATL GRAMS BEFORE WASHING =	50.3	FACTOR=%TOT PASS NO#4 / TOTAL WT =	1.989
DISH NO. #43		DRY MASS OF SAMPLE (SIEVED) AFTER WASHING =	7.8
SIEVING TIME	10 MIN	DATE	1-20-93

SIEVE NO.	MASS RET (GR)	MASS PASS (GR)	FACTOR X MASS PASS = % OF TOTAL PASSING	% TOTAL PASSING	PARTICAL DIAMETER	REMARKS	
8	0.00	50.28		100.0%	2.36 MM		
16	0.00	50.28		100.0%	1.18 MM	GRAVEL	0.0%
30	0.00	50.28		100.0%	.600 MM	SAND	14.9%
50	0.20	50.08		99.6%	.300 MM	-200	85.1%
100	1.50	48.78		97.0%	.150 MM	.075 TO	
200	7.50	42.78		85.1%	.075 MM	.005 =	48.1%
PAN	7.50	TESTED BY	BG	DATE	1-20-93	CU =	0.00
TOTAL	50.28					CC =	0.00

HYDROMETER ANALYSIS

HYDRO	#25644			DISPERSING AGENT		SODIUM HEX	
START	7:23	DATE	1-20-93			AMOUNT	125 ML
TIME	TEMP C	HYD READ	HYD CORR	COR READ	% TOT PAS	PARTDIA	REMARKS
1 MIN	20.50	42.0	5.38	36.62	72.83%	.037 MM	
4 MIN	20.50	36.0	5.38	30.62	60.90%	.019 MM	
19 MIN	20.50	31.0	5.38	25.62	50.95%	.009 MM	
60 MIN	20.50	24.0	5.38	18.62	37.03%	.005 MM	
7HR 15MIN	20.50	19.00	5.38	13.62	27.09%	.002 MM	
25H 45MIN	19.00	16.00	5.75	10.25	20.39%	.001 MM	

SOILS CLASSIFICATION AND COMMON NAME

9-1020 (12-66) Bureau of Reclamation | SOIL CONSISTENCY TEST (THREE-POINT LIQUID LIMIT METHOD) | Designation USBR 5300 - 89

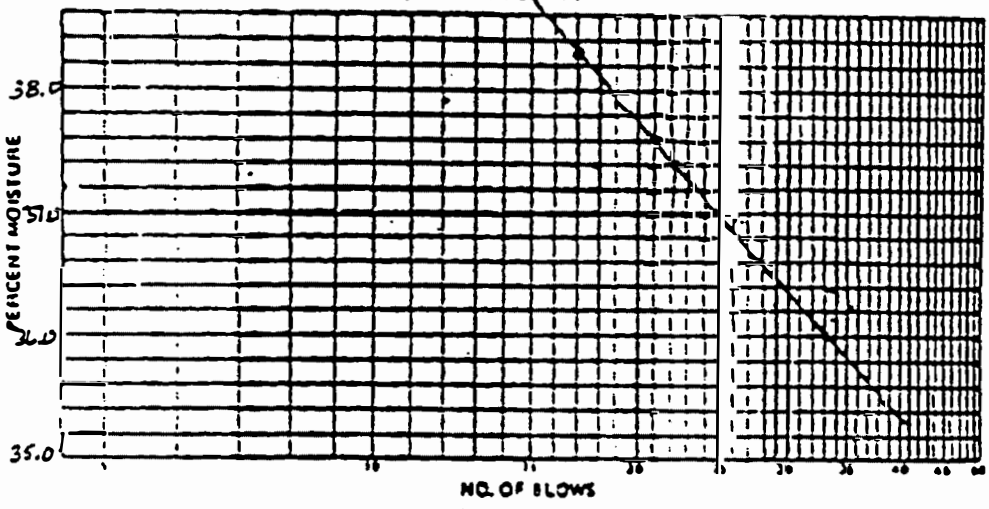
Sample No. X-SECTION 13 LEFT BANK SECONDARY CHANNEL | Source: SURFACE MATERIAL GUNNISON RIVER

Air dried ☐
Oven dried ☒
Natural ☐

Tested by: K. DALEIDEN Date 2-4-93
Computed by: K. DALEIDEN Date 2-5-93
Checked by: B. Geldenies Date 2-6-93

	Plastic Limit		Liquid Limit		
Test No.	1	2	1	2	3
Dish No.	7A	8C	7C	8F	0E
No. of blows			17	22	33
Mass of dish + wet soil (g)	21.9970	24.1732	22.6205	25.1938	27.0508
Mass of dish + dry soil (g)	20.4702	22.2641	20.3368	22.1524	23.6795
Mass of dish (g)	14.4578	14.1732	14.3788	14.0734	14.2044
Mass of water (g)	1.5268	1.9091	2.2837	3.0414	3.3713
Mass of dry soil (g)	6.0124	8.0909	5.9580	8.0790	9.4751
% moisture	25.4	23.6	38.3	37.6	35.6
Average plastic limit	23.7				

FLOW CURVE



Liquid Limit (LL)	37.0	Plastic Limit (PL)	23.7	Plasticity Index (PI = LL - PL)	13

• SHRINKAGE TEST

Shrinkage dish no.		Vol. of shrinkage dish (V)	
Mass of dish + wet soil (g)		Vol. of dry soil (Vo)	
Mass of dish + dry soil (g)		V - Vo	
Mass of water (g)			
Mass of dish (g)		$\frac{V - V_o}{W_o}$	
Mass of dry soil (Wo) (g)			
% moisture		Shrinkage limit	
		Shrinkage ratio	

Auxiliary tests: USBR 5200 - 89 ___
USBR 5300 - 89 ___
USBR 5360 - ___
USBR 5365 - ___

Remarks: ___

Soil consistency test (three-point liquid limit method)

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SAMPLE NO. 1-20-93	GRADATION AND SOILS CLASSIFICATION ANALYSIS		DEPTH SUBSTRATE
TEST BY JB			CHECK BY COMP
LEFT BANK OF SECONDARY CHANNEL CROSS SECTION 13 SUBSTRATE		FEATURE GUNNISON RIVER	EXC. NO. / HELP ALT H

PERCENT OF TEST PIT OR AUGER HOLE OVERSIZE BY VOLUME

MAX SIZE	4 3/4"	PLUS 12"	0.0%	5" TO 12"	0.0%	3" TO 5"	0.0%
P. INDEX		CLASS OF FINES =			+ OR - A LINE		

GRADATION OF GRAVEL SIZE

MOIST+4	0.00%	SAMP WT.	73.63	MOIST-4	0.00%	DRY SAMP	73.63
SIEVE SIZE		(75 MM) 3"	(37.5 MM) 1 1/2"	(19.0 MM) 3/4"	(9.5 MM) 3/8"	(4.75 MM) NO.4	SAMPLE WEIGHED IN POUNDS KILOGRAM GRAMS WT.IN PAN
WET MATL & PAN ACC		15.77	27.37	39.72	50.61	57.28	
MASS OF PAN		0.00	0.00	0.00	0.00	0.00	
WET MASS RET		15.77	27.37	39.72	50.61	57.28	
DRY MASS RET		15.77	27.37	39.72	50.61	57.28	
DRY MASS PASSING		57.86	46.26	33.91	23.02	16.35	
% OF TOTAL PASSING		78.58%	62.83%	46.05%	31.26%	22.21%	16.35

GRADATION OF SAND SIZE

DRY WT MATL GRAMS BEFORE WASHING = 776.5

FACTOR = % TOT PASS NO# 4 / TOTAL WT = 0.0286

DISH NO. pan #1

DRY MASS OF SAMPLE (SIEVED) AFTER WASHING = 776.5

SIEVING TIME 10 MIN

DATE 1-22-93

SIEVE NO.	MASS RET (GR)	MASS PASS (GR)	FACTOR X MASS PASS = % OF TOTAL PASSING	% TOTAL PASSING	PARTICAL DIAMETER	REMARKS	
8	130.90	645.60		18.5%	2.36 MM		
16	180.20	596.30		17.1%	1.18 MM	GRAVEL	77.8%
30	309.60	466.90		13.4%	.600 MM	SAND	22.1%
50	627.10	149.40		4.3%	.300 MM	-200	0.1%
100	755.50	21.00		0.6%	.150 MM	.075 TO	
200	772.70	3.80		0.1%	.075 MM	.005 =	0.1%
PAN	776.50	TESTED BY	JB	DATE	1-22-93	CU =	70.27
TOTAL	776.50					CC =	4.64

HYDROMETER ANALYSIS

HYDRO NO. N/A

DISPERSING AGENT SODIUM HEX

START DATE

AMOUNT M25 ML

TIME	TEMP C	HYD READ	HYD CORR	COR READ	% TOT PAS	PART DIA.	REMARKS
1 MIN	0.00	0.0	0.00	0.00	0.00%	.037 MM	
4 MIN	0.00	0.0	0.00	0.00	0.00%	.019 MM	
19 MIN	0.00	0.0	0.00	0.00	0.00%	.009 MM	
60 MIN	0.00	0.0	0.00	0.00	0.00%	.005 MM	
7HR 15MIN				0.00	0.00%	.002 MM	
25H 45MIN				0.00	0.00%	.001 MM	

SOILS CLASSIFICATION AND COMMON NAME

SAMPLE NO. X-SECTION-6	GRADATION AND SOILS CLASSIFICATION ANALYSIS		DEPTH SURFACE MATERIAL
TEST BY BG			CHECK BY COMP
SURFACE MATERIAL ON BAR 1-21-93		FEATURE GUNNISON RIVER	EXC. NO.

PERCENT OF TEST PIT OR AUGER HOLE OVERSIZE BY VOLUME 0%

MAX SIZE	FINE SAND	PLUS 12"	0.0%	5" TO 12"	0.0%	3" TO 5"	0.0%
P. INDEX		CLASS OF FINES =			+ OR - A LINE	

GRADATION OF GRAVEL SIZE

%MOIST+4	0.00%	SAMP WT.	1.71	%MOIST-4	0.00%	DRY SAMP	1.71
SIEVE SIZE		(75 MM) 3"	(37.5 MM) 1 1/2"	(19.0 MM) 3/4"	(9.5 MM) 3/8"	(4.75 MM) NO.4	SAMPLE WEIGHED IN POUNDS KILOGRAM GRAMS
WET MATL & PAN ACC		0.00	0.00	0.00	0.00	0.00	
MASS OF PAN		0.00	0.00	0.00	0.00	0.00	
WET MASS RET		0.00	0.00	0.00	0.00	0.00	
DRY MASS RET		0.00	0.00	0.00	0.00	0.00	
DRY MASS PASSING		1.71	1.71	1.71	1.71	1.71	WT.IN PAN
% OF TOTAL PASSING		100.00%	100.00%	100.00%	100.00%	100.00%	1.71

GRADATION OF SAND SIZE

DRY WT MATL GRAMS BEFORE WASHING =	50.3	FACTOR=%TOT PASS NO#4 / TOTAL WT =	1.986
DISH NO. #T304		DRY MASS OF SAMPLE (SIEVED) AFTER WASHING =	7.2
SIEVING TIME	10 MIN	DATE 1-21-93	

SIEVE NO.	MASS RET (GR)	MASS PASS (OR)	FACTOR X MASS PASS = % OF TOTAL PASSING	% TOTAL PASSING	PARTICAL DIAMETER	REMARKS
8	0.00	50.34		100.0%	2.36 MM	
16	0.00	50.34		100.0%	1.18 MM	GRAVEL 0.0%
30	0.20	50.14		99.6%	.600 MM	SAND 12.3%
50	0.60	49.74		98.8%	.300 MM	-200 87.7%
100	1.80	48.54		96.4%	.150 MM	.075 TO
200	6.20	44.14		87.7%	.075 MM	.005 = 60.8%
PAN	7.20	TESTED BY	BG	DATE	1-21-93	CU = 0.00
TOTAL	50.30					CC = 0.00

HYDROMETER ANALYSIS

HYDRO	#25680			DISPERSINO AGENT	SODIUM HEX
START	7:35	DATE	1-21-93	AMOUNT	125 ML

TIME	TEMP C	HYD READ	HYD CORR	COR READ	% TOT PAS	PARTDIA.	REMARKS
1 MIN	21.00	35.0	6.48	28.52	56.65%	.037 MM	
4 MIN	21.00	33.0	6.48	26.52	52.68%	.019 MM	
19 MIN	21.00	26.0	6.48	19.52	38.78%	.009 MM	
60 MIN	21.00	20.0	6.48	13.52	26.86%	.005 MM	
7HR 15MIN	20.50	13.00	6.60	6.40	12.71%	.002 MM	
25H 45MIN	19.00	11.00	6.96	4.04	8.03%	.001 MM	

SOILS CLASSIFICATION AND COMMON NAME

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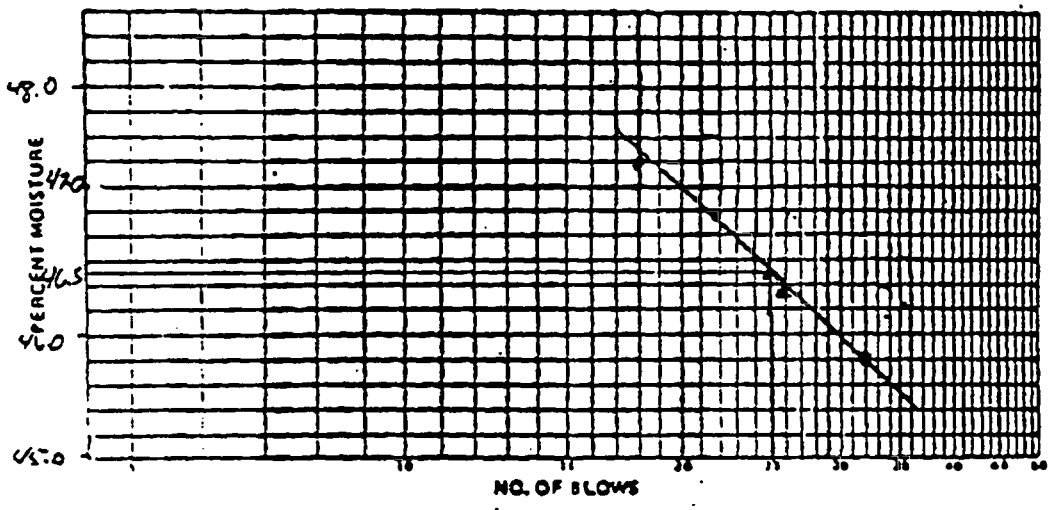
Bureau of Reclamation	SOIL CONSISTENCY TEST (THREE-POINT LIQUID LIMIT METHOD)	Designation USBR 5300 - 89
Sample no. SECTION #6	Feature SURFACE MATERIAL ON BAR	Project GUNNISON RIVER

Air dried ( )
Oven dried ☒
Natural C

Tested by JIM DALGIEDER Date 1-21-93
Computed by J.D. Date 1-21-93
Checked by Date

	Plastic Limit		Liquid Limit		
Test No.	1	2	1	2	3
Dish No.	7B	8F	UP	OH	41
No. of blows			18	22	32
Mass of dish + wet soil (g)	21.9410	24.5035	25.7933	21.3[illegible]54	26.6708
Mass of dish + dry soil (g)	19.9784	22.0730	22.1087	21.[illegible]61	22.9630
Mass of dish (g)	14.4984	14.0737	14.3094	17.[illegible]45	14.2207
Mass of water (g)	1.9626	2.5748	3.6846	[illegible].1915	3.9162
Mass of dry soil (g)	5.4807	7.9207	7.7993	17.0156	8.5429
% moisture	33.2	32.5	47.2	46.8	45.8
Average plastic limit	32.4				

FLOW CURVE



Liquid Limit (LL)	46.5	Plastic Limit (PL)	32.4	Plasticity Index (PI = LL - PL)	14.1

• SHRINKAGE TEST

Shrinkage dish no.		Vol. of shrinkage dish (V)	
Mass of dish + wet soil (g)		Vol. of dry soil (V_o)	
Mass of dish + dry soil (g)		$V - V_o$	
Mass of water (g)			
Mass of dish (g)		$\frac{V - V_o}{W_o}$	
Mass of dry soil (W_o) (g)		Shrinkage limit	
% moisture		Shrinkage ratio	

Auxiliary tests: USBR 5200 - 89
USBR 5300 - 89
USBR 5380 -
USBR 5385 -

Remarks:

Soil consistency test (three-point liquid limit method)

20

SAMPLE NO. X-SECTION #6	GRADATION AND SOILS CLASSIFICATION ANALYSIS	DEPTH HIGHER STAGE	
TEST BY BG		CHECK BY	COMP
BAR AT HIGHER STAGE NEXT TO GRASS	FEATURE GUNNISON RIVER	EXC. NO.	

PERCENT OF TEST PIT OR AUGER HOLE OVERSIZE BY VOLUME 0%

MAX SIZE	CS	PLUS 12"	0.0%	5" TO 12"	0.0%	3" TO 5"	0.0%
P. INDEX		CLASS OF FINES =			+ OR - A LINE		

GRADATION OF GRAVEL SIZE

%MOIST+4	0.00%	SAMP WT.	1.71	%MOIST-4	0.00%	DRY SAMP	1.71
SIEVE SIZE		(75 MM) 3"	(37.5 MM) 1 1/2"	(19.0 MM) 3/4"	(9.5 MM) 3/8"	(4.75 MM) NO.4	SAMPLE WEIGHED IN POUNDS KILOGRAM GRAMS
WET MATL & PAN ACC		0.00	0.00	0.00	0.00	0.00	
MASS OF PAN		0.00	0.00	0.00	0.00	0.00	
WET MASS RET		0.00	0.00	0.00	0.00	0.00	
DRY MASS RET		0.00	0.00	0.00	0.00	0.00	
DRY MASS PASSING		1.71	1.71	1.71	1.71	1.71	WT.IN PAN
% OF TOTAL PASSING		100.00%	100.00%	100.00%	100.00%	100.00%	1.71

GRADATION OF SAND SIZE

DRY WT MATL GRAMS BEFORE WASHING =	54.4	FACTOR=%TOT PASS NO#4 / TOTAL WT =	1.840
DISH NO. #2		DRY MASS OF SAMPLE (SIEVED) AFTER WASHING =	12.3
SIEVING TIME	10 MIN	DATE	1-20-93

SIEVE NO.	MASS RET (GR)	MASS PASS (GR)	FACTOR X MASS PASS = % OF TOTAL PASSING	% TOTAL PASSING	PARTICAL DIAMETER	REMARKS	
8	0.20	54.15		99.6%	2.36 MM		
16	0.30	54.05		99.4%	1.18 MM	GRAVEL	0.0%
30	0.40	53.95		99.3%	.600 MM	SAND	19.5%
50	1.00	53.35		98.2%	.300 MM	-200	80.5%
100	3.40	50.95		93.7%	.150 MM	.075 TO	
200	10.60	43.75		80.5%	.075 MM	.005 =	51.7%
PAN	12.30	TESTED BY	BG	DATE	1-20-93	CU =	0.00
TOTAL	12.30					CC =	0.00

HYDROMETER ANALYSIS

HYDRO	#25811			DISPERSING AGENT	SODIUM HEX
START	8:01	DATE	1-20-93		AMOUNT 125 ML

TIME	TEMP C	HYD READ	HYD CORR	COR READ	% TOT PAS	PART DIA.	REMARKS
1 MIN	21.00	36.0	6.19	29.51	54.85%	.037 MM	
4 MIN	21.00	31.0	6.19	24.51	45.65%	.019 MM	
19 MIN	21.00	25.0	6.19	18.51	34.61%	.009 MM	
60 MIN	20.50	22.0	6.33	15.67	28.83%	.005 MM	
7HR 15MIN	20.00	16.00	6.48	9.52	17.52%	.002 MM	
25H 45MIN	19.00	13.00	6.77	6.23	11.46%	.001 MM	

SOILS CLASSIFICATION AND COMMON NAME

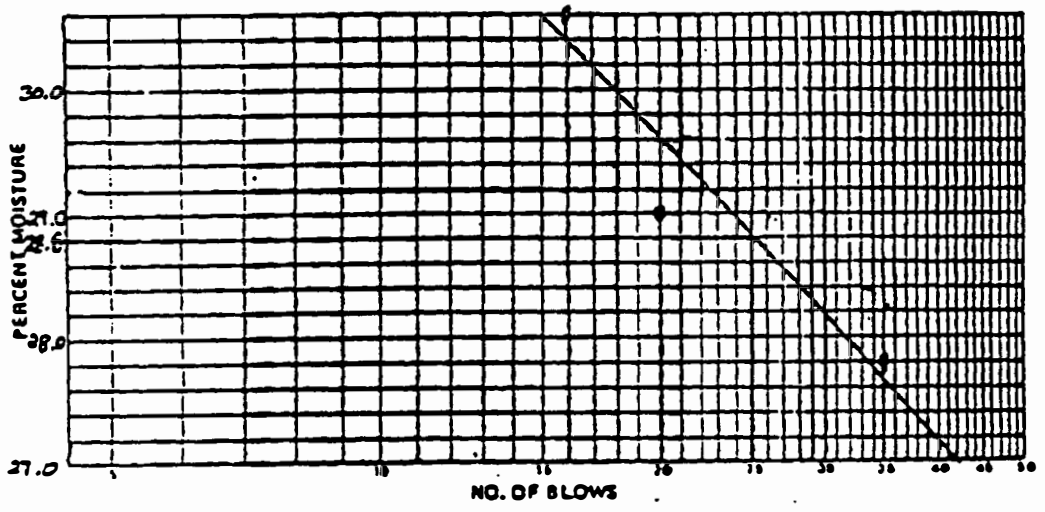
7-1030 (12-66) Bureau of Reclamation	SOIL CONSISTENCY TEST (THREE-POINT LIQUID LIMIT METHOD)	Designation USBR 5355 - 89
Sample No. X-section #6	Feature Top of higher stage, next to grass.	Project Gunnison River

Air dried ( )
Oven dried (X)
Natural ( )

Tested by J. Daleiden Date 2-5-93
Computed by J. Daleiden Date 2-6-93
Checked by Z. Gorislavier Date 2-6-93

	Plastic Limit		Liquid Limit		
Trial No.	1	2	1	2	3
Dish No.	3A	2A	8B	6A	9L
No. of blows			16	20	35
Mass of dish + wet soil (g)	24.6680	25.0109	24.6355	25.7743	28.4190
Mass of dish + dry soil (g)	22.5031	22.7956	22.1554	23.2171	25.3186
Mass of dish (g)	11.9233	11.9208	14.0527	14.3907	14.1779
Mass of water (g)	2.1649	2.2153	2.4801	2.5572	3.1004
Mass of dry soil (g)	10.5798	10.8746	8.1027	8.8264	11.1407
% moisture	20.4	20.4	30.6	29.0	27.8
Average plastic limit	20.4				

FLOW CURVE



Liquid Limit (LL)	28.8	Plastic Limit (PL)	20.4	Plasticity Index (PI = LL - PL)	8.4

• SHRINKAGE TEST

Shrinkage dish no.		Vol. of shrinkage dish (V)	
Mass of dish + wet soil (g)		Vol. of dry soil (Vo)	
Mass of dish + dry soil (g)		V - Vo	
Mass of water (g)			
Mass of dish (g)		$\frac{V - V_o}{W_o}$	
Mass of dry soil (Wo) (g)			
% moisture		Shrinkage limit	
		Shrinkage ratio	

Auxiliary tests: USBR 5205 - 89
USBR 5300 - 89
USBR 5360 - ___
USBR 5365 - ___

Remarks:

Soil consistency test (three-point liquid limit method)

22

MS-884 (10-85)
Bureau of Reclamation

UNITED STATES GOVERNMENT

memorandum

TO : Head, Sedimentation Section
Attention: D-5753

DATE: Denver, Colorado
May 11, 1993

FROM : Head, Land Suitability Section

SUBJECT: Transmittal of Laboratory Analyses of Sediment Samples (Laboratory)

Enclosed are the results of the laboratory analyses for the Gunnison River sediment samples submitted by Joe Lyons to the Interregional Soils and Water Laboratory.

