DISSERTATION

SERIES EXPANSION OF THE MODIFIED EINSTEIN PROCEDURE

Submitted by

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WE HEREBY RECOMMEND THAT THE DISSERTATION PREPARED UNDER OUR SUPERVISION BY SEEMA CHANDRAKANT SHAH-FAIRBANK ENTITLED SERIES EXPANSION OF THE MODIFIED EINSTEIN PROCEDURE BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREEE OF DOCTOR OF PHILOSOPHY.

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ABSTRACT OF DISSERTATION

SERIES EXPANSION OF THE MODIFIED EINSTEIN PROCEDURE

This study examines calculating total sediment discharge based on the Modified Einstein Procedure (MEP). A new procedure based on the Series Expansion of the Modified Einstein Procedure (SEMEP) has been developed. This procedure contains four main modifications to MEP. First, SEMEP solves the Einstein integrals quickly and accurately based on a series expansion. Next, instead of dividing the suspended sediment and bed material samples into particle size classes, the total sediment discharge calculation is based on a median grain size in suspension (d_{50ss}). Thirdly, for depth-integrated samples the Rouse number (Ro) is determined directly by calculating the fall velocity (ω) based on d_{50ss}, the shear velocity ($u_* = \sqrt{ghS}$) and assuming the value of the von Karman constant (κ) is 0.4. For point concentration measurements, the Ro is calculated by fitting the concentration profile to the measured points. Lastly, SEMEP uses the measured unit sediment discharge and Ro to determine the unit bed discharge directly. Thus, SEMEP can determine the unit bed discharge (q_b), unit suspended sediment discharge (q_s), unit total sediment discharge (q_t), ratio of measured to total sediment discharge (q_m/q_t) and ratio of suspended to total sediment discharge (q_s/q_t).

Depth-integrated concentration measurements, for fourteen streams and rivers in the United States are tested using SEMEP. Based on an evaluation of q_m/q_t the results indicate that when u_*/ω is greater than 5, SEMEP will perform accurately, with a coefficient of determination (R^2) of 0.99, concordance correlation coefficient (ρ_c) of 0.98 and Mean Absolute Percent Error (MAPE) of 5%. The high values of R^2 and ρ_c, and the low value of MAPE indicate that SEMEP works well. Seven of the fourteen streams and rivers were also tested using the Bureau of Reclamation Automated Modified Einstein Procedure (BORAMEP), which resulted in a R^2 of 0.65, ρ_c of 0.74 and MAPE of 18%. BORAMEP failed to calculated total sediment discharge for over 30% of the samples due to various errors. SEMEP always calculated total sediment discharge and performed better than BORAMEP because the series expansion procedure removed empirical relationships found in the original MEP.

The ratio of suspended sediment to total sediment discharge (q_s/q_t) as a function of u_*/ω and relative submergence (h/d_s) is determined using SEMEP. SEMEP supports a classification of the primary modes of sediment transport. It is found that that when u_*/ω is less than 0.2, sediment is not transported. When u_*/ω is between 0.2 and 0.5, more than 80% of the sediment moves as bed load; when u_*/ω is between 0.5 and 2 the sediment transport occurs as mixed load (both as bed and suspended load); and when u_*/ω is greater than 2, more than 80% of the sediment moves as suspended load. Depth-integrated laboratory data corroborates SEMEP results and showed a high degree of variability in q_s/q_t for mixed loads ($0.5<u_*/\omega<2$).

For point velocity and concentration measurements, data from one laboratory and six river measurements are used to test SEMEP. Results indicate that deeper rivers give a better estimate of total sediment discharge compared to shallow rivers. This is because shallower rivers are generally governed by bed load transport. Furthermore, if the ratio of the measured depth to the representative bed particle size (h_m/d_s) is greater than 1,000, the comparison between SEMEP and measurements of q_t are quite accurate with an MAPE less than 25%. These point measurements are also used to explain why a deviation occurs between calculated and measured *Ro*. The deviation is most pronounced when the value of *Ro* is greater than 0.5 ($u_*/\omega<5$), due to low concentrations and measurement errors. In streams with near uniform concentration profiles, varying the value of *Ro* from 0.01 to 0.5 ($250<u_*/\omega>5$), the total calculated sediment discharge changes by less than 25%.

In summary, the results indicate that SEMEP performs accurately (error less than 25%) when the value of u_*/ω is greater than 5 (or *Ro* less than 0.5). SEMEP calculations are acceptable, but less accurate when u_*/ω is between 2 to 5 ($1.25>Ro<0.5$). Both SEMEP and MEP should not be used when u_*/ω is less than 2.

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$\partial c/\partial y$		change in concentration as a function of depth
A	L	reference depth
A		d_n/h
A'		y_o/h
A/W	L	hydraulic depth
B_*		0.143
c		concentration
c_a		reference concentration at the reference depth
c_i		concentration at a particular point
C_1		regression constant
C_2		regression constant
C_S'	M/L^3	measured suspended sediment concentration in weight by volume
C_t	M/L^3	total sediment concentration in weight by volume
d	L	diameter of the sediment particle
d_*		dimensionless grain diameter
d_{10}	L	particle size associated with material finer than 10% of the sample
d_{35}	L	particle size associated with material finer than 35% of the sample
d_{50}	L	particle size associated with material finer than 50% of the sample
d_{65}	L	particle size associated with material finer than 65% of the sample
d_i	L	representative particle size for a given bin
d_n	L	unmeasured depth

d_{50ss}	L	median particle size of the bed
dv/dy		velocity gradient in the vertical direction
E		a/h
ERF		error function
Fr		Froude Number
g	L/T^2	gravitational acceleration
h	L	flow depth
h/d_s		relative submergence
h_m	L	measured flow depth
I_1		$0.216\frac{E^{Ro-1}}{(1-E)^{Ro}}J_1$
I_2		$0.216\frac{E^{Ro-1}}{(1-E)^{Ro}}J_2$
i_B		fraction of bed material for a given bin (size class)
i_S		fraction of measured suspended sediment for a given bin (size class)
J_1		$\int_E^1\left(\frac{1-y'}{y'}\right)^{Ro}dy'$
$J_{1A'}$		$\int_{A'}^1\left(\frac{1-y'}{y'}\right)^{Ro}dy'$
J_{1A}		$\int_A^1\left(\frac{1-y'}{y'}\right)^{Ro}dy'$
J_2		$\int_E^1\ln y'\left(\frac{1-y'}{y'}\right)^{Ro}dy'$

$J_{2A'}$		$\int_{A'}^{1} \ln y' \left(\frac{1-y'}{y'}\right)^{Ro} dy'$
J_{2A}		$\int_{A}^{1} \ln y' \left(\frac{1-y'}{y'}\right)^{Ro} dy'$
k		initial counter for summation
k_s	L	surface roughness thickness
l	L	Prandtl mixing length
n		number of slices need for numerical integration
p		probability of sediment particles entrained in flow
P_m		transport parameter
Q	L^3/T	water discharge
q	L^2/T	unit water discharge
q_b	M/LT	unit bed discharge
Q_b	M/T	bed load
q_{hs}	M/LT	unit sediment discharge measured with a Helley-Smith
q_{hs}/q_t		ratio of measured sediment discharge using a Helley-Smith and total discharge
q_{hsc}	M/LT	unit sediment discharge calculated based on the Helley-Smith
q_m	M/LT	unit measured sediment discharge
q_m/q_t		ratio of measured to total sediment discharge
Q_S	M/T	sediment load
q_s	M/LT	unit suspended sediment discharge
q_s/q_t		ratio of suspended to total sediment discharge

$q_{Si'}$	M/LT	unit sediment discharge for a given bin
$Q_{Si'}$	M/T	sediment load for a given bin
q_t	M/LT	unit total sediment discharge
Q_t	M/T	total load
Q_{ti}	M/T	total load for a given bin
q_{um}	M/LT	unit unmeasured sediment discharge
R'	L	hydraulic radius associated with grain roughness
Re		Reynolds Number
Ro		Rouse number
Ro_c		calculated Rouse number
Ro_i		Rouse number for a given bin
Ro_m		measured Rouse number
S		slope
So		bed slope
s_{xy}		covariance between measured and calculated data
s^2_x		variance of measured data
s^2_y		variance of calculated data
u_*	L/T	shear velocity
u_*'	L/T	grain shear velocity
u_{*c}	L/T	critical shear velocity
u_*/ω		ratio of shear to fall velocity
V	L/T	velocity

$\bar{V}$	L/T	average velocity in the vertical
v'	L/T	turbulent velocity fluctuation
v_a	L/T	average velocity at reference point
v_i	L/T	velocity at a given point
W	L	channel flow width
X_i		measured value
Y	L	vertical distance
Y_{avg}		average calculated value
Y_i		calculated value
Y_{min}		minimum calculated value
Y_{max}		maximum calculated value
y'		y/h
$y_{i+1} - y_i$	L	change in distance
y_o	L	vertical distance where velocity equals zero
α		Schmidt number
β		sediment diffusion coefficient
γ	M/LT^2	specific weight of fluid
γ_s	M/LT^2	specific weight of sediment
Δ	L	laminar sub layer thickness
Δv_x	L/T	change in velocity in the x direction
ε_m		momentum exchange coefficient
ε_s		sediment diffusivity coefficient

η_o		0.5
κ		von Kármán constant of 0.4
Π		approximately 3.14159
ρ	M/L^3	fluid density
τ	M/LT^2	shear stress
τ_{ci}	M/LT^2	critical tractive force for the beginning of motion for the given particle
τ_o’	M/LT^2	grain boundary shear stress
ν	L^2/T	kinematic viscosity
Φ_*		bed load transport function
χ		Einstein's correction factor
Ψ		intensity of shear
Ψ_*		modified intensity of shear
ω	L/T	fall velocity
ω_i	L/T	fall velocity for a given bin
Π_w		wake flow function

Chapter 1: Introduction

1.1 Overview

Sediment transport in river systems is a function of geology, hydrology and hydraulics. Based on natural change in the hydrological regime and manmade alterations to the landscape, the mass of sediment transported by a river is changes constantly. Sediment within the river corridor impacts the storage capacity of reservoirs, balance between supply and capacity of sediment, and the water quality. There are severe engineering and environmental problems associated with an imbalance in the transport, erosion and deposition of sediment (Julien 1998). The financial cost associated with sediment has grown over the years due to human influences. Therefore, the ability to quantify sediment loads or discharge is essential for the management of our water bodies and land for the future. Over the years, techniques have been developed to calculate the total load within the river environment. Total load is determined based on the mode of transport (bed or suspended load), measurement techniques (measured and unmeasured load) and sediment source (bed material and wash load (Watson et al. 2005).

Hans Albert Einstein, one of the pioneers of sediment transport, developed a sediment transport equation based on the modes of transport. His bed load transport equation is based on the probability that a given particle found in the bed will be entrained into the flow (Einstein 1942). Then in 1950, Einstein developed a method to calculate total load, based on evaluating the bed load transport and integrating the suspended sediment discharge equation. The suspended sediment was evaluated based on integrating the product of the theoretical velocity profile (Keulegan 1938) and the concentration profile (Rouse 1937). The integral is evaluated within the suspended sediment zone from the water surface (h) to a distance $2d_s$ (two times the median grain diameter within the bed) above the bed. The value of the sediment diffusion coefficient (β) was set equal to 1, the von Karman constant (κ) was set equal to 0.4 and the shear velocity (u_*) was replaced by the grain shear velocity(u_*'). This method is useful when the majority of sediment transported is near the bed. However, this study focuses on sand bed channels where the majority of the sediment is transported in suspension. Therefore, it is more beneficial to measure the suspended sediment discharge and then extrapolate to estimate the unmeasured sediment discharge.

Colby and Hembree (1955) measured sediment discharge at a constricted river cross section and 10 unconfined river cross sections to determine the suitability of the constricted section for measuring total sediment discharge. In this study, the Schoklitsch, Du Boys, Straub and Einstein formulas were used to determine the agreement between the calculated sediment discharge at the unconfined river cross sections and the measured sediment discharge at the constricted section. The Einstein equation was modified to provide a total sediment discharge calculation, known as the Modified Einstein Procedure (MEP). This method was developed to provide the total sediment discharge at a given point in time for a given cross-section. In this method, the total sediment discharge is determined by measuring a portion of the suspended sediment discharge (depth-integrated sampler) and extrapolating to estimate the unmeasured sediment discharge (in the zone located very near the bed) using the Rouse number (*Ro*). The spectrum of particle sizes are divided into bins (particle size classes). *Ro* is determined by calculating total sediment discharge based on particles found in the bed and measured suspended sediment. The value of *Ro* is varied until the total sediment discharge calculated based on the bed material and measured sediment discharge match for a given bin. *Ro* is determined for only one size class (bin) based on overlap between the particles measured in suspension and within the bed. Then a power law relationship to an exponent of 0.7 is used to determine *Ro* for the remaining bins. However, the procedure is tedious and total sediment discharge results vary between users because of the procedure requires the use of charts.

Over the years many researchers and engineers have made improvements to the estimation of total sediment discharge based on MEP (Colby and Hubbell 1961; Lara 1966; Burkham and Dawdy 1980; Shen and Hung 1983). Colby and Hubbell (1961) developed four nomographs simplify MEP calculations. Lara (1966) determined that *Ro* should be estimated based on a least squares exponential regression of two or more overlapping bins for more accurate total sediment discharge calculations. Burkham and Dawdy (1980) made three significant modifications. First, they developed a direct relationship between bed load transport (Φ_*) and bed load intensity functions (Ψ_*). Second, they redefined the roughness coefficient (k_s) to be $5.5*d_{65}$. Thirdly, they determined that u_* increased and the Einstein correction factor (χ) decreased compared to the values determined by Colby and Hembree. Shen and Hung (1983) optimized the method for determining the fraction of suspended and bed particles within each bin (i_S and i_B).

MEP has been widely used to estimate the total sediment discharge within rivers. In addition, it has been used to calibrate and check many existing sediment transport equations. Thus programs were developed to provide consistent results.

Numerous programs have been developed that incorporate MEP and revisions introduced to the procedure. These programs provide consistent total load calculations. The motivation of this study was based on Shah's (2006) detailed analysis on the Bureau of Reclamation Automated Modified Einstein Procedure "BORAMEP" (Holmquist-Johnson and Raff 2006). Three main errors were reveled from the analysis of BORAMEP. First, when particles in the measured zone were not found in the bed, a total load could not be determined because a *Ro* could not be evaluated because a minimum of two bins are required for a least squares regression analysis. Second, when overlapping bins exist a negative exponent can be generated from the regression analysis to calculate *Ro* for the remaining bins. A negative exponent is generated due to the size of the bin and the amount of sediment measured. The results suggest that a finer sediment particle would have a larger *Ro* value, which is physically impossible. Finally, on occasion the measured suspended sediment discharge was greater than the total sediment discharge. Though this is physically impossible, it occurred due to the location where the sediment is sampled versus the flow depth is measured.

Due to these errors and limitation associated with BORAMEP a new solution is needed to calculate total sediment discharge based using MEP. The proposed procedure implements a solution based on series expansion to determine the Einstein Integrals (Guo and Julien 2004). The series solution has been proven to be an accurate and rapid mean to determine values for the Einstein integrals. In addition, errors associated with *Ro* are avoided by simply determining the total sediment discharge based on a composite particle size. Finally, the bed sediment discharge is calculated based on the measured suspended sediment discharge, not based on Einstein's probability of entrainment. As a result, total sediment discharge can be calculated when the bed is armored or when bedforms are present.

1.2 Study Objectives

In many circumstances, MEP does not successfully calculate total sediment discharge. The main purpose of this research is to develop a new procedure to enhance the calculation of total sediment discharge and load from depth-integrated and point samplers. The main research objectives are as follows:

1. Develop and test a new procedure to determine the ratio of measured to total sediment discharge (q_m/q_t) as a function of the ratio of shear velocity (u_*) to fall velocity (ω). River data from numerous locations in the United States will be used to statistically validate the new procedure.
2. Show how the new procedure compares with the total sediment discharge calculated by the Bureau of Reclamation Automated Modified Einstein Procedure (BORAMEP).
3. Determine the primary mode of sediment transport based on the relationship between the ratio of suspended to total sediment discharge (q_s/q_t) as a function of u_*/ω. Data from flume experiments collected by Guy et al. (1966) will be used to verify the modes of transport.

4. Show how the new procedure can be used to analyze point sediment measurements and determine how sampling depth and bed material size affect total sediment discharge calculation (q_t).
5. Explain the deviation between the measured and calculated Rouse number (Ro_m and Ro_c).

1.3 Approach and Methodology

Development of the series expansion to solve the Einstein integrals by Guo and Julien (2004) presented an opportunity to develop a new program to calculate total sediment discharge. The new program uses Visual Basic for Applications (VBA) in an Excel platform and will allow users to calculate total sediment discharge based on a representative particle size (d_{50ss}) in suspension. In addition, it calculates total sediment discharge based on measurements from either a depth-integrated or point sampler. This study uses measurement data from various laboratory experiments and rivers. All improvements are based on the theory that the water velocity follows a logarithmic profile and sediment concentration is represented by the Rouse concentration profile.

In the past 20 years, programs have been developed to aid users in calculating total sediment discharge based on MEP. A few changes have been made to improve the overall calculation techniques within MEP, since the Remodified Einstein Procedure was developed in 1983. Thus, this study will provide substantial improvements that will aid in total sediment discharge calculations. In addition, it will provide for a better total sediment discharge calculation which researchers can use to test sediment transport equations.

Chapter 2: Literature Review

There exists no universal method to calculate sediment discharges in rivers. This is because sediment transport occurs in two distinct modes. The first is in suspension and the second is near the bed as bed sediment discharge. A fluctuation in turbulence and flow velocity has a tendency to move sediment from the river bed into suspension and keep it in suspension, while fall velocity (ω) has a tendency to deposit suspended particles along the river bed. When the turbulence function represented by the u_* is greater than ω, particles have a tendency to stay in suspension. Total sediment discharge is the summation of bed sediment discharge plus suspended sediment discharge (Equations (2.1) and (2.2)).

$$q_t = q_b + q_s \tag{2.1}$$

$$q_s = \int_a^h cvdy \tag{2.2}$$

Where,

q_t is unit total sediment discharge;
q_b is unit bed sediment discharge;
q_s is unit suspended sediment discharge;
h is the flow depth;
a is the minimum depth of the suspended sediment zone;
c is the concentration; and
v is the velocity.

This chapter provides a literature review for understanding sediment discharge, which aids in the calculation of the applicability and improvements to the Modified Einstein Procedure (MEP).

2.1 Turbulence and Velocity

In open channels, flow is usually defined as turbulent due to irregular velocity fluctuations at a given location with respect to time (Figure 2.1). However, as the fluid approaches the channel boundary, the effects of turbulence diminish. This region is referred to as the laminar sub layer (δ). The basis for sediment transport can be explained using the concepts of turbulence and velocity fluctuation.

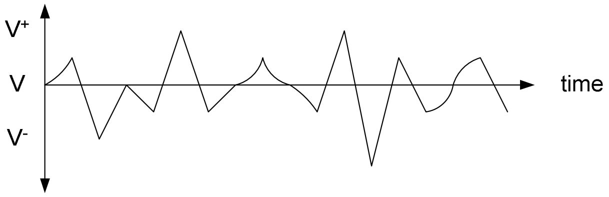


Figure 2.1. Velocity Fluctuation

2.1.1 Logarithmic Velocity Law

Prandtl (1925) first introduced the mixing length theory to explain turbulent fluctuation. This is done by defining a confined length for which mixing occurs. The study looks only at parallel flow, which varies along a streamline. The turbulent velocity fluctuation is expressed in Equation (2.3).

$$v' = l\left(\frac{dv}{dy}\right) \tag{2.3}$$

$$l = \kappa y \tag{2.4}$$

Where,

v' is the turbulent velocity fluctuation;
l is the Prandtl mixing length ;
$\frac{dv}{dy}$ is the velocity gradient in the y direction;
κ is the von Karman constant of 0.4; and
y is the vertical distance from the bed

Near the wall or boundary of the channel, Prandtl focuses on how velocity is related to turbulent shear stress. Shear stress, expressed in Equation (2.5), is the force exerted by the water on the bed.

$$\tau = \rho l^2 \left(\frac{dv}{dy} \right)^2 \tag{2.5}$$

Where,

τ is the turbulent shear stress; and
ρ is the fluid density.

Prandtl (1932) and von Karman (1932) both obtained the logarithmic velocity distribution (Equation (2.6)) by assuming the shear stress is equal to the bed shear $(\tau = \tau_o = \gamma S_o h)$and that there is a relationship between the shear velocity and shear stress $(\tau = u_*^2 \rho)$.

$$\frac{dv}{dy} = \frac{u_*}{\kappa y} \rightarrow \frac{v}{u_*} = \frac{1}{\kappa} \ln \frac{y}{y_o} \tag{2.6}$$

Where,

v is the velocity;
u_* is the shear velocity;
y_o vertical distance where velocity equals zero;
γ is the specific weight of the fluid;
S_o is the bed slope; and
h is the total flow depth.

Keulegan (1938) worked on developing detailed velocity distributions for the flow resistance in open channels, similar to what Nikuradse (1932; 1933) accomplished for circular pipes. The only difference between open channel and circular pipes is the values used for the water surface characteristics. The velocity distribution for open channels is described by Figure 2.2.

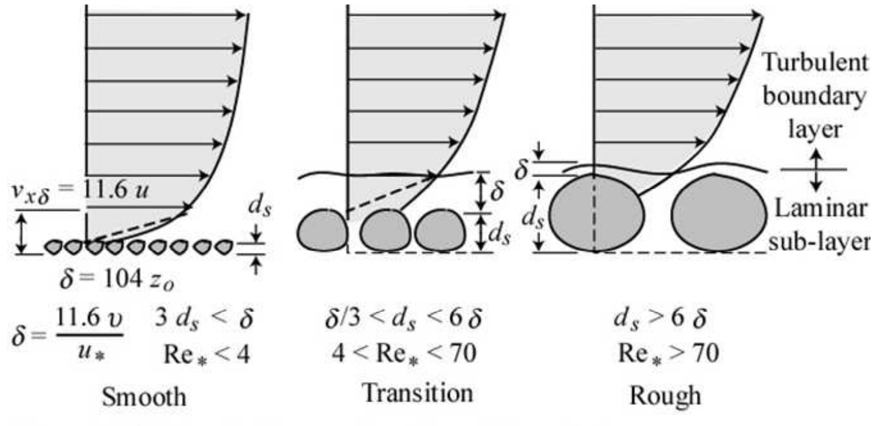


Figure 2.2. Description of the Velocity Profile (Julien 1998)

The figure shows the effects of grain diameter on the shape of the velocity profile, laminar sub layer and the grain Reynolds number. Refer to Equations (2.7) to (2.9) for a solution to the average velocity based on the boundary condition. A smooth boundary is expressed as:

$$\bar{v} = \frac{u_*}{\kappa}\ln\left(9.05\frac{y u_*}{v}\right) \tag{2.7}$$

Where,

$\bar{v}$ is the average velocity in the x direction; and
v is the kinematic viscosity of the fluid.

For a rough boundary the equation is expressed as:

$$\bar{v} = \frac{u_*}{\kappa}\ln\left(30.2\frac{y}{k_s}\right) \tag{2.8}$$

Where,

k_s is the thickness of the surface roughness layer.

The roughness layer is usually defined as a function of the particle size found in the bed. Finally, the transitional region between a smooth and rough boundary is expressed as:

$$\bar{v} = \frac{u_*}{\kappa} \ln\left(30.2 \frac{y\chi}{k_s}\right) \tag{2.9}$$

Where,

χ is a correction coefficient (Refer to Figure 2.3).

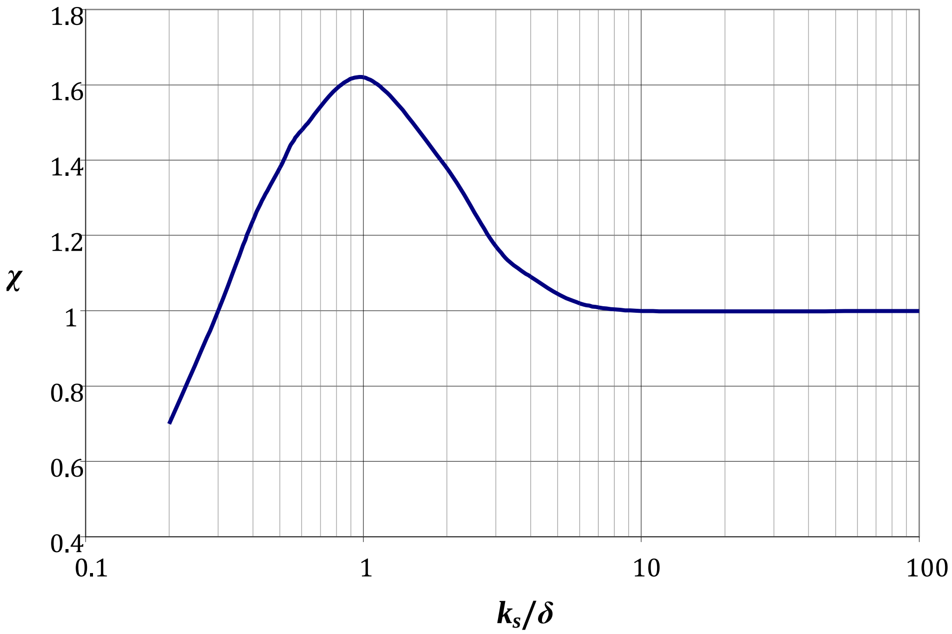


Figure 2.3. The Correction Factor for χ (Einstein 1950)

The effects of the correction factor (χ) are minor. Thus Equation (2.8) is usually used to describe the velocity fluctuation in natural rivers.

2.1.2 Wake Flow Function

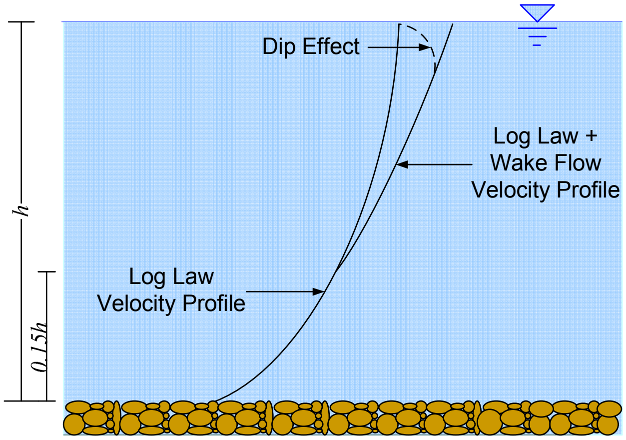
The wake flow function is a slight deviation from the logarithmic velocity law, which causes an increase in the flow velocity after fifteen percent of the flow depth(refer to Figure 2.4a). Coles (1956; 1969) suggests that the velocity distribution follows the following form:

$$\frac{\bar{v}}{u_*}=\underbrace{\frac{1}{\kappa}\ln\left(\frac{u_* y}{\nu}\right)}_{law\ of\ wall}-\underbrace{\frac{\Delta v_x}{u_*}}_{\substack{roughness\\ function}}+\underbrace{\frac{2\Pi_w}{\kappa}\sin^2\left(\frac{\pi y}{2h}\right)}_{wake\ flow\ function} \qquad (2.10)$$

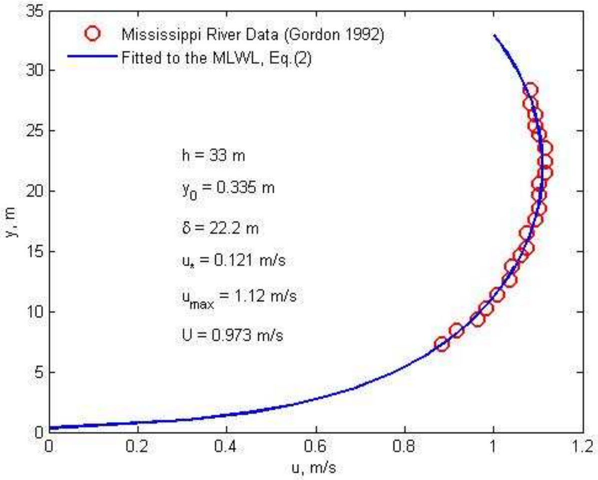
Where,

Δv_x is change in velocity in the downstream direction;
Π_W is wake flow function; and
π is 3.14.

Equation (2.10) is a function of the law of the wall (logarithmic velocity profile), roughness function and the law of the wake. Based on independent studies (Coleman 1981; 1986; Nezu and Rodi 1986; Nezu 1993), the wake law function has been shown to improve the accuracy of the velocity profile in open channels. A study has been performed by Guo and Julien to explain the dip in the velocity profile at the surface. This dip occurs due to surface tension at the water/air interphase(Guo and Julien 2008). Figure 2.4 shows the changes to the logarithmic velocity profile due to the law of the wake and the dip caused by the surface tension. An example from the Mississippi River is used to show how actual data follows a combination of the logarithmic law, wake law and dip effects.



a. Schematic of Velocity Profile



b. Example (Guo and Julien 2008)

Figure 2.4. Log-Law Velocity Profile and Deviation Due to Wake at the Surface

2.2 Sediment

Sediment is defined as inorganic particulate matter that can be transported by fluid flow. It is transported either by being pushed, rolled or saltated along the river bed (Einstein et al. 1940) or in suspension. Sediment may deposit as a layer of solid particles on the floodplain, the river bed or the bottom of a body of water. Sediment could also continue to be transported by fluid flow. Some of the main sediment sources within the river system are landscape erosion, channel erosion, bank failure and bed scour.

As explained in the introduction, total sediment discharge is classified in three distinct methodologies. Figure 2.5 shows the three distinct sediment classification methods. The representative particle (d_s) is used to define the division between the suspended sediment and bed load layers.

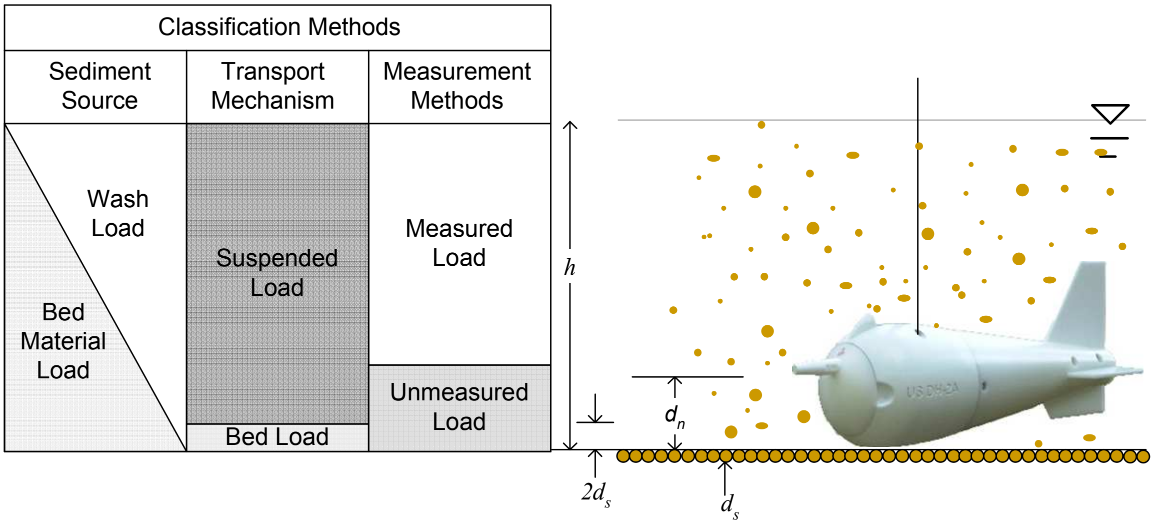


Figure 2.5. Classification of Sediment Load

Figure 2.5 provides a depiction of the measured and unmeasured zones based on a suspended sediment sampler. The suspended sediment sampler measures a water-sediment mixture from the water surface to a set distance above the bed. This set distance varies based on the type of sampler used. The unmeasured load is the portion of the sediment that is close to the bed, where the sampler cannot measure the sediment. The zone identified as measured load contains a portion of the suspended load. This is based on the depth of flow and the type of sampler used.

Sediment classification based on transport mechanism is divided into suspended and bed load. Suspended sediment load is the portion of the total load that is found in suspension and is distributed throughout the cross section. These suspended particles remain in suspension because the upward turbulent velocity fluctuation is greater than ω, which prevents the particles from settling. Bed load consists of particles, which are in direct contact with the river bed. The material that makes up the bed load is coarser than the material found in suspension. The particles are transported at a rate that is related to the discharge. Einstein's study in 1940 provided a clear distinction between the suspended and bed load zones. The study suggests that once particles were a certain size they were no longer found in the bed in appreciable quantities. Einstein defined the bed load layer as being two times the median bed particle size ($2d_s$).

Sediment can also be considered based on its source. Wash load is defined as all particles smaller than d_{10} (particles size finer than 10%), which are usually not found in the bed. Bed material load is the portion of sediment found in appreciable quantities in the bed. It is composed of the bed load and a portion of the suspended load. Many believe wash load has little impact on channel morphology, thus most sediment transport equations are based on bed material load. However, when measurements are made using a sampler, wash load cannot be excluded. A study performed on the hyper-concentrated Yellow River in China shows that wash load has a dramatic effect on channel morphology (Yang and Simoes 2005).

2.2.1 Sediment Concentration Profile

The sediment concentration profile in open channels was developed based on the theory of turbulent mixing of particulates in the atmosphere (Schmidt 1925), refer to Equation (2.11).

$$0 = \omega c + \varepsilon_s \frac{\partial c}{\partial y} \tag{2.11}$$

Where,

ω is the fall velocity;
c is the sediment concentration;
ε_s is the sediment diffusion coefficient; and
$\partial c/\partial y$ is the slope of the change in concentration over the change in depth.

This theory was extended for applications in water in the 1930's by Jakuschoff (1932) and Leighly (1932; 1934). Later, O'Brien (1933) added the diffusivity distribution associated with sediment flow in water based on the shear stress distribution, which is shown in Equation (2.12).

$$\varepsilon_m = \kappa u_* \frac{y}{h}(h - y) \tag{2.12}$$

Where,

ε_m is the momentum exchange coefficient.

The relationship between the momentum exchange coefficient and the sediment diffusion coefficient is presented in Equation (2.13).

$$\varepsilon_s = \beta \varepsilon_m \tag{2.13}$$

Where,

β is the diffusion coefficient.

In the original analysis performed by Rouse on the concentration profile, the value of β was assumed to equal 1. By combining Equations (2.11) through (2.13), the concentration profile was determined for open channels. The following equations were introduced by Rouse (1937) to explain the suspended sediment distribution.

$$\frac{c}{c_a} = \left(\frac{h-y}{y} \frac{a}{h-a} \right)^{Ro} \tag{2.14}$$

$$Ro = \frac{\omega}{\beta \kappa u_*} \tag{2.15}$$

$$\omega = \frac{8v}{d_{50ss}} \left\{ \left[1 + 0.0139 d_*^3 \right]^{0.5} - 1 \right\} \tag{2.16}$$

$$d_* = d_{50ss} \left[\frac{(G-1)g}{v^2} \right]^{\frac{1}{3}} \tag{2.17}$$

$$u_* = \sqrt{ghS} \tag{2.18}$$

Where,

c_a is the measured concentration at a specified distance "*a*" from the bed;
a is the depth where the concentration c_a is evaluated;
Ro is the Rouse number;
d_* is the dimensionless grain diameter;
d_{50ss} is the median particle size in suspension;
G is the specific gravity (2.65);
g is gravity; and
v is the kinematic viscosity.

Equation (2.14) provides the concentration at a specified distance *y* from the bed. The value of *Ro* is used to describe the curvature of the concentration profile. Figure 2.6 provides a graphical representation of the concentration profile for varying *Ro* values.

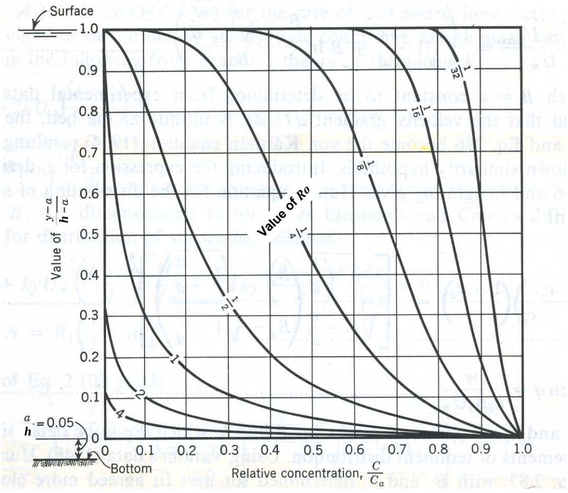


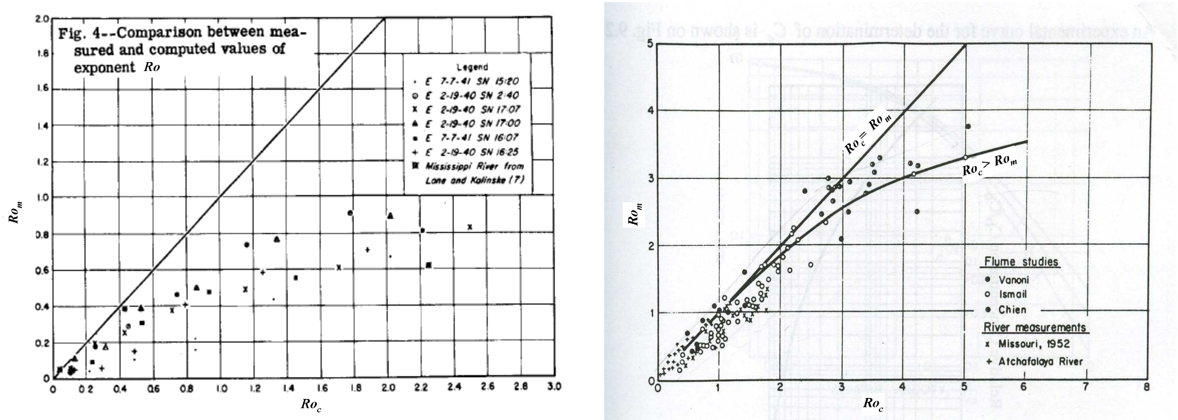
Figure 2.6. Rouse Concentration Distribution (Julien 1998)

As the value of *Ro* increases, the bed load becomes a more significant portion of the total load and as *Ro* decreases, the suspended sediment load is the majority of the total load.

2.3 Rouse Number – Effects of Sediment Stratification

Numerous studies have been conducted on *Ro*, both through laboratory and field experiments, to validate Equation (2.15). Vanoni (1941; 1946) performed experiments in the laboratory and determined that the concentration profile plotted logarithmically and that *Ro* followed Equation (2.15). This occurred because the study consisted of only small particle sizes (ω is small) and allows the value of κ to vary based on measured velocity profile. However, Anderson (1942) showed that the value of *Ro* used to calculate the concentration profile did not increase as rapidly for the Enoree River in South Carolina, with a constant κ of 0.4, as it did in Vanoni's experiment. The value of Ro_c and Ro_m has a tendency to deviate when the Ro_c values were greater than 0.2. In addition, Einstein and Chien (1954) confirmed Anderson's finding by recognizing that the Ro_c value was much larger than the Ro_m (refer to

Figure 2.7). Their study showed that the deviation occurs after Ro_c was greater than 1, instead of 0.2. All the authors agree that the concentration profile fits Equation (2.14); however, the value of *Ro* proposed by Equation (2.15) was not necessarily accurate for larger values of *Ro*.



a. (Anderson 1942) **b. (Einstein and Chien 1954)**

Figure 2.7. Measured Rouse versus Calculated Rouse

To explain the deviation between Ro_c and Ro_m, studies have been performed to show how suspended sediment affects open channel flow velocity and sediment concentration profiles. Early studies focused on the effects of sediment laden flow on the velocity profile. More recent studies have focused on the effects that the suspended sediment profile has on *Ro*.

2.3.1 Effects of the Velocity Profiles

Vanoni (1946), Einstein and Chien (1955), Vanoni and Nomicos (1960), Elata and Ippen (1961), Wang and Qian (1989) and many others have studied the effects of the logarithmic velocity law in sediment laden flows. They all determined that the logarithmic law was valid and κ decreased with an increase in suspended sediment concentration. Coleman (1981), Barenblatt (1996) and others stated that the reason for this decrease was due to the wake layer, thus κ is independent of the suspended sediment concentration. Nouh (1989) conducted an experiment on the effects of κ in the presence of sediment for both straight and meandering channels. Nouh's experiment showed that the value of the κ was a function of both sediment and channel patterns.

Continuing his work on wake law, Coleman (1981; 1986) studied the effects of suspended sediment on κ and Π_W (wake strength coefficient) terms. He determined that κ remains the same in sediment laden flow as it did in clear water, but Π_W increases. This has been supported by experiments conducted by Parker and Coleman (1986) and Cioffi and Gallerano (1991). Table 2.1 provides a summary of the variation in Π_W coefficient for studies performed from 1981 to 1995, all studies assume κ equals 0.4.

Table 2.1. Summary of Different Wake Strengths

Author	Π_W (Wake Strength)	General Note
Coleman (1981)	0.19	Low sediment concentrations
Nezu and Rodi (1986)	0.0 to 0.20	
Kirkgoz (1989)	0.10	
Cardoso et al. (1989)	0.077	Over a smooth bed
Wang and Larsen (1994)	NA	High sediment concentrations
Kironoto and Graf (1995)	-0.08 to 0.15	Over a gravel bed

These data suggest that there is no universal wake strength. Thus, many scientists disagree with Coleman's findings. Lyn (1986; 1988) suggests that the effects of suspension occur near the river bed, causing κ to decrease. Therefore, the wake strength coefficient is independent of sediment. Kereseidze and Kutavaia (1995) suggest that both the κ and Π terms vary with sediment suspension.

Villarent and Trowbridge (1991) developed a procedure based on a model, which uses existing measurements of mean velocity and mean particle concentration from laboratory models and theoretical calculations. Their model is based on the wake function (Coles 1956), the concentration profile (Rouse 1937) and the effects of stratification (series of distinct layers). The measured data showed that stratification is associated with the velocity profile, not the concentration profile. Recently, Guo (1998; Guo and Julien 2001) performed a theoretical analysis on the turbulent velocity profile and the effect of sediment laden flow. His analysis showed a decrease in κ and an increase in Π_W, but the change was negligible. Therefore, the modified wake law for clear water can be used to model sediment laden flow, which is based on the effects of the outer boundary. A program has been developed based on the modified wake flow function that calculates the Π_W (Guo and Julien 2007).

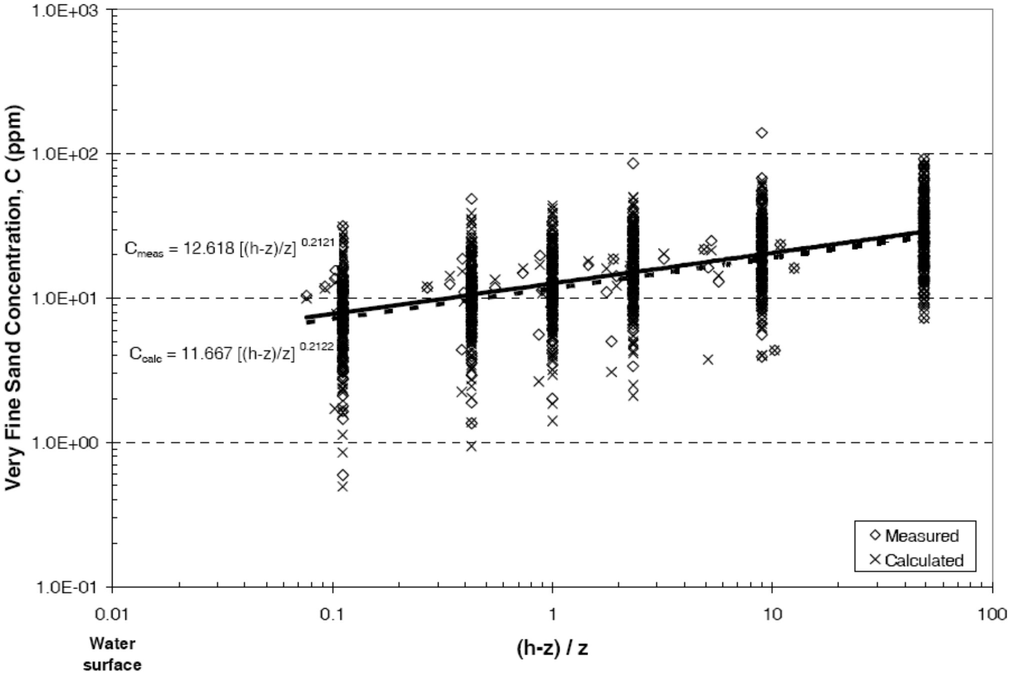
2.3.2 Variation Based on Particle Size

In 2002, Akalin looked at the effects that particle size had on the calculation of Ro. His study of the Mississippi River showed that the suspended sediment concentration would be underestimated if Ro_c is used versus Ro_m. In addition, his data indicated that as the particles coarsened the percent deviation between Ro_c and Ro_m varied significantly (refer to Table 2.2).

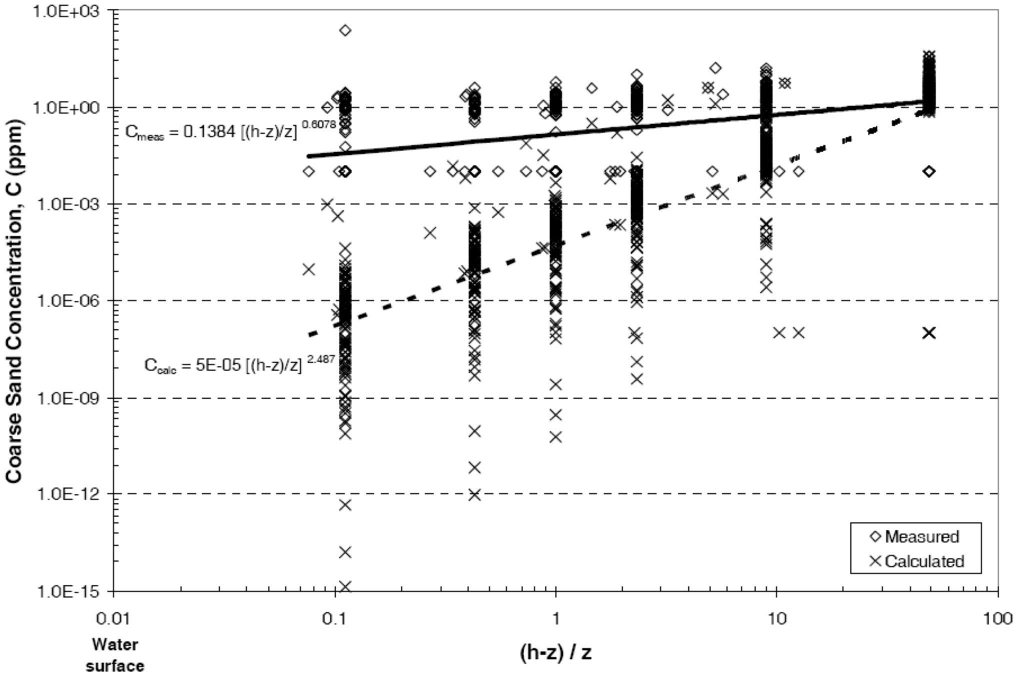
Table 2.2. Percent Deviation by Particle Size Fraction

Particles Size	Percent Deviation
Very Fine Sand	0.05%
Fine Sand	37%
Medium Sand	65%
Coarse Sand	76%

Figure 2.8 shows a comparison between the Ro_c and Ro_m. There is an underestimation of the concentration when Ro_c is used because the reference concentration is measured close to the bed.



a.) Very Fine Sand



d.) Coarse Sand

Figure 2.8. Measured and Calculated *Ro* for Different Sand Sizes (Akalin 2002)

Based on Akalin's study, it is clear that particle size has a significant effect on the deviation of *Ro*. However, he made no attempt to explain why this deviation occurred. This occurred because near the surface the coarser particles have a very low concentration, which can be hard to measure accurately. As a result there is a high deviation between the measured and calculated concentrations for large particles near the bed.

2.3.3 Effects of the Suspended Sediment Concentration Profiles

With the presence of sediment in the flow field, the effects of stratification can cause a variation in the idealized concentration profiles for different *Ro*, as shown in Figure 2.6. When density stratification is not present, the velocity profile and concentration profile follow Equations (2.8) and (2.14) respectively. Smith and McLean (1977) introduced the idea that the dampening of turbulence is based on density stratification. Over the years countless studies have been proposed on the effects that stratification has on the concentration and velocity profiles. A few of these studies are described below.

Chien (1954) studied the concentration profiles in flumes and natural channels. Chien determined that the Ro_m computed from the slope of the concentration profile was less than Ro_c determined using Equation (2.15), thus suggesting that the sediment diffusion coefficient (β) is greater than one. When β is greater than one there is a dominant influence by the centrifugal force. This is what allowed van Rijn (1984b) to develop Equation (2.19), which supports Chien's findings.

$$\beta = 1 + 2\left(\frac{\omega}{u_*}\right)^2 \quad \text{when } 0.1 < \frac{\omega}{u_*} < 1 \tag{2.19}$$

McLean (1991; 1992) looked at the effects of stratification on total load calculations and developed a methodology that iteratively solved the concentration and velocity profiles to determine the total load. This study states that stratification of sediment can lead to a reduction in the total sediment load calculated. Then, Herrmann and Madsen (2007) determined that the optimal values for α (ratio of neutral eddy diffusivity of mass to that of momentum; i.e., Schmidt number) and β (sediment diffusion coefficient). For stratified conditions α was 0.8 and β was 4, while for neutral conditions α was 1 and β was 0. Ghoshal and Mazumder (2006) also looked at the theoretical development of the mean velocity and concentration profile. They determined that the effects on sediment-induced stratification were caused by viscous and turbulent shear, which are functions of concentration. Wright and Parker (2004a; 2004b) developed a method to account for density stratification based on a simple semi-empirical model, which adjusts the velocity and concentration profiles. However, there is no consistent form that explains the deviation between Ro_m and Ro_c.

2.4 Sediment Transport Formulas

A wide variety of sediment transport formulas exist for the calculation of the sediment load. The equations developed have limited applicability due to the concepts surrounding their development. All of the existing equations can be classified as bed load, bed material load, suspended load or total load equations. There exists no completely theoretical solution to sediment transport.

2.4.1 Bed Load

In general the amount of bed load that is transported by sand bed rivers has been estimated to range from five to twenty-five percent of the total load. This number may seem insignificant, but the transport of sediment within the bed layer shapes the boundary and influences the stability of the river (Simons and Senturk 1992).

There are numerous equations for quantifying bed load; the following three equations are investigated in this study. The first equation is based on the tractive force relationship and was developed in 1879 by DuBoys (Vanoni 1975). Meyer-Peter and Műller (1948) developed a bed load formula based on the median sediment size (d_{50}), which has been found to be applicable in channels with large width to depth ratio. Wong and Parker (2006) corrected the MPM procedure by including an improved boundary roughness correction factor. Einstein (1942) developed a bed load equation based on the concept that particles in the bed are transported based on the laws of probability. All existing equations are based on steady flow and must be applied using engineering judgment. They estimated the maximum capacity of bed load a river can transport for a given flow condition.

2.4.2 Suspended Load

Fine particles are in suspension when the upward turbulent velocity fluctuation is greater than the downward ω. This section examines the relationship between the ratio of suspended to total sediment discharge (q_s/q_t) as a function of the ratio of shear velocity to fall velocity ($u_*/\omega = 2.5/Ro$). Studies performed by

Larsen, Bondurant, Madden, Copeland and Thomas, van Rijn, Julien, Dade and Friend, and Cheng are reviewed.

Laursen

Laursen (1958) developed a load relationship which accounts for total load (q_t) using data from numerous flume tests. The relationship includes three important criteria: 1) the ratio of shear velocity and fall velocity, 2) the ratio of tractive force to critical tractive force and 3) the ratio of the velocity of the particles moving as bed load to the fall velocity.

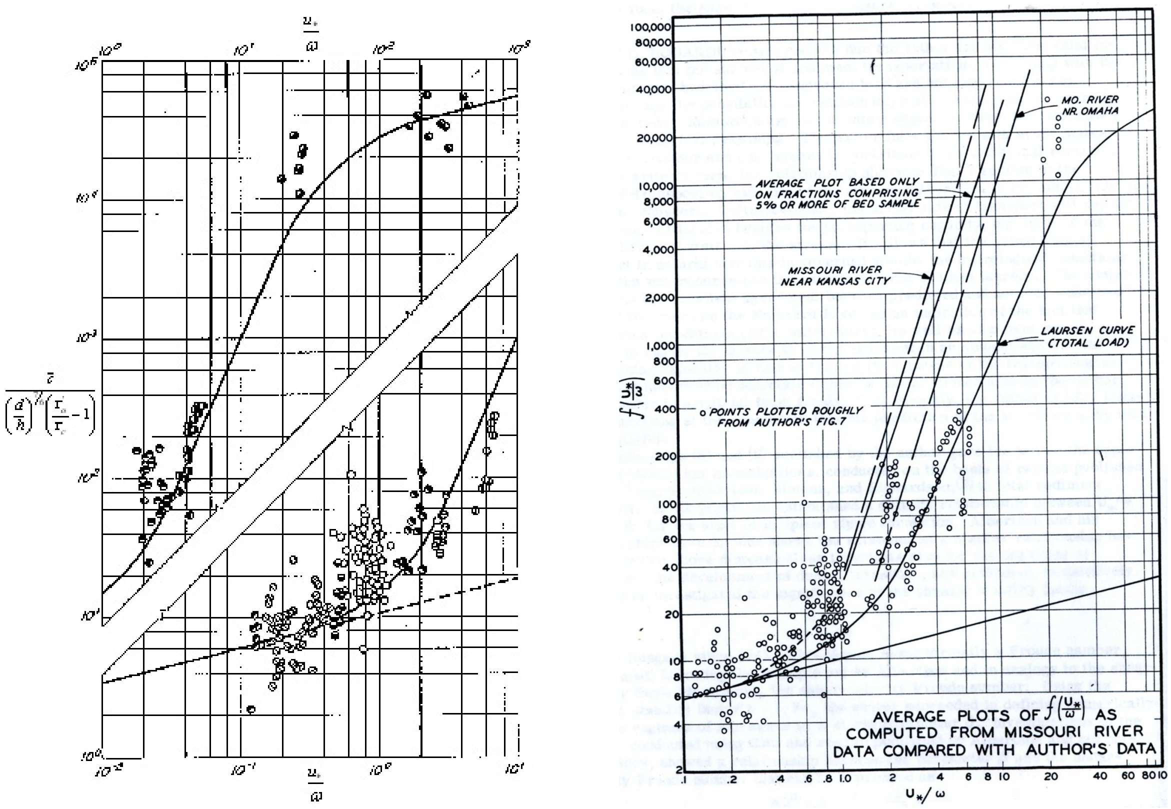
$$C_t = 0.01\gamma \sum_i^n i_b \left(\frac{d_i}{h} \right)^{7/6} \left(\frac{\tau_o'}{\tau_{ci}} - 1 \right) f \left(u_* / \omega_i \right) \tag{2.20}$$

Where,

C_t is total sediment concentration in weight by volume;
γ is the specific weight of fluid;
i_b fraction of material measured from the bed for the given bin;
d_i is the diameter of the sediment particle for the given bin in ft;
τ_o' is the grain boundary shear in lbs/ft^2;
τ_{ci} is the critical tractive force at beginning of motion for a given particle;
u_* is the shear velocity in ft/s; and
ω_i is the fall velocity of particle moving in the bed in ft/s.

Figure 2.9 provides a plot of the relationship described by (2.20. Laursen suggests that a single line can be used to describe the sediment load relationship. The figure shows the difference between bed sediment discharge and total sediment discharge transport and how as the value of u_*/ω increases, q_b becomes a small percentage of q_t.

Bondurant (1958) tested Laursen's findings using data from the Missouri River. His study showed that the data plotted considerably higher than Laursen's prediction. Thus Figure 2.9b contains a revision for larger rivers.



a (Laursen 1958) b (Bondurant 1958)

Figure 2.9. Sediment Discharge Relationship

Over the years, modifications have been proposed to the Laursen method. Copeland and Thomas (1989) modified the Laursen method by including the grain shear velocity(u_*') instead of the total shear velocity (u_*).

$$C_t = 0.01\gamma \sum_i^n i_b \left(\frac{d_i}{h}\right)^{7/6} \left(\frac{\tau_o'}{\tau_{c\,i}} - 1\right) f\left({u_*'}/{\omega_i}\right) \tag{2.21}$$

Where,

u_*' is the grain shear velocity

Madden (1993) modified the Laursen Procedure based on data from the Arkansas River accounting for Froude number (Fr).

$$C_t = 0.01\gamma \sum_i^n i_b \left(\frac{d_i}{h}\right)^{7/6} \left(\frac{\tau_o'}{\tau_{c\,i}} - 1\right) f\left(u_* \middle/ \omega_i\right) \left(\frac{0.1616}{Fr^{0.904}}\right) \tag{2.22}$$

Where,

Fr is the Froude number

Both studies resulted in the graph shifting similar to the Bondurant results. These studies suggest that Laursen's method will under-predict the total sediment concentration, therefore the modified formulations should be considered.

van Rijn

van Rijn (1984a; 1984b) developed an analysis looking at how u_*/ω varied q_s/q_t. This study is based on κ of 0.4 and a ratio of a/h equal to 0.5. The equation is developed based on a modification of the concentration profile (Equation (2.2)).

$$q_s = \frac{u_* c_a}{\kappa} \left[\frac{a}{h-a}\right]^{Ro} \left[\int_a^{0.5d} \left[\frac{h-y}{y}\right]^{Ro} Ln\left(\frac{y}{y_o}\right) dy + \int_{0.5d}^{d} e^{\left(4Ro\left(\frac{y}{h}-0.5\right)\right)} Ln\left(\frac{y}{y_o}\right) dy \right] \tag{2.23}$$

Equation (2.23) suggests that the concentration profile does not completely follow Rouse's formulation. The equation is further simplified as:

$$q_s = F\bar{u}hc_a \tag{2.24}$$

$$F = \frac{\left(\frac{a}{h}\right)^{Ro} - \left(\frac{a}{h}\right)^{1.2}}{\left(1-\frac{a}{h}\right)^{Ro}(1.2 - Ro)} \tag{2.25}$$

$$\frac{q_s}{q_t} = \frac{q_s}{q_b + q_s} = \frac{1}{1 + \frac{q_b}{q_s}} = \frac{1}{1 + \frac{1}{F}\frac{u_a a}{\bar{u}h}} \tag{2.26}$$

The simplification of F results in up to 25% inaccuracy in the sediment discharge estimation. Figure 2.10 provides a schematic representing Equation (2.26).

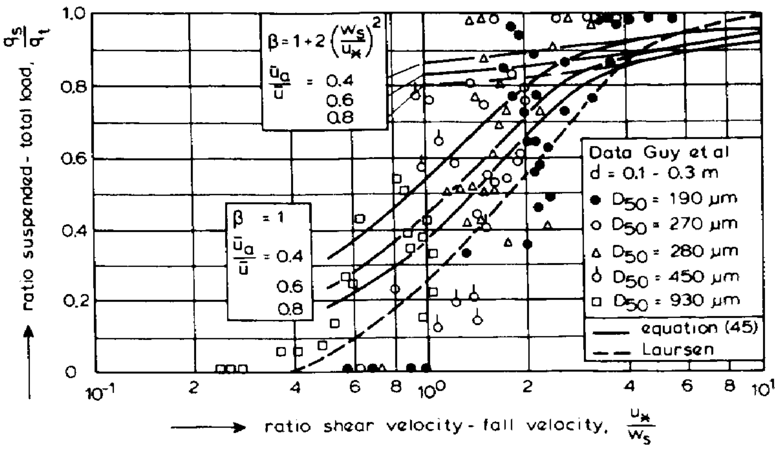


Figure 2.10. Ratio of Suspended to Total Sediment Discharge (van Rijn 1984b)

In addition, van Rijn recognized that the value of β was greater than 1. Thus, there are two sets of lines in Figure 2.10 to account for the variation in β. The data measured by Guy et al. (1966) have been plotted in the figure above, but it does not clearly show when to assume β is 1 versus greater than 1. This may be more significant when field data are used, since there is a higher degree of particle variability. The graph also shows that when the ratio of the average reference velocity ($\bar{v}_a$) to average channel velocity ($\bar{v}$) is small, the suspended sediment discharge is a greater percentage of the total sediment discharge.

Julien

After reviewing previous studies, Julien (1998) looked at the effects of relative submergence (h/d_s) has on q_s/q_t. By combining the concentration distribution (Equation (2.14)) and the velocity profile (Equation (2.9)), the following equation is developed:

$$q_s = \int_a^h c_a \left(\frac{h-y}{y} \frac{a}{h-a} \right)^{Ro} \frac{u_*}{\kappa} \ln\left(\frac{30.2y}{d_s} \right) dy \qquad (2.27)$$

Equation (2.27) can be further simplified as:

$$q_s = ac_a \frac{u_*}{\kappa} \frac{E^{Ro-1}}{(1-E)^{Ro}} \left\{ \ln\left(\frac{60}{E}\right) J_1 + J_2 \right\} \tag{2.28}$$

Where,

E is a/h;

$J_1 = \int_E^1 \left(\frac{1-y'}{y'} \right)^{Ro} dy'$;and

$J_2 = \int_E^1 \left(\frac{1-y'}{y'} \right)^{Ro} \ln(y') dy'$.

Based on studies performed by Einstein, the reference concentration and velocity were determined to be:

$$q_b = av_a c_a \tag{2.29}$$

$$v_a = 11.6 u_* \tag{2.30}$$

Where,

v_a is the reference velocity at $2d_s$ above the bed

Combining Equations (2.29) and (2.30) into Equation (2.28), Equation (2.31) is determined.

$$q_s = q_b \left\{ Ln\left(\frac{60}{E}\right) I_1 + I_2 \right\} \tag{2.31}$$

Where,

$I_1 = 0.216 \frac{E^{Ro-1}}{(1-E)^{Ro}} \int_E^1 \left(\frac{1-y'}{y'} \right)^{Ro} dy'$; and

$I_2 = 0.216 \frac{E^{Ro-1}}{(1-E)^{Ro}} \int_E^1 \left(\frac{1-y'}{y'} \right)^{Ro} Ln(y') dy'$

Equation (2.31) is the unit suspended sediment concentration based on the flow velocity and concentration profile within a river. The total unit sediment load can be determined based on the following equations.

$$q_t = q_b + q_s \tag{2.32}$$

Equation (2.33) provides the ratio of suspended to total sediment discharge.

$$\frac{q_s}{q_t} = \frac{\left\{ Ln\left(\frac{30h}{d_s}\right) I_1 + I_2 \right\}}{1 + \left\{ Ln\left(\frac{30h}{d_s}\right) I_1 + I_2 \right\}} \tag{2.33}$$

Julien (1998) assumed that $\beta = 1$ and $\kappa = 0.4$. Refer to Figure 2.11 to see how the relative submergence (h/d_s) varies based on q_s/q_t versus u_*/ω.

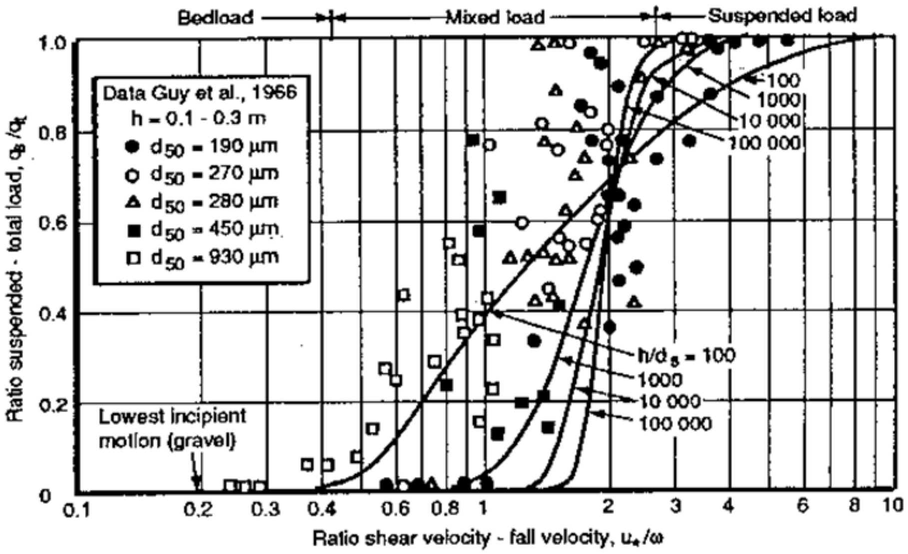


Figure 2.11. Ratio of Suspended to Total Sediment Discharge (Julien 1998)

Figure 2.11 shows that when the value of u_*/ω is equal to 2 the lines for h/d_s cross. There is no clear explanation why this occurred. This analysis also provides a good indication of the breaks in the mode of transport, which have been summarized in Table 2.3.

Table 2.3. Mode of Transport (Julien 1998)

u_*/ω	Rouse number (*Ro*)	q_s/q_t	Mode of Sediment Transport
<0.2	>12.5	0	No motion
0.2 to 0.4	6.25 to 12.5	0	Sediment Transported as bed load
0.4 to 2.5	1 to 6.25	0 to 0.8	Sediment Transported as mixed load
>2.5	<1	0.8 to 1.0	Sediment Transported as suspended sediment load

Dade and Friend

Dade and Friend (1998) performed an analysis to determine the relationship between channel morphology and grain size. They developed a relationship to determine the mode of transport based on the flux of sediment. Their findings, summarized in Table 2.4, are slightly different from Julien's findings.

Table 2.4. Mode of Transport (Dade and Friend 1998)

ω/u_*	q_s/q_t	Mode of Sediment Transport
≥3	<0.1	Sediment Transported as bed load
0.3 to 3	0.1 to 0.9	Sediment Transported as mixed load
≤0.3	>0.9	Sediment Transported as suspended sediment load

Using river data from various sources, they were able too show that slope and mode of transport were a function of relative grain size (d_s/h) (refer to Figure 2.12).

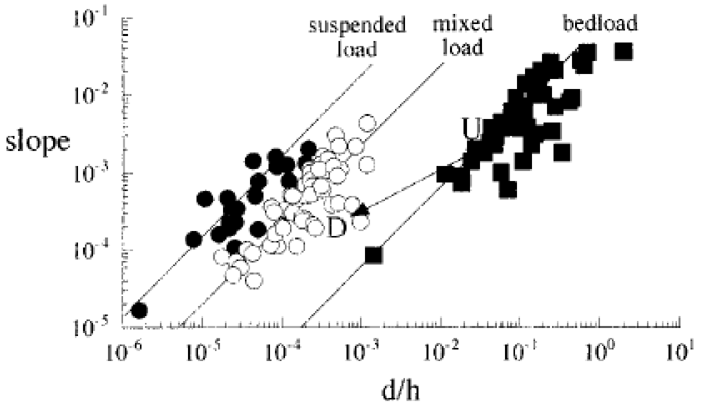


Figure 2.12. Channel Slope vs. Relative Grain Size (Dade and Friend 1998)

Cheng

Cheng (2008) developed a simple relationship between critical shear velocity (u_{c*}) and ω as a function of dimensionless grain diameter (d_*). The solution is based on probabilistic solution; refer to Equation (2.34) and Figure 2.13.

$$\frac{u_{*c}}{\omega} = 0.21\left[\left(\frac{41}{d_*}+0.76\right)^{\frac{1}{0.05}}+1\right]^{0.05} \tag{2.34}$$

Where,

u_{*c} is the critical shear velocity.

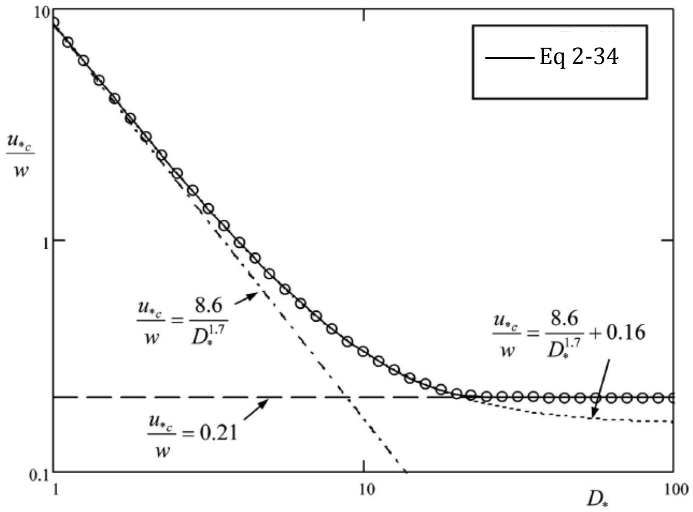


Figure 2.13.Threshold for Motion (Cheng 2008)

2.4.3 Total Load

The following section provides a summary of some equations developed to determine total load. The equations selected are based on the formulation of the Modified Einstein Procedure (MEP), which is the basis for this dissertation.

Einstein Procedure

Einstein's equation (1950) is based on the combination of a bed load equation and the concentration profile (Rouse equation) to represent the suspended sediment region. Einstein measured the bed material (sieve analysis) and a point suspended sediment sample at a distance $2d_s$ from the bed (transition point between the bed and the suspended sediment layers). Total load is calculated by taking the bed load transport and extrapolating to determine the suspended load. The functions used to develop the equation are based on the theory of turbulence, experiments, and engineering judgment. A second approximation was introduced to improve the suspended sediment theory (Einstein and Chien 1954). It is based on a necessary modification to Ro used as the exponent in the concentration profile to predict the suspended sediment concentration. Einstein and Chien used additional data sets to test this theory and suggested that the Ro_m is less than the Ro_c ((2.15). They recognized that there was need to improve the methods used to determine Ro. Their study indicated the need for more data prior to the development of a more accurate calculation. Einstein and Chien (1955) performed another study using a laboratory flume to understand the effects of heavy sediment concentration near the bed and how this affects the velocity profile and concentration distribution. They found a deviation from the initial equation developed and used by Einstein (1950). Einstein and Abdel-Aal (1972) developed a method to determine total load under high concentrations of sediment. They accomplished this by changing κ in the velocity profile and Ro. Einstein's procedure was groundbreaking for calculating total load within a river system, which led to the development of many other equations.

Derivatives of the Einstein Procedure

Laursen (1957; 1958) calculated the total load by assuming that the suspended sediment load was a factor of the bed load (0.01). This method deviates from Einstein's original method because it uses tractive force to explain whether the particles are in motion. Toffaleti (1968; 1969) looked at total load calculations based on rivers with high sediment concentrations near the bed. He deviates from Einstein's procedure by developing a velocity distribution based on the power function and by dividing the suspended sediment concentration profile into 3 distinct zones, which caused *Ro* to be variable within the concentration profile.

Modified Einstein Procedure

The Modified Einstein Procedure (MEP) was developed by Colby and Hembree in 1955. They wanted to determine an equation that could calculate the total load in the Niobrara River in Nebraska, which is a sand bed channel. They reviewed the Du Boys (1879), Schoklitsch (1930), Straub (1935) and Einstein (1950) formulas. None of the methods were consistent with the measurements made at the cross sections. Therefore, they developed a procedure based on the measured suspended sediment. The difference in their procedure was that a depth-integrated sampler was used to measure the suspended sediment concentration and a particle size distribution was determined for the bed through sieve analysis. *Ro* is determined by matching the total load determined based on the measured suspended sediment and the measured bed material. When the total load matches, *Ro* is known for the given bin. Next, a power equation is used to determine *Ro* for the remaining bins. Once this is done the load is calculated for each bin and they are summed to calculate the total load. Unlike many other equations, it does not give an equilibrium sediment load; it actually gives the total load at a given point and time based on the measurements. The research performed by Colby and Hembree in 1955 is used as a starting point for this research and is outlined in detail in Appendix A.

Over the years a few modifications have been suggested for MEP. Colby and Hubbell (1961) developed nomographs to simplify the calculations, which today can be easily programmed into a computer model. Table 2.5 summarizes the four nomographs that were developed by Colby and Hubbell.

Table 2.5. Summary of Developed Nomographs

Number	Description of Nomograph
1	Nomograph for computing $\sqrt{(RS)_m}$ and P_m
2	Nomograph for computing $i_b Q_b$
3	Nomograph for computing the Rouse number from $\frac{Q_s^{'}}{i_B \; Q_b} = \frac{I_1}{J_1}\left(P_m J_1^{'} + J_2^{'}\right)$
4	Nomograph for computing the total load from $Q_{si}' \frac{P_m J_1 + J_2}{P_m J_1' + J_2'}$

* Refer to Colby and Hubbell 1961 for these nomographs.

Lara (1966) noticed that the approach for calculation of *Ro* determined by Colby and Hembree (Step C, Appendix A) was subjective and could result in many different answers based on the bin used. Therefore, Lara introduced a least squares regression to determine the *Ro*. The regression analysis requires a minimum of two, or preferably three, overlapping bins (particle size classes) to determine an exponential relationship between *Ro* and ω. Equation (2.35) provides an example of the power function. Lara determined that the exponent was not always 0.7.

$$Ro = C_1(\omega)^{C_2} \tag{2.35}$$

Where,

C_1 and C_2 are constants determined from the regression analysis.

Burkham and Dawdy (1980) worked together and performed a general study of MEP in an attempt to develop a reliable method for measuring and computing sediment discharge. Their study resulted in 3 main deviations from the current procedure. First they determined a direct relationship between Φ_* (bed load transport function) and Ψ_* (bed load intensity function). In addition, they defined the roughness coefficient (k_s) as $5.5*d_{65}$. Lastly, their study also showed that the calculated u_* had a tendency to be higher and the Einstein correction factor (χ) had a tendency to be lower than the values determined by Colby and Hembree. Their studies focused on sand bed channels and they did not consider bedforms. This method is referred to as the Revised Modified Einstein Method.