For further information, please contact Juli Fahy at 236-9286.

Stanley C. Conway

Enclosure

cc: D-5700, D-5710, D-5715 (Fahy)
(w/o encl to each)

WBR:SConway:js:5/11/93:X68384
(LABANAL:D-5715:Disk5) (RES-3.00)

U.S. BUREAU OF RECLAMATION
LAND SUITABILITY SECTION
INTERREGIONAL SOIL AND WATER LABORATORY
DENVER, COLORADO
(303) 236-9286

TRANSMITTAL OF REPORT AND/OR DATA

DATE: May 13,1993

TO: Joe Lyons
Sedimentation Section
D5753

PROJECT: Gunnison River

NO. OF SAMPLES: 1

NO. OF ANALYSES: 2

TECHNICAL APPROVAL: Jules Faley

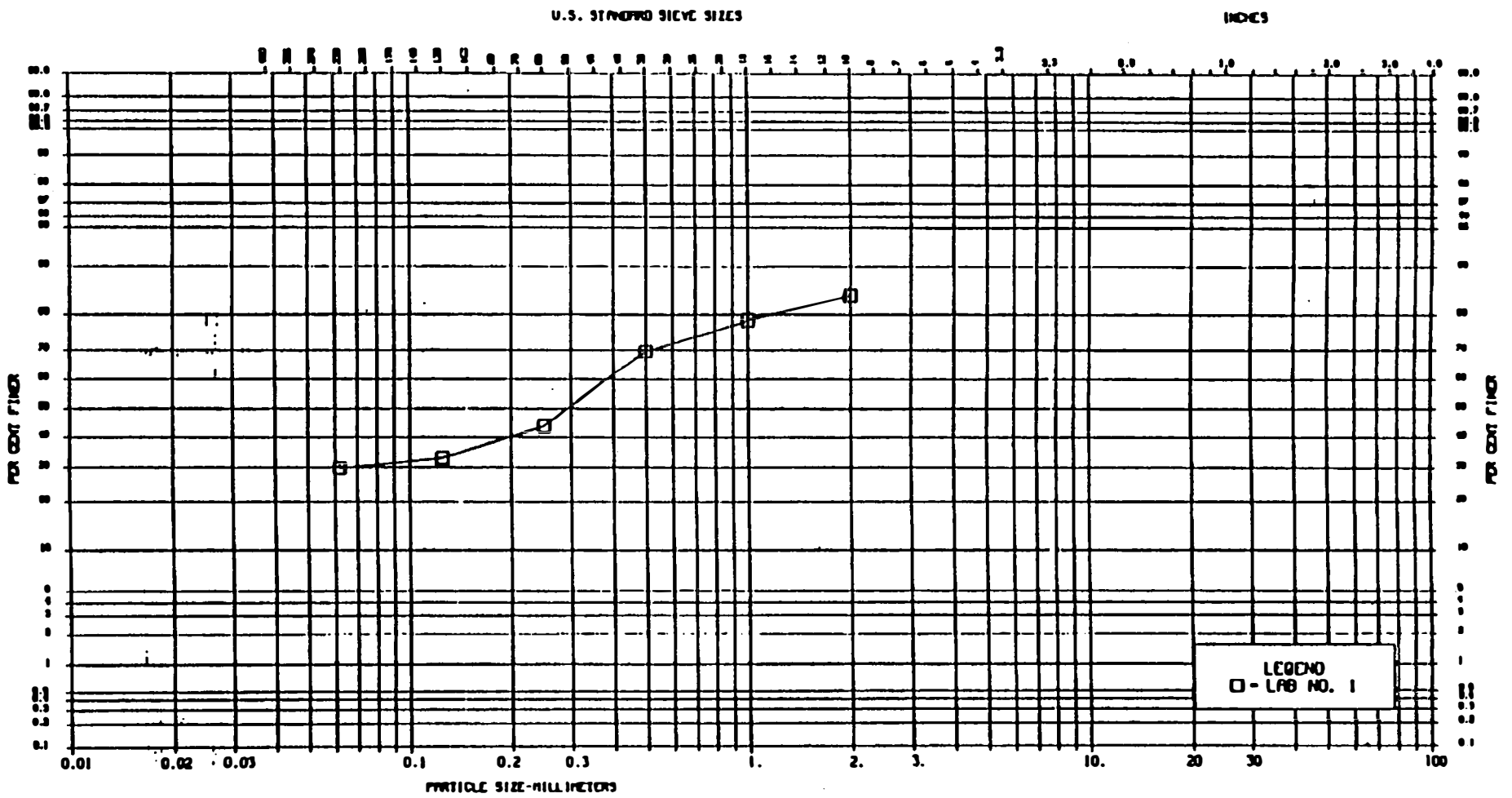
U.S. BUREAU OF RECLAMATION
INTERREGIONAL SOIL AND WATER LABORATORY
DENVER, COLORADO

SUSPENDED SEDIMENT ANALYSIS

PROJECT LOCATION:

LAB NO.	SAMPLING DATE	FIELD IDENTIFICATION	TIME 24HR	TOTAL MG/L	GAGE HEIGHT FT.	DISCHG. CFS	WATER TEMP. DEG. C	PERCENT FINER THAN SIZE INDICATED (IN MILLIMETERS)										
								.002	.004	.008	.016	.031	.062	.125	.250	.500	1.00	2.00
1		ISLAND XS SURFACE		3248	0	0		0.0	0.0	0.0	0.0	0.0	29.7	33.0	43.8	69.5	78.7	84.4

PLOT 1 06.35.28 THUR 13 MAY, 1993 JOB-FAKJ , BUREAU OF RECLAMATION DISSPLA 9.2



AMERICAN GEOPHYSICAL UNION (A.G.U.) CLASSIFICATION

ISLAND XS SURFACE SAMPLE

U. S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
ENGINEERING & RESEARCH CENTER
GUNNISON RIVER
MAY 14, 1993

SEDIMENT SIZE ANALYSIS | INTERREGIONAL SOIL & WATER LAB

PARTICLE SIZE ANALYSIS SUMMARY

LAB NO. 1

FIELD NO. ISLAND XS - GUNNISON RIVER

TOTAL WT. OF SEDIMENT (g) 6.6422

TOTAL % SAND 70.30

% V. COARSE SAND =	5.62
% COARSE SAND =	9.27
% MEDIUM SAND =	25.71
% FINE SAND =	10.79
% V. FINE SAND =	3.27

TOTAL % SILT 27.63

% COARSE SILT =	10.41
% MEDIUM SILT =	10.68
% FINE SILT =	5.17
% V. FINE SILT =	1.37

TOTAL % CLAY 1.69

STATISTICS FOR SILT & CLAY PORTIONS

WT. OF SILT & CLAY (g)	1.97
MEAN SIZE (UM)	30.63
SIZE BREAKS (UM)	
10% =	59.82
25% =	40.50
50% =	25.12
75% =	14.16

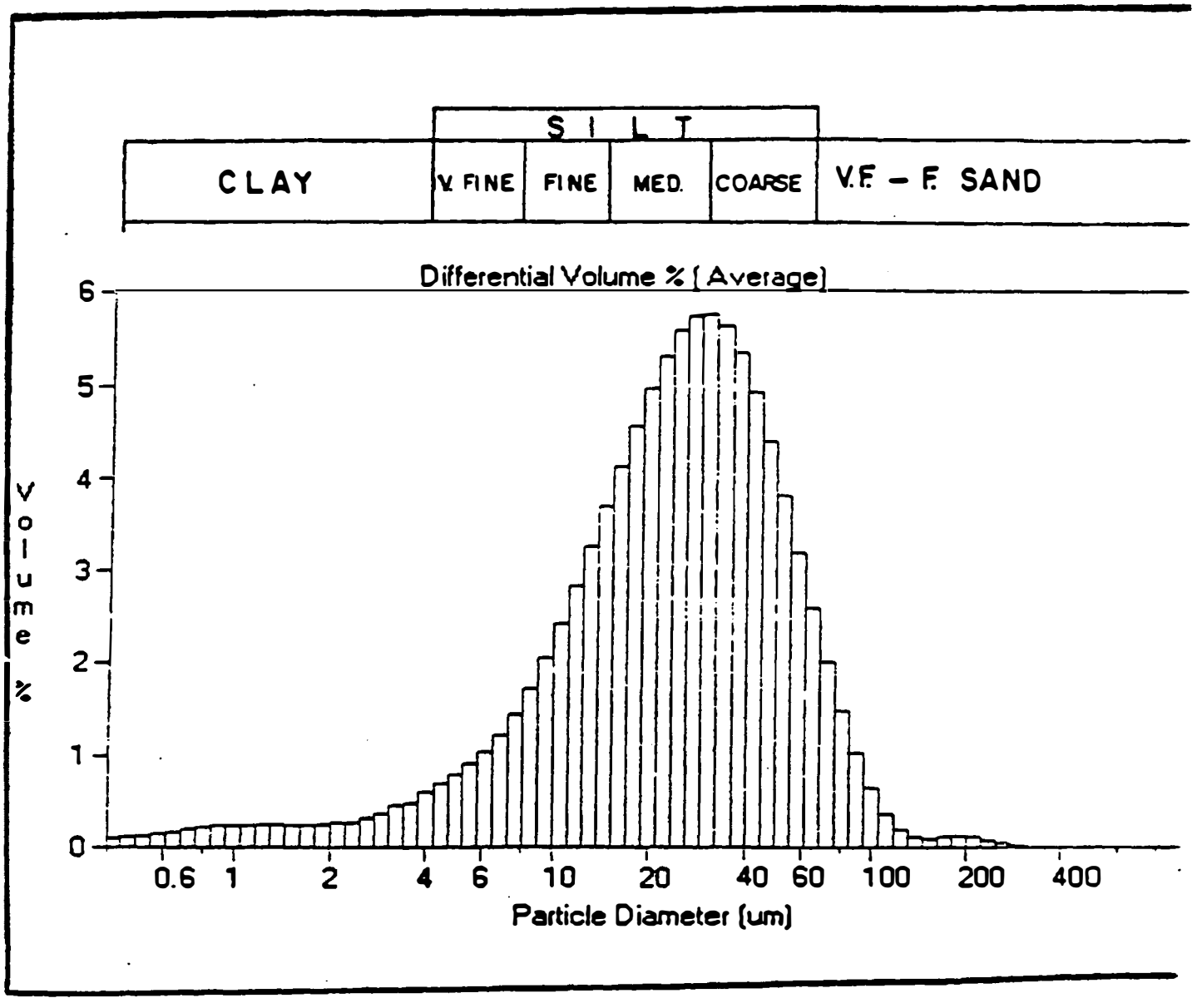
PARTICLE SIZE ANALYSIS

SAMPLE NO. ISLAND XS

LAB NO. 1

TOTAL SEDIMENT WT. 6.6422

WT. MINUS SIEVE PORTION 1.97



Rio Chama River

New Mexico

Colorado State University
Engineering Research Center Soil Laboratory
March 19, 1993

U. S. Fish and Wildlife Service Tested by: J. Burgi

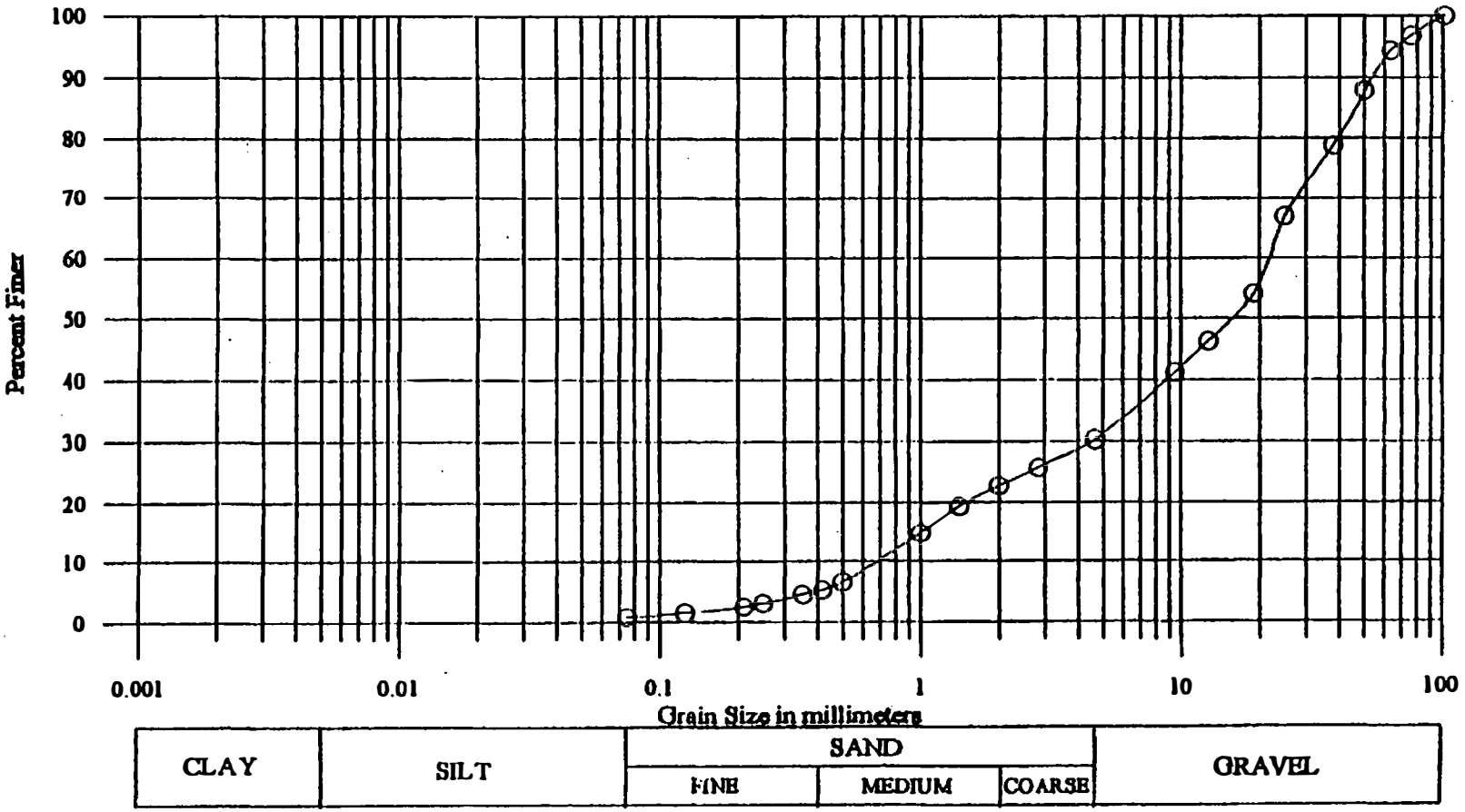
Rio Chama River
Sample: Substrate #1 - 1.2 miles downstream of El Vado dam

Sieve Size (mm)	Sieve Size (in)	US Standard	Percent Passing
101.6	4		100.0
76.2	3		96.9
63.50	2.5		94.4
50.80	2		87.8
38.10	1.5		78.8
25.00	1.000	1	66.9
19.00	0.750	3/4	54.0
12.70	1.200	1/2	46.2
9.50	0.375	3/8	41.2
4.700	0.1850	4	30.3
2.830	0.1110	7	25.8
2.000	0.0787	10	22.8
1.410	0.0555	14	19.3
1.000	0.0394	18	14.8
0.500	0.0197	35	6.5
0.420	0.0164	40	5.2
0.354	0.0139	45	4.4
0.250	0.0098	60	3.0
0.210	0.0083	70	2.5
0.125	0.0049	120	1.4
0.075	0.0029	200	0.8
Pan	Pan	Pan	0.0

GRAIN SIZE DISTRIBUTION

RIO CHAMA RIVER -1.2 miles downsteam of El Vado dam

Substrate #1



Colorado State University
Engineering Research Center Soil Laboratory
March 19, 1993

U. S. Fish and Wildlife Service Tested by: J. Burgi

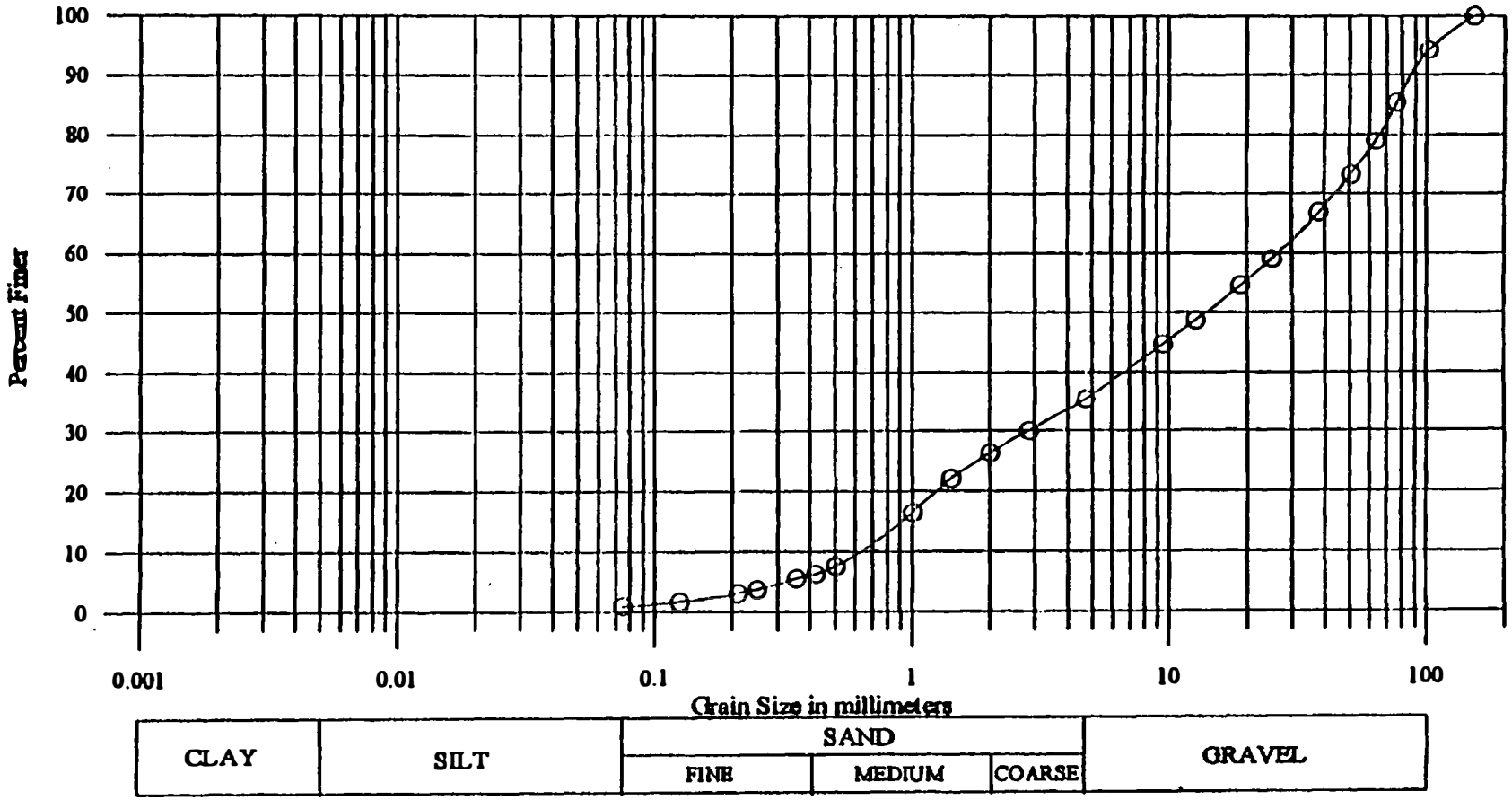
Rio Chama River
Sample: Substrate #2 - 1.2 miles downstream of El Vado dam

Sieve Size (mm)	Sieve Size (in)	US Standard	Percent Passing
152.4	6		100.0
101.6	4		94.3
76.2	3		85.4
63.50	2.500		78.9
50.80	2.000		73.3
38.10	1.500		66.9
25.00	1.000	1	58.9
19.00	0.750	3/4	54.5
12.70	1.200	1/2	48.7
9.50	0.375	3/8	44.8
4.700	0.1850	4	35.5
2.830	0.1110	7	29.9
2.000	0.0787	10	26.2
1.410	0.0555	14	22.1
1.000	0.0394	18	16.4
0.500	0.0197	35	7.4
0.420	0.0164	40	6.2
0.354	0.0139	45	5.4
0.250	0.0098	60	3.6
0.210	0.0083	70	3.0
0.125	0.0049	120	1.6
0.075	0.0029	200	0.8
Pan	Pan	Pan	0.0

GRAIN SIZE DISTRIBUTION

RIO CHAMA RIVER -1.2 miles downsteam of El Vado dam

Substrate #2



Colorado State University
Engineering Research Center Soil Laboratory
March 19, 1993

U. S. Fish and Wildlife Service Tested by: J. Burgi

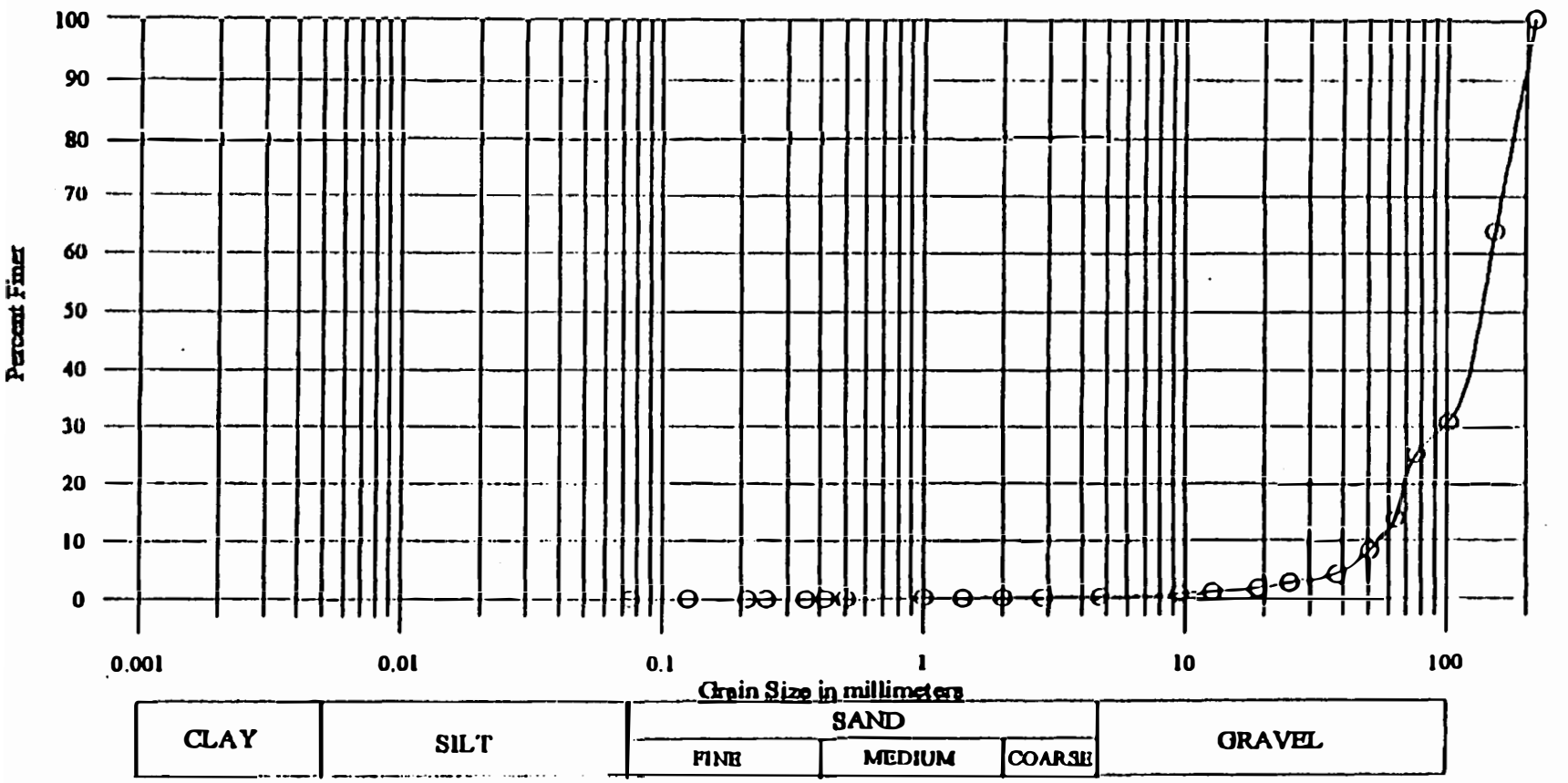
Rio Chama River
Sample: Armour Layer #1 - 1.2 miles downstream of El Vado dam

Sieve Size (mm)	Sieve Size (in)	US Standard	Percent Passing
213.4	8.4		100.00
152.4	6		63.85
101.6	4		30.77
76.2	3		25.22
63.50	2.500		13.98
50.80	2.000		8.09
38.10	1.500		4.37
25.00	1.000	1	2.92
19.00	0.750	3/4	1.82
12.70	1.200	1/2	1.46
9.50	0.375	3/8	0.81
4.700	0.1850	4	0.50
2.830	0.1110	7	0.38
2.000	0.0787	10	0.28
1.410	0.0555	14	0.21
1.000	0.0394	18	0.14
0.500	0.0197	35	0.12
0.420	0.0164	40	0.11
0.354	0.0139	45	0.10
0.250	0.0098	60	0.09
0.210	0.0083	70	0.08
0.125	0.0049	120	0.04
0.075	0.0029	200	0.00
Pan	Pan	Pan	0.00

GRAIN SIZE DISTRIBUTION

RIO CHAMA RIVER -1.2 miles downsteam of El Vado dam

Armour Layer #1



Colorado State University
Engineering Research Center Soil Laboratory
March 19, 1993

U. S. Fish and Wildlife Service Tested by: J. Burgi

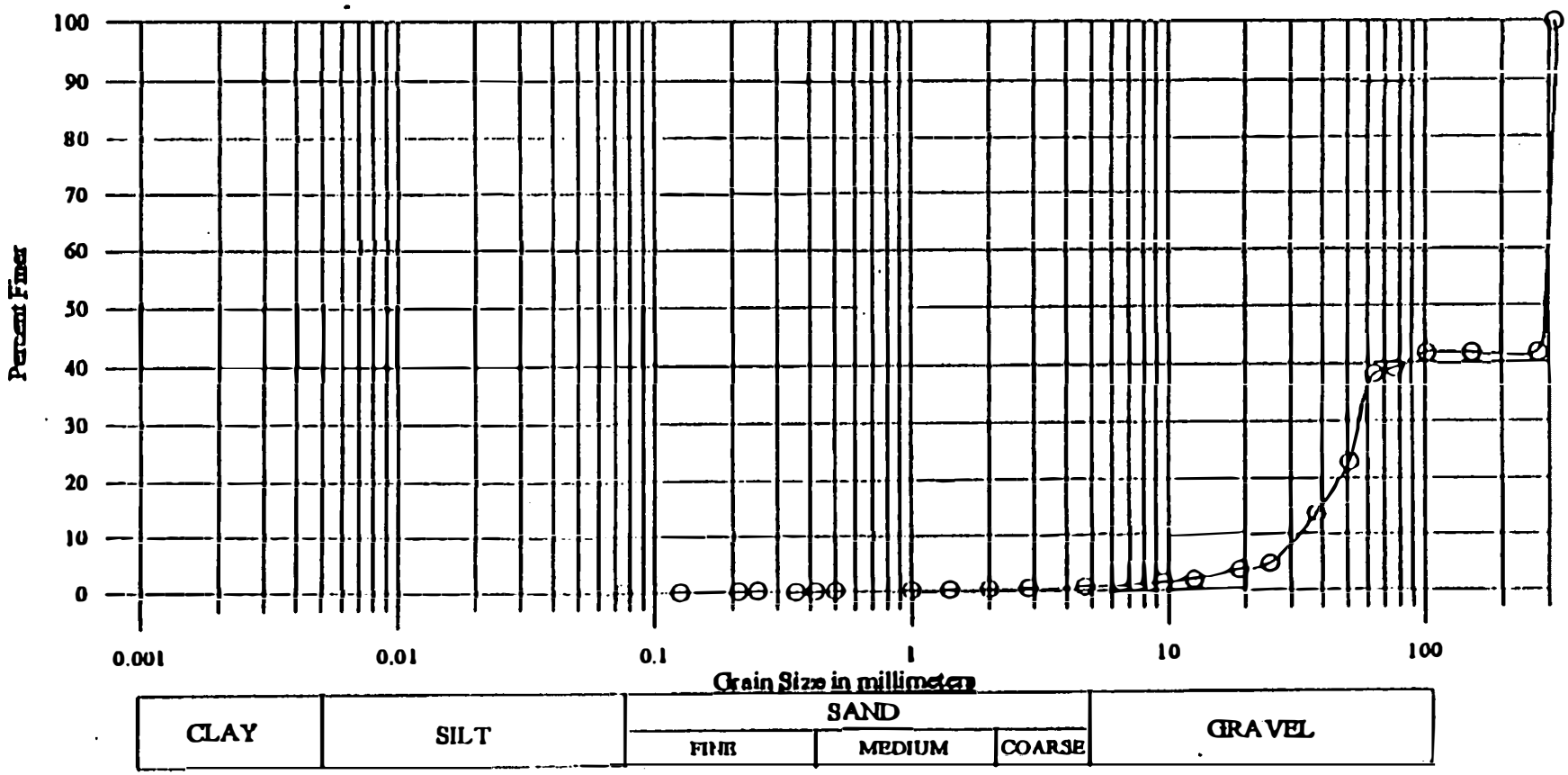
Rio Chama River
Sample: Armour Layer #2 - 1.2 miles downstream of El Vado dam

Sieve Size (mm)	Sieve Size (in)	US Standard	Percent Passing
313.9	12.4		100.00
274.3	10.8		41.66
152.4	6		41.66
101.6	4		41.66
76.2	3		39.03
63.50	2.500		37.97
50.80	2.000		22.83
38.10	1.500		13.62
25.00	1.000	1	4.67
19.00	0.750	3/4	3.24
12.70	1.200	1/2	1.76
9.50	0.375	3/8	1.31
4.700	0.1850	4	0.63
2.830	0.1110	7	0.37
2.000	0.0787	10	0.27
1.410	0.0555	14	0.20
1.000	0.0394	18	0.14
0.500	0.0197	35	0.08
0.420	0.0164	40	0.07
0.354	0.0139	45	0.06
0.250	0.0098	60	0.05
0.210	0.0083	70	0.04
0.125	0.0049	120	0.03
0.075	0.0029	200	0.01
Pan	Pan	Pan	0.00

GRAIN SIZE DISTRIBUTION

RIO CHAMA RIVER -1.2 miles downsteam of El Vado dam

Armour Layer #2



Engineering Research Center Soil Laboratory
March 19, 1993

U. S. Fish and Wildlife Service Tested by: J. Burgi

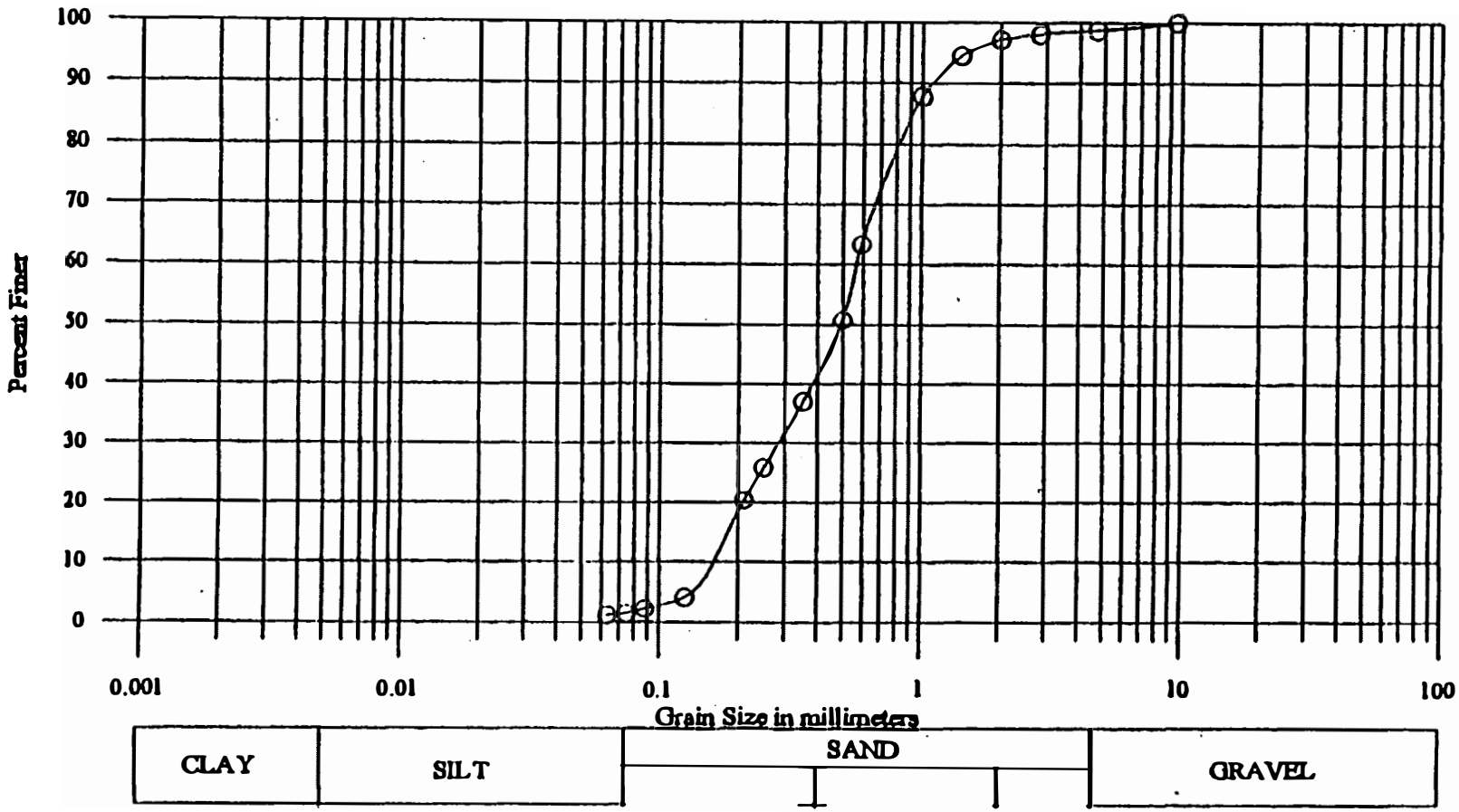
Rio Chama River
Sample: Sandy surface material - 30.3 miles downstream of El Vado dam

Sieve Size (mm)	Sieve Size (in)	US Standard	Percent Passing
9.525	0.3750	3/8	100.00
4.700	0.1850	4	98.73
2.830	0.1110	7	98.21
2.000	0.0787	10	97.33
1.410	0.0555	14	94.72
1.000	0.0394	18	87.87
0.589	0.0232	30	63.22
0.500	0.0197	35	50.74
0.354	0.0139	45	37.04
0.250	0.0098	60	25.87
0.210	0.0083	70	20.41
0.125	0.0049	120	4.18
0.088	0.0035	170	2.29
0.075	0.0029	200	1.51
0.063	0.0025	230	1.29
Pan	Pan		0.00

GRAIN SIZE DISTRIBUTION

RIO CHAMA RIVER - 30.3 miles downsteam of El Vado dam

Sandy Surface Material



Colorado State University
Engineering Research Center Soil Laboratory
March 19, 1993

U. S. Fish and Wildlife Service Tested by: J. Burgi

Rio Chama River
Sample: Substrates #1 and #2 - 1.2 miles downstream of El Vado dam

Specific Gravity Analysis of material passing US Standard #4 sieve

	Substrate #1	Substrate #2
Mass of Flask, g	174.00	174.00
Volume of flask, cm^3	500.00	500.00
Mass of specimen, g	189.90	200.00
Mass of flask + Specimen + water, g	787.00	793.48
Temperature of water, C	22.00	22.00
Mass of flask + water, g	597.10	593.48
Mass of water in flask	423.10	419.48
Absolute density of water, g/cm^3	0.998	0.998
Volume of water in flask, cm^3	423.95	420.32
Volume of soil, cm^3	76.05	79.68
Specific gravity	2.49	2.51

Colorado State University
Engineering Research Center Soils Laboratory
March 19, 1993

U. S. Fish and Wildlife Service Tested by: J. Burgi

Rio Chama River
Sample: Substrates #1 and #2 - 1.2 miles downstream of El Vado dam

Specific Gravity Analysis of material retained on a US Standard #4 sieve

	Substrate #1	Substrate #2
Weight of dry material, g	1976.0	1866.9
Weight of SSD material, g	2017.0	1888.8
Mass of material in water, g	1213.5	1135.0
Apparent SG	2.59	2.55
Bulk specific gravity	2.51	2.51

Stanislaus River

California

United States Department of the Interior

BUREAU OF RECLAMATION
WILLOWS CONSTRUCTION OFFICE
1140 West Wood Street
P.O. Box 988
WILLOWS, CALIFORNIA 95988-0988

IN REPLY
REFER TO:

WCO-220
RES-3.00

APR 16 1993

DATE		DATE
		3257
Classification		
Project		
Contract		
Folder		
Keyword		

Memorandum

To: Assistant Commissioner - Engineering and Research, Denver CO
Attention: D-1530 (Perry Johnson)

From: Acting Project Construction Engineer

Subject: Physical Properties and Gradation Analysis--Honolulu Bar--Stanislaus River Project, California (Soil Analysis)

Attached is the laboratory physical properties and gradation analysis.