Finally, the Remodified Einstein Procedure was developed to determine an even more accurate calculation of total sediment transport rates from the flow and suspended sediment measurement based on MEP (Shen and Hung 1983). They introduced an optimization technique to adjust the measured i_s (fraction of sampled suspended sediment for a given bin) and i_b (fraction of material measured from the bed for a given bin), so that the calculated suspended sediment loads in the sampled zone are a closer match to the measured suspended sediment load in the sample zone. They also include Lara's finding in their procedure. Over the years, computer programs have been developed to perform these calculations, but there are still many questions which have not been answered.

2.5 Current Programs

To provide consistency in calculations using MEP, computer programs have been developed to aid in the calculation of bed load, bed material load and total load. The programs have been developed and are supported by numerous agencies.

MODIN was developed at the US Geological Survey (USGS) (Stevens 1985). This program computes total sediment discharge at a given cross section for a sand bed alluvial stream based on measured hydraulic variables, measured suspended sediment concentration and particle-size distributions of the measured suspended sediment and bed material. The program is based on the procedure developed by Hubbell and Matejka (1959). The program requires the user to enter the measured/calculated *Ro*. Then, based on the given data, the program performs a best fit to the computed *Ro* value and returns a total load calculation. The program contains a polynomial approximation of the nomographs used in MEP.

Zaghloul and Khondaker (1985) developed a computer program to calculate total load based on MEP. Their procedure uses A Programming Language (APL) to convert the standard polynomials into equations that can be implemented.

The US Bureau of Reclamation (USBR) developed BORAMEP to calculate total load (Holmquist-Johnson and Raff 2006). It does not require the user to make engineering judgment on the calculation of *Ro*. It uses the method outlined by the USBR (1955; 1955 revised) and Lara (1966) to determine *Ro* for each bin.

Shah (2006) performed a detailed analysis of BORAMEP. There were three main errors that were observed in the analysis. First, when particles in the measured zone were not found in the bed, a total load could not be determined because a *Ro* could not be evaluated since a minimum of two bins are required. Next, when overlapping bins exist, a regression analysis is performed to determine *Ro* for the remaining bins, but a negative exponent is generated based on the data. The program stopped calculating total load because a negative exponent would result in a larger *Ro* for fine particles and a smaller *Ro* for coarser particles, which is not valid. Finally, on occasion the suspended sediment load was greater than the total load because in performing total load calculations based on the estimation of the *Ro*, the program underestimates the total load. Therefore, the goal of this study is to revisit MEP and develop improvements that will aid in the overall total load calculation.

Due to the complexity of the integral used in the Einstein Procedure and MEP to calculate suspended sediment load, many sediment load programs do not include these two procedures. The computation of the Einstein Integrals in closed form is not possible. An analytical expansion of the Einstein Integrals has been developed by Guo and Julien (2004). This has not been implemented into a program at this time, but it has been tested and matches with the curves presented by Einstein. Equations (2.36) to (2.41) summarize how the Einstein Integrals are solved by the series expansion approach.

$$J_1(Ro) = \int_E^1 \left(\frac{1-y'}{y'}\right)^{Ro} dy' = \int_0^1 \left(\frac{1-y'}{y'}\right)^{Ro} dy' - \int_0^E \left(\frac{1-y'}{y'}\right)^{Ro} dy' \tag{2.36}$$

$$J_1(Ro) = \frac{Ro\pi}{\sin Ro\pi} - F_1(Ro) \tag{2.37}$$

$$F_1(Ro) = \left\{\frac{(1-E)^{Ro}}{E^{Ro-1}} - Ro\sum_{k=1}^{\infty} \frac{(-1)^k}{Ro-k}\left(\frac{E}{1-E}\right)^{k-Ro}\right\} \tag{2.38}$$

$$J_2(Ro) = \int_E^1 \ln y' \left(\frac{1-y'}{y'}\right)^{Ro} dy' = \int_0^1 \ln y' \left(\frac{1-y'}{y'}\right)^{Ro} dy' - \int_0^E \ln y' \left(\frac{1-y'}{y'}\right)^{Ro} dy' \tag{2.39}$$

$$J_2(Ro) = \frac{Ro\pi}{\sin Ro\pi}\left\{\pi \cot Ro\pi - 1 - \frac{1}{Ro} + \sum_{k=1}^{\infty}\left(\frac{1}{k} - \frac{1}{Ro-k}\right)\right\} - F_2(Ro) \tag{2.40}$$

$$F_2(Ro) = \left\{F_1(Ro)\left(\ln E + \frac{1}{Ro-1}\right) + Ro\sum_{k=1}^{\infty} \frac{(-1)^k F_1(Ro-k)}{(Ro-k)(Ro-k-1)}\right\} \tag{2.41}$$

Where,

E is equal to *a/h;*
y' is equal to *y/h; and*
k is equal to 1 for the initial point for performing a summation.

Appendix B contains the procedure developed by Guo to solve the Einstein Integrals. The procedure has the following limitations: the range of E is from 0.1 to 0.0001 and the range of *Ro* is from 0 to 6.

2.6 Statistical Analysis

Statistical tools are used to describe how data behave. These statistical parameters provide a goodness of fit between the computed and measured data. Table 2.6 summarizes the statistical parameters used to analyze the data (Lin 1989; Ott and Longnecker 2001).

Table 2.6. Statistical Parameters

Function Name	Abbreviation	Equation	Equation Number
Coefficient of Determination	R^2	$\left(\frac{\sum_{i=1}^{n}\left(X_i-\bar{X}\right)\left(Y_i-\bar{Y}\right)}{\sqrt{\sum_{i=1}^{n}\left(X_i-\bar{X}\right)^2\sum_{i=1}^{n}\left(Y_i-\bar{Y}\right)^2}}\right)^2$	(2.42)
Concordance Correlation Coefficient (How data fits to a 45° line)	ρ_c	$\frac{2s_{xy}}{s_x^2+s_x^2+\left(\bar{X}-\bar{Y}\right)^2}$	(2.43)
Mean Square Error	MSE	$\frac{\sum_{i=1}^{n}\left(X_i-Y_i\right)^2}{n}$	(2.44)
Root Mean Square Error	RMSE	$\sqrt{\frac{\sum_{i=1}^{n}\left(X_i-Y_i\right)^2}{n}}$	(2.45)
Normal Root Mean Square Error	NRMSE	$\frac{\sqrt{\frac{\sum_{i=1}^{n}\left(X_i-Y_i\right)^2}{n}}}{Y_{\max}-Y_{\min}}$	(2.46)
Mean Error	ME	$\frac{\sum_{i=1}^{n}\left(X_i-Y_i\right)}{n}$	(2.47)
Mean Percent Error	MPE	$100*\frac{\sum_{i=1}^{n}\frac{\left(X_i-Y_i\right)}{X_i}}{n}$	(2.48)
Mean Absolute Percent Error	MAPE	$100*\frac{\sum_{i=1}^{n}\frac{abs\left(X_i-Y_i\right)}{X_i}}{n}$	(2.49

Where,

X_i is the measured load;
s_{xy} is the covariance;
s_x^2 and s_y^2 are the variances;
Y_i is the calculated load;
Y_{avg} is the average calculated load;
Y_{max} is the maximum calculated load;
Y_{min} is the minimum calculated load; and
n is the number of samples.

The values of these statistical parameters vary. The calculated and measured data are in good agreement if the coefficient of determination and concordance correlation coefficient are close to one. However, the values of the other statistical parameters need to be close to zero for a good agreement.

Chapter 3: Available Data

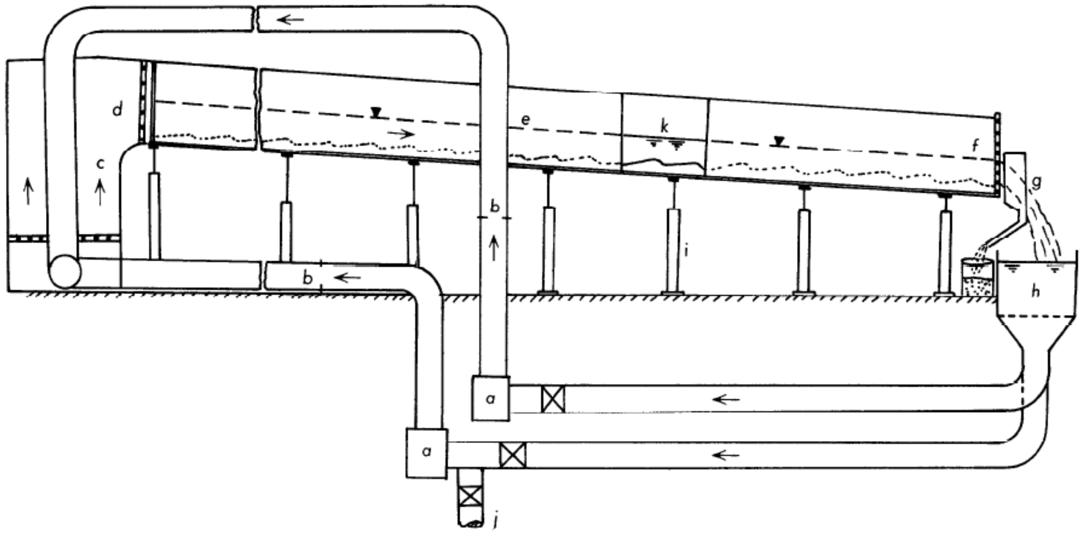
Thorough research was conducted to obtain data for this study. Both laboratory and field data have been obtained from the following sources: refereed journal publications, US Geological Survey publications, US Army Corp of Engineers publications, and various dissertations. Appendix C contains a review of all data initially obtained for this analysis. This chapter provides a summary of only the data used as part of this dissertation.

3.1 Laboratory Data

3.1.1 Total Load Data Set

Guy, Simons and Richardson – Alluvial Channel Data from Flume Experiments

From 1956 to 1961 Simons and Richardson performed studies on a two foot and an eight foot wide, 150 foot long flume to determine the flow resistances and sediment transport rates. They conducted 339 equilibrium runs in the re-circulating flumes. The study was conducted at Colorado State University in Fort Collins, Colorado. The discharge varied between 0 and 22 cfs. The channel slope varied from 0 to 0.015. The following data were collected or calculated: water discharge, flow depth, average velocity, water surface slope, suspended sediment concentration and gradation, total sediment concentration and gradation and bed configuration. The primary purpose of their study was to collect and summarize hydraulic and sediment data for other researchers (Guy et al. 1966). The data can be categorized based on bed forms and particle sizes for analysis purposes. Figure 3.1 provides a schematic of the 8 foot flume used to obtain samples.



a. pumping units; b. orifices; c. headbox and diffuser; d. baffles and screens; e. Flume (8 by 2 by 150); f. tailgate; g. total-load sampler; h. tail box; i. jack supporting flume; j. connection to storage sump; k. transparent viewing window

Figure 3.1. Flume Set-up at Colorado State University (after Simons et al. 1961)

3.1.2 Point Velocity and Concentration

Coleman – Velocity Profiles and Suspended Sediment

Coleman (1981; 1986) performed flume studies to develop a better understanding of the influence of suspended sediment on the velocity profile. A Plexiglas flume 356 millimeters (1.2 feet) wide by 15 meters (49 feet) long was used in the experiments. The bed slope was adjusted to ensure uniform flow conditions within the flume. A total of 40 runs were conducted with three distinct sand sizes (0.105, 0.210 and 0.420 mm). The following data were obtained: water discharge, total flow depth, energy grade line, water temperature, boundary layer thickness, velocity distribution and a suspended sediment concentration distribution.

3.2 Field Data

3.2.1 Total Load (Depth Integrated and Helley-Smith Sampler)

93 US Streams

Williams and Rosgen (1989) summarized measured total sediment discharge data from 93 US streams. Only 10 rivers were selected for testing based on the completeness of the data set. A total of 256 data sets were tested on the following rivers: Susitna River near Talkeetna, Alaska; Chulitna River below Canyon near Talkeetna, Alaska; Susitna River near Sunshine, Alaska; Snake River near Anatone, Washington; Toutle River at Tower Road near Sliver Lake, Washington; North Fork Toutle River, Washington; Clearwater River, Idaho; Mad Creek Site 1 near Empire, Colorado; Craig Creek near Bailey, Colorado; North Fork of South Platte River at Buffalo Creek, Colorado. The following data were obtained: discharge, mean flow velocity, top width, mean flow depth, water surface slope, water temperature, suspended sediment discharge (measured using depth integrated sampler), bed sediment discharge (measured using a Helley-Smith sampler), particle size distribution of suspended sediment, bed sediment discharge and bed material. The three rivers from Colorado did not include suspended sediment particle size distribution due to low measured concentration.

Idaho River Data

The Boise Adjudication Team of Idaho (RMRS 2008) developed a website that summarized the following river data: bed sediment discharge, suspended sediment discharge, particle size distribution of surface material, channel geometry, cross section, longitudinal profile and discharge data. Particle size distribution is provided for the bed sediment discharge but not for the suspended sediment discharge. The following sites were used to determine if measuring data from a Helley-Smith will give good results for determining total sediment discharge: Big Wood River; Blackmare Creek; Boise River; Cat Spur Creek; Dollar Creek; Eggers Creek; Fourth of July Creek; Hawley Creek; Herd Creek; Johns Creek; Johnson Creek; Little Buckhorn Creek; Little Slate Creek; Lochsa River; Lolo Creek; Main Fork Red River; Marsh Creek; Middle Fork Salmon River; North Fork Clearwater River; Rapid River; Salmon River below Yankee Fork; Salmon River near Obsidian; Salmon River near Shoup; Selway River; South Fork Payette River; South Fork Red River; South Fork Salmon River; Squaw Creek (USFS); Squaw Creek (USGS); Thompson Creek; Trapper Creek; Valley Creek; West Fork Buckhorn Creek.

South Platte, North Platte and Platte Rivers in Colorado and Nebraska

Data on the South Platte, North Platte and Platte Rivers were collected in 1979 and 1980. The data are summarized by Kircher (1981). The following data were collected: discharge, width, mean depth, mean velocity, area, temperature, suspended sediment concentration (integrated depth sampler), bed sediment discharge rate (Helley–Smith sampler), and particle size distribution of suspended sediment, bed sediment discharge and bed material. There were 50 samples taken in 1979 to 1980, but only 17 samples were tested based on the completeness of the results. Figure 3.2 shows the location of the South Platte, North Platte and Platte Rivers.

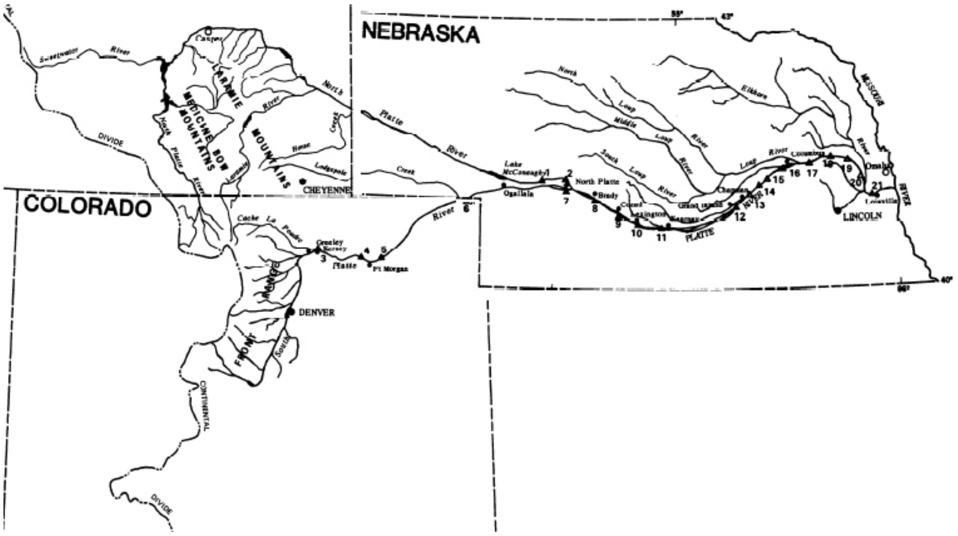


Figure 3.2. South Platte, North Platte and Platte Rivers (after Kircher 1981)

3.2.2 Total Load (Depth Integrated at Contracted Section)

Colby and Hembree – Niobrara River, near Cody Nebraska

Field data on the Niobrara River located near Cody, Nebraska were collected from April 1948 to September 1953 (Colby and Hembree 1955). Data were collected by the US Geological Survey (USGS). The study to determine total sediment discharge in the Niobrara River was conducted jointly by the USGS and the USBR. The following data were collected to aid with the development of MEP: water discharge, water surface slope, cross sectional area, channel width, flow depth, water temperature, mean velocity, point velocity measurements, point sediment concentration and particle gradation, depth-integrated sediment concentration and particle gradation and bed gradation. Total sediment discharge was measured at the contracted section where the sediment is in complete suspension. Figure 3.3 is a site map of the Niobrara River in Nebraska.

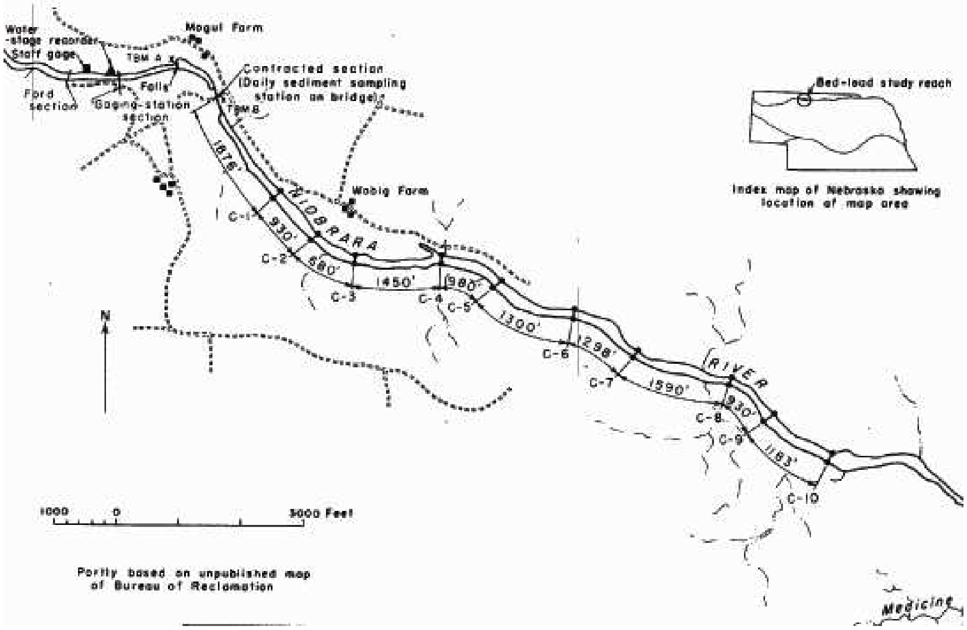


Figure 3.3. Niobrara River (Colby and Hembree 1955)

3.2.3 Point Velocity and Concentration Data

Anderson - Enoree River, South Carolina

The Sediment Division of the Soil Conservation Service collected data on the Enoree River in South Carolina to determine the relationship between the Ro_m and Ro_c (Anderson 1942). The following data were collected: flow depth, channel width, bed slope, water temperature, point velocity measurements, point suspended sediment measurements and particle gradation. On average, the flow depth of the Enoree River is between 3 and 5 feet. Figure 3.4 is a site map of the Enoree River and site picture of the sediment sampling station.

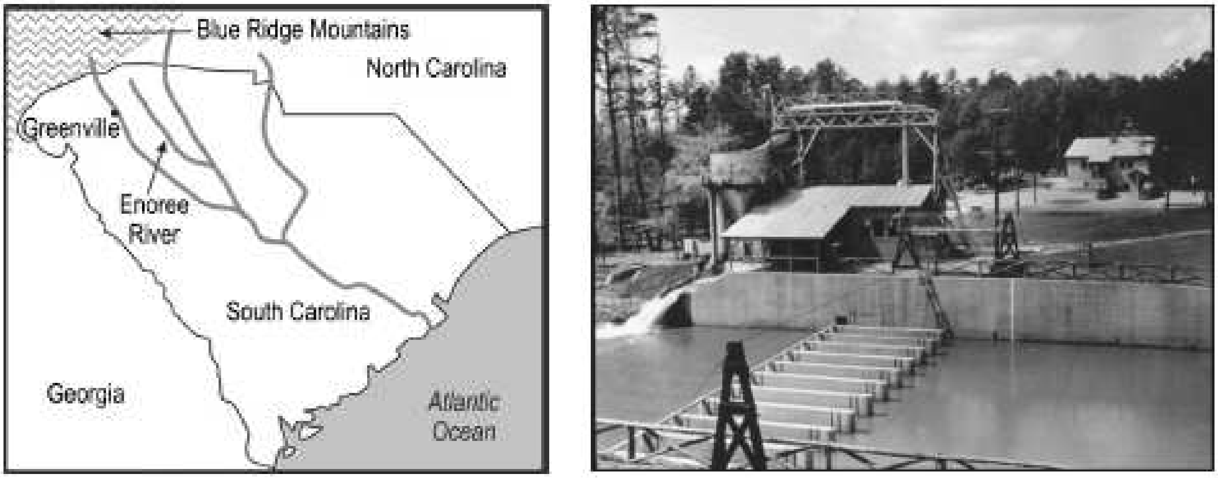


Figure 3.4. Enoree River Map and Sampling Location (after Ettema and Mutel 2006)

<u>Nordin – Middle Rio Grande, New Mexico</u>

In the 1960's, three studies were performed on the Middle Rio Grande (Nordin and Dempster 1963; Nordin 1964; Nordin and Beverage 1965). The reports contain data from the 1950's and 1960's. The suspended sediment transported by the Middle Rio Grande consists of silts, sands and fine gravel. The following data were obtained: water discharge, flow depth, mean velocity, water temperature, point velocity measurements, point concentration and particle gradation, depth-integrated concentration and particle gradation and bed gradation. Some of the data were supplemented by surface water quality data of the United States (Love 1959; 1960; 1961; 1963). The average flow depth was approximately 3 feet. The site used contains data from Bernalillo, Figure 3.5.

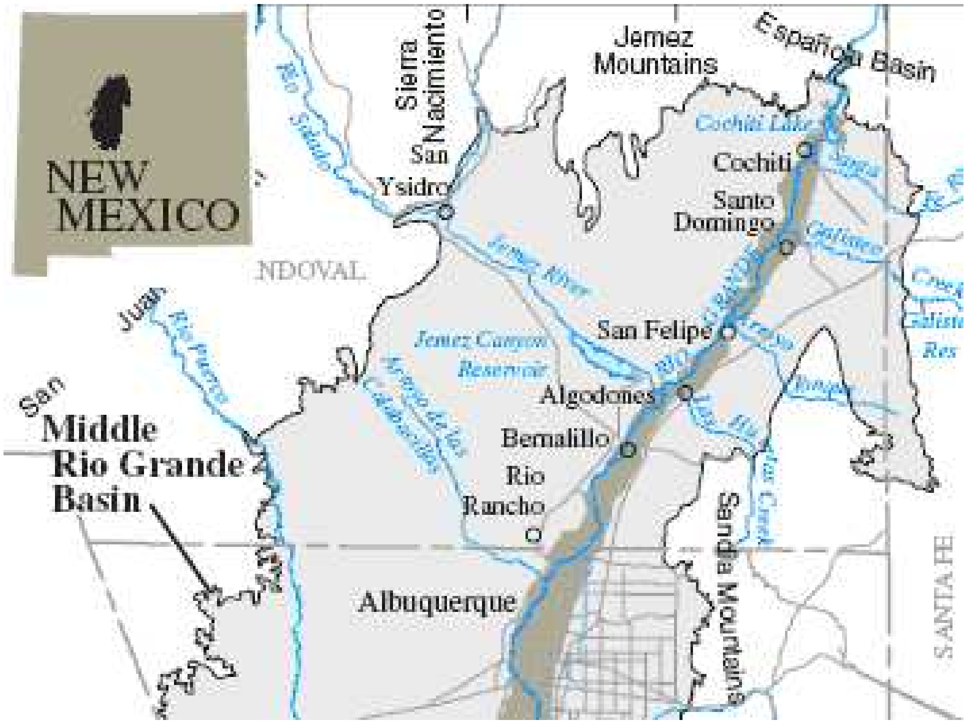


Figure 3.5. Middle Rio Grande (Bartolino and Cole 2002)

Mississippi River

The Mississippi River is the longest river in the United States. It is the source of water for millions of people in many different states. There has been a substantial amount of data collected on the Mississippi River over the years. In the 1990's, efforts were made by the US Army Corp of Engineers to collect additional information. The data have been summarized by Akalin (2002). The following data were collected: water discharge, bed slope, point velocity measurements, point-integrated sediment concentration and particle gradation. Figure 3.6 is a map of the 4 sites (Union Point, Line 13, Line 6 and Tarbert Landing) on the Mississippi where point data have been collected.

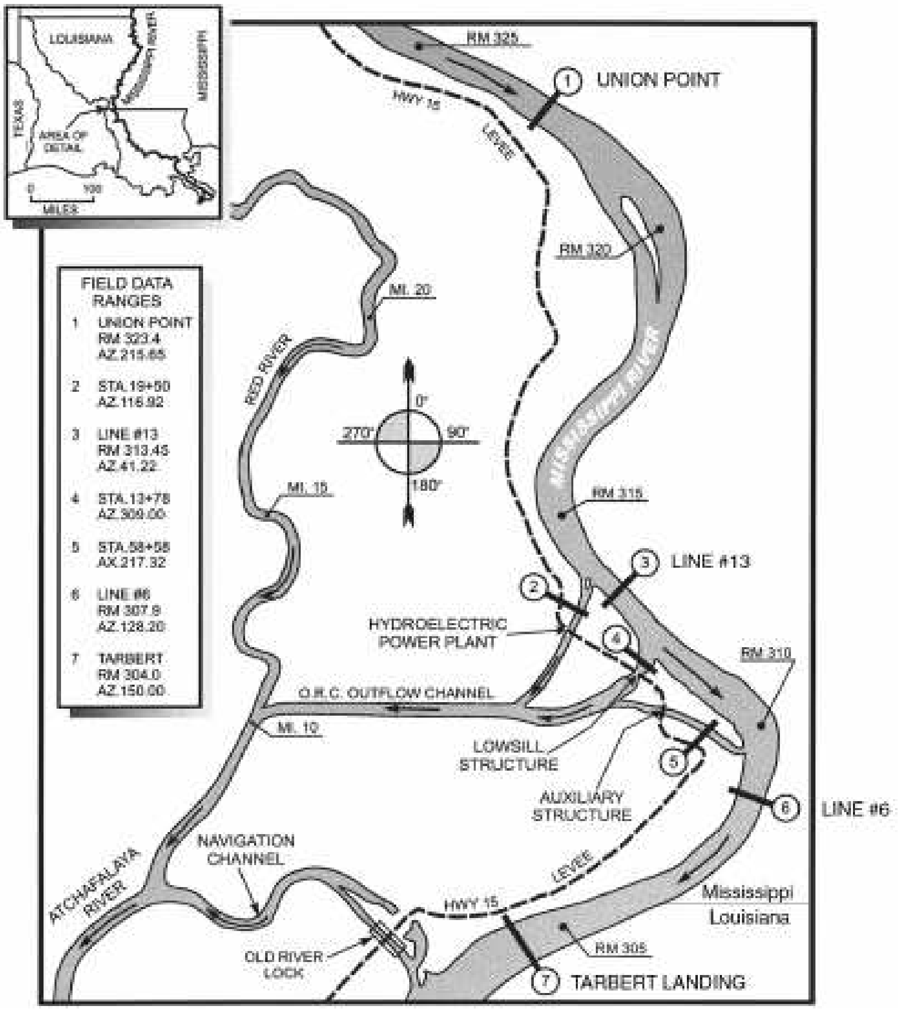


Figure 3.6. Mississippi River and Location of the Sampling Sites (Akalin 2002)

Chapter 4: Theory and Proposed Methodology

The Modified Einstein Procedure (MEP) calculates total sediment discharge based on the relationship between the material in the bed and the material measured in suspension. In order to understand MEP, a review was performed on some of the different modes of transport (bed sediment discharge, suspended sediment discharge, measured sediment discharge and total sediment discharge). This section provides detailed derivation of the proposed procedure, which has been coded into Visual Basic Applications (VBA). The proposed procedure is called the Series Expansion of the Modified Einstein Procedure (SEMEP)

4.1 Suspended Sediment

Sediment is found in suspension when the upward turbulent velocity is greater than ω. In order to quantify suspended sediment, the logarithmic velocity law (Equation (2.8)) and the concentration profile (Equation (2.14)) are inserted into Equation (4.1), resulting in Equation (4.2).

$$q_s = \int_a^h cv\,dy \tag{4.1}$$

$$q_s = \int_a^h c_a \left(\frac{h-y}{y} \frac{a}{h-a} \right)^{Ro} \frac{u_*}{\kappa} \ln\left(\frac{30y}{d_{65}} \right) dy \tag{4.2}$$

Where,

d_{65} is the particle size found in the bed associated with material finer than 65% and is the thickness of the roughness layer used by Einstein.

Einstein performed laboratory experiments to relate unit bed sediment discharge (q_b) to the reference concentration (c_a). Equation (4.3) is the results of his experiments.

$$c_a = \frac{q_b}{u_a a} = \frac{q_b}{11.6 u_* a} \tag{4.3}$$

When Equation (4.3) is inserted into Equation (4.2), u_* cancels out and Equation (4.4) is formed.

$$q_s = 0.213 q_b \frac{E^{Ro-1}}{(1-E)^{Ro}} \int_E^1 \left(\frac{1-y'}{y'} \right)^{Ro} \ln\left(\frac{60y'}{E} \right) dy' \tag{4.4}$$

The Einstein Integrals cannot be solved explicitly; therefore, a numerical analysis is needed. The trapezoidal rule is used to solve these integrals. Equations (4.5) to (4.7) outline the mathematical procedure.

$$f(y') = \left(\frac{1-y'}{y'} \right)^{Ro} \ln\left(\frac{60y'}{E} \right) \tag{4.5}$$

$$q_s = 0.216 q_b \frac{E^{Ro-1}}{(1-E)^{Ro}} \sum \left(f(i) + \frac{f(i-1) - f(i)}{2} \Delta y \right) \tag{4.6}$$

$$q_t = q_b + 0.216 q_b \frac{E^{Ro-1}}{(1-E)^{Ro}} \sum \left(f(i) + \frac{f(i-1) - f(i)}{2} \Delta y \right) \tag{4.7}$$

Where,

n is the number of slices.

To calculate the value of q_s/q_t accurately using the trapezoidal rule, numerous slices are needed to provide accuracy.

Guo and Julien (2004) developed an efficient series expansion algorithm to solve the Einstein Integrals. Their solution for computing the Einstein Integrals is both accurate and rapid compared to the trapezoidal rule. The algorithm is used to determine the value of J_1 and J_2 in the following equations.

$$q_s = 0.216 q_b \frac{E^{Ro-1}}{(1-E)^{Ro}} \left\{ \ln\left(\frac{60}{E}\right) J_1 + J_2 \right\} \tag{4.8}$$

$$q_t = q_b + 0.216 q_b \frac{E^{Ro-1}}{(1-E)^{Ro}} \left\{ \ln\left(\frac{60}{E}\right) J_1 + J_2 \right\} \tag{4.9}$$

Where

$$J_1 = \int_E^1 \left(\frac{1-y'}{y'}\right)^{Ro} dy'\,;$$

$$J_2 = \int_E^1 \ln y' \left(\frac{1-y'}{y'}\right)^{Ro} dy'\,; and$$

E is $2d_s/h$.

A paper describing the series expansion can be found in Appendix B.

The values of J_1 and J_2 from the trapezoidal rule are compared to the series expansion. When solving the Einstein Integrals using the trapezoidal rule, the slices are divided as follows:

$$J_1 = \int_E^{10E} \left(\frac{1-y'}{y'}\right)^{Ro} dy' + \int_{10E}^{1} \left(\frac{1-y'}{y'}\right)^{Ro} dy' \tag{4.10}$$

$$J_2 = \int_E^{10E} \ln y' \left(\frac{1-y'}{y'}\right)^{Ro} dy' + \int_{10E}^{1} \ln y' \left(\frac{1-y'}{y'}\right)^{Ro} dy' \tag{4.11}$$

The values of J_1 and J_2 are summarized in Table 4.1 and Figure 4.1.

Table 4.1. Numerical Values of the Einstein Integrals

Rouse Number	Trapezoidal Rule - Number of Slices						Series Expansion	
	100		1,000		10,000			
	J_1	J_2	J_1	J_2	J_1	J_2	J_1	J_2
6	9.2E+17	-7.7E+18	6.5E+17	-5.4E+18	6.3E+17	-5.2E+18	6.2E+17	-5.2E+18
1	1.4E+01	-7.5E+01	8.0E+00	-3.9E+01	7.6E+00	-3.6E+01	7.5E+00	-3.5E+01
0.5	1.8E+00	-5.1E+00	1.6E+00	-3.6E+00	1.5E+00	-3.5E+00	1.5E+00	-3.4E+00
0.25	1.2E+00	-2.0E+00	1.1E+00	-1.7E+00	1.1E+00	-1.7E+00	1.1E+00	-1.7E+00

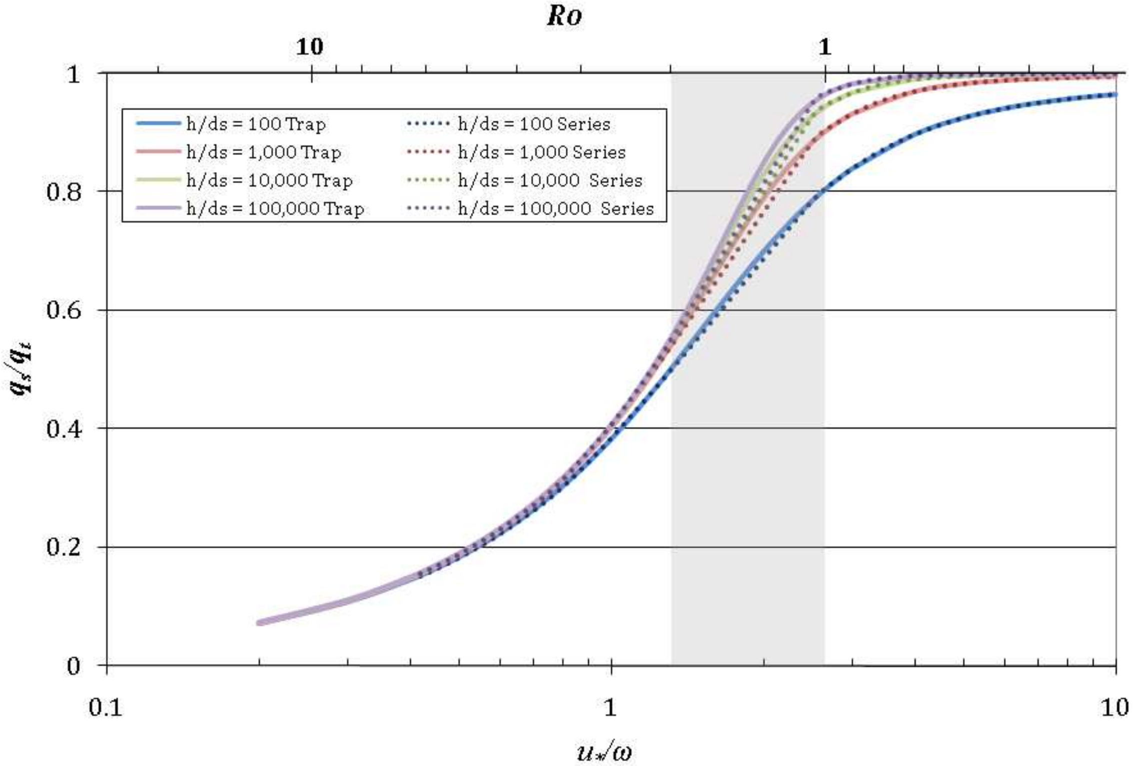


Figure 4.1. Comparison between the Trapezoidal and Series Expansion

The comparison between the trapezoidal rule and series expansion for the Einstein integrals show that approximately 10,000 slices are needed for the trapezoidal rule to have similar results to the series expansion. Also, there is a discrepancy between the trapezoidal rule and series expansion when u_*/ω is between 1.25 and 2.5. This occurs because addition slices are necessary for the range of u_*/ω due to the rapid variation in q_s/q_t value. In addition, the trapezoidal rule takes more time for calculation. There are limitations to the series expansion program developed by Guo. The value of relative submergence (h/d_s) must be greater than 20 and Ro must be less than 6. Therefore, the trapezoidal rule will be used under certain circumstances.

SEMEP incorporates the series expansion algorithm and Figure 4.2 provides a flow chart. Refer to Appendix D for detailed computer code.

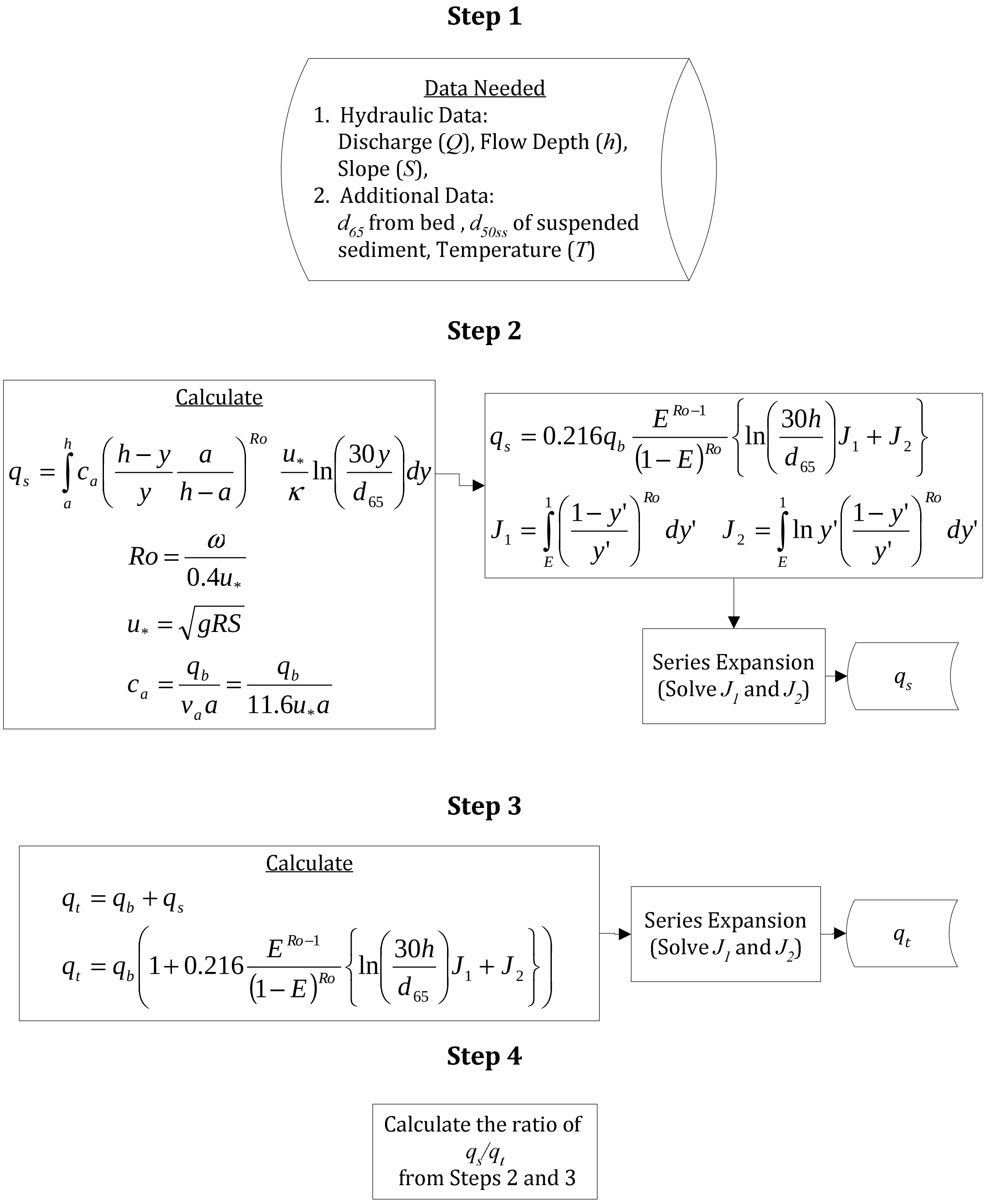


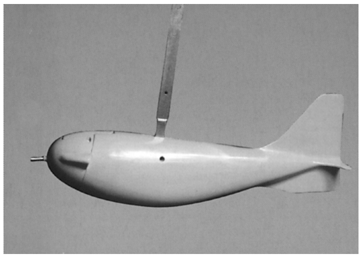
Figure 4.2. Flow Chart Describing Calculation of q_s/q_t Using SEMEP

4.2 Measured Load

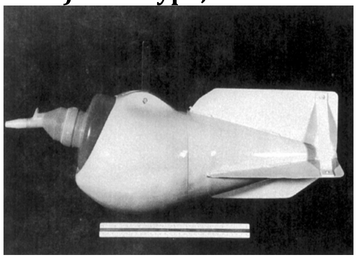
The transport of sediment in a river environment is sampled as particles (bed load sampler) or as a water-sediment mixture (suspended sediment sampler). The suspended sediment discharge can be measured using a point sampler or a depth-integrated sampler. The bed load per unit time is sampled using a Helley-Smith sampler, which has a tendency to measure the bed sediment discharge and a portion of the suspended sediment discharge.

4.2.1 Suspended Sediment Sampler

There are two types of samplers that measure the concentration in suspension. A depth-integrated sampler continuously extracts a water-sediment sample into a container isokinetically, which means that water-sediment is entering the nozzle at a rate equal to the velocity of the stream. The sampler is lowered from the water surface to the streambed and returned back to the surface (Edwards and Glysson 1999). Figure 4.3 shows different depth-integrated samplers.



b) Reel Type, US D-74



a) Wading Type, US DH-48 **c) Suspended Type- US D-77** **d) USGS Frame-Bag Sampler**

Figure 4.3. Depth Integrated Samplers (Rickly Hydrological Company 1997-2007)

The second type of sampler is a point sampler. It is used to determine the concentration at a given depth in the stream over a given time interval. An electronic or manual control allows the user to open and close the sampler valve (Edwards and Glysson 1999). A point sampler is useful in determining the suspended sediment concentration profile within a river and is often the only way to get samples in large rivers due to the size of the sampling bottles. Refer to Figure 4.4 for a point integrated sampler.

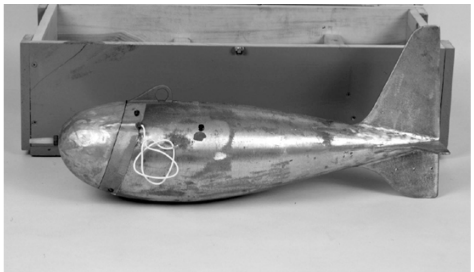


Figure 4.4. Point Integrated Sampler US P-72 (Rickly Hydrological Company 1997-2007)

When a suspended sediment sampler is used to determine the measured suspended sediment discharge, Equation (4.12) can be used to describe the measured suspended sediment discharge.

$$q_m = \int_{d_n}^{h} c u_y \, dy \tag{4.12}$$

Where,

d_n is the nozzle depth or the unmeasured depth.

The differences between Equations (4.1) and (4.12) are the limits of integration. The value of d_n (unmeasured depth) is based on the type of sampler.

Equation (4.13)is used to determine the calculated sediment discharge when a depth integrated sampler is used.

$$q_m = 0.216 q_b \frac{E^{Ro-1}}{(1-E)^{Ro}} \left\{ \ln\left(\frac{60}{E}\right) J_{1A} + J_{2A} \right\} \tag{4.13}$$

Where,

$$J_{1A} = \int_A^1 \left(\frac{1-y'}{y'}\right)^{Ro} dy';$$

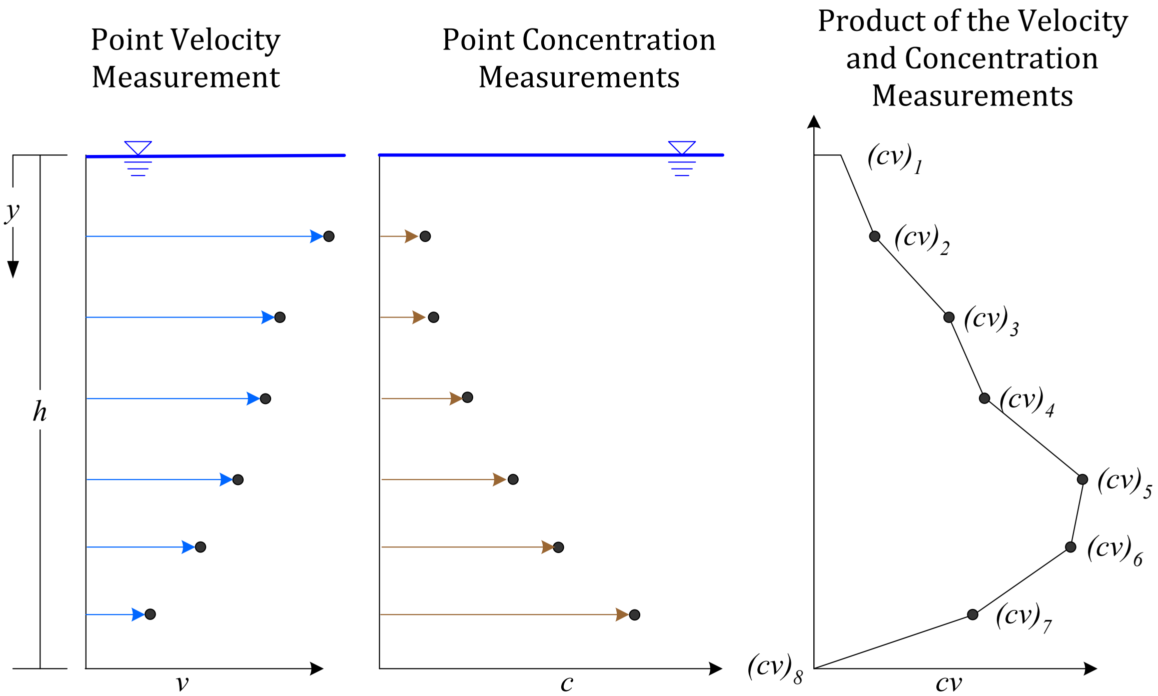
$$J_{1A} = \int_A^1 \left(\frac{1-y'}{y'}\right)^{Ro} \ln y' dy'; \text{ and}$$

A is d_n/h.

The value of *Ro* is determined by Equation (2.15). The value of q_b is determined directly since all other variable in Equation (4.13) are known. Once q_b is determined, q_t can be calculated based on Equation (4.9). When just the ratio of measured sediment discharge to total sediment discharge (q_m/q_t) is desired, the bed sediment discharge does not need to be calculated because the variable will cancel out of the equation.

$$\frac{q_m}{q_t} = \frac{0.216 \frac{E^{Ro-1}}{(1-E)^{Ro}} \left\{ \ln\left(\frac{60}{E}\right) J_{1A} + J_{2A} \right\}}{1 + 0.216 \frac{E^{Ro-1}}{(1-E)^{Ro}} \left\{ \ln\left(\frac{60}{E}\right) J_1 + J_2 \right\}} \tag{4.14}$$

When using a point sampler, the actual or measured sediment discharge needs to be determined. The actual sediment discharge is determined by multiplying the velocity profile by the concentration profile and calculating the area under the curve. Refer to Figure 4.5 for a graphical explanation of this method used to determine the measured sediment discharge from point data.


Point Velocity Measurement

Point Concentration Measurements

Product of the Velocity and Concentration Measurements

Figure 4.5. Schematic on Calculating Measured Sediment Discharge

The sediment discharge can be determined for each incremental flow depth by calculating the area under the curve using the trapezoidal rule. Equation (4.15) is used to calculate the total sediment discharge.

$$q_t = \sum_{1}^{n} \left[\min(cv_i, cv_{i+1}) + 0.5 * abs(cv_i - cv_i + 1)\right](y_{i+1} - y_i) \qquad (4.15)$$

Where,

q_t is the total sediment discharge
n is the number of point samples
c_i is the concentration at given point
v_i is the velocity at a given point
y_{i+1} -y_i is the unit distance

In general, due to the type of instrumentation, measurements of suspended sediment and velocity cannot be made at the bed or surface using a point sampler. Therefore, it is assumed that the concentration and velocity are equal to the closest measurement to get a feel for the total sediment discharge. The velocity measurement at the bed is assumed to be zero, as shown in Figure 4.5. The measured sediment discharge is determined by excluding the slice closest to the bed from the analysis.

The calculated sediment discharge is determined by fitting a logarithmic velocity profile and Rouse concentration profile to the measured data sets. Figure 4.6 shows a schematic of the trend lines generated for the velocity and concentration data set.

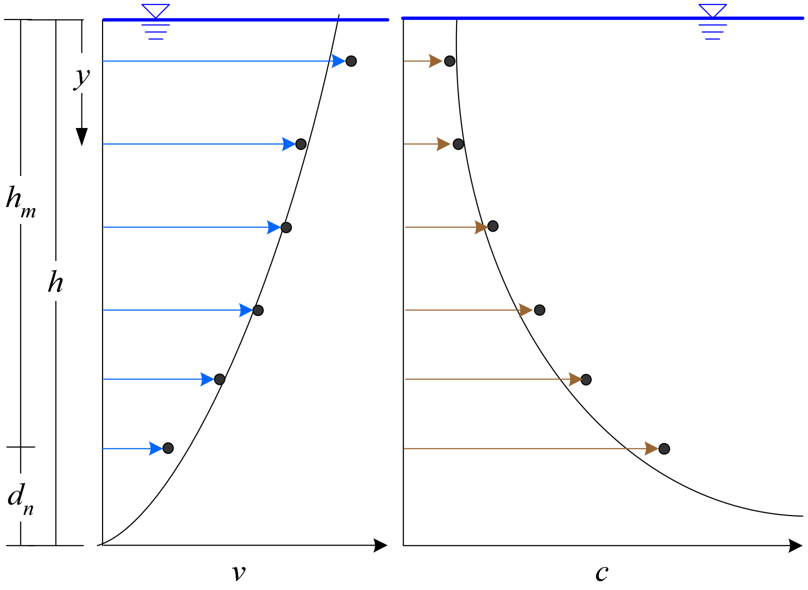


Figure 4.6. Fitted Velocity and Concentration Profiles

Equation (4.16) is derived from the logarithmic trend line generated from the measured velocity data and Equation (4.17) is developed from the power function fitted to the concentration measurements.

$$v = \frac{u_*}{\kappa} \ln\left(\frac{y}{y_o}\right) \tag{4.16}$$

$$c = c_a \left(\frac{h-y}{h} \frac{a}{h-a}\right)^{Ro} \tag{4.17}$$

Assume that the value of κ is 0.4. The values of u_*, y_o (depth of zero velocity), c_a and Ro are constants determined from the regression analysis. The calculated measured and total sediment discharges can be determined from Equations (4.18) and (4.19).

$$q_m = \int_{d_n}^{h} c_a \left(\frac{h-y}{h} \frac{a}{h-a} \right)^{Ro} \frac{u_*}{\kappa} \ln\left(\frac{y}{y_o} \right) dy$$
$$q_m = \frac{c_a h u_*}{\kappa} \left(\frac{E}{1-E} \right)^{Ro} \left\{ \ln\left(\frac{h}{y_o} \right) J_{1A} + J_{2A} \right\} \qquad (4.18)$$

$$q_m = c_a u_a a + \frac{c_a h u_*}{\kappa} \left(\frac{E}{1-E} \right)^{Ro} \left\{ \ln\left(\frac{h}{y_o} \right) J_{1E} + J_{2E} \right\} \qquad (4.19)$$

If the value of d_n is less than the value of y_o the measured sediment discharge is equal to the total sediment discharge shown in Equation (4.19).

Finally, sediment discharges are determined based on SEMEP. Equation (4.13) is used to calculate q_m and Equation (4.9) is used to determine q_t. The actual unit measured sediment discharge (q_m) is known from Equation (4.15) and Ro is based on the concentration profile (Equation (4.17)). The value of q_b can be determined directly since all other variables are known. When evaluating the theoretical sediment discharges, the Ro_m is used because Ro_c results in a theoretical total sediment discharge that is significantly higher.

Figure 4.7 provides a flow chart to explain the different approaches to determine the measured sediment discharge using SEMEP. Refer to Appendix E for detailed VBA code.

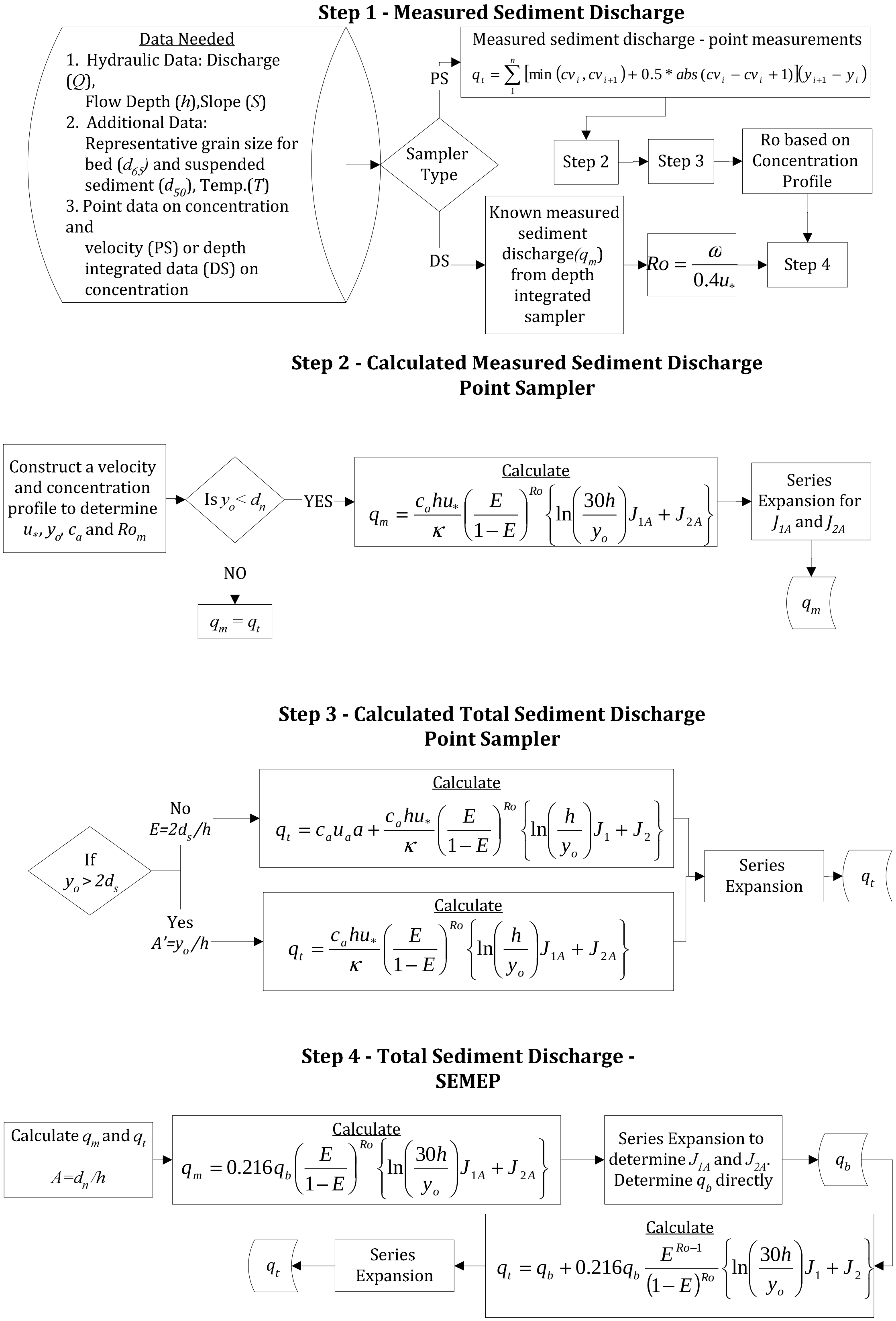


Figure 4.7. Flow Chart Describing Calculation of q_m/q_t

4.2.2 Helley–Smith

Bed sediment discharge is measured using a Helley-Smith sampler. It is a device designed to capture sediment near the bed. The sampler measures the bed sediment discharge and a portion of the suspended sediment zone based on the depth of the river. The sampler has a standard 3-inch by 3-inch opening for sediment to enter. The sampling bag contains a screen mesh to capture sediment particles; this mesh allows particles finer than 0.2 mm to pass through the bag. This suggests that a Helley–Smith sampler primarily collects sediment samples within a portion of the bed zone. Fine particles are referred to as wash load and are considered not significant in the channel forming process. Therefore, fines are not captured by a Helley Smith. Refer to Figure 4.8 for a typical Helley-Smith.

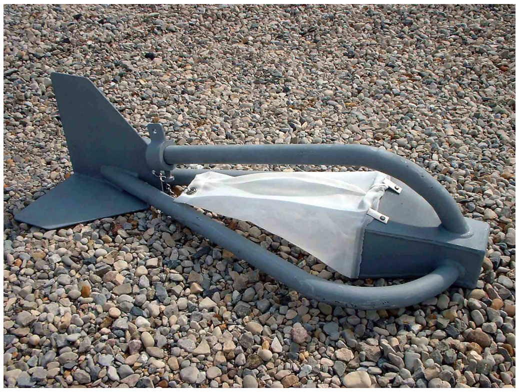


Figure 4.8. Helley-Smith Sampler (Rickly Hydrological Company 1997-2007)

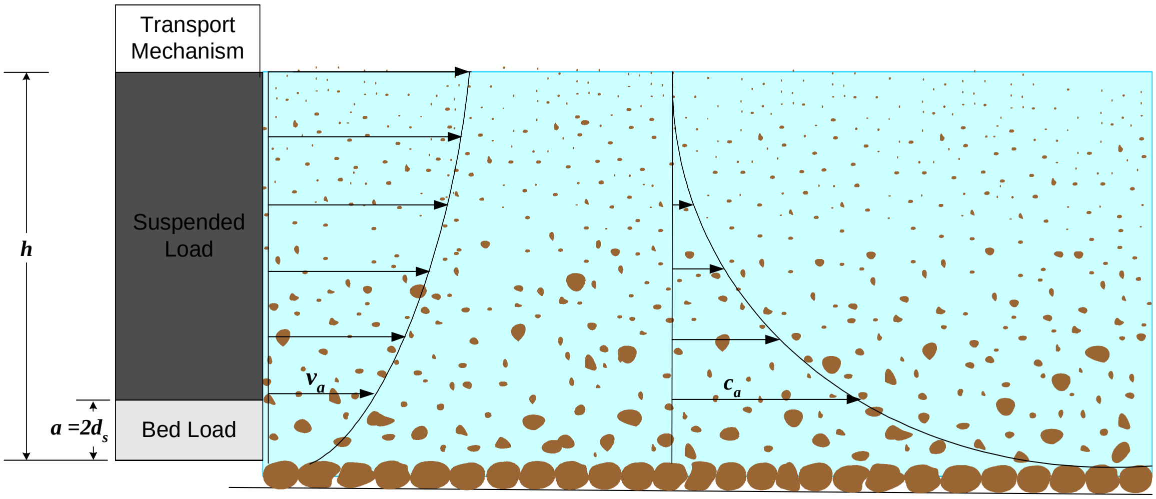
In gravel and mountain streams a Helley-Smith sampler is ideal for measuring sediment discharge, because most of the sediment is transported near the bed. Equation (4.20) is used to determine the unit sediment discharge captured by the sampler (q_{hs}).

$$q_{hs} = q_b + \frac{0.216 q_b}{a} \int_{a=2d_s}^{3inch} \left(\frac{h-y}{y} \frac{a}{h-a} \right)^{Ro} \ln\left(\frac{30y}{d_{65}} \right) dy \qquad (4.20)$$

The value of Ro is calculated based on Equation (2.15). The value of q_b is determined directly since all other variables are known in Equation ((4.20). Then, q_t is determined using Equation (4.9). Due to the fact that the limits of integration are not normalized to one, the trapezoidal rule is used to calculate the integral. This is because the series expansion requires the upper limit of integration to be set equal to 1.

Chapter 5: Results from Depth-Integrated and Helley-Smith Samplers

Velocity and concentration profiles within a river can be expressed by the logarithmic velocity and Rouse concentration equations, respectively (Figure 5.1). This study looks at understanding the relationship between suspended sediment discharge, bed sediment discharge, measured sediment discharge (in suspension or near the bed) and total sediment discharge. Data from laboratory experiments and natural rivers composed of sand and gravel bed streams are used in this analysis.



$$v = \frac{u_*}{\kappa} Ln\left(\frac{30\,y}{d_s}\right) \qquad c = c_a\left(\frac{h-y}{y}\frac{a}{h-a}\right)^{Ro}$$

Figure 5.1. Velocity and Concentration Profiles

5.1 Ratio of Suspended to Total Sediment Discharge

The ratio of suspended to total sediment discharge is defined as q_s/q_t. The values of q_s/q_t are determined using SEMEP, outlined in Section 4.1.

5.1.1 *Mode of Transport*

The value of q_s/q_t is used to determine the mode of sediment transport. There are three main modes of transport: suspended load, mixed load, and bed load. The modes of transport are a function of u_* of the river and ω of the d_{50ss}. The value of q_s/q_t is determined by varying the value of relative submergence (h/d_s) and u_*/ω. Equations (4.8) and (4.9) are used to determine q_s/q_t. Figure 5.2 shows the influence that h/d_s has on u_*/ω as a function of the q_s/q_t and the modes of transport. The value of h/d_s is an important variable when evaluating the modes of transport. The significance of this figure is to identify the modes of transport related to u_*/ω or *Ro*.

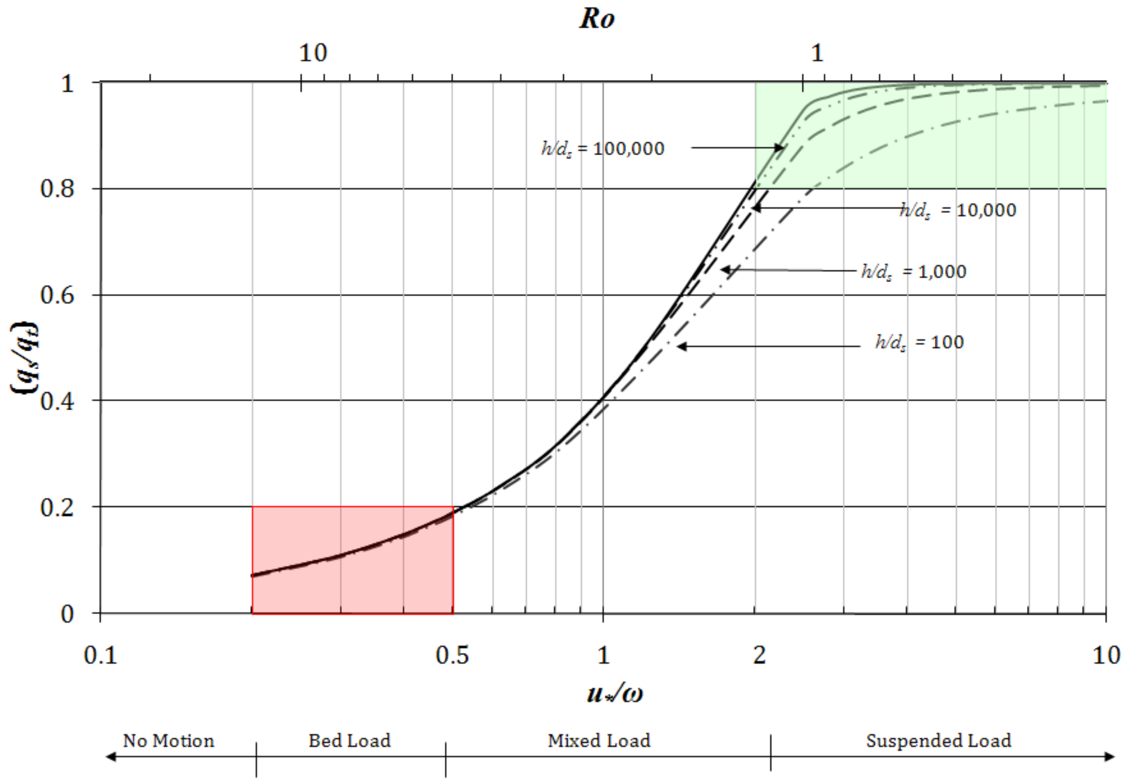


Figure 5.2. Modes of Transport as a function of q_s/q_t

Based on figure it is clear to identify the transport mechanism based on where the theoretical lines cross q_s/q_t. The mode of transport can be classified as bed load when the ratio of q_s/q_t is less than 0.2; this occurs when u_*/ω is less than 0.5 (*Ro* is greater than 5). However, once the value of u_*/ω is less than 0.2, theoretically sediment will not be transported. This is also shown in the literature review based on the study by Julien (1998) and Cheng (2008) on incipient motion. In addition, the mode of transport can be classified as suspended load when the ratio of q_s/q_t is greater than 0.8; this occurs when u_*/ω is greater than 2 (*Ro* less than 1.25). Therefore, Table 5.1 provides a revision to the modes of transport developed by Julien (1998), and Dade and Friend (1998).

Table 5.1. Revised Mode of Transport

u_*/ω	*Ro*	q_s/q_t	Mode of Sediment Transport
<0.2	>12.5	0	No motion
0.2 to 0.5	5 to 12.5	0 to 0.2	Sediment Transported as bed load
0.5 to 2	1.25 to 5	0.2 to 0.8	Sediment Transported as mixed load
>2	<1.25	0.8 to 1.0	Sediment Transported as suspended sediment load

5.1.2 Explanation of Theoretical Lines

When the value of u_*/ω is less than 1 (or *Ro* is greater than 2.5), the various lines associated with h/d_s has a tendency to converge. This suggests that the majority of the sediment is located close to the bed (Refer to Figure 2.6) and the suspended sediment concentration is small and the bed load is a higher quantity. The bed load is determined using Equation (4.3), which is a function of the reference concentration (c_a). The lines converge because at low values of u_*/ω (<1) the variation in concentration at a given depth hardly varies (refer to Figure 5.3).

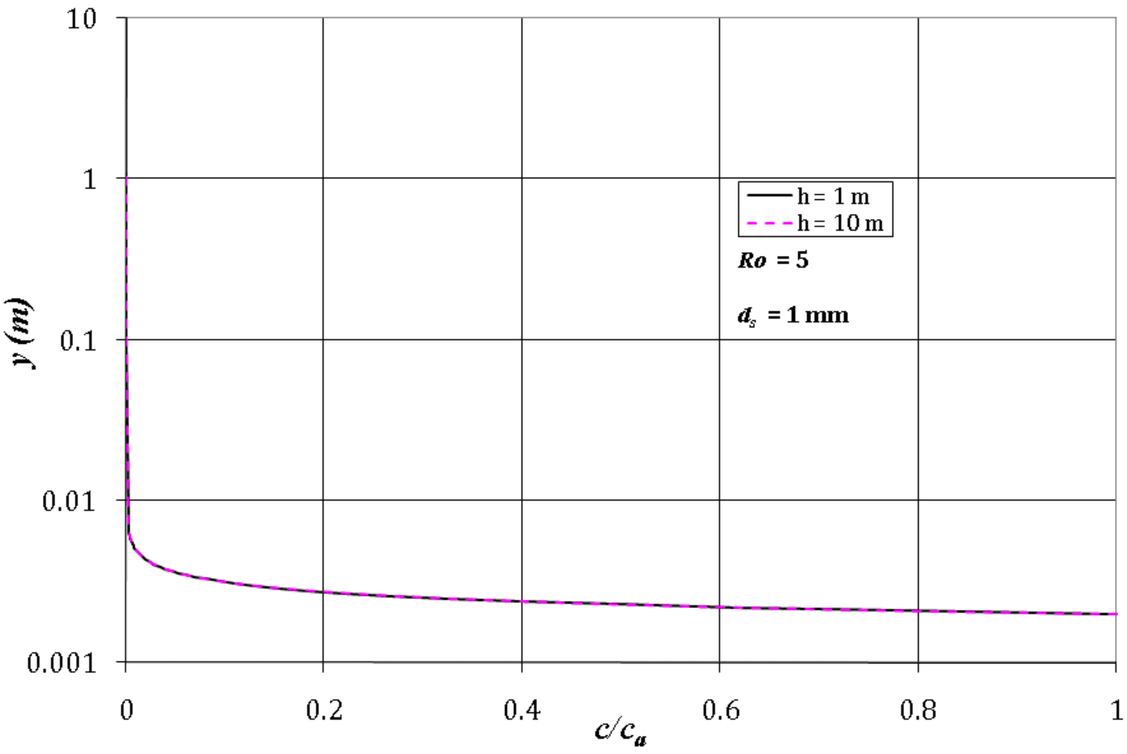


Figure 5.3. Concentration as a Function of Depth for *Ro* = 5 and d_s = 1 mm

The figure shows that regardless of flow depth when R*o* is 5 (u_*/ω is 0.5) the ratio of *c* to c_a is equal at all flow depths for both examples. This is because there is very little sediment within the water column.

When the value of u_*/ω is greater than 2.5 (or *Ro* is less than 1), lines associated with relative submergence have a tendency to diverge. This occurs because the majority of load is in suspension, based on the concentration profile (Refer to Figure 2.6). The suspended sediment is determined by integrating Equation (4.2) from *2ds* to *h*. As the value of flow depth increases, the amount of sediment in suspension has a tendency to increase, refer to Figure 5.4.

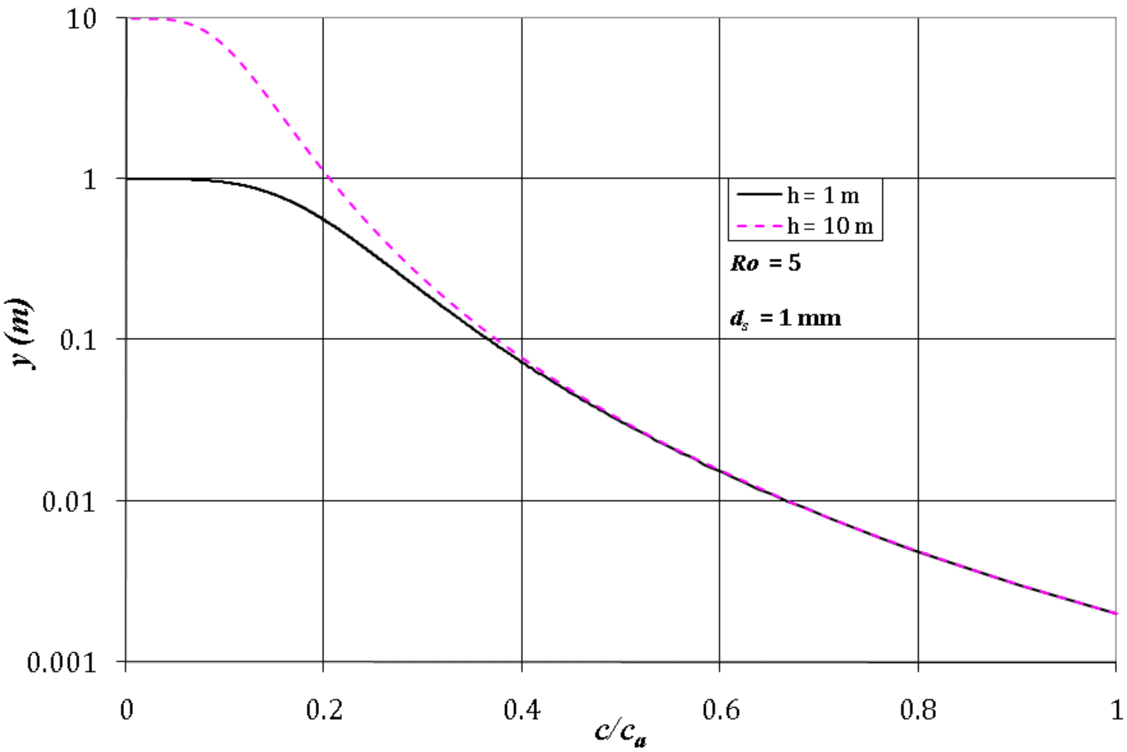
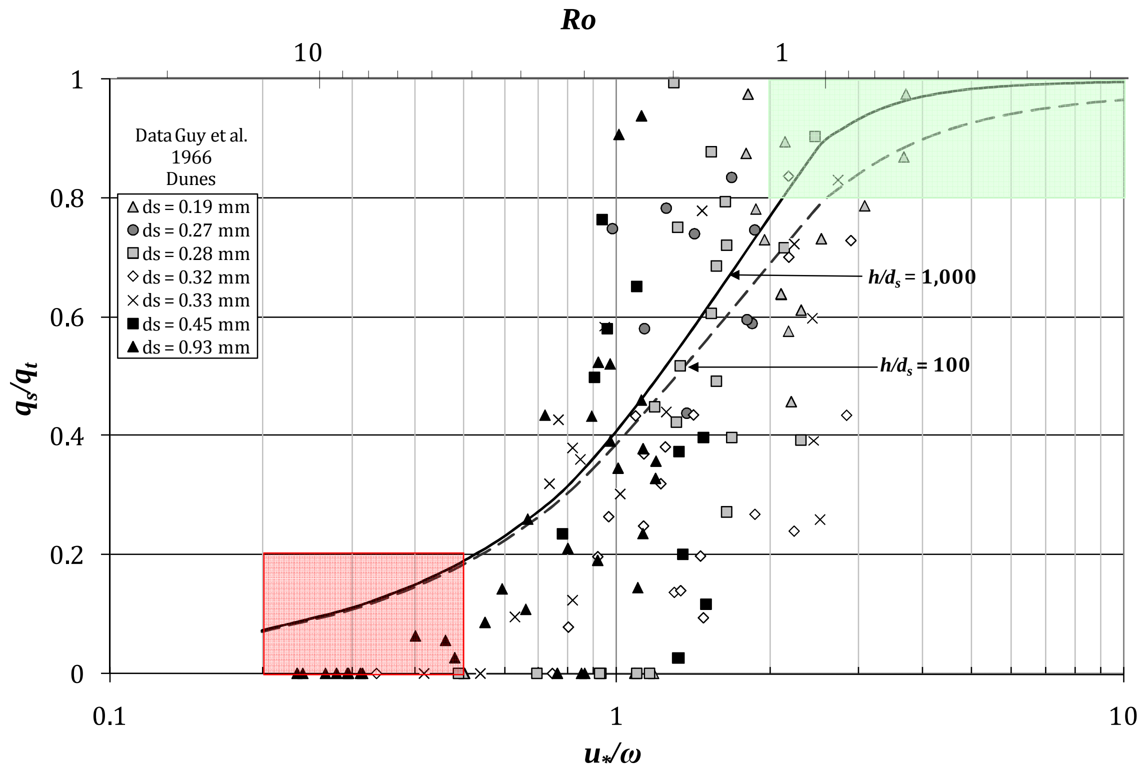


Figure 5.4. Concentration ration as a Function of Depth for *Ro* = 0.25 and d_s = 1 mm

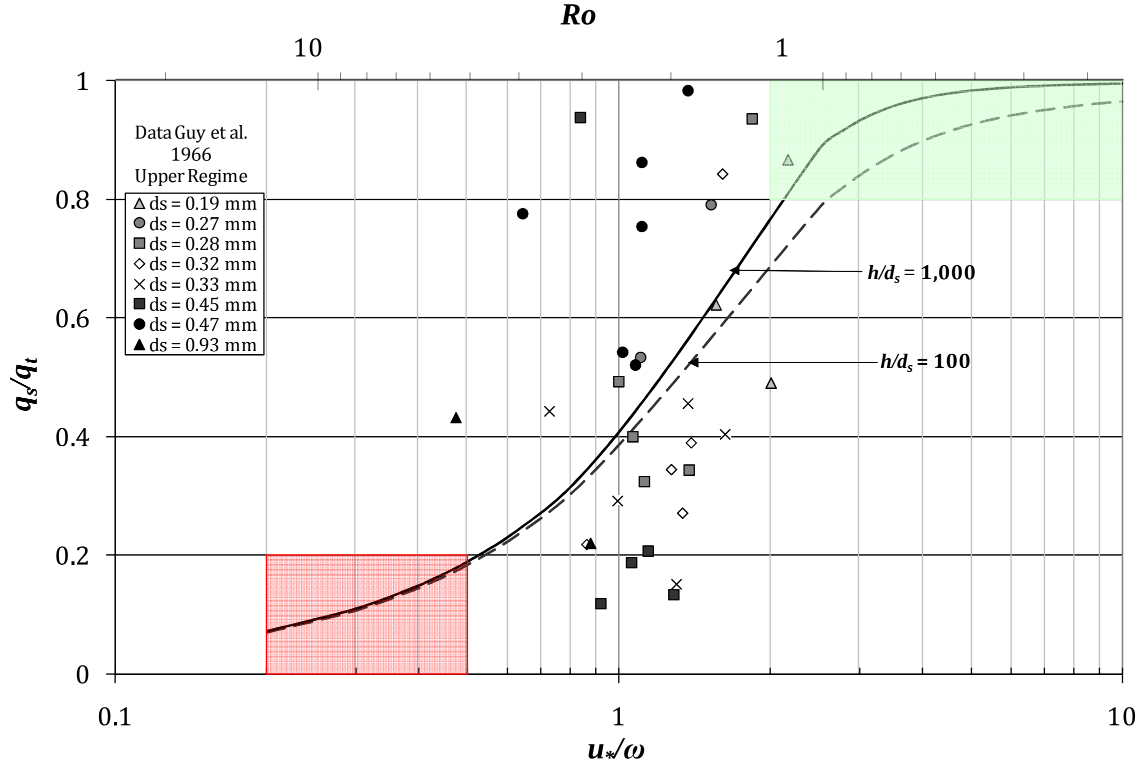
Therefore, for the same value of *Ro*, the total concentration will be higher in a deeper river (area under curve), thus making h/d_s an important factor when the suspended load is over 60% of the total load. In this case the ratio of c to c_a is only equal when the flow depth is less than 0.1 meters.