Dellen Lindquist

Enclosure

NOTICE
If you detach enclosures, please insert your card number

Form 7-1386
(3-62)
Bureau of Reclamation

SOILS ENGINEERING
Stanislaus River
SUMMARY OF GRADATION TEST DATA
Honolulu Bar

Table SR-93-2
Sheet 1 of 1

Identification Data			Gradation Data																		
			Percentage Passing, Based on the Dry Weight of Total Sample																		
			Particle Size (mm.)							Sieve Size											
Laboratory Sample No.	Excavation No.	Depth of Strata (ft.)			.005	.009	.019	.037	.050	#200	#100	#50	#30	#16	#8	#4	3/8"	3/4"	1½"	3"	5"
Island XS Armour Layer										0	0.1	0.2	0.3	0.6	1.0	2.2	12.3	46.9	81.4	100	
Bulk Density			92.11	lbs	→					0.1	0.4	1.1	4.5	7.9	9.9	12.3	19.0	43.3	83.5	100	
Bulk Density Armour Layer			53.66	lb.	→											0.1	0.2	6.0	52.9	91.6	100
Island XS Substrate Layer										0.2	0.5	3.2	11.6	17.9	22.5	27.5	36.7	56.4	77.8	91.5 6" =	93.9 100.0
Downstream XS I Substrate Layer										0.1	0.3	2.1	7.9	13.0	16.9	21.6	29.9	46.2	67.9	81.8 6" = 7" =	87.5 92.1 100.0
Downstream XS I Armour Layer																0.2	0.4	1.4	6.0	20.7 6" = 7" = 8" = 9" =	38.1 48.4 67.0 90.5 100.0

Table Sheet of

7-1786 (8-71)
Bureau of Reclamation

SUMMARY OF PHYSICAL PROPERTIES TEST RESULTS (Proctor Compaction)

PROJECT Stanislaus River FEATURE Honolulu Bar

TABLE SR-9.3-
SHEET 1 OF 1

IDENTIFICATION				PARTICLE-SIZE FRACTIONS IN PERCENT						CONSISTENCY LIMITS			SPECIFIC GRAVITY				COMPACTION TEST		
				FINES										PLUS NO. 4					
SAMPLE NUMBER	HOLE NUMBER	DEPTH - feet (m)	CLASSIFICATION SYMBOL	SMALLER THAN 0.005 mm	0.005 TO 0.074 mm	SAND NO. 200 (0.074 mm) TO NO. 4 (4.76 mm)	GRAVEL NO. 4 (4.76 mm) TO 3 IN. (76.2 mm)	COBBLES 3 IN. (76.2 mm) TO 5 IN. (127 mm)	OVERSIZE LARGER THAN 5 IN. (127 mm)	LIQUID LIMIT - %	PLASTICITY INDEX - %	SHRINKAGE LIMIT - %	MINUS NO. 4	BULK	APPARENT	ABSORPTION - %	MAXIMUM DRY DENSITY - pcf (gm/cm³)	OPTIMUM WATER CONTENT - %	PENETRATION RESISTANCE - psi (kg/cm²)
Island XS Armour layer			GP		0.0	2.2	97.8						2.63	2.65	2.71	1.4			
Bulk Density			GP		0.1	12.2	87.7						2.72	2.69	2.74	1.1			
Bulk Density Armour layer			GP		0.0	0.1	91.5	8.4				43"		2.74	2.78	0.7			
														2.58	2.64	1.4			
Island XS Substrate layer			GW		0.7	2.73	64.0	8.5				43"	2.80	2.68	2.74	1.3			
														2.73	2.74	0.2			
Downstream XS I Substrate layer			GP/GW		0.1	21.4	60.3	5.7	12.5			43"	2.83	2.69	2.75	1.4			
														2.69	2.70	0.3			
Downstream XS I			GP		0.0	0.2	20.5	18.0	61.3			43"		2.68	2.72	0.8			
														2.62	2.64	0.6			

NOTE: Numbers in parentheses are metric [illegible]

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TABLE ___ SHEET ___ OF ___

BL-808 (8-71)
Bureau of Reclamation

JOB NO. EE041

LAB. INDEX 65Y

DATE RECEIVED 4-21-93

TRANS. BY LTR. OF N/A

SAMPLE INDEX 93I-15

FEATURE Hydrologic Lab

PROJECT Hydrologic Lab/FWS

SAMPLE NO.	AREA OR STATION	EXCAV. NO.	DEPTH (OR ELEV.) FEET	TYPE OF SAMPLE	NOTES, REMARKS AND FIELD INFORMATION	VISUAL CLASSIFICATION	GRADATION	ATTERBERG LIMITS	SPECIFIC GRAVITY	STANDARD COMPACTION	STANDARD PERMEABILITY	LARGE PERMEABILITY	NATURAL MOIST. & DEN.	RELATIVE DENSITY	K-ZERO	ONE-DIMENSIONAL CONSOLIDATION	EXPANSION (0 LOAD - %)	UPLIFT (0 ΔV - PSI)	TRIAXIAL SHEAR	UNCONFINED COMPRESSION	DIRECT SHEAR	PETRO				
65Y																										
1				1-gallon Ziplock	Stanilaus River Upstream Island X5 - Right Bank																					
2				"	Stanilaus River Side Channel US Island X5																					
3				"	Valley Oak Sand Sample Near Root Zone																					
					Samples 65Y-1 and 65Y-2 have fresh water clams present in the samples.																					

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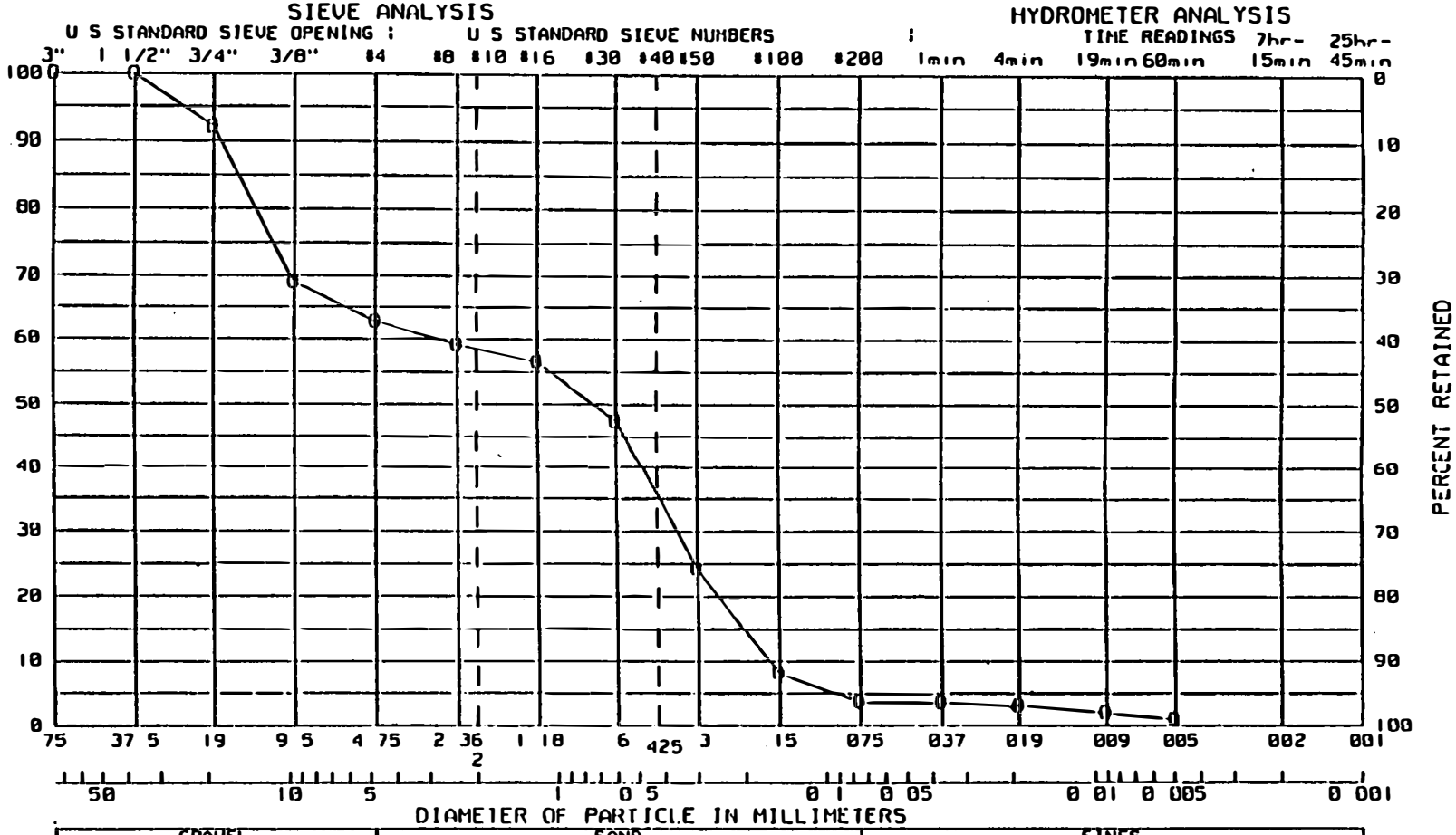
GPO 888-848

GRADATION TEST



PHYSICAL PROPERTIES SUMMARY

FEATURE HYDROLOGIC LAB
PROJECT HYDROLOGIC LAB/FISH AND WILDLIFE SERVICE
DRILL HOLE
DEPTH feet
SAMPLE NUMBER 65Y-1
NOTES SpG performed on -8 sample Insufficient amount of -200 (4 36g)

ATTERBERG LIMITS NO TEST PERFORMED
SPECIFIC GRAVITY Minus No 4 2 76
GRADATION Percent Gravel 37 3 Percent Sand 59 1 Percent Fines 3 6
D60 (mm) 2 851 D50 (mm) 720 D30 358 D10 (mm) 163
Coefficient of Curvature Cc 27 Coefficient of Uniformity Cu 17 44

PREPARED BY [illegible] CHECKED BY [illegible]

FIGURE

PHYSICAL PROPERTIES SUMMARY

FEATURE: HYDROLOGIC LAB PROJECT: HYDROLOGIC LAB/FISH AND WILDLIF
E SERVICE
DRILL HOLE: DEPTH: feet
SAMPLE NUMBER: 65Y-1
NOTES: SpG performed on -8 sample. Insufficient amount of -200 (4.36g)

ATTERBERG LIMITS
NO TEST PERFORMED

SPECIFIC GRAVITY
Minus No. 4: 2.76

GRADATION
Percent Gravel: 37.3 Percent Sand: 59.1 Percent Fines: 3.6
D60 (mm): 2.851 D50 (mm): .728 D30: .358 D10 (mm): .163
Coefficient of Curvature Cc: .27 Coefficient of Uniformity Cu: 17.44

U.S. STANDARD SIEVE OPENING	DIAMETER (mm)	PERCENT PASSING
3"	75.0	100.0
1 1/2"	37.5	100.0
3/4"	19.0	92.1
3/8"	9.5	68.8
U.S. STANDARD SIEVE NUMBERS		
#4	4.750	62.7
#8	2.360	59.0
#16	1.180	56.5
#30	.600	47.4
#50	.300	24.1
#100	.150	8.0
#200	.075	3.6
HYDROMETER ANALYSIS TIME READINGS		
1min	.037	3.5
4min	.019	3.0
19min	.009	2.0
60min	.005	1.0

TABLE_____

7-1451 (9-86)
Bureau of Reclamation

GRADATION ANALYSIS

Designation USBR 5325-__
Designation USBR 5330-__
Designation USBR 5335-__

SAMPLE NO. 65Y-1	PROJECT Hydrologic Lab / FWS	FEATURE Hydrologic Lab
AREA Iskiri Creek	EXC. NO. [illegible]	DEPTH [illegible]

GRADATION OF GRAVEL SIZES

TESTED AND COMPUTED BY Buttram	DATE 5-2-93	% MOISTURE CONTENT OF + NO. 4	WET MASS OF TOTAL SPECIMEN
CHECKED BY Sheham	DATE 5-6-93	% MOISTURE CONTENT OF - NO. 4	TOTAL DRY MASS OF SPECIMEN 621.6

SIEVE SIZE		3" (75 mm)	1-1/2" (37.5 mm)	3/4" (19.0 mm)	3/8" (9.5 mm)	NO. 4 (4.75 mm)	PAN
MASS OF CONTAINER AND RETAINED MATERIAL							Air Dried
MASS OF CONTAINER							
WET MASS RETAINED							
DRY MASS RETAINED				49.4	144.8	37.7	389.7
DRY MASS PASSING			621.6	572.2	427.4	389.7	☐ lbm ☐ kg ☒ g
% OF TOTAL PASSING			100	92.1	68.8	62.7	

GRADATION OF SAND SIZES

DRY MASS OF SPECIMEN 63.3 g

FACTOR = % TOTAL PASSING NO. 4 / DRY MASS OF SPECIMEN = 62.7 / 63.3 = 0.991

DISH NO. 155

DRY MASS OF SPECIMEN (SIEVED) 59.9

SIEVING TIME 15 min

DATE 5-4-93

SIEVE NO.	MASS RETAINED (g)	MASS PASSING (g)	FACTOR X MASS PASSING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER	REMARKS
8	3.8	59.5		59.0	2.36 mm	
16	6.3	57.0		56.5	1.18 mm	
30	15.5	47.8		47.4	600 µm	
50	39.0	24.3		24.1	300 µm	
100	55.2	8.1		8.0	150 µm	Dish weight = 170.7
200	59.7	3.6		3.6	75 µm	
PAN	.2					
TOTAL	59.9					

TESTED AND COMPUTED BY	DATE	CHECKED BY	DATE
Buttram	5-4-93	Sheham	5-6-93

HYDROMETER ANALYSIS

HYDROMETER NO. 3192

DISPERSING AGENT $(NaPO_3)_6$

STARTING TIME 10:11

DATE 5-3-93

AMOUNT 4% 125 mL

TIME	TEMP °C	HYD READ	HYD CORR	CORR READ	FACTOR X CORRECT READ = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER	REMARKS
1 min	19.2	10.0	6.5	3.5		3.5	37 µm	
4 min	19.0	9.5	6.5	3.0		3.0	19 µm	
19 min	19.0	8.5	6.5	2.0		2.0	9 µm	
60 min	19.0	7.5	6.5	1.0		1.0	5 µm	AUXILIARY TESTS: USBR 5205-__ USBR 5300-__
7 h 15 min*							2 µm	
25 h 45 min*							1 µm	

TESTED AND COMPUTED BY	DATE	CHECKED BY	DATE
Buttram	5-3-93	Sheham	5-6-93

*Not required for standard test.

GPO 853-659

7-1589 (10-86)
Bureau of Reclamation

SPECIFIC GRAVITY DETERMINATION
(VOLUME METHOD)

Designation USBR 5320-__

SAMPLE NO. 654-1	PROJECT Hydrologic Lab/FWS	FEATURE Hydrologic Lab
SPECIMEN NO.	HOLE NO. Island Cross/Right Bank	DEPTH ft ☐ m ☐
TESTED BY Eckland DATE 4-29-93	COMPUTED BY Burkard DATE 5-4-93	CHECKED BY Stehman DATE 5-4-93

	TRIAL NO. 1	TRIAL NO. 2
1. FLASK NO.	46	52
2. MASS OF FLASK * (g)	101.56	100.65
3. VOLUME OF FLASK * (cm³)	249.64	249.75
4. MASS OF SPECIMEN (g)	74.52	74.24
5. MASS OF FLASK + SPECIMEN + WATER (g)	399.16	397.37
6. TEMPERATURE OF WATER (°C)	19.2	19.5
7. MASS OF FLASK + WATER = (5) - (4) (g)	323.84	323.13
8. MASS OF WATER IN FLASK = (7) - (2) (g)	222.28	222.48
9. ABSOLUTE DENSITY OF WATER AT TEMP (6) (g/cm³)	0.998365	0.998205
10. VOLUME OF WATER IN FLASK = (8) / (9) (cm³)	222.64	222.86
11. VOLUME OF SOIL = (3) - (10) (cm³)	27.00	26.89
12. SPECIFIC GRAVITY = (4) / (11) **	2.76	2.76
13. AVERAGE	2.76	

*Calibration data from USBR 1030
**Implies that for water 1 g = 1 mL = 1 cm³

Sample was not put through the splitter

4.36g of -200

254.68g of +200

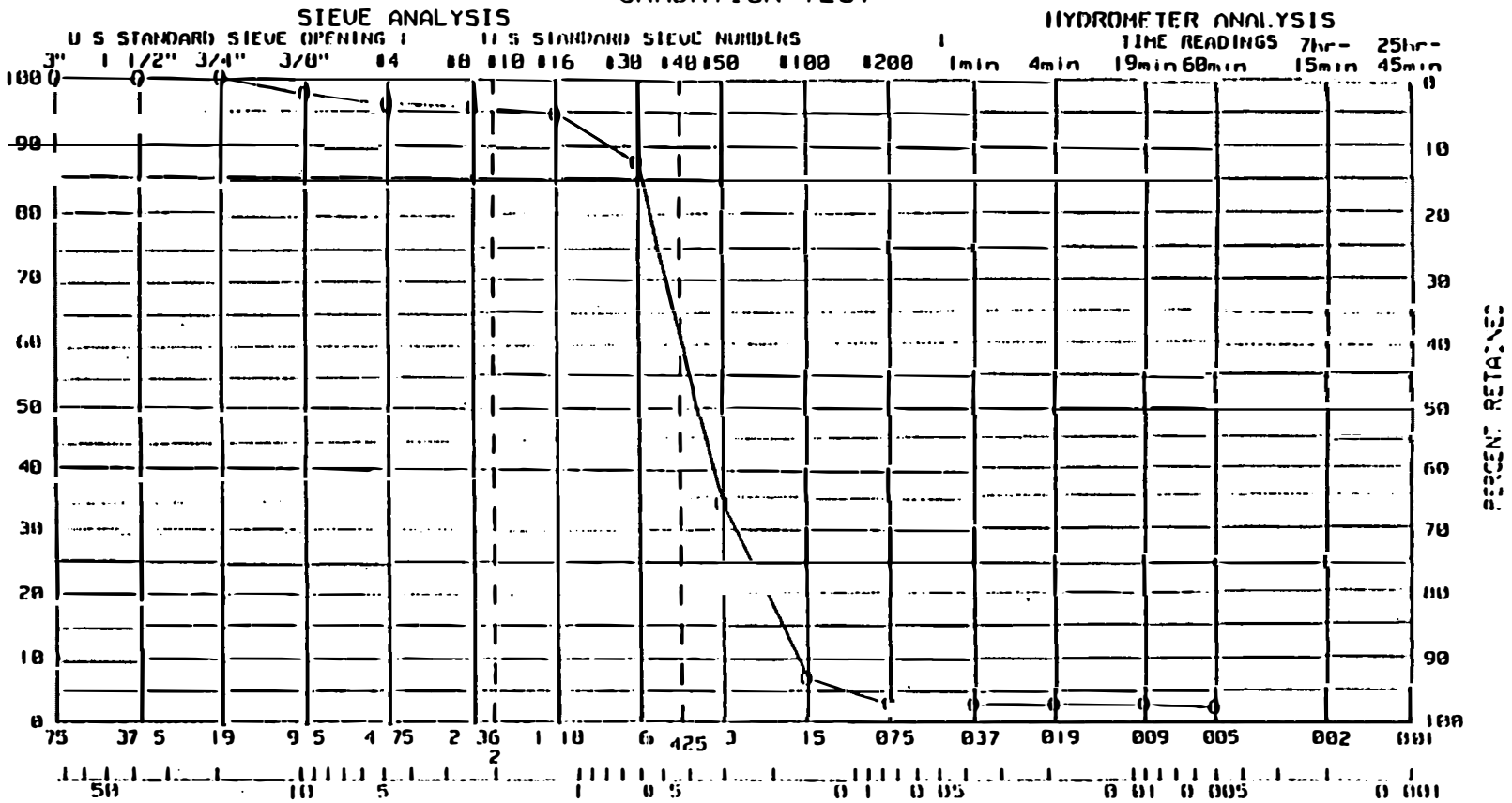
Mettler Postal Scale PB2400 weighs to two decimal places.00 Checked 6-92 (yearly)

Specific Gravity performed on oven dried -8 sample

Organics present in sample

0 852-303

GRADATION TEST



PHYSICAL PROPERTIES SUMMARY

FEATURE HYDROLOGIC LAB PROJECT HYDROLOGIC LAB/FISH AND WILDLIFE SERVICE
DRILL HOLE DEPTH feet
SAMPLE NUMBER 65Y-2
NOTES. SpG performed on -8 sample Insufficient amount of -200 (1 48g)

ATTERBERG LIMITS NO TEST PERFORMED
SPECIFIC GRAVITY Minus No 4 2 86
GRADATION Percent Gravel 3 8 Percent Sand 93 3 Percent Fines 2 9
D60 (mm) 420 D50 (mm) 369 D30 271 D10 (mm) 162
Coefficient of Curvature Cc 1 08 Coefficient of Uniformity Cu 2 59

PREPARED BY [signature] CHECKED BY [signature] FIGURE

PHYSICAL PROPERTIES SUMMARY

FEATURE: HYDROLOGIC LAB PROJECT: HYDROLOGIC LAB/FISH AND WILDLIF
E SERVICE
DRILL HOLE: DEPTH: feet
SAMPLE NUMBER: 65Y-2
NOTES: SpG performed on -8 sample. Insufficient amount of -200 (1.48g)

ATTERBERG LIMITS
NO TEST PERFORMED

SPECIFIC GRAVITY
Minus No. 4: 2.86

GRADATION
Percent Gravel: 3.8 Percent Sand: 93.3 Percent Fines: 2.9
D60 (mm): .420 D50 (mm): .369 D30: .271 D10 (mm): .162
Coefficient of Curvature Cc: 1.08 Coefficient of Uniformity Cu: 2.59

U.S. STANDARD SIEVE OPENING	DIAMETER (mm)	PERCENT PASSING
3"	75.0	100.0
1 1/2"	37.5	100.0
3/4"	19.0	100.0
3/8"	9.5	97.7
U.S. STANDARD SIEVE NUMBERS		
#4	4.750	96.2
#8	2.360	95.7
#16	1.180	94.8
#30	.600	87.5
#50	.300	34.0
#100	.150	7.0
#200	.075	2.9
HYDROMETER ANALYSIS TIME READINGS		
1min	.037	2.8
4min	.019	2.8
19min	.009	2.8
60min	.005	2.3