5.1.3 Validation using Flume Data

Laboratory data summarized by Guy et al. (1966) were used to determine whether the theoretical calculation of q_s/q_t based on SEMEP as a function of u_*/ω is accurate (refer to Section 3.1.1) compared with laboratory data. When the data for q_t was reported as "not detected" or where q_s/q_t was greater than one, those data points were removed from the analysis due to measurement error. The data were categorized based on particle size and bed forms. The results from dunes and upper regime are shown in Figure 5.5.



A) Dunes



B) Upper Regime

Figure 5.5. Values of q_s/q_t from Flume Experiments Stratified by Bedform Type

Figure 5.5 shows how the theoretical lines somewhat agree with the measured data. The red and green shaded zones identify the bed load and suspended sediment load transport zones, respectively. In both cases the majority of the data was collected in the mixed load zone, where there is a high degree of variability. This occurs because both modes of transport (bed and suspended) are present in the mixed load zone. When the value of u_*/ω is less than 0.2 there are no measurements, suggesting no motion. When analyzing the data from Figure 5.5 the theoretical lines seem to follow the same general trend as the data from Guy et al., even though there is a high degree of scatter. For the dune data set, there are a few points located in the suspended and bed load transport zone; however, the upper regime data set shows data primarily located in the mixed transport zone. One of the potential reasons for the scatter in the data occurred because the measurement depth is unknown. It is assumed that since the publication refers to the measured unit sediment discharge as q_s, the measurement occurred from the water surface to a distance $2d_s$ from the bed. In addition, most of the data in both graphs are located within the mixed load zone, where scatter is the most dramatic because of the high degree of variability in the value of q_s/q_t when u_*/ω is between 0.5 and 2.

Further analysis was performed to clearly show that once u_*/ω is less than 0.2, data are not collected. This was performed by plotting u_*/ω by dimensionless grain diameter (d_*). The results from the Guy et al. (1966) data set and the line of incipient motion developed by Cheng and Chiew (1998; 1999) are shown in Figure 5.6.

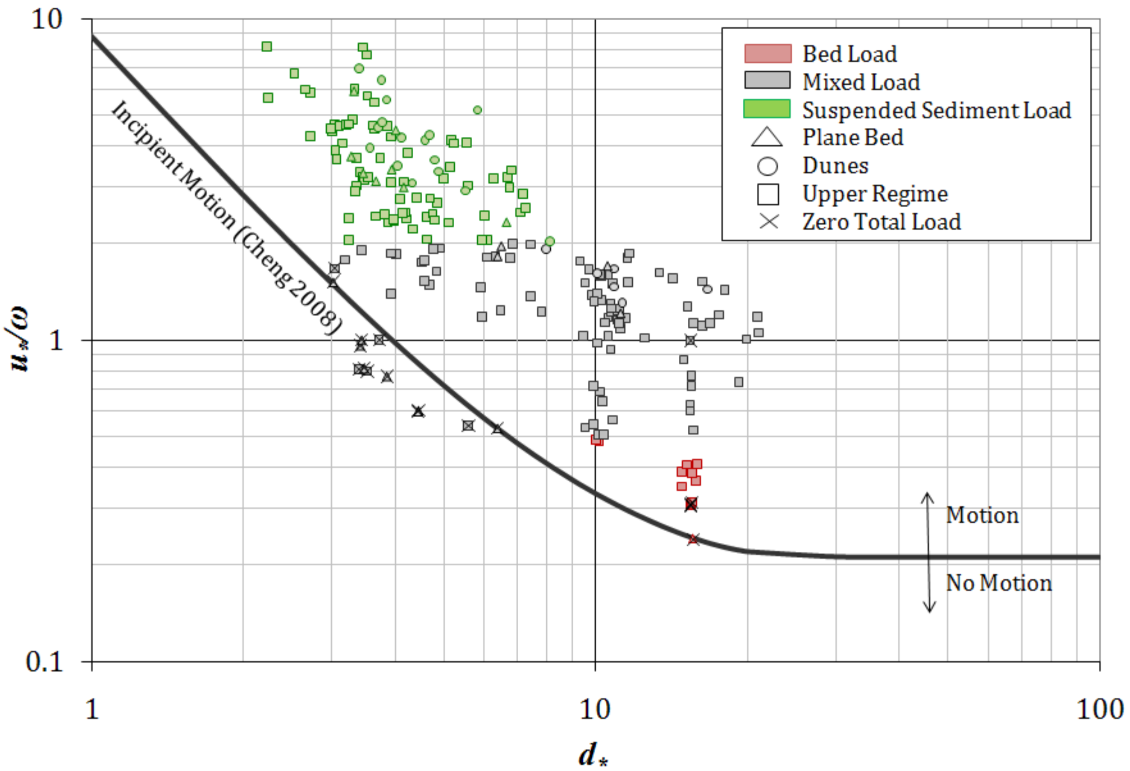


Figure 5.6. u_*/ω as a Function of d_* for Flume Data

The solid line in Figure 5.6 represents the division between sediment in motion and not in motion. The figure shows no stratification based on bed form; however, most of the samples are in motion. In addition, the green points represent suspended sediment ($u_*/\omega > 2$), the gray points represent mixed load ($2 < u_*/\omega > 0.5$) and the red points represent bed load ($u_*/\omega < 0.5$). The samples that are crossed out indicated that zero sediment was measured. Most of those samples are plotted below or close to the line of incipient motion. One of the crossed out samples is not located near the line of incipient motion; this is most likely associated with measurement error. This figure is similar to the Shields diagram. This also shows that as the value of d_* increases, the value of u_*/ω asymptotically approaches 0.2.

Next a particle motion diagram was developed which plots the Shields parameter (τ_*) against the d_*. The data from Guy et al. are re-plotted and the modes of transport are shown (suspended sediment is green, mixed load is white and bed load is red) in Figure 5.7.

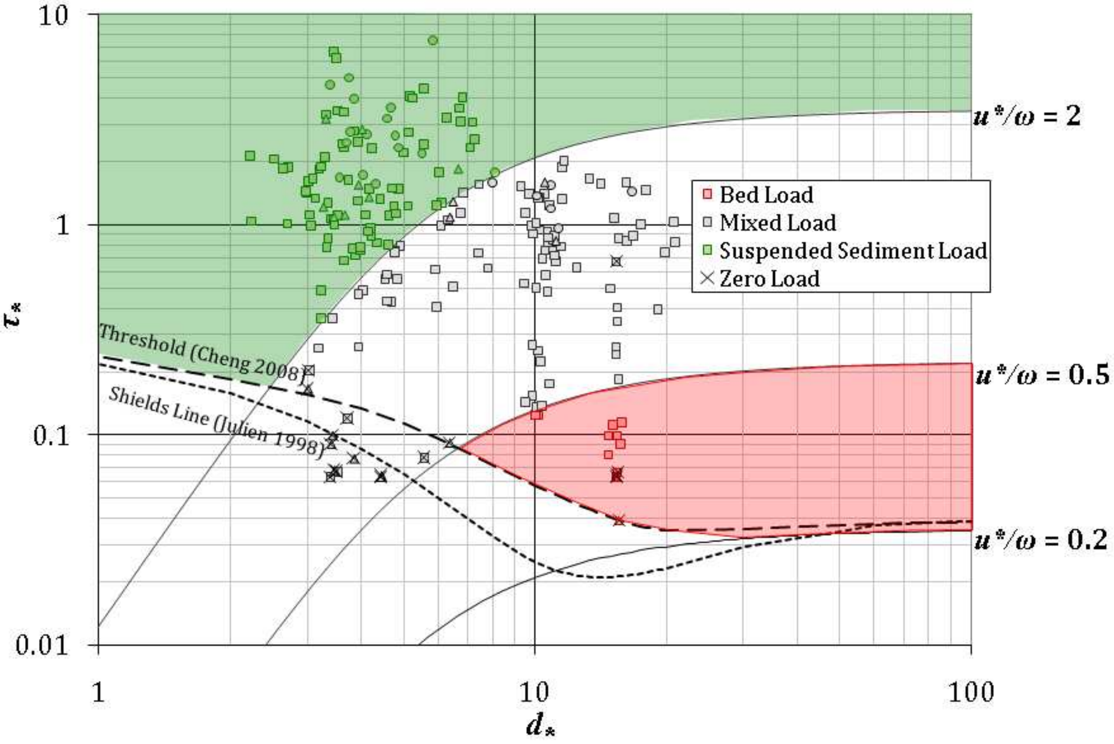


Figure 5.7. Shields Parameter as a Function for of d_* for Flume Data

The figure shows that the probabilistic approach of Cheng plots slightly higher than the original particle motion diagram developed by Shields. Once d_* is less than one or greater than forty, the two lines converge. The samples which have been crossed out are associated with no measured sediment transport. Figure 5.7 suggests that d_* and τ_* are also important variables when calculating modes of transport. However, d_* can be related to ω through d_s and u_* is directly related to τ_*.

Next the data are stratified based on the bed slope (S_o) and submergence depth (h/d_s), similar to the analysis of Dade and Friend(1998). The results are shown in Figure 5.8.

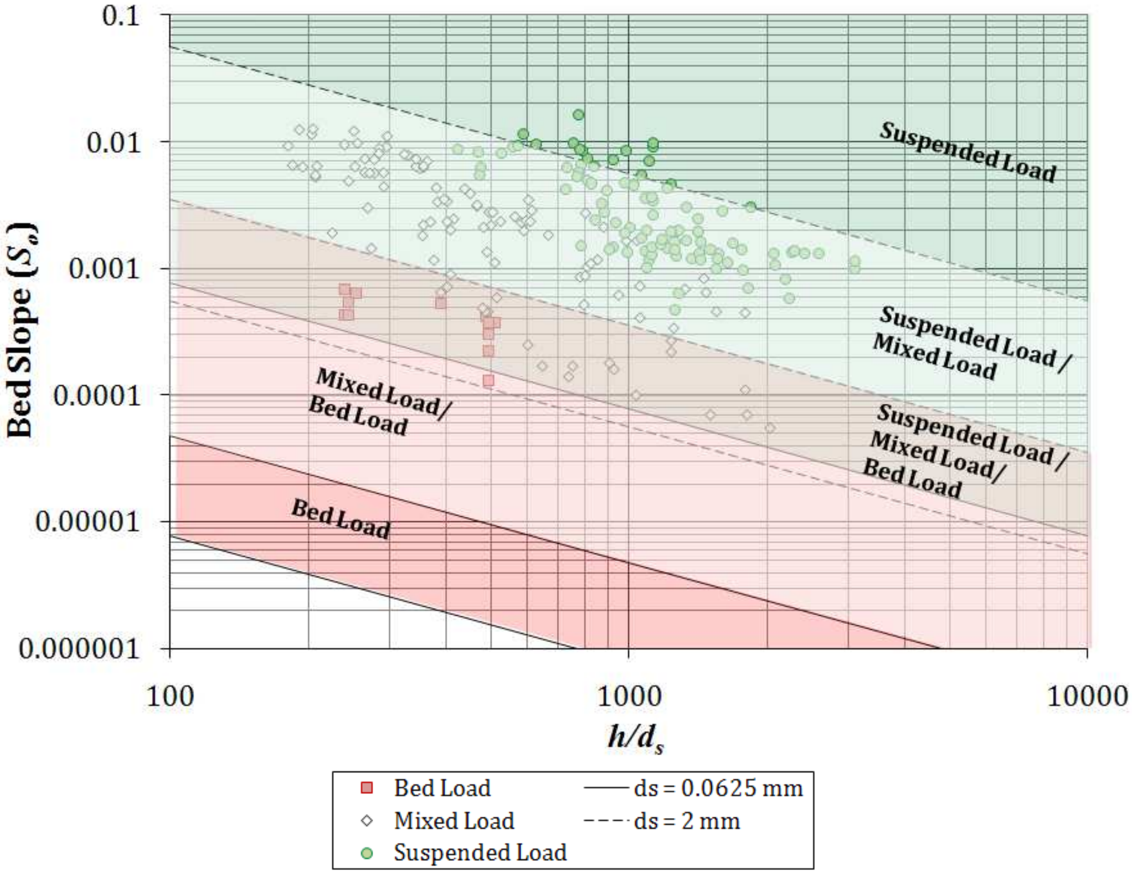


Figure 5.8. Channel Slope as a Function of Submergence Depth for Flume Data

This figure shows that there is overlap between the modes of transport. Thus, if the S_o and h/d_s are known, the mode of transport can be identified. The scatter observed in Figure 5.5 can be explained using this graph, because most of the data is located in the mixed load zone where multiple modes of transport are possible.

5.2 Ratio of Measured to Total Sediment Discharge

Sediment in rivers can be measured using a suspended sediment sampler and or a bed load sampler. Measured sediment discharge is generally defined as the sediment measured by a suspended sediment sampler (Figure 2.5). Suspended sediment samplers cannot measure sediment close to the bed due to the location of the sampling nozzle. The ratio of measured to total sediment discharge (q_m/q_t) is determined by taking the ratio of the unit measured sediment discharge to the unit total sediment discharge. The value of q_m/q_t is calculated using SEMEP, outlined in Section 4.2.

5.2.1 Function of Grain Size and Flow Depth

Measured unit sediment discharge (q_m) is a function of the sampling depth (h_m). If the unmeasured flow depth (d_n) is constant, then the value of q_m/q_t will increase as the flow depth increases for a given value of u_*/ω. Figure 5.9 shows how d_s and percent of measured flow, which cause q_m/q_t to vary. In this graph, d_n equals 0.1 meters and h is varied from 0.2 to 10 meters for particle sizes of 0.2 and 2 mm. As a result, a series of lines are constructed to represent the q_m/q_t as a function of u_*/ω.

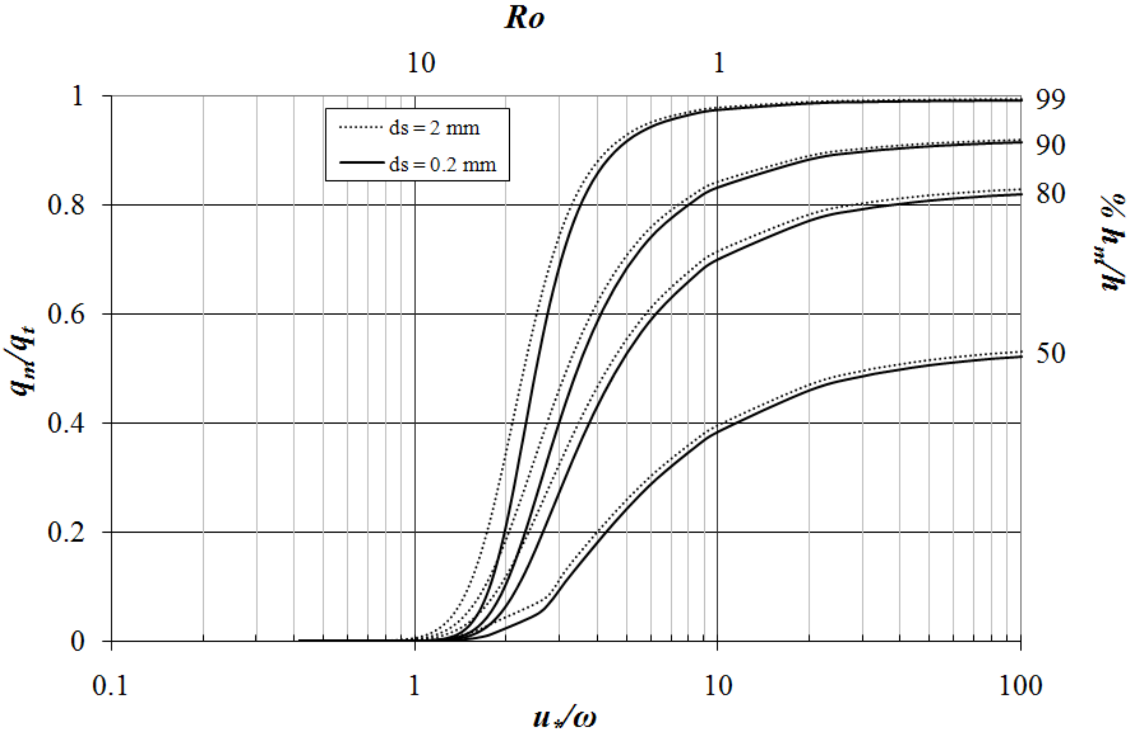
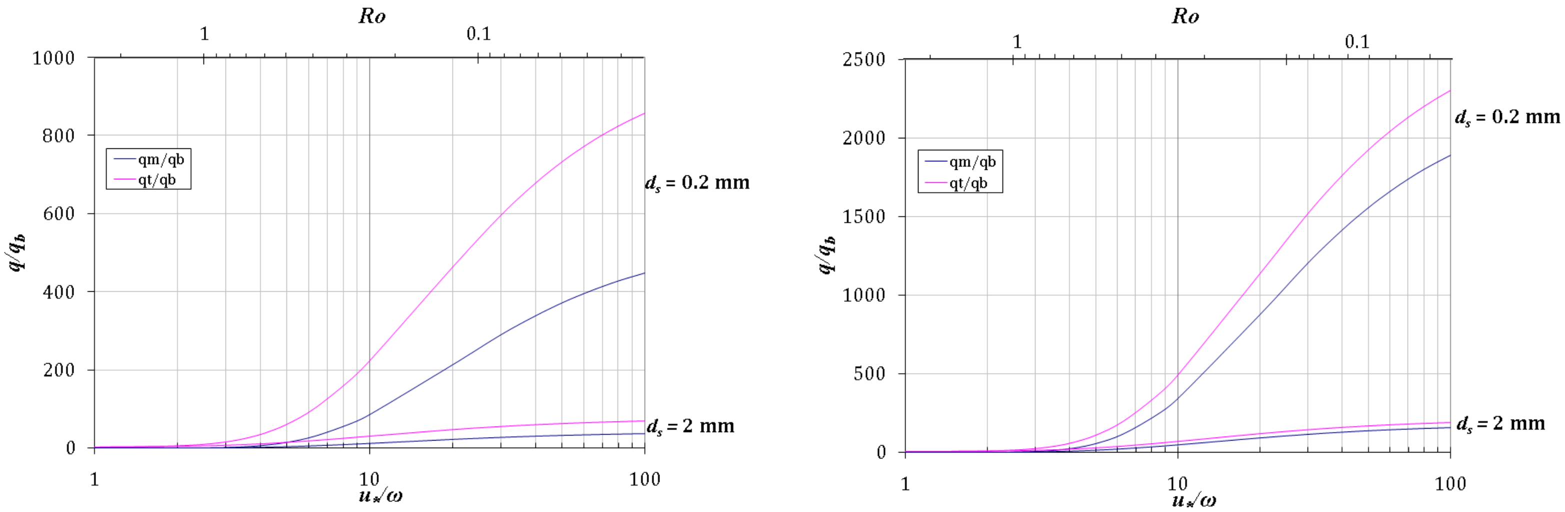


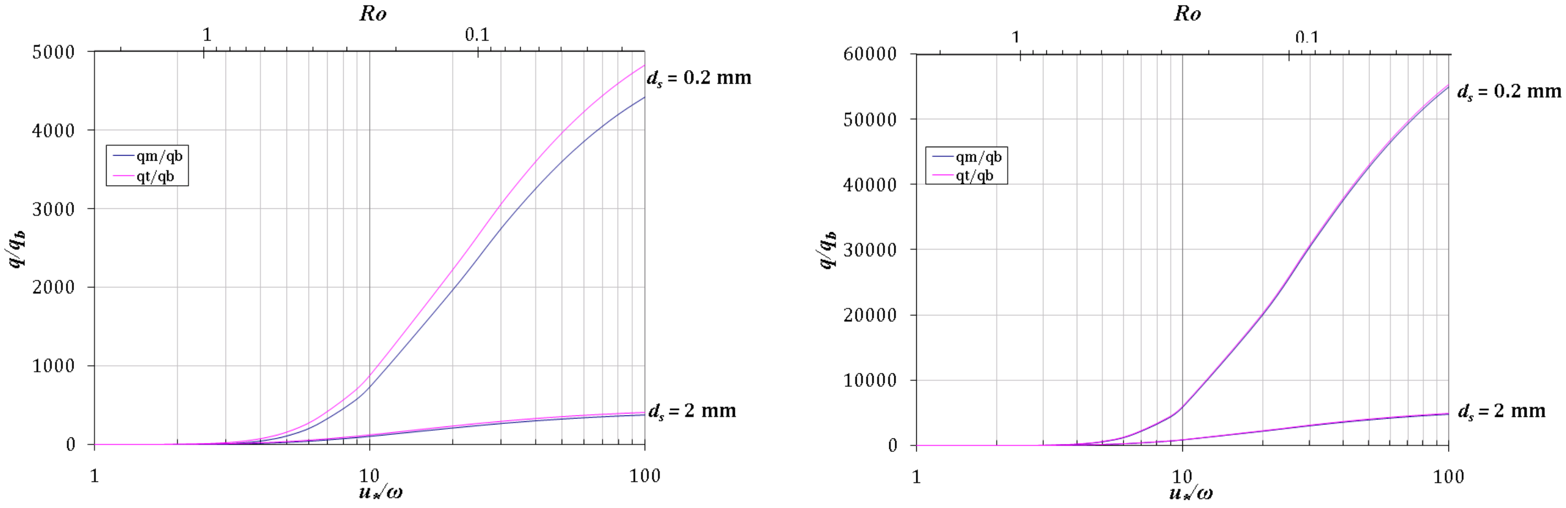
Figure 5.9. Ratio of Measured to Total Sediment Discharge for Sand Size Particles

Figure 5.9 suggests that particles with a larger diameter have a tendency to have a higher q_m/q_t at the same depth. However, the actual sediment discharge is significantly smaller for the larger particles (refer to Figure 5.10) since a smaller quantity of sediment is found in suspension.



a) Flow Depth 0.2 m

b) Flow Depth 0.5 m



c) Flow Depth 1 m

d) Flow Depth 10 m

Figure 5.10. Unit Total and Unit Bed Sediment Discharge at Different Flow Depths

Figure 5.10 shows the ratio of sediment discharge (unit measured or total) to unit bed sediment discharge. For a given river, smaller particles (0.2 mm) have a higher measured sediment discharge and total sediment discharge compared to larger particles (2 mm). Mathematically for a given percent h_m/h the value of q_m/q_t is smaller for finer particles because the overall concentration of sediment is higher near the bed.

5.2.2 Calculation based on Depth-Integrated Sampler

SEMEP was tested using data from natural rivers. This procedure was tested using data from three different USGS publications (Colby and Hembree 1955; Kircher 1981; Williams and Rosgen 1989). Additional details of each data set can be found in Section 3.2. The Platte River (Colby and Hembree 1955; Kircher 1981; Williams and Rosgen 1989) and 93 US Stream (Colby and Hembree 1955; Kircher 1981; Williams and Rosgen 1989) publications are considered to be total sediment discharge data sets because they contain measurements from both a Helley-Smith and a depth-integrated sample. In addition, data from the Niobrara River collected by Colby and Hembree (1955) were also tested to determine the validity of the method. The Niobrara River data contains a total load sample at a constricted section using a depth-integrated sampler, where it is assumed that a suspended sediment sampler can measure the total sediment discharge.

The approach assumes that Ro follows Equation (2.15). The values of ω are determined based on Equation (2.16) and assume that the median particle in suspension will be used. The values of u_* are based on Equation (2.18). The q_b for each sample is determined directly based on the value of q_m, which is known from the depth integrated sampler and discharge measurements. Then the suspended sediment discharge is determined by integrating the concentration and velocity profile from h to $2d_s$ (Equation (4.8)). The total sediment discharge is calculated by adding the bed sediment discharge and suspended sediment discharge (Equation (4.9)).

Some of the data from the South Platte, North Platte and Platte Rivers in Colorado and Nebraska were incomplete. As a result only 17 samples were tested. In addition, bed slope was not measured; therefore, the shear velocity was determined based on the velocity profile shown in Equation (5.1).

$$\begin{aligned} \bar{v} &= \frac{u_*}{\kappa}\ln\left(12.2\frac{h}{d_{65}}\right) \\ u_* &= \frac{\bar{v}\,\kappa}{\ln\left(12.2\frac{h}{d_{65}}\right)} \end{aligned} \tag{5.1}$$

When using Equation (5.1) instead of Equation (2.18), the resulting value of u_* is smaller. As a result, the value of Ro would be larger for a given data set. Refer to Figure 5.11, Figure 5.12 and Figure 5.13 to see the results that compare the calculated and measured sediment discharges.

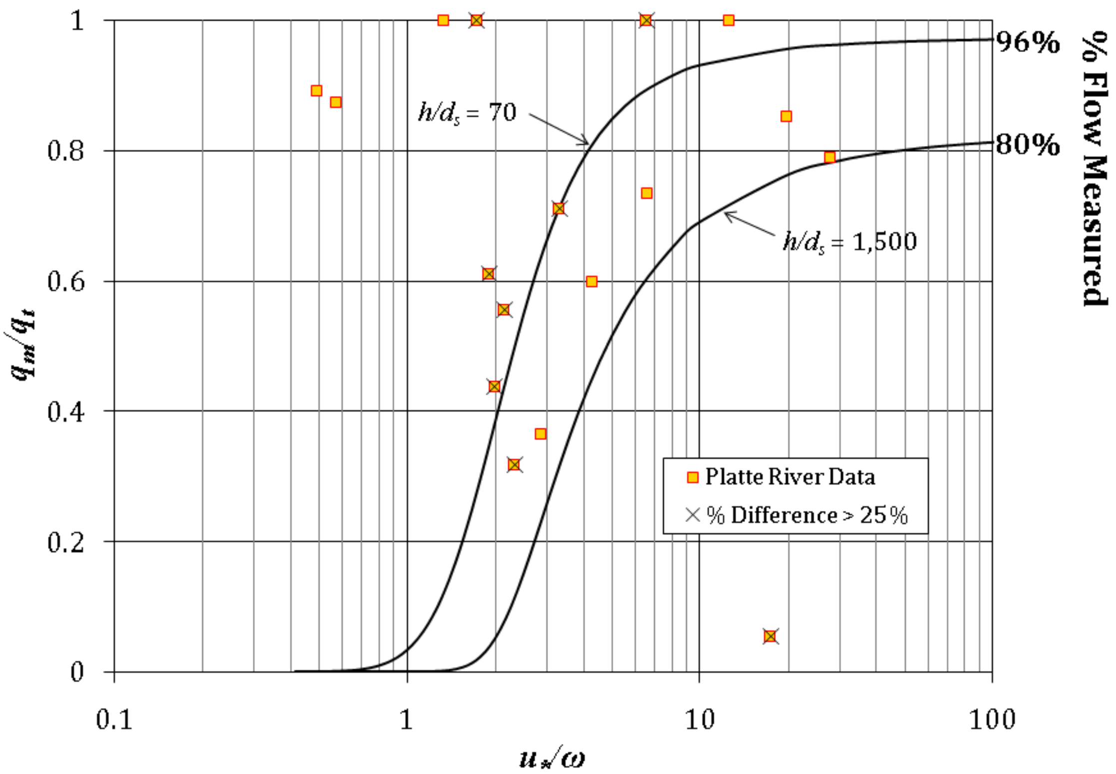


Figure 5.11. q_m/q_t **as a function of** u_*/ω **and** $\%h_m/h$ **for Platte River**

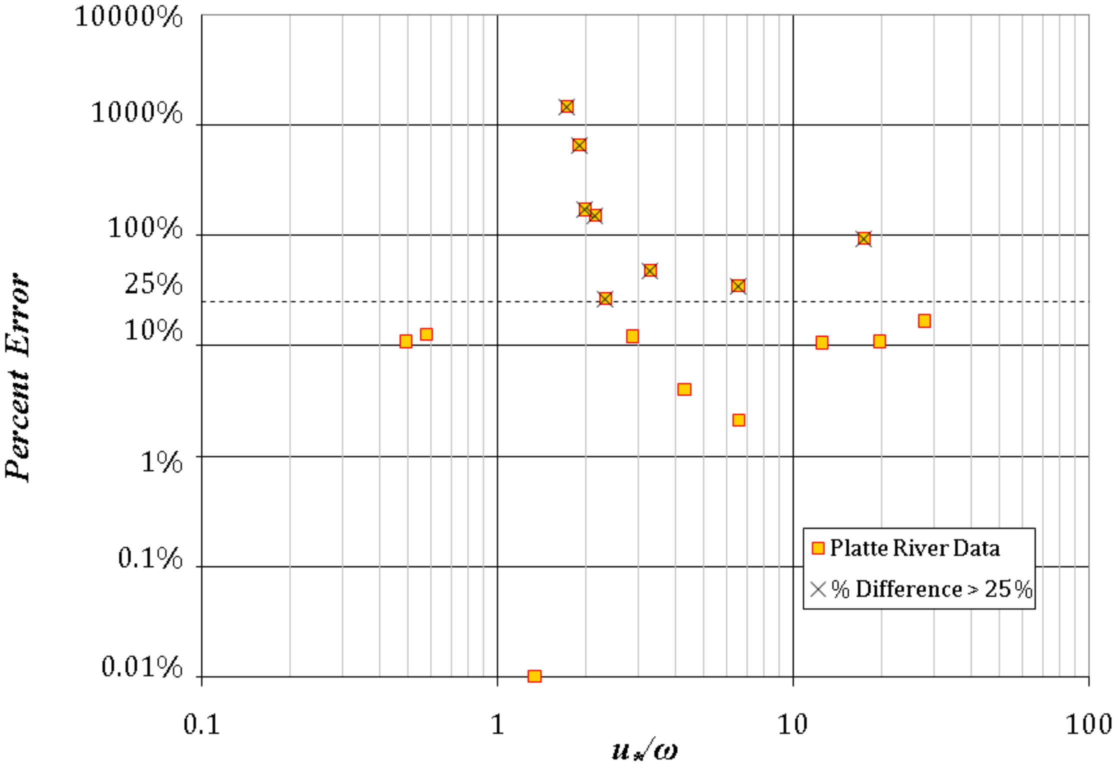


Figure 5.12. % Error in Measured and Calculated q_t **for Platte River**

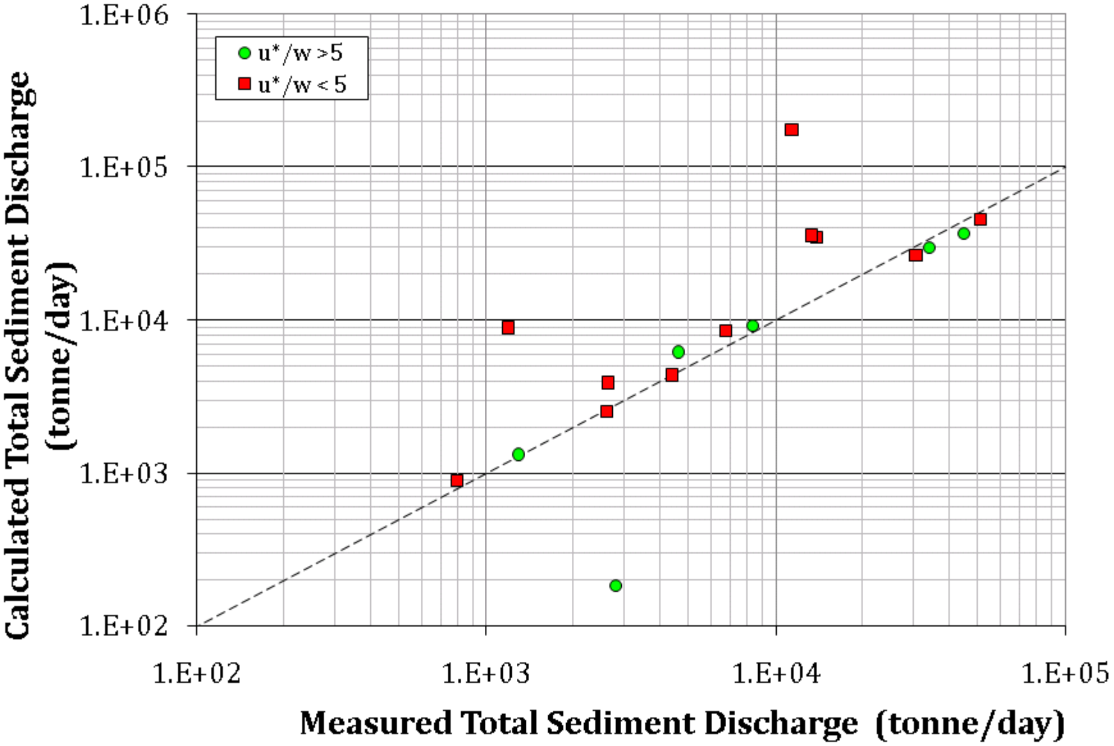


Figure 5.13. Accuracy of Calculated q_t for Platte River

The results in Figure 5.11 show the relative location of the measured value of q_m/q_t based on the theoretical lines represented by SEMEP. The results are quite variable. If the slope was known, the data points would have been shifted slightly to the right, thus more points would have been contained within the theoretical lines determined by SEMEP. The Figure 5.12 shows that 50% of the procedure has good results. The measured total which is not within 25% of the actual total sediment discharge is crossed out, indicating poor agreement. Figure 5.13 divides those data based on the value of u_*/ω. The results indicated that once u_*/ω is greater than 5 the results seem to follow the line of perfect agreement (45° line), with only one outlier.

To provide a more meaningful explanation, the following statistical parameters are determined: Mean Percent Error (MPE), Mean Absolute Percent Error (MAPE), Coefficient of Determination (R^2) and Concordance Correlation

Coefficient (ρ_c). Table 5.2 summarizes the statistical results for the Platte River data set.

Table 5.2. Statistical Results for Platte River Data Set

		n	MPE	MAPE	R^2	ρ_c
Platte River	**All Data**	17	-6.8%	17.2%	0.574	0.719
	$u_*/\omega < 5$	11	-17.1%	18.0%	0.621	0.706
	$u_*/\omega > 5$	6	12.1%	15.6%	0.706	0.762

The results indicate that when the value of u_*/ω is greater than 5 the data fit well with the line of perfect agreement, with a MPE and MAPE close to zero and an R^2 and ρ_c are close to one. Better agreement between the measured and calculated total sediment discharge would have been achieved if the one outlying point was removed from the analysis. The value of MAPE, R^2 and ρ_c would be 3.1%, 0.988 and 0.991. When the value of u_*/ω is small (less than 5), the measured and calculated data do not as correlate well, with a slightly smaller R^2 and ρ_c, and high MPE and MAPE.

The next data set was obtained from the USGS publication on total measured sediment discharge in 93 US streams (Williams and Rosgen 1989). Two distinct data sets are used. The first is composed of data with higher measured sediment discharge and a complete summary of results. The second set does not contain particle size distributions of the suspended sediment measurements due to the low measured sediment discharge. Figure 5.14 show the relative location of the actual q_m/q_t compared with the theoretical lines represented by SEMEP. Figure 5.15 and Figure 5.16 show two distinct methods for comparing the measured and calculated total sediment discharges.

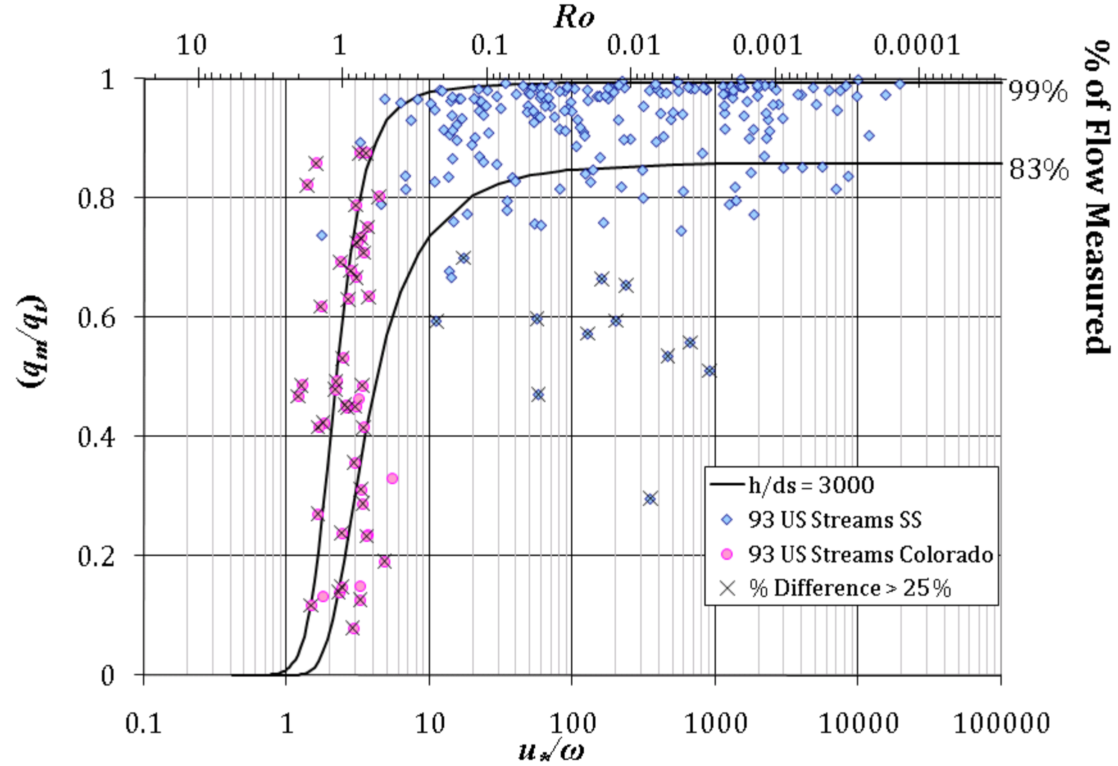


Figure 5.14. q_m/q_t as a function of u_*/ω and % h_m/h for US Stream

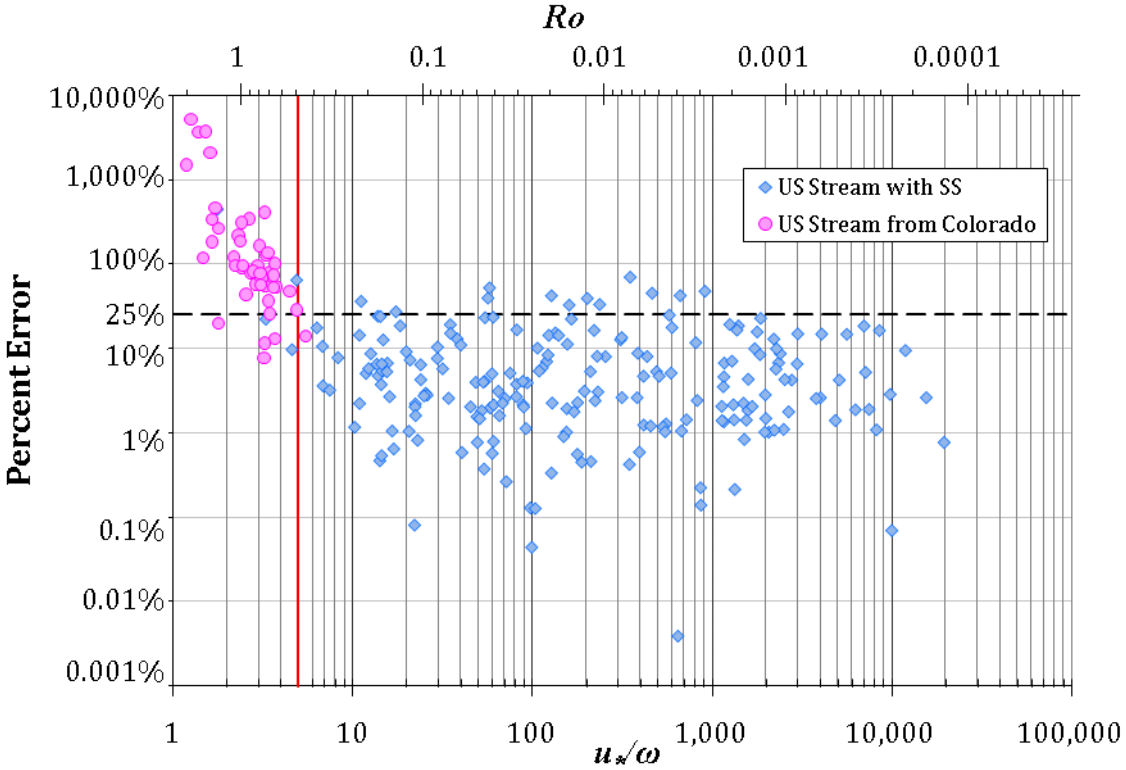


Figure 5.15. % Error in Measured and Calculated q_t for US Stream

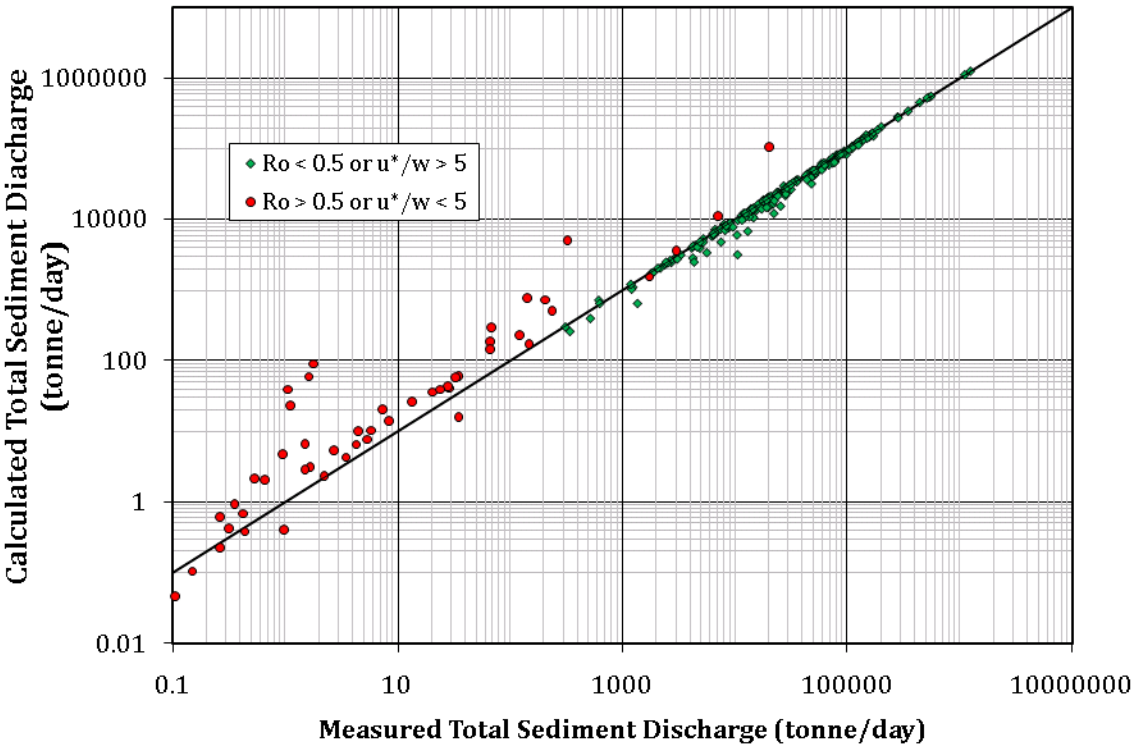


Figure 5.16. Accuracy of Calculated q_t for US Stream

Figure 5.14 shows the relative location of the actual q_m/q_t with respect to SEMEP. Once the value of u_*/ω is greater than 5, the majority of the measurements are within the bounds of the theoretical derivation of SEMEP. Figure 5.15 represents the percent difference between the measured total sediment discharge and calculated total sediment discharge. It validates that once the value of u_*/ω is less than 5 the procedure is not able to accurately calculate total sediment discharge. There are twelve points in Figure 5.14 and Figure 5.15, which have been crossed out because the percent difference is greater than 25%. Figure 5.16 shows how the data deviate from the line of perfect agreement. In addition, the data set has been divided based on the value of u_*/ω. When the value of u_*/ω is greater than 5; the values seem to line up well with the line of perfect agreement, and the calculated data have a tendency to be greater than the measured total sediment discharge.

However, when the value of u_*/ω is less than 5 the calculated data have a tendency to be less than the measured total sediment discharge.

To provide a more meaningful explanation, the following statistical parameters are determined: MPE, MAPE, R^2 and ρ_c. The results are summarized in Table 5.3.

Table 5.3. Statistical Results from the 10 selected US streams

		n	MPE	MAPE	R^2	ρ_c
US streams with SS	**All Data**	207	1%	2%	0.98	0.99
	$u_*/\omega < 5$	4	-11%	13%	0.99	0.81
	$u_*/\omega > 5$	203	2%	2%	0.99	0.99
US streams Colorado	**All Data**	46	26%	76%	0.84	0.85
	$u_*/\omega < 5$	45	26%	77%	0.82	0.84
	$u_*/\omega > 5$	1	2%	2%	-	-

The statistical results show that when u_*/ω is greater than 5 the values of MPE and MAPE are close to zero and the value of R^2 is close to one. This suggests that the SEMEP works well. However, the proposed procedure does not work well when the value of u_*/ω is less than 5. The value of ρ_c is also closer to one for the data set with values of u_*/ω greater than 5. There is only one data point where the value of u_*/ω is greater than 5 for the streams in Colorado, thus an R^2 and ρ_c were not calculated.

Finally, testing is conducted using data from the Niobrara River (Colby and Hembree 1955). Only 26 samples were used in this analysis because measurements were made at both the contracted cross section and the gaging station on the same day. Figure 5.17 show the relative location of the ratio of the actual measured to total sediment discharge and the theoretical lines represented by SEMEP. Figure

5.18 and Figure 5.19 show two distinct methods for comparing the measured and calculated total sediment discharges.

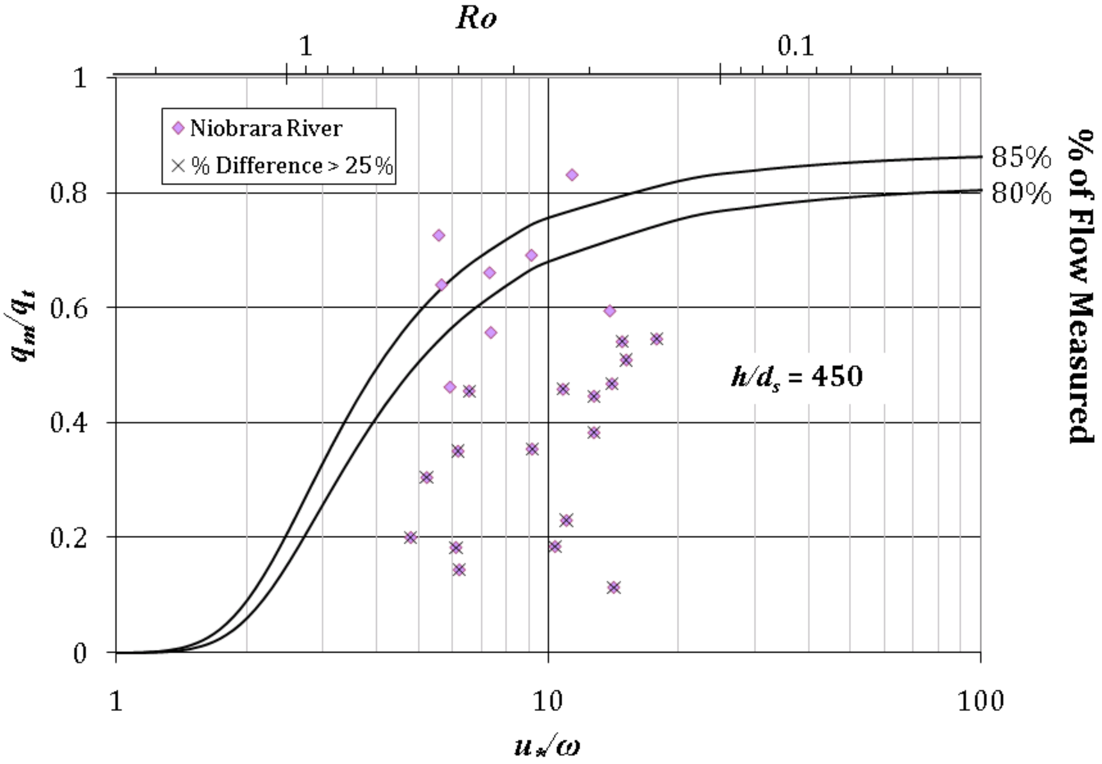


Figure 5.17. q_m/q_t **as a function of** u_*/ω **and %** h_m/h **for Niobrara River**

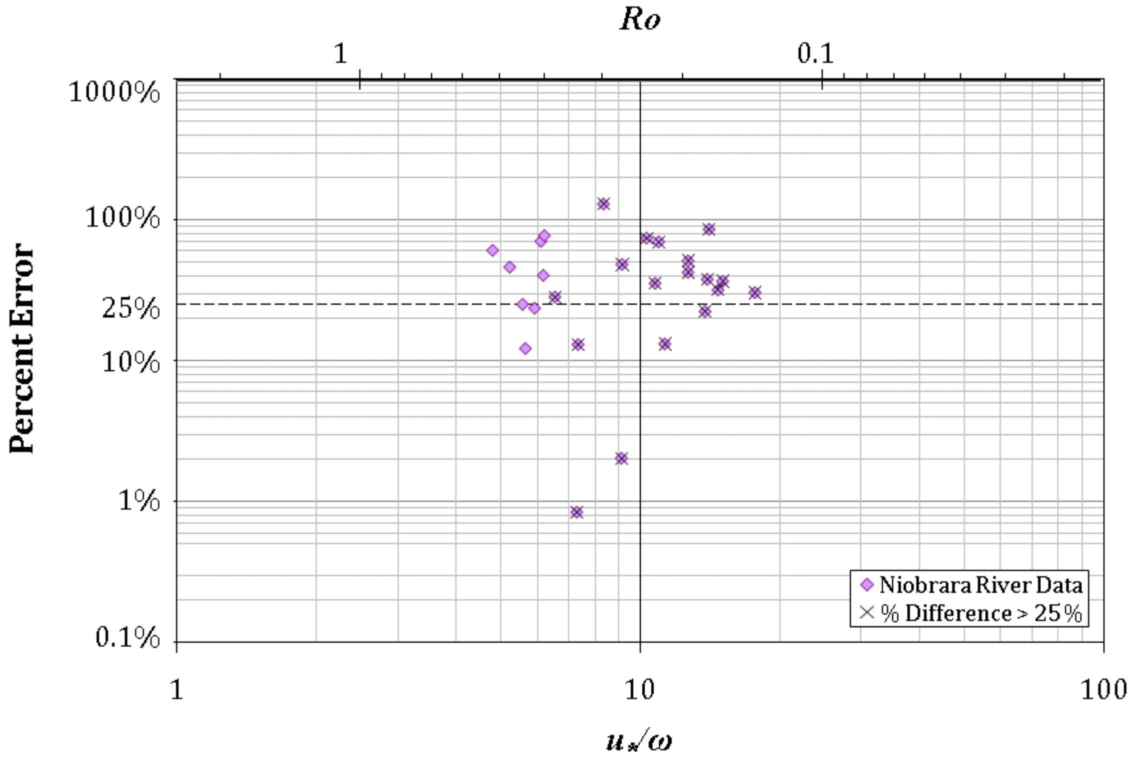


Figure 5.18. % Error in Measured and Calculated q_t for Niobrara River

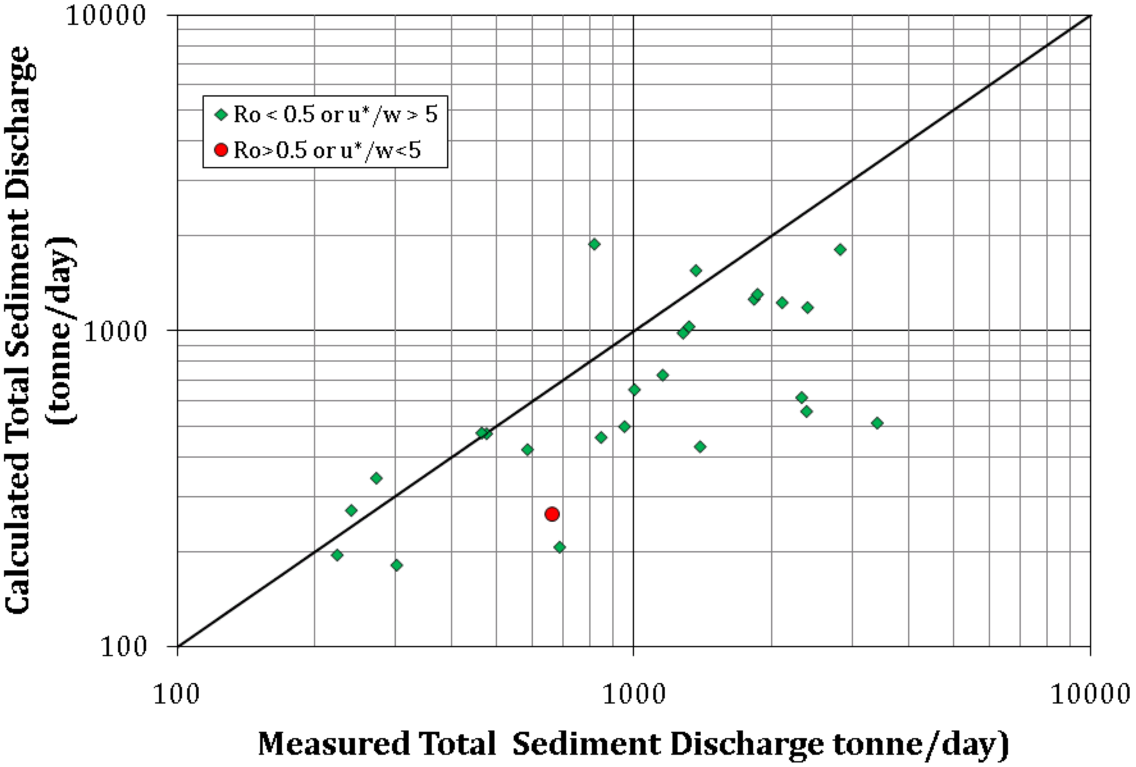


Figure 5.19. Accuracy of Calculated q_t for Niobrara River

The results from Figure 5.17, Figure 5.18 and Figure 5.19 indicate significant variability. Only 31% of the data are within 25% of the measured total sediment discharge. Based on previous results, it was expected that the proposed procedure would have better results, since the values of u_*/ω were almost always greater than 5; however this was not the case due to low measured total sediment discharge. On average, the measured results are greater than the calculated results. Table 5.4 summarizes the statistical parameters of this data set.

Table 5.4. Statistical Results for Niobrara River

		n	MPE	MAPE	R^2	ρ_c
Niobrara River	**All Data**	26	18%	24%	0.48	0.56
	$u_*/\omega < 5$	1	45%	45%	-	-
	$u_*/\omega > 5$	25	17%	23%	0.48	0.57

This data set shows very poor agreement based on the statistics. However, if more data were available there might have been better agreement. The data from the Niobrara River were collected in the late 40s and 50s versus the data from the 93 US streams, which were collected in the 70s and 80s. Thus, the measurement technique may have improved, which causes an increased level of accuracy. Finally, the measured sediment discharge is significantly less in the Niobrara data set compared to the 93 US streams data set.

The following analysis looks at the effects that total sediment discharge has on the correlation between the measured and calculated total sediment discharges. The three data sets are divided based on the actual total sediment discharge measured. Only the samples with total sediment discharge values less than 10,000 tones/day are analyzed. The results are shown in Figure 5.20.

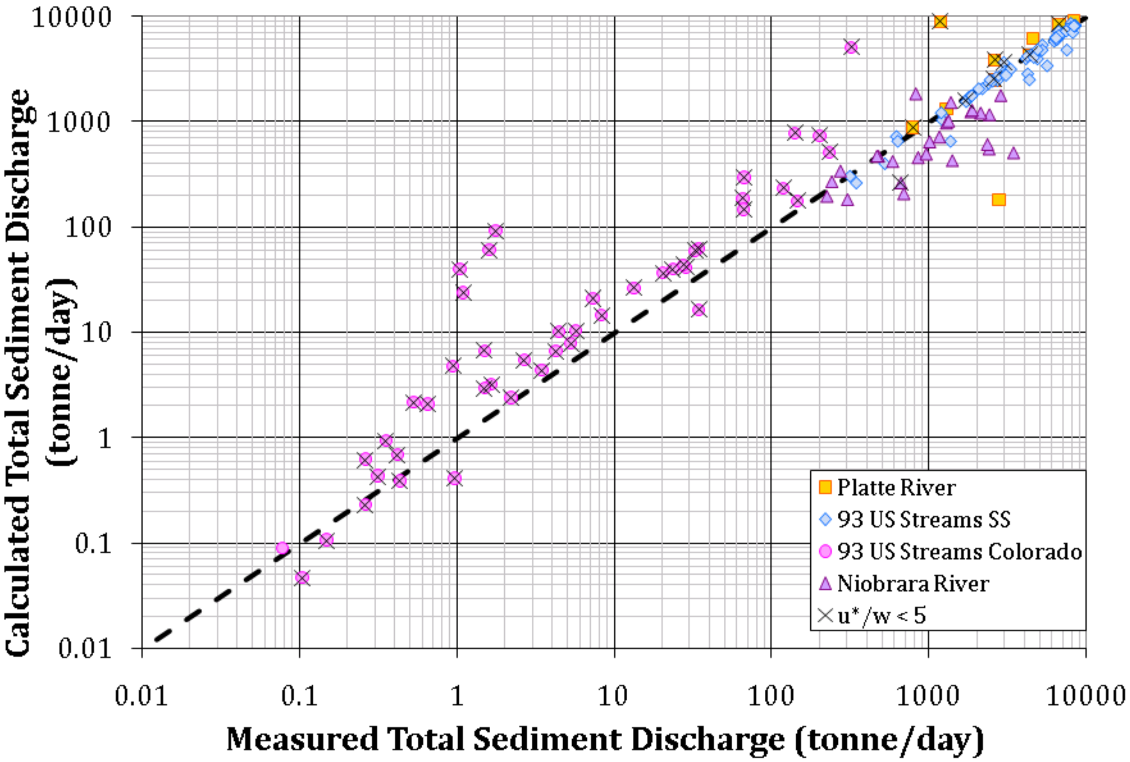


Figure 5.20. Accuracy of Low Calculated q_t

The results indicate that the low sediment discharges has a significant effect on the scatter of the data, even in cases where the value of u_*/ω is greater than 5. Table 5.5 summarizes the statistical parameters for the data plotted in Figure 5.20.

Table 5.5. Statistical Summary of Total Sediment Discharge < 10,000 tonne/day

River		n	MAPE	R²	ρc
Platte River	All Data	10	19%	0.20	0.40
	u*/ω < 5	6	17%	0.31	0.48
	u*/ω > 5	4	22%	0.38	0.42
US streams with SS	All Data	57	4%	0.96	0.97
	u*/ω < 5	3	7%	1.00	0.92
	u*/ω > 5	54	3%	0.97	0.98
US streams from Colorado	All Data	46	79%	0.65	0.73
	u*/ω < 5	45	77%	0.82	0.84
	u*/ω > 5	1	125%	-	-
Niobrara River	All Data	26	24%	0.48	0.56
	u*/ω < 5	1	45%	-	-
	u*/ω > 5	25	23%	0.48	0.57
Overall	All Data	139	2%	0.93	0.96
	u*/ω < 5	55	66%	0.89	0.92
	u*/ω > 5	84	10%	0.91	0.94

The results show that low sediment discharges results in a significant amount of scatter. The values of MAPE deviated significantly from zero and the value of the R^2 and ρ_c are close to 1 only for the US streams; the other samples suggest that the line of perfect agreement is off. Therefore, the value of u_*/ω needs to be greater than 5 and the sediment discharge needs to greater than 10,000 tonne/day for a higher degree of accuracy.

5.2.3 Applicability of Procedure

Based on the data analysis from the Platte River, US streams and Niobrara River, Figure 5.21 can be constructed on the applicability of the procedure.

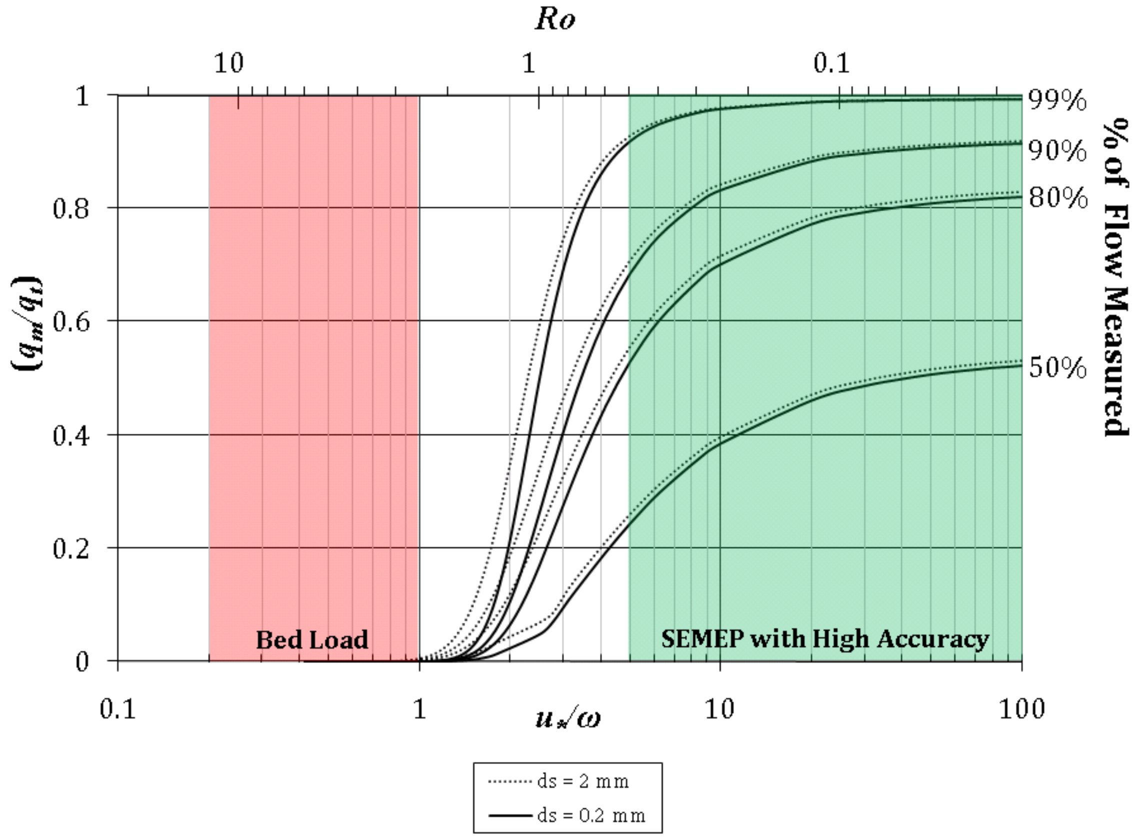


Figure 5.21. Applicability of SEMEP

Based on the analysis using the data from the USGS publications, a range of applicability is developed. Figure 5.21 shows that once u_*/ω is greater than 5 (*Ro* less than 0.5), SEMEP is valid. When the value of u_*/ω is between 1 to 5 there is a higher degree of uncertainty between the measurement and calculated sediment discharge from SEMEP. This is due to the low measured concentrations and the fact that wash load is more significant in the suspended sediment zone but cannot be measured by the Helley-Smith sampler. This is validated by the statistical analysis performed on the data sets based on u_*/ω and sediment discharge. The applicability analysis can be combined with the modes of transport. Figure 5.21 and Table 5.6, shows which procedure to use at a given u_*/ω value.

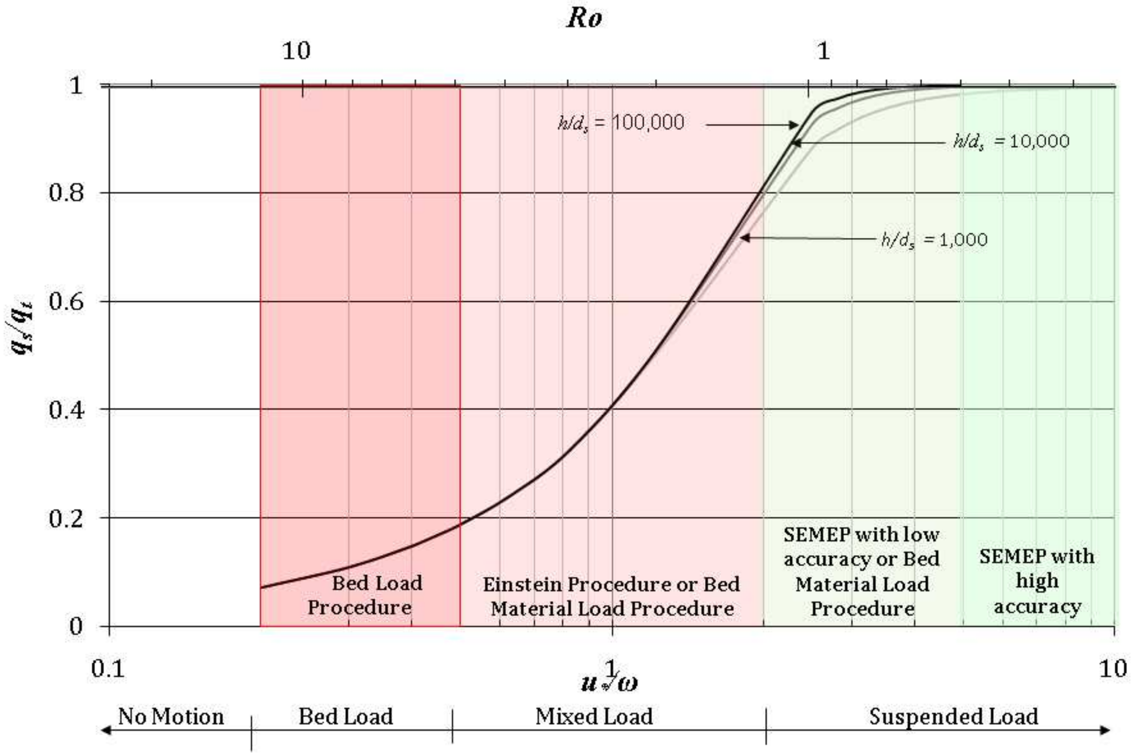


Figure 5.22. Modes of Transport and Procedure for Sediment Load Calculation

Table 5.6. Mode of Transport and Procedure

u*/ω	Ro	Mode of Transport	Procedure
<0.2	> 12.5	no motion	
0.2 to 0.5	5 to 12.5	bed load	Bed Load Procedure
0.5 to 2	1.25 to 5	mixed load	Einstein Procedure / Bed Material Load Procedure
2 to 5	0.5 to 5	suspended load	SEMEP with low accuracy/ Bed Material Load Procedure
>5	< 0.5		SEMEP with high accuracy

5.3 Comparison with the Modified Einstein Method

MEP was developed in 1955 by Colby and Hembree. It is based on data obtained at a single cross section to calculate total sediment discharge. Though the procedure is simpler to use than the Einstein Procedure, a great deal of experience and judgment is needed to calculate total sediment discharge reliably. In addition, the results could vary 20% between users due to the fact that there is not an explicit solution to the Einstein Integrals. MEP is useful in determining total sediment discharge at a given location and time within a cross section to quantify total sediment discharge. It has been beneficial for the development of equilibrium sediment transport equations.

5.3.1 Bureau of Reclamation Automated Modified Einstein Procedure

In 2006, the US Bureau of Reclamation developed BORAMEP. It is a computer program that was developed to provide more reliable and consistent total sediment discharge results based on MEP. The program requires users to enter necessary at-a-station hydraulic data, suspended sediment concentration and particle size distribution, and bed material particle size distribution. Numerical solutions are developed to calculate the Einstein Integrals, which removes the variability of answers between users. BORAMEP is based on the method developed by Colby and Hembree (1955) and the Bureau of Reclamation (Lara 1966; Shen and Hung 1983). Details of the procedure are outlined in Appendix A.

As mentioned earlier, prior to developing SEMEP, the author reviewed BORAMEP in detail. There were three main errors that were observed in the analysis. First, when the bed was armored (particles in the measured zone were not found in the bed), a total sediment discharge could not be determined because BORAMEP requires a minimum of two overlapping bins to determine the *Ro*. Next, when overlapping bins exist, a regression analysis is performed to determine *Ro* for the remaining bins, but a negative exponent is generated based on the data. Finally, on occasion the suspended sediment discharge was greater than the total sediment discharge because in performing total sediment discharge calculations based on the estimation of the *Ro*, the program underestimates the total sediment discharge. Therefore, the goal of this study is to develop a program that can be more applicable.

5.3.2 Calculation of Total Sediment Discharge Based on Particle Size Classification

Total sediment discharge calculations based on a median particle in suspension resulted in good agreement between the measured total sediment discharge and the calculated total sediment discharge. However, the original MEP and BORAMEP both divide the bed material and suspended sediment into bins for analysis. An analysis is performed to determine if dividing particles into bins will result in a better analysis based on SEMEP. SEMEP does not perform a regression to determine *Ro* for each bin. It calculated *Ro* for each bin based on a representative particle (d_i) from each bin.

Table 5.7 shows the particle size classes associated with each bin.

Table 5.7. Bin division for Total Sediment Discharge Analysis

Bin No	Lower Limit (mm)	Upper Limit (mm)
Bin 1	0.001	0.002
Bin 2	0.002	0.004
Bin 3	0.004	0.008
Bin 4	0.008	0.016
Bin 5	0.016	0.032
Bin 6	0.032	0.064
Bin 7	0.064	0.125
Bin 8	0.125	0.25
Bin 9	0.25	0.5
Bin 10	0.5	1
Bin 11	1	2
Bin 12	2	4
Bin 13	4	8
Bin 14	8	16
Bin 15	16	32
Bin 16	32	64
Bin 17	64	128

The data set used to test total sediment discharge calculated was from the USGS publication (Williams and Rosgen 1989). Data from Chulitna River below Canyon near Talkeetna, Alaska contained 43 samples tested in the 1980s. This river was used to test compare the results from the median particle size and bin analysis. Figure 5.23 shows the results from the bin analysis, composite analysis and measured total sediment discharge.

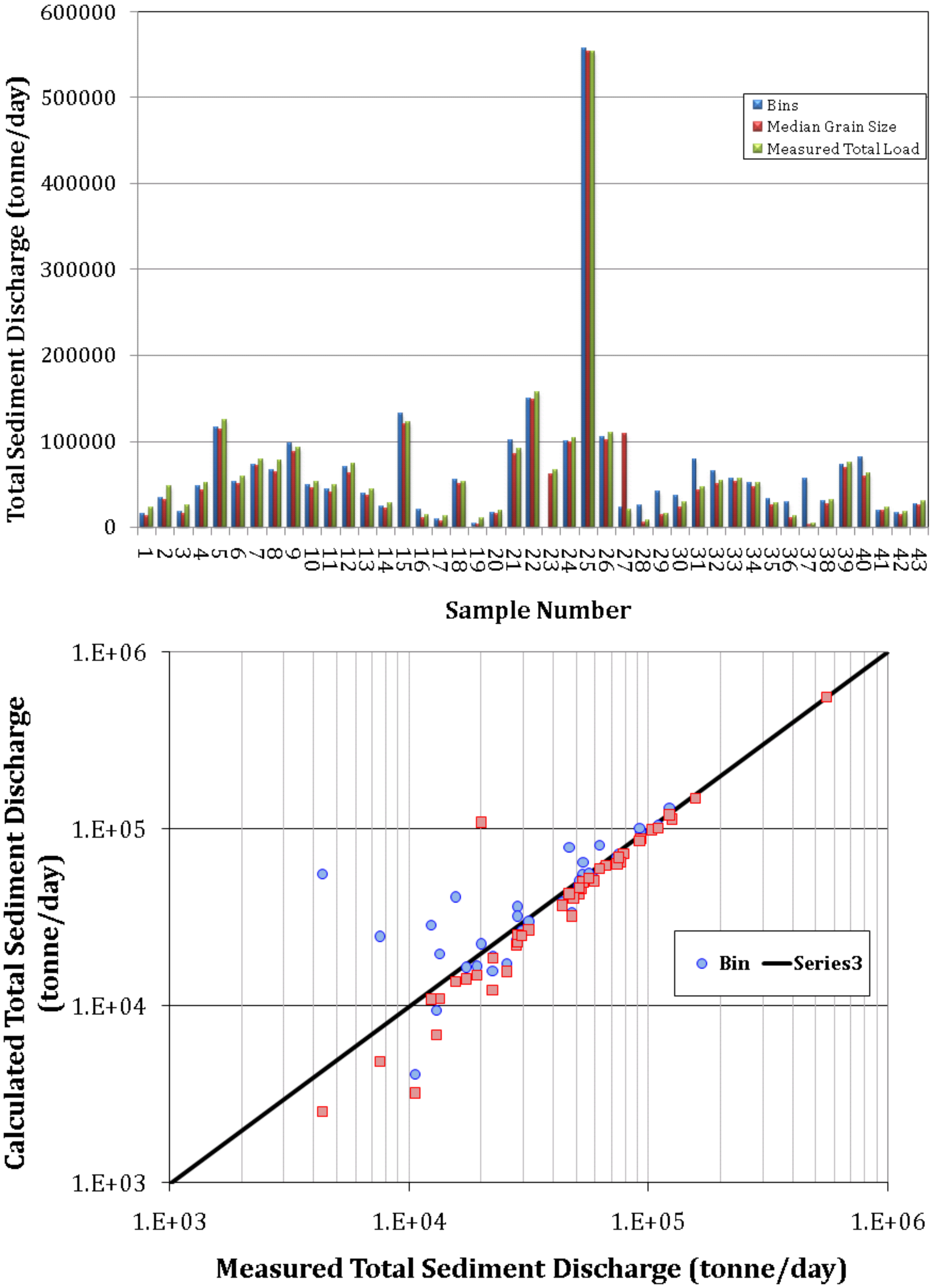


Figure 5.23. Comparison for Bin, d_{ss50} and Measured q_t for Chulitna River

In general, the results indicate that the total sediment discharge calculated based on a median grain size in suspension has a tendency to be slightly less than the measured sediment discharge, except for sample 26. The total sediment discharge based on the bin analysis is always greater than the median grain size in suspension analysis, except for sample 26, and also occasionally greater than the measured total sediment discharge. For some samples the bin analysis results in a total sediment discharge significantly greater than that determined by the median grain size in suspension. There are more samples further from the line of perfect agreement and calculated sediment discharge is greater than the measured sediment discharge in the bin analysis. Therefore, it is recommended that the analysis be performed based on a median grain size in suspension analysis, since the results are more consistent and provide better accuracy.

5.3.3 Comparison of Proposed Procedure to BORAMEP

Data from the 93 US streams publication was also used to compare BORAMEP to SEMEP. The seven sites are summarized in Table 5.8, were used to perform the analysis in BORAMEP and SEMEP. The number of calculated total sediment discharge within 25% of the measured total sediment discharge is also shown in the table.

Table 5.8. Comparison between Proposed Procedure and BORAMEP

RIVER	No. of Samples	Total Sediment Discharge BORAMEP		Total Sediment Discharge SEMEP	
		Not Calculated	Within 25% of Measurement	Not Calculated	Within 25% of Measurement
Susitna River near Talkeetna Alaska	37	8	2	0	37
Chulitna River below Canyon near Talkeetna, Alaska	43	40	0	0	35
Susitna River at Sunshine, Alaska	37	7	3	0	36
Snake River near Anatone, Washington	31	5	1	0	28
Toutle River at Tower Road near Silver Lake, Washington	19	5	9	0	18
North Fork Toutle River near Kid Valley, Washington	5	3	2	0	5
Clearwater River at Spalding, Idaho	35	0	1	0	34
Totals	**207**	**68 (33%)**	**18 (9%)**	**0 (0%)**	**193 (93%)**

The analysis shows that out of the 207 samples, total sediment discharge could not be calculated by BORAMEP for 68 samples. There were a variety of reasons why total sediment discharge was not calculated. Of the remaining samples, only 18 were within 25% of the measured total sediment discharge. However, SEMEP calculates total sediment discharge for all 207 sites and 193 sites contained total sediment discharge calculations within 25% of the measured total sediment discharge. This suggests that SEMEP is an improvement on the existing MEP used in BORAMEP. Figure 5.25 shows a schematic representation of the results from both BORAMEP and the proposed procedure. There is a greater percent difference in measured total sediment discharge when using BORAMEP.

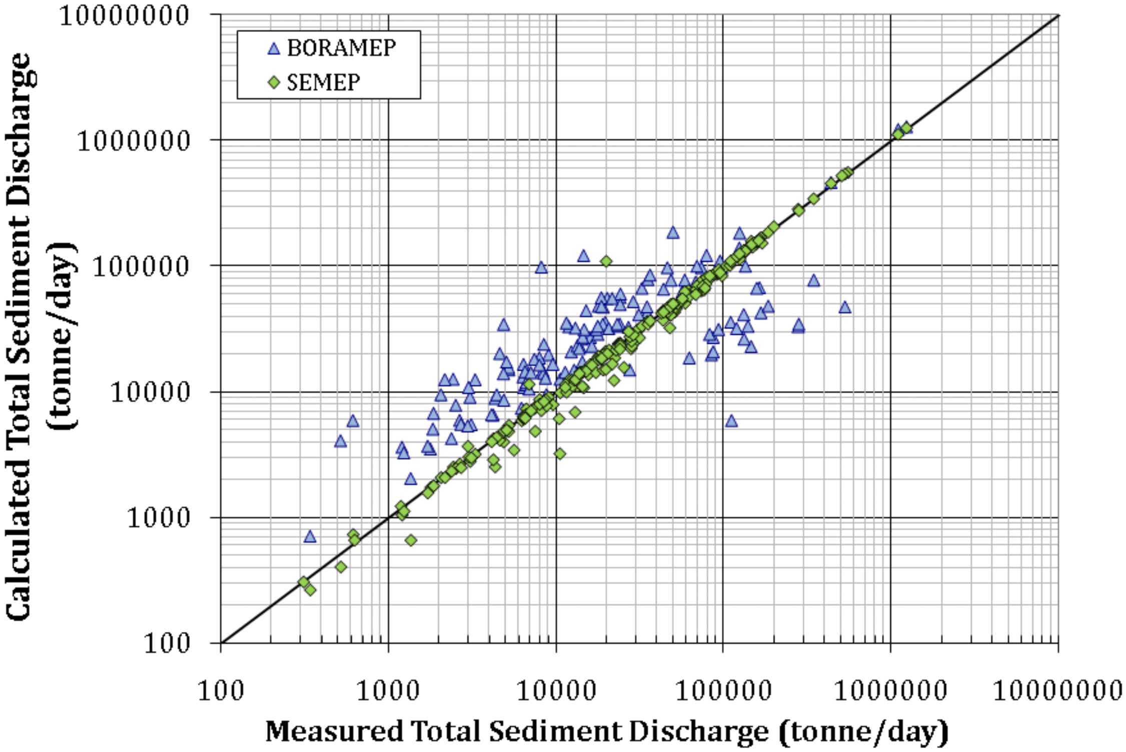


Figure 5.24. Comparison between BORAMEP and SEMEP vs. Measured q_t

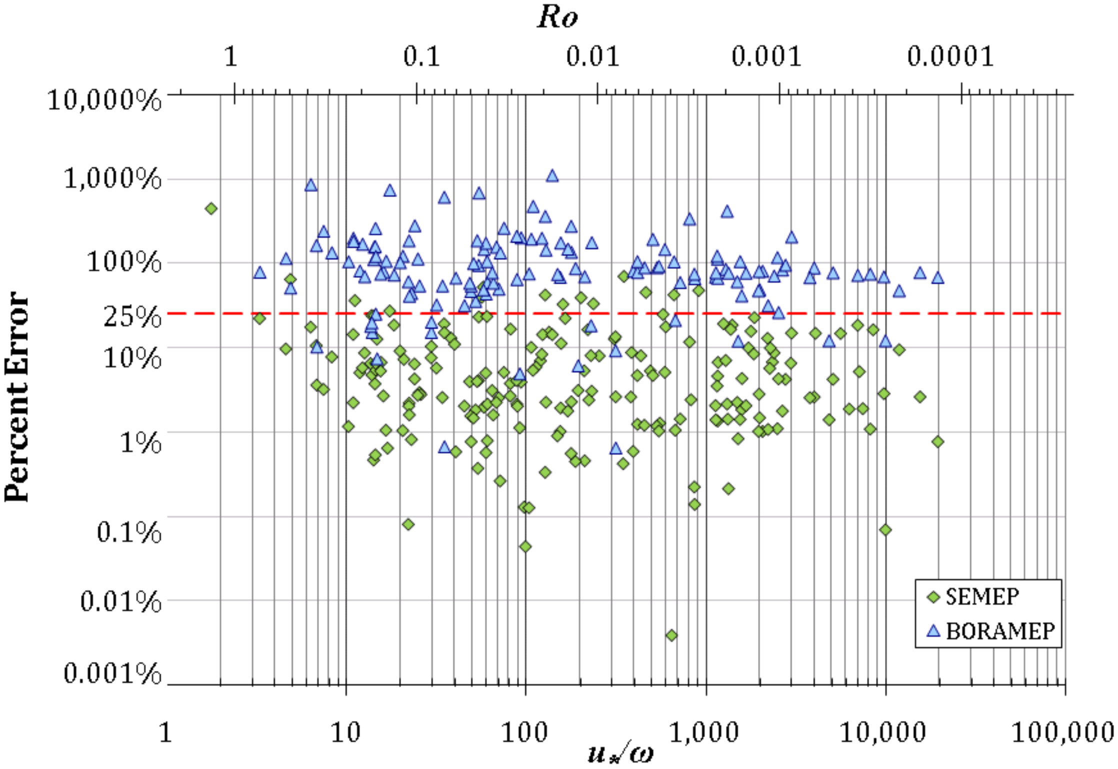


Figure 5.25. % Error Analysis of q_t for BORAMEP and SEMEP

Figure 5.24 and Figure 5.25 both show that SEMEP improves total sediment discharge calculations compared to BORAMEP. Table 5.9 summarizes the statistical parameters for the comparison between BORAMEP and SEMEP.

Table 5.9. Statistical Summary between BORAMEP and SEMEP

Program	n	MAPE	R^2	CC
BORAMEP	139	18%	0.65	0.74
SEMEP	207	2%	0.98	0.99

The results in Table 5.9 show that SEMEP has a MAPE closer to zero and a R^2 and ρ_c closer to 1 compared to the data from BORAMEP. In addition, total sediment discharge could be determined for all the samples.

5.4 Calculation of Total Sediment Discharge based on Helley-Smith

The previous section calculated total sediment discharge by using the measured suspended sediment discharge and extrapolating to determine the sediment discharge near the bed. This section looks at the material near the bed, collected using a Helley-Smith sampler, and extrapolates to determine the material in suspension. The procedure for this analysis is outlined in Section 4.2.2. Figure 5.26 is a schematic of a handheld Helley-Smith and the zone of measured and unmeasured sediment discharge.

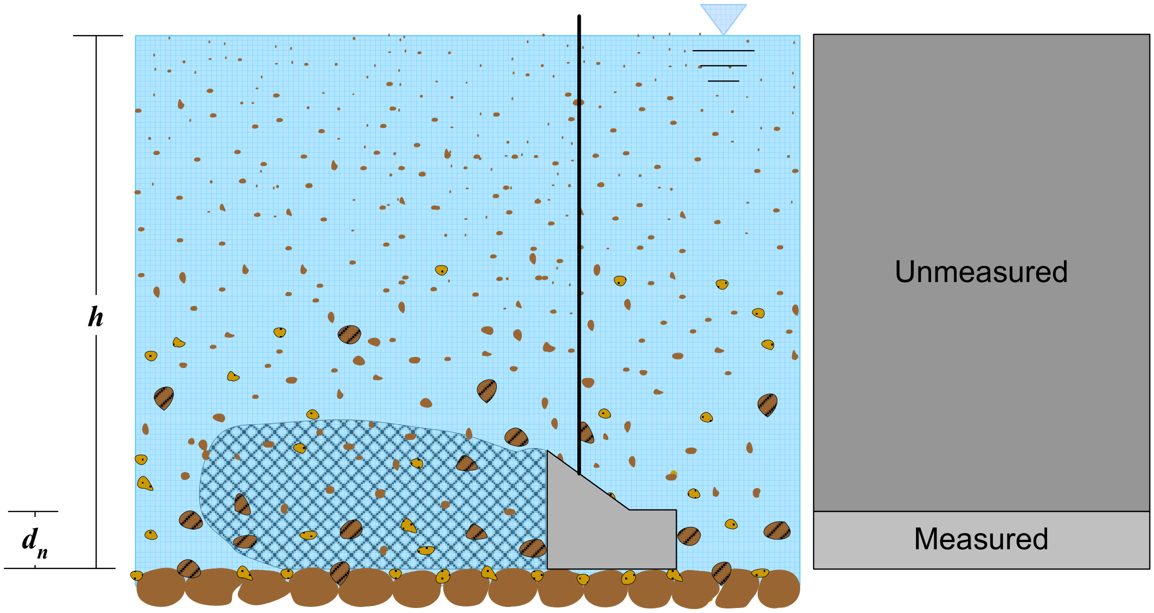


Figure 5.26. Schematic to depict measured and unmeasured zone of a Helley-Smith

This procedure would be applicable in regions where the majority of sediment is transported near the bed. To test this method, data sets from Idaho and Colorado were used where the majority of transport is expected to be near the bed since the rivers are gravel to cobble bed (Williams and Rosgen 1989; RMRS 2008). It is important to note that that the Helley-Smith sampler does not collect particles smaller than 0.2 mm. As a result, fine particles moving near the bed cannot be measured. Figure 5.27 and Figure 5.28 show how the measured data fit the theoretical derivation of the total sediment discharge.

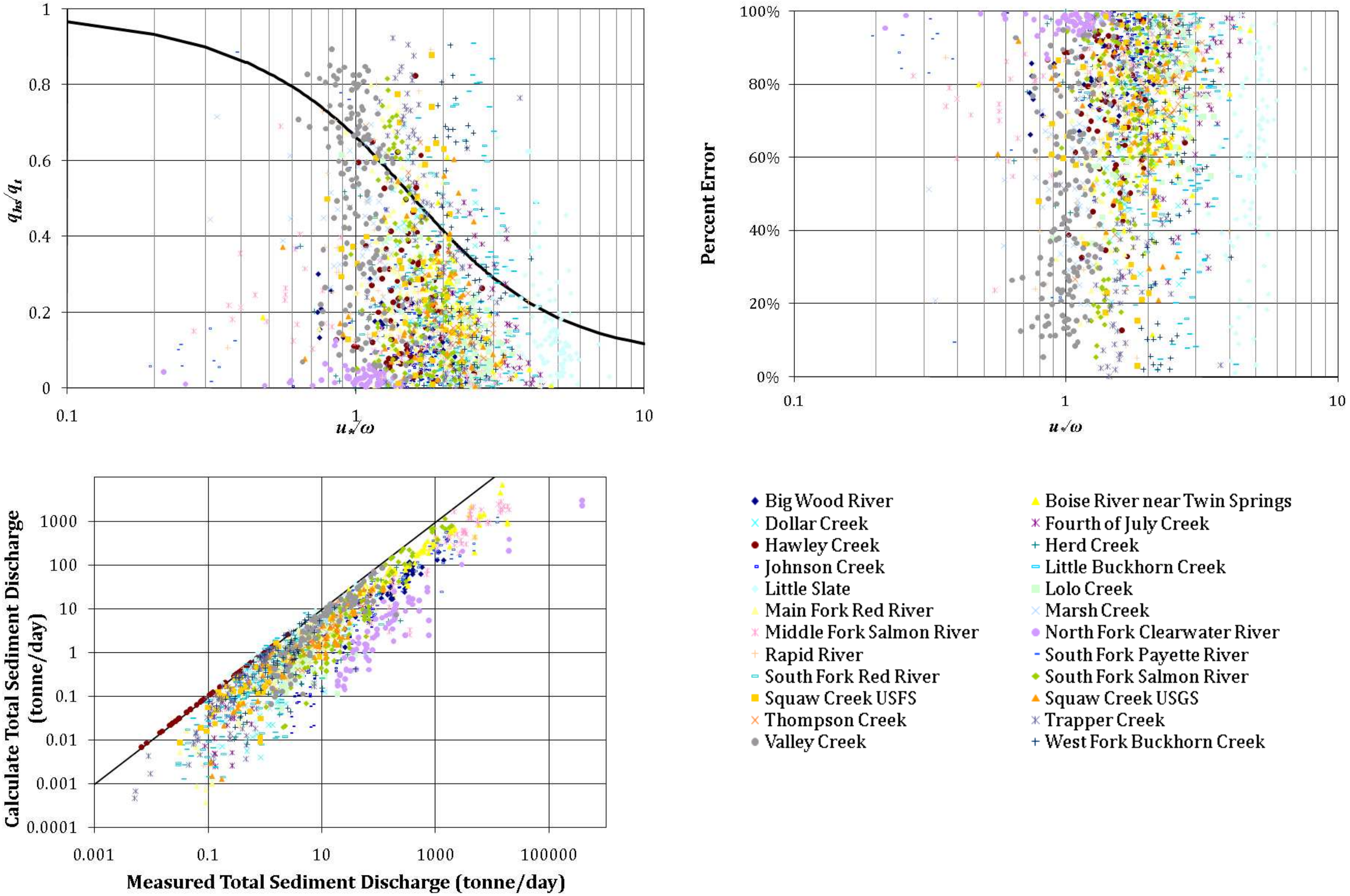


Figure 5.27. Helley-Smith Analysis of Idaho Streams

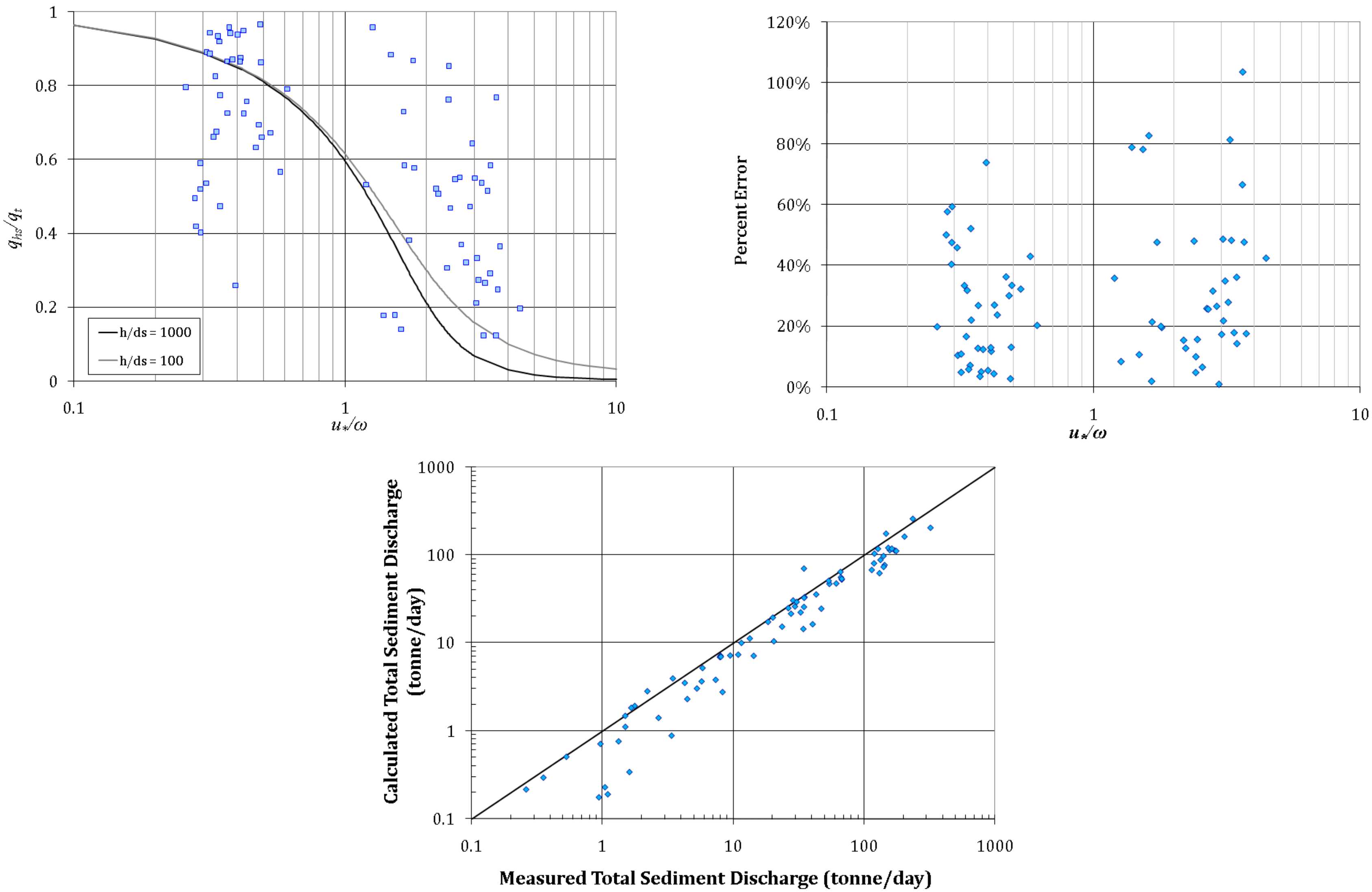


Figure 5.28. Helley-Smith Analysis of Colorado Streams

The results suggest that the method cannot be used to determine what is in suspension based on the measurements found near the bed. The figures show that when SEMEP is graphed with the measured data (q_{hs}/q_t); there is significant scatter in the data. One of the main causes of this error is the fact that even though these streams are coarse sand to cobble bed streams, a significant amount of sediment was measured in suspension. The high suspended sediment measurement is associated with the measurement of fine particles by the depth-integrated sampler, while the Helley-Smith sampler cannot measure fine material. Thus, the calculated sediment discharge is usually less than the measured total sediment discharge. In addition, the total sediment discharges for all these streams are very low (less than 10,000 tonnes/day for Idaho and less than 1,000 tonnes/day for Colorado). The low measured sediment discharges and the Helley-Smith sampler's inability to fine particles is why this procedure in not valid.

Chapter 6: Validation and Effect of Unmeasured Depth

Suspended sediment data are collected by either a point sampler or depth-integrated sampler. The previous chapter uses data from a depth-integrated sampler or Helley-Smith sampler to determine the total sediment discharge by calculating *Ro* based on u_*, κ and ω. Research has shown that there is a deviation between the measured and calculated Rouse number (Ro_m and Ro_c). On average, the Ro_m is less than Ro_c (Anderson 1942; Einstein and Chien 1954). Thus, using a point sampler allows for the total sediment discharge to be calculated directly by fitting a regression through the measured concentration and velocity points. As a result, the following parameters are determined directly: u_*, y_o, c_a and *Ro*. This chapter compares total sediment discharge results between the measured, calculated (based on regression analysis) and proposed procedures (SEMEP). In addition, an explanation is developed for the deviation between the Ro_m and Ro_c.

6.1 Effects of Unmeasured Depth

The depth of flow is variable based on the sampler type, percent of flow sampled and site being analyzed. Using SEMEP, the value of q_m/q_t is determined and plotted against u_*/ω at different values of d_n. Figure 6.1 shows how the percent of flow depth affects the calculation of q_m/q_t. The value of h/d_s is held constant.

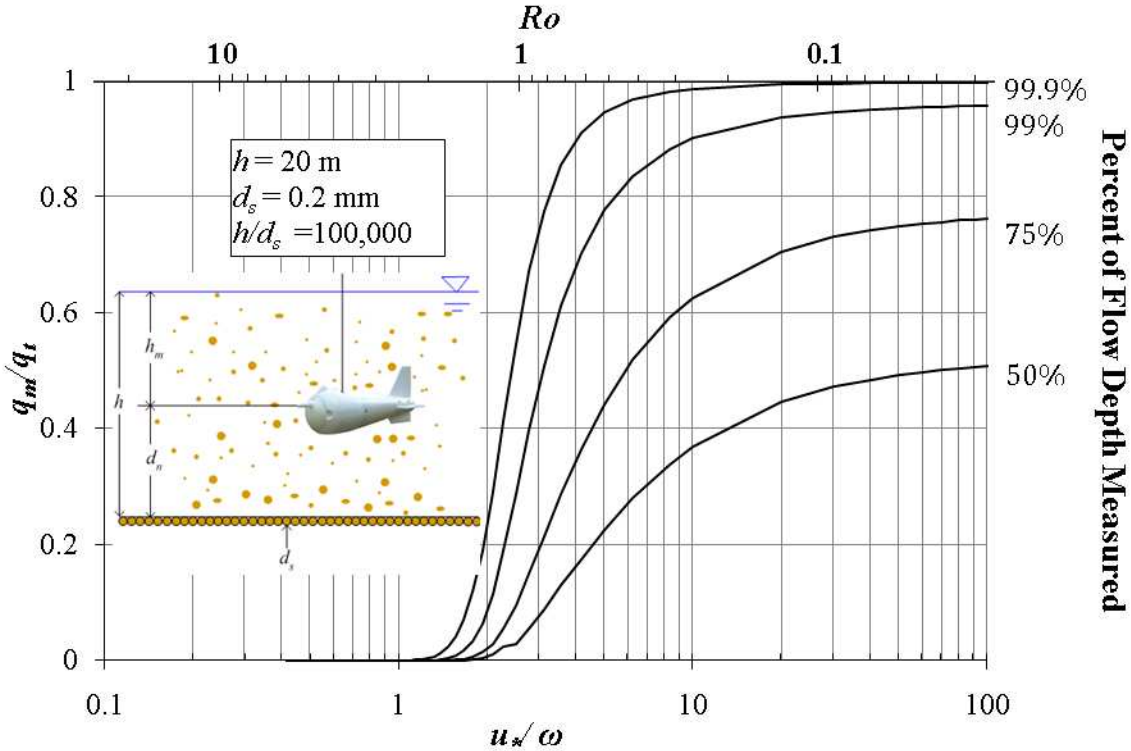


Figure 6.1. Variation in q_m/q_t based on Percent flow depth measured.

Figure 6.1 suggests that as a higher percentage of flow is measured, a large value of q_m/q_t is determined. The benefit of this graph is to show that measuring 50% of the flow does not mean that one will measure 50% of the sediment. The value of q_m/q_t is a function of the measured depth (h_m) and u_*/ω. Table 6.1 summarizes the results in a tabular form.

Table 6.1. q_m/q_t Based on the Measured Depth

h_m (m)	% Flow Depth Measured	q_m/q_t			
		$u_*/\omega = 1$	$u_*/\omega = 2.5$	$u_*/\omega = 10$	$u_*/\omega = 100$
19.9	99.50%	0.0	0.55	0.986	0.996
19	95%	0.0	0.29	0.9	0.96
15	75%	0.0	0.1	0.63	0.76
10	50%	0.0	0.03	0.37	0.51

This analysis is helpful for understanding how much of a given river will need to be sampled to provide an accurate estimate of total sediment discharge based on the value of u_*/ω.

6.2 Validation using Point Data

To validate SEMEP, laboratory and rivers are used. Table 6.2 summarizes the data used for this analysis; more detailed information can be found in Chapter 3. Coleman's laboratory experiment, the Enoree River, Middle Rio Grande and Mississippi River data sets were selected because they contain point velocity and concentration measurements.

Table 6.2. Data Summary

Data	h	d_n	h/d_s
a.) Coleman Lab Data (Coleman 1986)	0.170 to 0.172 m	0.006 m	1,600
b.) Enoree River, SC (Anderson 1942)	3 to 5.15 ft	0.06 to 0.103 ft	3,200 to 6300
c.) Middle Rio Grande at Bernalillo, NM (Nordin and Dempster 1963)	2.36 to 2.56 ft	0.27 to 0.37 ft	11,500 to 12,500
d.) Mississippi River, MS (Akalin 2002)	21 to 110 ft	0.4 to 2.2 ft	15,000 to 530,000

The data from the point measurements are analyzed by determining the measured sediment discharge, calculated sediment discharge based on regression and sediment discharge determined using SEMEP. This will provide validation of SEMEP. In addition, the significance of the h/d_s and h_m can be determined. Statistical analyses are performed on each of the data sets to determine the reliability of the results. The values will be compared based on q_m/q_t and q_t.

6.2.1 Ratio of Measured to Total Sediment Discharge

Using SEMEP, outlined in Section 4.2.1, the values of q_m/q_t are determined and graphed as a function of u_*/ω and d_n/h. These results are shown in Figure 6.2 to Figure 6.8.

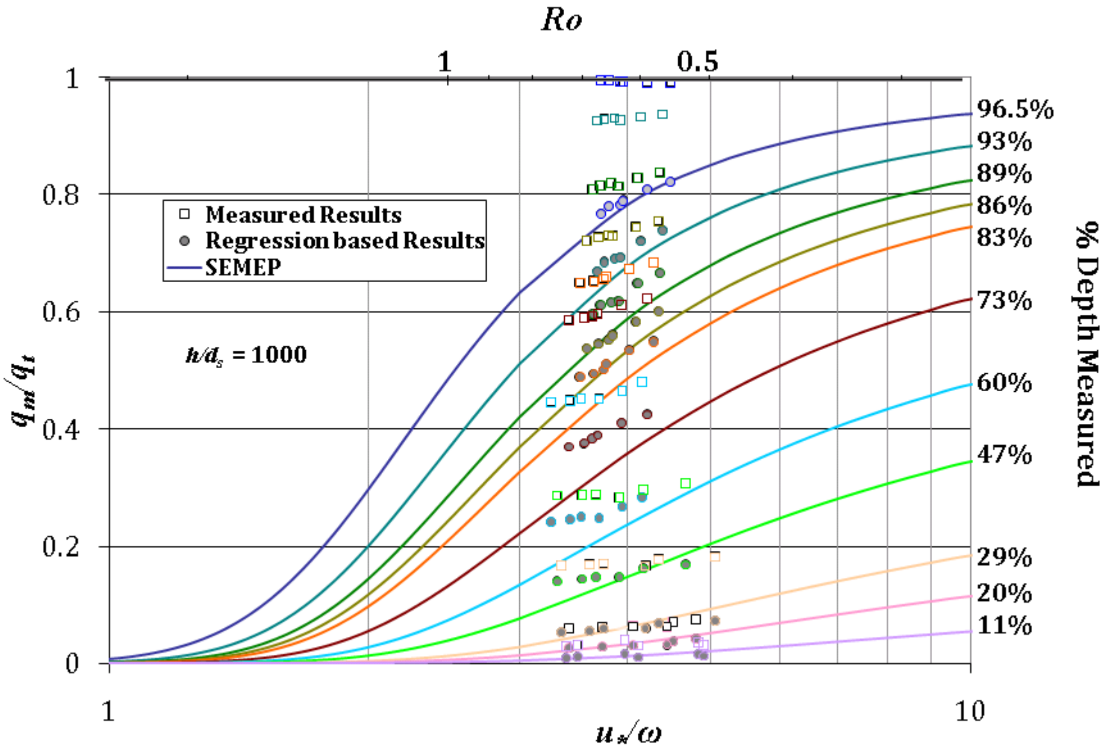


Figure 6.2. q_m/q_t **for Coleman Laboratory Data**

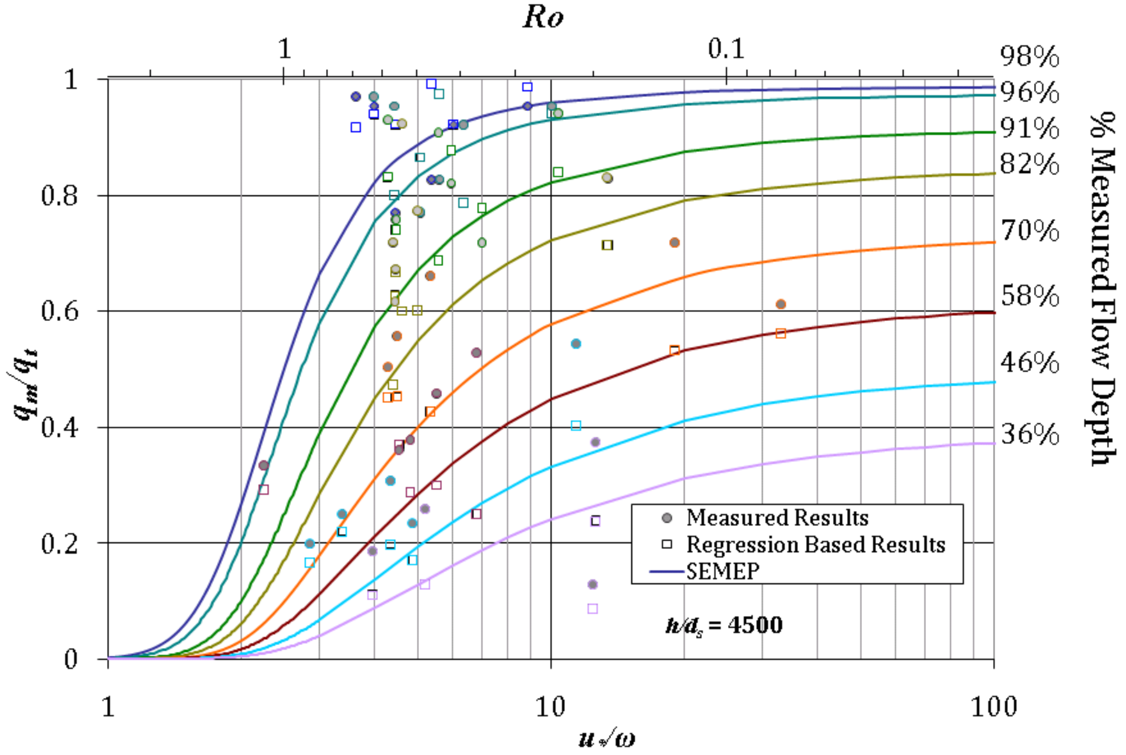


Figure 6.3. q_m/q_t **for Enoree River**

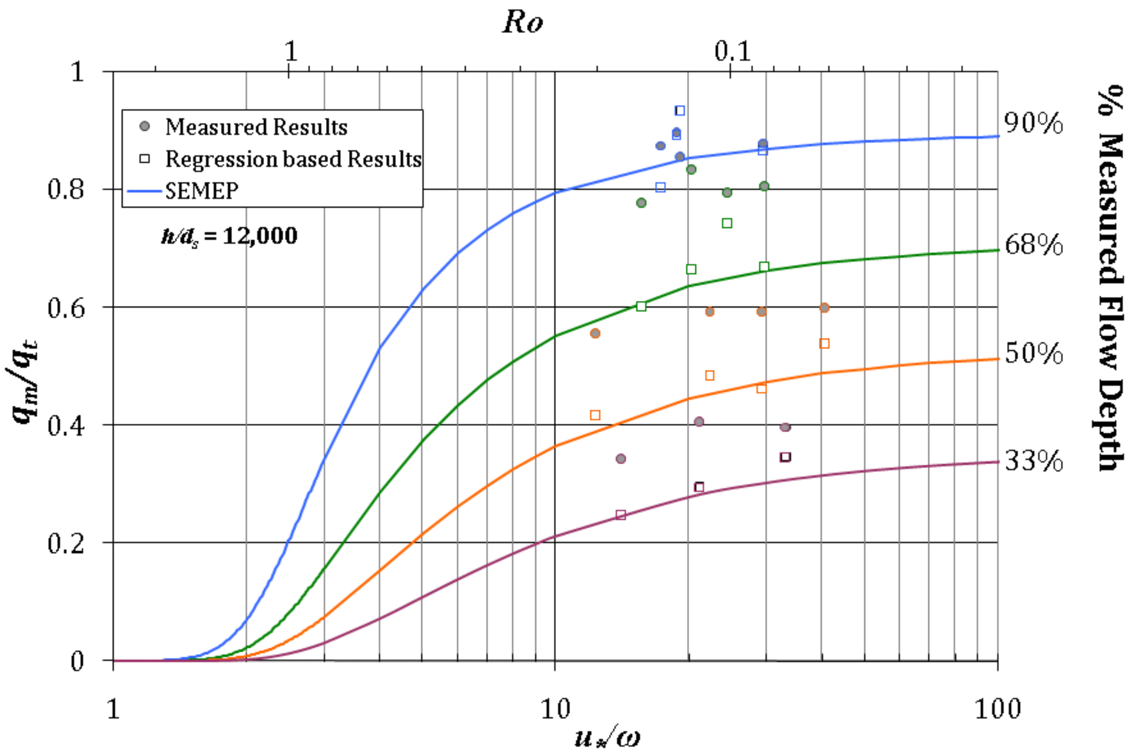


Figure 6.4. q_m/q_t for Middle Rio Grande

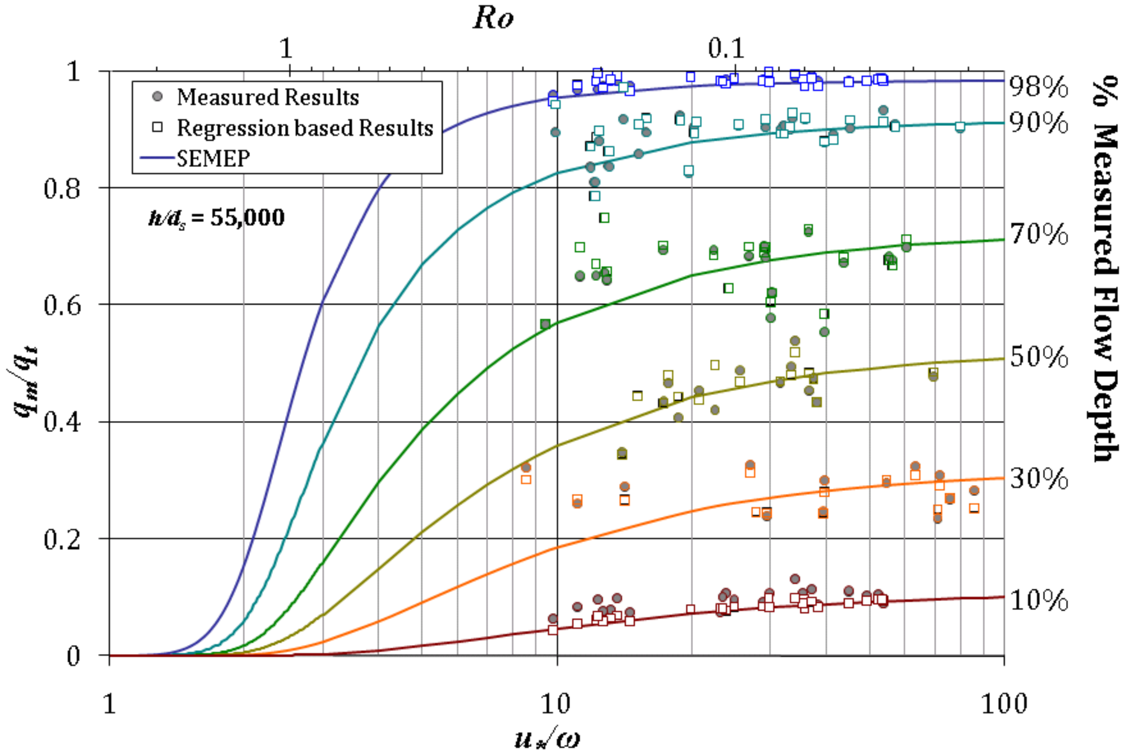


Figure 6.5. q_m/q_t for Mississippi River – Tarbert Landing

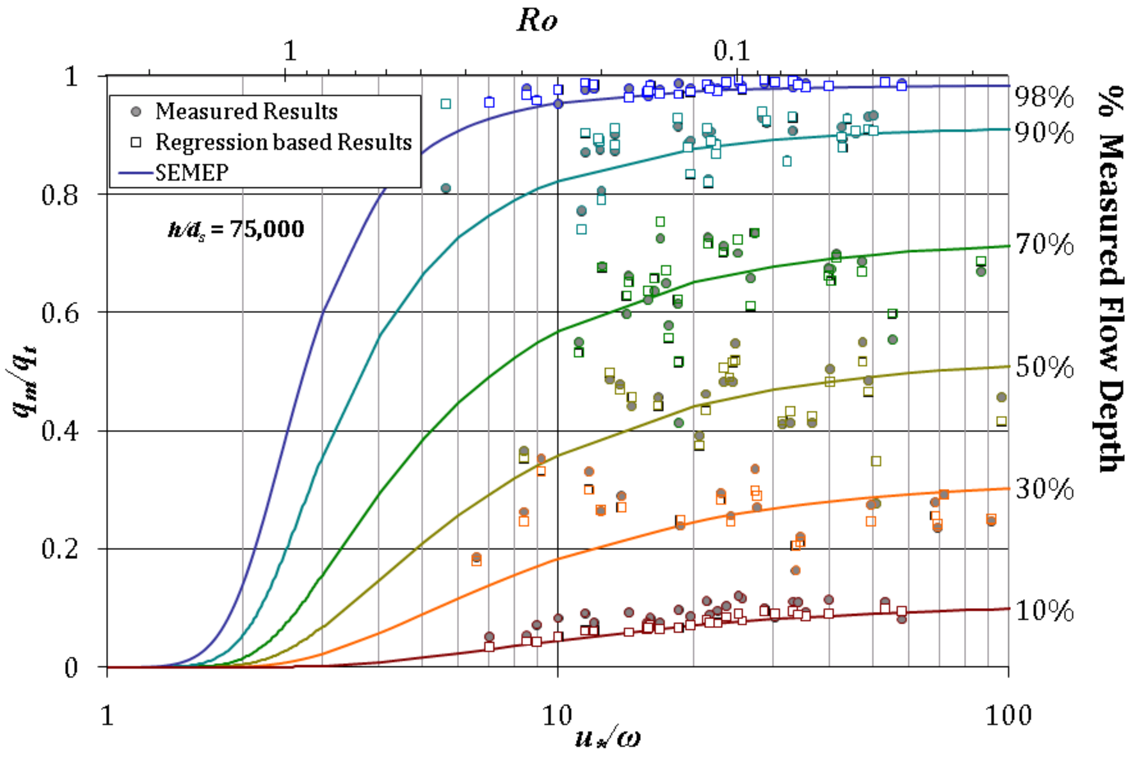


Figure 6.6. q_m/q_t **for Mississippi River - Union Station**

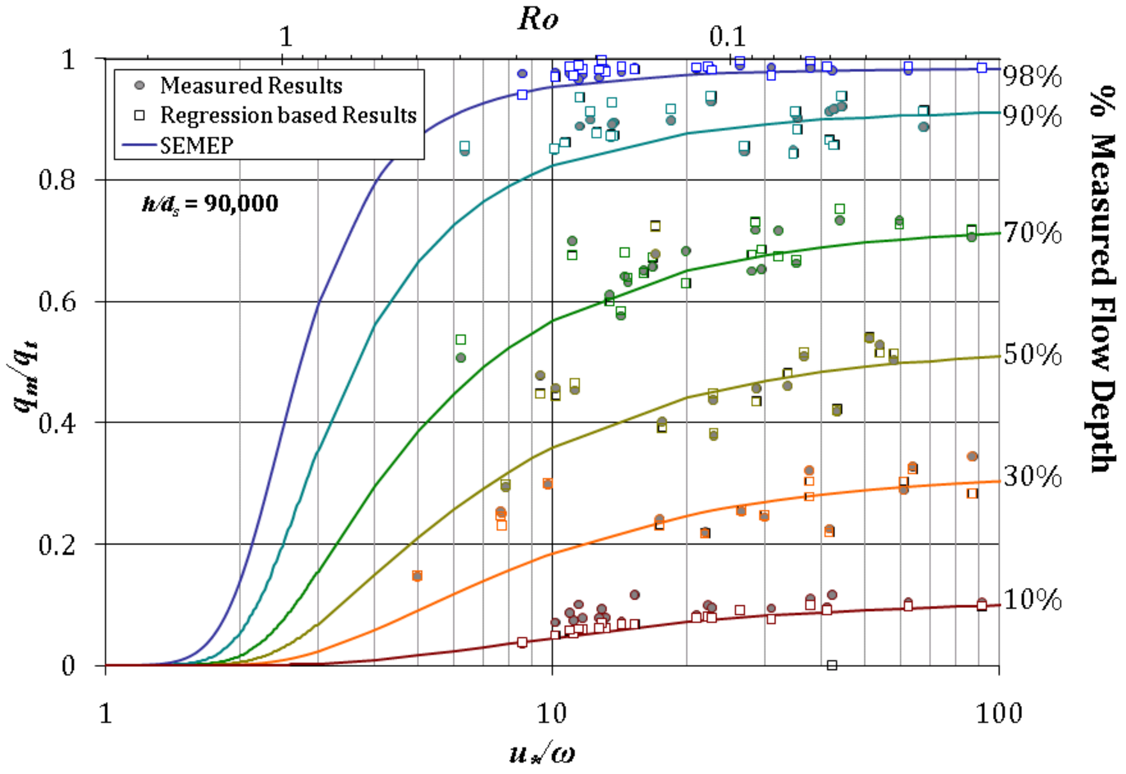


Figure 6.7. q_m/q_t **for Mississippi River - Line 6**

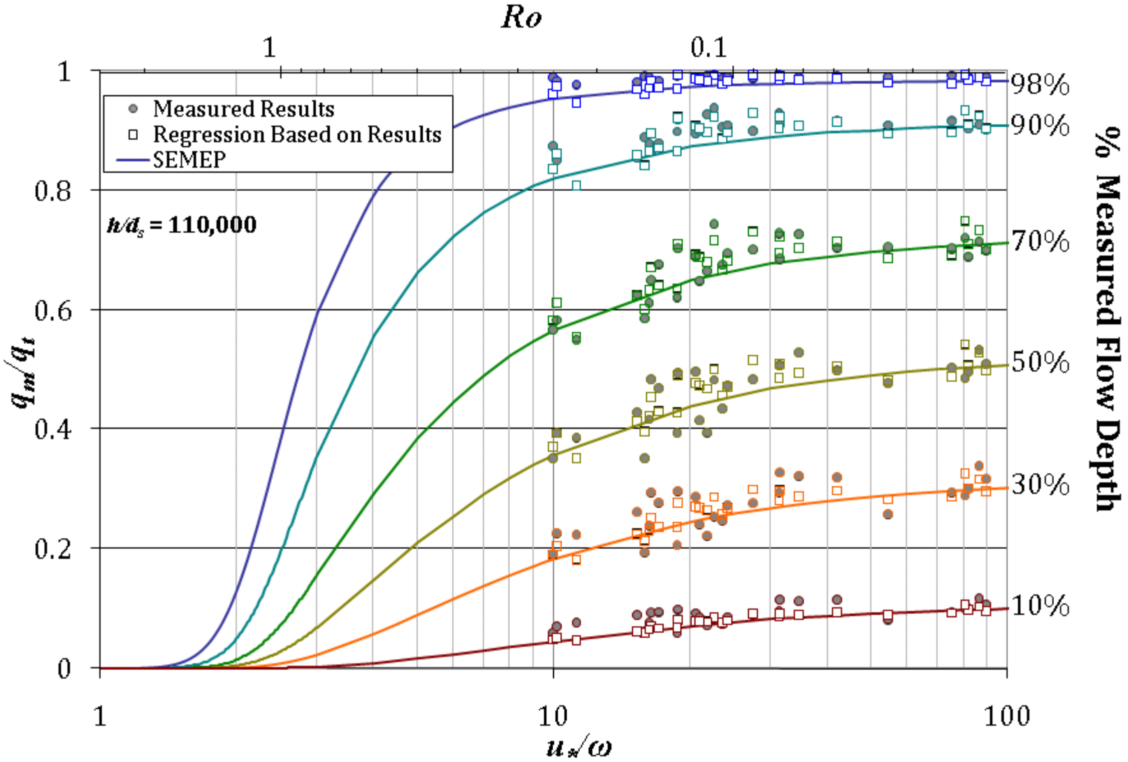
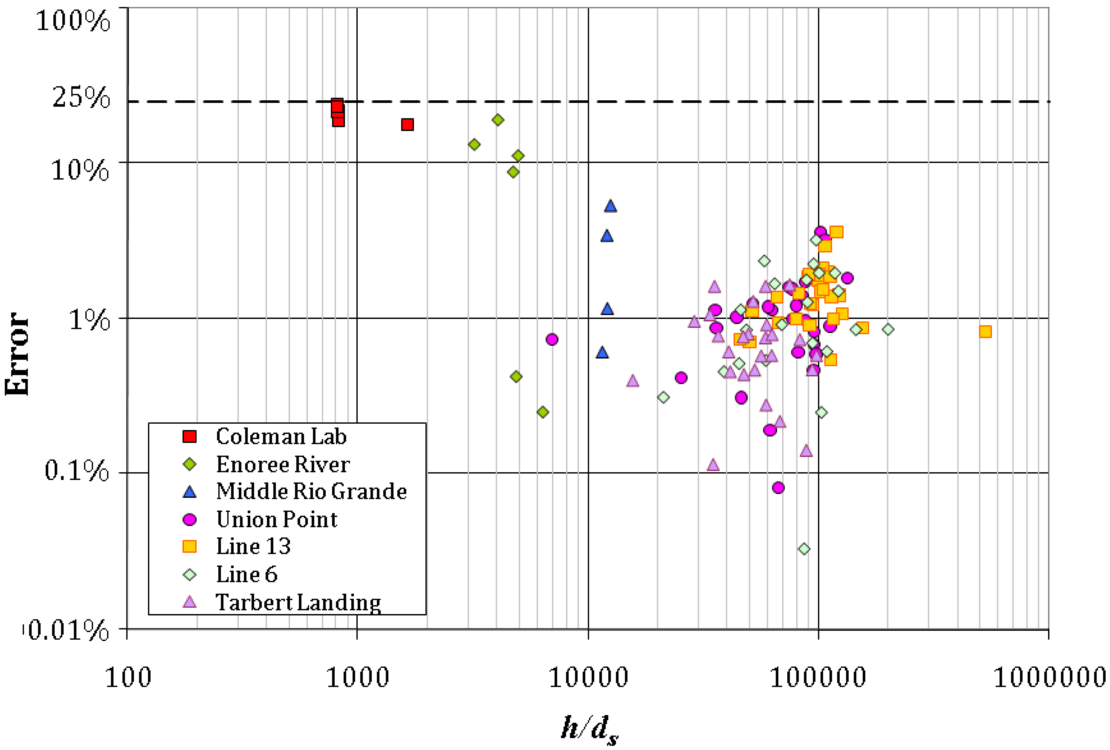


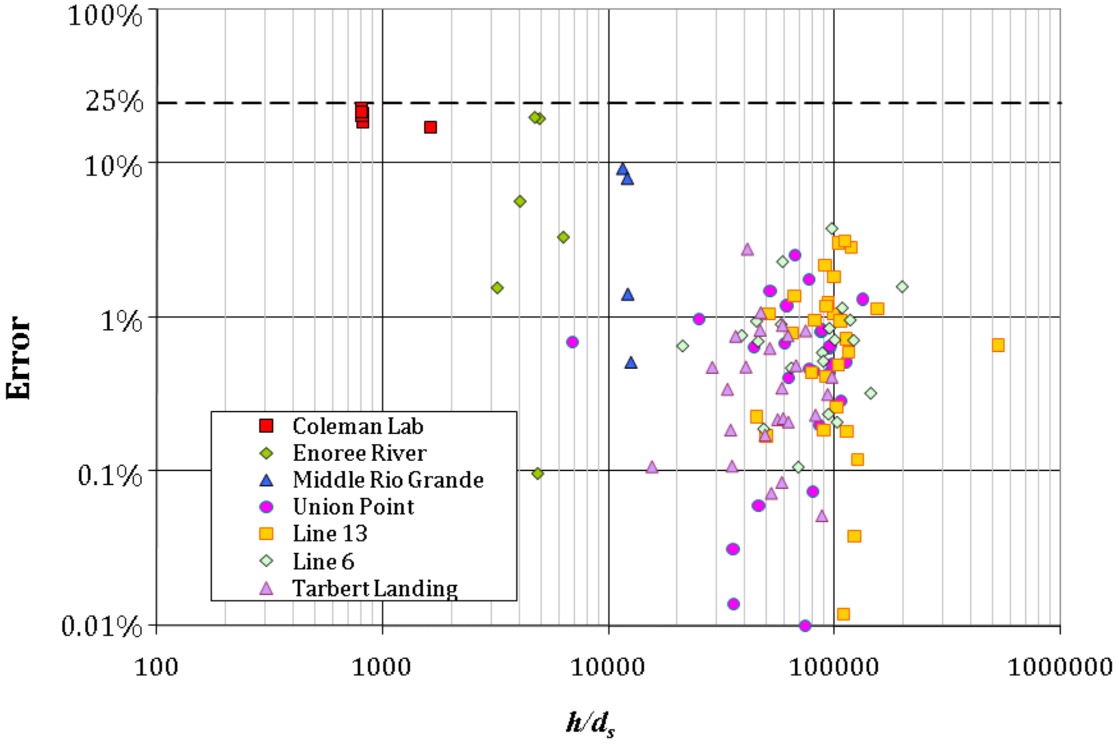
Figure 6.8. q_m/q_t **for Mississippi River – Line 13**

The figures compare the value of q_m/q_t determined by SEMEP to the measured and calculated q_m/q_t. The series of solid lines represent SEMEP. The actual measured data points are represented by a filled dot and the calculated data determined from the regression analysis are represented by a square. As the ratio of h/d_s increases, so does the value of u_*/ω, thus the calculated and SEMEP values of q_m/q_t are closer to the measured q_m/q_t. In Chapter 5, the applicability of SEMEP was determined. If the value of u_*/ω is less than 5 the procedure is not valid. Based on Figure 6.2 and Figure 6.3 that data from Coleman's laboratory experiment and the Enoree River have values of u_*/ω less than 5. The value of q_m/q_t determined based on SEMEP and calculated based on the regression analysis under-predicts q_m/q_t compared to the actual measurements. As a result, the total sediment discharge is over-predicted using SEMEP. It is interesting to note that once a minimum of 80% of the flow depth is measured the error between the measured, calculated and SEMEP q_m/q_t coincide well. This occurs because a limited amount of data points are used to determine the measured and calculated total sediment discharges. Figure 6.4 to Figure 6.8 shows data with value of u_*/ω greater than 5. In general, this analysis validates previous findings that once the value of u_*/ω is greater than 5, SEMEP works well. In addition, the higher the value of h/d_s, the higher the degree of agreement with the amount of sediment that will be measured versus the amount of sediment calculated or determined based on the proposed procedure (refer to Figure 6.9).

Figure 6.9 clearly shows that as the value of h/d_s increases the percent difference decreases significantly. As seen in Figure 6.2 to Figure 6.8, as the percent of measured flow depth decreased there seems to be less agreement with the amount of sediment that will be measured versus the amount of sediment calculated or determined based on SEMEP (refer to Figure 6.10).

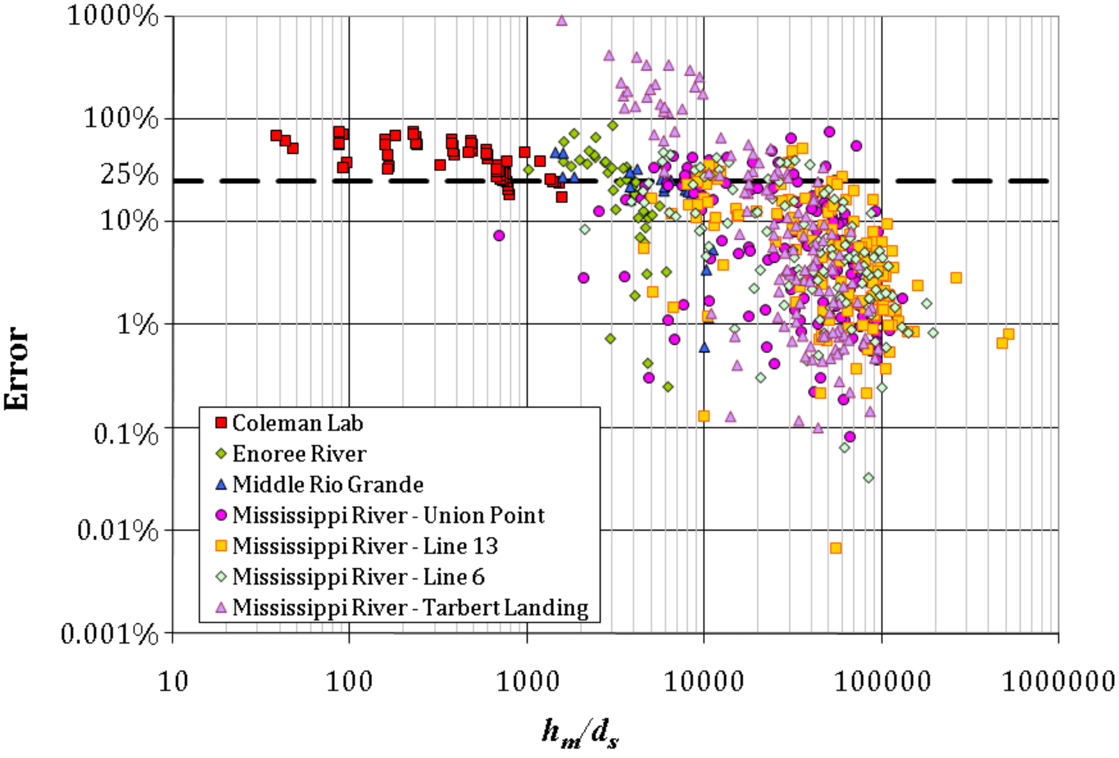


a.) SEMEP (use Ro from regression)

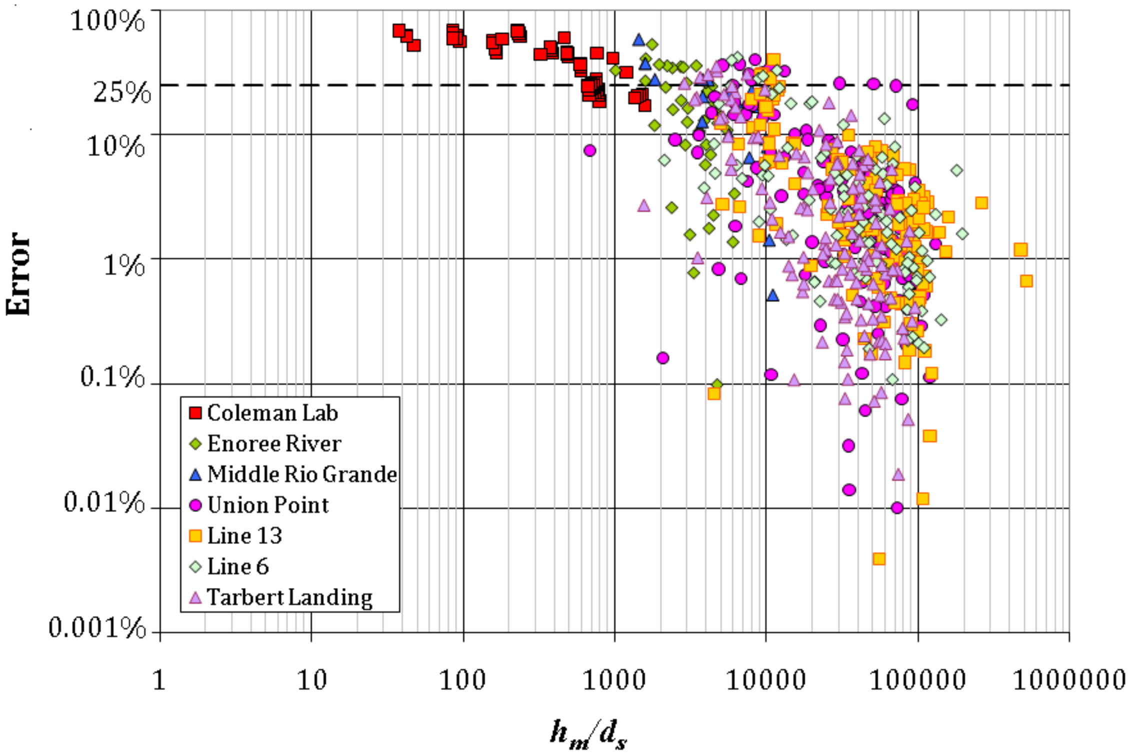


b.) SEMEP (use all regression variables)

Figure 6.9. Variation in Percent Difference at various h/d_s



a.) SEMEP (use Ro from Regression)



b.) SEMEP (use all variables from Regression)

Figure 6.10. Variation in Percent Difference at various *h/(d$_s$)*

Figure 6.10 shows that as the value of h_m/d_s increases, the percent difference decreases. However, the results are a function of the site. Table 6.3 summarizes the number of data points with h_m/d_s greater than 1,000 and a percent difference less than 25%.

Table 6.3. Summary of Point Data with h_m/d_s greater than 1000

Data Set	Number of Samples	hm/ds > 1000 and % Difference < 25%			
		SEMEP (Ro)		SEMEP (all variables)	
		No. Samples	Percent of Samples	No. Samples	Percent of Samples
Coleman Laboratory Experiment	72	3	4.2%	5	6.9%
Enoree River	43	23	53.5%	30	69.8%
Middle Rio Grande	20	12	60.0%	13	65.0%
Mississippi River at Union Point	145	122	84.1%	134	92.4%
Mississippi River at Line 13	140	128	91.4%	136	97.1%
Mississippi River at Line 6	115	99	86.1%	110	95.7%
Mississippi River at Tarbert	133	91	68.4%	126	94.7%
Total	**668**	**478**	**71.6%**	**554**	**82.9%**

The table shows that once the value of h_m/d_s is greater than 1,000, most of the samples will have less than a 25% error. In addition, the calculated sediment discharge based on the regression analysis performs better than SEMEP due to the method in which the variables are determined.

For detailed interpretation of the data, a statistical analysis is performed on q_m/q_t. The mean percent error (MPE) and mean absolute percent error (MAPE) are the best descriptors of how the actual measurements compare with the calculated and SEMEP values of q_m/q_t. The mean square error (MSE), root mean square error (RMSE), and normal root mean square error (NRMSE) cannot be used with meaning because the analysis is based on q_m/q_t. The values of the MPE and MAPE are summarized in Table 6.4.

Table 6.4. Statistical Results from q_m/q_t

Data Set	h/d_s	% Flow Measured	h_m/d_s	Ratio of Measured vs SEMEP		Ratio of Measured vs Regression	
				MPE	MAPE	MPE	MAPE
COLEMAN LAB DATA	1000	96%	965	21%	21%	10%	10%
	1000	93%	930	28%	28%	15%	15%
	1000	89%	895	28%	28%	14%	14%
	1000	86%	860	29%	29%	13%	13%
	1000	82%	824	31%	31%	13%	13%
	1000	73%	731	45%	45%	26%	26%
	1000	60%	596	56%	56%	37%	37%
	1000	47%	467	53%	53%	41%	41%
	1000	29%	286	64%	64%	60%	60%
	1000	20%	198	46%	46%	44%	44%
	1000	11%	110	59%	59%	57%	57%
	1000	5%	52	63%	57%	57%	57%
ENOREE RIVER - SC	4500	98%	4,410	2%	9%	-6%	8%
	4500	96%	4,337	5%	11%	-2%	13%
	4500	89%	4,014	15%	15%	5%	11%
	4500	82%	3,682	26%	26%	17%	18%
	4500	70%	3,147	24%	24%	20%	20%
	4500	58%	2,614	47%	47%	24%	25%
	4500	46%	2,087	53%	53%	23%	23%
	4500	36%	1,633	30%	46%	40%	40%
MIDDLE RIO GRANDE - NM	12,000	87%	10,436	3%	3%	0%	5%
	12,000	68%	8,149	21%	21%	17%	17%
	12,000	50%	5,974	24%	24%	19%	19%
	12,000	32%	3,877	26%	26%	22%	22%
	12,000	13%	1,608	38%	38%	40%	40%
MISSISSIPPI RIVER - TARBERT	55,000	98%	53,900	1%	1%	0%	1%
	55,000	90%	49,500	1%	3%	-1%	2%
	55,000	70%	38,500	-1%	6%	-2%	3%
	55,000	50%	27,500	-11%	21%	-2%	4%
	55,000	30%	16,500	3%	28%	2%	4%
	55,000	10%	5,500	-220%	220%	15%	17%
MISSISSIPPI RIVER - UNION POINT	75,000	98%	73,500	1%	1%	0%	1%
	75,000	90%	67,500	2%	4%	0%	2%
	75,000	70%	52,500	-3%	8%	-1%	4%
	75,000	50%	37,500	-3%	14%	0%	5%
	75,000	30%	22,500	5%	21%	2%	6%
	75,000	10%	7,500	24%	25%	19%	20%
MISSISSIPPI RIVER - LINE 6	90,000	98%	88,200	1%	1%	4%	5%
	90,000	90%	81,000	2%	3%	4%	6%
	90,000	70%	63,000	1%	4%	0%	2%
	90,000	50%	45,000	2%	9%	0%	3%
	90,000	30%	27,000	6%	11%	2%	3%
	90,000	10%	9,000	21%	22%	19%	19%
MISSISSIPPI RIVER - LINE 13	110,000	98%	107,800	1%	1%	1%	1%
	110,000	90%	99,000	2%	3%	0%	2%
	110,000	70%	77,000	4%	7%	-1%	3%
	110,000	50%	55,000	-4%	10%	-1%	3%
	110,000	30%	33,000	-9%	18%	-3%	5%
	110,000	10%	11,000	15%	17%	11%	14%

The results show that h/d_s, h_m/d_s and u_*/ω are important characteristics in determining the validation of the method and to calculate the necessary measured flow depth. When a negative value is reported for MPE the measured q_m/q_t is less than the calculated or SEMEP value for q_m/q_t. The statistical analysis on Coleman's laboratory data shows poor agreement since the values of MPE and MAPE are quite large. For the remaining samples, as the flow depth increases the amount of measured depth does not have too be as large to get reasonable results. When the value of h_m/d_s is greater than 1000, the results between SEMEP and measured data are quite accurate, with an MAPE of less than 0.25 for approximately 80% of the data sets. This aggresses well with previous findings. Even though the Enoree River is deeper than the Middle Rio Grande, the larger particle size in the Enoree River causes a smaller value of h/d_s, thus requiring more of the flow depth to be sampled to get good results. The Enoree River requires 70% of the flow depth to be sampled compared to only 50% for the Middle Rio Grande to get good results (within 25% of the measured data). The Mississippi River is a large sand bed river with a significant amount of sediment transported in suspension. As a result, only 30% of the flow depth needs to be sampled to have good agreement.

When the measured data are compared to the data determined from the regression calculations, even less flow depth needs to be sampled for good agreement. This is because the values of u_*, y_o, c_a and Ro are all determined from the measured point data. A comparison is performed on the total sediment discharge to have a better understanding of the results in the next section.

6.2.2 *Total Sediment Discharge Calculations*

The measured total sediment discharge is determined for each of the data sets. Then the total sediment discharge is compared to the calculated total sediment discharge and SEMEP total sediment discharge. These results are shown in Figure 6.11 and Figure 6.17.