TABLE_____

7-1451 (9-86)
Bureau of Reclamation

GRADATION ANALYSIS

Designation USBR 5325-__
Designation USBR 5330-__
Designation USBR 5335-__

SAMPLE NO. 65Y-2	PROJECT Hydrologic lab / FWS	FEATURE Hydrologic Lab
AREA Island Cross	EXC. NO. US Island X5 / side channel	DEPTH

GRADATION OF GRAVEL SIZES

TESTED AND COMPUTED BY Fuirn	DATE 4-27-93	% MOISTURE CONTENT OF + NO. 4	WET MASS OF TOTAL SPECIMEN
CHECKED BY Sheleen	DATE 5-6-93	% MOISTURE CONTENT OF - NO. 4	TOTAL DRY MASS OF SPECIMEN 515.3

SIEVE SIZE		3" (75 mm)	1-1/2" (37.5 mm)	3/4" (19.0 mm)	3/8" (9.5 mm)	NO. 4 (4.75 mm)	PAN
MASS OF CONTAINER AND RETAINED MATERIAL							air dried
MASS OF CONTAINER							
WET MASS RETAINED							
DRY MASS RETAINED					11.7	7.8	495.8
DRY MASS PASSING				515.3	503.6	495.8	☐ lbm ☐ kg ☒ g
% OF TOTAL PASSING				100	97.7	96.2	

GRADATION OF SAND SIZES

DRY MASS OF SPECIMEN 85.2 g FACTOR = % TOTAL PASSING NO. 4 / DRY MASS OF SPECIMEN = 96.2 / 85.2 = 1.129

DISH NO. 129 DRY MASS OF SPECIMEN (SIEVED) 82.7

SIEVING TIME 15 min DATE 5-4-93

SIEVE NO.	MASS RETAINED (g)	MASS PASSING (g)	FACTOR X MASS PASSING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER	REMARKS
8	.4	84.8		95.7	2.36 mm	
16	1.2	84.0		94.8	1.18 mm	
30	7.7	77.5		87.5	600 µm	
50	55.1	30.1		34.0	300 µm	
100	79.0	6.2		7.0	150 µm	Dish weight = 158.7
200	82.6	2.6		2.9	75 µm	
PAN	.1					
TOTAL	85.7					

TESTED AND COMPUTED BY Fuirn DATE 5-4-93 CHECKED BY Sheleen DATE 5-6-93

HYDROMETER ANALYSIS

HYDROMETER NO. 785 DISPERSING AGENT $(NaPO_3)_6$

STARTING TIME 10:05 DATE 5-3-93 AMOUNT 4% 125 mL

TIME	TEMP °C	HYD READ	HYD CORR	CORR READ	FACTOR X CORRECT READ = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER	REMARKS
1 min	19.0	7.0	4.5	2.5		2.8	37 µm	
4 min	19.0	7.0	4.5	2.5		2.8	19 µm	
19 min	19.0	7.0	4.5	2.5		2.8	9 µm	
60 min	19.0	6.5	4.5	2.0		2.3	5 µm	AUXILIARY TESTS: USBR 5205-__ USBR 5300-__
7 h 15 min*							2 µm	
25 h 45 min*							1 µm	

TESTED AND COMPUTED BY Bushman DATE 5-3-93 CHECKED BY Sheleen DATE 5-6-93

*Not required for standard test.

GPO 833-659

7-1589 (10-86)
Bureau of Reclamation

SPECIFIC GRAVITY DETERMINATION
(VOLUME METHOD)

Designation USBR 5330-__

SAMPLE NO.	PROJECT	FEATURE
654-2	[illegible]	[illegible]

SPECIMEN NO.	HOLE NO.	DEPTH
	Island [illegible] / [illegible]	Side Channel ft ☐ m ☐

TESTED BY	DATE	COMPUTED BY	DATE	CHECKED BY	DATE
[illegible]	4-20-93	[illegible]	5-4-93	[illegible]	5-4-93

	TRIAL NO. 1	TRIAL NO. 2
1. FLASK NO.	71	83
2. MASS OF FLASK * (g)	105.16	106.36
3. VOLUME OF FLASK * (cm³)	249.74	249.66
4. MASS OF SPECIMEN (g)	77.64	77.11
5. MASS OF FLASK + SPECIMEN + WATER (g)	424.90	405.72
6. TEMPERATURE OF WATER (°C)	20.0	20.0
7. MASS OF FLASK + WATER = (5) - (4) (g)	327.26	328.62
8. MASS OF WATER IN FLASK = (7) - (2) (g)	222.10	222.26
9. ABSOLUTE DENSITY OF WATER AT TEMP (6) (g/cm³)	0.998203	0.998203
10. VOLUME OF WATER IN FLASK = (8) / (9) (cm³)	222.50	222.66
11. VOLUME OF SOIL = (3) - (10) (cm³)	27.24	27.00
12. SPECIFIC GRAVITY = (4) / (11) **	2.85	2.86
13. AVERAGE	2.86	

*Calibration data from USBR 1030
**Implies that for water 1 g = 1 mL = 1 cm³

Sample was not put through the splitter

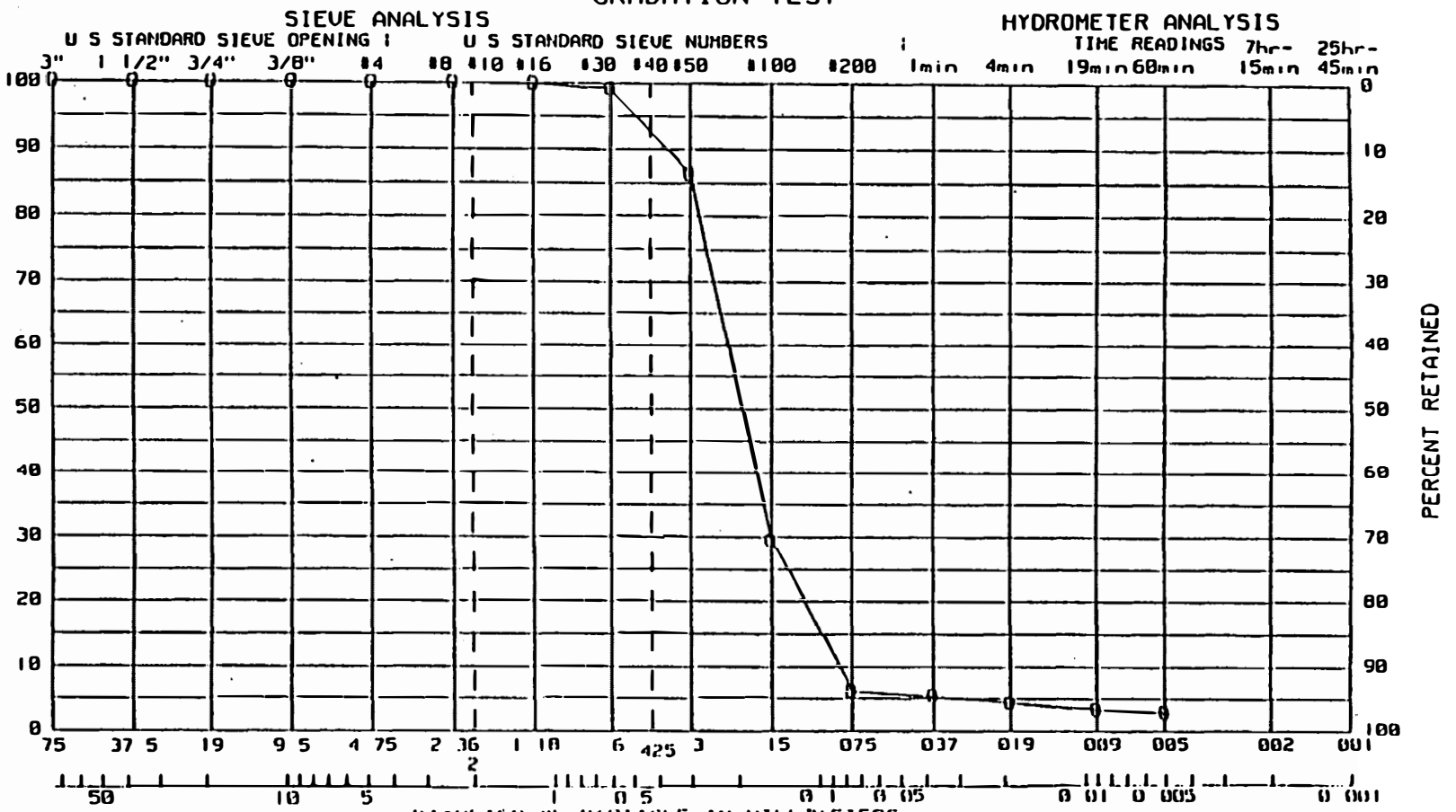
Dry 1.4% of -200
32.8% of +200

Mettler Balance Scale 3B2400 weights to two decimal .00
checked 6-92 (yearly)

Specific Gravity performed on oven dried -8 sample.
Organics present in [illegible]

GPO 892-303

GRADATION TEST



PHYSICAL PROPERTIES SUMMARY

FEATURE HYDROLOGIC LAB
PROJECT HYDROLOGIC LAB/FISH AND WILDLIFE SERVICE
DRILL HOLE
DEPTH feet
SAMPLE NUMBER 65Y-3
NOTES Sp G performed on -8 sample Insufficient amount of -200 (13 52g)

ATTERBERG LIMITS NO TEST PERFORMED
SPECIFIC GRAVITY Minus No 4 2 76
GRADATION Percent Gravel 0 0 Percent Sand 93 9 Percent Fines 6 1
D60 (mm) 218 D50 (mm) 193 D30 151 D10 (mm) 084
Coefficient of Curvature Cc 1 24 Coefficient of Uniformity Cu 2 59

PREPARED BY [illegible] CHECKED BY [illegible]

FIGURE

PHYSICAL PROPERTIES SUMMARY

FEATURE: HYDROLOGIC LAB PROJECT: HYDROLOGIC LAB/FISH AND WILDLIF
E SERVICE
DRILL HOLE: DEPTH: feet
SAMPLE NUMBER: 65Y-3
NOTES: SpG performed on -8 sample. Insufficient amount of -200 (13.52g)

ATTERBERG LIMITS
NO TEST PERFORMED

SPECIFIC GRAVITY
Minus No. 4: 2.76

GRADATION
Percent Gravel: 0.0 Percent Sand: 93.9 Percent Fines: 6.1
D60 (mm): .218 D50 (mm): .193 D30: .151 D10 (mm): .084
Coefficient of Curvature Cc: 1.24 Coefficient of Uniformity Cu: 2.59

U.S. STANDARD SIEVE OPENING	DIAMETER (mm)	PERCENT PASSING
3"	75.0	100.0
1 1/2"	37.5	100.0
3/4"	19.0	100.0
3/8"	9.5	100.0
U.S. STANDARD SIEVE NUMBERS		
#4	4.750	100.0
#8	2.360	100.0
#16	1.180	99.9
#30	.600	99.1
#50	.300	86.2
#100	.150	29.4
#200	.075	6.1
HYDROMETER ANALYSIS TIME READINGS		
1min	.037	5.3
4min	.019	4.3
19min	.009	3.2
60min	.005	2.7

TABLE_____

7-1451 (9-46)
Bureau of Reclamation

GRADATION ANALYSIS

Designation USBR 5325-__
Designation USBR 5330-__
Designation USBR 5335-__

SAMPLE NO. 65Y-3	PROJECT Hydrologic Lab [illegible]	FEATURE [illegible]
AREA [illegible]	EXC. NO.	DEPTH

GRADATION OF GRAVEL SIZES

TESTED AND COMPUTED BY	DATE	% MOISTURE CONTENT OF + NO. 4	WET MASS OF TOTAL SPECIMEN
CHECKED BY	DATE	% MOISTURE CONTENT OF - NO. 4	TOTAL DRY MASS OF SPECIMEN 813.6

SIEVE SIZE		3" (75 mm)	1-1/2" (37.5 mm)	3/4" (19.0 mm)	3/8" (9.5 mm)	NO. 4 (4.75 mm)	PAN
MASS OF CONTAINER AND RETAINED MATERIAL							Air dried
MASS OF CONTAINER							
WET MASS RETAINED							
DRY MASS RETAINED							813.6
DRY MASS PASSING							☐ lbm ☐ kg ☒ g
% OF TOTAL PASSING						100	

GRADATION OF SAND SIZES

DRY MASS OF SPECIMEN 94.1 g | FACTOR = % TOTAL PASSING NO. 4 / DRY MASS OF SPECIMEN = 100 / 94.1 = 1.063

DISH NO. 203 | DRY MASS OF SPECIMEN (SIEVED) 89.3

SIEVING TIME 15 min | DATE 5-4-93

SIEVE NO.	MASS RETAINED (g)	MASS PASSING (g)	FACTOR X MASS PASSING = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER	REMARKS
8	—	94.1		100	2.36 mm	
16	.1	94.0		99.9	1.18 mm	
30	.9	93.2		99.1	600 µm	
50	13.0	81.1		86.2	300 µm	Dish weight = 122.8
100	66.4	27.7		29.4	150 µm	
200	88.4	5.7		6.1	75 µm	
PAN	.9					
TOTAL	89.3	TESTED AND COMPUTED BY Duiran	DATE 5-4-93	CHECKED BY Sloboda		DATE 5-6-93

HYDROMETER ANALYSIS

HYDROMETER NO. 781 | DISPERSING AGENT $(NaPO_3)_6$

STARTING TIME 9:58 | DATE 5-3-93 | AMOUNT 1% 125 mL

TIME	TEMP °C	HYD READ	HYD CORR	CORR READ	FACTOR X CORRECT READ = % OF TOTAL PASSING	% OF TOTAL PASSING	PARTICLE DIAMETER	REMARKS
1 min	19.0	10.5	5.5	5.0		5.3	37 µm	
4 min	19.0	9.5	5.5	4.0		4.3	19 µm	
19 min	19.0	8.5	5.5	3.0		3.2	9 µm	
60 min	19.0	[illegible]	5.5	2.5		2.7	5 µm	AUXILIARY TESTS: USBR 5205-__ USBR 5300-__
7 h 15 min*							2 µm	
25 h 45 min*							1 µm	

TESTED AND COMPUTED BY Duiran	DATE 5-3-93	CHECKED BY Sloboda	DATE 5-6-93

*Not required for standard test.

GPO 853-459

7-1589 (10-86)
Bureau of Reclamation

SPECIFIC GRAVITY DETERMINATION
(VOLUME METHOD)

Designation USBR 5320.__

SAMPLE NO. 654-3	PROJECT Hydrologic Lab/[illegible]	FEATURE Hydrologic Lab
SPECIMEN NO.	HOLE NO. Valley Oak	DEPTH ft ☐ m ☐
TESTED BY Bluhard DATE 4-29-93	COMPUTED BY [illegible] DATE 5-4-93	CHECKED BY Stelens DATE 5-4-93

	TRIAL NO. 1	TRIAL NO. 2
1. FLASK NO.	56	63
2. MASS OF FLASK * (g)	100.79	101.67
3. VOLUME OF FLASK * (cm³)	249.78	249.67
4. MASS OF SPECIMEN (g)	84.07	84.47
5. MASS OF FLASK + SPECIMEN + WATER (g)	403.78	404.12
6. TEMPERATURE OF WATER (°C)	19.8	19.6
7. MASS OF FLASK + WATER = (5) - (4) (g)	319.71	319.95
8. MASS OF WATER IN FLASK = (7) - (2) (g)	218.92	218.68
9. ABSOLUTE DENSITY OF WATER AT TEMP (6) (g/cm³)	0.998244	[illegible]
10. VOLUME OF WATER IN FLASK = (8) / (9) (cm³)	219.31	219.06
11. VOLUME OF SOIL = (3) - (10) (cm³)	30.47	30.61
12. SPECIFIC GRAVITY = (4) / (11) **	2.76	2.76
13. AVERAGE	2.76	

*Calibration data from USBR 1030
**Implies that for water 1 g = 1 mL = 1 cm³

Sample was not put through the splitter

13.52g of -200

467.94g of +200

Mettler Toledo Scale Balance weighs to two decimal places .00 Checked 6-93 (yearly)

Specific gravity determined on oven dried - 8 samples

Organics present in samples

GPO 882-303

7-1702 (11-85)
Bureau of Reclamation

SOIL CONSISTENCY TEST (ONE-POINT LIQUID LIMIT METHOD)

Designation USBR ____ - ____

SAMPLE NO. 65Y-3

FEATURE Hydrologic Lab

PROJECT Hydrologic Lab / FMS

Air dried ☐
Oven dried ☐
Natural ☐

Tested by Dullnond Date 2-4-93
Computed by _____ Date _____
Checked by _____ Date _____

		PLASTIC LIMIT 1	PLASTIC LIMIT 2	LIQUID LIMIT 1	LIQUID LIMIT 2
Trial No.					
Dish No.					
No. of blows (N)					
Mass of dish + wet soil	(g)				
Mass of dish + dry soil	(g)				
Mass of dish	(g)				
Mass of water	(g)				
Mass of dry soil	(g)				
Moisture	%			W_n =	
Average Plastic Limit				F_n =	
				Liquid Limit	

SHRINKAGE LIMIT

1. Shrinkage Dish No.			
2. Mass of dish + wet soil	(g)		
3. Mass of dish + dry soil	(g)		
4. Mass of dish	(g)		
5. Mass of water (2-3)	(g)		
6. Mass of dry soil (W_o) (3-4)	(g)		
7. % Moisture (5/6 x 100)			
8. Vol. Shrinkage Dish (V)			
9. Vol. Dry Soil (V_o)			
10. $V - V_o$ = (8-9)			
11. $\frac{V - V_o}{W_o} \times 100 = \left(\frac{10}{6} \times 100\right)$			
12. Shrinkage Limit (7-11)			
13. Shrinkage Ratio (6/9)			

$$LL = W_n \left(\frac{N}{25}\right)^{0.120}$$

$$F_n = \left(\frac{N}{25}\right)^{0.120}$$

$$LL = (F_n)(W_n)$$

N	F_n
20	0.974
21	0.979
22	0.985
23	0.990
24	0.995
25	1.000
26	1.005
27	1.009
28	1.014
29	1.018
30	1.022

PLASTICITY INDEX: PI = LL - PL

PI = ____ - ____ = ____

LIQUID LIMIT (LL) = _____
PLASTIC LIMIT (PL) = _____
PLASTICITY INDEX (PI) = _____
SHRINKAGE LIMIT (SL) = _____

MINIMUM SPECIMEN MASS REQUIRED 150 g
SPECIMEN MASS TESTED 0

Auxiliary tests: USBR 5205- ____
USBR 5300- ____
USBR 5350- ____
USBR 5360- ____
USBR 5365- ____

Remarks: Insufficient -200
Visually on the -40 fraction
Sample [illegible] [illegible].