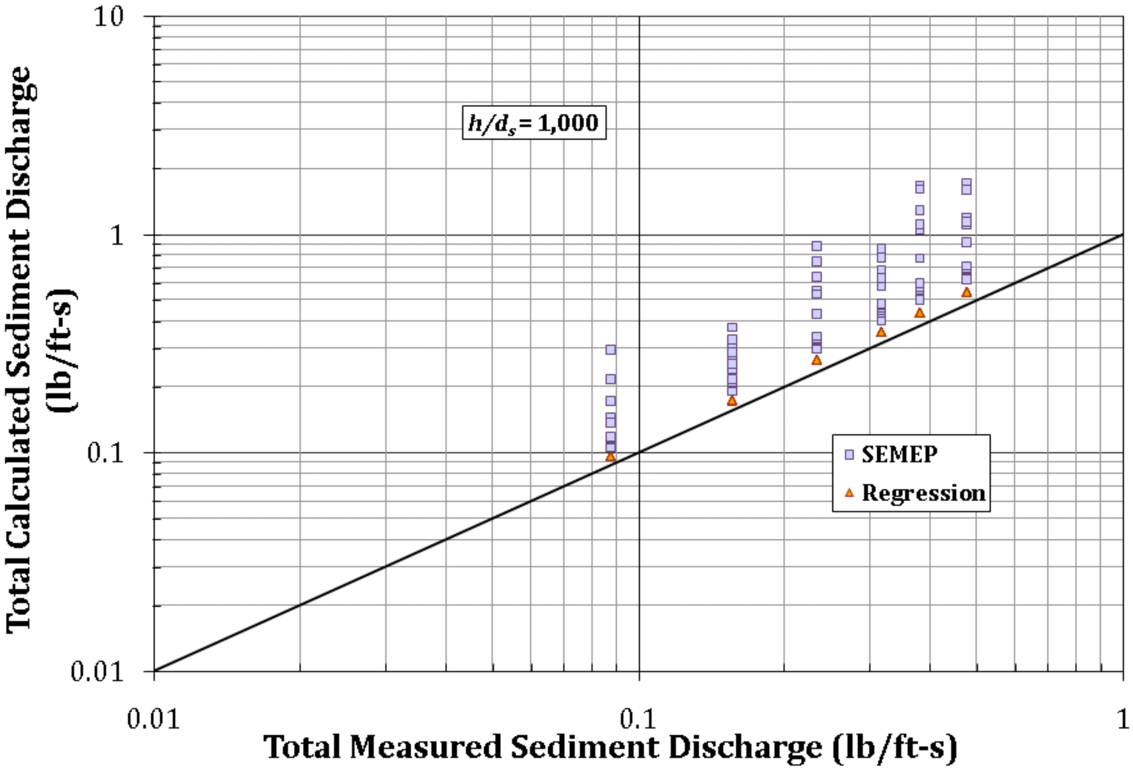


Figure 6.11. Total Sediment Discharge on Coleman Laboratory Data

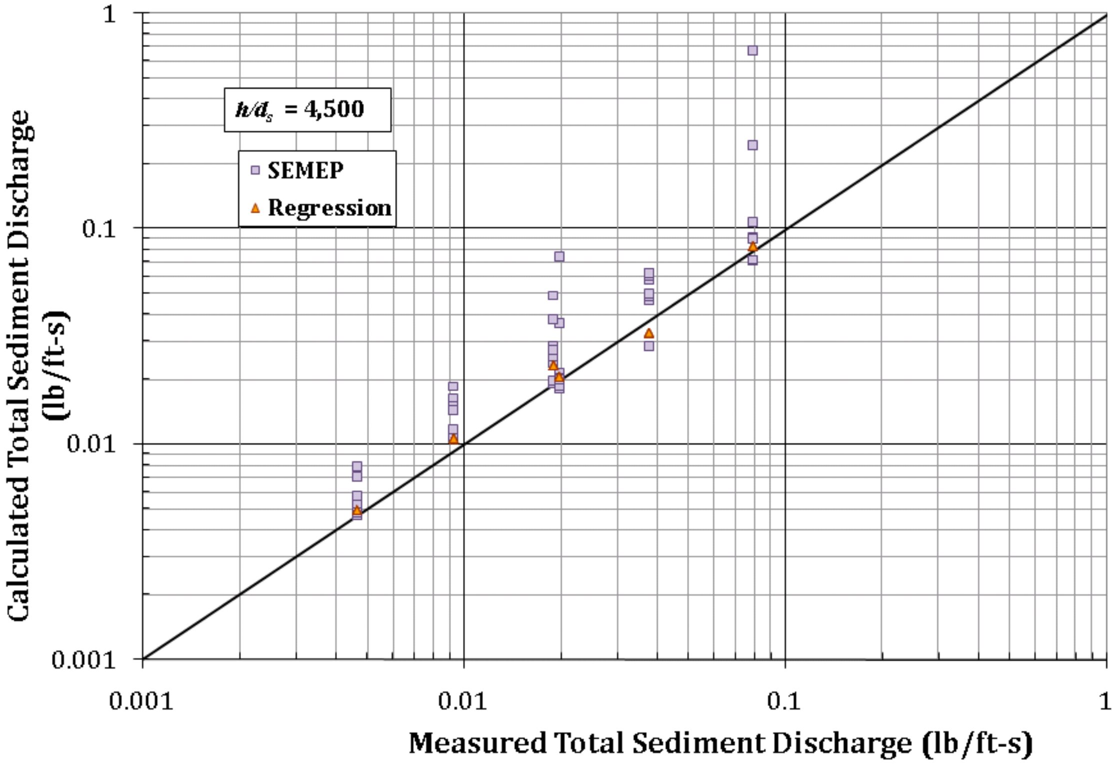


Figure 6.12. Total Sediment Discharge on Enoree River

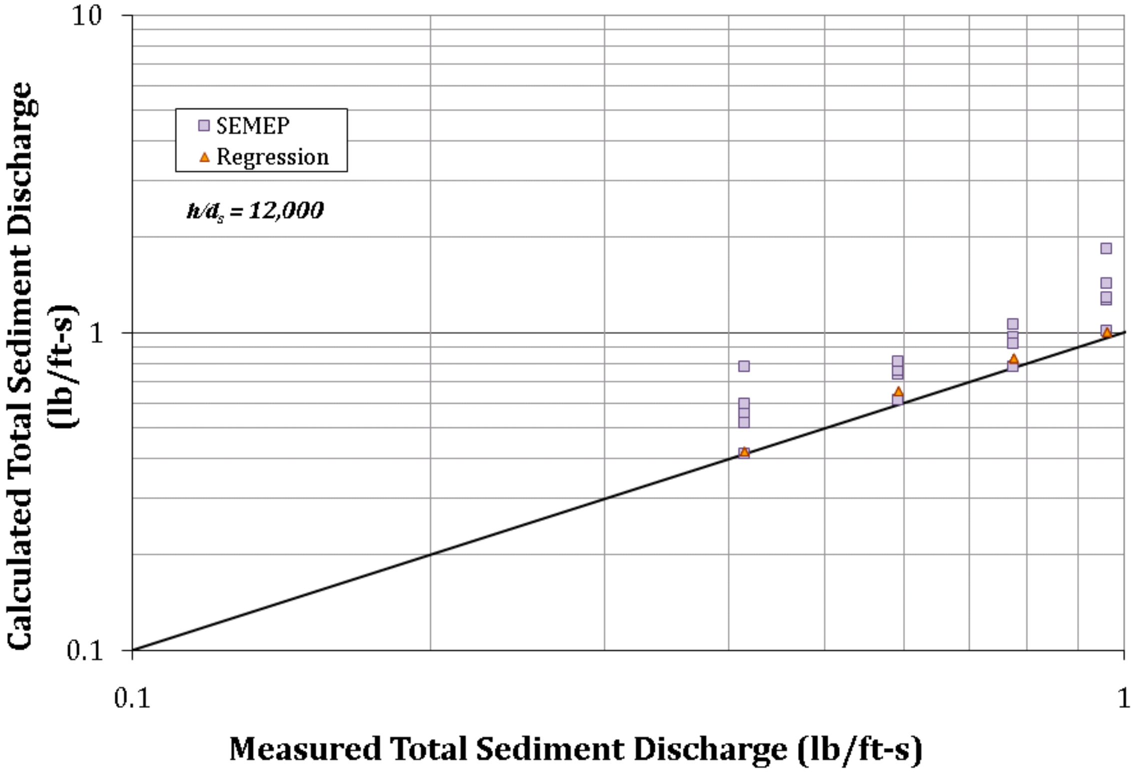


Figure 6.13. Total Sediment Discharge on the Middle Rio Grande

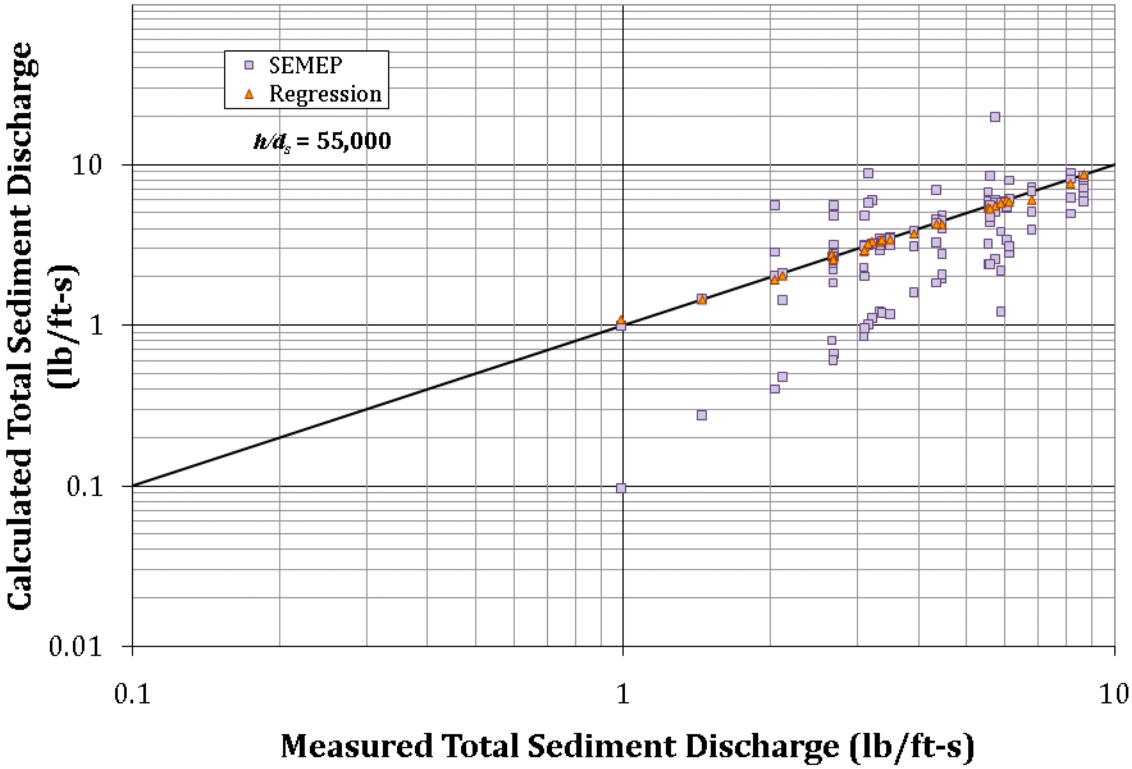


Figure 6.14. Total Sediment Discharge on the Mississippi River at Tarbert Landing

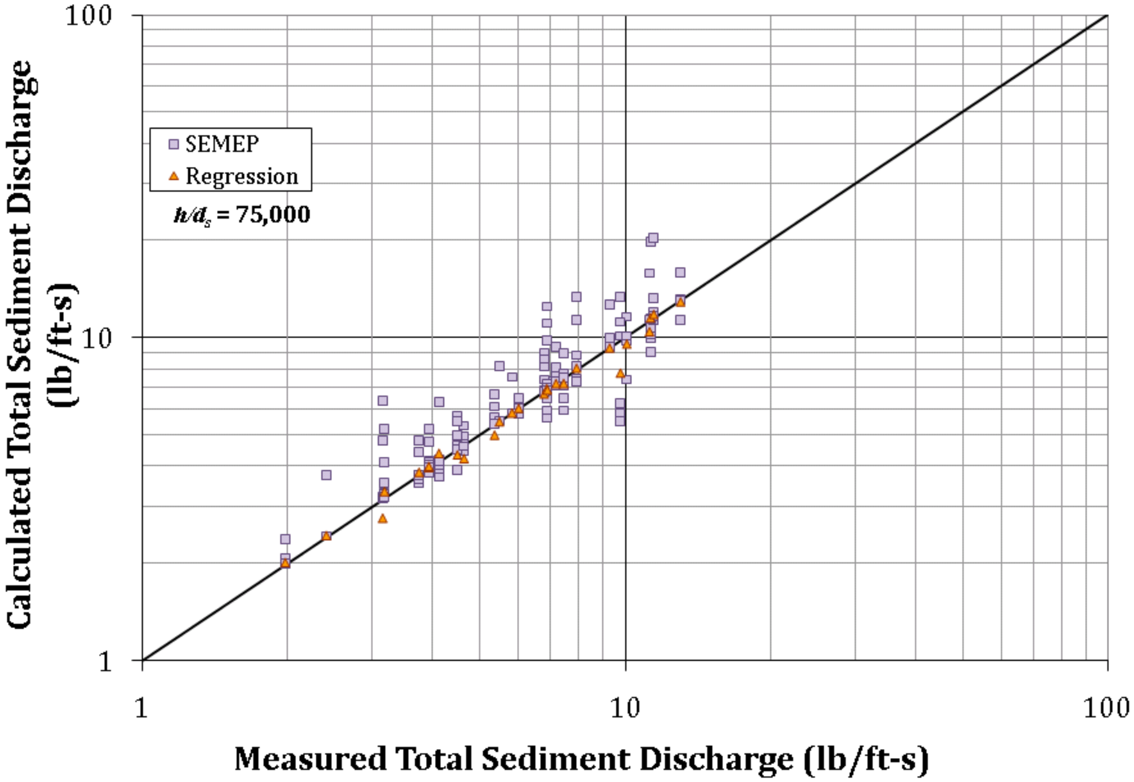


Figure 6.15. Total Sediment Discharge on the Mississippi River at Union Point

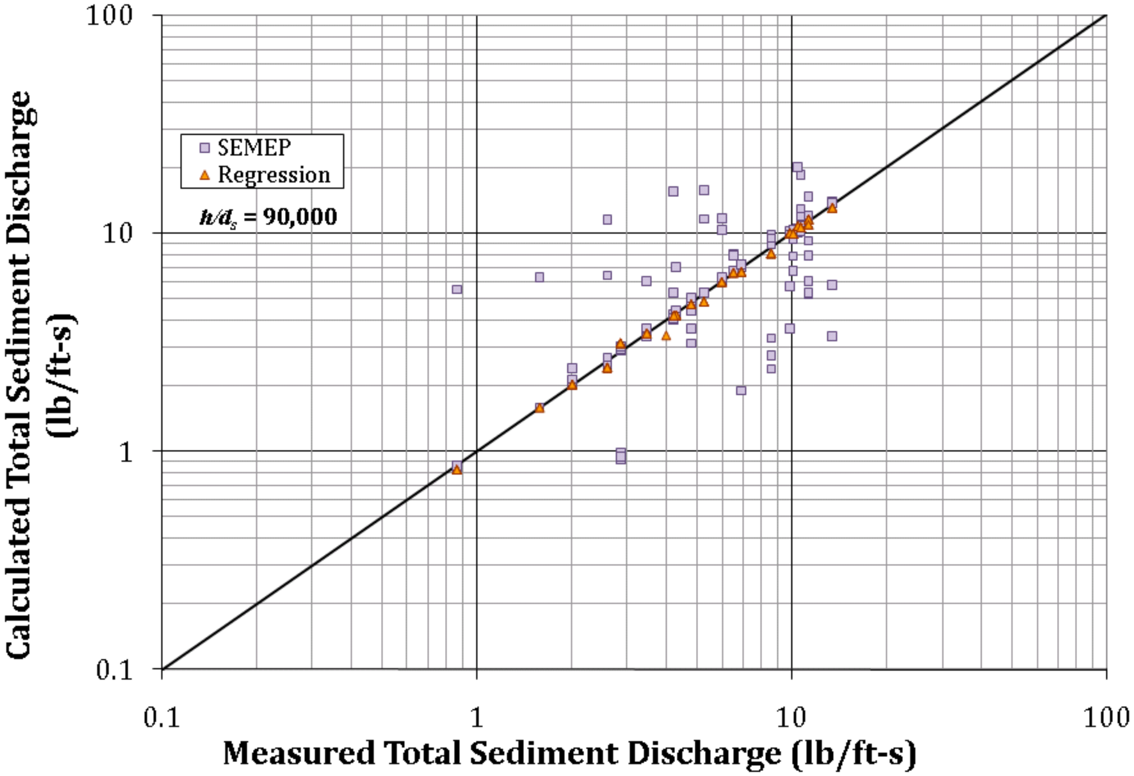


Figure 6.16. Total Sediment Discharge on the Mississippi River at Line 6

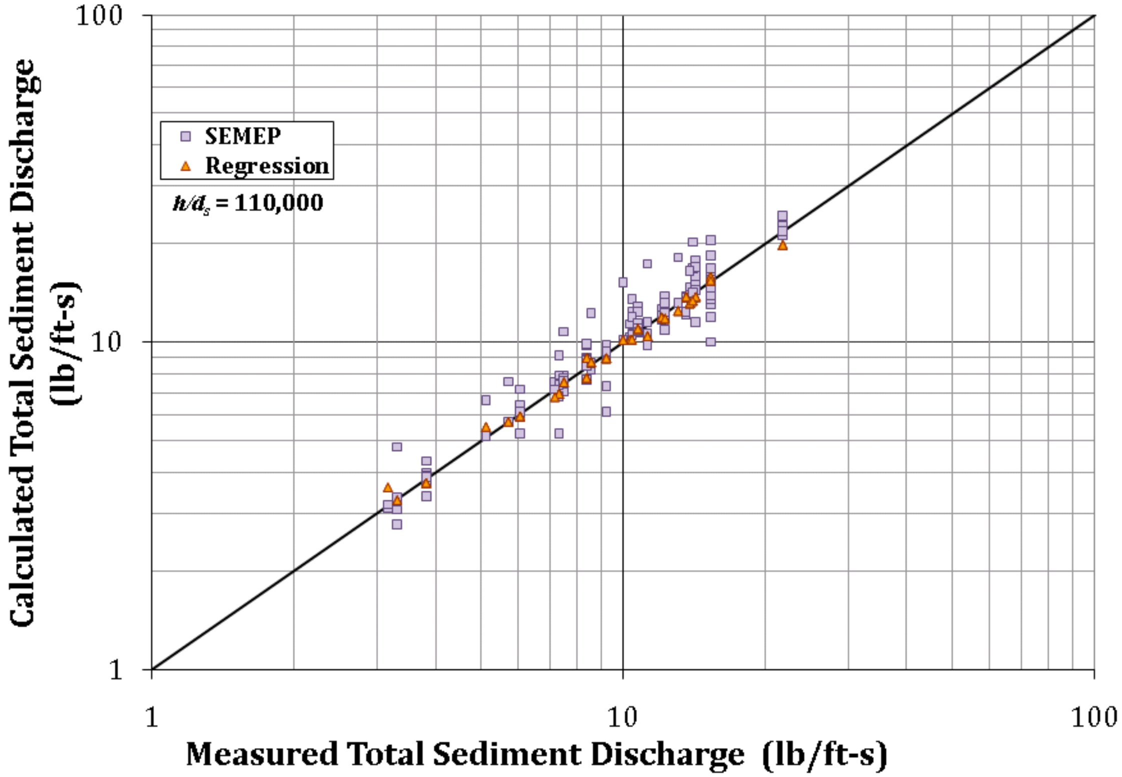


Figure 6.17. Total Sediment Discharge on the Mississippi River at Line 13

SEMEP results are represented by purple squares and the calculated results are represented as orange triangles. The one to one line represents perfect agreement. The results indicate that for the Coleman laboratory data, Enoree River and Middle Rio Grande data all results have a tendency to have a calculated and SEMEP total unit sediment discharge greater than the measured unit total sediment discharge. This is partially associated with the low measured sediment discharge (less than 1 lb/ft-s) and smaller value of u_*/ω. The measured unit total sediment discharge for the Mississippi River has a tendency to be greater than 1 lb/ft-s and the calculated and SEMEP total unit sediment discharge has a tendency to be greater and less than the measured total unit sediment discharge. As the measured unit total sediment discharge increases, a higher degree of accuracy is achieved in both SEMEP and calculated total sediment discharge based on regression.

A statistical analysis is performed to understand the total unit sediment discharge. The MSE, RMSE, ME, MPE and MAPE all are meaningful statistical parameters. Table 6.5 contains a summary of the statistical parameters which compare the total measured unit sediment discharge to the total calculated unit sediment discharge and total SEMEP unit sediment discharge.

Table 6.5. Statistical Results from the Total Sediment Discharge Comparison

Data Set	h/ds	% Flow Measured	hm/ds	Measured vs SEMEP - Total Load					Measured vs Regression - Total Load				
				MSE	RMSE	ME	MPE	MAPE	MSE	RMSE	ME	MPE	MAPE
COLEMAN LAB DATA	1000	96.5%	965	0.008	0.089	-0.078	-27%	27%	0.002	0.043	-0.038	-13%	13%
	1000	93.0%	930	0.016	0.127	-0.111	-38%	38%					
	1000	89.5%	895	0.017	0.131	-0.114	-39%	39%					
	1000	86.0%	860	0.019	0.139	-0.121	-42%	42%					
	1000	82.4%	824	0.023	0.153	-0.133	-45%	45%					
	1000	73.1%	731	0.079	0.280	-0.244	-83%	83%					
	1000	59.6%	596	0.203	0.451	-0.384	-128%	128%					
	1000	46.7%	467	0.205	0.453	-0.372	-119%	119%					
	1000	28.6%	286	0.614	0.784	-0.632	-199%	199%					
	1000	19.8%	198	0.168	0.410	-0.309	-95%	95%					
	1000	11.0%	110	0.404	0.636	-0.500	-181%	181%					
	1000	5.2%	52	0.425	0.652	-0.543	-179%	179%					
ENOREE RIVER - SC	4500	98.0%	4,410	2.53E-05	0.005	0.000	-4%	10%	9.64E-06	0.003	-0.001	-7%	11%
	4500	96.4%	4,337	3.12E-05	0.006	-0.001	-8%	13%					
	4500	89.2%	4,014	9.48E-05	0.010	-0.007	-20%	20%					
	4500	81.8%	3,682	6.23E-05	0.008	-0.007	-38%	38%					
	4500	69.9%	3,147	3.71E-04	0.019	-0.021	-81%	81%					
	4500	58.1%	2,614	0.071	0.267	-0.150	-278%	278%					
	4500	46.4%	2,087	0.077	0.278	-0.203	-417%	417%					
	4500	36.3%	1,633	0.097	0.312	-0.263	-610%	622%					
MIDDLE RIO GRANDE - NM	12,000	87.0%	10,436	0.001	0.030	-0.022	-3%	3%	0.002	0.049	-0.044	-6%	6%
	12,000	67.9%	8,149	0.040	0.200	-0.185	-26%	26%					
	12,000	49.8%	5,974	0.050	0.223	-0.211	-31%	31%					
	12,000	32.3%	3,877	0.077	0.277	-0.244	-35%	35%					
	12,000	13.4%	1,608	0.264	0.514	-0.443	-64%	64%					
MISSISSIPPI RIVER - UNION POINT	75,000	98.0%	73,500	0.014	0.118	-0.081	-1%	1%	0.221	0.470	0.043	14%	2%
	75,000	90.0%	67,500	0.150	0.387	-0.116	-2%	4%					
	75,000	70.0%	52,500	0.933	0.966	0.189	1%	7%					
	75,000	50.0%	37,500	1.773	1.332	0.234	0%	13%					
	75,000	30.0%	22,500	4.179	2.044	-0.514	-14%	26%					
	75,000	10.0%	7,500	11.870	3.445	-2.541	-36%	37%					
MISSISSIPPI RIVER - LINE 13	110,000	98.0%	107,800	0.036	0.191	-0.154	-1%	1%	0.283	0.532	0.032	16%	1%
	110,000	90.0%	99,000	0.245	0.495	-0.265	-2%	3%					
	110,000	70.0%	77,000	1.293	1.137	-0.487	-5%	7%					
	110,000	50.0%	55,000	2.011	1.418	0.221	3%	9%					
	110,000	30.0%	33,000	4.423	2.103	0.611	5%	16%					
	110,000	10.0%	11,000	8.527	2.920	-2.028	-20%	22%					
MISSISSIPPI RIVER - LINE 6	90,000	98.0%	88,200	0.015	0.123	-0.089	-1%	1%	0.852	0.923	0.075	22%	5%
	90,000	90.0%	81,000	0.153	0.391	-0.232	-3%	4%					
	90,000	70.0%	63,000	0.165	0.406	-0.111	-2%	5%					
	90,000	50.0%	45,000	1.316	1.147	-0.109	-6%	13%					
	90,000	30.0%	27,000	6.829	2.613	-0.935	-19%	26%					
	90,000	10.0%	9,000	8.670	2.945	-2.170	-35%	36%					
MISSISSIPPI RIVER - TARBERT	55,000	98.0%	53,900	0.002	0.042	-0.031	-1%	1%	0.038	0.195	0.025	8%	1%
	55,000	90.0%	49,500	0.031	0.176	-0.072	-2%	3%					
	55,000	70.0%	38,500	0.188	0.434	0.019	1%	6%					
	55,000	50.0%	27,500	1.439	1.200	0.398	6%	19%					
	55,000	30.0%	16,500	9.942	3.153	-1.347	-16%	33%					
	55,000	10.0%	5,500	5.842	2.417	2.330	62%	62%					

The results in Figure 6.11 to Figure 6.17 and Table 6.5 show that h/d_s, h_m and u_*/ω are important characteristics in validating SEMEP and determining the necessary flow depth needed for measurement. The results from SEMEP suggest that most of the measured data are less than the calculated unit total sediment discharge. The MSE and RMSE are always positive values since the term is squared. The value of the MSE and RMSE increases with increased unmeasured depth, but there is no set pattern to the increase. The results from the statistical analysis signify that the error between the measured and SEMEP unit total sediment discharge increases as the percent of flow depth measured decreases. The ME is a negative number when the actual total unit sediment discharge is less than the measured unit total sediment discharge. The value deviates from zero as percent of sampling depth decreases. The MAPE is a better indicator than the MPE because it summarizes the deviation from the actual measurements and it is not an average of positive and negative numbers, thus causing the MPE to be a smaller value. The MAPE suggest that for the Coleman's data set, more data points are needed near the bed to reduce the percent error. For the Enoree River and Middle Rio Grande data, when the value of h_m/d_s must be greater than 5,000 then SEMEP total unit sediment discharge is within 25% of the measured unit total sediment discharge. Finally, for the Mississippi River data when h_m/d_s must be greater than 10,000 then SEMEP total sediment discharge is within 25% of the measured unit total sediment discharge.

6.3 Rouse Number Deviation

Previous studies have shown a deviation in the Ro_m and Ro_c (Anderson 1942; Einstein and Chien 1954) . The location of the deviation varied based on the data tested. A similar comparison is performed on the point data available from this study. The results are shown in Figure 6.18.

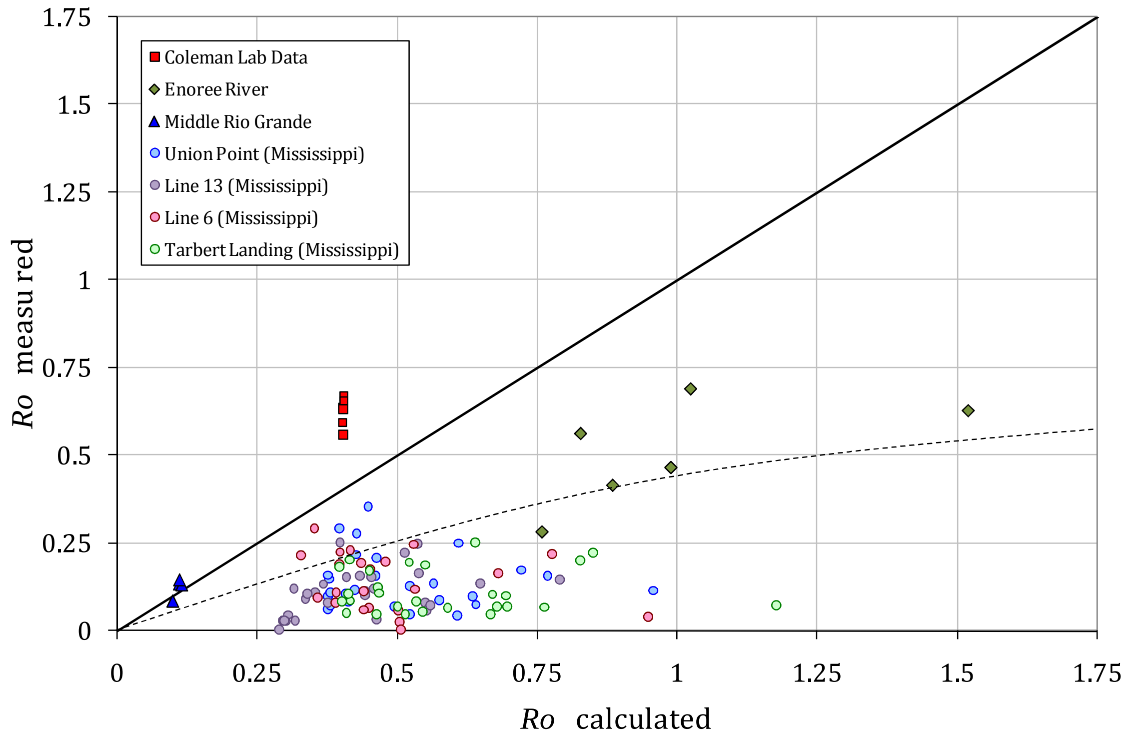


Figure 6.18. Comparison of measured and calculated Ro

The results from the Coleman laboratory data, Enoree River, Middle Rio Grande and Lower Mississippi River show that there is a deviation between the Ro_m and Ro_c. The value of Ro_c is determined based on calculating the ω based on the d_{50ss} and determining the u_* based on the flow depth and slope of a given river. In general, the value of Ro_m is less than Ro_c. However, when the Coleman data are plotted, Ro_m is actually larger than Ro_c; this can be attributed to the use of the energy slope (S_e) to determine u_* or the low sediment discharge, which results in poor measurements.

The data from the Middle Rio Grande agree the best. This is associated with the fact that the value of Ro is very low (< 0.15). The data from the Enoree River and Mississippi River show that there is a reduction in Ro_m compared to the Ro_c. The values of the Ro_c determined for the Mississippi River might deviate due to the unknown value of slope in determining u_*. A value of S_o of 0.0000583 was used for this analysis for all four sites (Biedenharn et al. 2000). Based on the results in Section 6.2, even though Ro_m and Ro_c do not agree well, the procedure calculates total sediment discharge quite accurately.

Akalin (2002) performed a study where he divided the point measurements into bins to evaluate the variability in the Ro_m and Ro_c. He determined that finer particles had better agreement between the Ro_m and Ro_c. The value of *Ro* matches well because of the amount of sediment sampled. Smaller particles have a lower *Ro* value and are found in larger quantities, resulting in a better agreement. Thus, based on this study, if the value of *Ro* is less than 0.5, the proposed total sediment concentration will agree well with the measured total sediment concentration. Akalin's study shows similar findings. This is because the concentration profile is relatively uniform.

The following study is performed to see the effects that the value of the Ro_c has on the total sediment discharge calculations. Data from the Susitna River in Alaska are used (Williams and Rosgen 1989). There are 37 total sediment discharge samples taken between 1982 and 1985 (refer to Figure 6.19).

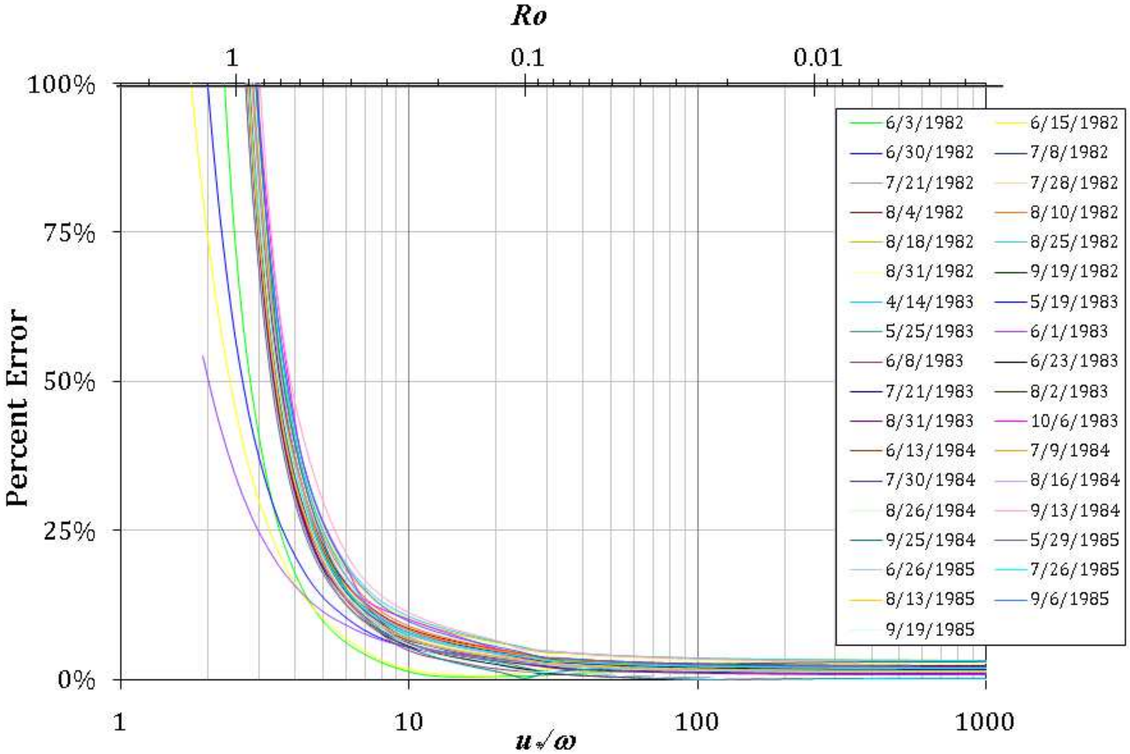


Figure 6.19. % Error between the Actual and Calculated q_t for Susitna River

The results indicate that the variation in total sediment discharge is not that large as long as *Ro* is less than 0.5. This coincides well with the previous analyses. The proposed procedure total sediment discharges will be relatively close to the measured total sediment discharge when the value of *Ro* is less than 0.5. The five samples (4/14/83, 10/6/63, 9/13/83, 9/25/84 and 9/6/85) that have a difference of more than 25% are the samples where the measured total sediment discharge was less than 2600 tonne/day. This also concurs with earlier findings, that the total sediment discharge needs to be high to get an accurate comparison. This is because the measurement is not sufficient to get an accurate particle size distribution and sediment discharge measurement and there are measurement errors.

Chapter 7: Conclusions

This study improves total sediment load calculations based on a depth-integrated and point sediment concentration measurements. The new total load calculation uses a Series Expansion of the Modified Einstein Procedure (SEMEP) to remove the empiricism found in the Modified Einstein Procedure (MEP). This procedure contains four main modifications to MEP. First, SEMEP solves the Einstein integrals quickly and accurately based on a series expansion. Next, instead of dividing the suspended sediment and bed material samples into particle size classes, the total sediment discharge calculation was based on a median grain size in suspension (d_{50ss}). Thirdly, for depth-integrated samples the Rouse number (Ro) was determined directly by calculating the fall velocity (ω) based on d_{50ss}, the shear velocity ($u_* = \sqrt{ghS}$) and assuming the value of the von Kármán constant (κ) was 0.4. For point concentration measurements, the Ro was calculated by fitting the concentration profile to the measured points. As a result there was no need to determine the Ro for each overlapping bin and fitting a power regression to the data. Lastly, SEMEP uses the measured unit sediment discharge and Ro to determine the unit bed discharge directly, rather than Einstein's probability of entrainment. SEMEP was developed using measurements from two laboratory and twenty rivers within the United States. The main conclusions of this research effort are summarized:

1. The developed code for SEMEP can be found in Appendix F. The procedure can calculate total sediment discharge (q_t) in both SI and English units. The

applicability of SEMEP was determined based on the ratio of the measured to total sediment discharge (q_m/q_t). Depth-integrated concentration measurements, from fourteen streams and rivers in the United States were used to test SEMEP. SEMEP performs well (Figure 5.16 and Figure 5.20) when the value of u_*/ω was greater than 5 and the measured total sediment discharge was greater than 10,000 tonnes/day. These results have a coefficient of determination (R^2) of 0.98, a concordance coefficient (ρ_c) of 0.99 and a mean absolute percent error (MAPE) of 5% when u_*/ω was greater than 5 compared to a R^2 of 0.92, ρ_c of 0.96 and MAPE of 62% when u_*/ω was less than 5.

2. Total sediment discharge comparison between SEMEP and BORAMEP were possible for seven streams within the United States. A total of 207 samples were tested. BORAMEP failed to calculate total sediment discharge for 68 of those samples. Further, only 18 samples calculated using BORAMEP were within 25% of the measured total sediment discharge. In comparison, SEMEP always calculated a total sediment discharge, and over 90% of the samples were within 25% of the measured total sediment discharge. The statistical analysis for SEMEP were a R^2 of 0.98, ρ_c of 0.99 and MAPE of 2%, compared to BORAMEP values with a R^2 of 0.65, ρ_c of 0.74 and MAPE of 18%. Statistically, SEMEP performed much better than BORAMEP.
3. Criteria defining thresholds for different modes of transport were redefined based on SEMEP. The laboratory data set of Guy et al. (1966) were used to define the transport modes. Figure 5.5 shows the ratio of suspended to total

sediment discharge (q_s/q_t) as a function of u_*/ω. The results indicate that when the value of u_*/ω was between 0.2 and 0.5, the sediment will move primarily as bed load. When u_*/ω was between 0.5 and 2, the sediment will move as mixed load. Mixed load can be defined as sediment that contains a high percentage of both bed and suspended sediment load. When the value of u_*/ω was greater than 2, the sediment will move primarily as suspended load. Finally, Figure 5.7 was used to show that when u_*/ω was less than 0.2, no sediment will be transported.

4. SEMEP can be used to determine total sediment discharge based on point sediment concentration and point velocity measurements by calculating the ratio of measured to total sediment discharge (q_m/q_t). The relative submergence (h/d_s), the measured depth (h_m) and the u_*/ω were all important characteristics in total sediment discharge calculations using SEMEP. Figure 6.9 shows that as the value of h/d_s increases, a better estimate was calculated for q_m/q_t. Thus, for a given grain size deeper rivers have better total sediment discharge estimates. Figure 6.10 shows that as the value of h_m/d_s increases, the accuracy of the calculations improve. When values of h_m/d_s were greater than 1,000, over 80% of the SEMEP results were in good agreement (errors less than 25%) with the measurements. The point data also coincided with the fact that when u_*/ω was greater than 5 (Figure 6.2 to Figure 6.8), there was good agreement between SEMEP total sediment discharge and the measurements.

5. As discussed in Section 6.3, the deviation of *Ro* between the calculated and measured *Ro* can be significant when the value of *Ro* was greater than 0.5 (u_*/ω<5). This occurs because of low concentration measurements and measurement errors. In addition, when the value of *Ro* was changed from 0.01 to 0.5 (250>u_*/ω>5) the total sediment discharge was calculated using SEMEP will vary by less than 25% of the measurements (Figure 6.19). However, as *Ro* was increased above 0.5, the variability in total sediment discharge increased exponentially. Therefore, a more uniform concentration distribution gave more accurate results because a higher amount of sediment in suspension was measured.

In summary, SEMEP is most beneficial in streams where most of the sediment is transported in suspension. The results indicate that SEMEP performs accurately (error less than 25%) when the value of u_*/ω is greater than 5 (or *Ro* less than 0.5). SEMEP calculations are acceptable, but less accurate when u_*/ω is between 2 to 5 (1.25 >*Ro*<0.5). Both SEMEP and MEP should not be used when u_*/ω is less than 2.

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Appendix A– Modified Einstein Procedure

MEP computes total sediment discharge based on: channel width, flow depth, water temperature, water discharge, velocity, measured sediment concentration (depth integrated sampler), suspended sediment particle gradation and sampled bed gradation. Table A-1 provides a comparison of the Einstein and Modified Einstein Procedures.

Table A-1 – Comparison of Einstein and Modified Einstein (Shah 2006)

Einstein Method	Modified Einstein Method
• Developed for Design • • Estimates bed-material discharge o Based on Channel Cross Section o Bed Sediment Sample • • Based on calculated velocity • • Rouse value determined based on a trial and error methodology • • Water Discharge computed from formulas (eg. Manning's)	• Single Cross Section • • Estimates total sediment discharge o Includes wash load • • Necessary Measurements o A depth integrated sediment sampler o Water discharge measurement • • Temperature Measurement • • Based on mean velocity • • Observed z value for a dominate grain size. • • Change to hiding factor • • Einstein's intensity of bed load transport is arbitrarily divided by 2. •

There are three main departures from the Einstein Method, the calculation of the Rouse number (z), shear velocity (u_*) and intensity of the bed load transport (Φ_*).

The following are the steps required for total sediment discharge based on MEP:

Step A. Trial and Error determine the Correction Coefficient

1. Assume a value for the correction coefficient χ.

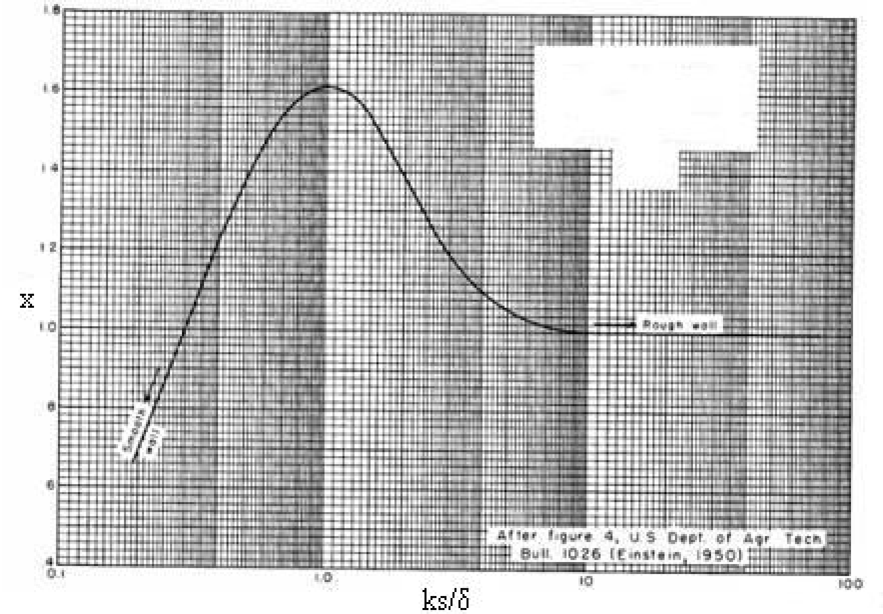

Figure A-1 – Correction coefficient χ based on ks/δ

2. Calculate the value of $u_*' = \sqrt{gSR'}$ using the velocity profile

$$\frac{\bar{u}}{\sqrt{gSR'}} = 5.75 \log \left(\frac{12.27 \chi \left(\frac{A}{W} \right)}{d_{65}} \right) \tag{A-1}$$

Where,

$\bar{u}$ is the mean velocity;
u_*' is the grain shear stress;
g is gravity;
S is the slope;
R' is the hydraulic radius associated with grain roughness;
χ is a correction coefficient;
A is the cross sectional area;
W is the stream width; and
d_{65} is the particles size where 65% of the material is finer.

3. The laminar sub layer is needed to determine if the initial estimate of x was appropriate.

$$\delta = \frac{11.6\nu}{u_*^{'}} \qquad \text{(A-2)}$$

Where
  δ is the laminar sub layer; and
  v is the kinematic viscosity.

4. Calculate the x-axis of Figure A.1. $k_s/\delta = d_{65}/\delta$

5. If the initial guess in step 1 is equal to the value determined using Figure 2.3 then continue. If not, assume that the new value of χ is that from step 4 and repeat.

6. Calculate the transport parameter P_m

$$P_m = 2.3\log\frac{30.2\chi\frac{A}{W}}{d_{65}} \qquad \text{(A-3)}$$

Step B. Calculation of Total Sediment Discharge...Place sample into bins.

1. Choose a representative size for each bin.

2. Identify the percent of suspended and sampled bed material in each bin.

3. Calculate the intensity of shear on each particle based on the following two equation. Use the larger value.

-

$$\psi = 1.65\left(\frac{d_{35}}{RS'}\right) \quad or \quad 0.66\left(\frac{d_i}{RS'}\right) \qquad \text{(A-4)}$$

Where,
  S is defined as slope;
  R' is the hydraulic radius associated with grain roughness;
  d_{35} is the particle diameter where 35% of the material is finer;
  d_i is the mean particle diameter for the given bin; and
  Ψ is the Intensity of Shear.

4. Compute ½ of the intensity of the bed-load transport (Φ_*) using the following equation.

$$\phi_* = \frac{0.023p}{(1-p)} \qquad \text{(A -5)}$$

Where,
  p is the probability a sediment particle entrained in the flow

The probability function is determined based on the following Error Function (Yang 1996):

$$p = 1 - \frac{1}{\sqrt{\pi}} \int_a^b e^{-t^2} dt \quad \text{(A-6)}$$

Where:

a is equal to $-\frac{B_*}{\psi} - \frac{1}{\eta_0}$;

b is equal to $\frac{B_*}{\psi} - \frac{1}{\eta_0}$;

B_* is equal to a value of 0.143; and

η_0 is equal to a value of 0.5.

$$ERF = \frac{2}{\sqrt{\pi}} \int_a^b e^{-t^2} dt \quad \text{(A -7)}$$

Therefore, to compute the probability "*p*", evaluate the Error function from *a* to *b*. Then, multiply the Error Function by ½ and subtract it from 1.

5. Calculated the bed load discharge

$$i_b q_b = \frac{1}{2} \phi_* i_b \gamma_s \sqrt{g d_i^3 1.65} \text{ (in lbs/sec-ft)} \quad \text{(A -8)}$$

$$i_b Q_b = 43.2 W i_b q_b \text{ (tons/day)} \quad \text{(A -9)}$$

Where,

Φ_* is the intensity of bed load transport;

i_b is the fraction of particles in the bed within that bin range;

γ_s is the specific weight of sediment;

g is gravitational acceleration;

d_i is the mean particle diameter for the given bin range; and

W is the cross section width.

6. Calculate the suspended sediment discharge

$$Q_{si}' = 43.2 W q_{si}'$$

$$q_{si}' = i_s \gamma C_s' q \left[(1-E) - 2.3 \left(E \log \frac{E}{P_m} - 1 \right) \right] \text{ (in lbs/sec-ft)} \qquad \text{(A -10)}$$

Where,

Q_{si}' is the suspended sediment discharge for a given size fraction (tons/day)
i_s is the fraction of particles in suspension within that bin range
γ is the specific weight of water
C_s' is the measured concentration
q is the water discharge per unit width
E is the ratio of unstable depth to total depth
P_m is the parameter calculated in Equation (A-3).

7. Need to determine the Rouse number for each bin (Refer to Step C)

8. Need to determine the limits of integration

$$A = \frac{2d_s}{h} \qquad \text{(A -11)}$$

Where,

h is the flow depth
d_s is the d_{50} of the bed material

9. Calculate the Einstein Integrals (J_1, J_2, J_1', J_2', I_1 and I_2).

10. There are two distinct methods for calculating the total sediment for the given particle size:

$$Q_{ti} = Q_{si}' \frac{P_m J_1 + J_2}{P_m J_1' + J_2'} \qquad \text{(A -12)}$$

$$Q_{ti} = i_b Q_b \left(P_m I_1 + I_2 + 1 \right) \qquad \text{(A -13)}$$

$$Q_t = \sum Q_{ti} \qquad \text{(A-14)}$$

Step C. Calculation of the Rouse number

1. Determine all location where there is overlap.
2. Assume a value for the Rouse number.
3. If the following equations are equal then the assumed rouse number is good. Otherwise one needs to recalculate the rouse number

$$\frac{Q_s^{'}}{i_B\ Q_b} \text{ and } \frac{I_1}{J_1}\left(PJ_1^{'} + J_2^{'}\right) \tag{A -15}$$

The Rouse numbers for the remaining bins are determined as follows:

$$z_i = z\left(\frac{\omega_i}{\omega}\right)^{0.7} \tag{A -16}$$

Appendix B – Series Expansion Paper

Efficient Algorithm for Computing Einstein Integrals

Junke Guo[1] and Pierre Y. Julien[2]

Abstract: Analytical approximations to Einstein integrals are proposed. The approximations represented by two fast-converging series are valid for all values of their arguments. Accordingly, the algorithm can be easily incorporated into professional software like *HEC-RAS* or *HEC-6* with minimum computational effort.

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CE Database subject headings: Bed load; Suspended load; Sediment transport; Computation; Algorithms.

Introduction

The Einstein bed load function is a landmark of modern sediment transport mechanics. It provides the first theoretical framework for sediment transport calculation, which guided many of the following researchers. Nevertheless, the computation of Einstein bed load function requires an estimation of two integrals J_1 and J_2, which cannot be integrated in closed form for most cases and are very slowly convergent for direct numerical integration because of singularity of the integrands near the bed (Nakato 1984). Einstein (1950) provided a numerical table and graphs to facilitate the calculation. Some mathematical software, such as *MatLab* and *Maple* can also be used to integrate them numerically. However, both methods cannot be easily implemented in professional software. For example, the widely used *HEC-RAS* and *HEC-6* do not include Einstein bed load function (U.S. Army Corps of Engineers 1993, 2003) probably because of the complexity. The purpose of this article is to provide a fast-converging algorithm to estimate Einstein integrals J_1 and J_2.

Einstein Integrals

In his bed load function, Einstein (1950) defined

$$J_1(z) = \int_E^1 \left(\frac{1-\xi}{\xi}\right)^z d\xi \qquad (1)$$

and

$$J_2(z) = \int_E^1 \left(\frac{1-\xi}{\xi}\right)^z \ln \xi d\xi \qquad (2)$$

where E=relative bed-layer thickness to water depth. Eq. (1) originates from Rouse's sediment concentration distribution; and z=Rouse number that expresses the ratio of the sediment properties to the hydraulic characteristics of the flow (Julien 1995, p. 185). Eq. (2) comes from the product of the logarithmic velocity profile and Rouse sediment concentration distribution. For the purpose of manipulation, the above two integrals can be rearranged as

$$J_1(z) = \int_0^1 \left(\frac{1-\xi}{\xi}\right)^z d\xi - \int_0^E \left(\frac{1-\xi}{\xi}\right)^z d\xi \qquad (3)$$

and

$$J_2(z) = \int_0^1 \left(\frac{1-\xi}{\xi}\right)^z \ln \xi d\xi - \int_0^E \left(\frac{1-\xi}{\xi}\right)^z \ln \xi d\xi \qquad (4)$$

Integral J_1

After using Beta function, Guo and Hui (1991) and Guo and Wood (1995) found that for $z < 1$,

$$\int_0^1 \left(\frac{1-\xi}{\xi}\right)^z d\xi = B(1+z, 1-z) = \frac{\Gamma(1+z)\Gamma(1-z)}{\Gamma(2)} = \frac{z\pi}{\sin z\pi} \qquad (5)$$

On the other hand, the second term on the right-hand side of Eq. (3) is defined as

$$F_1(z) = \int_0^E \left(\frac{1-\xi}{\xi}\right)^z d\xi \qquad (6)$$

It can be solved using integration by parts as

$$F_1(z) = E\left(\frac{1-E}{E}\right)^z + zF_1(z) + zF_1(z-1) \qquad (7a)$$

or

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$$F_1(z) = -\frac{1}{z-1}\frac{(1-E)^z}{E^{z-1}} - \frac{z}{z-1}F_1(z-1) \qquad (7b)$$

Multiple applications of the above recurrence formula results in

$$F_1(z) = -\frac{(1-E)^z}{E^{z-1}}\frac{1}{z-1} + \frac{(1-E)^{z-1}}{E^{z-2}}\frac{z}{z-1}\frac{1}{z-2} + \frac{z}{z-2}F_1(z-2)$$

$$= \frac{(1-E)^z}{E^{z-1}} - z\sum_{k=1}^{\infty}\frac{(-1)^k}{k-z}\left(\frac{E}{1-E}\right)^{k-z} \qquad (8)$$

Thus, from Eqs. (3), (5), (6), and (8), one can get J_1 for $z<1$

$$J_1(z) = \frac{z\pi}{\sin z\pi} - \underbrace{\left\{\frac{(1-E)^z}{E^{z-1}} - z\sum_{k=1}^{\infty}\frac{(-1)^k}{k-z}\left(\frac{E}{1-E}\right)^{k-z}\right\}}_{F_1(z)} \qquad (9)$$

Similar to Eq. (7*b*), applying integration by parts to Eq. (1), one gets

$$J_1(z) = \frac{1}{z-1}\frac{(1-E)^z}{E^{z-1}} - \frac{z}{z-1}J_1(z-1) \qquad (10)$$

Therefore, for $1<z<2$, one obtains

$$J_1(z) = \frac{1}{z-1}\frac{(1-E)^z}{E^{z-1}} - \frac{z}{z-1}\left\{\frac{(z-1)\pi}{\sin(z-1)\pi} - \frac{(1-E)^{z-1}}{E^{z-2}} + (z-1)\sum_{k=1}^{\infty}\frac{(-1)^k}{k-(z-1)}\left(\frac{E}{1-E}\right)^{k-(z-1)}\right\}$$

$$= \frac{1}{z-1}\frac{(1-E)^z}{E^{z-1}} + \frac{z\pi}{\sin z\pi} + \frac{z}{z-1}\frac{(1-E)^{z-1}}{E^{z-2}} - z\sum_{k=1}^{\infty}\frac{(-1)^k}{k-z+1}\left(\frac{E}{1-E}\right)^{k-z+1}$$

$$= \frac{z\pi}{\sin z\pi} - \frac{(1-E)^z}{E^{z-1}} + z\sum_{k=1}^{\infty}\frac{(-1)^k}{k-z}\left(\frac{E}{1-E}\right)^{k-z} \qquad (11)$$

which is identical to Eq. (9). Furthermore, one can recognize the self similarity of Eq. (9) for any noninteger value of z.

For any integer $z=n$, a closed solution can be obtained by applying the binomial theorem to the integrand

$$J_1(n) = \int_E^1\left(\frac{1-\xi}{\xi}\right)^n d\xi = \sum_{k=0}^{n}\frac{(-1)^k n!}{(n-k)!k!}\int_E^1 \xi^{k-n}d\xi$$

$$= \sum_{k=0}^{n-2\geq 0}\frac{(-1)^k n!}{(n-k)!k!}\frac{1-E^{k-n+1}}{k-n+1} + n(-1)^{n-1}\int_E^1 \xi^{-1}d\xi + (-1)^n\int_E^1 d\xi$$

$$= \sum_{k=0}^{n-2\geq 0}\frac{(-1)^k n!}{(n-k)!k!}\frac{E^{k-n+1}-1}{n-k-1} + (-1)^n(n\ln E - E + 1) \qquad (12)$$

For example, when $n=3$, it gives

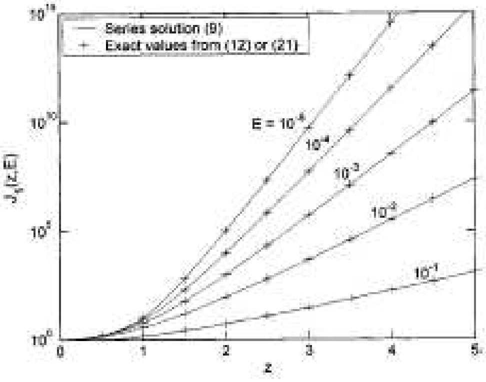

Fig. 1. Plot of integral J_1 (z,E), Eq. (9)

$$J_1(3) = -3\ln E + \frac{1}{2E^2} - \frac{3}{E} + \frac{3}{2} + E \qquad (13)$$

To avoid computational overflow, it is suggested to apply Eq. (9) to any noninteger z value, and use Eq. (12) for any integer z value. In practice, an integer z can be considered $z=n\pm 10^{-3}$. For example, if $z=2.998$, Eq. (9) is used; if $z=2.999$, it can be considered $z\approx 3$ and Eq. (12) is then applied. Besides, from Fig. 1, one can see that Eq. (9) converges to Eq. (12) when z tends to an integer n. In fact, this convergence can also be analytically demonstrated, the proof being beyond the scope of this note.

Integral J_2

Guo and Wood (1995) and Guo (2002) also showed that for $z<1$, one has

$$\int_0^1\left(\frac{1-\xi}{\xi}\right)^z \ln\xi\, d\xi = \frac{z\pi}{\sin z\pi}[\psi(1-z)-(1-\gamma)]$$

$$= \frac{z\pi}{\sin z\pi}[\psi(z)+\pi\cot z\pi-(1-\gamma)]$$

$$= \frac{z\pi}{\sin z\pi}\left\{\pi\cot z\pi - 1 - \frac{1}{z} + \sum_{k=1}^{\infty}\left(\frac{1}{k}-\frac{1}{z+k}\right)\right\} \qquad (14)$$

where $\gamma=0.577\,215\ldots$ = Euler constant; and $\psi(z)$ = psi function, a special function (Andrews 1985). Defining

$$F_2(z) = \int_0^E\left(\frac{1-\xi}{\xi}\right)^z \ln\xi\, d\xi \qquad (15)$$

in Eq. (4) and applying integration by parts gives

$$F_2(z) = E\left(\frac{1-E}{E}\right)^z \ln E + zF_2(z-1) + zF_2(z) - F_1(z) \qquad (16a)$$

or

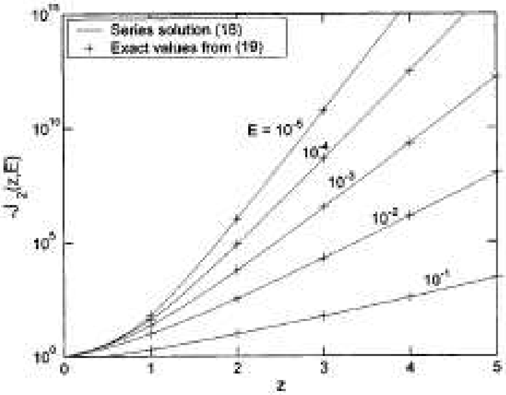

Fig. 2. Plot of integral $J_2\ (z,E)$, Eq. (18)

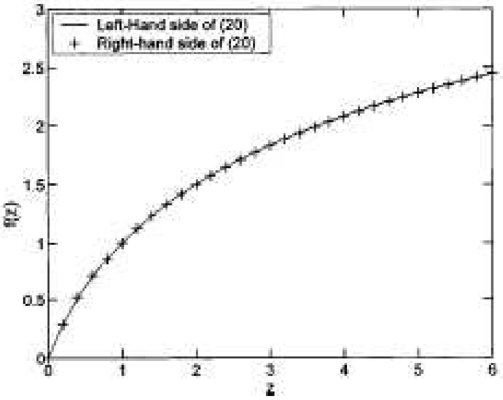

Fig. 3. Approximation of Eq. (20)

$$F_2(z) = -\frac{(1-E)^z}{E^{z-1}}\frac{\ln E}{z-1} - \frac{z}{(z-1)}F_2(z-1) + \frac{F_1(z)}{(z-1)} \quad (16b)$$

This result is similar to Eq. (7*b*). After a complicated derivation, one can show that

$$F_2(z) = F_1(z)\left(\ln E + \frac{1}{z-1}\right) + z\sum_{k=1}^{\infty}\frac{(-1)^k F_1(z-k)}{(z-k)(z-k-1)} \quad (17)$$

in which $F_1(z)$ is estimated by Eq. (8). Finally, Eq. (4) becomes

$$J_2(z) = \frac{z\pi}{\sin z\pi}\left\{\pi\cot z\pi - 1 - \frac{1}{z} + \sum_{k=1}^{\infty}\left(\frac{1}{k} - \frac{1}{z+k}\right)\right\} - \underbrace{\left\{F_1(z)\left(\ln E + \frac{1}{z-1}\right) + z\sum_{k=1}^{\infty}\frac{(-1)^k F_1(z-k)}{(z-k)(z-k-1)}\right\}}_{F_2(z)} \quad (18)$$

Like Eq. (9), Eq. (18) is valid for any noninteger z although it is derived for $z<1$. For integer $z=n$, the following closed solution exists

$$\begin{aligned} J_2(n) &= \int_E^1\left(\frac{1-\xi}{\xi}\right)^n \ln\xi d\xi = \sum_{k=0}^{n}\frac{n!(-1)^k}{(n-k)!k!}\int_E^1 \xi^{k-n}\ln\xi d\xi \\ &= \sum_{k=0}^{n-2\geq 0}\frac{(-1)^k n!}{(n-k)!k!}\int_E^1 \xi^{k-n}\ln\xi d\xi - (-1)^n n\int_E^1\frac{\ln\xi}{\xi}d\xi \\ &\quad + (-1)^n\int_E^1 \ln\xi d\xi \\ &= \sum_{k=0}^{n-2\geq 0}\frac{(-1)^k n!}{(n-k)!k!}\cdot\left\{\frac{E^{1+k-n}\ln E}{n-k-1} + \frac{E^{1+k-n}-1}{(n-k-1)^2}\right\} \\ &\quad + (-1)^n\left\{\frac{n}{2}\ln^2 E - E\ln E + E - 1\right\} \end{aligned} \quad (19)$$

For the interest of application, the convergence of Eq. (18) to Eq. (19) is only shown in Fig. 2.

Proposed Algorithm and Convergence

Eqs. (9) and (18) include three infinite series. Series (8) and (17) are rapidly convergent as soon as $k-z>1$, because E^{k-z} quickly tends to zero. In practice, taking the first 10 terms in Eqs. (8) and (17) is accurate enough since there is no sediment transport under $z>10$. The convergence of the first series in Eq. (18) is comparatively slower. For calculation, the following approximation can be used in a program

$$\sum_{k=1}^{\infty}\left(\frac{1}{k} - \frac{1}{z+k}\right) = f(z) \approx \frac{\pi^2}{6}\frac{z}{(1+z)^{0.7162}} \quad (20)$$

which is shown in Fig. 3 where the maximum relative error is 0.26% for $0 \leq z \leq 6$.

The above analysis can be summarized in the form of a computational algorithm. First, for an integer value z, i.e., $|z-\mathrm{round}(z)| < 10^{-3}$, Eqs. (12) and (19) are directly applied. Otherwise, the following algorithm is used.

- *Step 1*: Estimate $F_1(z)$ from Eq. (8) using a maximum of 10 terms, $k=10$.
- *Step 2*: Estimate $J_1(z)$ from Eq. (9).
- *Step 3*: Estimate the first series in Eq. (18) by using the approximation (20).
- *Step 4*: Estimate $F_2(z)$ from Eq. (17) using $k=10$ terms.
- *Step 5*: Estimate $J_2(z)$ from Eq. (18).

A *Fortran* subroutine or *Excel* spreadsheet can be downloaded from http://courses.nus.edu.sg/course/cveguoj/ce5309/pierre.html for the above algorithm. The results of applying this algorithm are plotted in Figs. 1 and 2 where the symbol of a cross indicates the exact values from Eqs. (12) and (19). In addition, the exact values of J_1 for $z=n+1/2$ can be found with *Maple* and are also plotted in Fig. 1. For example,

$$J_1\left(\frac{1}{2}\right) = \frac{\pi}{4} - \frac{1}{2}\sin^{-1}(2E-1) - E\sqrt{\frac{1}{E}-1} \quad (21a)$$

$$J_1\left(\frac{3}{2}\right) = -\frac{3\pi}{4} + \frac{3}{2}\sin^{-1}(2E-1) + (2+E)\sqrt{\frac{1}{E}-1} \quad (21b)$$

$$J_1\left(\frac{5}{2}\right)=\frac{5\pi}{4}-\frac{5}{2}\sin^{-1}(2E-1)+\left(\frac{2}{3E}-\frac{14}{3}-E\right)\sqrt{\frac{1}{E}-1} \tag{21c}$$

$$J_1\left(\frac{7}{2}\right)=-\frac{7\pi}{4}+\frac{7}{2}\sin^{-1}(2E-1)+\left(\frac{2}{5E^2}-\frac{32}{15E}+\frac{116}{15}+E\right)\sqrt{\frac{1}{E}-1} \tag{21d}$$

$$J_1\left(\frac{9}{2}\right)=\frac{9\pi}{4}-\frac{9}{2}\sin^{-1}(2E-1)+\left(\frac{2}{7E^3}-\frac{58}{35E^2}+\frac{156}{35E}-\frac{388}{35}-E\right)\sqrt{\frac{1}{E}-1} \tag{21e}$$

One can see that Eqs. (9) and (18), respectively, converge to Eqs. (12) and (19), the results for integer z values from Eq. (21) also coincide with those from Eq. (9). Thus, one can consider that Eqs. (9) and (18) correctly represent the accurate vales of J_1 and J_2, respectively. The numerical calculation shows that the presented approximations are computationally efficient and can avoid computational overflow. Therefore, they can be incorporated into professional software like *HEC-RAS* or *HEC-6*.

Conclusions

This note presents an effective approximation to Einstein integrals J_1 and J_2 that are valid over the entire range of the Rouse number z and the relative bed-layer thickness E. The approximations can be readily implemented using widespread tools such as programmable calculators, spreadsheets, *Fortran*, or *MatLab*. In particular, it may provide a simple way to incorporate Einstein bed load function into widely used hydraulic software. The numerical experiment shows that the proposed algorithm rapidly converges to the exact values of J_1 and J_2.

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Appendix C – Available Data

Table C.1. Summary of Available Data

Report Number	Depth Integrated Suspended Sediment Concentration	Particle Size Distribution of Suspended Sediment	Point Sample Sediment	Particle Size for Each Point sampled	Discharge	Flow Depth	Unmeasured Depth	Width	Slope	Mean Velocity	Velocity Distribution	Temperature	Bed Load Concentration	Particle Size Distribution of Bed Material	Total Load	Average Concentration	Concentration at "a"	Bedform	Area	Hydraulic Radius
Vanoni - Some Experiments on Suspended Sediment			X (hard to read in a graph)			X			X		X	X				X	X			
Brooks - Dissertation Lab Study			X	X (1 run)	X	X			X		X							X (dunes)		
Colman Lab Experiments			X		X	X					X									
Paper 462-I CSU Flume Data	X (different type of sampler)	Uniform Particles			X	X		X	X	X		X		d50	Bed Material Total Load			X		
Modified Laursen Method for Estimating Bed Material Sediment Load - Arkansas River	X	X			X	X		X		X		X		X						
Mississippi River Data from Akalin's Dissertation			X	X	X	X	X				X	X		X			X			
Paper 1819-J - Mississippi River at St Louis			X	X		X		X			X	X		X (Some days)						
Paper 1802 - Mississippi River at St Louis	X		X	X	X	X		X	X	X	X	X		d50						X
Paper 1373 - Wind River Basin, Wyoming (Fivemile Creek)	X	X	X	X	X	X					X			X						
Anderson - Enoree River			X	X	X	X			X		X						X			
Paper 562-J: Summary of Alluvial Channel Data from LFCC	X	X	X	X	X	X		X	X		X			X				X	X	
462-B - Middle Rio Grande			X	X	X	X		X	X	X	X	X		X						
Paper 462-F Rio Grande	X	X (some data) found in other reports			X	X		X	X	X		X		X						
Paper 1498-H Rio Grande near Bernalillo	X	X			X	X		X	X	X		X		X				X		
Paper 1357 - Niobrara River Data	X	X	X	X	X	A/W		X	X	X		X		X	Measured at Contacted Section				X	
Paper 1476 - Middle Loup River	X	X	X	X	X			X	X	X		X		X	Measured at a Turbulent Flume				X	
79-515: Suspended Sediment and Velocity Data Amazon River and Tributaries	X	X	X	X		X		X		X	X									
83-135 Sediment and Stream Velocity Data for Sacramento River	X	% Sand	X	% Sand	X	X					X	X		X						
83-773 James River Basin	X				X							X								
80-1189-80-1191 East Fork River Wyoming	x (TWO STATIONS)	MISSING			X	X		X	Sw	X			X (HELLEY SMITH)	X						
89-233 - South Fork Salmon River	X	Percent Sand			X	X		X	X	X		X	X	X	X				X	
89-67 Measured Total Loads For 93 US Streams	X	X			X	X		X	X	X		X	X	X						
81-207 : Sediment Analyses for Selected Sited on the Platte River	X	X			X	X		X	X	X		X	X	X					X	
93-174 Stream flow and Sediment Data Colorado River and Tributaries	X	X			X	X	USP-61A1 (1985-1986) and USD-77 (1983)	X		X		X	X (Helley smith load needs to be determined time 30 sec)	X					X	

Table C.2. Guy et al. Raw Data 1

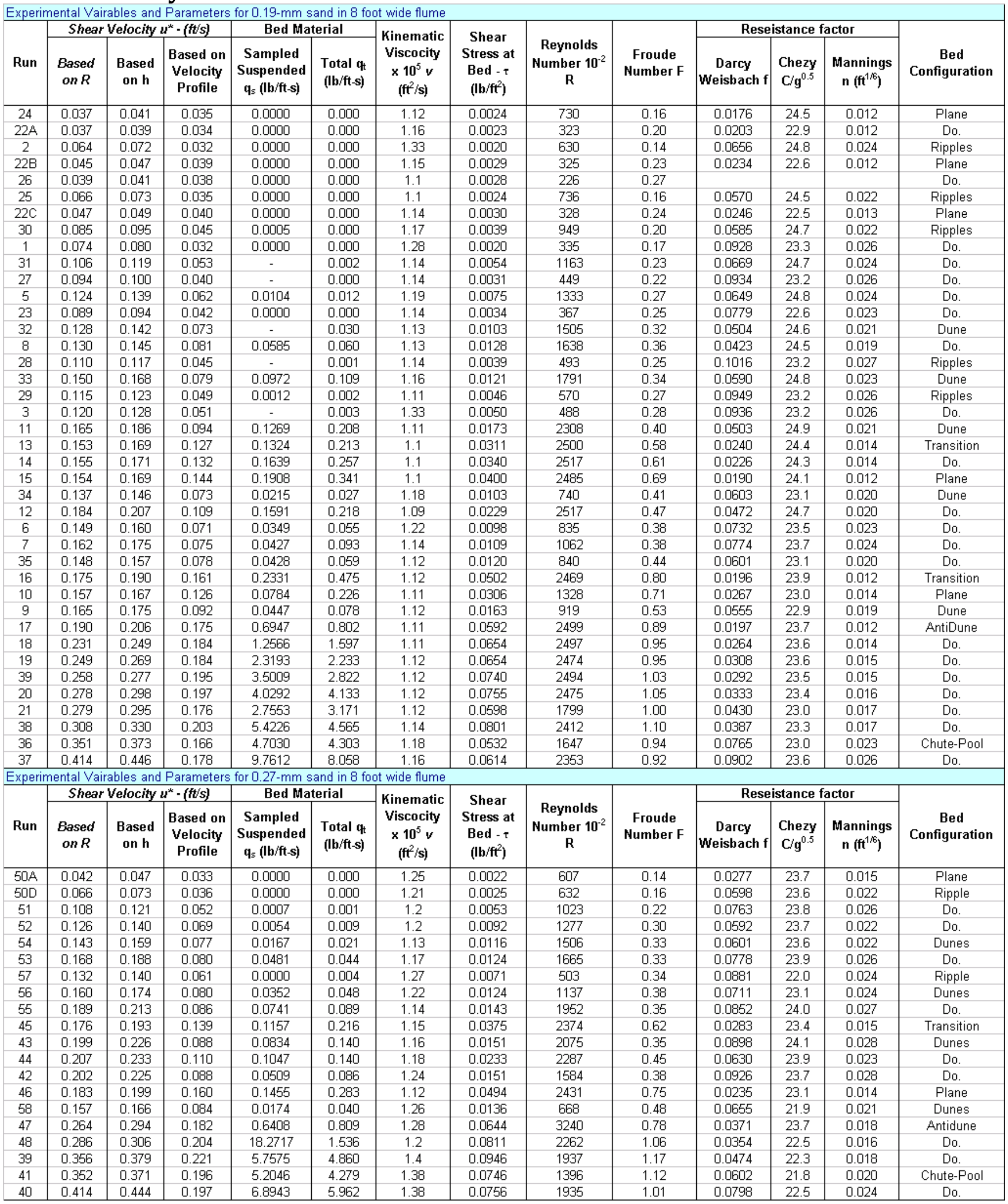
Experimental Vairables and Parameters for 0.19-mm sand in 8 foot wide flume

						Suspended Concentration		Total Bed Material			
Run	Slope x10^2 S	Depth h (ft)	Hydraulic Radius (ft)	Water Discharge - Q (ft^3/sec)	Temp - T (°C)	C_s (ppm)	Particle Size - d_{50ss} (ft x 10^3)	C_b (ppm)	Particle Size - d_{50} (ft x 10^3)	Bed Material Particle Size d_{50} (ft x 10^3)	Mean Velocity V (ft/s)
24	0.0055	0.94	0.76	6.52	18.6	0	0.463	0	-	-	0.87
22A	0.01	0.48	0.43	2.99	17.5	0	0.463	0	-	-	0.78
2	0.015	1.06	0.84	6.68	12.3	0	0.463	0.2	-	0.656	0.79
22B	0.016	0.43	0.39	2.99	17.8	0	0.463	0	-	-	0.87
26	0.017	0.3	0.28	2	19.2	0	0.463	0	-	0.626	0.83
25	0.018	0.93	0.75	6.45	19.2	0	0.463	0.3	-	0.613	0.87
22C	0.018	0.42	0.38	2.99	18	0	0.463	0	-	-	0.89
30	0.028	1	0.80	8.91	17	7	0.463	3.7	0.321	0.626	1.11
1	0.034	0.58	0.51	3.42	13.6	0	0.463	1.2	0.712	0.643	0.74
31	0.043	1.02	0.81	10.62	18.1	42	0.423	29	0.433	0.623	1.3
27	0.057	0.55	0.48	4.08	18.1	-	0.463	4	0.334	0.623	0.93
5	0.058	1.03	0.82	12.67	16.4	105	0.462	120	0.499	0.64	1.54
23	0.062	0.44	0.40	2.99	18.1	0	0.463	2	0.499	0.597	0.95
32	0.066	0.95	0.77	13.64	18.2	-	0.456	281	0.456	0.649	1.79
8	0.07	0.93	0.75	14.81	18.3	506	0.511	519	0.427	0.63	1.99
28	0.079	0.54	0.48	4.49	18	-	0.463	34	0.518	0.623	1.04
33	0.083	1.06	0.84	16.66	17.4	748	0.482	836	0.482	0.656	1.96
29	0.084	0.56	0.49	5.08	19.1	31	0.463	58	0.558	0.643	1.13
3	0.092	0.55	0.48	5.2	12.3	-	0.463	84	0.528	0.659	1.18
11	0.099	1.09	0.86	20.47	18.9	795	0.351	1300	0.446	0.583	2.35
13	0.1	0.89	0.73	21.98	19.3	772	0.371	1240	0.453	0.59	3.09
14	0.106	0.86	0.71	22.12	19.4	950	0.413	1490	0.522	0.564	3.22
15	0.112	0.79	0.66	21.84	19.3	1120	0.482	2000	0.561	0.584	3.46
34	0.127	0.52	0.46	7	16.6	393	0.463	503	0.518	0.653	1.68
12	0.13	1.02	0.81	21.96	19.7	929	0.423	1270	0.436	0.593	2.69
6	0.13	0.61	0.53	8.14	15.3	550	0.429	861	0.489	0.62	1.67
7	0.14	0.68	0.58	9.66	18	567	0.452	1240	0.499	0.614	1.78
35	0.147	0.52	0.46	7.52	18.5	729	0.462	999	0.531	0.656	1.81
16	0.156	0.72	0.61	22.14	18.8	1350	0.528	2750	0.62	0.597	3.84
10	0.17	0.51	0.45	11.68	19.1	861	0.433	2480	0.548	0.587	2.89
9	0.194	0.49	0.44	8.22	18.6	697	0.397	1210	0.495	0.623	2.1
17	0.196	0.67	0.57	22.1	19.1	4030	0.472	4650	0.544	0.561	4.14
18	0.3	0.64	0.55	22.16	18.9	7270	0.478	9240	0.522	0.597	4.33
19	0.35	0.64	0.55	22.19	18.7	13400	0.495	12900	0.522	0.564	4.33
39	0.39	0.61	0.53	22.33	18.8	20100	0.521	16200	0.495	-	4.58
20	0.46	0.6	0.52	22.17	18.5	23300	0.485	23900	0.512	0.59	4.62
21	0.542	0.5	0.44	16.13	18.7	21900	0.469	25200	0.502	-	4.03
38	0.582	0.58	0.51	22	17.9	31600	0.508	26600	0.522	-	4.74
36	0.845	0.51	0.45	15.54	16.8	38800	0.518	35500	0.541	0.676	3.81
37	0.95	0.65	0.56	21.84	17.3	57300	0.561	47300	0.512	0.689	4.2

Experimental Vairables and Parameters for 0.27-mm sand in 8 foot wide flume

						Suspended Concentration		Total Bed Material			
Run	Slope x10^2 S	Depth - h (ft)	Hydraulic Radius (ft)	Water Discharge - Q (ft^3/sec)	Temp - T (°C)	Sampled C_s (ppm)	Particle Size - d_{50} (ft x 10^3)	Concentration C_b (ppm)	Particle Size - d_{50} (ft x 10^3)	Bed Material Particle Size d_{50} (ft x 10^3)	Mean Velocity V (ft/s)
50A	0.007	0.96	0.77	6.09	14.5	0	0.638	-	-	-	0.79
50D	0.018	0.91	0.74	6.09	15.8	0	0.638	0.5	-	0.856	0.84
51	0.046	0.99	0.79	9.86	16	9	0.638	12	0.705	0.889	1.24
52	0.065	0.94	0.76	12.25	16	57	0.638	98	0.696	0.82	1.63
54	0.084	0.93	0.75	13.62	18.3	157	0.638	200	0.607	0.935	1.83
53	0.108	1.02	0.81	15.58	16.9	396	0.584	358	0.584	0.902	1.91
57	0.126	0.48	0.43	5.11	13.9	0	0.638	93	0.771	0.951	1.33
56	0.126	0.75	0.63	11.09	15.3	407	0.591	550	0.623	0.823	1.85
55	0.13	1.08	0.85	17.8	18.1	534	0.689	639	0.646	0.886	2.06
45	0.138	0.84	0.69	21.84	17.8	679	0.541	1270	0.755	0.951	3.25
43	0.14	1.13	0.88	19.23	17.4	556	0.64	931	0.686	0.912	2.13
44	0.163	1.03	0.82	21.55	16.8	623	0.82	833	0.63	0.856	2.62
42	0.167	0.94	0.76	15.68	14.8	416	0.902	704	0.656	0.837	2.09
46	0.167	0.74	0.62	21.76	18.5	857	0.554	1670	0.853	0.827	3.68
58	0.185	0.46	0.41	6.75	14.2	331	0.689	753	0.702	0.902	1.83
47	0.28	0.96	0.77	21.79	13.6	3770	0.6	4760	0.758	0.863	4.32
48	0.493	0.59	0.51	21.69	15.9	108000	0.662	9080	0.646	0.856	4.6
39	0.813	0.55	0.48	21.71	1.2	34000	0.327	28700	0.656	0.787	4.93
41	0.952	0.45	0.40	15.41	11	43300	0.715	35600	0.636	0.955	4.28
40	1.022	0.6	0.52	21.35	10.8	41400	0.623	35800	0.656	1.033	4.45

Table C.3. Guy et al. Raw Data 2



Experimental Vairables and Parameters for 0.19-mm sand in 8 foot wide flume

Run	*Shear Velocity u^* - (ft/s)*			Bed Material		Kinematic Viscosity x 10^5 ν (ft^2/s)	Shear Stress at Bed - τ (lb/ft^2)	Reynolds Number 10^{-2} R	Froude Number F	Reseistance factor			Bed Configuration
	Based on R	Based on h	Based on Velocity Profile	Sampled Suspended q_s (lb/ft-s)	Total q_t (lb/ft-s)					Darcy Weisbach f	Chezy $C/g^{0.5}$	Mannings n ($ft^{1/6}$)	
24	0.037	0.041	0.035	0.0000	0.000	1.12	0.0024	730	0.16	0.0176	24.5	0.012	Plane
22A	0.037	0.039	0.034	0.0000	0.000	1.16	0.0023	323	0.20	0.0203	22.9	0.012	Do.
2	0.064	0.072	0.032	0.0000	0.000	1.33	0.0020	630	0.14	0.0656	24.8	0.024	Ripples
22B	0.045	0.047	0.039	0.0000	0.000	1.15	0.0029	325	0.23	0.0234	22.6	0.012	Plane
26	0.039	0.041	0.038	0.0000	0.000	1.1	0.0028	226	0.27				Do.
25	0.066	0.073	0.035	0.0000	0.000	1.1	0.0024	736	0.16	0.0570	24.5	0.022	Ripples
22C	0.047	0.049	0.040	0.0000	0.000	1.14	0.0030	328	0.24	0.0246	22.5	0.013	Plane
30	0.085	0.095	0.045	0.0005	0.000	1.17	0.0039	949	0.20	0.0585	24.7	0.022	Ripples
1	0.074	0.080	0.032	0.0000	0.000	1.28	0.0020	335	0.17	0.0928	23.3	0.026	Do.
31	0.106	0.119	0.053	-	0.002	1.14	0.0054	1163	0.23	0.0669	24.7	0.024	Do.
27	0.094	0.100	0.040	-	0.000	1.14	0.0031	449	0.22	0.0934	23.2	0.026	Do.
5	0.124	0.139	0.062	0.0104	0.012	1.19	0.0075	1333	0.27	0.0649	24.8	0.024	Do.
23	0.089	0.094	0.042	0.0000	0.000	1.14	0.0034	367	0.25	0.0779	22.6	0.023	Do.
32	0.128	0.142	0.073	-	0.030	1.13	0.0103	1505	0.32	0.0504	24.6	0.021	Dune
8	0.130	0.145	0.081	0.0585	0.060	1.13	0.0128	1638	0.36	0.0423	24.5	0.019	Do.
28	0.110	0.117	0.045	-	0.001	1.14	0.0039	493	0.25	0.1016	23.2	0.027	Ripples
33	0.150	0.168	0.079	0.0972	0.109	1.16	0.0121	1791	0.34	0.0590	24.8	0.023	Dune
29	0.115	0.123	0.049	0.0012	0.002	1.11	0.0046	570	0.27	0.0949	23.2	0.026	Ripples
3	0.120	0.128	0.051	-	0.003	1.33	0.0050	488	0.28	0.0936	23.2	0.026	Do.
11	0.165	0.186	0.094	0.1269	0.208	1.11	0.0173	2308	0.40	0.0503	24.9	0.021	Dune
13	0.153	0.169	0.127	0.1324	0.213	1.1	0.0311	2500	0.58	0.0240	24.4	0.014	Transition
14	0.155	0.171	0.132	0.1639	0.257	1.1	0.0340	2517	0.61	0.0226	24.3	0.014	Do.
15	0.154	0.169	0.144	0.1908	0.341	1.1	0.0400	2485	0.69	0.0190	24.1	0.012	Plane
34	0.137	0.146	0.073	0.0215	0.027	1.18	0.0103	740	0.41	0.0603	23.1	0.020	Dune
12	0.184	0.207	0.109	0.1591	0.218	1.09	0.0229	2517	0.47	0.0472	24.7	0.020	Do.
6	0.149	0.160	0.071	0.0349	0.055	1.22	0.0098	835	0.38	0.0732	23.5	0.023	Do.
7	0.162	0.175	0.075	0.0427	0.093	1.14	0.0109	1062	0.38	0.0774	23.7	0.024	Do.
35	0.148	0.157	0.078	0.0428	0.059	1.12	0.0120	840	0.44	0.0601	23.1	0.020	Do.
16	0.175	0.190	0.161	0.2331	0.475	1.12	0.0502	2469	0.80	0.0196	23.9	0.012	Transition
10	0.157	0.167	0.126	0.0784	0.226	1.11	0.0306	1328	0.71	0.0267	23.0	0.014	Plane
9	0.165	0.175	0.092	0.0447	0.078	1.12	0.0163	919	0.53	0.0555	22.9	0.019	Dune
17	0.190	0.206	0.175	0.6947	0.802	1.11	0.0592	2499	0.89	0.0197	23.7	0.012	AntiDune
18	0.231	0.249	0.184	1.2566	1.597	1.11	0.0654	2497	0.95	0.0264	23.6	0.014	Do.
19	0.249	0.269	0.184	2.3193	2.233	1.12	0.0654	2474	0.95	0.0308	23.6	0.015	Do.
39	0.258	0.277	0.195	3.5009	2.822	1.12	0.0740	2494	1.03	0.0292	23.5	0.015	Do.
20	0.278	0.298	0.197	4.0292	4.133	1.12	0.0755	2475	1.05	0.0333	23.4	0.016	Do.
21	0.279	0.295	0.176	2.7553	3.171	1.12	0.0598	1799	1.00	0.0430	23.0	0.017	Do.
38	0.308	0.330	0.203	5.4226	4.565	1.14	0.0801	2412	1.10	0.0387	23.3	0.017	Do.
36	0.351	0.373	0.166	4.7030	4.303	1.18	0.0532	1647	0.94	0.0765	23.0	0.023	Chute-Pool
37	0.414	0.446	0.178	9.7612	8.058	1.16	0.0614	2353	0.92	0.0902	23.6	0.026	Do.

Experimental Vairables and Parameters for 0.27-mm sand in 8 foot wide flume

Run	*Shear Velocity u^* - (ft/s)*			Bed Material		Kinematic Viscosity x 10^5 ν (ft^2/s)	Shear Stress at Bed - τ (lb/ft^2)	Reynolds Number 10^{-2} R	Froude Number F	Reseistance factor			Bed Configuration
	Based on R	Based on h	Based on Velocity Profile	Sampled Suspended q_s (lb/ft-s)	Total q_t (lb/ft-s)					Darcy Weisbach f	Chezy $C/g^{0.5}$	Mannings n ($ft^{1/6}$)	
50A	0.042	0.047	0.033	0.0000	0.000	1.25	0.0022	607	0.14	0.0277	23.7	0.015	Plane
50D	0.066	0.073	0.036	0.0000	0.000	1.21	0.0025	632	0.16	0.0598	23.6	0.022	Ripple
51	0.108	0.121	0.052	0.0007	0.001	1.2	0.0053	1023	0.22	0.0763	23.8	0.026	Do.
52	0.126	0.140	0.069	0.0054	0.009	1.2	0.0092	1277	0.30	0.0592	23.7	0.022	Do.
54	0.143	0.159	0.077	0.0167	0.021	1.13	0.0116	1506	0.33	0.0601	23.6	0.022	Dunes
53	0.168	0.188	0.080	0.0481	0.044	1.17	0.0124	1665	0.33	0.0778	23.9	0.026	Do.
57	0.132	0.140	0.061	0.0000	0.004	1.27	0.0071	503	0.34	0.0881	22.0	0.024	Ripple
56	0.160	0.174	0.080	0.0352	0.048	1.22	0.0124	1137	0.38	0.0711	23.1	0.024	Dunes
55	0.189	0.213	0.086	0.0741	0.089	1.14	0.0143	1952	0.35	0.0852	24.0	0.027	Do.
45	0.176	0.193	0.139	0.1157	0.216	1.15	0.0375	2374	0.62	0.0283	23.4	0.015	Transition
43	0.199	0.226	0.088	0.0834	0.140	1.16	0.0151	2075	0.35	0.0898	24.1	0.028	Dunes
44	0.207	0.233	0.110	0.1047	0.140	1.18	0.0233	2287	0.45	0.0630	23.9	0.023	Do.
42	0.202	0.225	0.088	0.0509	0.086	1.24	0.0151	1584	0.38	0.0926	23.7	0.028	Do.
46	0.183	0.199	0.160	0.1455	0.283	1.12	0.0494	2431	0.75	0.0235	23.1	0.014	Plane
58	0.157	0.166	0.084	0.0174	0.040	1.26	0.0136	668	0.48	0.0655	21.9	0.021	Dunes
47	0.264	0.294	0.182	0.6408	0.809	1.28	0.0644	3240	0.78	0.0371	23.7	0.018	Antidune
48	0.286	0.306	0.204	18.2717	1.536	1.2	0.0811	2262	1.06	0.0354	22.5	0.016	Do.
39	0.356	0.379	0.221	5.7575	4.860	1.4	0.0946	1937	1.17	0.0474	22.3	0.018	Do.
41	0.352	0.371	0.196	5.2046	4.279	1.38	0.0746	1396	1.12	0.0602	21.8	0.020	Chute-Pool
40	0.414	0.444	0.197	6.8943	5.962	1.38	0.0756	1935	1.01	0.0798	22.5	0.024	Do.

Table C.4. Guy et al. Raw Data 3

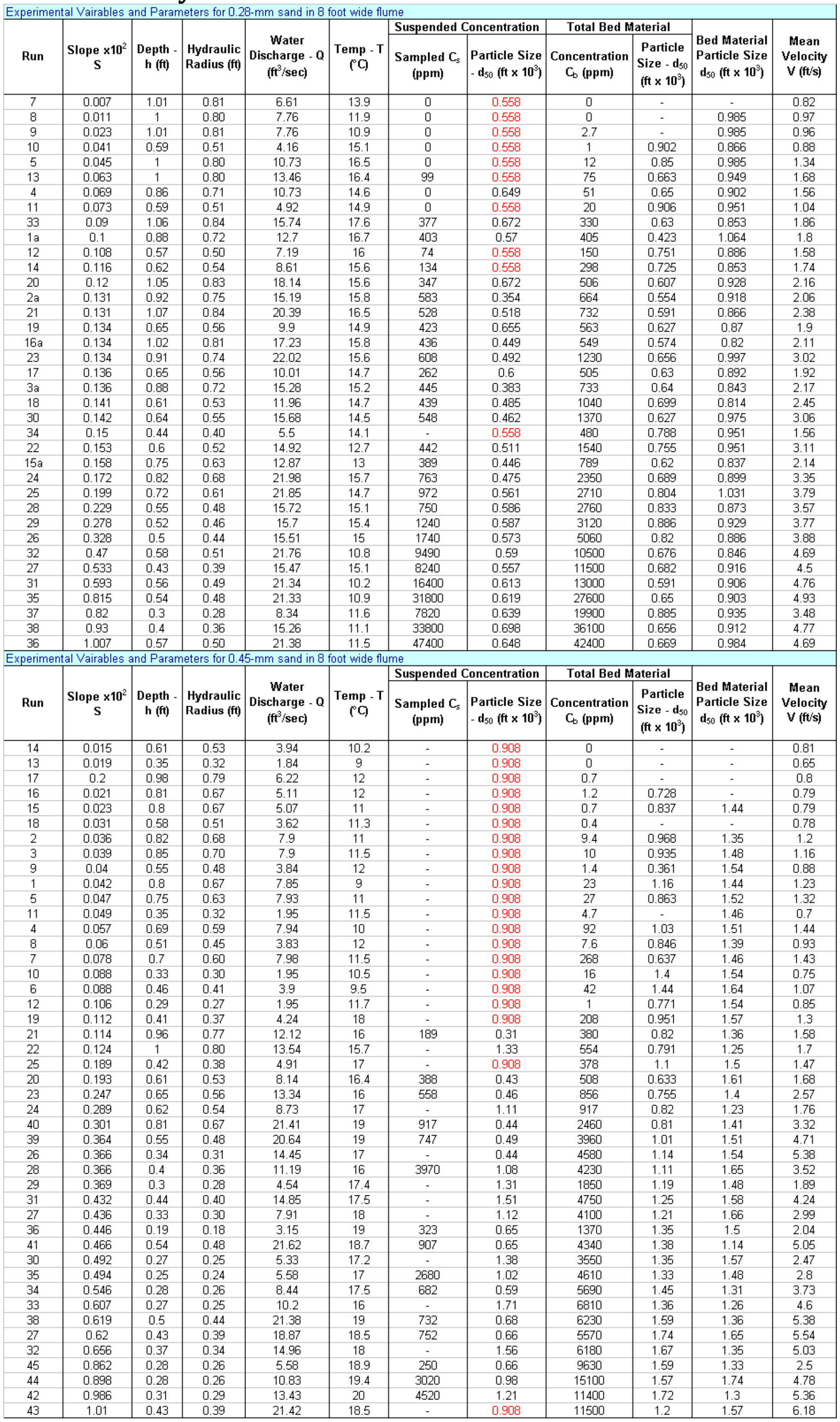
Experimental Vairables and Parameters for 0.19-mm sand in 8 foot wide flume

Run	ds	qs/qt	Useful Variables							
			w	ds (ft)	2ds/h	h/ds	Ro	ds (mm)	Re*	Shields
24	0.19	-	0.050	0.001	0.002	2030.238	3.068	0.141	1.466	0.068
22A	0.19	-	0.049	0.001	0.003	1036.717	3.096	0.141	1.362	0.063
2	0.19	0	0.043	0.001	0.001	2289.417	1.520	0.141	1.107	0.208
22B	0.19	-	0.049	0.001	0.003	928.726	2.604	0.141	1.551	0.090
26	0.19	-	0.051	0.001	0.005	647.948	3.133	0.141	1.611	0.067
25	0.19	0	0.051	0.001	0.002	2008.639	1.729	0.141	1.494	0.219
22C	0.19	-	0.049	0.001	0.003	907.127	2.501	0.141	1.605	0.099
30	0.19	1.891891892	0.048	0.001	0.001	2159.827	1.273	0.141	1.779	0.367
1	0.19	0	0.045	0.001	0.002	1252.700	1.409	0.141	1.147	0.258
31	0.19	-	0.042	0.001	0.001	2411.348	0.888	0.129	1.950	0.628
27	0.19	-	0.049	0.001	0.003	1187.905	1.228	0.141	1.628	0.410
5	0.19	0.875	0.048	0.001	0.001	2229.437	0.856	0.141	2.414	0.784
23	0.19	0	0.049	0.001	0.003	950.324	1.317	0.141	1.704	0.357
32	0.19	-	0.048	0.001	0.002	2083.333	0.852	0.139	2.941	0.833
8	0.19	0.97495183	0.059	0.001	0.002	1819.961	1.011	0.156	3.672	0.772
28	0.19	-	0.049	0.001	0.003	1166.307	1.053	0.141	1.824	0.558
33	0.19	0.894736842	0.052	0.001	0.001	2199.170	0.774	0.147	3.279	1.106
29	0.19	0.534482759	0.050	0.001	0.003	1209.503	1.024	0.141	2.028	0.616
3	0.19	-	0.043	0.001	0.003	1187.905	0.852	0.141	1.771	0.662
11	0.19	0.611538462	0.031	0.001	0.001	3105.413	0.414	0.107	2.984	1.863
13	0.19	0.622580645	0.034	0.001	0.002	2398.922	0.509	0.113	4.271	1.454
14	0.19	0.637583893	0.042	0.001	0.002	2082.324	0.609	0.126	4.972	1.338
15	0.19	0.56	0.054	0.001	0.002	1639.004	0.804	0.147	6.290	1.113
34	0.19	0.781312127	0.048	0.001	0.003	1123.110	0.823	0.141	2.859	0.864
12	0.19	0.731496063	0.044	0.001	0.001	2411.348	0.530	0.129	4.219	1.900
6	0.19	0.638792102	0.041	0.001	0.002	1421.911	0.640	0.131	2.503	1.120
7	0.19	0.457258065	0.047	0.001	0.002	1504.425	0.677	0.138	2.974	1.276
35	0.19	0.72972973	0.050	0.001	0.003	1125.541	0.795	0.141	3.238	1.003
16	0.19	0.490909091	0.062	0.001	0.002	1363.636	0.817	0.161	7.584	1.289
10	0.19	0.347177419	0.045	0.001	0.003	1177.829	0.673	0.132	4.900	1.214
9	0.19	0.576033058	0.038	0.001	0.003	1234.257	0.548	0.121	3.249	1.451
17	0.19	0.866666667	0.052	0.001	0.002	1419.492	0.633	0.144	7.431	1.686
18	0.19	0.786796537	0.053	0.001	0.002	1338.912	0.535	0.146	7.909	2.434
19	0.19	1.03875969	0.056	0.001	0.002	1292.929	0.521	0.151	8.117	2.743
39	0.19	1.240740741	0.061	0.001	0.002	1170.825	0.549	0.159	9.083	2.767
20	0.19	0.974895397	0.054	0.001	0.002	1237.113	0.454	0.148	8.544	3.449
21	0.19	0.869047619	0.051	0.001	0.003	1066.098	0.433	0.143	7.350	3.502
38	0.19	1.187969925	0.058	0.001	0.002	1141.732	0.437	0.155	9.053	4.027
36	0.19	1.092957746	0.058	0.001	0.003	984.556	0.389	0.158	7.269	5.042
37	0.19	1.21141649	0.067	0.001	0.002	1158.645	0.374	0.171	8.601	6.671

Experimental Vairables and Parameters for 0.27-mm sand in 8 foot wide flume

Run	ds	qs/qt	Useful Variables							
			w	ds (ft)	2ds/h	h/ds	Ro	ds (mm)	Re*	Shields
50A	0.27	#DIV/0!	0.077	0.001	0.002	1504.702	4.148	0.194	1.700	0.064
50D	0.27	0	0.079	0.001	0.002	1426.332	2.715	0.194	1.878	0.156
51	0.27	0.75	0.079	0.001	0.002	1551.724	1.637	0.194	2.771	0.433
52	0.27	0.581632653	0.079	0.001	0.002	1473.354	1.413	0.194	3.663	0.580
54	0.27	0.785	0.082	0.001	0.002	1457.680	1.299	0.194	4.372	0.742
53	0.27	1.106145251	0.071	0.001	0.002	1746.575	0.937	0.178	3.995	1.143
57	0.27	0	0.076	0.001	0.004	752.351	1.368	0.194	3.040	0.575
56	0.27	0.74	0.070	0.001	0.003	1269.036	1.001	0.180	3.880	0.969
55	0.27	0.835680751	0.091	0.001	0.002	1567.489	1.075	0.210	5.186	1.235
45	0.27	0.534645669	0.063	0.001	0.002	1552.680	0.820	0.165	6.540	1.299
43	0.27	0.597207304	0.081	0.001	0.002	1765.625	0.902	0.195	4.872	1.498
44	0.27	0.74789916	0.113	0.001	0.002	1256.098	1.214	0.250	7.622	1.241
42	0.27	0.590909091	0.124	0.001	0.002	1042.129	1.378	0.275	6.426	1.055
46	0.27	0.513173653	0.067	0.001	0.003	1335.740	0.840	0.169	7.893	1.352
58	0.27	0.439575033	0.086	0.001	0.004	667.634	1.299	0.210	4.575	0.749
47	0.27	0.792016807	0.069	0.001	0.002	1600.000	0.587	0.183	8.540	2.715
48	0.27	11.89427313	0.084	0.001	0.003	891.239	0.684	0.202	11.281	2.663
39	0.27	1.18466899	0.022	0.001	0.004	1681.957	0.144	0.100	5.159	8.287
41	0.27	1.216292135	0.086	0.001	0.005	629.371	0.577	0.218	10.163	3.631
40	0.27	1.156424581	0.069	0.001	0.003	963.082	0.391	0.190	8.914	5.965

Table C.5. Guy et al. Raw Data 4



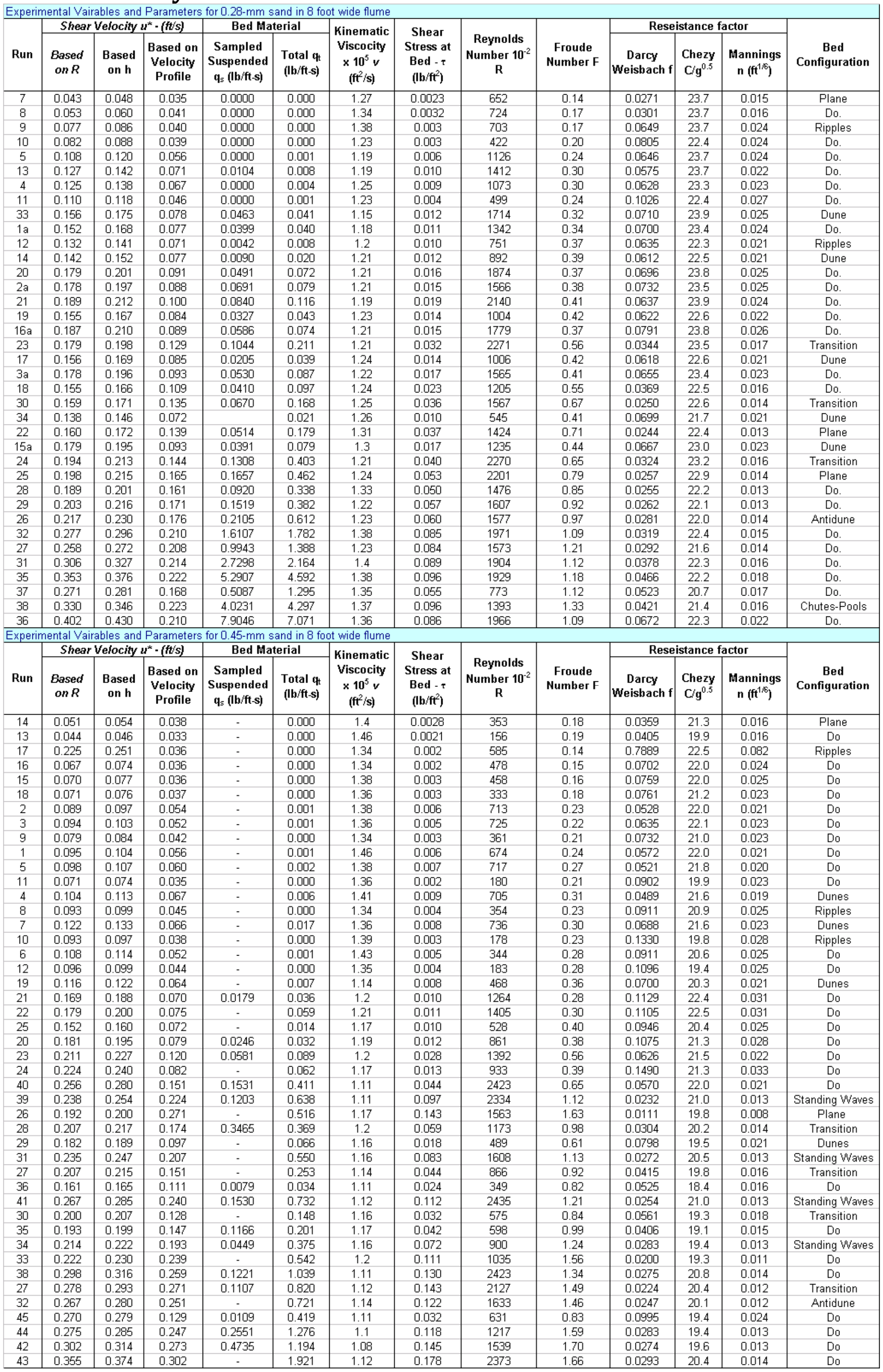
Experimental Vairables and Parameters for 0.28-mm sand in 8 foot wide flume

Run	Slope x10^2 S	Depth - h (ft)	Hydraulic Radius (ft)	Water Discharge - Q (ft^3/sec)	Temp - T (°C)	Suspended Concentration		Total Bed Material		Bed Material Particle Size d_{50} (ft x 10^3)	Mean Velocity V (ft/s)
						Sampled C_s (ppm)	Particle Size - d_{50} (ft x 10^3)	Concentration C_b (ppm)	Particle Size - d_{50} (ft x 10^3)		
7	0.007	1.01	0.81	6.61	13.9	0	0.558	0	-	-	0.82
8	0.011	1	0.80	7.76	11.9	0	0.558	0	-	0.985	0.97
9	0.023	1.01	0.81	7.76	10.9	0	0.558	2.7	-	0.985	0.96
10	0.041	0.59	0.51	4.16	15.1	0	0.558	1	0.902	0.866	0.88
5	0.045	1	0.80	10.73	16.5	0	0.558	12	0.85	0.985	1.34
13	0.063	1	0.80	13.46	16.4	99	0.558	75	0.663	0.949	1.68
4	0.069	0.86	0.71	10.73	14.6	0	0.649	51	0.65	0.902	1.56
11	0.073	0.59	0.51	4.92	14.9	0	0.558	20	0.906	0.951	1.04
33	0.09	1.06	0.84	15.74	17.6	377	0.672	330	0.63	0.853	1.86
1a	0.1	0.88	0.72	12.7	16.7	403	0.57	405	0.423	1.064	1.8
12	0.108	0.57	0.50	7.19	16	74	0.558	150	0.751	0.886	1.58
14	0.116	0.62	0.54	8.61	15.6	134	0.558	298	0.725	0.853	1.74
20	0.12	1.05	0.83	18.14	15.6	347	0.672	506	0.607	0.928	2.16
2a	0.131	0.92	0.75	15.19	15.8	583	0.354	664	0.554	0.918	2.06
21	0.131	1.07	0.84	20.39	16.5	528	0.518	732	0.591	0.866	2.38
19	0.134	0.65	0.56	9.9	14.9	423	0.655	563	0.627	0.87	1.9
16a	0.134	1.02	0.81	17.23	15.8	436	0.449	549	0.574	0.82	2.11
23	0.134	0.91	0.74	22.02	15.6	608	0.492	1230	0.656	0.997	3.02
17	0.136	0.65	0.56	10.01	14.7	262	0.6	505	0.63	0.892	1.92
3a	0.136	0.88	0.72	15.28	15.2	445	0.383	733	0.64	0.843	2.17
18	0.141	0.61	0.53	11.96	14.7	439	0.485	1040	0.699	0.814	2.45
30	0.142	0.64	0.55	15.68	14.5	548	0.462	1370	0.627	0.975	3.06
34	0.15	0.44	0.40	5.5	14.1	-	0.558	480	0.788	0.951	1.56
22	0.153	0.6	0.52	14.92	12.7	442	0.511	1540	0.755	0.951	3.11
15a	0.158	0.75	0.63	12.87	13	389	0.446	789	0.62	0.837	2.14
24	0.172	0.82	0.68	21.98	15.7	763	0.475	2350	0.689	0.899	3.35
25	0.199	0.72	0.61	21.85	14.7	972	0.561	2710	0.804	1.031	3.79
28	0.229	0.55	0.48	15.72	15.1	750	0.586	2760	0.833	0.873	3.57
29	0.278	0.52	0.46	15.7	15.4	1240	0.587	3120	0.886	0.929	3.77
26	0.328	0.5	0.44	15.51	15	1740	0.573	5060	0.82	0.886	3.88
32	0.47	0.58	0.51	21.76	10.8	9490	0.59	10500	0.676	0.846	4.69
27	0.533	0.43	0.39	15.47	15.1	8240	0.557	11500	0.682	0.916	4.5
31	0.593	0.56	0.49	21.34	10.2	16400	0.613	13000	0.591	0.906	4.76
35	0.815	0.54	0.48	21.33	10.9	31800	0.619	27600	0.65	0.903	4.93
37	0.82	0.3	0.28	8.34	11.6	7820	0.639	19900	0.885	0.935	3.48
38	0.93	0.4	0.36	15.26	11.1	33800	0.698	36100	0.656	0.912	4.77
36	1.007	0.57	0.50	21.38	11.5	47400	0.648	42400	0.669	0.984	4.69

Experimental Vairables and Parameters for 0.45-mm sand in 8 foot wide flume

Run	Slope x10^2 S	Depth - h (ft)	Hydraulic Radius (ft)	Water Discharge - Q (ft^3/sec)	Temp - T (°C)	Suspended Concentration		Total Bed Material		Bed Material Particle Size d_{50} (ft x 10^3)	Mean Velocity V (ft/s)
						Sampled C_s (ppm)	Particle Size - d_{50} (ft x 10^3)	Concentration C_b (ppm)	Particle Size - d_{50} (ft x 10^3)		
14	0.015	0.61	0.53	3.94	10.2	-	0.908	0	-	-	0.81
13	0.019	0.35	0.32	1.84	9	-	0.908	0	-	-	0.65
17	0.2	0.98	0.79	6.22	12	-	0.908	0.7	-	-	0.8
16	0.021	0.81	0.67	5.11	12	-	0.908	1.2	0.728	-	0.79
15	0.023	0.8	0.67	5.07	11	-	0.908	0.7	0.837	1.44	0.79
18	0.031	0.58	0.51	3.62	11.3	-	0.908	0.4	-	-	0.78
2	0.036	0.82	0.68	7.9	11	-	0.908	9.4	0.968	1.35	1.2
3	0.039	0.85	0.70	7.9	11.5	-	0.908	10	0.935	1.48	1.16
9	0.04	0.55	0.48	3.84	12	-	0.908	1.4	0.361	1.54	0.88
1	0.042	0.8	0.67	7.85	9	-	0.908	23	1.16	1.44	1.23
5	0.047	0.75	0.63	7.93	11	-	0.908	27	0.863	1.52	1.32
11	0.049	0.35	0.32	1.95	11.5	-	0.908	4.7	-	1.46	0.7
4	0.057	0.69	0.59	7.94	10	-	0.908	92	1.03	1.51	1.44
8	0.06	0.51	0.45	3.83	12	-	0.908	7.6	0.846	1.39	0.93
7	0.078	0.7	0.60	7.98	11.5	-	0.908	268	0.637	1.46	1.43
10	0.088	0.33	0.30	1.95	10.5	-	0.908	16	1.4	1.54	0.75
6	0.088	0.46	0.41	3.9	9.5	-	0.908	42	1.44	1.64	1.07
12	0.106	0.29	0.27	1.95	11.7	-	0.908	1	0.771	1.54	0.85
19	0.112	0.41	0.37	4.24	18	-	0.908	208	0.951	1.57	1.3
21	0.114	0.96	0.77	12.12	16	189	0.31	380	0.82	1.36	1.58
22	0.124	1	0.80	13.54	15.7	-	1.33	554	0.791	1.25	1.7
25	0.189	0.42	0.38	4.91	17	-	0.908	378	1.1	1.5	1.47
20	0.193	0.61	0.53	8.14	16.4	388	0.43	508	0.633	1.61	1.68
23	0.247	0.65	0.56	13.34	16	558	0.46	856	0.755	1.4	2.57
24	0.289	0.62	0.54	8.73	17	-	1.11	917	0.82	1.23	1.76
40	0.301	0.81	0.67	21.41	19	917	0.44	2460	0.81	1.41	3.32
39	0.364	0.55	0.48	20.64	19	747	0.49	3960	1.01	1.51	4.71
26	0.366	0.34	0.31	14.45	17	-	0.44	4580	1.14	1.54	5.38
28	0.366	0.4	0.36	11.19	16	3970	1.08	4230	1.11	1.65	3.52
29	0.369	0.3	0.28	4.54	17.4	-	1.31	1850	1.19	1.48	1.89
31	0.432	0.44	0.40	14.85	17.5	-	1.51	4750	1.25	1.58	4.24
27	0.436	0.33	0.30	7.91	18	-	1.12	4100	1.21	1.66	2.99
36	0.446	0.19	0.18	3.15	19	323	0.65	1370	1.35	1.5	2.04
41	0.466	0.54	0.48	21.62	18.7	907	0.65	4340	1.38	1.14	5.05
30	0.492	0.27	0.25	5.33	17.2	-	1.38	3550	1.35	1.57	2.47
35	0.494	0.25	0.24	5.58	17	2680	1.02	4610	1.33	1.48	2.8
34	0.546	0.28	0.26	8.44	17.5	682	0.59	5690	1.45	1.31	3.73
33	0.607	0.27	0.25	10.2	16	-	1.71	6810	1.36	1.26	4.6
38	0.619	0.5	0.44	21.38	19	732	0.68	6230	1.59	1.36	5.38
27	0.62	0.43	0.39	18.87	18.5	752	0.66	5570	1.74	1.65	5.54
32	0.656	0.37	0.34	14.96	18	-	1.56	6180	1.67	1.35	5.03
45	0.862	0.28	0.26	5.58	18.9	250	0.66	9630	1.59	1.33	2.5
44	0.898	0.28	0.26	10.83	19.4	3020	0.98	15100	1.57	1.74	4.78
42	0.986	0.31	0.29	13.43	20	4520	1.21	11400	1.72	1.3	5.36
43	1.01	0.43	0.39	21.42	18.5	-	0.908	11500	1.2	1.57	6.18

Table C.6. Guy et al. Raw Data 5



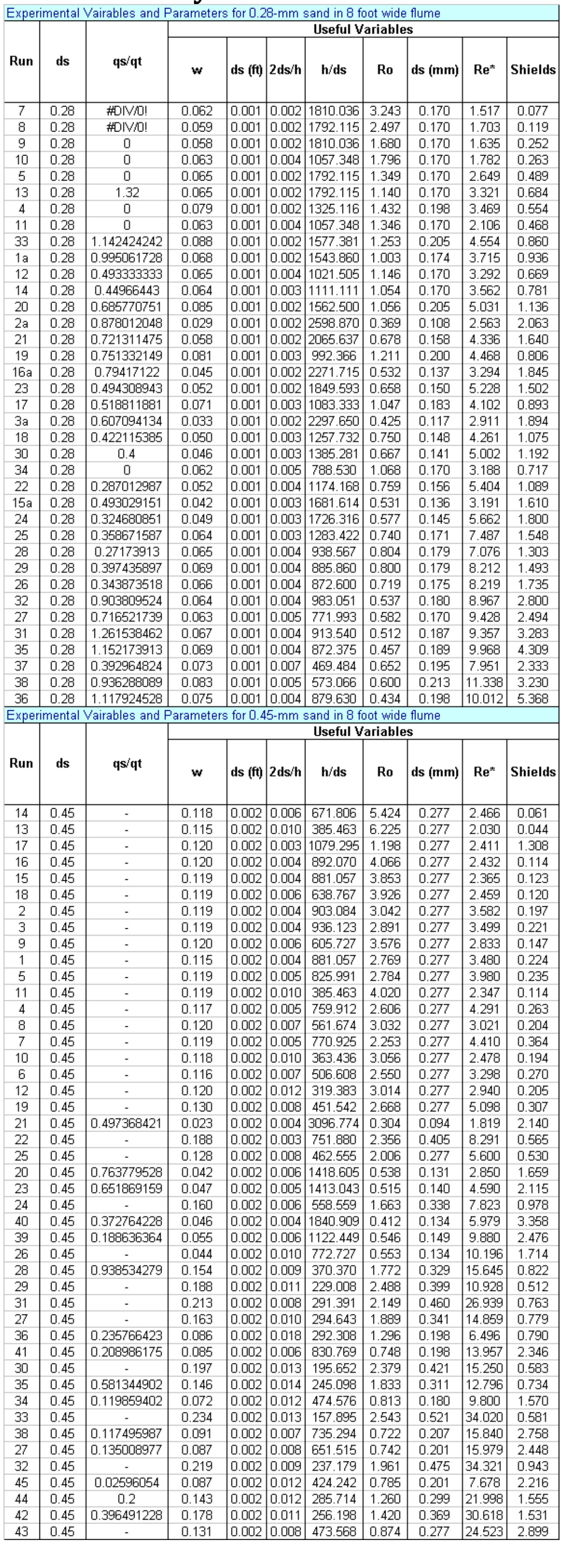
Experimental Vairables and Parameters for 0.28-mm sand in 8 foot wide flume

Run	*Shear Velocity u^* - (ft/s)*			Bed Material		Kinematic Viscosity × 10^5 ν (ft^2/s)	Shear Stress at Bed - τ (lb/ft^2)	Reynolds Number 10^{-2} R	Froude Number F	Reseistance factor			Bed Configuration
	Based on R	Based on h	Based on Velocity Profile	Sampled Suspended q_s (lb/ft-s)	Total q_t (lb/ft-s)					Darcy Weisbach f	Chezy $C/g^{0.5}$	Mannings n ($ft^{1/6}$)	
7	0.043	0.048	0.035	0.0000	0.000	1.27	0.0023	652	0.14	0.0271	23.7	0.015	Plane
8	0.053	0.060	0.041	0.0000	0.000	1.34	0.0032	724	0.17	0.0301	23.7	0.016	Do.
9	0.077	0.086	0.040	0.0000	0.000	1.38	0.003	703	0.17	0.0649	23.7	0.024	Ripples
10	0.082	0.088	0.039	0.0000	0.000	1.23	0.003	422	0.20	0.0805	22.4	0.024	Do.
5	0.108	0.120	0.056	0.0000	0.001	1.19	0.006	1126	0.24	0.0646	23.7	0.024	Do.
13	0.127	0.142	0.071	0.0104	0.008	1.19	0.010	1412	0.30	0.0575	23.7	0.022	Do.
4	0.125	0.138	0.067	0.0000	0.004	1.25	0.009	1073	0.30	0.0628	23.3	0.023	Do.
11	0.110	0.118	0.046	0.0000	0.001	1.23	0.004	499	0.24	0.1026	22.4	0.027	Do.
33	0.156	0.175	0.078	0.0463	0.041	1.15	0.012	1714	0.32	0.0710	23.9	0.025	Dune
1a	0.152	0.168	0.077	0.0399	0.040	1.18	0.011	1342	0.34	0.0700	23.4	0.024	Do.
12	0.132	0.141	0.071	0.0042	0.008	1.2	0.010	751	0.37	0.0635	22.3	0.021	Ripples
14	0.142	0.152	0.077	0.0090	0.020	1.21	0.012	892	0.39	0.0612	22.5	0.021	Dune
20	0.179	0.201	0.091	0.0491	0.072	1.21	0.016	1874	0.37	0.0696	23.8	0.025	Do.
2a	0.178	0.197	0.088	0.0691	0.079	1.21	0.015	1566	0.38	0.0732	23.5	0.025	Do.
21	0.189	0.212	0.100	0.0840	0.116	1.19	0.019	2140	0.41	0.0637	23.9	0.024	Do.
19	0.155	0.167	0.084	0.0327	0.043	1.23	0.014	1004	0.42	0.0622	22.6	0.022	Do.
16a	0.187	0.210	0.089	0.0586	0.074	1.21	0.015	1779	0.37	0.0791	23.8	0.026	Do.
23	0.179	0.198	0.129	0.1044	0.211	1.21	0.032	2271	0.56	0.0344	23.5	0.017	Transition
17	0.156	0.169	0.085	0.0205	0.039	1.24	0.014	1006	0.42	0.0618	22.6	0.021	Dune
3a	0.178	0.196	0.093	0.0530	0.087	1.22	0.017	1565	0.41	0.0655	23.4	0.023	Do.
18	0.155	0.166	0.109	0.0410	0.097	1.24	0.023	1205	0.55	0.0369	22.5	0.016	Do.
30	0.159	0.171	0.135	0.0670	0.168	1.25	0.036	1567	0.67	0.0250	22.6	0.014	Transition
34	0.138	0.146	0.072		0.021	1.26	0.010	545	0.41	0.0699	21.7	0.021	Dune
22	0.160	0.172	0.139	0.0514	0.179	1.31	0.037	1424	0.71	0.0244	22.4	0.013	Plane
15a	0.179	0.195	0.093	0.0391	0.079	1.3	0.017	1235	0.44	0.0667	23.0	0.023	Dune
24	0.194	0.213	0.144	0.1308	0.403	1.21	0.040	2270	0.65	0.0324	23.2	0.016	Transition
25	0.198	0.215	0.165	0.1657	0.462	1.24	0.053	2201	0.79	0.0257	22.9	0.014	Plane
28	0.189	0.201	0.161	0.0920	0.338	1.33	0.050	1476	0.85	0.0255	22.2	0.013	Do.
29	0.203	0.216	0.171	0.1519	0.382	1.22	0.057	1607	0.92	0.0262	22.1	0.013	Do.
26	0.217	0.230	0.176	0.2105	0.612	1.23	0.060	1577	0.97	0.0281	22.0	0.014	Antidune
32	0.277	0.296	0.210	1.6107	1.782	1.38	0.085	1971	1.09	0.0319	22.4	0.015	Do.
27	0.258	0.272	0.208	0.9943	1.388	1.23	0.084	1573	1.21	0.0292	21.6	0.014	Do.
31	0.306	0.327	0.214	2.7298	2.164	1.4	0.089	1904	1.12	0.0378	22.3	0.016	Do.
35	0.353	0.376	0.222	5.2907	4.592	1.38	0.096	1929	1.18	0.0466	22.2	0.018	Do.
37	0.271	0.281	0.168	0.5087	1.295	1.35	0.055	773	1.12	0.0523	20.7	0.017	Do.
38	0.330	0.346	0.223	4.0231	4.297	1.37	0.096	1393	1.33	0.0421	21.4	0.016	Chutes-Pools
36	0.402	0.430	0.210	7.9046	7.071	1.36	0.086	1966	1.09	0.0672	22.3	0.022	Do.

Experimental Vairables and Parameters for 0.45-mm sand in 8 foot wide flume

Run	*Shear Velocity u^* - (ft/s)*			Bed Material		Kinematic Viscosity × 10^5 ν (ft^2/s)	Shear Stress at Bed - τ (lb/ft^2)	Reynolds Number 10^{-2} R	Froude Number F	Reseistance factor			Bed Configuration
	Based on R	Based on h	Based on Velocity Profile	Sampled Suspended q_s (lb/ft-s)	Total q_t (lb/ft-s)					Darcy Weisbach f	Chezy $C/g^{0.5}$	Mannings n ($ft^{1/6}$)	
14	0.051	0.054	0.038	-	0.000	1.4	0.0028	353	0.18	0.0359	21.3	0.016	Plane
13	0.044	0.046	0.033	-	0.000	1.46	0.0021	156	0.19	0.0405	19.9	0.016	Do
17	0.225	0.251	0.036	-	0.000	1.34	0.002	585	0.14	0.7889	22.5	0.082	Ripples
16	0.067	0.074	0.036	-	0.000	1.34	0.002	478	0.15	0.0702	22.0	0.024	Do
15	0.070	0.077	0.036	-	0.000	1.38	0.003	458	0.16	0.0759	22.0	0.025	Do
18	0.071	0.076	0.037	-	0.000	1.36	0.003	333	0.18	0.0761	21.2	0.023	Do
2	0.089	0.097	0.054	-	0.001	1.38	0.006	713	0.23	0.0528	22.0	0.021	Do
3	0.094	0.103	0.052	-	0.001	1.36	0.005	725	0.22	0.0635	22.1	0.023	Do
9	0.079	0.084	0.042	-	0.000	1.34	0.003	361	0.21	0.0732	21.0	0.023	Do
1	0.095	0.104	0.056	-	0.001	1.46	0.006	674	0.24	0.0572	22.0	0.021	Do
5	0.098	0.107	0.060	-	0.002	1.38	0.007	717	0.27	0.0521	21.8	0.020	Do
11	0.071	0.074	0.035	-	0.000	1.36	0.002	180	0.21	0.0902	19.9	0.023	Do
4	0.104	0.113	0.067	-	0.006	1.41	0.009	705	0.31	0.0489	21.6	0.019	Dunes
8	0.093	0.099	0.045	-	0.000	1.34	0.004	354	0.23	0.0911	20.9	0.025	Ripples
7	0.122	0.133	0.066	-	0.017	1.36	0.008	736	0.30	0.0688	21.6	0.023	Dunes
10	0.093	0.097	0.038	-	0.000	1.39	0.003	178	0.23	0.1330	19.8	0.028	Ripples
6	0.108	0.114	0.052	-	0.001	1.43	0.005	344	0.28	0.0911	20.6	0.025	Do
12	0.096	0.099	0.044	-	0.000	1.35	0.004	183	0.28	0.1096	19.4	0.025	Do
19	0.116	0.122	0.064	-	0.007	1.14	0.008	468	0.36	0.0700	20.3	0.021	Dunes
21	0.169	0.188	0.070	0.0179	0.036	1.2	0.010	1264	0.28	0.1129	22.4	0.031	Do
22	0.179	0.200	0.075	-	0.059	1.21	0.011	1405	0.30	0.1105	22.5	0.031	Do
25	0.152	0.160	0.072	-	0.014	1.17	0.010	528	0.40	0.0946	20.4	0.025	Do
20	0.181	0.195	0.079	0.0246	0.032	1.19	0.012	861	0.38	0.1075	21.3	0.028	Do
23	0.211	0.227	0.120	0.0581	0.089	1.2	0.028	1392	0.56	0.0626	21.5	0.022	Do
24	0.224	0.240	0.082	-	0.062	1.17	0.013	933	0.39	0.1490	21.3	0.033	Do
40	0.256	0.280	0.151	0.1531	0.411	1.11	0.044	2423	0.65	0.0570	22.0	0.021	Do
39	0.238	0.254	0.224	0.1203	0.638	1.11	0.097	2334	1.12	0.0232	21.0	0.013	Standing Waves
26	0.192	0.200	0.271	-	0.516	1.17	0.143	1563	1.63	0.0111	19.8	0.008	Plane
28	0.207	0.217	0.174	0.3465	0.369	1.2	0.059	1173	0.98	0.0304	20.2	0.014	Transition
29	0.182	0.189	0.097	-	0.066	1.16	0.018	489	0.61	0.0798	19.5	0.021	Dunes
31	0.235	0.247	0.207	-	0.550	1.16	0.083	1608	1.13	0.0272	20.5	0.013	Standing Waves
27	0.207	0.215	0.151	-	0.253	1.14	0.044	866	0.92	0.0415	19.8	0.016	Transition
36	0.161	0.165	0.111	0.0079	0.034	1.11	0.024	349	0.82	0.0525	18.4	0.016	Do
41	0.267	0.285	0.240	0.1530	0.732	1.12	0.112	2435	1.21	0.0254	21.0	0.013	Standing Waves
30	0.200	0.207	0.128	-	0.148	1.16	0.032	575	0.84	0.0561	19.3	0.018	Transition
35	0.193	0.199	0.147	0.1166	0.201	1.17	0.042	598	0.99	0.0406	19.1	0.015	Do
34	0.214	0.222	0.193	0.0449	0.375	1.16	0.072	900	1.24	0.0283	19.4	0.013	Standing Waves
33	0.222	0.230	0.239	-	0.542	1.2	0.111	1035	1.56	0.0200	19.3	0.011	Do
38	0.298	0.316	0.259	0.1221	1.039	1.11	0.130	2423	1.34	0.0275	20.8	0.014	Do
27	0.278	0.293	0.271	0.1107	0.820	1.12	0.143	2127	1.49	0.0224	20.4	0.012	Transition
32	0.267	0.280	0.251	-	0.721	1.14	0.122	1633	1.46	0.0247	20.1	0.012	Antidune
45	0.270	0.279	0.129	0.0109	0.419	1.11	0.032	631	0.83	0.0995	19.4	0.024	Do
44	0.275	0.285	0.247	0.2551	1.276	1.1	0.118	1217	1.59	0.0283	19.4	0.013	Do
42	0.302	0.314	0.273	0.4735	1.194	1.08	0.145	1539	1.70	0.0274	19.6	0.013	Do
43	0.355	0.374	0.302	-	1.921	1.12	0.178	2373	1.66	0.0293	20.4	0.014	Do

Table C.7. Guy et al. Raw Data 6



Experimental Vairables and Parameters for 0.28-mm sand in 8 foot wide flume

Run	ds	qs/qt	Useful Variables							
			w	ds (ft)	2ds/h	h/ds	Ro	ds (mm)	Re*	Shields
7	0.28	#DIV/0!	0.062	0.001	0.002	1810.036	3.243	0.170	1.517	0.077
8	0.28	#DIV/0!	0.059	0.001	0.002	1792.115	2.497	0.170	1.703	0.119
9	0.28	0	0.058	0.001	0.002	1810.036	1.680	0.170	1.635	0.252
10	0.28	0	0.063	0.001	0.004	1057.348	1.796	0.170	1.782	0.263
5	0.28	0	0.065	0.001	0.002	1792.115	1.349	0.170	2.649	0.489
13	0.28	1.32	0.065	0.001	0.002	1792.115	1.140	0.170	3.321	0.684
4	0.28	0	0.079	0.001	0.002	1325.116	1.432	0.198	3.469	0.554
11	0.28	0	0.063	0.001	0.004	1057.348	1.346	0.170	2.106	0.468
33	0.28	1.142424242	0.088	0.001	0.002	1577.381	1.253	0.205	4.554	0.860
1a	0.28	0.995061728	0.068	0.001	0.002	1543.860	1.003	0.174	3.715	0.936
12	0.28	0.493333333	0.065	0.001	0.004	1021.505	1.146	0.170	3.292	0.669
14	0.28	0.44966443	0.064	0.001	0.003	1111.111	1.054	0.170	3.562	0.781
20	0.28	0.685770751	0.085	0.001	0.002	1562.500	1.056	0.205	5.031	1.136
2a	0.28	0.878012048	0.029	0.001	0.002	2598.870	0.369	0.108	2.563	2.063
21	0.28	0.721311475	0.058	0.001	0.002	2065.637	0.678	0.158	4.336	1.640
19	0.28	0.751332149	0.081	0.001	0.003	992.366	1.211	0.200	4.468	0.806
16a	0.28	0.79417122	0.045	0.001	0.002	2271.715	0.532	0.137	3.294	1.845
23	0.28	0.494308943	0.052	0.001	0.002	1849.593	0.658	0.150	5.228	1.502
17	0.28	0.518811881	0.071	0.001	0.003	1083.333	1.047	0.183	4.102	0.893
3a	0.28	0.607094134	0.033	0.001	0.002	2297.650	0.425	0.117	2.911	1.894
18	0.28	0.422115385	0.050	0.001	0.003	1257.732	0.750	0.148	4.261	1.075
30	0.28	0.4	0.046	0.001	0.003	1385.281	0.667	0.141	5.002	1.192
34	0.28	0	0.062	0.001	0.005	788.530	1.068	0.170	3.188	0.717
22	0.28	0.287012987	0.052	0.001	0.004	1174.168	0.759	0.156	5.404	1.089
15a	0.28	0.493029151	0.042	0.001	0.003	1681.614	0.531	0.136	3.191	1.610
24	0.28	0.324680851	0.049	0.001	0.003	1726.316	0.577	0.145	5.662	1.800
25	0.28	0.358671587	0.064	0.001	0.003	1283.422	0.740	0.171	7.487	1.548
28	0.28	0.27173913	0.065	0.001	0.004	938.567	0.804	0.179	7.076	1.303
29	0.28	0.397435897	0.069	0.001	0.004	885.860	0.800	0.179	8.212	1.493
26	0.28	0.343873518	0.066	0.001	0.004	872.600	0.719	0.175	8.219	1.735
32	0.28	0.903809524	0.064	0.001	0.004	983.051	0.537	0.180	8.967	2.800
27	0.28	0.716521739	0.063	0.001	0.005	771.993	0.582	0.170	9.428	2.494
31	0.28	1.261538462	0.067	0.001	0.004	913.540	0.512	0.187	9.357	3.283
35	0.28	1.152173913	0.069	0.001	0.004	872.375	0.457	0.189	9.968	4.309
37	0.28	0.392964824	0.073	0.001	0.007	469.484	0.652	0.195	7.951	2.333
38	0.28	0.936288089	0.083	0.001	0.005	573.066	0.600	0.213	11.338	3.230
36	0.28	1.117924528	0.075	0.001	0.004	879.630	0.434	0.198	10.012	5.368

Experimental Vairables and Parameters for 0.45-mm sand in 8 foot wide flume

Run	ds	qs/qt	Useful Variables							
			w	ds (ft)	2ds/h	h/ds	Ro	ds (mm)	Re*	Shields
14	0.45	-	0.118	0.002	0.006	671.806	5.424	0.277	2.466	0.061
13	0.45	-	0.115	0.002	0.010	385.463	6.225	0.277	2.030	0.044
17	0.45	-	0.120	0.002	0.003	1079.295	1.198	0.277	2.411	1.308
16	0.45	-	0.120	0.002	0.004	892.070	4.066	0.277	2.432	0.114
15	0.45	-	0.119	0.002	0.004	881.057	3.853	0.277	2.365	0.123
18	0.45	-	0.119	0.002	0.006	638.767	3.926	0.277	2.459	0.120
2	0.45	-	0.119	0.002	0.004	903.084	3.042	0.277	3.582	0.197
3	0.45	-	0.119	0.002	0.004	936.123	2.891	0.277	3.499	0.221
9	0.45	-	0.120	0.002	0.006	605.727	3.576	0.277	2.833	0.147
1	0.45	-	0.115	0.002	0.004	881.057	2.769	0.277	3.480	0.224
5	0.45	-	0.119	0.002	0.005	825.991	2.784	0.277	3.980	0.235
11	0.45	-	0.119	0.002	0.010	385.463	4.020	0.277	2.347	0.114
4	0.45	-	0.117	0.002	0.005	759.912	2.606	0.277	4.291	0.263
8	0.45	-	0.120	0.002	0.007	561.674	3.032	0.277	3.021	0.204
7	0.45	-	0.119	0.002	0.005	770.925	2.253	0.277	4.410	0.364
10	0.45	-	0.118	0.002	0.010	363.436	3.056	0.277	2.478	0.194
6	0.45	-	0.116	0.002	0.007	506.608	2.550	0.277	3.298	0.270
12	0.45	-	0.120	0.002	0.012	319.383	3.014	0.277	2.940	0.205
19	0.45	-	0.130	0.002	0.008	451.542	2.668	0.277	5.098	0.307
21	0.45	0.497368421	0.023	0.002	0.004	3096.774	0.304	0.094	1.819	2.140
22	0.45	-	0.188	0.002	0.003	751.880	2.356	0.405	8.291	0.565
25	0.45	-	0.128	0.002	0.008	462.555	2.006	0.277	5.600	0.530
20	0.45	0.763779528	0.042	0.002	0.006	1418.605	0.538	0.131	2.850	1.659
23	0.45	0.651869159	0.047	0.002	0.005	1413.043	0.515	0.140	4.590	2.115
24	0.45	-	0.160	0.002	0.006	558.559	1.663	0.338	7.823	0.978
40	0.45	0.372764228	0.046	0.002	0.004	1840.909	0.412	0.134	5.979	3.358
39	0.45	0.188636364	0.055	0.002	0.006	1122.449	0.546	0.149	9.880	2.476
26	0.45	-	0.044	0.002	0.010	772.727	0.553	0.134	10.196	1.714
28	0.45	0.938534279	0.154	0.002	0.009	370.370	1.772	0.329	15.645	0.822
29	0.45	-	0.188	0.002	0.011	229.008	2.488	0.399	10.928	0.512
31	0.45	-	0.213	0.002	0.008	291.391	2.149	0.460	26.939	0.763
27	0.45	-	0.163	0.002	0.010	294.643	1.889	0.341	14.859	0.779
36	0.45	0.235766423	0.086	0.002	0.018	292.308	1.296	0.198	6.496	0.790
41	0.45	0.208986175	0.085	0.002	0.006	830.769	0.748	0.198	13.957	2.346
30	0.45	-	0.197	0.002	0.013	195.652	2.379	0.421	15.250	0.583
35	0.45	0.581344902	0.146	0.002	0.014	245.098	1.833	0.311	12.796	0.734
34	0.45	0.119859402	0.072	0.002	0.012	474.576	0.813	0.180	9.800	1.570
33	0.45	-	0.234	0.002	0.013	157.895	2.543	0.521	34.020	0.581
38	0.45	0.117495987	0.091	0.002	0.007	735.294	0.722	0.207	15.840	2.758
27	0.45	0.135008977	0.087	0.002	0.008	651.515	0.742	0.201	15.979	2.448
32	0.45	-	0.219	0.002	0.009	237.179	1.961	0.475	34.321	0.943
45	0.45	0.02596054	0.087	0.002	0.012	424.242	0.785	0.201	7.678	2.216
44	0.45	0.2	0.143	0.002	0.012	285.714	1.260	0.299	21.998	1.555
42	0.45	0.396491228	0.178	0.002	0.011	256.198	1.420	0.369	30.618	1.531
43	0.45	-	0.131	0.002	0.008	473.568	0.874	0.277	24.523	2.899

Table C.8. Guy et al. Raw Data 7

Experimental Vairables and Parameters for 0.93-mm sand in 8 foot wide flume

Run	Slope x10^2 S	Depth - h (ft)	Hydraulic Radius (ft)	Water Discharge - Q (ft^3/sec)	Temp - T (°C)	Suspended Concentration		Total Bed Material		Bed Material Particle Size d_{50} (ft x 10^3)	Mean Velocity V (ft/s)
						Sampled C_s (ppm)	Particle Size - d_{50} (ft x 10^3)	Concentration C_b (ppm)	Particle Size - d_{50} (ft x 10^3)		
19	0.013	1.01	0.81	8.06	19.8	0	2.038	0	-	-	1
25	0.022	1.01	0.81	9.88	19.3	0	2.038	0	-	-	1.22
26	0.22	1.02	0.81	10.8	19	0	2.038	0	-	-	1.32
27	0.28	1.01	0.81	11.86	22.7	0	2.038	2.8	-	2.79	1.47
30	0.28	1.03	0.82	10.91	19.6	0	2.038	0.4	-	-	1.32
21	0.03	1.01	0.81	12.06	20.5	0	2.038	0.4	-	-	1.49
18	0.037	1.01	0.81	13.42	18	0	2.038	21	2.64	3.15	1.66
28	0.037	1.04	0.83	14.53	20.7	0	2.038	28	2.95	3.02	1.75
29	0.043	0.5	0.44	4.62	18.9	0	2.038	0	-	-	1.16
22	0.043	0.49	0.44	4.49	19	0	2.038	0	-	-	1.15
30	0.05	0.51	0.45	5.06	18.9	0	2.038	-	-	-	1.25
31	0.054	0.5	0.44	5.42	16.8	0	2.038	4.2	-	3.22	1.36
15	0.059	1.05	0.83	16.25	19.7	4.1	2.038	65	2.58	3.28	1.93
23	0.062	0.49	0.44	5.1	19.2	0	2.038	-	-	-	1.3
32	0.064	0.52	0.46	6.25	16.7	0	2.038	26	2.79	2.98	1.5
24	0.068	0.49	0.44	5.71	19.3	0	2.038	15	-	-	1.46
14	0.071	0.58	0.51	7.41	17.4	-	2.038	63	2.72	3.25	1.6
34	0.08	0.54	0.48	7.08	19.5	-	2.038	73	2.56	2.82	1.64
16	0.112	1.04	0.83	16.85	19.4	12	2.038	140	2.69	3.18	2.03
35	0.13	0.53	0.47	7.64	17.1	-	2.038	201	2.82	3.02	1.8
17	0.136	1	0.80	16.83	19.2	30	2.038	211	2.89	3.08	2.1
33	0.145	0.56	0.49	8.18	19	14	2.038	253	2.53	2.99	1.83
5	0.183	0.93	0.75	16.41	17.5	80	2.62	308	2.62	2.98	2.21
10	0.192	0.46	0.41	6.9	19	12	2.038	450	2.76	3.22	1.88
37	0.275	1.11	0.87	22.58	18	260	1.38	601	2.35	2.43	2.54
36	0.304	0.55	0.48	8.96	17.3	56	2.038	519	2.69	3.07	2.04
6	0.313	1.04	0.83	22.3	19.1	281	2.23	537	2.16	2.92	2.68
7	0.339	0.59	0.51	10.1	18.3	357	1.54	822	3.12	3.38	2.14
38	0.356	1.02	0.81	22.69	18.9	422	0.94	1080	2.41	2.48	2.78
11	0.393	0.92	0.75	22.22	18.3	614	2.038	1180	2.39	3.15	3.02
8	0.43	0.57	0.50	11.2	17.4	313	1.3	1490	2.8	2.89	2.46
12	0.437	0.89	0.73	22.19	18.5	656	2.34	1900	2.49	3.02	3.12
13	0.587	0.82	0.68	22.09	18.4	1190	2.79	2750	2.63	3.02	3.37
9	0.66	0.49	0.44	11.32	18.5	498	2.65	2620	3.05	3.17	2.89
3	0.65	0.6	0.52	16.46	17.3	2820	2.87	3110	2.85	3.08	3.43
1	0.71	0.68	0.58	22.33	18.3	3770	1.87	4020	2.21	3.28	4.1
2	0.92	0.53	0.47	22.07	18.2	2320	1.79	6140	2.82	3.02	5.2
4	0.94	0.51	0.45	15.64	18	2340	2.82	5090	2.76	3.08	3.83
41	1.12	0.44	0.40	15.67	21.7	2230	1.48	9480	2.68	3.41	4.45
42	1.16	0.44	0.40	20.44	20.4	1610	2.16	7320	2.95	2.66	5.81
40	1.23	0.38	0.35	15.53	19.6	1470	1.51	10200	3.47	2.72	5.11
43	1.26	0.44	0.40	20.63	21	2500	2.3	7000	3.45	2.49	5.86
39	1.28	0.43	0.39	20.88	20.5	2300	2.1	7010	3.35	3.35	6.07

Experimental Vairables and Parameters for 0.32-mm sand in 2 foot wide flume

Run	Slope x10^2 S	Depth - h (ft)	Hydraulic Radius (ft)	Water Discharge - Q (ft^3/sec)	Temp - T (°C)	Suspended Concentration		Total Bed Material		Bed Material Particle Size d_{50} (ft x 10^3)	Mean Velocity V (ft/s)
						Sampled C_s (ppm)	Particle Size - d_{50} (ft x 10^3)	Concentration C_b (ppm)	Particle Size - d_{50} (ft x 10^3)		
1	0.014	0.51	0.34	0.91		0	0.69	0	-	-	0.9
2	0.017	0.52	0.34	0.88		0	0.69	0	-	-	0.86
3	0.112	0.54	0.35	1.31		0	0.69	55	0.886	-	1.24
4	0.086	0.54	0.35	1.31		0	0.69	61	0.998	0.854	1.24
30	0.11	0.57	0.36	1.56		24	0.69	91	0.886	1.021	1.39
29	0.103	0.56	0.36	1.57		9.1	0.69	117	1.248	1.019	1.43
5	0.139	0.56	0.36	1.88		56	0.616	226	0.782	0.837	1.72
6	0.118	0.59	0.37	1.88		33	0.69	168	0.788	0.854	1.62
27	0.147	0.58	0.37	2.28		168	0.626	455	0.854	1.038	2.01
28	0.214	0.63	0.39	2.29		251	0.715	787	0.913	1.035	1.85
26	0.201	0.71	0.42	2.67		80	0.649	854	0.933	1.071	1.93
25	0.21	0.66	0.40	2.64		274	0.655	719	0.867	1.019	2.05
21	0.184	0.58	0.37	3.13		198	0.538	907	0.847	1.035	2.74
22	0.166	0.64	0.39	3.13		498	0.649	1150	0.886	1.051	2.48
24	0.172	0.74	0.43	3.48		307	0.695	706	0.847	0.969	2.39
23	0.261	0.73	0.42	3.48		227	0.646	1150	0.894	0.916	2.43
7	0.189	0.6	0.38	3.48		196	0.613	1410	0.925	0.95	2.95
8	0.194	0.72	0.42	3.5		248	0.567	1820	0.926	1.003	2.48
20	0.566	0.55	0.35	4.55		1520	0.708	5600	1.012	1.001	4.23
19	0.417	0.56	0.36	4.55		735	0.767	4340	0.831	0.979	4.18
10	0.71	0.59	0.37	4.78		2020	0.636	5180	1.015	1.001	4.12
9	0.493	0.56	0.36	4.78		1480	0.688	5530	1.184	0.935	4.35
12	0.456	0.67	0.40	5.32		1480	0.652	3960	0.923	1.051	4.03
11	0.408	0.6	0.38	5.3		1810	0.672	5250	1.035	1.051	4.51
14	0.865	0.6	0.38	5.7		5340	0.767	12300	0.906	1.215	4.86
13	0.73	0.6	0.38	5.7		2100	0.737	8780	0.991	1.049	4.84
15	0.835	0.63	0.39	6.63		19000	0.793	26100	0.801	1.16	5.36
16	0.635	0.62	0.38	6.64		14700	0.737	21000	0.864	1.527	5.42
17	0.97	0.62	0.38	6.79		29900	0.816	29600	0.871	1.103	5.58
18	0.656	0.61	0.38	6.82		17400	0.777	20800	0.886	1.231	5.73
31	1.62	0.65	0.39	6.71		41600	0.836	49300	0.833	-	5.27

Table C.9. Guy et al. Raw Data 10

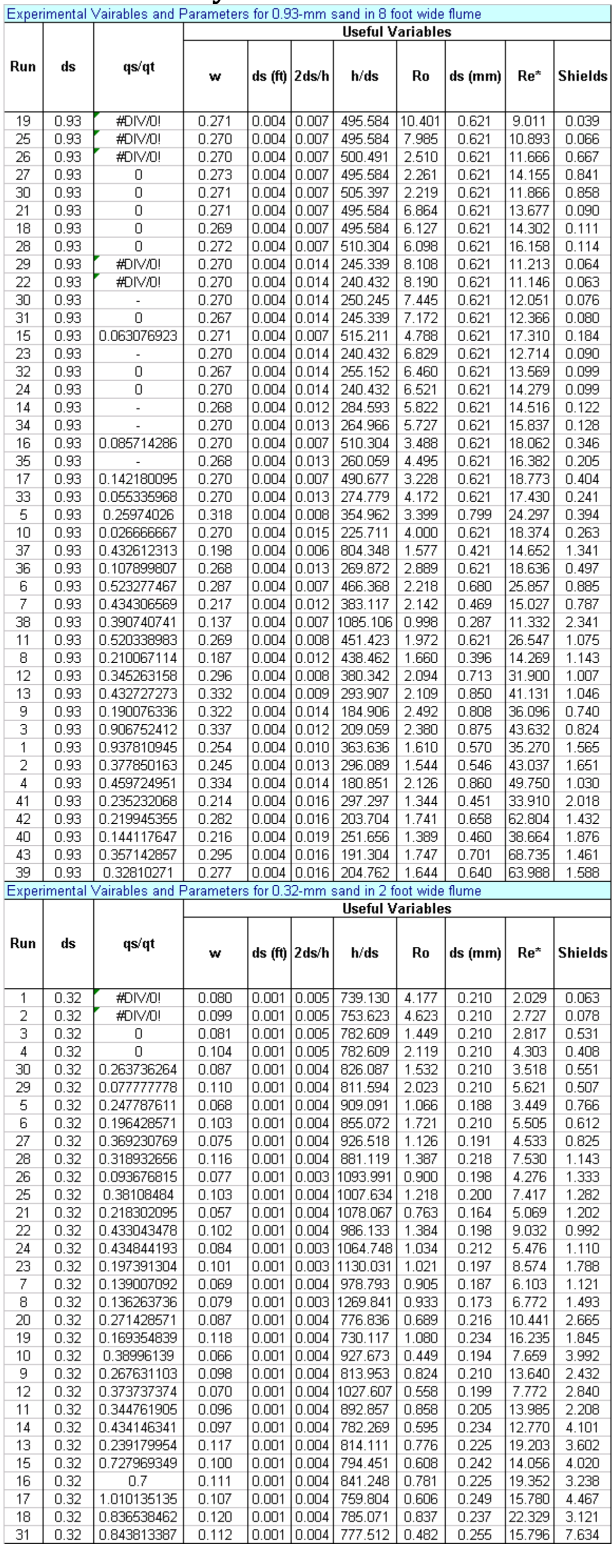
Experimental Vairables and Parameters for 0.93-mm sand in 8 foot wide flume

Run	*Shear Velocity u^* - (ft/s)*			Bed Material		Kinematic Viscosity x 10^5 v (ft^2/s)	Shear Stress at Bed - τ (lb/ft^2)	Reynolds Number 10^{-2} R	Froude Number F	Reseistance factor			Bed Configuration
	Based on R	Based on h	Based on Velocity Profile	Sampled Suspended q_s (lb/ft-s)	Total q_t (lb/ft-s)					Darcy Weisbach f	Chezy $C/g^{0.5}$	Mannings n ($ft^{1/6}$)	
19	0.058	0.065	0.048	0.0000	0.000	1.09	0.0045	927	0.18	0.0338	20.8	0.017	Plane
25	0.076	0.085	0.059	0.0000	0.000	1.1	0.0067	1120	0.21	0.0385	20.8	0.018	Do.
26	0.240	0.269	0.064	0.0000	0.000	1.11	0.0078	1213	0.23	0.3318	20.8	0.054	Do.
27	0.270	0.302	0.071	0.0000	0.000	1.02	0.0097	1456	0.26	0.3371	20.8	0.054	Do.
30	0.272	0.305	0.063	0.0000	0.000	1.09	0.0078	1247	0.23	0.4264	20.8	0.061	Do.
21	0.088	0.099	0.072	0.0000	0.000	1.07	0.0100	1406	0.26	0.0352	20.8	0.017	Do.
18	0.098	0.110	0.080	0.0000	0.002	1.14	0.0124	1471	0.29	0.0349	20.8	0.017	Dune
28	0.099	0.111	0.084	0.0000	0.003	1.06	0.0137	1717	0.30	0.0324	20.8	0.017	Do.
29	0.078	0.083	0.061	0.0000	0.000	1.11	0.0072	523	0.29	0.0412	19.0	0.017	Plane
22	0.078	0.082	0.061	0.0000	0.000	1.11	0.0071	508	0.29	0.0410	18.9	0.017	Do.
30	0.085	0.091	0.066	0.0000	-	1.11	0.0084	574	0.31	0.0420	19.0	0.017	Do.
31	0.088	0.093	0.072	0.0000	0.000	1.18	0.0099	576	0.34	0.0376	19.0	0.016	Do.
15	0.126	0.141	0.093	0.0005	0.008	1.09	0.0166	1859	0.33	0.0428	20.8	0.019	Dune
23	0.093	0.099	0.069	0.0000	-	1.1	0.0091	579	0.33	0.0463	18.9	0.018	Plane
32	0.097	0.104	0.079	0.0000	0.001	1.18	0.0120	661	0.37	0.0381	19.1	0.016	Do.
24	0.098	0.104	0.077	0.0000	0.001	1.1	0.0115	650	0.37	0.0403	18.9	0.017	Do.
14	0.108	0.115	0.083	-	0.004	1.16	0.0132	800	0.37	0.0414	19.4	0.017	Dune
34	0.111	0.118	0.085	-	0.004	1.1	0.0142	805	0.39	0.0414	19.2	0.017	Do.
16	0.173	0.194	0.097	0.0016	0.018	1.1	0.0184	1919	0.35	0.0728	20.8	0.025	Do.
35	0.140	0.149	0.094	-	0.012	1.17	0.0172	815	0.44	0.0548	19.1	0.020	Do.
17	0.187	0.209	0.101	0.0039	0.028	1.1	0.0199	1909	0.37	0.0794	20.7	0.026	Do.
33	0.151	0.162	0.095	0.0009	0.016	1.11	0.0175	923	0.43	0.0625	19.3	0.021	Do.
5	0.211	0.234	0.108	0.0102	0.039	1.16	0.0225	1772	0.40	0.0898	20.5	0.027	Do.
10	0.160	0.169	0.100	0.0006	0.024	1.11	0.0194	779	0.49	0.0644	18.8	0.021	Do.
37	0.277	0.314	0.121	0.0458	0.106	1.14	0.0284	2473	0.42	0.1219	21.0	0.033	Do.
36	0.218	0.232	0.106	0.0039	0.036	1.16	0.0218	967	0.48	0.1035	19.2	0.027	Do.
6	0.288	0.324	0.129	0.0489	0.093	1.11	0.0321	2511	0.46	0.1167	20.8	0.032	Do.
7	0.237	0.254	0.110	0.0281	0.065	1.13	0.0236	1117	0.49	0.1125	19.4	0.029	Do.
38	0.305	0.342	0.134	0.0747	0.191	1.11	0.0347	2555	0.49	0.1210	20.8	0.032	Do.
11	0.308	0.341	0.147	0.1064	0.205	1.13	0.0420	2459	0.55	0.1021	20.5	0.029	Do.
8	0.263	0.281	0.127	0.0273	0.130	1.16	0.0314	1209	0.57	0.1043	19.3	0.027	Do.
12	0.320	0.354	0.153	0.1135	0.329	1.12	0.0452	2479	0.58	0.1029	20.4	0.029	Do.
13	0.359	0.394	0.167	0.2050	0.474	1.13	0.0538	2445	0.66	0.1092	20.2	0.030	Transition
9	0.305	0.323	0.153	0.0440	0.231	1.12	0.0452	1264	0.73	0.0997	18.9	0.026	Do.
3	0.330	0.354	0.176	0.3621	0.399	1.16	0.0603	1774	0.78	0.0854	19.4	0.025	Do.
1	0.365	0.394	0.207	0.6566	0.700	1.1	0.0835	2535	0.88	0.0740	19.8	0.024	Do.
2	0.372	0.396	0.272	0.3994	1.057	1.13	0.1432	2439	1.26	0.0465	19.1	0.018	Do.
4	0.370	0.393	0.201	0.2855	0.621	1.14	0.0785	1713	0.95	0.0842	19.0	0.024	Do.
41	0.378	0.398	0.238	0.2726	1.159	1.04	0.1102	1883	1.18	0.0641	18.7	0.020	Do.
42	0.385	0.405	0.311	0.2567	1.167	1.07	0.1878	2389	1.54	0.0389	18.7	0.016	Standing Waves
40	0.371	0.388	0.279	0.1781	1.236	1.09	0.1511	1781	1.46	0.0461	18.3	0.017	Do.
43	0.401	0.423	0.314	0.4023	1.126	1.05	0.1910	2456	1.56	0.0416	18.7	0.017	Do.
39	0.400	0.421	0.326	0.3746	1.142	1.07	0.2062	2439	1.63	0.0385	18.6	0.016	Do.