APPENDIX III
Field Equipment List

Field Sampling Equipment List

30 gallon drum(ends cut out)
5 gallon buckets(4)
sample bags(20)
sample tags
permanent marker
100' tape measure
20 kg capacity balance
digging equipment(i.e., bowls, spoons, screwdriver, pans. etc.)
bulk density frame
rebar stakes for frame
plastic sheeting to cover frame
pick
shovel
bottles for suspended sediment sample
5 lb hammer
crescent wrench (for bulk density frame)
wet suits (2)
wet suit jackets (2)
neoprene booties (2)
neoprene gloves (2)
Camera
film
Field Book
Chest waders and suspenders (2)
Diving Mask and hood

APPENDIX IV
Schematics of Samplers

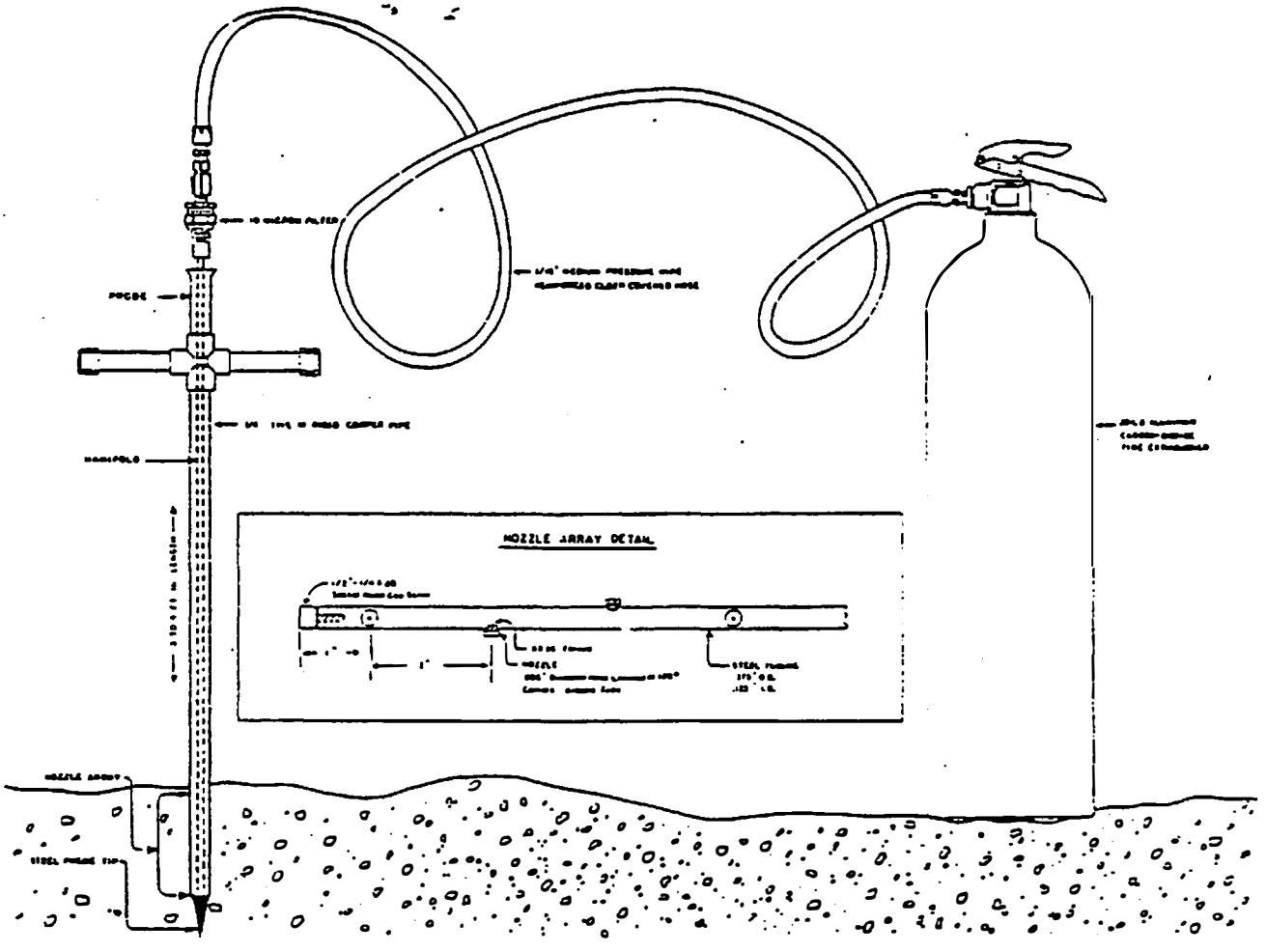


Figure IX Schematic of a single tube freeze core sampler

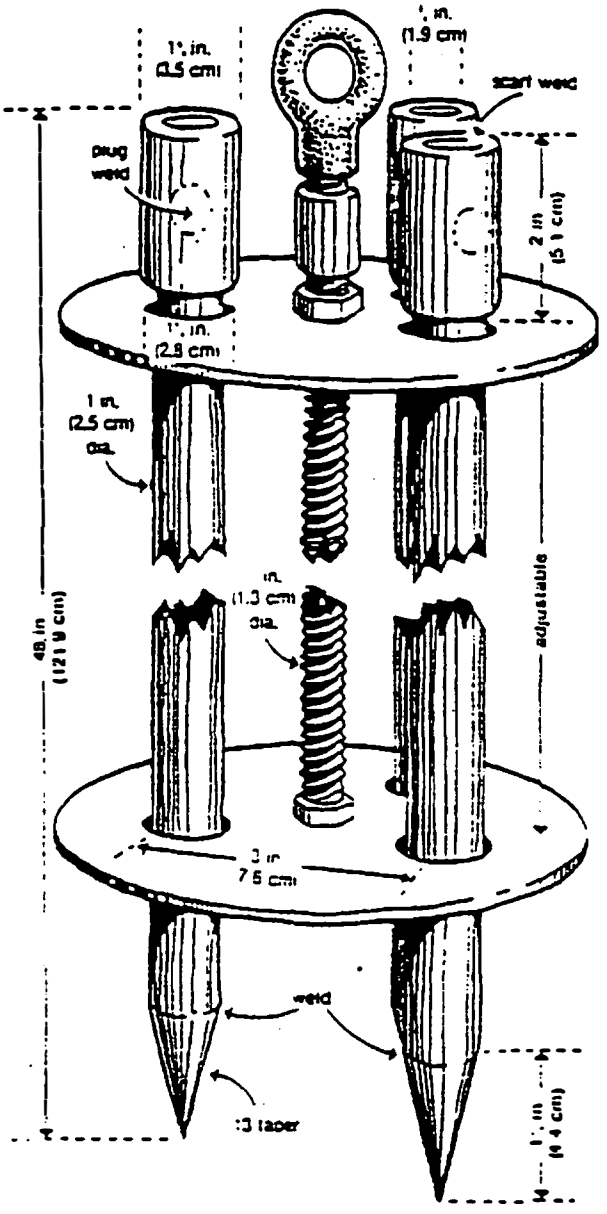


Figure X Schematic of a tri-tube freeze core sampler

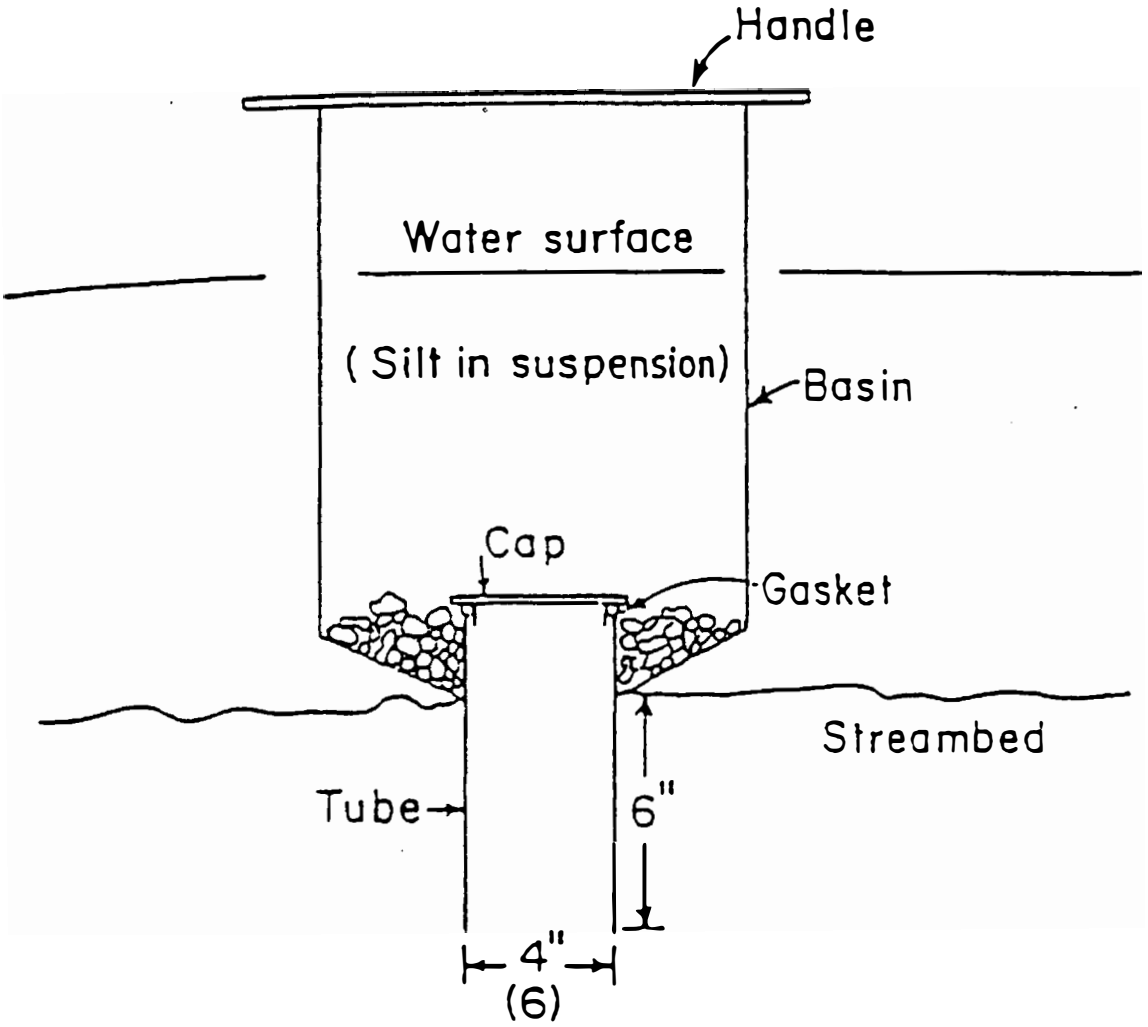


Figure XI Schematic of a McNeil Sampler

APPENDIX V
Rio Chama River Freeze Core Sampling data

* * * * Dry Sieve Analysis For BTVB, 1992 W.Y. * * * *

Sample ID : EL VADO Date : 910930 Time : 1000M Analysis for : SS Lab No. : SR0238
Location : 1 PRE 0-10CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
2639.5	27.1	2612.4	100.0	48.7	43.0	37.7	31.9	25.9	22.6	18.6	12.5	6.5	2.8	1.0
** Percent in Class **			0.0	51.3	5.7	5.3	5.8	6.0	3.3	4.0	6.1	6.0	3.7	1.8

Sample ID : EL VADO Date : 910930 Time : 1000M Analysis for : SS Lab No. : SR0239
Location : 1 PRE 10-20CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
3925.2	26.7	3898.5	100.0	34.3	23.3	19.5	16.5	14.0	11.7	8.5	5.2	2.8	1.3	0.5
** Percent in Class **			0.0	65.7	11.0	3.8	3.0	2.5	2.3	3.2	3.3	2.4	1.5	0.8

Sample ID : EL VADO Date : 910930 Time : 1000M Analysis for : SS Lab No. : SR0240
Location : 1 PRE 20-30CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
1641.1	27.7	1613.4	100.0	100.0	67.9	44.2	34.5	27.7	21.8	13.3	8.1	4.9	2.4	0.8
** Percent in Class **			0.0	0.0	32.1	23.7	9.7	6.8	5.9	8.5	5.2	3.2	2.5	1.6

Sample ID : EL VADO Date : 910930 Time : 1000M Analysis for : SS Lab No. : SR5010
Location : 1 PRE HUBBELL #1
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
34306.6	0.0	34306.6	100.0	100.0	78.8	66.9	57.5	48.9	42.2	32.9	19.7	10.3	4.6	1.7
** Percent in Class **			0.0	0.0	21.2	11.9	9.4	8.6	6.7	9.3	13.2	9.4	5.7	2.9

* * * * Dry Sieve Analysis For BTV8, 1992 W.Y. * * * *

Sample ID : EL VADO Date : 910930 Time : HHMM Analysis for : 88 Lab No. : 8R3008
Location : 2 PRE HUBBELL #2
Remarks :

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
			(Percent Finer Than)											
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
32524.7	0.0	32524.7	100.0	100.0	89.1	75.1	65.2	57.6	51.2	38.4	21.7	10.9	4.4	1.4
** Percent In Class **			0.0	0.0	10.9	14.0	9.9	7.6	6.4	12.8	16.7	10.8	6.5	3.0

* * * * Dry Sieve Analy[illegible] 1992 W.Y. * * * *

Sample ID : EL VADO Date : 911002 [illegible] Analysis for : 89 Lab No. : 9R0247
Location : 3 PRE 0-10CM
Remarks :

(Percent [illegible] Than)

* * * * Dry Sieve Analysis For BTVB, 1992 W.Y. * * * *

Sample ID : EL VADO Date : 911002 Time : HHMM Analysis for : BB Lab No. : BR0247
Location : 3 PRE 0-10CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
1244.4	26.4	1218.0	100.0	100.0	89.5	69.1	55.6	45.3	38.9	29.4	18.7	10.2	4.7	1.8
** Percent in Class **			0.0	0.0	10.5	20.4	13.5	10.3	6.4	9.5	10.7	8.5	5.5	2.9

Sample ID : EL VADO Date : 911002 Time : HHMM Analysis for : BB Lab No. : BR0248
Location : 3 PRE 10-20CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
1432.4	26.3	1406.1	100.0	100.0	76.4	50.4	40.7	34.5	27.7	18.4	10.8	6.3	3.1	1.3
** Percent in Class **			0.0	0.0	23.6	26.0	9.7	6.2	6.8	9.3	7.6	4.5	3.2	1.8

Sample ID : EL VADO Date : 911002 Time : HHMM Analysis for : ** Lab No. : BR0249
Location : 3 PRE 20-30CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
1531.3	28.0	1503.3	100.0	66.9	60.4	42.9	34.2	28.0	22.6	15.6	10.5	6.8	3.3	1.5
** Percent in Class **			0.0	33.1	6.5	17.5	8.7	6.2	5.4	7.0	5.1	3.7	3.5	1.8

Sample ID : EL VADO Date : 911002 Time : HHMM Analysis for : BB Lab No. : BR0290
Location : 4 PRE 0-10CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
2390.1	26.4	2363.7	100.0	100.0	88.6	68.1	57.7	49.0	42.5	33.2	22.8	13.5	6.2	2.6
** Percent in Class **			0.0	0.0	11.4	20.5	10.4	8.7	6.5	9.3	10.4	9.3	7.3	3.6

* * * * Dry Sieve Analysis For BTVB, 1992 W.Y. * * * *

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : BB Lab No. : BR5003
Location : 2 FORT HUBBELL #2
Remarks :

(Percent Finer Than)

* * * * Dry Sieve Analysis For STVB, 1992 W.Y. * * * *

Sample ID : EL VADO Date : 911002 Time : 1000M Analysis for : BB Lab No. : BR0291
Location : 4 PRE 10-20CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
2152.4	0.0	2152.4	100.0	49.0	0.0	37.5	30.4	25.4	21.3	15.6	10.3	6.3	3.0	1.1
** Percent In Class **			0.0	51.0	49.0	-37.5	7.1	5.0	4.1	3.7	5.3	4.0	3.3	1.9

Sample ID : EL VADO Date : 911002 Time : 1000M Analysis for : BB Lab No. : BR0292
Location : 4 PRE 20-30CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
452.5	26.9	425.6	100.0	100.0	100.0	65.7	51.4	41.0	31.3	20.3	13.6	8.5	4.6	1.7
** Percent In Class **			0.0	0.0	0.0	34.3	14.3	10.4	9.7	11.0	6.7	5.1	3.9	2.9

Sample ID : EL VADO Date : 911002 Time : 1000M Analysis for : BB Lab No. : BR0220
Location : 5-A PRE 0-10CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
939.2	25.7	913.5	100.0	100.0	100.0	82.0	67.0	52.7	44.1	32.7	20.4	11.1	5.5	2.3
** Percent In Class **			0.0	0.0	0.0	18.0	15.0	14.3	8.6	11.4	12.3	9.3	5.6	3.2

Sample ID : EL VADO Date : 911002 Time : 1000M Analysis for : BB Lab No. : BR0219
Location : 5-A PRE 10-20CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
405.6	27.1	378.5	100.0	100.0	100.0	97.8	82.2	68.3	57.8	41.4	24.5	14.4	8.0	3.6
** Percent In Class **			0.0	0.0	0.0	2.2	15.6	13.9	10.5	16.4	16.9	10.1	6.4	4.4

* * * * Dry Sieve Analysis For STVB, 1992 W.Y. * * * *

Sample ID : EL VADO Date : 911002 Time : 1000M Analysis for : BB Lab No. : BR0263
Location : 5-B PRE 0-10CM
Remarks :

(Percent Finer Than)

* * * * Dry Sieve Analysis For BTVB, 1992 W.Y. * * * *

Sample ID : EL VADO Date : 911002 Time : HHMM Analysis for : BB Lab No. : BR0263
Location : 5-B PRE 0-10CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
1133.1	27.7	1105.4	100.0	100.0	100.0	84.8	68.0	54.9	46.7	35.8	21.2	11.1	4.9	1.8
** Percent in Class **			0.0	0.0	0.0	15.2	16.8	13.1	8.2	10.9	14.6	10.1	6.2	3.1

Sample ID : EL VADO Date : 911002 Time : HHMM Analysis for : BB Lab No. : BR0264
Location : 5-B PRE 10-20CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
1921.9	25.2	1896.7	100.0	69.6	56.0	47.3	37.6	29.9	24.4	16.7	10.3	5.9	3.1	1.0
** Percent in Class **			0.0	30.4	13.6	8.7	9.7	7.7	5.5	7.7	6.4	4.4	2.8	[illegible]

Sample ID : EL VADO Date : 911002 Time : HHMM Analysis for : BB Lab No. : BR0265
Location : 5-B PRE 20-30CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
524.5	25.4	499.1	100.0	100.0	100.0	82.2	64.1	49.9	38.8	23.6	13.4	7.4	3.8	1.7
** Percent in Class **			0.0	0.0	0.0	17.8	18.1	14.2	11.1	15.2	10.2	6.0	[illegible]	[illegible]

Sample ID : EL VADO Date : 911002 Time : HHMM Analysis for : BB Lab No. : [illegible]
Location : 6 PRE 0-10CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm
3698.3	26.4	3671.9	100.0	100.0	40.6	35.3	29.3	24.8	20.6	14.2	9.0	[illegible]
** Percent in Class **			0.0	0.0	59.4	5.3	6.0	4.5	4.2	6.4	5.2	[illegible]

* * * * Dry Sieve Analysis For BTVB, 1992 W.Y. * * * *

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : BB Lab No. : BR3003
Location : 2 POST HUBBELL #2
Remarks :

Percent Finer Than

* * * * Dry Sieve Analysis For BTVB, 1992 W.Y. * * * *

Sample ID : EL VADO Date : 911002 Time : HHMM Analysis for : 88 Lab No. : 8R0241
Location : 6 PRE 10-20CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
2663.1	27.0	2636.1	100.0	100.0	31.8	24.1	20.5	16.1	12.5	8.2	5.0	3.1	1.7	0.7
** Percent in Class **			0.0	0.0	68.2	7.7	3.6	4.4	3.6	4.3	3.2	1.9	1.4	1.0

Sample ID : EL VADO Date : 911002 Time : HHMM Analysis for : 88 Lab No. : 8R0243
Location : 6 PRE 20-30CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
667.6	25.8	641.8	100.0	100.0	72.3	64.8	49.9	38.1	28.5	17.5	10.7	6.8	3.6	1.4
** Percent in Class **			0.0	0.0	27.7	7.5	14.9	11.8	9.6	11.0	6.8	3.9	3.2	2.2

Sample ID : EL VADO Date : 911002 Time : HHMM Analysis for : 88 Lab No. : 8R0313
Location : 7 PRE 0-10CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
4661.8	0.0	4661.8	100.0	45.3	26.1	18.9	14.1	10.0	7.0	4.0	2.4	1.7	1.0	0.5
** Percent in Class **			0.0	54.7	19.2	7.2	4.8	4.1	3.0	3.0	1.6	0.7	0.7	0.5

Sample ID : EL VADO Date : 911002 Time : HHMM Analysis for : 88 Lab No. : 8R0314
Location : 7 PRE 10-20CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
2064.5	27.4	2037.1	100.0	100.0	51.3	35.5	26.7	19.8	14.1	8.8	5.8	3.9	2.2	0.9
** Percent in Class **			0.0	0.0	48.7	15.8	8.8	6.9	5.7	5.3	3.0	1.9	1.7	1.3

* * * * Dry Sieve Analysis For BTVB, 1992 W.Y. * * * *

Sample ID : EL VADO Date : 911002 Time : HHMM Analysis for : 88 Lab No. : 8R0315
Location : 7 PRE 20-30CM
Remarks :

* * * * Dry Sieve Analysis For BTVB, 1992 W.Y. * * * *

Sample ID : EL VADO Date : 911002 Time : HHMM Analysis for : BB Lab No. : BR0315
Location : 7 PRE 20-30CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
570.4	26.8	543.6	100.0	100.0	70.0	50.7	39.0	28.1	21.0	14.2	11.0	7.9	4.8	1.7
** Percent in Class **			0.0	0.0	30.0	19.3	11.7	10.9	7.1	6.8	3.2	3.1	3.1	3.1

Sample ID : EL VADO Date : 911002 Time : HHMM Analysis for : BB Lab No. : BR0339
Location : 8 PRE 0-10CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
1871.1	25.8	1845.3	100.0	100.0	75.9	59.2	47.9	40.2	32.4	21.6	12.3	6.7	3.2	1.4
** Percent in Class **			0.0	0.0	24.1	16.7	11.3	7.7	7.8	10.8	9.3	5.6	3.5	1.8

Sample ID : EL VADO Date : 911002 Time : HHMM Analysis for : BB Lab No. : BR0340
Location : 8 PRE 10-20CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
2091.1	28.4	2062.7	100.0	61.1	51.9	39.0	32.5	27.0	21.9	15.0	9.3	5.8	2.8	1.0
** Percent in Class **			0.0	38.9	9.2	12.9	6.5	5.5	5.1	6.9	5.7	3.8	2.7	1.8

Sample ID : EL VADO Date : 911002 Time : HHMM Analysis for : BB Lab No. : BR0341
Location : 8 PRE 20-30CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
1158.5	25.6	1132.9	100.0	100.0	72.7	52.9	42.5	35.1	28.3	21.2	15.9	12.3	7.8	2.6
** Percent in Class **			0.0	0.0	27.3	19.8	10.4	7.4	6.8	7.1	5.3	[illegible]	[illegible]	[illegible]