Experimental Vairables and Parameters for 0.32-mm sand in 2 foot wide flume

Run	*Shear Velocity u^* - (ft/s)*			Bed Material		Kinematic Viscosity x 10^5 v (ft^2/s)	Shear Stress at Bed - τ (lb/ft^2)	Reynolds Number 10^{-2} R	Froude Number F	Reseistance factor			Bed Configuration
	Based on R	Based on h	Based on Velocity Profile	Sampled Suspended q_s (lb/ft-s)	Total q_t (lb/ft-s)					Darcy Weisbach f	Chezy $C/g^{0.5}$	Mannings n ($ft^{1/6}$)	
1	0.039	0.048	0.041	0.0000	0.000	1.41	0.0033	326	0.22	0.0057	21.7	0.013	Plane
2	0.043	0.053	0.040	0.0000	0.000	1	0.0030	447	0.21	0.0077	21.8	0.015	Do
3	0.112	0.140	0.057	0.0000	0.002	1.39	0.0062	482	0.30	0.0253	21.9	0.027	Ripples
4	0.099	0.122	0.057	0.0000	0.002	0.91	0.0062	736	0.30	0.0195	21.9	0.023	Do
30	0.113	0.142	0.063	0.0012	0.004	1.24	0.0078	639	0.32	0.0209	22.0	0.024	Do
29	0.109	0.136	0.065	0.0004	0.006	0.8	0.0082	1001	0.34	0.0182	21.9	0.023	Dunes
5	0.127	0.158	0.078	0.0033	0.013	1.4	0.0119	688	0.41	0.0169	21.9	0.022	Do
6	0.119	0.150	0.073	0.0019	0.010	0.92	0.0105	1039	0.37	0.0171	22.1	0.022	Do
27	0.132	0.166	0.091	0.0120	0.032	1.26	0.0162	925	0.47	0.0136	22.0	0.020	Do
28	0.163	0.208	0.083	0.0179	0.056	0.79	0.0134	1475	0.41	0.0254	22.2	0.027	Do
26	0.164	0.214	0.086	0.0067	0.071	1.3	0.0142	1054	0.40	0.0247	22.5	0.028	Do
25	0.164	0.211	0.092	0.0226	0.059	0.81	0.0163	1670	0.44	0.0212	22.4	0.025	Do
21	0.147	0.185	0.124	0.0193	0.089	1.32	0.0300	1204	0.63	0.0092	22.0	0.016	Transition
22	0.144	0.185	0.111	0.0486	0.112	0.8	0.0240	1984	0.55	0.0111	22.3	0.018	Do
24	0.153	0.202	0.106	0.0333	0.077	1.34	0.0216	1320	0.49	0.0143	22.6	0.021	Do
23	0.188	0.248	0.108	0.0246	0.125	0.81	0.0224	2190	0.50	0.0208	22.6	0.025	Do
7	0.151	0.191	0.133	0.0213	0.153	1.34	0.0345	1321	0.67	0.0084	22.1	0.016	Do
8	0.162	0.212	0.110	0.0271	0.199	0.92	0.0234	1941	0.52	0.0146	22.6	0.021	Do
20	0.254	0.317	0.193	0.2158	0.795	1.31	0.0724	1776	1.01	0.0112	21.9	0.018	Antidunes
19	0.220	0.274	0.191	0.1043	0.616	0.9	0.0704	2601	0.98	0.0086	21.9	0.016	Plane
10	0.291	0.367	0.187	0.3013	0.773	1.55	0.0676	1568	0.95	0.0159	22.1	0.021	Antidunes
9	0.239	0.298	0.198	0.2207	0.825	1	0.0763	2436	1.02	0.0094	21.9	0.016	Do
12	0.243	0.314	0.180	0.2457	0.657	1.51	0.0629	1788	0.87	0.0121	22.4	0.019	Plane
11	0.222	0.281	0.204	0.2993	0.868	0.98	0.0807	2761	1.03	0.0078	22.1	0.015	Antidunes
14	0.323	0.409	0.220	0.9497	2.187	1.32	0.0937	2209	1.11	0.0142	22.1	0.020	Do
13	0.297	0.376	0.219	0.3735	1.561	0.84	0.0929	3457	1.10	0.0120	22.1	0.019	Do
15	0.322	0.412	0.241	3.9303	5.399	1.36	0.1127	2483	1.19	0.0118	22.2	0.019	Do
16	0.280	0.356	0.244	3.0454	4.351	0.93	0.1157	3613	1.21	0.0086	22.2	0.016	Do
17	0.346	0.440	0.251	6.3343	6.271	1.3	0.1226	2661	1.25	0.0124	22.2	0.019	Do
18	0.283	0.359	0.259	3.7024	4.426	0.9	0.1298	3884	1.29	0.0078	22.2	0.015	Do
31	0.453	0.582	0.236	8.7090	10.321	1.25	0.1082	2740	1.15	0.0244	22.3	0.027	Chutes-Pools

Table C.10. Guy et al. Raw Data 11



Experimental Vairables and Parameters for 0.93-mm sand in 8 foot wide flume

Run	ds	qs/qt	Useful Variables							
			w	ds (ft)	2ds/h	h/ds	Ro	ds (mm)	Re*	Shields
19	0.93	#DIV/0!	0.271	0.004	0.007	495.584	10.401	0.621	9.011	0.039
25	0.93	#DIV/0!	0.270	0.004	0.007	495.584	7.985	0.621	10.893	0.066
26	0.93	#DIV/0!	0.270	0.004	0.007	500.491	2.510	0.621	11.666	0.667
27	0.93	0	0.273	0.004	0.007	495.584	2.261	0.621	14.155	0.841
30	0.93	0	0.271	0.004	0.007	505.397	2.219	0.621	11.866	0.858
21	0.93	0	0.271	0.004	0.007	495.584	6.864	0.621	13.677	0.090
18	0.93	0	0.269	0.004	0.007	495.584	6.127	0.621	14.302	0.111
28	0.93	0	0.272	0.004	0.007	510.304	6.098	0.621	16.158	0.114
29	0.93	#DIV/0!	0.270	0.004	0.014	245.339	8.108	0.621	11.213	0.064
22	0.93	#DIV/0!	0.270	0.004	0.014	240.432	8.190	0.621	11.146	0.063
30	0.93	-	0.270	0.004	0.014	250.245	7.445	0.621	12.051	0.076
31	0.93	0	0.267	0.004	0.014	245.339	7.172	0.621	12.366	0.080
15	0.93	0.063076923	0.271	0.004	0.007	515.211	4.788	0.621	17.310	0.184
23	0.93	-	0.270	0.004	0.014	240.432	6.829	0.621	12.714	0.090
32	0.93	0	0.267	0.004	0.014	255.152	6.460	0.621	13.569	0.099
24	0.93	0	0.270	0.004	0.014	240.432	6.521	0.621	14.279	0.099
14	0.93	-	0.268	0.004	0.012	284.593	5.822	0.621	14.516	0.122
34	0.93	-	0.270	0.004	0.013	264.966	5.727	0.621	15.837	0.128
16	0.93	0.085714286	0.270	0.004	0.007	510.304	3.488	0.621	18.062	0.346
35	0.93	-	0.268	0.004	0.013	260.059	4.495	0.621	16.382	0.205
17	0.93	0.142180095	0.270	0.004	0.007	490.677	3.228	0.621	18.773	0.404
33	0.93	0.055335968	0.270	0.004	0.013	274.779	4.172	0.621	17.430	0.241
5	0.93	0.25974026	0.318	0.004	0.008	354.962	3.399	0.799	24.297	0.394
10	0.93	0.026666667	0.270	0.004	0.015	225.711	4.000	0.621	18.374	0.263
37	0.93	0.432612313	0.198	0.004	0.006	804.348	1.577	0.421	14.652	1.341
36	0.93	0.107899807	0.268	0.004	0.013	269.872	2.889	0.621	18.636	0.497
6	0.93	0.523277467	0.287	0.004	0.007	466.368	2.218	0.680	25.857	0.885
7	0.93	0.434306569	0.217	0.004	0.012	383.117	2.142	0.469	15.027	0.787
38	0.93	0.390740741	0.137	0.004	0.007	1085.106	0.998	0.287	11.332	2.341
11	0.93	0.520338983	0.269	0.004	0.008	451.423	1.972	0.621	26.547	1.075
8	0.93	0.210067114	0.187	0.004	0.012	438.462	1.660	0.396	14.269	1.143
12	0.93	0.345263158	0.296	0.004	0.008	380.342	2.094	0.713	31.900	1.007
13	0.93	0.432727273	0.332	0.004	0.009	293.907	2.109	0.850	41.131	1.046
9	0.93	0.190076336	0.322	0.004	0.014	184.906	2.492	0.808	36.096	0.740
3	0.93	0.906752412	0.337	0.004	0.012	209.059	2.380	0.875	43.632	0.824
1	0.93	0.937810945	0.254	0.004	0.010	363.636	1.610	0.570	35.270	1.565
2	0.93	0.377850163	0.245	0.004	0.013	296.089	1.544	0.546	43.037	1.651
4	0.93	0.459724951	0.334	0.004	0.014	180.851	2.126	0.860	49.750	1.030
41	0.93	0.235232068	0.214	0.004	0.016	297.297	1.344	0.451	33.910	2.018
42	0.93	0.219945355	0.282	0.004	0.016	203.704	1.741	0.658	62.804	1.432
40	0.93	0.144117647	0.216	0.004	0.019	251.656	1.389	0.460	38.664	1.876
43	0.93	0.357142857	0.295	0.004	0.016	191.304	1.747	0.701	68.735	1.461
39	0.93	0.32810271	0.277	0.004	0.016	204.762	1.644	0.640	63.988	1.588

Experimental Vairables and Parameters for 0.32-mm sand in 2 foot wide flume

Run	ds	qs/qt	Useful Variables							
			w	ds (ft)	2ds/h	h/ds	Ro	ds (mm)	Re*	Shields
1	0.32	#DIV/0!	0.080	0.001	0.005	739.130	4.177	0.210	2.029	0.063
2	0.32	#DIV/0!	0.099	0.001	0.005	753.623	4.623	0.210	2.727	0.078
3	0.32	0	0.081	0.001	0.005	782.609	1.449	0.210	2.817	0.531
4	0.32	0	0.104	0.001	0.005	782.609	2.119	0.210	4.303	0.408
30	0.32	0.263736264	0.087	0.001	0.004	826.087	1.532	0.210	3.518	0.551
29	0.32	0.077777778	0.110	0.001	0.004	811.594	2.023	0.210	5.621	0.507
5	0.32	0.247787611	0.068	0.001	0.004	909.091	1.066	0.188	3.449	0.766
6	0.32	0.196428571	0.103	0.001	0.004	855.072	1.721	0.210	5.505	0.612
27	0.32	0.369230769	0.075	0.001	0.004	926.518	1.126	0.191	4.533	0.825
28	0.32	0.318932656	0.116	0.001	0.004	881.119	1.387	0.218	7.530	1.143
26	0.32	0.093676815	0.077	0.001	0.003	1093.991	0.900	0.198	4.276	1.333
25	0.32	0.38108484	0.103	0.001	0.004	1007.634	1.218	0.200	7.417	1.282
21	0.32	0.218302095	0.057	0.001	0.004	1078.067	0.763	0.164	5.069	1.202
22	0.32	0.433043478	0.102	0.001	0.004	986.133	1.384	0.198	9.032	0.992
24	0.32	0.434844193	0.084	0.001	0.003	1064.748	1.034	0.212	5.476	1.110
23	0.32	0.197391304	0.101	0.001	0.003	1130.031	1.021	0.197	8.574	1.788
7	0.32	0.139007092	0.069	0.001	0.004	978.793	0.905	0.187	6.103	1.121
8	0.32	0.136263736	0.079	0.001	0.003	1269.841	0.933	0.173	6.772	1.493
20	0.32	0.271428571	0.087	0.001	0.004	776.836	0.689	0.216	10.441	2.665
19	0.32	0.169354839	0.118	0.001	0.004	730.117	1.080	0.234	16.235	1.845
10	0.32	0.38996139	0.066	0.001	0.004	927.673	0.449	0.194	7.659	3.992
9	0.32	0.267631103	0.098	0.001	0.004	813.953	0.824	0.210	13.640	2.432
12	0.32	0.373737374	0.070	0.001	0.004	1027.607	0.558	0.199	7.772	2.840
11	0.32	0.344761905	0.096	0.001	0.004	892.857	0.858	0.205	13.985	2.208
14	0.32	0.434146341	0.097	0.001	0.004	782.269	0.595	0.234	12.770	4.101
13	0.32	0.239179954	0.117	0.001	0.004	814.111	0.776	0.225	19.203	3.602
15	0.32	0.727969349	0.100	0.001	0.004	794.451	0.608	0.242	14.056	4.020
16	0.32	0.7	0.111	0.001	0.004	841.248	0.781	0.225	19.352	3.238
17	0.32	1.010135135	0.107	0.001	0.004	759.804	0.606	0.249	15.780	4.467
18	0.32	0.836538462	0.120	0.001	0.004	785.071	0.837	0.237	22.329	3.121
31	0.32	0.843813387	0.112	0.001	0.004	777.512	0.482	0.255	15.796	7.634

Table C.11. Guy et al. Raw Data 12

Experimental Vairables and Parameters for 0.33-mm sand in 2 foot wide flume

Run	Slope x10^2 S	Depth - h (ft)	Hydraulic Radius (ft)	Water Discharge - Q (ft^3/sec)	Temp - T (°C)	Suspended Concentration		Total Bed Material		Bed Material Particle Size d_{50} (ft x 10^3)	Mean Velocity V (ft/s)
						Sampled C_s (ppm)	Particle Size - d_{50} (ft x 10^3)	Concentration C_b (ppm)	Particle Size - d_{50} (ft x 10^3)		
7	0.025	0.5	0.33	1.12		0	0.83	0	-	-	1.14
8	0.087	0.5	0.33	1		0	0.83	6.6	1	1.049	1.02
5	0.088	0.49	0.33	1.12		15	0.61	47	0.912	1.075	1.17
11	0.102	0.52	0.34	1.41		54	0.475	142	1.009	1.163	1.38
10	0.213	0.49	0.33	1.69		568	1.016	460	1.033	1.163	1.76
6	0.24	0.52	0.34	1.96		323	0.617	732	0.951	1.016	1.92
4	0.27	0.49	0.33	3.29		648	0.83	2210	0.969	1.02	3.43
1	0.29	0.51	0.34	4.01		393	0.83	3090	1.085	1.115	4.02
9	0.32	0.52	0.34	2.62		2070	0.934	1960	0.918	1.082	2.57
12	0.35	0.51	0.34	4.24		625	0.844	3280	1.113	1.18	4.24
13	0.62	0.5	0.33	4.42		761	1.05	4990	1.18	1.12	4.52
2	0.8	0.5	0.33	4.66		5140	0.945	7110	1.115	1.016	4.76
3	0.91	0.52	0.34	5.4		11000	0.928	18400	0.99	1.049	5.3
14	1.14	0.52	0.34	6.04		15300	0.885	18400	1.015	1.082	5.93

Experimental Vairables and Parameters for 0.33-mm sand in 2 foot wide flume

Run	Slope x10^2 S	Depth - h (ft)	Hydraulic Radius (ft)	Water Discharge - Q (ft^3/sec)	Temp - T (°C)	Suspended Concentration		Total Bed Material		Bed Material Particle Size d_{50} (ft x 10^3)	Mean Velocity V (ft/s)
						Sampled C_s (ppm)	Particle Size - d_{50} (ft x 10^3)	Concentration C_b (ppm)	Particle Size - d_{50} (ft x 10^3)		
11A	0.022	0.5	0.33	1.06		0	0.4045	0	-	-	1.08
11B	0.027	0.5	0.33	1.25		0	0.4045	0	-	-	1.28
16	0.029	0.5	0.33	1.05		0	0.4045	3.5	0.449	1.015	1.07
6	0.047	0.51	0.34	1.06		0	0.4045	12	0.443	0.95	1.06
5	0.063	0.52	0.34	1.46		8.1	0.4045	85	0.985	1.1	1.43
1	0.097	0.5	0.33	1.95		217	0.282	507	0.575	1.05	1.9
10	0.117	0.48	0.32	1.69		56	0.335	452	0.453	1.17	1.8
8	0.12	0.51	0.34	2.11		372	0.373	1030	0.482	1.445	2.11
9	0.143	0.52	0.34	2.46		888	0.429	1520	0.45	1.335	2.42
7	0.163	0.53	0.35	2.32		370	0.37	1220	0.54	1.408	2.23
2	0.188	0.52	0.34	2.62		1240	0.354	2790	0.423	1.11	2.57
3	0.343	0.52	0.34	3.34		3370	0.459	4320	0.443	1.016	3.27
4	0.433	0.51	0.34	4		2560	0.42	5100	0.738	0.95	4
12	0.447	0.49	0.33	4.6		3610	0.478	7900	0.689	0.985	4.79
13	0.695	0.49	0.33	5.38		6130	0.443	15100	0.502	0.919	5.61
15	0.91	0.52	0.34	6.46		8820	0.459	22500	0.557	1.082	6.34
14	0.98	0.51	0.34	6.04		3770	0.452	14600	0.715	1.147	6.05

Experimental Vairables and Parameters for 0.47-mm sand in 8 foot wide flume

Run	Slope x10^2 S	Depth - h (ft)	Hydraulic Radius (ft)	Water Discharge - Q (ft^3/sec)	Temp - T (°C)	Suspended Concentration		Total Bed Material		Bed Material Particle Size d_{50} (ft x 10^3)	Mean Velocity V (ft/s)
						Sampled C_s (ppm)	Particle Size - d_{50} (ft x 10^3)	Concentration C_b (ppm)	Particle Size - d_{50} (ft x 10^3)		
46	0.084	1.11	0.87	14.54		-	1.542	181	-	-	1.64
47	0.042	0.75	0.63	9.59		-	1.542	23	1.141	-	1.6
48	0.052	1.23	0.94	15.26		-	1.542	59	1.148	-	1.55
49	0.173	1.33	1.00	21.32		-	1.542	585	0.823	-	2
85	0.047	0.78	0.65	7.11		0	1.542	6	1.364	1.502	1.13
86	0.046	0.76	0.64	6.92		4800	1.542	1.6	0.249	1.437	1.14
87	0.046	0.75	0.63	6.96		8400	1.542	2.3	0.21	1.521	1.16
88	0.049	0.74	0.62	7.1		11400	1.542	2.5	0.417	1.64	1.2
90	0.053	0.6	0.52	6.97		6950	1.542	37	1.345	1.355	1.45
89	0.065	0.6	0.52	7.08		9000	1.542	31	1.361	1.509	1.47
93	0.072	0.62	0.54	7.2		1	1.542	99	1.482	1.742	1.45
92	0.09	0.63	0.54	7.14		6070	1.542	106	1.509	1.619	1.43
91	0.117	0.58	0.51	7.12		8400	1.542	195	1.443	1.61	1.53
82	0.248	0.64	0.55	8.16		133	1.542	429	1.463	1.679	1.6
51	0.236	0.62	0.54	8.11		584	1.542	545	1.351	-	1.62
52	0.222	0.55	0.48	8.01		1620	1.542	578	1.456	1.417	1.81
73	0.222	0.61	0.53	8.2		5670	1.542	662	1.509	1.565	1.67
74	0.215	0.65	0.56	8.18		7970	1.542	534	1.42	1.627	1.58
76	0.203	0.63	0.54	8.49		9330	1.542	463	1.387	1.456	1.69
75	0.204	0.64	0.55	8.24		9460	1.542	625	1.574	1.443	1.6
53	0.235	0.57	0.50	8.01		10700	1.542	571	1.361	1.564	1.77
77	0.199	0.65	0.56	8.76		12500	1.542	639	1.246	1.581	1.68
96	0.201	0.53	0.47	8.31		25000	1.542	761	1.066	1.588	1.94
94	0.237	0.81	0.67	11.3		7	1.542	480	1.404	1.624	1.74
83	0.2	0.91	0.74	15.58		0	1.542	588	1.151	1.633	2.14
54	0.24	0.92	0.75	15.36		1940	1.542	657	1.253	1.469	2.08
56	0.242	0.9	0.73	15.36		2860	1.542	41100	1.148	-	2.14
55	0.237	0.94	0.76	15.36		4060	1.542	765	1.164	1.692	2.04
57	0.259	0.87	0.71	15.39		4320	1.542	761	1.325	1.518	2.2
58	0.233	0.9	0.73	15.28		5270	1.542	807	1.21	1.535	2.11
95	0.18	0.8	0.67	15.38		28300	1.542	1640	1.099	1.771	2.39
78	0.32	0.72	0.61	11.52		12000	1.542	1510	1.089	1.453	2
59	0.326	0.65	0.56	15.36		4570	1.542	2920	1.312	1.535	2.96
60	0.342	0.62	0.54	21.35		3600	1.542	3290	1.427	1.699	4.28
61	0.355	0.61	0.53	21.32		6170	1.542	3390	1.44	1.722	4.36
71	0.531	0.32	0.30	8.22		3600	1.542	5250	1.525	1.673	3.21
72	0.55	0.32	0.30	8.26		7100	1.542	5680	1.505	1.588	3.26
70	0.64	0.3	0.28	8.14		3910	1.542	6310	1.476	1.515	3.41
63	0.57	0.43	0.39	15.5		3020	1.542	5360	1.633	1.535	4.48
64	0.578	0.41	0.37	15.61		6440	1.542	5480	1.63	1.601	4.76
65	0.571	0.42	0.38	15.6		9090	1.542	5160	1.584	1.506	4.63
66	0.575	0.45	0.40	15.52		12300	1.542	5130	1.647	1.526	4.34
80	0.643	0.39	0.36	15.27		12100	1.542	7140	1.624	1.594	4.91
81	0.634	0.55	0.48	21.35		7	1.542	4480	2.076	1.584	4.85
62	0.622	0.54	0.48	21.23		4790	1.542	4490	2.03	1.647	4.89
67	0.646	0.53	0.47	20.87		11200	1.542	4390	1.994	1.62	4.91
79	0.651	0.55	0.48	21.31		12400	1.542	5760	2.204	1.355	4.82
84	0.74	0.41	0.37	15.36		7	1.542	7100	1.41	1.64	4.67
69	0.734	0.43	0.39	15.54		7020	1.542	8280	1.601	1.43	4.48
98	0.821	0.44	0.40	15.8		42000	1.542	17700	1.237	1.44	4.51
68	0.74	0.53	0.47	20.94		7620	1.542	6760	2.181	1.738	4.95
100	0.79	0.51	0.45	21.42		106	1.542	8440	2.322	1.561	5.28
99	0.806	0.5	0.44	21.27		26900	1.542	16100	1.361	1.492	5.32
97	0.96	0.37	0.34	12.01		5800	1.542	8960	2.165	1.597	4.07

Table C.12. Guy et al. Raw Data 11

Experimental Vairables and Parameters for 0.33-mm sand in 2 foot wide flume

Run	Shear Velocity u^* - (ft/s)			Bed Material		Kinematic Viscosity x 10^5 ν (ft^2/s)	Shear Stress at Bed - τ (lb/ft^2)	Reynolds Number 10^{-2} R	Froude Number F	Reseistance factor			Bed Configuration
	Based on R	Based on h	Based on Velocity Profile	Sampled Suspended q_s (lb/ft-s)	Total q_t (lb/ft-s)					Darcy Weisbach f	Chezy $C/g^{0.5}$	Mannings n ($ft^{1/6}$)	
7	0.052	0.063	0.053	0.0000	0.000	1.08	0.0054	528	0.28	0.0062	21.6	0.013	Plane
8	0.097	0.118	0.047	0.0000	0.000	1.08	0.0043	472	0.25	0.0269	21.6	0.027	Ripple
5	0.097	0.118	0.054	0.0005	0.002	1.08	0.0057	531	0.29	0.0203	21.5	0.023	Do
11	0.106	0.131	0.064	0.0024	0.006	1.08	0.0079	664	0.34	0.0179	21.7	0.022	Dune
10	0.150	0.183	0.082	0.0299	0.024	1.08	0.0130	799	0.44	0.0217	21.5	0.024	Do
6	0.163	0.200	0.089	0.0198	0.045	1.08	0.0152	924	0.47	0.0218	21.7	0.025	Do
4	0.169	0.206	0.159	0.0665	0.227	1.08	0.0492	1556	0.86	0.0072	21.5	0.014	Transition
1	0.178	0.218	0.186	0.0492	0.387	1.08	0.0670	1898	0.99	0.0059	21.6	0.013	Plane
9	0.188	0.231	0.119	0.1692	0.160	1.08	0.0273	1237	0.63	0.0162	21.7	0.021	Dune
12	0.195	0.240	0.196	0.0827	0.434	1.08	0.0745	2002	1.05	0.0064	21.6	0.013	Plane
13	0.258	0.316	0.209	0.1049	0.688	1.07	0.0851	2112	1.13	0.0098	21.6	0.016	Antidune
2	0.293	0.359	0.221	0.7473	1.034	1.08	0.0944	2204	1.19	0.0114	21.6	0.018	Do
3	0.317	0.390	0.244	1.8533	3.100	1.07	0.1159	2576	1.30	0.0108	21.7	0.017	Do
14	0.354	0.437	0.274	2.8833	3.467	1.08	0.1451	2855	1.45	0.0109	21.7	0.017	Do

Experimental Vairables and Parameters for 0.33-mm sand in 2 foot wide flume

Run	Shear Velocity u^* - (ft/s)			Bed Material		Kinematic Viscosity x 10^5 ν (ft^2/s)	Shear Stress at Bed - τ (lb/ft^2)	Reynolds Number 10^{-2} R	Froude Number F	Reseistance factor			Bed Configuration
	Based on R	Based on h	Based on Velocity Profile	Sampled Suspended q_s (lb/ft-s)	Total q_t (lb/ft-s)					Darcy Weisbach f	Chezy $C/g^{0.5}$	Mannings n ($ft^{1/6}$)	
11A	0.049	0.060	0.050	0.0000	0.000	1.13	0.0049	478	0.27	0.0061	21.6	0.013	Plane
11B	0.054	0.066	0.059	0.0000	0.000	1.12	0.0068	571	0.32	0.0053	21.6	0.012	Do
16	0.056	0.068	0.050	0.0000	0.000	1.07	0.0048	500	0.27	0.0082	21.6	0.015	Ripple
6	0.071	0.088	0.049	0.0000	0.000	1.02	0.0047	530	0.26	0.0137	21.6	0.019	Do
5	0.083	0.103	0.066	0.0004	0.004	1.02	0.0084	729	0.35	0.0103	21.7	0.017	Do
1	0.102	0.125	0.088	0.0132	0.031	1.03	0.0150	922	0.47	0.0087	21.6	0.015	Dune
10	0.111	0.134	0.084	0.0030	0.024	1	0.0136	864	0.46	0.0112	21.5	0.017	Do
8	0.114	0.140	0.098	0.0245	0.068	0.98	0.0185	1098	0.52	0.0089	21.6	0.016	Do
9	0.126	0.155	0.112	0.0682	0.117	1.01	0.0242	1246	0.59	0.0082	21.7	0.015	Do
7	0.135	0.167	0.103	0.0268	0.088	1	0.0204	1182	0.54	0.0112	21.7	0.018	Do
2	0.144	0.177	0.119	0.1014	0.228	1.03	0.0273	1297	0.63	0.0095	21.7	0.016	Transition
3	0.194	0.240	0.151	0.3512	0.450	1.03	0.0441	1651	0.80	0.0107	21.7	0.017	Do
4	0.217	0.267	0.185	0.3195	0.636	1.04	0.0663	1962	0.99	0.0089	21.6	0.016	Plane
12	0.218	0.266	0.222	0.5181	1.134	1.04	0.0960	2257	1.21	0.0061	21.5	0.013	Standing Waves
13	0.271	0.331	0.261	1.0290	2.535	1.09	0.1317	2522	1.41	0.0070	21.5	0.014	Antidunes
15	0.317	0.390	0.292	1.7777	4.535	1.09	0.1659	3025	1.55	0.0076	21.7	0.014	Do
14	0.326	0.401	0.280	0.7104	2.751	1.09	0.1518	2831	1.49	0.0088	21.6	0.016	Do

Experimental Vairables and Parameters for 0.47-mm sand in 8 foot wide flume

Run	Shear Velocity u^* - (ft/s)			Bed Material		Kinematic Viscosity x 10^5 ν (ft^2/s)	Shear Stress at Bed - τ (lb/ft^2)	Reynolds Number 10^{-2} R	Froude Number F	Reseistance factor			Bed Configuration
	Based on R	Based on h	Based on Velocity Profile	Sampled Suspended q_s (lb/ft-s)	Total q_t (lb/ft-s)					Darcy Weisbach f	Chezy $C/g^{0.5}$	Mannings n ($ft^{1/6}$)	
46	0.153	0.173	0.072		0.021	1.3	0.0101	1400	0.27	0.0893	22.7	0.028	Dune
47	0.092	0.101	0.074	#VALUE!	0.002	1.36	0.0105	882	0.33	0.0317	21.7	0.016	Do.
48	0.126	0.144	0.068	#VALUE!	0.007	1.36	0.0089	1402	0.25	0.0686	22.9	0.025	Do.
49	0.236	0.272	0.086	#VALUE!	0.097	1.38	0.0145	1928	0.31	0.1482	23.1	0.037	Do.
85	0.099	0.109	0.052	#VALUE!	0.000	1.31	0.0052	673	0.23	0.0740	21.8	0.024	Ripples
86	0.097	0.106	0.052	0.0000	0.259	1.32	0.0053	656	0.23	0.0693	21.7	0.023	Do.
87	0.097	0.105	0.053	1.0363	0.456	1.37	0.0055	635	0.24	0.0660	21.7	0.023	Do.
88	0.099	0.108	0.055	1.8241	0.631	1.5	0.0059	592	0.25	0.0649	21.7	0.022	Do.
90	0.094	0.101	0.069	2.5253	0.380	1.39	0.0091	626	0.33	0.0390	21.2	0.017	Do.
89	0.104	0.112	0.069	1.5114	0.499	1.42	0.0094	621	0.33	0.0465	21.2	0.018	Do.
93	0.112	0.120	0.068	1.9881	0.006	1.24	0.0090	725	0.32	0.0547	21.2	0.020	Dune
92	0.126	0.135	0.067	0.0002	0.344	1.33	0.0088	677	0.32	0.0714	21.3	0.023	Do.
91	0.138	0.148	0.073	1.3522	0.477	1.42	0.0102	625	0.35	0.0747	21.1	0.023	Do.
82	0.210	0.226	0.075	1.8660	0.036	1	0.0109	1024	0.35	0.1597	21.3	0.034	Do.
51	0.202	0.217	0.076	0.0339	0.071	1.28	0.0113	785	0.36	0.1436	21.2	0.032	Do.
52	0.186	0.198	0.086	0.1478	0.137	1.26	0.0145	790	0.43	0.0960	20.9	0.026	Do.
73	0.195	0.209	0.079	0.4049	0.405	1.24	0.0120	822	0.38	0.1251	21.2	0.030	Do.
74	0.197	0.212	0.074	1.4506	0.543	1.31	0.0106	784	0.35	0.1442	21.4	0.033	Do.
76	0.189	0.203	0.079	2.0341	0.649	1.38	0.0122	772	0.38	0.1153	21.3	0.029	Do.
75	0.190	0.205	0.075	2.4714	0.648	1.36	0.0109	753	0.35	0.1314	21.3	0.031	Do.
53	0.194	0.208	0.084	2.4321	0.704	1.52	0.0137	664	0.41	0.1101	21.0	0.028	Do.
77	0.189	0.204	0.079	2.6741	0.898	1.52	0.0120	718	0.37	0.1181	21.4	0.030	Do.
96	0.174	0.185	0.093	3.4164	1.670	1.93	0.0168	533	0.47	0.0729	20.8	0.023	Do.
94	0.227	0.249	0.079	6.4818	0.043	1.28	0.0122	1101	0.34	0.1633	21.9	0.036	Do.
83	0.219	0.242	0.096	0.0025	0.071	1.19	0.0180	1636	0.40	0.1024	22.2	0.029	Do.
54	0.240	0.267	0.094	0.0000	0.311	1.25	0.0170	1531	0.38	0.1315	22.2	0.033	Do.
56	0.239	0.265	0.097	0.9297	5.267	1.11	0.0181	1735	0.40	0.1225	22.2	0.032	Do.
55	0.241	0.268	0.092	1.3706	0.578	1.26	0.0163	1522	0.37	0.1379	22.3	0.034	Do.
57	0.244	0.269	0.100	1.9457	0.610	1.19	0.0193	1608	0.42	0.1199	22.1	0.031	Do.
58	0.235	0.260	0.095	2.0743	0.724	1.25	0.0176	1519	0.39	0.1213	22.2	0.032	Do.
95	0.197	0.215	0.109	2.5124	3.592	2.03	0.0232	942	0.47	0.0649	21.9	0.023	Do.
78	0.251	0.272	0.093	13.5799	1.214	1.41	0.0166	1021	0.42	0.1484	21.6	0.034	Do.
59	0.242	0.261	0.139	4.3131	0.897	1.2	0.0373	1603	0.65	0.0623	21.4	0.022	Transition
60	0.243	0.261	0.202	2.1901	1.147	1.18	0.0788	2249	0.96	0.0298	21.2	0.015	Plane
61	0.246	0.264	0.206	2.3980	1.590	1.2	0.0821	2216	0.98	0.0293	21.2	0.015	Do.
71	0.225	0.234	0.164	4.1042	0.567	1.18	0.0521	871	1.00	0.0425	19.6	0.016	Do.
72	0.229	0.238	0.166	0.9233	0.823	1.31	0.0538	796	1.02	0.0427	19.6	0.016	Do.
70	0.240	0.249	0.176	1.8298	0.649	1.2	0.0598	853	1.10	0.0425	19.4	0.016	Do.
63	0.267	0.281	0.220	0.9930	1.013	1.16	0.0943	1661	1.20	0.0315	20.3	0.014	Antidune
64	0.263	0.276	0.236	1.4605	1.451	1.26	0.1077	1549	1.31	0.0269	20.2	0.013	Do.
65	0.264	0.278	0.228	3.1365	1.734	1.34	0.1013	1451	1.26	0.0288	20.3	0.014	Do.
66	0.274	0.289	0.212	4.4243	2.110	1.38	0.0875	1415	1.14	0.0354	20.4	0.015	Do.
80	0.271	0.284	0.245	5.9560	2.292	1.43	0.1160	1339	1.39	0.0268	20.1	0.013	Do.
81	0.314	0.335	0.232	5.7647	0.747	1.38	0.1041	1933	1.15	0.0382	20.9	0.016	Standing Waves
62	0.309	0.329	0.234	0.0047	1.537	1.12	0.1063	2358	1.17	0.0362	20.9	0.016	Do.
67	0.312	0.332	0.236	3.1728	2.538	1.36	0.1076	1913	1.19	0.0366	20.8	0.016	Do.
79	0.318	0.340	0.230	7.2928	3.019	1.46	0.1028	1816	1.15	0.0397	20.9	0.017	Do.
84	0.298	0.313	0.231	8.2444	0.851	1.23	0.1037	1557	1.29	0.0358	20.2	0.015	Antidune
69	0.303	0.319	0.220	0.0034	1.855	1.24	0.0943	1554	1.20	0.0405	20.3	0.016	Do.
98	0.324	0.341	0.221	3.4036	7.357	2.46	0.0950	807	1.20	0.0457	20.4	0.017	Do.
68	0.334	0.355	0.237	20.7043	2.349	1.23	0.1094	2133	1.20	0.0412	20.8	0.017	Standing Waves
100	0.339	0.360	0.254	4.9784	1.428	1.29	0.1256	2087	1.30	0.0372	20.7	0.016	Plane
99	0.340	0.360	0.257	0.0708	7.134	1.96	0.1282	1357	1.33	0.0367	20.7	0.016	Antidune
97	0.324	0.338	0.204	17.8515	1.383	1.29	0.0808	1167	1.18	0.0552	19.9	0.018	Do.

Table C.13. Guy et al. Raw Data 12

Experimental Vairables and Parameters for 0.33-mm sand in 2 foot wide flume

Run	ds	qs/qt	Useful Variables							
			w	ds (ft)	2ds/h	h/ds	Ro	ds (mm)	Re*	Shields
7	0.33	#DIV/0!	0.120	0.001	0.005	602.410	4.715	0.253	4.060	0.091
8	0.33	0	0.120	0.001	0.005	602.410	2.528	0.253	3.632	0.318
5	0.33	0.319148936	0.079	0.001	0.005	803.279	1.686	0.186	3.069	0.428
11	0.33	0.38028169	0.054	0.001	0.005	1094.737	1.029	0.145	2.800	0.677
10	0.33	1.234782609	0.150	0.001	0.005	482.283	2.046	0.310	7.690	0.623
6	0.33	0.441256831	0.081	0.001	0.005	842.788	1.008	0.188	5.060	1.226
4	0.33	0.29321267	0.120	0.001	0.005	590.361	1.449	0.253	12.243	0.966
1	0.33	0.127184466	0.120	0.001	0.005	614.458	1.371	0.253	14.282	1.080
9	0.33	1.056122449	0.137	0.001	0.005	556.745	1.480	0.285	10.252	1.080
12	0.33	0.19054878	0.122	0.001	0.005	604.265	1.273	0.257	15.318	1.282
13	0.33	0.15250501	0.156	0.001	0.005	476.190	1.232	0.320	20.552	1.789
2	0.33	0.722925457	0.139	0.001	0.005	529.101	0.967	0.288	19.299	2.565
3	0.33	0.597826087	0.137	0.001	0.005	560.345	0.875	0.283	21.203	3.090
14	0.33	0.831521739	0.129	0.001	0.005	587.571	0.738	0.270	22.414	4.060

Experimental Vairables and Parameters for 0.33-mm sand in 2 foot wide flume

Run	ds	qs/qt	Useful Variables							
			w	ds (ft)	2ds/h	h/ds	Ro	ds (mm)	Re*	Shields
11A	0.33	#DIV/0!	0.039	0.001	0.005	1236.094	1.651	0.123	1.791	0.165
11B	0.33	#DIV/0!	0.040	0.001	0.005	1236.094	1.502	0.123	2.142	0.202
16	0.33	0	0.041	0.001	0.005	1236.094	1.506	0.123	1.874	0.217
6	0.33	0	0.043	0.001	0.005	1260.816	1.219	0.123	1.943	0.359
5	0.33	0.095294118	0.043	0.001	0.005	1285.538	1.043	0.123	2.616	0.491
1	0.33	0.42800789	0.022	0.001	0.005	1773.050	0.440	0.086	2.410	1.042
10	0.33	0.123893805	0.031	0.001	0.005	1432.836	0.579	0.102	2.807	1.016
8	0.33	0.361165049	0.038	0.001	0.005	1367.292	0.684	0.114	3.713	0.994
9	0.33	0.584210526	0.048	0.001	0.005	1212.121	0.772	0.131	4.741	1.051
7	0.33	0.303278689	0.037	0.001	0.005	1432.432	0.558	0.113	3.798	1.415
2	0.33	0.444444444	0.034	0.001	0.005	1468.927	0.472	0.108	4.074	1.674
3	0.33	0.780092593	0.053	0.001	0.005	1132.898	0.550	0.140	6.722	2.355
4	0.33	0.501960784	0.045	0.001	0.005	1214.286	0.422	0.128	7.468	3.187
12	0.33	0.456962025	0.056	0.001	0.005	1025.105	0.526	0.146	10.225	2.777
13	0.33	0.405960265	0.047	0.001	0.005	1106.095	0.358	0.135	10.589	4.659
15	0.33	0.392	0.050	0.001	0.005	1132.898	0.323	0.140	12.315	6.248
14	0.33	0.258219178	0.049	0.001	0.005	1128.319	0.306	0.138	11.598	6.702

Experimental Vairables and Parameters for 0.47-mm sand in 8 foot wide flume

Run	ds	qs/qt	Useful Variables							
			w	ds (ft)	2ds/h	h/ds	Ro	ds (mm)	Re*	Shields
46	0.47	0	0.211	0.002	0.003	719.844	3.042	0.470	8.573	0.366
47	0.47	#VALUE!	0.208	0.002	0.005	486.381	5.175	0.470	8.356	0.124
48	0.47	#VALUE!	0.208	0.002	0.003	797.665	3.632	0.470	7.659	0.251
49	0.47	#VALUE!	0.208	0.002	0.003	862.516	1.908	0.470	9.657	0.904
85	0.47	#VALUE!	0.210	0.002	0.005	505.837	4.842	0.470	6.099	0.144
86	0.47	0	0.210	0.002	0.005	492.866	4.949	0.470	6.125	0.137
87	0.47	2.271955914	0.208	0.002	0.005	486.381	4.936	0.470	6.014	0.136
88	0.47	2.888617828	0.203	0.002	0.005	479.896	4.700	0.470	5.691	0.143
90	0.47	6.648132554	0.207	0.002	0.006	389.105	5.122	0.470	7.604	0.125
89	0.47	3.030459428	0.206	0.002	0.006	389.105	4.599	0.470	7.546	0.153
93	0.47	354	0.213	0.002	0.006	402.075	4.446	0.470	8.491	0.175
92	0.47	0.000653111	0.210	0.002	0.006	408.560	3.879	0.470	7.793	0.223
91	0.47	2.832833304	0.206	0.002	0.006	376.135	3.487	0.470	7.886	0.267
82	0.47	52.16663178	0.223	0.002	0.006	415.045	2.466	0.470	11.575	0.624
51	0.47	0.474118602	0.212	0.002	0.006	402.075	2.437	0.470	9.190	0.575
52	0.47	1.076052569	0.212	0.002	0.006	356.680	2.678	0.470	10.580	0.480
73	0.47	0.999661033	0.213	0.002	0.006	395.590	2.552	0.470	9.798	0.532
74	0.47	2.673500979	0.210	0.002	0.005	421.530	2.480	0.470	8.710	0.549
76	0.47	3.136520798	0.208	0.002	0.006	408.560	2.559	0.470	8.876	0.503
75	0.47	3.812819192	0.208	0.002	0.006	415.045	2.542	0.470	8.511	0.513
53	0.47	3.453690163	0.202	0.002	0.006	369.650	2.436	0.470	8.540	0.526
77	0.47	2.978584096	0.202	0.002	0.005	421.530	2.479	0.470	7.981	0.508
96	0.47	2.046022329	0.188	0.002	0.007	343.709	2.535	0.470	7.436	0.419
94	0.47	151.0057967	0.212	0.002	0.004	525.292	2.128	0.470	9.570	0.755
83	0.47	0.034537563	0.215	0.002	0.004	590.143	2.222	0.470	12.494	0.715
54	0.47	0	0.213	0.002	0.004	596.628	1.995	0.470	11.547	0.868
56	0.47	0.176524113	0.218	0.002	0.004	583.658	2.062	0.470	13.412	0.856
55	0.47	2.370984456	0.212	0.002	0.004	609.598	1.983	0.470	11.208	0.876
57	0.47	3.189990766	0.215	0.002	0.004	564.202	1.997	0.470	12.910	0.886
58	0.47	2.863978592	0.213	0.002	0.004	583.658	2.047	0.470	11.743	0.824
95	0.47	0.699496957	0.184	0.002	0.004	518.807	2.142	0.470	8.300	0.566
78	0.47	11.18651822	0.207	0.002	0.005	466.926	1.896	0.470	10.122	0.906
59	0.47	4.806408545	0.215	0.002	0.005	421.530	2.056	0.470	17.812	0.833
60	0.47	1.908755519	0.216	0.002	0.006	402.075	2.063	0.470	26.338	0.833
61	0.47	1.508395676	0.215	0.002	0.006	395.590	2.034	0.470	26.434	0.851
71	0.47	7.232980054	0.216	0.002	0.011	207.523	2.304	0.470	21.419	0.668
72	0.47	1.121304096	0.210	0.002	0.011	207.523	2.210	0.470	19.594	0.692
70	0.47	2.819831039	0.215	0.002	0.012	194.553	2.160	0.470	22.560	0.755
63	0.47	0.98013396	0.216	0.002	0.008	278.859	1.926	0.470	29.305	0.963
64	0.47	1.006281466	0.212	0.002	0.009	265.888	1.922	0.470	28.834	0.931
65	0.47	1.808878093	0.209	0.002	0.009	272.374	1.883	0.470	26.294	0.943
66	0.47	2.096811399	0.208	0.002	0.008	291.829	1.799	0.470	23.731	1.017
80	0.47	2.599038513	0.206	0.002	0.009	252.918	1.810	0.470	26.370	0.986
81	0.47	7.714902641	0.208	0.002	0.006	356.680	1.550	0.470	25.885	1.371
62	0.47	0.003034296	0.218	0.002	0.007	350.195	1.658	0.470	32.227	1.320
67	0.47	1.250192631	0.208	0.002	0.007	343.709	1.570	0.470	26.708	1.346
79	0.47	2.416023583	0.205	0.002	0.006	356.680	1.507	0.470	24.315	1.407
84	0.47	9.682501993	0.214	0.002	0.009	265.888	1.708	0.470	28.979	1.192
69	0.47	0.001808868	0.213	0.002	0.008	278.859	1.672	0.470	27.414	1.240
98	0.47	0.462611793	0.171	0.002	0.008	285.344	1.253	0.470	13.872	1.420
68	0.47	8.815172298	0.214	0.002	0.007	343.709	1.503	0.470	29.772	1.541
100	0.47	3.486657476	0.211	0.002	0.007	330.739	1.466	0.470	30.420	1.584
99	0.47	0.009930003	0.187	0.002	0.007	324.254	1.296	0.470	20.221	1.584
97	0.47	12.91071803	0.211	0.002	0.010	239.948	1.561	0.470	24.391	1.396

Table C.14. Guy et al. Raw Data 13

Experimental Vairables and Parameters for 0.54-mm sand in 2 foot wide flume

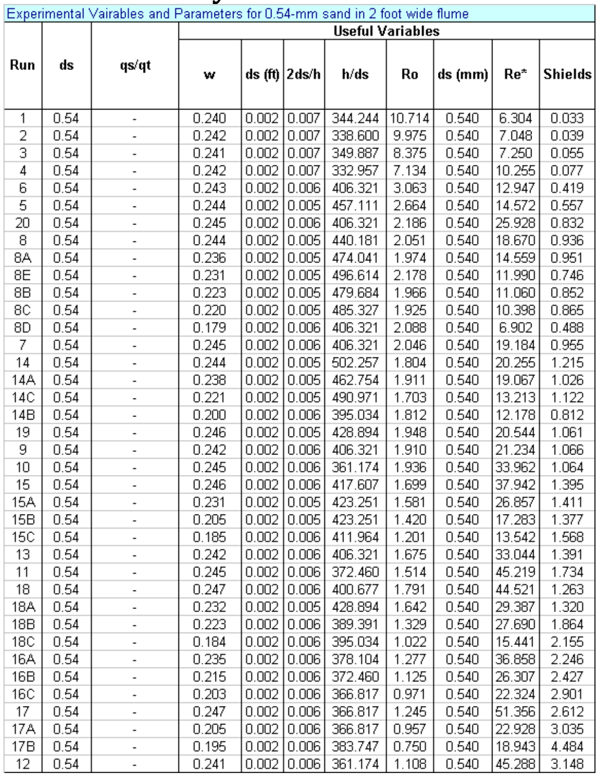
Run	Slope x10^2 S	Depth - h (ft)	Hydraulic Radius (ft)	Water Discharge - Q (ft^3/sec)	Temp - T (°C)	Suspended Concentration		Total Bed Material		Bed Material Particle Size d_{50} (ft x 10^3)	Mean Velocity V (ft/s)
						Sampled C_s (ppm)	Particle Size - d_{50} (ft x 10^3)	Concentration C_b (ppm)	Particle Size - d_{50} (ft x 10^3)		
1	0.016	0.61	0.38	1.06		0	1.772	0	-	-	0.89
2	0.019	0.6	0.38	1.12		0	1.772	0	-	-	0.96
3	0.026	0.62	0.38	1.21		0	1.772	0.6	-	1.585	1
4	0.038	0.59	0.37	1.59		0	1.772	17	1.647	1.526	1.37
6	0.17	0.72	0.42	2.45		0	1.772	387	1.539	1.64	1.74
5	0.201	0.81	0.45	3.12		0	1.772	408	1.499	1.575	1.95
20	0.338	0.72	0.42	4.74		0	1.772	2620	1.621	1.716	3.36
8	0.351	0.78	0.44	3.82		0	1.772	1200	1.585	1.903	2.51
8A	0.331	0.84	0.46	3.82		570	1.772	1050	1.417	1.699	2.33
8E	0.248	0.88	0.47	3.69		14500	1.772	720	1.621	1.968	2.15
8B	0.293	0.85	0.46	3.84		20600	1.772	904	1.482	1.949	2.3
8C	0.294	0.86	0.46	3.83		24300	1.772	1100	1.594	1.772	2.28
8D	0.198	0.72	0.42	3.77		63700	1.772	521	1.787	1.706	2.65
7	0.388	0.72	0.42	3.42		0	1.772	1250	2.224	1.804	2.44
14	0.399	0.89	0.47	4.77		0	1.772	1790	1.667	1.903	2.74
14A	0.366	0.82	0.45	4.78		9580	1.772	1970	1.532	1.837	2.95
14C	0.377	0.87	0.47	4.8		22400	1.772	1950	1.739	1.837	2.82
14B	0.339	0.7	0.41	4.84		44100	1.772	2960	1.296	1.837	3.51
19	0.408	0.76	0.43	3.82		0	1.772	1200	1.463	1.788	2.58
9	0.433	0.72	0.42	4.16		0	1.772	1520	1.421	1.549	2.93
10	0.486	0.64	0.39	5.33		0	1.772	2690	1.706	1.824	4.3
15	0.551	0.74	0.43	6.94		0	1.772	3330	1.821	1.732	4.75
15A	0.55	0.75	0.43	6.99		14200	1.772	4350	1.519	1.8954	4.76
15B	0.537	0.75	0.43	6.96		40900	1.772	4710	1.476	1.837	4.73
15C	0.628	0.73	0.42	6.99		58600	1.772	7640	1.247	1.722	4.85
13	0.565	0.72	0.42	6.37		0	1.772	3350	1.847	1.713	4.52
11	0.768	0.66	0.40	7.48		0	1.772	5690	2.067	1.509	5.8
18	0.52	0.71	0.42	7.62		13200	1.772	3330	1.87	1.87	5.44
18A	0.508	0.76	0.43	7.57			1.772	3400	1.804	1.837	5.11
18B	0.79	0.69	0.41	7.59		37900	1.772	9730	1.558	1.837	5.62
18C	0.9	0.7	0.41	7.59		58700	1.772	22300	1.421	1.191	5.54
16A	0.98	0.67	0.40	7.82		11200	1.772	5600	2.198	-	5.92
16B	1.075	0.66	0.40	7.84		31500	1.772	10300	1.496	1.713	6.03
16C	1.305	0.65	0.39	7.86		44500	1.772	15800	1.132	1.837	6.14
17	1.175	0.65	0.39	7.89		0	1.772	9180	1.46	1.69	6.21
17A	1.365	0.65	0.39	7.83		39600	1.772	21800	1.214	1.837	6.17
17B	1.928	0.68	0.40	7.86		51900	1.772	5000	1.46	2.1	5.87
12	1.438	0.64	0.39	7.84		0	1.772	26000	1.486	1.847	6.27

Table C.15. Guy et al. Raw Data 14

Experimental Vairables and Parameters for 0.54-mm sand in 2 foot wide flume

Run	*Shear Velocity u* - (ft/s)*			Bed Material		Kinematic Viscocity x 10^5 ν (ft^2/s)	Shear Stress at Bed - τ (lb/ft^2)	Reynolds Number 10^{-2} R	Froude Number F	Reseistance factor			Bed Configuration
	Based on R	Based on h	Based on Velocity Profile	Sampled Suspended q_s (lb/ft-s)	Total q_t (lb/ft-s)					Darcy Weisbach f	Chezy $C/g^{0.5}$	Mannings n ($ft^{1/6}$)	
1	0.044	0.056	0.043	-	0.000	1.2	0.0035	452	0.20	0.0079	20.8	0.015	Plane
2	0.048	0.061	0.046	-	0.000	1.16	0.0041	497	0.22	0.0080	20.8	0.015	Do
3	0.057	0.072	0.048	-	0.000	1.17	0.0044	530	0.22	0.0104	20.9	0.017	Ripples
4	0.067	0.085	0.066	-	0.001	1.14	0.0084	709	0.31	0.0077	20.8	0.015	Do
6	0.151	0.199	0.082	-	0.030	1.12	0.0130	1119	0.36	0.0260	21.3	0.028	Dunes
5	0.170	0.229	0.090	-	0.040	1.1	0.0159	1436	0.38	0.0276	21.6	0.030	Do
20	0.213	0.280	0.158	-	0.387	1.08	0.0484	2240	0.70	0.0139	21.3	0.021	Transition
8	0.223	0.297	0.117	-	0.143	1.11	0.0265	1764	0.50	0.0280	21.5	0.030	Dunes
8A	0.221	0.299	0.108	-	0.193	1.31	0.0225	1494	0.45	0.0330	21.6	0.033	Do
8E	0.193	0.265	0.099	-	1.752	1.46	0.0189	1296	0.40	0.0304	21.8	0.032	Do
8B	0.208	0.283	0.106	-	2.576	1.7	0.0218	1150	0.44	0.0303	21.7	0.031	Do
8C	0.209	0.285	0.105	-	3.035	1.79	0.0214	1095	0.43	0.0313	21.7	0.032	Do
8D	0.163	0.214	0.125	-	7.554	3.2	0.0301	596	0.55	0.0131	21.3	0.020	Transition
7	0.229	0.300	0.115	-	0.133	1.06	0.0255	1657	0.51	0.0302	21.3	0.031	Dunes
14	0.246	0.338	0.126	-	0.266	1.1	0.0307	2217	0.51	0.0305	21.8	0.032	Transition
14A	0.230	0.311	0.137	-	1.723	1.27	0.0362	1905	0.57	0.0222	21.6	0.027	Do
14C	0.238	0.325	0.130	-	3.647	1.74	0.0327	1410	0.53	0.0266	21.7	0.030	Do
14B	0.212	0.276	0.166	-	7.106	2.41	0.0532	1020	0.74	0.0124	21.2	0.019	Plane
19	0.238	0.316	0.121	-	0.143	1.04	0.0282	1885	0.52	0.0300	21.4	0.031	Transition
9	0.242	0.317	0.138	-	0.197	1.15	0.0368	1834	0.61	0.0234	21.3	0.027	Dp
10	0.247	0.316	0.205	-	0.447	1.07	0.0816	2572	0.95	0.0108	21.0	0.018	Plane
15	0.275	0.362	0.223	-	0.721	1.04	0.0962	3380	0.97	0.0116	21.3	0.019	Standing Waves
15A	0.275	0.364	0.223	-	4.046	1.47	0.0963	2429	0.97	0.0117	21.4	0.019	Do
15B	0.272	0.360	0.221	-	9.904	2.27	0.0951	1563	0.96	0.0116	21.4	0.019	Do
15C	0.292	0.384	0.228	-	14.446	2.98	0.1006	1188	1.00	0.0126	21.3	0.020	Do
13	0.276	0.362	0.213	-	0.666	1.14	0.0877	2855	0.94	0.0128	21.3	0.020	Do
11	0.314	0.404	0.276	-	1.328	1.08	0.1474	3544	1.26	0.0097	21.0	0.017	Do
18	0.264	0.345	0.256	-	3.930	1.02	0.1274	3787	1.14	0.0080	21.2	0.016	Do
18A	0.266	0.353	0.239	-	0.803	1.44	0.1106	2697	1.03	0.0095	21.4	0.017	Do
18B	0.322	0.419	0.266	-	11.279	1.7	0.1369	2281	1.19	0.0111	21.2	0.018	Do
18C	0.345	0.450	0.261	-	19.181	3	0.1326	1293	1.17	0.0132	21.2	0.020	Antidune
16A	0.356	0.460	0.281	-	4.099	1.35	0.1530	2938	1.27	0.0121	21.1	0.019	Standing Waves
16B	0.371	0.478	0.287	-	10.225	1.93	0.1593	2062	1.31	0.0126	21.0	0.019	Antidune
16C	0.407	0.523	0.292	-	14.787	2.32	0.1657	1720	1.34	0.0145	21.0	0.021	Do
17	0.386	0.496	0.296	-	2.260	1.02	0.1695	3957	1.36	0.0128	21.0	0.020	Do
17A	0.416	0.535	0.294	-	15.000	2.27	0.1674	1767	1.35	0.0150	21.0	0.021	Do
17B	0.501	0.650	0.278	-	13.954	2.6	0.1499	1535	1.25	0.0245	21.1	0.027	Do
12	0.425	0.544	0.299	-	6.360	1.17	0.1735	3430	1.38	0.0151	21.0	0.021	Do

Table C.16. Guy et al. Raw Data 15



Experimental Vairables and Parameters for 0.54-mm sand in 2 foot wide flume

Run	ds	qs/qt	Useful Variables							
			w	ds (ft)	2ds/h	h/ds	Ro	ds (mm)	Re*	Shields
1	0.54	-	0.240	0.002	0.007	344.244	10.714	0.540	6.304	0.033
2	0.54	-	0.242	0.002	0.007	338.600	9.975	0.540	7.048	0.039
3	0.54	-	0.241	0.002	0.007	349.887	8.375	0.540	7.250	0.055
4	0.54	-	0.242	0.002	0.007	332.957	7.134	0.540	10.255	0.077
6	0.54	-	0.243	0.002	0.006	406.321	3.063	0.540	12.947	0.419
5	0.54	-	0.244	0.002	0.005	457.111	2.664	0.540	14.572	0.557
20	0.54	-	0.245	0.002	0.006	406.321	2.186	0.540	25.928	0.832
8	0.54	-	0.244	0.002	0.005	440.181	2.051	0.540	18.670	0.936
8A	0.54	-	0.236	0.002	0.005	474.041	1.974	0.540	14.559	0.951
8E	0.54	-	0.231	0.002	0.005	496.614	2.178	0.540	11.990	0.746
8B	0.54	-	0.223	0.002	0.005	479.684	1.966	0.540	11.060	0.852
8C	0.54	-	0.220	0.002	0.005	485.327	1.925	0.540	10.398	0.865
8D	0.54	-	0.179	0.002	0.006	406.321	2.088	0.540	6.902	0.488
7	0.54	-	0.245	0.002	0.006	406.321	2.046	0.540	19.184	0.955
14	0.54	-	0.244	0.002	0.005	502.257	1.804	0.540	20.255	1.215
14A	0.54	-	0.238	0.002	0.005	462.754	1.911	0.540	19.067	1.026
14C	0.54	-	0.221	0.002	0.005	490.971	1.703	0.540	13.213	1.122
14B	0.54	-	0.200	0.002	0.006	395.034	1.812	0.540	12.178	0.812
19	0.54	-	0.246	0.002	0.005	428.894	1.948	0.540	20.544	1.061
9	0.54	-	0.242	0.002	0.006	406.321	1.910	0.540	21.234	1.066
10	0.54	-	0.245	0.002	0.006	361.174	1.936	0.540	33.962	1.064
15	0.54	-	0.246	0.002	0.006	417.607	1.699	0.540	37.942	1.395
15A	0.54	-	0.231	0.002	0.005	423.251	1.581	0.540	26.857	1.411
15B	0.54	-	0.205	0.002	0.005	423.251	1.420	0.540	17.283	1.377
15C	0.54	-	0.185	0.002	0.006	411.964	1.201	0.540	13.542	1.568
13	0.54	-	0.242	0.002	0.006	406.321	1.675	0.540	33.044	1.391
11	0.54	-	0.245	0.002	0.006	372.460	1.514	0.540	45.219	1.734
18	0.54	-	0.247	0.002	0.006	400.677	1.791	0.540	44.521	1.263
18A	0.54	-	0.232	0.002	0.005	428.894	1.642	0.540	29.387	1.320
18B	0.54	-	0.223	0.002	0.006	389.391	1.329	0.540	27.690	1.864
18C	0.54	-	0.184	0.002	0.006	395.034	1.022	0.540	15.441	2.155
16A	0.54	-	0.235	0.002	0.006	378.104	1.277	0.540	36.858	2.246
16B	0.54	-	0.215	0.002	0.006	372.460	1.125	0.540	26.307	2.427
16C	0.54	-	0.203	0.002	0.006	366.817	0.971	0.540	22.324	2.901
17	0.54	-	0.247	0.002	0.006	366.817	1.245	0.540	51.356	2.612
17A	0.54	-	0.205	0.002	0.006	366.817	0.957	0.540	22.928	3.035
17B	0.54	-	0.195	0.002	0.006	383.747	0.750	0.540	18.943	4.484
12	0.54	-	0.241	0.002	0.006	361.174	1.108	0.540	45.288	3.148

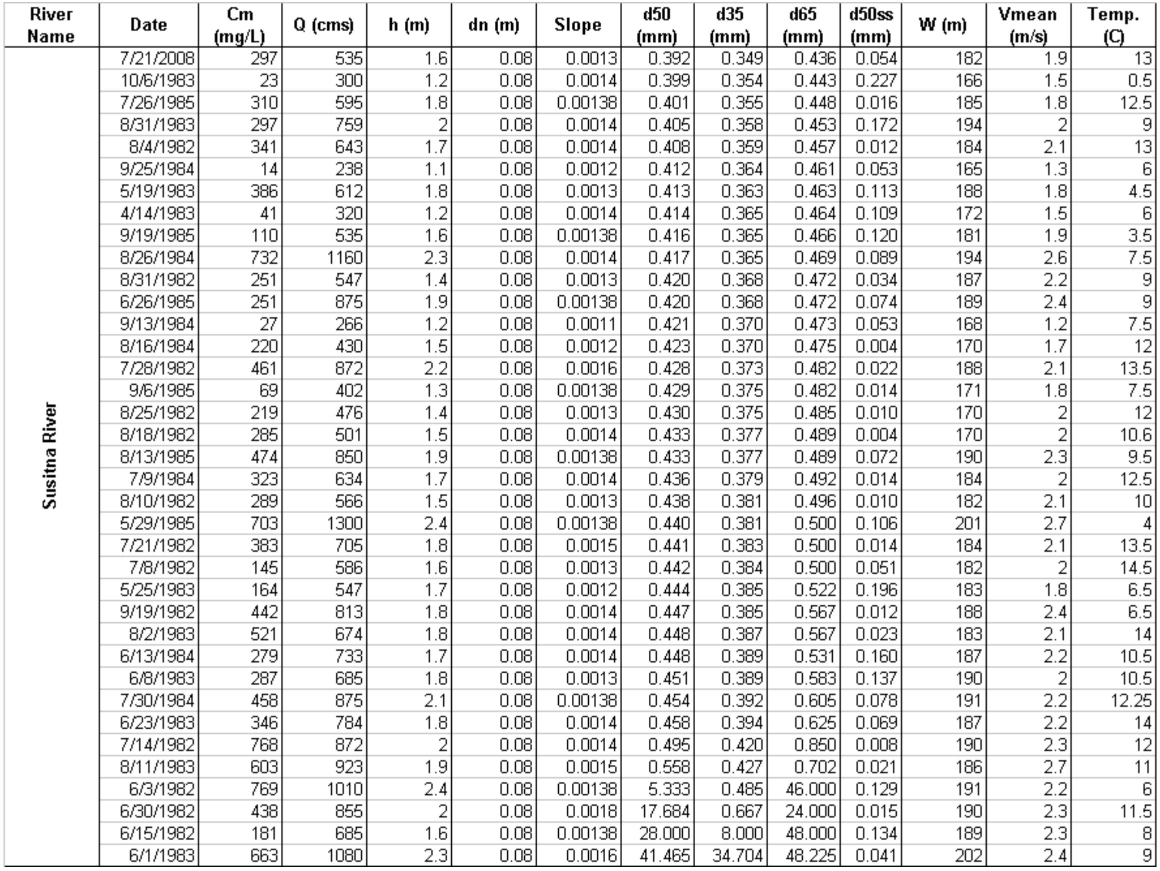
Table C.17. Platte River Data

River Name	Sample No.	Date	Cm (mg/L)	Q (cms)	h (m)	dn (m)	Slope	d50 (mm)	d35 (mm)	d65 (mm)	d50ss (mm)	W (m)	Vmean (m/s)	Temp. (C)
North Platte River	1	8/9/1979	8/9/1979	370	22.6	0.39	0.08	0.909	0.568	1.524	0.184	83.5	0.7	21
	1	8/11/1979	8/11/1979	120	27.9	0.49	0.08	0.773	0.471	1.294	0.135	89.3	0.64	21
	2	8/12/1979	8/12/1979	350	31.4	0.59	0.08	0.617	0.441	0.867	0.090	75.3	0.7	18.5
	2	8/4/1980	8/4/1980	310	58.4	0.73	0.08	0.593	0.424	0.870	0.125	89.3	0.9	20
	2	8/5/1980	8/5/1980	370	58.4	0.73	0.08	0.500	0.383	0.813	0.144	89.3	0.9	20
South Platte River	3	5/6/1980	5/6/1980	950	351	1.91	0.08	1.462	0.700	3.067	0.062	197	0.93	13.5
	4	9/26/1979	9/26/1979	100	17.7	0.56	0.08	1.333	0.833	2.091	0.062	39.6	0.79	17.5
	5	6/20/1979	6/20/1979	520	253	1.06	0.08	0.313	0.204	0.500	0.183	302	0.79	20.5
	5	6/25/1979	6/25/1979	900	107	1.21	0.08	0.604	0.400	0.917	0.075	85.6	1.03	20
	5	8/17/1979	8/17/1979	1350	39.5	0.66	0.08	0.823	0.581	1.235	0.096	72.5	0.82	23
	7	5/22/1980	5/22/1980	1160	351	1.53	0.08	0.773	0.545	1.000	0.062	146	1.57	19
Platte River	10	5/1/1980	5/1/1980	2120	146	0.86	0.08	0.827	0.538	1.353	0.487	198	0.8	17.5
	12	4/30/1980	4/30/1980	3710	142	0.65	0.08	0.586	0.426	0.845	0.591	266	0.83	18
	12	5/15/1980	5/15/1980	330	271	1.02	0.08	0.733	0.492	0.983	0.200	268	0.99	15
	12	5/21/1980	5/21/1980	270	250	0.97	0.08	0.672	0.462	0.931	0.197	268	0.93	18.2
	12	6/10/1980	6/10/1980	120	207	0.79	0.08	0.679	0.461	0.946	0.180	260	1	26
	12	6/27/1980	6/27/1979	710	71.2	0.85	0.08	1.294	0.737	2.300	0.261	96	0.87	20

Table C.18. Niobrara River Data

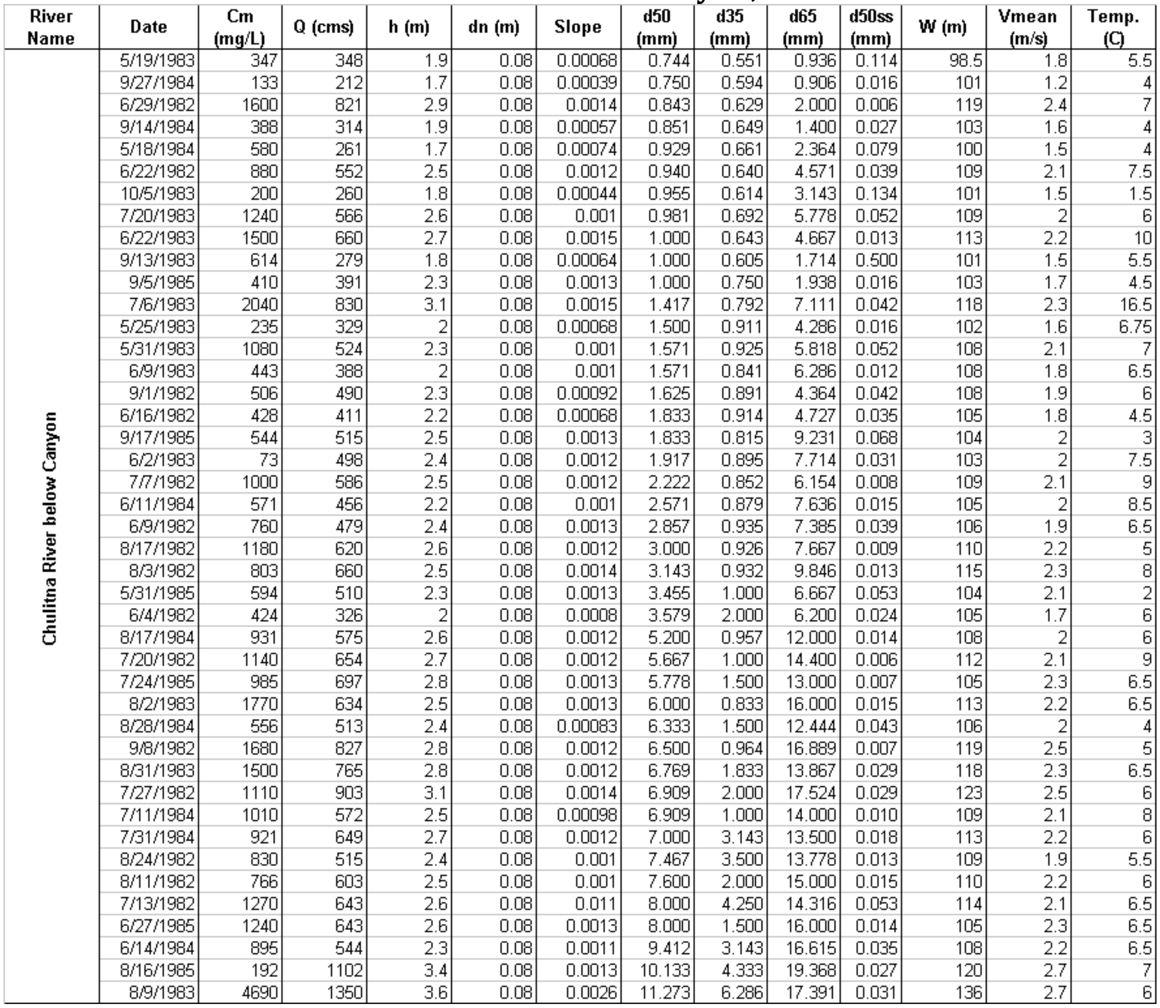
Date	Cm (mg/L)	Q (cms)	h (m)	dn (m)	Slope	d50 (mm)	d35 (mm)	d65 (mm)	d50ss (mm)	W (m)	Vmean (m/s)	Temp. (C)
7/13/1949	219	6.626	0.467	0.091	0.00134	0.317	0.254	0.379	0.147	21.488	0.753	23.889
3/3/1950	1060	11.100	0.488	0.091	0.00170	0.309	0.227	0.419	0.103	21.336	1.088	5.000
5/11/1950	1040	16.027	0.576	0.091	0.00180	0.217	0.185	0.248	0.113	21.946	1.271	11.667
6/7/1950	421	7.306	0.479	0.091	0.00127	0.293	0.228	0.372	0.146	21.336	0.747	18.333
9/20/1950	711	9.628	0.477	0.091	0.00140	0.292	0.208	0.363	0.161	21.031	0.936	16.111
3/15/1951	1220	12.176	0.477	0.091	0.00137	0.314	0.239	0.394	0.148	21.641	1.158	1.667
4/27/1951	874	12.459	0.528	0.091	0.00169	0.327	0.255	0.399	0.116	21.641	1.128	14.444
5/10/1951	558	8.891	0.435	0.091	0.00137	0.327	0.255	0.399	0.120	21.336	0.975	11.111
5/24/1951	782	11.610	0.496	0.091	0.00137	0.276	0.220	0.352	0.100	21.336	1.155	20.000
7/18/1951	470	8.438	0.479	0.091	0.00137	0.262	0.215	0.349	0.146	21.336	0.789	25.556
10/24/1951	572	9.288	0.440	0.091	0.00137	0.247	0.207	0.326	0.121	21.336	0.991	7.778
4/10/1952	1080	12.176	0.485	0.091	0.00137	0.211	0.179	0.244	0.121	21.641	1.128	7.222
5/8/1952	862	12.318	0.549	0.091	0.00137	0.286	0.228	0.355	0.112	21.641	0.972	13.889
5/24/1952	890	12.884	0.549	0.091	0.00137	0.222	0.186	0.271	0.098	21.641	1.161	21.111
6/5/1952	514	8.665	0.473	0.091	0.00137	0.256	0.212	0.341	0.094	21.031	0.902	24.444
6/19/1952	458	6.513	0.475	0.091	0.00125	0.295	0.231	0.370	0.162	21.336	0.655	20.556
7/4/1952	462	7.872	0.492	0.091	0.00129	0.331	0.267	0.394	0.135	21.336	0.747	22.778
7/20/1952	246	6.201	0.429	0.091	0.00114	0.288	0.229	0.361	0.156	21.336	0.716	24.444
7/31/1952	204	6.003	0.421	0.091	0.00125	0.335	0.268	0.402	0.135	21.031	0.668	28.333
8/29/1952	245	5.890	0.440	0.091	0.00121	0.365	0.290	0.440	0.128	21.336	0.625	22.778
9/12/1952	282	6.315	0.444	0.091	0.00137	0.323	0.259	0.388	0.160	21.336	0.671	16.667
9/26/1952	346	6.626	0.469	0.091	0.00114	0.314	0.246	0.382	0.156	21.184	0.671	16.111
10/11/1952	446	8.325	0.432	0.091	0.00137	0.352	0.291	0.414	0.128	21.184	0.869	11.111
10/23/1952	482	8.099	0.435	0.091	0.00137	0.291	0.228	0.367	0.128	21.336	0.887	11.111
4/22/1953	605	10.336	0.459	0.091	0.00137	0.262	0.213	0.351	0.105	21.641	1.024	9.444
7/8/1953	471	7.872	0.517	0.091	0.00137	0.267	0.215	0.350	0.114	21.031	0.765	20.278