* * * * Dry Sieve Analysis For BTVB, 1992 W.Y. * * * *

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : BB Lab No. : BR0003
Location : 2 FORT RUSSELL #2
Remarks :

(Percent Finer Than)

**** Dry Sieve Analysis For STVS, 1992 W.Y. ****

Sample ID : EL VADO Date : 911002 Time : HHMM Analysis for : SS Lab No. : SR0223
Location : 9 PRE 0-10CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
1618.4	25.9	1592.5	100.0	100.0	73.2	50.6	38.7	32.0	27.0	20.1	12.6	7.2	4.0	2.0
** Percent in Class **			0.0	0.0	26.8	22.6	11.9	6.7	5.0	6.9	7.5	5.4	3.2	2.0

Sample ID : EL VADO Date : 911002 Time : HHMM Analysis for : SS Lab No. : SR0224
Location : 9 PRE 10-20CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
1287.3	25.7	1261.6	100.0	100.0	83.9	57.7	44.2	35.0	29.4	22.1	14.7	8.3	4.1	1.8
** Percent in Class **			0.0	0.0	16.1	26.2	13.5	9.2	5.6	7.3	7.4	6.4	4.2	2.3

Sample ID : EL VADO Date : 911002 Time : HHMM Analysis for : SS Lab No. : SR0244
Location : 10 PRE 0-10CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
3442.8	27.1	3415.7	100.0	100.0	49.5	32.5	24.4	21.5	19.2	15.1	10.0	5.9	3.1	1.4
** Percent in Class **			0.0	0.0	50.5	17.0	8.1	2.9	2.3	4.1	5.1	4.1	2.8	1.7

Sample ID : EL VADO Date : 911002 Time : HHMM Analysis for : SS Lab No. : SR0245
Location : 10 PRE 10-20CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
1340.5	26.2	1314.3	100.0	100.0	87.4	57.1	43.8	33.7	28.1	20.8	13.4	7.0	3.3	1.4
** Percent in Class **			0.0	0.0	12.6	30.3	13.3	10.1	5.6	7.3	7.4	6.4	3.7	1.9

**** Dry Sieve Analysis [illegible] 1992 W.Y. ****

Sample ID : EL VADO Date : 911002 Time : [illegible] Analysis for : SS Lab No. : SR0246
Location : 10 PRE 20-30CM
Remarks :

(Percent Finer Than)

**** Dry Sieve Analysis For BTV8, 1992 W.Y. ****

Sample ID : EL VADO Date : 911002 Time : HHMM Analysis for : 88 Lab No. : BR0246
Location : 10 PRE 20-30CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
782.3	25.5	756.8	100.0	100.0	88.3	60.0	41.2	31.7	25.7	18.2	11.6	6.5	3.1	1.3
** Percent in Class **			0.0	0.0	11.7	28.3	18.8	9.5	6.0	7.5	6.6	5.1	3.4	1.8

Sample ID : EL VADO Date : 911002 Time : HHMM Analysis for : 88 Lab No. : BR0251
Location : 11 PRE 0-10CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
2932.9	26.2	2906.7	100.0	72.0	40.2	30.3	24.9	20.7	18.6	15.1	10.8	7.0	4.4	2.3
** Percent in Class **			0.0	28.0	31.8	9.9	5.4	4.2	2.1	3.5	4.6	3.5	2.1	2.1

Sample ID : EL VADO Date : 911002 Time : HHMM Analysis for : 88 Lab No. : BR0250
Location : 11 PRE 10-20CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
1042.1	25.9	1016.2	100.0	100.0	84.9	51.4	36.3	29.5	25.7	20.5	13.6	6.7	3.4	1.7
** Percent in Class **			0.0	0.0	15.1	33.5	15.1	6.8	3.8	5.2	6.9	6.9	1.7	1.7

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**** Dry Sieve Analysis For BTV8, 1992 W.Y. ****

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : 88 Lab No. : BR5003
Location : 2 POST HUBBELL #2
Remarks :

* * * * Dry Sieve Analysis For BTVB, 1992 W.Y. * * * *

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : BB Lab No. : BR0294
Location : 1-2 POST 0-10CM
Remarks : PBT-FLSH 1 OF 2 0-10 CM

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
3135.0	26.6	3108.4	100.0	100.0	83.0	67.7	58.0	50.7	46.6	40.0	26.6	13.8	5.8	2.0
** Percent In Class **			0.0	0.0	17.0	15.3	9.7	7.3	4.1	6.6	13.4	12.8	8.0	3.8

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : BB Lab No. : BR0293
Location : 1-2 POST 10-20CM
Remarks : 10-20CM POST-FLSH #1 OF

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
6143.5	204.1	5939.4	100.0	84.2	43.0	32.5	26.7	22.1	19.5	14.4	8.4	3.9	1.7	0.6
** Percent In Class **			0.0	45.8	11.2	10.5	5.8	4.6	2.6	5.1	6.0	4.5	2.2	1.1

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : BB Lab No. : BR0217
Location : 1-2 POST 20-30CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
4317.3	26.5	4290.8	100.0	55.0	45.2	33.5	26.0	20.5	16.6	10.7	6.1	3.7	1.8	0.6
** Percent In Class **			0.0	45.0	9.8	11.7	7.5	5.5	3.9	3.9	4.6	2.4	1.9	1.2

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : BB Lab No. : BR0228
Location : 3-2 POST 0-10CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
1221.0	27.3	1193.7	100.0	100.0	80.4	58.2	46.7	38.6	33.3	24.4	14.3	7.9	3.7	1.4
** Percent In Class **			0.0	0.0	19.6	22.2	11.5	8.1	5.3	8.9	10.1	6.4	4.2	2.3

* * * * Dry Sieve Analysis For BTVB, 1992 W.Y. * * * *

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : BB Lab No. : BR0229
Location : 3-2 POST 10-20CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4

* * * * Dry Sieve Analysis For STVB, 1992 W.Y. * * * *

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : BB Lab No. : BR0229
Location : 3-2 POST 10-20CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
550.1	14.2	535.9	100.0	100.0	50.4	30.2	21.5	17.5	14.9	10.9	6.4	3.9	2.1	0.7
** Percent in Class **			0.0	0.0	49.6	20.2	8.7	4.0	2.6	4.0	4.5	2.5	1.8	1.4

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : BB Lab No. : BR0211
Location : 4-2 POST 0-10CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
1626.4	27.9	1598.5	100.0	100.0	72.0	63.3	58.4	51.2	43.9	30.7	16.6	8.7	3.4	1.2
** Percent in Class **			0.0	0.0	28.0	8.7	4.9	7.2	7.3	13.2	14.1	7.9	5.3	2.2

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : BB Lab No. : BR0212
Location : 4-2 POST 10-20CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
2183.6	26.3	2157.3	100.0	58.1	43.9	40.8	33.9	28.0	21.4	13.0	7.7	4.3	2.0	0.6
** Percent in Class **			0.0	41.9	14.2	3.1	6.9	5.9	6.6	8.4	5.3	3.4	2.3	1.4

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : BB Lab No. : BR0213
Location : 4-2 POST 20-30CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
581.4	25.8	555.6	100.0	100.0	80.5	65.2	52.2	43.6	32.8	19.3	12.1	[illegible]	[illegible]	1.3
** Percent in Class **			0.0	0.0	19.5	15.3	13.0	8.6	10.8	13.5	7.2	4.8	[illegible]	2.2

(1)

* * * * Dry Sieve Analysis For STVB, 1992 W.Y. * * * *

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : BB Lab No. : BR5003
Location : 2 POST HUBBELL #2
Remarks :

(Percent Finer Than)

**** Dry Sieve Analysis For BTVS, 1992 W.Y. ****

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : 88 Lab No. : BR0337
Location : 5-2 POST 0-10CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
958.6	177.7	780.9	100.0	100.0	92.8	71.7	57.0	44.1	34.9	26.2	17.3	11.0	5.8	2.3
** Percent in Class **			0.0	0.0	7.2	21.1	14.7	12.9	9.2	8.7	8.9	6.3	5.2	3.5

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : 88 Lab No. : BR0338
Location : 5-2 POST 10-20CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
135.1	27.0	108.1	100.0	100.0	63.1	63.1	54.8	49.4	35.5	25.2	17.1	10.5	5.1	1.8
** Percent in Class **			0.0	0.0	36.9	0.0	8.3	9.4	9.9	10.3	8.1	6.6	5.4	3.3

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : 88 Lab No. : BR0316
Location : 6-2 POST 0-10CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
1360.0	27.4	1332.6	100.0	100.0	75.1	62.1	52.3	45.3	39.5	26.7	14.0	7.7	4.2	1.6
** Percent in Class **			0.0	0.0	24.9	13.0	9.8	7.0	5.8	12.8	12.7	6.3	3.5	2.6

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : 88 Lab No. : BR0317
Location : 6-2 POST 10-20CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
1433.6	26.4	1407.2	100.0	100.0	59.9	51.4	41.7	33.9	27.8	19.1	11.0	6.6	3.3	1.2
** Percent in Class **			0.0	0.0	40.1	8.5	9.7	7.8	6.1	8.7	8.1	4.4	3.3	2.1

**** Dry Sieve Analysis For BTVS, 1992 W.Y. ****

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : 88 Lab No. : BR0318
Location : 6-2 POST 20-30CM
Remarks :

(Percent Finer Than)

* * * * Dry Sieve Analysis For STVS, 1992 W.Y. * * * *

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : SS Lab No. : SR0318
Location : 6-2 POST 20-30CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
486.5	26.1	460.4	100.0	100.0	100.0	74.9	61.4	49.6	38.6	25.7	17.6	11.4	6.4	2.2
** Percent in Class **			0.0	0.0	0.0	25.1	13.5	11.8	11.0	12.9	8.1	6.2	5.0	4.2

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : SS Lab No. : SR0310
Location : 7-2 POST 0-10CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
2508.6	27.7	2480.9	100.0	63.1	56.5	50.0	40.9	35.1	30.7	22.4	13.2	7.4	3.4	1.3
** Percent in Class **			0.0	36.9	6.6	6.5	9.1	5.8	4.4	8.3	9.2	5.8	2.0	2.3

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : SS Lab No. : SR0311
Location : 7-2 POST 10-20CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
954.7	0.0	954.7	100.0	100.0	88.5	72.5	56.7	44.1	33.5	22.0	10.1	6.1	[illegible]	2.0
** Percent in Class **			0.0	0.0	11.5	16.0	15.8	12.6	10.6	11.5	8.9	5.0	[illegible]	2.4

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : SS Lab No. : SR0312
Location : 7-2 POST 20-30CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
339.4	27.2	312.2	100.0	100.0	100.0	74.2	64.7	51.0	40.2	25.5	16.2	10.4	[illegible]	2.2
** Percent in Class **			0.0	0.0	0.0	25.8	9.5	13.7	10.8	14.7	[illegible]	[illegible]	[illegible]	[illegible]

* * * * Dry Sieve Analysis For STVS, 1992 W.Y. * * * *

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : SS Lab No. : SR5003
Location : 2 POST HUBBELL #2
Remarks :

* * * * Dry Sieve Analysis For STV8, 1992 W.Y. * * * *

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : 88 Lab No. : 8R0287
Location : 8-2 POST 0-10CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
1805.9	26.4	1779.5	100.0	100.0	66.3	57.6	48.4	38.4	30.1	21.3	14.3	9.2	4.9	2.0
** Percent in Class **			0.0	0.0	33.7	8.7	9.2	10.0	8.3	8.8	7.0	5.1	4.3	2.9

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : 88 Lab No. : 8R0288
Location : 8-2 POST 10-20CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
2759.0	28.0	2731.0	100.0	79.0	48.1	38.3	31.2	24.1	17.9	10.7	6.5	4.1	2.3	1.0
** Percent in Class **			0.0	21.0	30.9	9.8	7.1	7.1	6.2	7.2	4.2	2.4	1.8	1.3

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : 88 Lab No. : 8R0289
Location : 8-2 POST 20-30CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
1245.5	26.8	1218.7	100.0	100.0	77.6	55.4	46.1	34.9	25.5	15.4	9.5	6.1	3.3	1.4
** Percent in Class **			0.0	0.0	22.4	22.2	9.3	11.2	9.4	10.1	5.9	3.4	2.8	1.9

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : 88 Lab No. : 8R0325
Location : 9-2 POST 0-10CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
3392.3	26.9	3365.4	100.0	100.0	84.3	66.7	53.2	43.9	38.7	31.7	21.0	12.1	6.2	2.8
** Percent in Class **			0.0	0.0	15.7	17.6	13.5	9.3	5.2	7.0	10.7	8.9	5.9	3.4

* * * * Dry Sieve Analysis For [illegible] 1992 W.Y. * * * *

Sample ID : EL VADO Date : 911009 Time : [illegible] Analysis for : 88 Lab No. : 8R0326
Location : 9-2 POST 10-20CM
Remarks : [illegible]

(Percent Finer Than)

Sample ID : EL VADO Date : 911009 Time : HHMM Analysis for : 88 Lab No. : BR0326
Location : 9-2 POST 10-20CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
2205.0	26.3	2178.7	100.0	76.4	60.3	46.7	35.4	29.1	24.0	18.0	11.4	6.2	2.9	1.2
** Percent in Class **			0.0	23.6	16.1	13.6	11.3	6.3	5.1	6.0	6.6	5.2	3.3	1.7

(5)

* * * * Dry Sieve Analysis For BTVB, 1992 W.Y. * * * *

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : 88 Lab No. : BR5003
Location : 2 POST HUBBELL #2
Remarks :

(Percent Finer Than)

Phi sizes	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4

* * * * Dry Sieve Analysis For BTV8, 1992 W.Y. * * * *

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : 88 Lab No. :
Location : 9-2 POST 20-30CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm
849.7	27.3	822.4	100.0	100.0	63.5	48.6	36.6	29.2	22.8	13.5	8.7	5.8	3.6
** Percent in Class **			0.0	0.0	36.5	14.9	12.0	7.4	6.4	9.3	4.8	2.9	2.2

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : 88 Lab No. : [illegible]
Location : 10-2 POST 0-10CM
Remarks : PST 0-10CM 10-2 RCH B

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
2285.9	27.9	2258.0	100.0	100.0	60.7	44.8	35.4	27.6	23.7	18.5	13.3	6.7	3.3	1.4
** Percent in Class **			0.0	0.0	39.3	15.9	9.4	7.8	3.9	5.2	5.2	6.6	3.4	1.9

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : 88 Lab No. : BR0300
Location : 10-2 POST 10-20CM
Remarks : 10-20CM PST RCH B 10-2

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
3158.1	27.0	3131.1	100.0	100.0	56.5	37.1	28.8	23.7	20.1	15.7	11.0	5.3	1.9	0.7
** Percent in Class **			0.0	0.0	43.5	19.4	8.3	5.1	3.6	4.4	4.7	5.7	3.4	1.2

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : 88 Lab No. : BR0298
Location : 10-2 POST 20-30CM
Remarks : PST RCH B 10-20

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
1274.0	26.5	1247.5	100.0	35.3	35.3	29.5	23.3	18.4	14.5	9.9	6.4	3.5	1.5	0.7
** Percent in Class **			0.0	64.7	0.0	5.8	6.2	4.9	3.9	4.6	3.5	2.9	2.0	0.8

(6)

* * * * Dry Sieve Analysis For BTV8, 1992 W.Y. * * * *

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : 88 Lab No. : BR0275
Location : 11-2 POST 0-10CM
Remarks :

(Percent Finer Than)

* * * * Dry Sieve Analysis For BTVB, 1992 W.Y. * * * *

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : BB Lab No. : BR0275
Location : 11-2 POST 0-10CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
2084.3	27.5	2056.8	100.0	100.0	96.2	69.0	50.0	39.6	34.7	29.5	20.7	8.1	3.3	1.6
** Percent in Class **			0.0	0.0	3.8	27.2	19.0	10.4	4.9	5.2	8.8	12.6	4.8	1.7

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : BB Lab No. : BR0276
Location : 11-2 POST 10-20CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
4222.5	26.2	4196.3	100.0	62.3	47.1	34.4	25.7	20.4	17.1	13.3	8.9	3.5	1.4	0.5
** Percent in Class **			0.0	37.7	15.2	12.7	8.7	5.3	3.3	3.8	4.4	5.4	2.1	0.9

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : BB Lab No. : BR0277
Location : 11-2 POST 20-30CM
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
955.3	26.6	928.7	100.0	100.0	83.2	61.1	47.7	37.5	27.9	18.4	12.1	7.7	4.5	2.2
** Percent in Class **			0.0	0.0	16.8	22.1	13.4	10.2	9.6	9.5	6.3	4.4	3.2	2.3

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : BB Lab No. : BR5001
Location : 1 POST HUBBELL #1
Remarks :

(Percent Finer Than)

Phi sizes			-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
Gross Wt.	Tare Wt.	Net Wt.	128mm	64mm	32mm	16mm	8.0mm	4.0mm	2.0mm	1.0mm	0.5mm	.25mm	.125mm	.063mm
29000.4	0.0	29000.4	100.0	100.0	89.2	75.7	64.7	54.7	47.1	35.2	21.9	9.9	2.8	0.7
** Percent in Class **			0.0	0.0	10.8	13.5	11.0	10.0	7.6	11.9	13.3	12.0	7.1	2.1

* * * * Dry Sieve Analysis For BTVB, 1992 W.Y. * * * *

Sample ID : EL VADO Date : 911008 Time : HHMM Analysis for : BB Lab No. : BR5003
Location : 2 POST HUBBELL #2
Remarks :

(Percent Finer Than)

APPENDIX VI
Field Testing Photographs

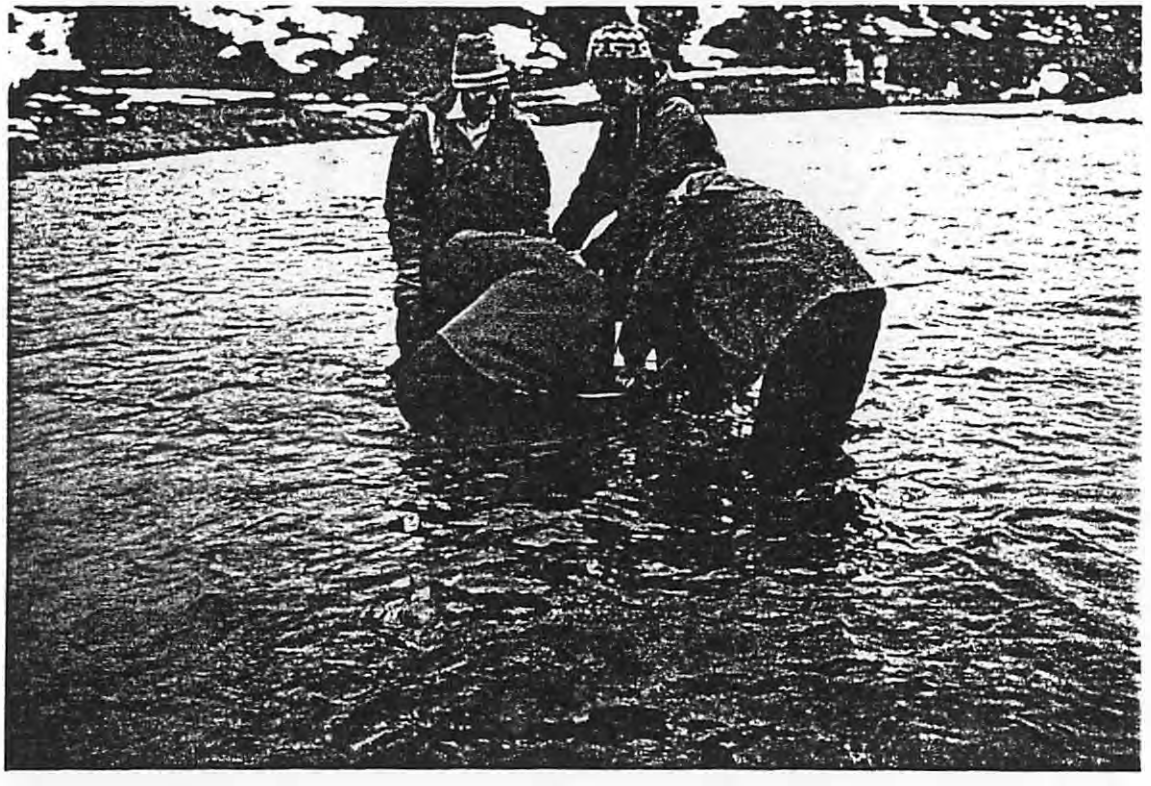

Figure XII Armour/Substrate sampling with a drum sampler (Rio Chama River, New Mexico)

Figure XIII Armour/Substrate sampling with a drum sampler (Gunnison River, Colorado)

Figure XIV Drum sampling under submerged conditions (Gunnison River Colorado)

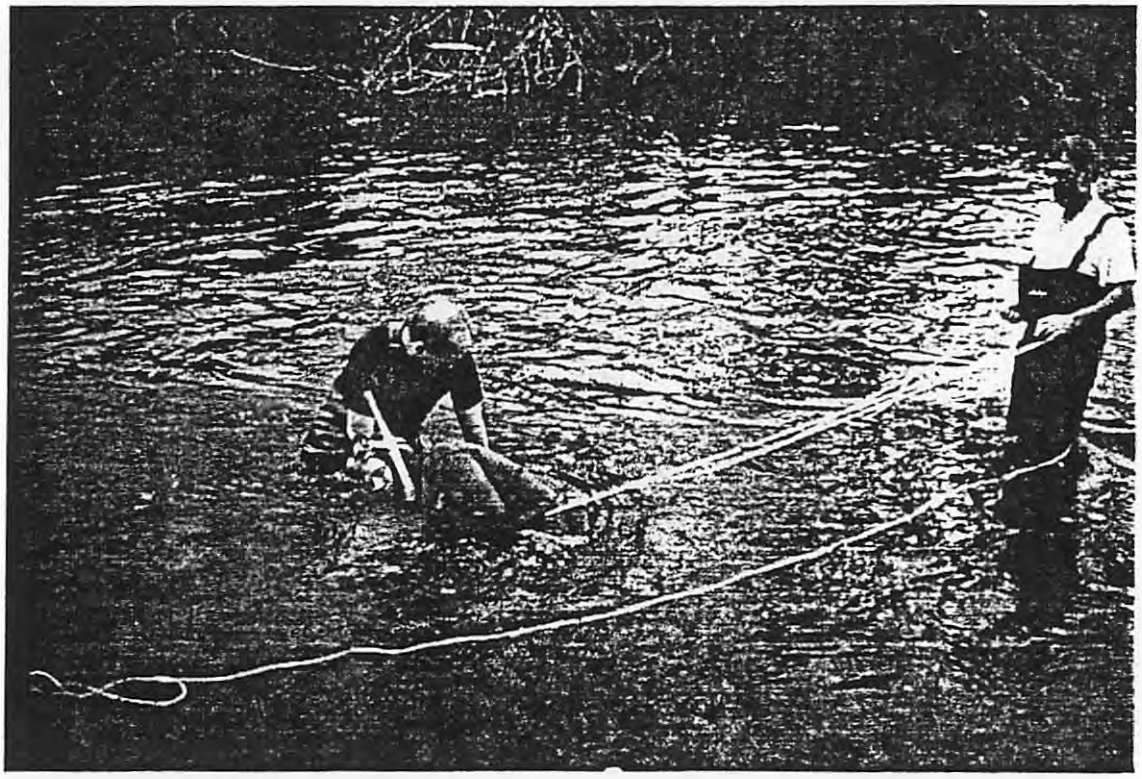

Figure XV Drum sampling under submerged conditions (Stanislaus River, California)

Figure XVI Drum sampler with filter cloth sampling bag (Stanislaus River, California)

Figure XVII Collecting surface material grab sample using a drum sampler to isolate the sampling area (Gunnison River, Colorado)

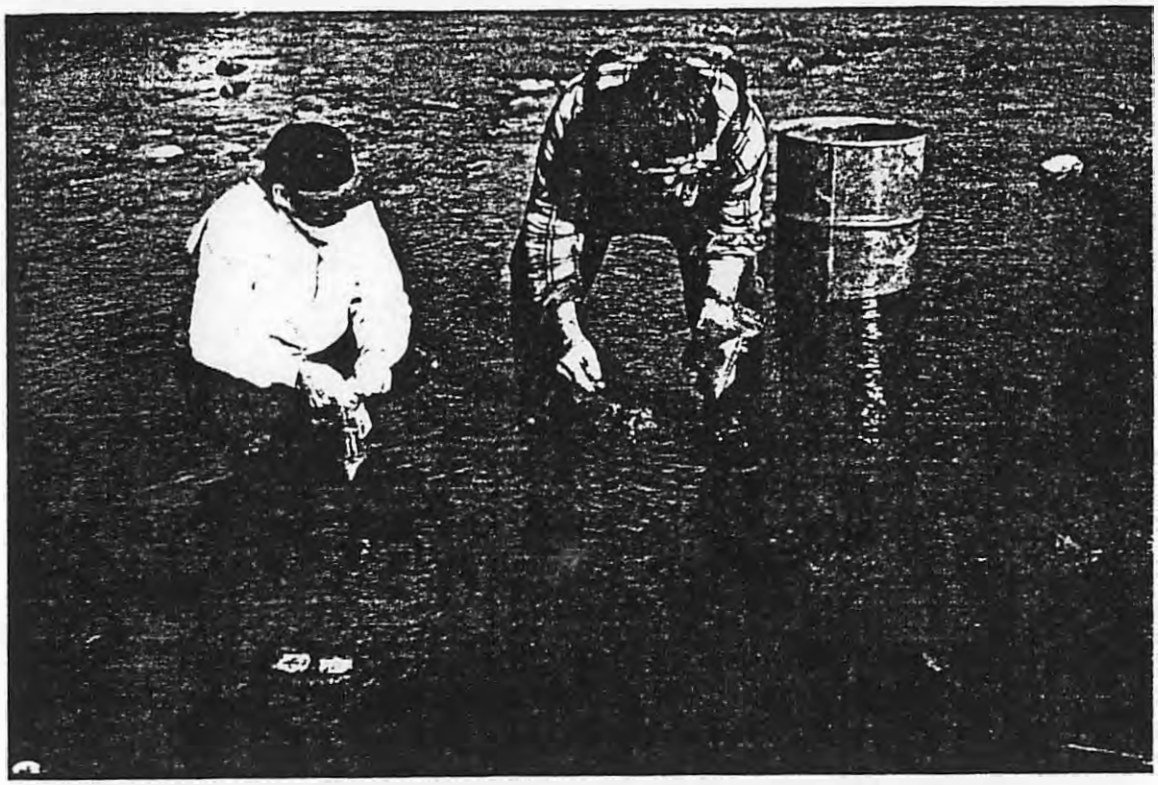

Figure XVIII Collecting a surface material grab sample using a large spoon (Gunnison River, Colorado)

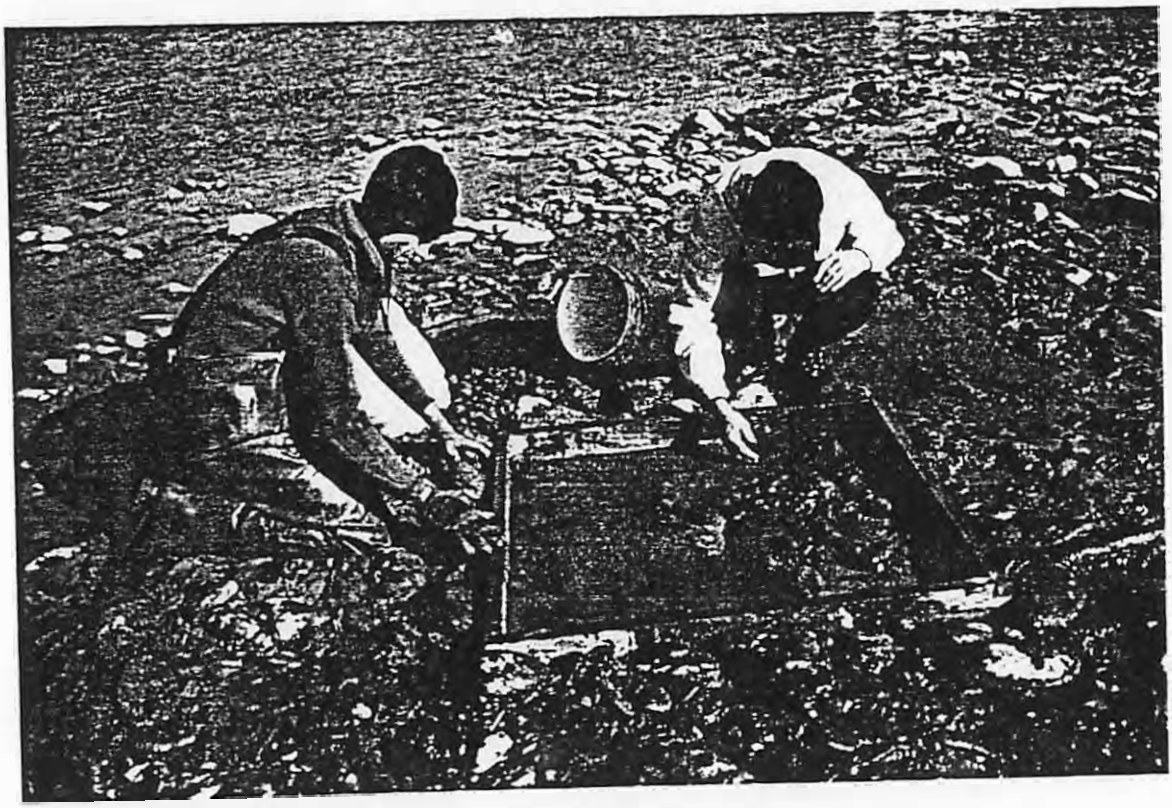

Figure XIX Placement of bulk density frame (Gunnison River, Colorado)

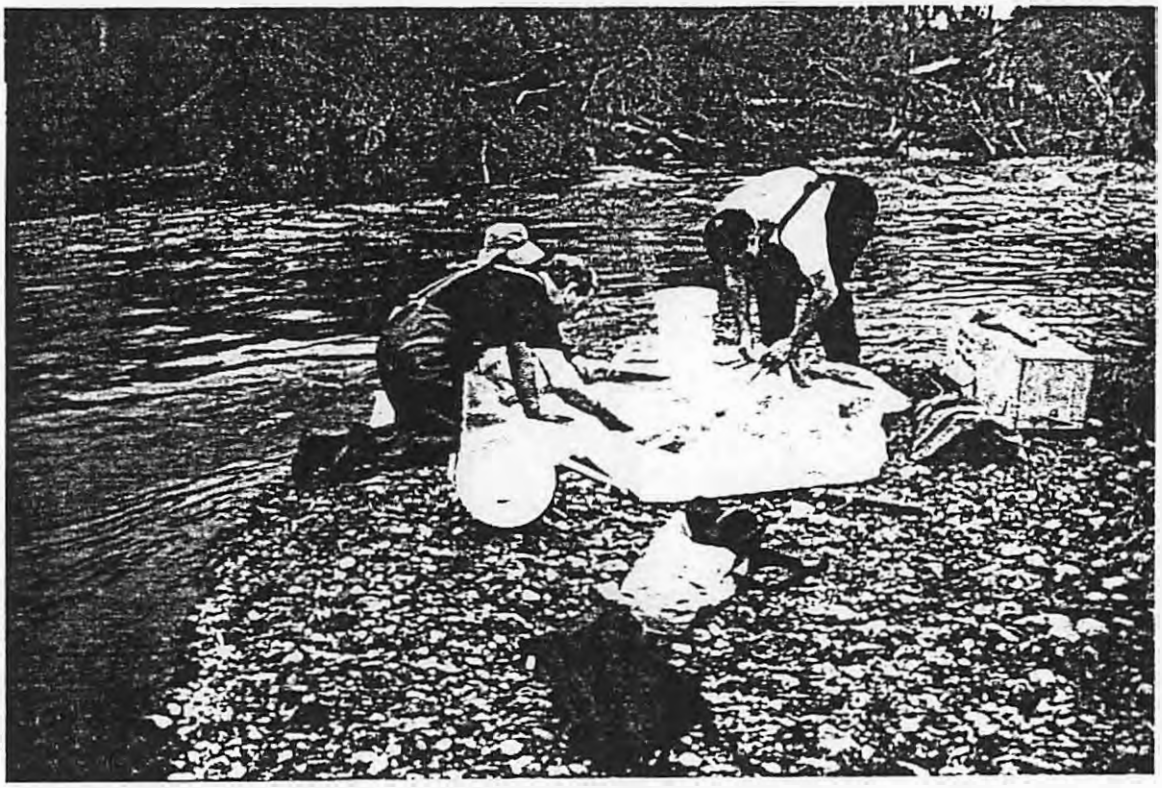

Figure XX Placement of plastic sheeting in bulk density frame (Stanislaus River, California)

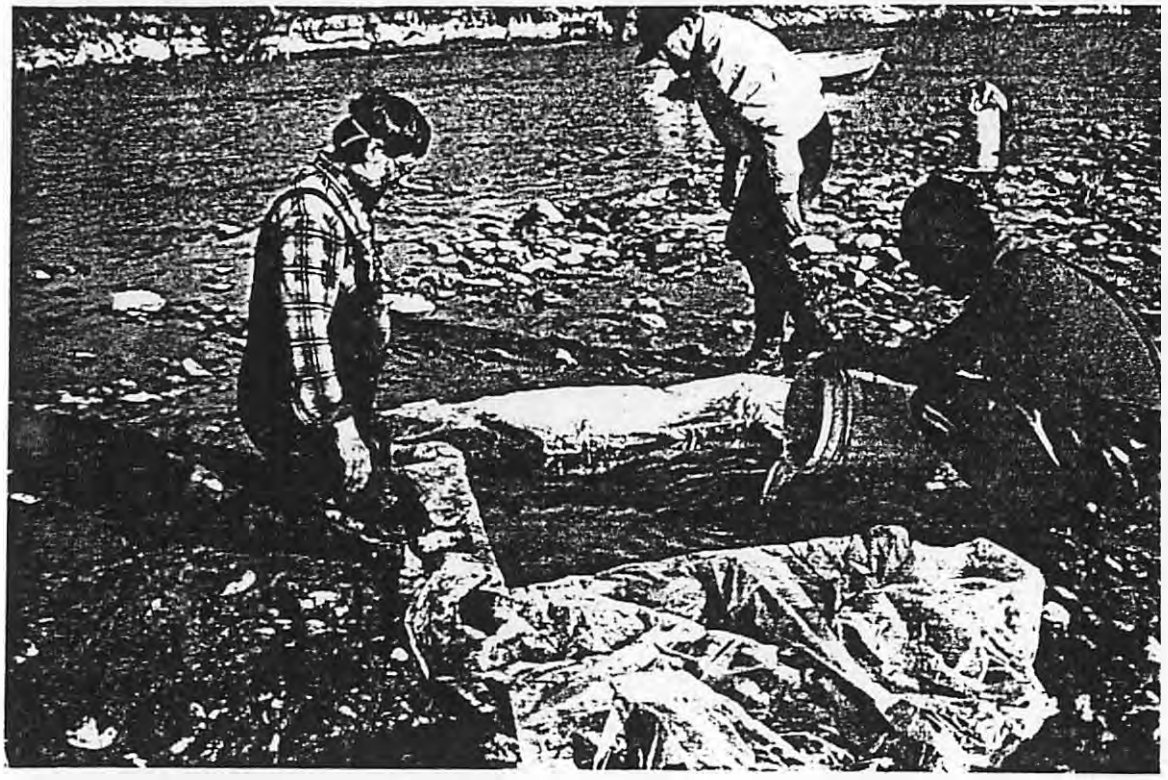

Figure XXI Addition of water to bulk density frame for volume determination (Gunnison River, Colorado)

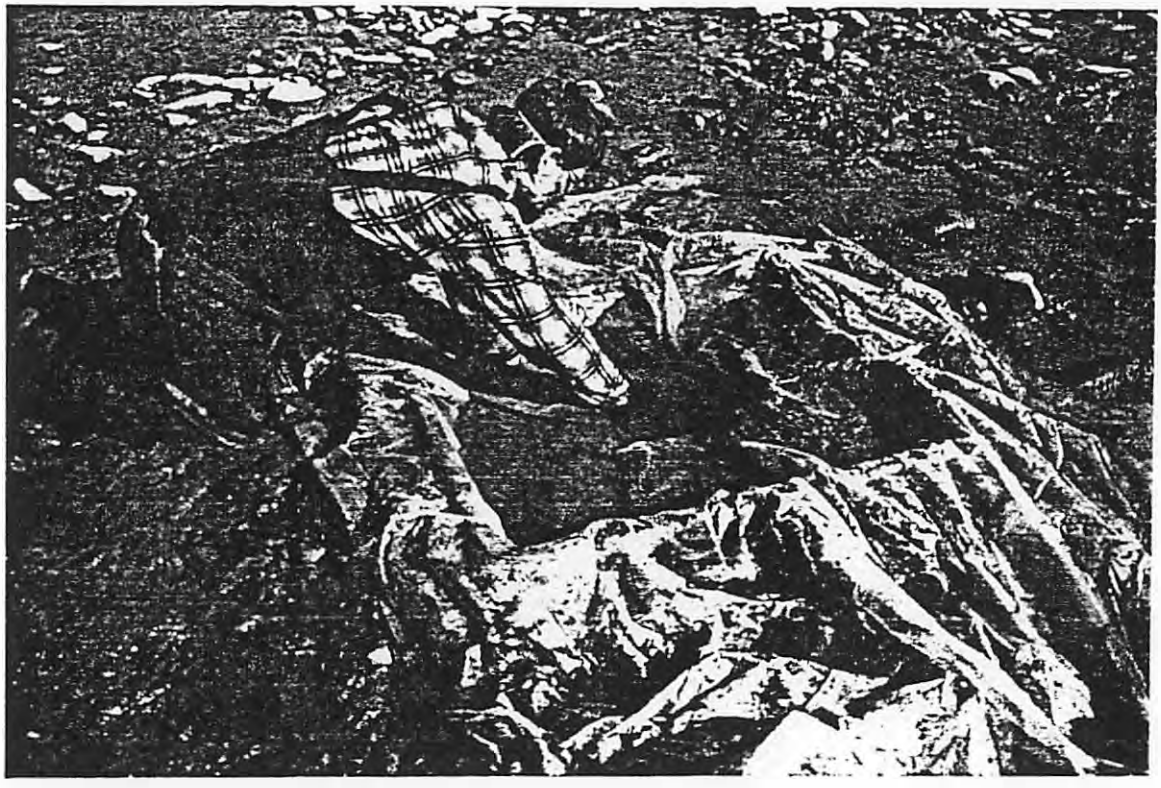

Figure XXII Placement and smoothing of plastic sheeting in the bulk density frame for final volume determination (Gunnison River, Colorado)

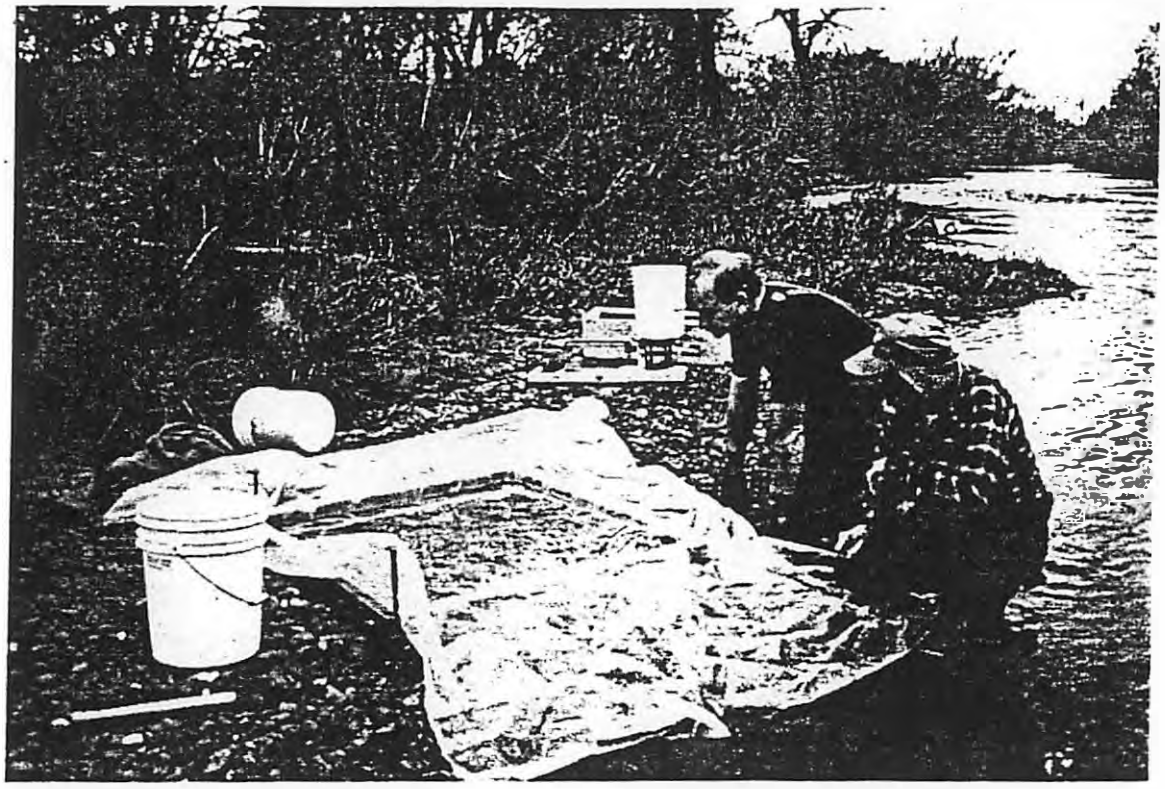

Figure XXIII Bulk density setup on the Stanislaus River, California