Table C.19. Data from Susitna River, AK



River Name	Date	Cm (mg/L)	Q (cms)	h (m)	dn (m)	Slope	d50 (mm)	d35 (mm)	d65 (mm)	d50ss (mm)	W (m)	Vmean (m/s)	Temp. (C)
Susitna River	7/21/2008	297	535	1.6	0.08	0.0013	0.392	0.349	0.436	0.054	182	1.9	13
	10/6/1983	23	300	1.2	0.08	0.0014	0.399	0.354	0.443	0.227	166	1.5	0.5
	7/26/1985	310	595	1.8	0.08	0.00138	0.401	0.355	0.448	0.016	185	1.8	12.5
	8/31/1983	297	759	2	0.08	0.0014	0.405	0.358	0.453	0.172	194	2	9
	8/4/1982	341	643	1.7	0.08	0.0014	0.408	0.359	0.457	0.012	184	2.1	13
	9/25/1984	14	238	1.1	0.08	0.0012	0.412	0.364	0.461	0.053	165	1.3	6
	5/19/1983	386	612	1.8	0.08	0.0013	0.413	0.363	0.463	0.113	188	1.8	4.5
	4/14/1983	41	320	1.2	0.08	0.0014	0.414	0.365	0.464	0.109	172	1.5	6
	9/19/1985	110	535	1.6	0.08	0.00138	0.416	0.365	0.466	0.120	181	1.9	3.5
	8/26/1984	732	1160	2.3	0.08	0.0014	0.417	0.365	0.469	0.089	194	2.6	7.5
	8/31/1982	251	547	1.4	0.08	0.0013	0.420	0.368	0.472	0.034	187	2.2	9
	6/26/1985	251	875	1.9	0.08	0.00138	0.420	0.368	0.472	0.074	189	2.4	9
	9/13/1984	27	266	1.2	0.08	0.0011	0.421	0.370	0.473	0.053	168	1.2	7.5
	8/16/1984	220	430	1.5	0.08	0.0012	0.423	0.370	0.475	0.004	170	1.7	12
	7/28/1982	461	872	2.2	0.08	0.0016	0.428	0.373	0.482	0.022	188	2.1	13.5
	9/6/1985	69	402	1.3	0.08	0.00138	0.429	0.375	0.482	0.014	171	1.8	7.5
	8/25/1982	219	476	1.4	0.08	0.0013	0.430	0.375	0.485	0.010	170	2	12
	8/18/1982	285	501	1.5	0.08	0.0014	0.433	0.377	0.489	0.004	170	2	10.6
	8/13/1985	474	850	1.9	0.08	0.00138	0.433	0.377	0.489	0.072	190	2.3	9.5
	7/9/1984	323	634	1.7	0.08	0.0014	0.436	0.379	0.492	0.014	184	2	12.5
	8/10/1982	289	566	1.5	0.08	0.0013	0.438	0.381	0.496	0.010	182	2.1	10
	5/29/1985	703	1300	2.4	0.08	0.00138	0.440	0.381	0.500	0.106	201	2.7	4
	7/21/1982	383	705	1.8	0.08	0.0015	0.441	0.383	0.500	0.014	184	2.1	13.5
	7/8/1982	145	586	1.6	0.08	0.0013	0.442	0.384	0.500	0.051	182	2	14.5
	5/25/1983	164	547	1.7	0.08	0.0012	0.444	0.385	0.522	0.196	183	1.8	6.5
	9/19/1982	442	813	1.8	0.08	0.0014	0.447	0.385	0.567	0.012	188	2.4	6.5
	8/2/1983	521	674	1.8	0.08	0.0014	0.448	0.387	0.567	0.023	183	2.1	14
	6/13/1984	279	733	1.7	0.08	0.0014	0.448	0.389	0.531	0.160	187	2.2	10.5
	6/8/1983	287	685	1.8	0.08	0.0013	0.451	0.389	0.583	0.137	190	2	10.5
	7/30/1984	458	875	2.1	0.08	0.00138	0.454	0.392	0.605	0.078	191	2.2	12.25
	6/23/1983	346	784	1.8	0.08	0.0014	0.458	0.394	0.625	0.069	187	2.2	14
	7/14/1982	768	872	2	0.08	0.0014	0.495	0.420	0.850	0.008	190	2.3	12
	8/11/1983	603	923	1.9	0.08	0.0015	0.558	0.427	0.702	0.021	186	2.7	11
	6/3/1982	769	1010	2.4	0.08	0.00138	5.333	0.485	46.000	0.129	191	2.2	6
	6/30/1982	438	855	2	0.08	0.0018	17.684	0.667	24.000	0.015	190	2.3	11.5
	6/15/1982	181	685	1.6	0.08	0.00138	28.000	8.000	48.000	0.134	189	2.3	8
	6/1/1983	663	1080	2.3	0.08	0.0016	41.465	34.704	48.225	0.041	202	2.4	9

Table C.20. Data from Chulitna River below Canyon, AK



River Name	Date	Cm (mg/L)	Q (cms)	h (m)	dn (m)	Slope	d50 (mm)	d35 (mm)	d65 (mm)	d50ss (mm)	W (m)	Vmean (m/s)	Temp. (C)
Chulitna River below Canyon	5/19/1983	347	348	1.9	0.08	0.00068	0.744	0.551	0.936	0.114	98.5	1.8	5.5
	9/27/1984	133	212	1.7	0.08	0.00039	0.750	0.594	0.906	0.016	101	1.2	4
	6/29/1982	1600	821	2.9	0.08	0.0014	0.843	0.629	2.000	0.006	119	2.4	7
	9/14/1984	388	314	1.9	0.08	0.00057	0.851	0.649	1.400	0.027	103	1.6	4
	5/18/1984	580	261	1.7	0.08	0.00074	0.929	0.661	2.364	0.079	100	1.5	4
	6/22/1982	880	552	2.5	0.08	0.0012	0.940	0.640	4.571	0.039	109	2.1	7.5
	10/5/1983	200	260	1.8	0.08	0.00044	0.955	0.614	3.143	0.134	101	1.5	1.5
	7/20/1983	1240	566	2.6	0.08	0.001	0.981	0.692	5.778	0.052	109	2	6
	6/22/1983	1500	660	2.7	0.08	0.0015	1.000	0.643	4.667	0.013	113	2.2	10
	9/13/1983	614	279	1.8	0.08	0.00064	1.000	0.605	1.714	0.500	101	1.5	5.5
	9/5/1985	410	391	2.3	0.08	0.0013	1.000	0.750	1.938	0.016	103	1.7	4.5
	7/6/1983	2040	830	3.1	0.08	0.0015	1.417	0.792	7.111	0.042	118	2.3	16.5
	5/25/1983	235	329	2	0.08	0.00068	1.500	0.911	4.286	0.016	102	1.6	6.75
	5/31/1983	1080	524	2.3	0.08	0.001	1.571	0.925	5.818	0.052	108	2.1	7
	6/9/1983	443	388	2	0.08	0.001	1.571	0.841	6.286	0.012	108	1.8	6.5
	9/1/1982	506	490	2.3	0.08	0.00092	1.625	0.891	4.364	0.042	108	1.9	6
	6/16/1982	428	411	2.2	0.08	0.00068	1.833	0.914	4.727	0.035	105	1.8	4.5
	9/17/1985	544	515	2.5	0.08	0.0013	1.833	0.815	9.231	0.068	104	2	3
	6/2/1983	73	498	2.4	0.08	0.0012	1.917	0.895	7.714	0.031	103	2	7.5
	7/7/1982	1000	586	2.5	0.08	0.0012	2.222	0.852	6.154	0.008	109	2.1	9
	6/11/1984	571	456	2.2	0.08	0.001	2.571	0.879	7.636	0.015	105	2	8.5
	6/9/1982	760	479	2.4	0.08	0.0013	2.857	0.935	7.385	0.039	106	1.9	6.5
	8/17/1982	1180	620	2.6	0.08	0.0012	3.000	0.926	7.667	0.009	110	2.2	5
	8/3/1982	803	660	2.5	0.08	0.0014	3.143	0.932	9.846	0.013	115	2.3	8
	5/31/1985	594	510	2.3	0.08	0.0013	3.455	1.000	6.667	0.053	104	2.1	2
	6/4/1982	424	326	2	0.08	0.0008	3.579	2.000	6.200	0.024	105	1.7	6
	8/17/1984	931	575	2.6	0.08	0.0012	5.200	0.957	12.000	0.014	108	2	6
	7/20/1982	1140	654	2.7	0.08	0.0012	5.667	1.000	14.400	0.006	112	2.1	9
	7/24/1985	985	697	2.8	0.08	0.0013	5.778	1.500	13.000	0.007	105	2.3	6.5
	8/2/1983	1770	634	2.5	0.08	0.0013	6.000	0.833	16.000	0.015	113	2.2	6.5
	8/28/1984	556	513	2.4	0.08	0.00083	6.333	1.500	12.444	0.043	106	2	4
	9/8/1982	1680	827	2.8	0.08	0.0012	6.500	0.964	16.889	0.007	119	2.5	5
	8/31/1983	1500	765	2.8	0.08	0.0012	6.769	1.833	13.867	0.029	118	2.3	6.5
	7/27/1982	1110	903	3.1	0.08	0.0014	6.909	2.000	17.524	0.029	123	2.5	6
	7/11/1984	1010	572	2.5	0.08	0.00098	6.909	1.000	14.000	0.010	109	2.1	8
	7/31/1984	921	649	2.7	0.08	0.0012	7.000	3.143	13.500	0.018	113	2.2	6
	8/24/1982	830	515	2.4	0.08	0.001	7.467	3.500	13.778	0.013	109	1.9	5.5
	8/11/1982	766	603	2.5	0.08	0.001	7.600	2.000	15.000	0.015	110	2.2	6
	7/13/1982	1270	643	2.6	0.08	0.011	8.000	4.250	14.316	0.053	114	2.1	6.5
	6/27/1985	1240	643	2.6	0.08	0.0013	8.000	1.500	16.000	0.014	105	2.3	6.5
	6/14/1984	895	544	2.3	0.08	0.0011	9.412	3.143	16.615	0.035	108	2.2	6.5
	8/16/1985	192	1102	3.4	0.08	0.0013	10.133	4.333	19.368	0.027	120	2.7	7
	8/9/1983	4690	1350	3.6	0.08	0.0026	11.273	6.286	17.391	0.031	136	2.7	6

Table C.21. Data from Susitna River at Sunshine, AK

River Name	Date	Cm (mg/L)	Q (cms)	h (m)	dn (m)	Slope	d50 (mm)	d35 (mm)	d65 (mm)	d50ss (mm)	W (m)	Vmean (m/s)	Temp. (C)
Susitna River at Sunshine	8/3/1983	1030	1630	0.8	0.08	0.00183	0.436	0.379	0.492	0.013	275	2.1	10.5
	8/9/1982	813	1530	2.9	0.08	0.0019	0.447	0.382	0.579	0.013	290	1.8	10.5
	8/16/1982	726	1350	2.9	0.08	0.0016	0.453	0.390	0.591	0.006	262	1.8	10.5
	8/2/1982	704	1770	3.1	0.08	0.0022	0.455	0.388	0.692	0.056	305	1.9	11
	9/28/1984	88	504	2.1	0.08	0.00183	0.461	0.397	0.597	0.108	174	1.4	5
	8/23/1982	527	1090	2.6	0.08	0.0017	0.477	0.407	0.667	0.008	209	2	10
	7/12/1982	800	1690	2.9	0.08	0.0015	0.490	0.413	0.783	0.052	286	2	10
	9/3/1985	381	1310	2.4	0.08	0.00183	0.490	0.415	0.906	0.035	286	2	6.5
	5/16/1984	440	697	2.3	0.08	0.00183	0.559	0.438	0.779	0.093	181	1.7	5
	6/14/1982	360	1440	2.7	0.08	0.0014	0.583	0.433	2.000	0.172	295	1.8	7
	8/12/1985	1680	1920	3.1	0.08	0.00183	0.583	0.429	4.800	0.030	291	2.6	8.5
	6/25/1985	333	1580	2.8	0.08	0.00183	0.615	0.448	0.904	0.038	288	2	7
	8/30/1982	424	1130	2.7	0.08	0.0015	0.658	0.444	8.000	0.017	206	2	9
	10/4/1983	171	793	2.4	0.08	0.0014	0.692	0.468	0.981	0.175	186	1.8	2
	6/14/1984	990	1930	3	0.08	0.00183	0.692	0.439	8.000	0.067	287	2.3	7
	9/11/1984	168	660	2.3	0.08	0.00183	0.850	0.493	5.333	0.042	177	1.6	7
	7/19/1982	548	1720	3	0.08	0.0022	0.857	0.467	5.714	0.010	305	1.9	9.5
	8/14/1984	748	1300	2.7	0.08	0.00183	0.870	0.543	9.778	0.016	260	1.9	9.5
	5/24/1983	225	1110	2.8	0.08	0.0023	0.905	0.548	13.000	0.161	197	2	6.5
	7/13/1984	638	1480	2.5	0.08	0.00183	0.907	0.630	8.000	0.022	288	2	10.5
	6/21/1982	683	2220	3.7	0.08	0.0018	1.000	0.424	22.000	0.036	308	2	7
	9/12/1983	167	714	2.3	0.08	0.0012	2.667	0.654	9.067	0.141	181	1.7	7.5
	8/1/1983	950	1680	2.8	0.08	0.0018	3.000	0.654	11.333	0.018	275	2.2	13
	9/21/1984	284	838	2.5	0.08	0.00183	3.000	0.706	8.571	0.173	181	1.9	6
	7/6/1982	503	1320	2.7	0.08	0.0014	4.500	0.500	12.571	0.012	274	1.8	10
	9/16/1985	710	2140	3.4	0.08	0.00183	4.889	0.808	11.048	0.049	290	2.2	6.5
	6/23/1983	850	1920	3.1	0.08	0.0021	5.600	0.833	11.789	0.014	275	2.3	14
	7/28/1984	960	2200	3.3	0.08	0.00183	6.857	0.667	16.000	0.024	291	2.3	9
	5/31/1985	560	1890	3.2	0.08	0.00183	7.556	4.222	13.200	0.113	288	2	3.5
	8/8/1983	2840	2160	3.2	0.08	0.0021	8.000	1.333	20.174	0.030	291	2.3	10
	9/17/1982	1300	2450	4.1	0.08	0.002	12.522	7.273	20.444	0.012	305	2	6.5
	5/18/1983	396	1230	2.8	0.08	0.00183	13.818	1.800	24.727	0.081	194	2.2	5.5
	7/26/1982	1430	2740	4.4	0.08	0.0024	14.286	5.333	24.000	0.039	308	2.1	9.5
	6/1/1983	871	2130	3.2	0.08	0.0023	16.615	8.533	25.846	0.095	290	2.3	7.5
	6/28/1982	702	2140	3.4	0.08	0.00183	19.556	9.714	32.889	0.014	305	2.1	11
	6/3/1982	847	2090	3.1	0.08	0.00183	23.385	13.000	32.889	0.085	311	2.1	7.5
	6/10/1982	414	1830	3.1	0.08	0.0015	29.440	19.840	40.381	0.059	311	1.9	7.5

Table C.22. Data from Snake River near Anatone, WA

River Name	Date	Cm (mg/L)	Q (cms)	h (m)	dn (m)	Slope	d50 (mm)	d35 (mm)	d65 (mm)	d50ss (mm)	W (m)	Vmean (m/s)	Temp. (C)
Snake River near Anatone	6/7/1978	89	2290	4.9	0.08	0.00098	0.412	0.346	0.478	0.045	186	2.6	16
	5/15/1979	20	1180	3.9	0.08	0.00072	0.417	0.357	0.476	0.049	169	1.9	14
	5/24/1979	82	2000	4.7	0.08	0.0009	0.422	0.361	0.484	0.029	181	2.4	14
	6/13/1978	82	2040	4.7	0.08	0.00092	0.450	0.382	0.571	0.018	183	2.4	13.5
	6/5/1979	20	1590	4.4	0.08	0.00082	0.485	0.408	0.786	0.056	177	2.2	14.5
	5/2/1979	52	1400	4.2	0.08	0.00078	0.494	0.411	1.500	0.009	172	2.1	13
	6/2/1972	338	37770	5.8	0.08	0.00124	0.500	0.411	0.857	0.018	197	3.3	13
	4/7/1976	152	1750	4.5	0.08	0.00084	0.520	0.424	0.820	0.014	177	2.2	8
	5/5/1976	64	2600	5.4	0.08	0.00104	0.559	0.424	1.000	0.030	189	2.7	11
	6/7/1979	17	1390	4.1	0.08	0.00074	0.567	0.445	0.733	0.054	171	2	13.5
	5/27/1976	94	2890	5.3	0.08	0.00109	0.588	0.425	1.200	0.050	191	2.8	13
	5/17/1973	58	1440	4.2	0.08	0.00078	0.597	0.441	0.839	0.050	171	2.1	15
	6/11/1974	88	2600	5.5	0.08	0.00114	0.650	0.453	0.900	0.055	194	3	11.5
	5/22/1979	54	1720	4.4	0.08	0.00084	0.654	0.479	0.846	0.017	177	2.2	13
	5/25/1976	95	2890	5.3	0.08	0.00109	0.675	0.446	1.222	0.051	191	2.8	13
	5/13/1976	20	2360	5.5	0.08	0.00116	0.694	0.444	8.000	0.024	195	3	12
	6/10/1976	77	2680	5.2	0.08	0.00106	0.722	0.514	0.931	0.068	189	2.8	13.5
	6/20/1978	29	1900	4.5	0.08	0.00086	0.790	0.548	1.333	0.053	177	2.3	16.5
	5/14/1975	123	2660	5.2	0.08	0.00105	0.875	0.500	22.000	0.015	189	2.7	11.5
	6/8/1976	77	2740	5.2	0.08	0.00107	0.940	0.640	32.000	0.079	189	2.8	15
	5/16/1978	66	2170	4.8	0.08	0.00094	4.000	0.727	48.941	0.026	183	2.5	11
	4/15/1976	64	2690	5.2	0.08	0.00105	25.143	18.286	32.000	0.028	189	2.8	9
	4/13/1976	141	2790	5.2	0.08	0.00108	26.667	0.563	53.895	0.020	191	2.8	8
	4/4/1978	22	1780	5.3	0.08	0.000087	28.000	19.429	40.828	0.048	178	2.3	8.5
	4/19/1976	30	2320	4.9	0.08	0.00098	29.419	21.677	40.889	0.058	184	2.6	9
	5/3/1978	50	2290	4.9	0.08	0.00098	30.222	2.000	53.333	0.012	184	2.5	12
	5/17/1978	125	2120	4.8	0.08	0.00094	30.431	2.800	50.824	0.031	183	2.5	11
	4/5/1978	20	1640	4.3	0.08	0.00082	31.273	20.364	48.593	0.048	177	2.1	8.5
	4/21/1976	34	2380	5	0.08	0.00099	32.889	18.000	46.222	0.056	186	2.6	9
	5/2/1978	42	2170	4.8	0.08	0.00094	33.600	13.333	57.600	0.008	183	2.5	12
	4/29/1978	111	2270	4.9	0.08	0.00098	43.077	24.615	61.538	0.013	184	2.5	12

Table C.23. Data from Toutle River at Tower Road near Silver Lake, WA

River Name	Date	Cm (mg/L)	Q (cms)	h (m)	dn (m)	Slope	d50 (mm)	d35 (mm)	d65 (mm)	d50ss (mm)	W (m)	Vmean (m/s)	Temp. (C)
Toutle River at Tower Road near Silver Lake	1/17/1985	3000	38.2	1.2	0.08	0.0027	1.273	0.727	4.000	0.165	20	1.6	5
	1/31/1985	2080	29.2	1	0.08	0.0027	0.955	0.667	1.884	0.165	22.5	1.2	3
	2/21/1985	2430	46.7	0.94	0.08	0.0027	1.200	0.600	4.400	0.158	28.5	1.7	5.5
	3/23/1985	7140	90.9	0.77	0.08	0.0024	0.583	0.380	1.000	0.092	61	1.7	8.5
	4/11/1985	6860	92.6	0.76	0.08	0.0026	2.333	0.794	9.846	0.029	63	1.9	11
	6/7/1985	23000	253	1.5	0.08	0.0055	20.766	12.121	30.979	0.025	69	2.5	12
	6/8/1985	10400	160	1.1	0.08	0.0027	10.462	4.000	22.000	0.056	66	2.3	13
	11/6/1985	5720	158	1.1	0.08	0.0032	8.952	3.579	14.667	0.103	67	2.2	8.5
	11/8/1985	6290	151	1	0.08	0.0035	6.000	2.000	12.903	0.114	67	2.3	7
	12/9/1985	1980	85	0.78	0.08	0.0027	5.000	0.907	11.940	0.150	63	1.9	3.5
	1/3/1986	1240	57.2	0.64	0.08	0.0021	3.741	1.883	10.113	0.141	59	1.5	4.5
	1/19/1986	9780	235	1.6	0.08	0.0027	13.579	7.525	23.048	0.033	67	2.4	7.5
	1/29/1986	2570	64.6	0.73	0.08	0.0027	0.894	0.650	1.586	0.114	57	1.6	6.5
	2/11/1986	1480	43.6	1	0.08	0.002	1.992	1.623	3.600	0.112	24.5	1.7	4
	10/31/1986	5410	56.6	0.62	0.08	0.0021	4.286	2.250	8.941	0.085	62	1.5	12
	11/14/1986	2250	34.6	0.46	0.08	0.0013	1.914	1.520	3.741	0.183	53	1.4	9.5
	11/21/1986	7540	189	1.2	0.08	0.0027	15.904	10.120	29.296	0.117	66	2.3	9.5
	1/28/1987	4300	125	1.1	0.08	0.0019	7.200	1.958	14.689	0.220	64	1.9	7.5
	2/1/1987	23900	592	2.3	0.08	0.0027	14.000	3.750	30.857	0.073	70	3.1	8

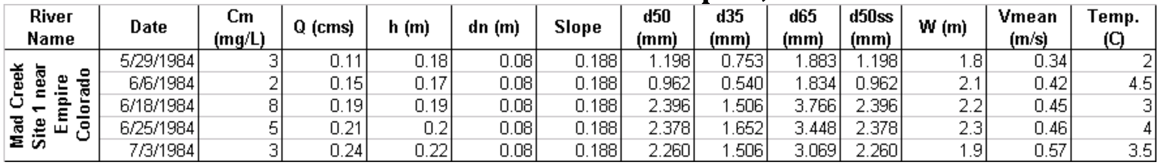
Table C.24. Data from North Fork Toutle River, WA

River Name	Date	Cm (mg/L)	Q (cms)	h (m)	dn (m)	Slope	d50 (mm)	d35 (mm)	d65 (mm)	d50ss (mm)	W (m)	Vmean (m/s)	Temp. (C)
North Fork Toutle River	2/2/1987	12400	132	0.98	0.08	0.0032	3.161	1.786	7.400	0.096	59	2.4	5
	2/13/1986	2980	26.1	0.74	0.08	0.0036	3.571	1.981	6.491	0.158	20.5	1.7	2
	2/26/1986	12500	127	0.85	0.08	0.0037	5.636	2.412	11.800	0.080	59	2.4	8.5
	6/8/1985	15200	113	0.9	0.08	0.0037	9.000	4.444	14.000	0.065	56	2.4	5
	6/7/1985	29100	171	1.1	0.08	0.0038	9.290	3.524	17.730	0.047	56	2.8	5

Table C.25. Data from Clearwater River, ID

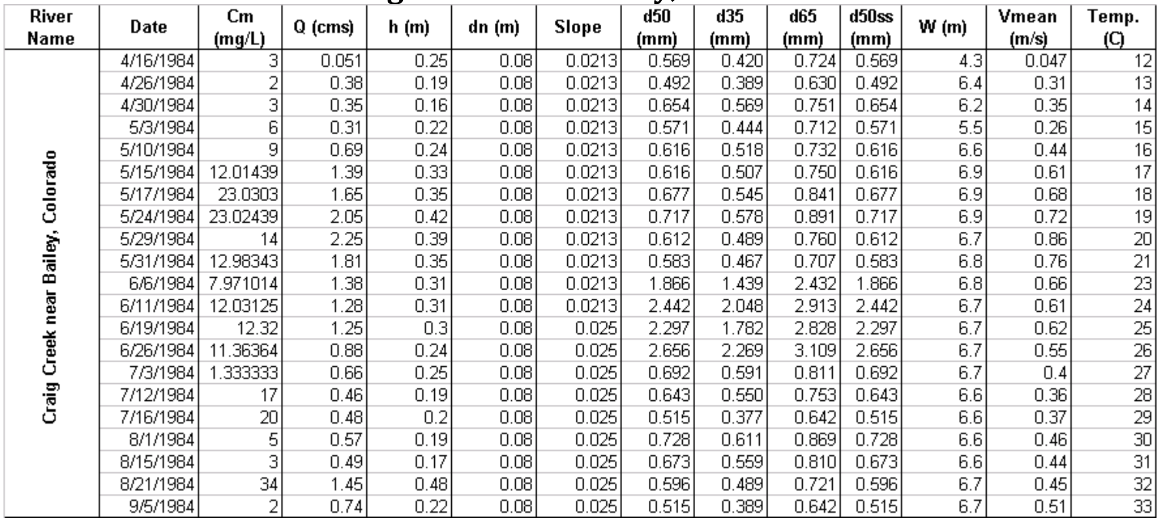
River Name	Date	Cm (mg/L)	Q (cms)	h (m)	dn (m)	Slope	d50 (mm)	d35 (mm)	d65 (mm)	d50ss (mm)	W (m)	Vmean (m/s)	Temp. (C)
Clearwater River	4/26/1977	29	677	4.1	0.08	0.000183	0.390	0.339	0.442	0.055	134	1.2	10
	5/8/1979	1070	1350	4.8	0.08	0.000325	0.391	0.332	0.449	0.005	140	2.1	7
	5/4/1977	11	680	4.1	0.08	0.000184	0.405	0.352	0.458	0.054	134	1.2	9.5
	6/6/1978	46	1560	4.9	0.08	0.00036	0.408	0.350	0.465	0.126	141	2.3	10
	4/6/1976	96	1040	4.4	0.08	0.000245	0.423	0.363	0.484	0.010	137	1.6	6
	5/1/1979	55	875	4.3	0.08	0.000225	0.425	0.363	0.488	0.061	136	1.5	12
	5/15/1978	19	1060	4.5	0.08	0.000262	0.428	0.364	0.492	0.060	138	1.7	8.5
	5/3/1979	34	884	4.3	0.08	0.000225	0.432	0.369	0.496	0.096	136	1.5	10.5
	5/12/1976	81	1950	5.1	0.08	0.000405	0.441	0.362	0.682	0.113	143	2.5	10
	6/8/1978	23	1570	4.8	0.08	0.000346	0.445	0.377	0.560	0.103	141	2.2	9.5
	4/8/1976	63	1200	4.6	0.08	0.00028	0.455	0.386	0.566	0.014	139	1.8	5.5
	6/5/1978	35	1410	4.8	0.08	0.00033	0.462	0.389	0.600	0.099	140	2.1	10
	6/10/1975	42	1670	5	0.08	0.000379	0.466	0.394	0.598	0.137	141	2.4	11
	6/17/1975	22	1550	4.9	0.08	0.000402	0.474	0.396	0.622	0.139	143	2.3	10.5
	5/16/1973	55	827	4.2	0.08	0.000195	0.475	0.402	0.614	0.058	133	1.3	13.5
	5/17/1978	19	1070	4.5	0.08	0.000266	0.484	0.406	0.658	0.054	138	1.7	6.5
	5/16/1979	41	1310	4.7	0.08	0.000302	0.484	0.406	0.633	0.065	140	2	10
	6/12/1978	11	1060	4.5	0.08	0.000262	0.485	0.410	0.630	0.141	138	1.7	10.5
	4/28/1978	67	841	4.3	0.08	0.000218	0.494	0.409	0.646	0.005	135	1.4	8.5
	4/14/1976	21	1330	4.8	0.08	0.000318	0.495	0.413	0.780	0.052	140	2	8.5
	5/11/1979	30	884	4.3	0.08	0.000227	0.510	0.422	0.660	0.055	136	1.5	8
	6/19/1978	5	918	4.4	0.08	0.000235	0.575	0.455	0.717	0.058	136	1.6	14.5
	5/14/1979	32	1050	4.5	0.08	0.000252	0.578	0.461	0.707	0.115	137	1.7	11
	5/21/1979	21	1340	4.7	0.08	0.000315	0.593	0.456	0.767	0.108	140	2	11
	6/18/1979	4	753	4.2	0.08	0.0002	0.617	0.500	0.734	0.054	128	1.3	10
	6/4/1979	27	1150	4.5	0.08	0.000271	0.623	0.508	0.738	0.291	139	1.8	12
	6/14/1978	14	1130	4.6	0.08	0.000275	0.667	0.542	0.792	0.236	139	1.8	11
	6/6/1979	11	1100	4.5	0.08	0.00027	0.676	0.574	0.777	0.185	139	1.8	10
	5/26/1976	42	1660	4.9	0.08	0.000367	0.696	0.461	4.000	0.134	142	2.3	11
	5/6/1976	53	1520	4.9	0.08	0.000353	0.717	0.463	20.000	0.072	142	2.3	6.5
	5/24/1976	53	1680	4.9	0.08	0.00036	0.719	0.447	6.626	0.162	142	2.3	11
	5/23/1979	60	1560	4.9	0.08	0.000359	0.862	0.603	2.500	0.157	141	2.3	10
	5/11/1976	185	2270	5.3	0.08	0.00049	0.917	0.454	41.481	0.066	145	3	10
	6/11/1976	36	1530	4.9	0.08	0.000354	0.959	0.757	32.000	0.192	142	2.3	12
	6/1/1972	209	2740	5.5	0.08	0.00056	27.636	9.000	40.170	0.043	146	3.4	10

Table C.26. Data from Mad Creek Site 1 near Empire, CO



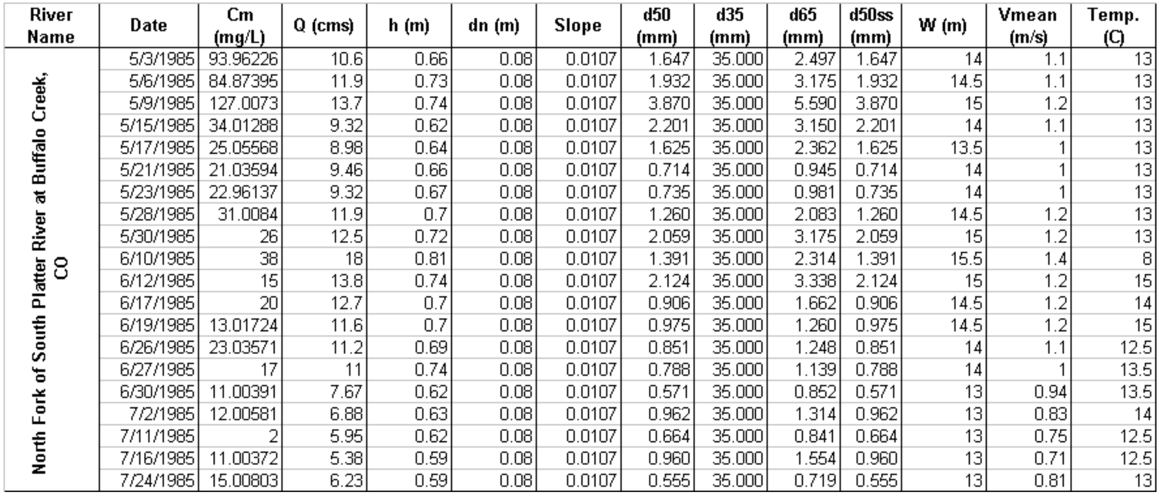
River Name	Date	Cm (mg/L)	Q (cms)	h (m)	dn (m)	Slope	d50 (mm)	d35 (mm)	d65 (mm)	d50ss (mm)	W (m)	Vmean (m/s)	Temp. (C)
Mad Creek Site 1 near Empire Colorado	5/29/1984	3	0.11	0.18	0.08	0.188	1.198	0.753	1.883	1.198	1.8	0.34	2
	6/6/1984	2	0.15	0.17	0.08	0.188	0.962	0.540	1.834	0.962	2.1	0.42	4.5
	6/18/1984	8	0.19	0.19	0.08	0.188	2.396	1.506	3.766	2.396	2.2	0.45	3
	6/25/1984	5	0.21	0.2	0.08	0.188	2.378	1.652	3.448	2.378	2.3	0.46	4
	7/3/1984	3	0.24	0.22	0.08	0.188	2.260	1.506	3.069	2.260	1.9	0.57	3.5

Table C.27. Data from Craig Creek near Bailey, CO



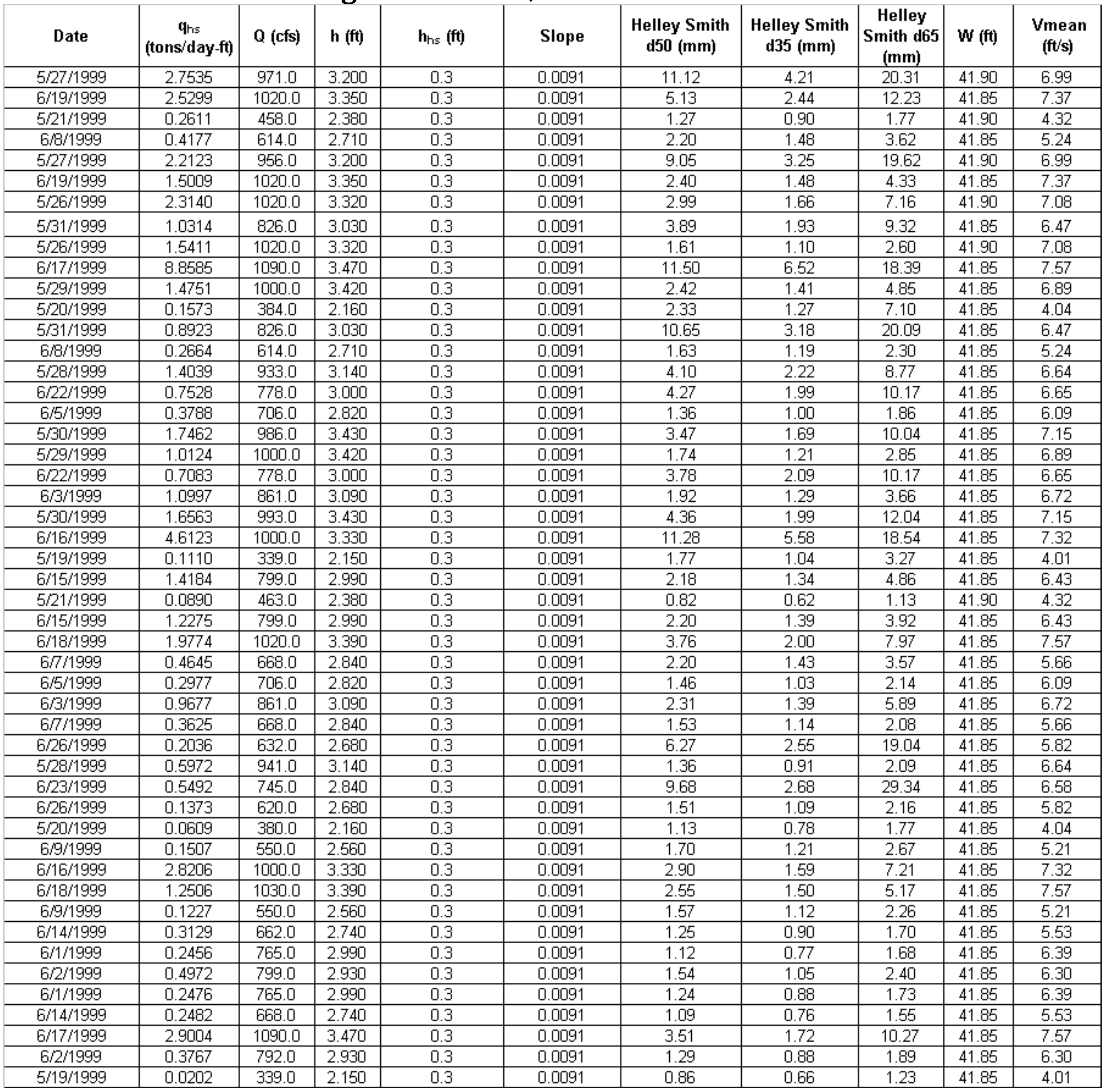
River Name	Date	Cm (mg/L)	Q (cms)	h (m)	dn (m)	Slope	d50 (mm)	d35 (mm)	d65 (mm)	d50ss (mm)	W (m)	Vmean (m/s)	Temp. (C)
Craig Creek near Bailey, Colorado	4/16/1984	3	0.051	0.25	0.08	0.0213	0.569	0.420	0.724	0.569	4.3	0.047	12
	4/26/1984	2	0.38	0.19	0.08	0.0213	0.492	0.389	0.630	0.492	6.4	0.31	13
	4/30/1984	3	0.35	0.16	0.08	0.0213	0.654	0.569	0.751	0.654	6.2	0.35	14
	5/3/1984	6	0.31	0.22	0.08	0.0213	0.571	0.444	0.712	0.571	5.5	0.26	15
	5/10/1984	9	0.69	0.24	0.08	0.0213	0.616	0.518	0.732	0.616	6.6	0.44	16
	5/15/1984	12.01439	1.39	0.33	0.08	0.0213	0.616	0.507	0.750	0.616	6.9	0.61	17
	5/17/1984	23.0303	1.65	0.35	0.08	0.0213	0.677	0.545	0.841	0.677	6.9	0.68	18
	5/24/1984	23.02439	2.05	0.42	0.08	0.0213	0.717	0.578	0.891	0.717	6.9	0.72	19
	5/29/1984	14	2.25	0.39	0.08	0.0213	0.612	0.489	0.760	0.612	6.7	0.86	20
	5/31/1984	12.98343	1.81	0.35	0.08	0.0213	0.583	0.467	0.707	0.583	6.8	0.76	21
	6/6/1984	7.971014	1.38	0.31	0.08	0.0213	1.866	1.439	2.432	1.866	6.8	0.66	23
	6/11/1984	12.03125	1.28	0.31	0.08	0.0213	2.442	2.048	2.913	2.442	6.7	0.61	24
	6/19/1984	12.32	1.25	0.3	0.08	0.025	2.297	1.782	2.828	2.297	6.7	0.62	25
	6/26/1984	11.36364	0.88	0.24	0.08	0.025	2.656	2.269	3.109	2.656	6.7	0.55	26
	7/3/1984	1.333333	0.66	0.25	0.08	0.025	0.692	0.591	0.811	0.692	6.7	0.4	27
	7/12/1984	17	0.46	0.19	0.08	0.025	0.643	0.550	0.753	0.643	6.6	0.36	28
	7/16/1984	20	0.48	0.2	0.08	0.025	0.515	0.377	0.642	0.515	6.6	0.37	29
	8/1/1984	5	0.57	0.19	0.08	0.025	0.728	0.611	0.869	0.728	6.6	0.46	30
	8/15/1984	3	0.49	0.17	0.08	0.025	0.673	0.559	0.810	0.673	6.6	0.44	31
	8/21/1984	34	1.45	0.48	0.08	0.025	0.596	0.489	0.721	0.596	6.7	0.45	32
	9/5/1984	2	0.74	0.22	0.08	0.025	0.515	0.389	0.642	0.515	6.7	0.51	33

Table C.28. Data from North Fork South Platte River at Buffalo Creek, CO



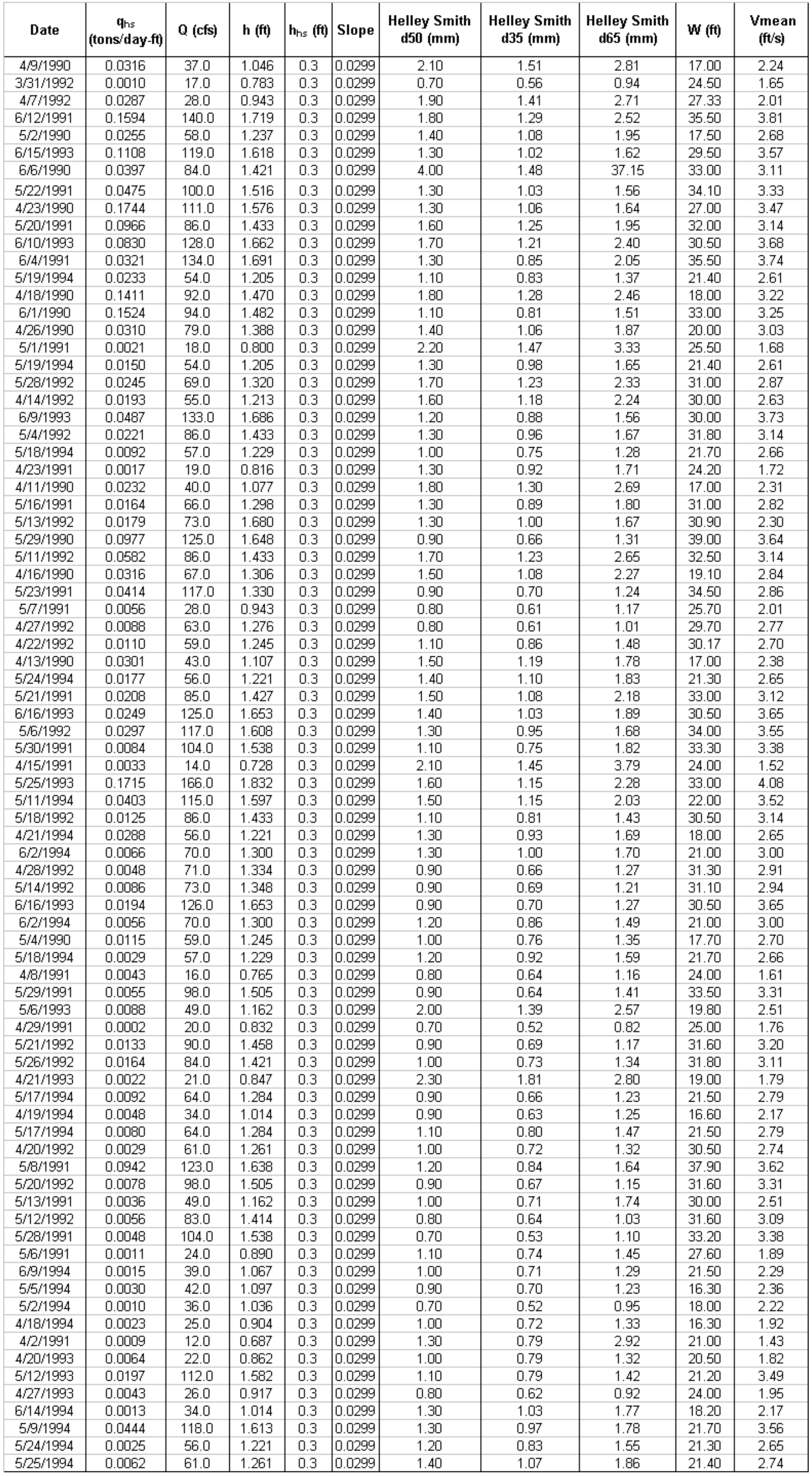
River Name	Date	Cm (mg/L)	Q (cms)	h (m)	dn (m)	Slope	d50 (mm)	d35 (mm)	d65 (mm)	d50ss (mm)	W (m)	Vmean (m/s)	Temp. (C)
North Fork of South Platter River at Buffalo Creek, CO	5/3/1985	93.96226	10.6	0.66	0.08	0.0107	1.647	35.000	2.497	1.647	14	1.1	13
	5/6/1985	84.87395	11.9	0.73	0.08	0.0107	1.932	35.000	3.175	1.932	14.5	1.1	13
	5/9/1985	127.0073	13.7	0.74	0.08	0.0107	3.870	35.000	5.590	3.870	15	1.2	13
	5/15/1985	34.01288	9.32	0.62	0.08	0.0107	2.201	35.000	3.150	2.201	14	1.1	13
	5/17/1985	25.05568	8.98	0.64	0.08	0.0107	1.625	35.000	2.362	1.625	13.5	1	13
	5/21/1985	21.03594	9.46	0.66	0.08	0.0107	0.714	35.000	0.945	0.714	14	1	13
	5/23/1985	22.96137	9.32	0.67	0.08	0.0107	0.735	35.000	0.981	0.735	14	1	13
	5/28/1985	31.0084	11.9	0.7	0.08	0.0107	1.260	35.000	2.083	1.260	14.5	1.2	13
	5/30/1985	26	12.5	0.72	0.08	0.0107	2.059	35.000	3.175	2.059	15	1.2	13
	6/10/1985	38	18	0.81	0.08	0.0107	1.391	35.000	2.314	1.391	15.5	1.4	8
	6/12/1985	15	13.8	0.74	0.08	0.0107	2.124	35.000	3.338	2.124	15	1.2	15
	6/17/1985	20	12.7	0.7	0.08	0.0107	0.906	35.000	1.662	0.906	14.5	1.2	14
	6/19/1985	13.01724	11.6	0.7	0.08	0.0107	0.975	35.000	1.260	0.975	14.5	1.2	15
	6/26/1985	23.03571	11.2	0.69	0.08	0.0107	0.851	35.000	1.248	0.851	14	1.1	12.5
	6/27/1985	17	11	0.74	0.08	0.0107	0.788	35.000	1.139	0.788	14	1	13.5
	6/30/1985	11.00391	7.67	0.62	0.08	0.0107	0.571	35.000	0.852	0.571	13	0.94	13.5
	7/2/1985	12.00581	6.88	0.63	0.08	0.0107	0.962	35.000	1.314	0.962	13	0.83	14
	7/11/1985	2	5.95	0.62	0.08	0.0107	0.664	35.000	0.841	0.664	13	0.75	12.5
	7/16/1985	11.00372	5.38	0.59	0.08	0.0107	0.960	35.000	1.554	0.960	13	0.71	12.5
	7/24/1985	15.00803	6.23	0.59	0.08	0.0107	0.555	35.000	0.719	0.555	13	0.81	13

Table C.29. Data from Big Wood River, ID



Date	q_{hs} (tons/day-ft)	Q (cfs)	h (ft)	h_{hs} (ft)	Slope	Helley Smith d50 (mm)	Helley Smith d35 (mm)	Helley Smith d65 (mm)	W (ft)	Vmean (ft/s)
5/27/1999	2.7535	971.0	3.200	0.3	0.0091	11.12	4.21	20.31	41.90	6.99
6/19/1999	2.5299	1020.0	3.350	0.3	0.0091	5.13	2.44	12.23	41.85	7.37
5/21/1999	0.2611	458.0	2.380	0.3	0.0091	1.27	0.90	1.77	41.90	4.32
6/8/1999	0.4177	614.0	2.710	0.3	0.0091	2.20	1.48	3.62	41.85	5.24
5/27/1999	2.2123	956.0	3.200	0.3	0.0091	9.05	3.25	19.62	41.90	6.99
6/19/1999	1.5009	1020.0	3.350	0.3	0.0091	2.40	1.48	4.33	41.85	7.37
5/26/1999	2.3140	1020.0	3.320	0.3	0.0091	2.99	1.66	7.16	41.90	7.08
5/31/1999	1.0314	826.0	3.030	0.3	0.0091	3.89	1.93	9.32	41.85	6.47
5/26/1999	1.5411	1020.0	3.320	0.3	0.0091	1.61	1.10	2.60	41.90	7.08
6/17/1999	8.8585	1090.0	3.470	0.3	0.0091	11.50	6.52	18.39	41.85	7.57
5/29/1999	1.4751	1000.0	3.420	0.3	0.0091	2.42	1.41	4.85	41.85	6.89
5/20/1999	0.1573	384.0	2.160	0.3	0.0091	2.33	1.27	7.10	41.85	4.04
5/31/1999	0.8923	826.0	3.030	0.3	0.0091	10.65	3.18	20.09	41.85	6.47
6/8/1999	0.2664	614.0	2.710	0.3	0.0091	1.63	1.19	2.30	41.85	5.24
5/28/1999	1.4039	933.0	3.140	0.3	0.0091	4.10	2.22	8.77	41.85	6.64
6/22/1999	0.7528	778.0	3.000	0.3	0.0091	4.27	1.99	10.17	41.85	6.65
6/5/1999	0.3788	706.0	2.820	0.3	0.0091	1.36	1.00	1.86	41.85	6.09
5/30/1999	1.7462	986.0	3.430	0.3	0.0091	3.47	1.69	10.04	41.85	7.15
5/29/1999	1.0124	1000.0	3.420	0.3	0.0091	1.74	1.21	2.85	41.85	6.89
6/22/1999	0.7083	778.0	3.000	0.3	0.0091	3.78	2.09	10.17	41.85	6.65
6/3/1999	1.0997	861.0	3.090	0.3	0.0091	1.92	1.29	3.66	41.85	6.72
5/30/1999	1.6563	993.0	3.430	0.3	0.0091	4.36	1.99	12.04	41.85	7.15
6/16/1999	4.6123	1000.0	3.330	0.3	0.0091	11.28	5.58	18.54	41.85	7.32
5/19/1999	0.1110	339.0	2.150	0.3	0.0091	1.77	1.04	3.27	41.85	4.01
6/15/1999	1.4184	799.0	2.990	0.3	0.0091	2.18	1.34	4.86	41.85	6.43
5/21/1999	0.0890	463.0	2.380	0.3	0.0091	0.82	0.62	1.13	41.90	4.32
6/15/1999	1.2275	799.0	2.990	0.3	0.0091	2.20	1.39	3.92	41.85	6.43
6/18/1999	1.9774	1020.0	3.390	0.3	0.0091	3.76	2.00	7.97	41.85	7.57
6/7/1999	0.4645	668.0	2.840	0.3	0.0091	2.20	1.43	3.57	41.85	5.66
6/5/1999	0.2977	706.0	2.820	0.3	0.0091	1.46	1.03	2.14	41.85	6.09
6/3/1999	0.9677	861.0	3.090	0.3	0.0091	2.31	1.39	5.89	41.85	6.72
6/7/1999	0.3625	668.0	2.840	0.3	0.0091	1.53	1.14	2.08	41.85	5.66
6/26/1999	0.2036	632.0	2.680	0.3	0.0091	6.27	2.55	19.04	41.85	5.82
5/28/1999	0.5972	941.0	3.140	0.3	0.0091	1.36	0.91	2.09	41.85	6.64
6/23/1999	0.5492	745.0	2.840	0.3	0.0091	9.68	2.68	29.34	41.85	6.58
6/26/1999	0.1373	620.0	2.680	0.3	0.0091	1.51	1.09	2.16	41.85	5.82
5/20/1999	0.0609	380.0	2.160	0.3	0.0091	1.13	0.78	1.77	41.85	4.04
6/9/1999	0.1507	550.0	2.560	0.3	0.0091	1.70	1.21	2.67	41.85	5.21
6/16/1999	2.8206	1000.0	3.330	0.3	0.0091	2.90	1.59	7.21	41.85	7.32
6/18/1999	1.2506	1030.0	3.390	0.3	0.0091	2.55	1.50	5.17	41.85	7.57
6/9/1999	0.1227	550.0	2.560	0.3	0.0091	1.57	1.12	2.26	41.85	5.21
6/14/1999	0.3129	662.0	2.740	0.3	0.0091	1.25	0.90	1.70	41.85	5.53
6/1/1999	0.2456	765.0	2.990	0.3	0.0091	1.12	0.77	1.68	41.85	6.39
6/2/1999	0.4972	799.0	2.930	0.3	0.0091	1.54	1.05	2.40	41.85	6.30
6/1/1999	0.2476	765.0	2.990	0.3	0.0091	1.24	0.88	1.73	41.85	6.39
6/14/1999	0.2482	668.0	2.740	0.3	0.0091	1.09	0.76	1.55	41.85	5.53
6/17/1999	2.9004	1090.0	3.470	0.3	0.0091	3.51	1.72	10.27	41.85	7.57
6/2/1999	0.3767	792.0	2.930	0.3	0.0091	1.29	0.88	1.89	41.85	6.30
5/19/1999	0.0202	339.0	2.150	0.3	0.0091	0.86	0.66	1.23	41.85	4.01

Table C.30. Data from Blackmare Creek, ID



Date	q_{hs} (tons/day-ft)	Q (cfs)	h (ft)	h_{hs} (ft)	Slope	Helley Smith d50 (mm)	Helley Smith d35 (mm)	Helley Smith d65 (mm)	W (ft)	Vmean (ft/s)
4/9/1990	0.0316	37.0	1.046	0.3	0.0299	2.10	1.51	2.81	17.00	2.24
3/31/1992	0.0010	17.0	0.783	0.3	0.0299	0.70	0.56	0.94	24.50	1.65
4/7/1992	0.0287	28.0	0.943	0.3	0.0299	1.90	1.41	2.71	27.33	2.01
6/12/1991	0.1594	140.0	1.719	0.3	0.0299	1.80	1.29	2.52	35.50	3.81
5/2/1990	0.0255	58.0	1.237	0.3	0.0299	1.40	1.08	1.95	17.50	2.68
6/15/1993	0.1108	119.0	1.618	0.3	0.0299	1.30	1.02	1.62	29.50	3.57
6/6/1990	0.0397	84.0	1.421	0.3	0.0299	4.00	1.48	37.15	33.00	3.11
5/22/1991	0.0475	100.0	1.516	0.3	0.0299	1.30	1.03	1.56	34.10	3.33
4/23/1990	0.1744	111.0	1.576	0.3	0.0299	1.30	1.06	1.64	27.00	3.47
5/20/1991	0.0966	86.0	1.433	0.3	0.0299	1.60	1.25	1.95	32.00	3.14
6/10/1993	0.0830	128.0	1.662	0.3	0.0299	1.70	1.21	2.40	30.50	3.68
6/4/1991	0.0321	134.0	1.691	0.3	0.0299	1.30	0.85	2.05	35.50	3.74
5/19/1994	0.0233	54.0	1.205	0.3	0.0299	1.10	0.83	1.37	21.40	2.61
4/18/1990	0.1411	92.0	1.470	0.3	0.0299	1.80	1.28	2.46	18.00	3.22
6/1/1990	0.1524	94.0	1.482	0.3	0.0299	1.10	0.81	1.51	33.00	3.25
4/26/1990	0.0310	79.0	1.388	0.3	0.0299	1.40	1.06	1.87	20.00	3.03
5/1/1991	0.0021	18.0	0.800	0.3	0.0299	2.20	1.47	3.33	25.50	1.68
5/19/1994	0.0150	54.0	1.205	0.3	0.0299	1.30	0.98	1.65	21.40	2.61
5/28/1992	0.0245	69.0	1.320	0.3	0.0299	1.70	1.23	2.33	31.00	2.87
4/14/1992	0.0193	55.0	1.213	0.3	0.0299	1.60	1.18	2.24	30.00	2.63
6/9/1993	0.0487	133.0	1.686	0.3	0.0299	1.20	0.88	1.56	30.00	3.73
5/4/1992	0.0221	86.0	1.433	0.3	0.0299	1.30	0.96	1.67	31.80	3.14
5/18/1994	0.0092	57.0	1.229	0.3	0.0299	1.00	0.75	1.28	21.70	2.66
4/23/1991	0.0017	19.0	0.816	0.3	0.0299	1.30	0.92	1.71	24.20	1.72
4/11/1990	0.0232	40.0	1.077	0.3	0.0299	1.80	1.30	2.69	17.00	2.31
5/16/1991	0.0164	66.0	1.298	0.3	0.0299	1.30	0.89	1.80	31.00	2.82
5/13/1992	0.0179	73.0	1.680	0.3	0.0299	1.30	1.00	1.67	30.90	2.30
5/29/1990	0.0977	125.0	1.648	0.3	0.0299	0.90	0.66	1.31	39.00	3.64
5/11/1992	0.0582	86.0	1.433	0.3	0.0299	1.70	1.23	2.65	32.50	3.14
4/16/1990	0.0316	67.0	1.306	0.3	0.0299	1.50	1.08	2.27	19.10	2.84
5/23/1991	0.0414	117.0	1.330	0.3	0.0299	0.90	0.70	1.24	34.50	2.86
5/7/1991	0.0056	28.0	0.943	0.3	0.0299	0.80	0.61	1.17	25.70	2.01
4/27/1992	0.0088	63.0	1.276	0.3	0.0299	0.80	0.61	1.01	29.70	2.77
4/22/1992	0.0110	59.0	1.245	0.3	0.0299	1.10	0.86	1.48	30.17	2.70
4/13/1990	0.0301	43.0	1.107	0.3	0.0299	1.50	1.19	1.78	17.00	2.38
5/24/1994	0.0177	56.0	1.221	0.3	0.0299	1.40	1.10	1.83	21.30	2.65
5/21/1991	0.0208	85.0	1.427	0.3	0.0299	1.50	1.08	2.18	33.00	3.12
6/16/1993	0.0249	125.0	1.653	0.3	0.0299	1.40	1.03	1.89	30.50	3.65
5/6/1992	0.0297	117.0	1.608	0.3	0.0299	1.30	0.95	1.68	34.00	3.55
5/30/1991	0.0084	104.0	1.538	0.3	0.0299	1.10	0.75	1.82	33.30	3.38
4/15/1991	0.0033	14.0	0.728	0.3	0.0299	2.10	1.45	3.79	24.00	1.52
5/25/1993	0.1715	166.0	1.832	0.3	0.0299	1.60	1.15	2.28	33.00	4.08
5/11/1994	0.0403	115.0	1.597	0.3	0.0299	1.50	1.15	2.03	22.00	3.52
5/18/1992	0.0125	86.0	1.433	0.3	0.0299	1.10	0.81	1.43	30.50	3.14
4/21/1994	0.0288	56.0	1.221	0.3	0.0299	1.30	0.93	1.69	18.00	2.65
6/2/1994	0.0066	70.0	1.300	0.3	0.0299	1.30	1.00	1.70	21.00	3.00
4/28/1992	0.0048	71.0	1.334	0.3	0.0299	0.90	0.66	1.27	31.30	2.91
5/14/1992	0.0086	73.0	1.348	0.3	0.0299	0.90	0.69	1.21	31.10	2.94
6/16/1993	0.0194	126.0	1.653	0.3	0.0299	0.90	0.70	1.27	30.50	3.65
6/2/1994	0.0056	70.0	1.300	0.3	0.0299	1.20	0.86	1.49	21.00	3.00
5/4/1990	0.0115	59.0	1.245	0.3	0.0299	1.00	0.76	1.35	17.70	2.70
5/18/1994	0.0029	57.0	1.229	0.3	0.0299	1.20	0.92	1.59	21.70	2.66
4/8/1991	0.0043	16.0	0.765	0.3	0.0299	0.80	0.64	1.16	24.00	1.61
5/29/1991	0.0055	98.0	1.505	0.3	0.0299	0.90	0.64	1.41	33.50	3.31
5/6/1993	0.0088	49.0	1.162	0.3	0.0299	2.00	1.39	2.57	19.80	2.51
4/29/1991	0.0002	20.0	0.832	0.3	0.0299	0.70	0.52	0.82	25.00	1.76
5/21/1992	0.0133	90.0	1.458	0.3	0.0299	0.90	0.69	1.17	31.60	3.20
5/26/1992	0.0164	84.0	1.421	0.3	0.0299	1.00	0.73	1.34	31.80	3.11
4/21/1993	0.0022	21.0	0.847	0.3	0.0299	2.30	1.81	2.80	19.00	1.79
5/17/1994	0.0092	64.0	1.284	0.3	0.0299	0.90	0.66	1.23	21.50	2.79
4/19/1994	0.0048	34.0	1.014	0.3	0.0299	0.90	0.63	1.25	16.60	2.17
5/17/1994	0.0080	64.0	1.284	0.3	0.0299	1.10	0.80	1.47	21.50	2.79
4/20/1992	0.0029	61.0	1.261	0.3	0.0299	1.00	0.72	1.32	30.50	2.74
5/8/1991	0.0942	123.0	1.638	0.3	0.0299	1.20	0.84	1.64	37.90	3.62
5/20/1992	0.0078	98.0	1.505	0.3	0.0299	0.90	0.67	1.15	31.60	3.31
5/13/1991	0.0036	49.0	1.162	0.3	0.0299	1.00	0.71	1.74	30.00	2.51
5/12/1992	0.0056	83.0	1.414	0.3	0.0299	0.80	0.64	1.03	31.60	3.09
5/28/1991	0.0048	104.0	1.538	0.3	0.0299	0.70	0.53	1.10	33.20	3.38
5/6/1991	0.0011	24.0	0.890	0.3	0.0299	1.10	0.74	1.45	27.60	1.89
6/9/1994	0.0015	39.0	1.067	0.3	0.0299	1.00	0.71	1.29	21.50	2.29
5/5/1994	0.0030	42.0	1.097	0.3	0.0299	0.90	0.70	1.23	16.30	2.36
5/2/1994	0.0010	36.0	1.036	0.3	0.0299	0.70	0.52	0.95	18.00	2.22
4/18/1994	0.0023	25.0	0.904	0.3	0.0299	1.00	0.72	1.33	16.30	1.92
4/2/1991	0.0009	12.0	0.687	0.3	0.0299	1.30	0.79	2.92	21.00	1.43
4/20/1993	0.0064	22.0	0.862	0.3	0.0299	1.00	0.79	1.32	20.50	1.82
5/12/1993	0.0197	112.0	1.582	0.3	0.0299	1.10	0.79	1.42	21.20	3.49
4/27/1993	0.0043	26.0	0.917	0.3	0.0299	0.80	0.62	0.92	24.00	1.95
6/14/1994	0.0013	34.0	1.014	0.3	0.0299	1.30	1.03	1.77	18.20	2.17
5/9/1994	0.0444	118.0	1.613	0.3	0.0299	1.30	0.97	1.78	21.70	3.56
5/24/1994	0.0025	56.0	1.221	0.3	0.0299	1.20	0.83	1.55	21.30	2.65
5/25/1994	0.0062	61.0	1.261	0.3	0.0299	1.40	1.07	1.86	21.40	2.74

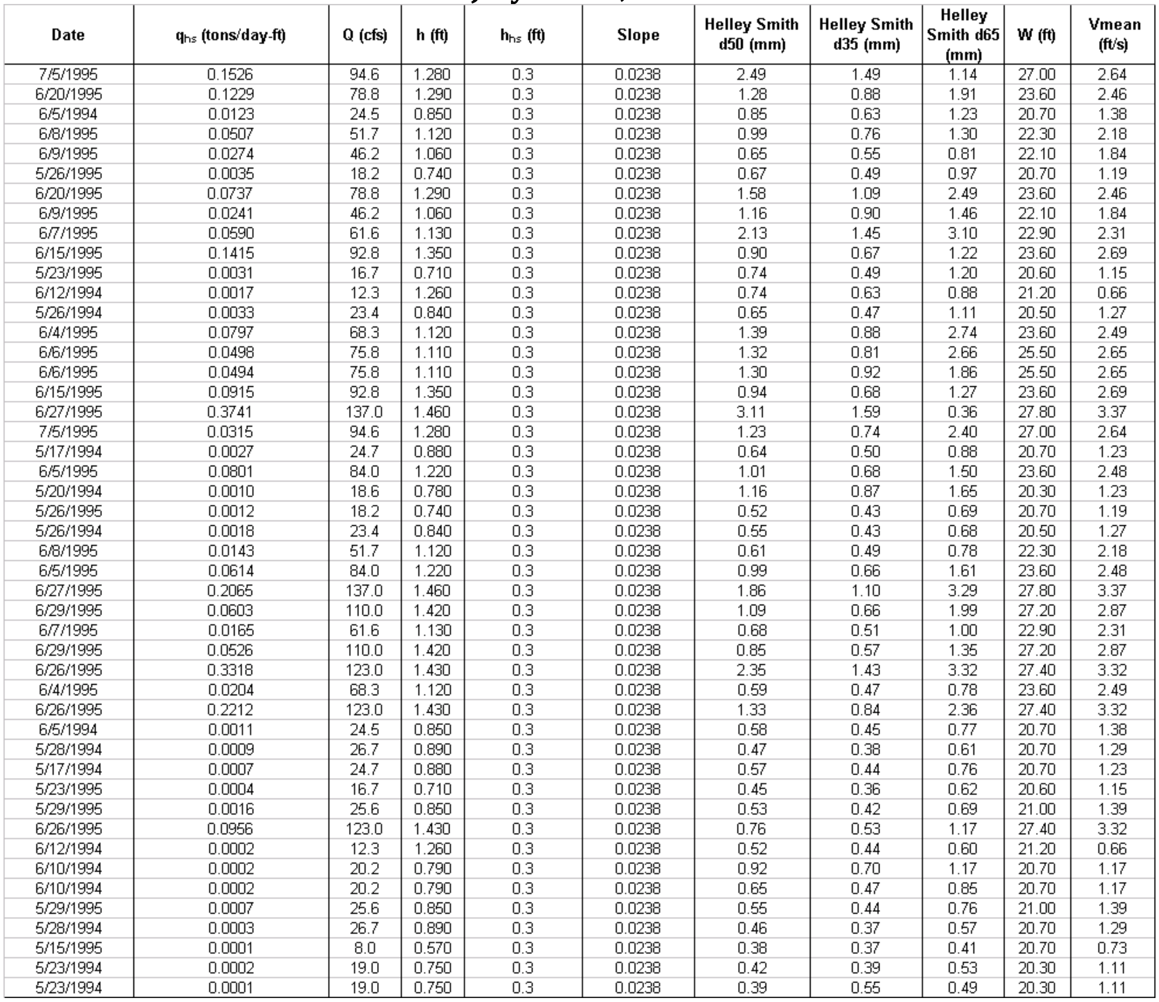
Table C.31. Data from Boise River near Twin Springs, ID

Date	q_{hs} (tons/day-ft)	Q (cfs)	h (ft)	h_{hs} (ft)	Slope	Helley Smith d50 (mm)	Helley Smith d35 (mm)	Helley Smith d65 (mm)	W (ft)	Vmean (ft/s)
5/19/1994	0.1199	1550.0	2.468	0.3	0.0038	0.64	0.51	0.80	171.00	4.08
5/5/1994	0.0668	1370.0	2.023	0.3	0.0038	0.78	0.60	1.00	170.57	0.39
4/26/1994	0.1798	1760.0	2.324	0.3	0.0038	0.68	0.52	0.88	174.59	0.43
5/31/1994	0.1372	1790.0	2.346	0.3	0.0038	0.99	0.74	1.26	174.87	0.43
6/7/1994	0.0672	1310.0	2.011	0.3	0.0038	1.14	0.88	1.40	174.00	3.71
5/1/1995	0.3542	2500.0	2.823	0.3	0.0038	1.46	1.16	1.84	180.38	0.49
5/14/1994	0.3413	2470.0	2.804	0.3	0.0038	0.66	0.54	0.80	180.18	0.49
5/5/1994	0.0350	1370.0	2.023	0.3	0.0038	1.13	0.85	1.37	170.57	0.39
5/16/1994	0.1376	1900.0	2.425	0.3	0.0038	0.71	0.57	0.89	175.84	0.44
5/14/1994	0.3263	2470.0	2.804	0.3	0.0038	0.65	0.52	0.80	180.18	0.49
4/26/1994	0.0945	1760.0	2.324	0.3	0.0038	0.65	0.51	0.84	174.59	0.43
6/16/1995	1.4152	4390.0	3.856	0.3	0.0038	1.03	0.75	1.38	190.08	0.60
5/2/1994	0.0390	1300.0	1.965	0.3	0.0038	0.70	0.57	0.88	169.74	0.39
5/25/1995	1.2211	4370.0	3.846	0.3	0.0038	1.08	0.80	1.40	190.00	0.59
5/31/1994	0.0795	1790.0	2.346	0.3	0.0038	0.69	0.52	0.92	174.87	0.43
6/22/1995	0.2770	2920.0	3.076	0.3	0.0038	0.72	0.56	0.92	183.01	0.52
5/1/1995	0.2145	2500.0	2.823	0.3	0.0038	0.91	0.71	1.18	180.38	0.49
5/9/1994	0.3384	2270.0	2.676	0.3	0.0038	0.67	0.54	1.00	178.77	0.47
6/22/1995	0.2585	2920.0	3.076	0.3	0.0038	0.75	0.59	0.95	183.01	0.52
4/25/1994	0.1527	1940.0	2.453	0.3	0.0038	0.61	0.50	0.74	176.18	0.45
5/16/1994	0.0967	1900.0	2.425	0.3	0.0038	0.64	0.53	0.78	175.84	0.44
6/13/1994	0.0182	1190.0	1.871	0.3	0.0038	0.66	0.54	0.96	168.35	0.38
5/15/1995	0.2935	3220.0	3.248	0.3	0.0038	0.81	0.63	1.06	184.68	0.53
6/9/1995	0.7231	3620.0	3.465	0.3	0.0038	0.85	0.61	1.20	186.70	0.56
4/25/1994	0.1169	1940.0	2.453	0.3	0.0038	0.57	0.57	0.75	176.18	0.45
5/26/1994	0.0488	1770.0	2.331	0.3	0.0038	0.78	0.59	1.04	174.68	0.43
5/19/1994	0.0217	1550.0	2.468	0.3	0.0038	0.67	0.50	0.90	171.00	4.08
5/23/1994	0.0294	1360.0	2.015	0.3	0.0038	0.67	0.54	0.82	170.45	0.39
5/15/1995	0.2458	3220.0	3.248	0.3	0.0038	0.78	0.63	0.96	184.68	0.53
5/4/1995	0.1644	2730.0	2.964	0.3	0.0038	0.77	0.63	0.95	181.87	0.50
6/29/1995	0.5991	4040.0	3.682	0.3	0.0038	0.79	0.63	1.00	188.62	0.58
6/26/1995	1.2768	4650.0	3.981	0.3	0.0038	0.71	0.56	0.90	191.10	0.61
5/25/1995	0.6895	4370.0	3.846	0.3	0.0038	0.77	0.61	0.98	190.00	0.59
6/2/1995	2.1460	5710.0	4.460	0.3	0.0038	0.82	0.65	1.06	194.78	0.65
5/8/1995	0.9942	3920.0	3.621	0.3	0.0038	0.95	0.73	1.24	188.09	0.57
5/4/1995	0.1534	2730.0	2.964	0.3	0.0038	0.76	0.63	0.92	181.87	0.50
6/29/1995	0.5355	4040.0	3.682	0.3	0.0038	0.71	0.57	0.89	188.62	0.58
6/26/1995	1.1355	4650.0	3.981	0.3	0.0038	0.65	0.51	0.82	191.10	0.61
5/29/1996	4.6532	5890.0	4.538	0.3	0.0038	0.61	0.47	0.78	195.35	0.66
5/30/1995	1.0006	4860.0	4.079	0.3	0.0038	0.73	0.56	0.94	191.89	0.62
5/17/1997	15.3140	10300.0	6.135	0.3	0.0038	0.90	0.72	1.33	207.00	7.95
5/22/1995	1.1000	5080.0	4.358	0.3	0.0038	0.82	0.65	1.08	190.00	6.27
6/16/1995	0.6629	4390.0	3.856	0.3	0.0038	0.70	0.57	0.86	190.08	0.60
6/10/1996	7.2330	8150.0	5.049	0.3	0.0038	17.58	0.88	40.71	206.00	7.18
5/30/1995	0.8964	4860.0	4.079	0.3	0.0038	0.89	0.66	1.21	191.89	0.62
6/19/1995	0.6667	4540.0	4.022	0.3	0.0038	0.65	0.53	0.81	186.00	6.07
5/18/1995	0.9141	4460.0	3.890	0.3	0.0038	0.76	0.59	0.97	190.36	0.60
5/26/1994	0.0358	1770.0	2.331	0.3	0.0038	0.74	0.56	0.97	174.68	0.43
6/2/1995	1.6480	5710.0	4.460	0.3	0.0038	0.76	0.61	0.95	194.78	0.65
6/7/1994	0.0168	1310.0	2.011	0.3	0.0038	0.62	0.54	0.85	174.00	3.71
5/18/1995	0.8458	4460.0	3.890	0.3	0.0038	0.78	0.61	0.98	190.36	0.60
5/12/1994	0.3055	2910.0	3.070	0.3	0.0038	0.59	0.53	0.73	182.95	0.52
6/13/1994	0.0099	1190.0	1.871	0.3	0.0038	0.47	0.66	0.63	168.35	0.38
5/9/1994	0.1594	2270.0	2.676	0.3	0.0038	0.57	0.57	0.76	178.77	0.47
5/8/1995	0.7124	3920.0	3.621	0.3	0.0038	0.85	0.67	1.11	188.09	0.57
4/18/1994	0.3415	1720.0	2.294	0.3	0.0038	0.45	0.67	0.56	174.22	0.43
5/22/1995	0.8368	5080.0	4.358	0.3	0.0038	0.72	0.56	0.92	190.00	6.27
6/19/1995	0.5484	4540.0	4.022	0.3	0.0038	0.65	0.52	0.81	186.00	6.07
6/3/1994	0.0187	1640.0	2.235	0.3	0.0038	0.55	0.60	0.74	173.45	0.42
6/3/1994	0.0182	1640.0	2.235	0.3	0.0038	0.53	0.62	0.77	173.45	0.42
6/9/1995	0.3642	3620.0	3.465	0.3	0.0038	0.66	0.52	0.84	186.70	0.56
5/29/1996	3.0049	5890.0	4.538	0.3	0.0038	0.61	0.49	0.77	195.35	0.66
5/2/1994	0.0125	1300.0	1.965	0.3	0.0038	0.54	0.59	0.71	169.74	0.39
6/5/1995	1.5909	6360.0	4.735	0.3	0.0038	0.66	0.54	0.81	196.75	0.68
5/17/1997	9.1787	10300.0	6.135	0.3	0.0038	0.83	0.68	1.08	207.00	7.95
5/12/1994	0.2219	2910.0	3.070	0.3	0.0038	0.51	0.61	0.66	182.95	0.52
6/5/1995	1.4943	6360.0	4.735	0.3	0.0038	0.69	0.55	0.87	196.75	0.68
6/4/1995	1.2631	6220.0	4.677	0.3	0.0038	0.68	0.54	0.85	196.34	0.67
5/23/1994	0.0128	1360.0	2.015	0.3	0.0038	0.65	0.50	0.83	170.45	0.39
4/21/1994	0.1517	2350.0	2.837	0.3	0.0038	0.52	0.62	0.75	178.00	4.65
6/10/1996	2.2621	8150.0	5.049	0.3	0.0038	0.59	0.45	0.80	206.00	7.18
6/4/1995	0.6316	6220.0	4.677	0.3	0.0038	0.70	0.54	0.91	196.34	0.67
4/18/1994	0.1246	1720.0	2.294	0.3	0.0038	0.42	0.70	0.51	174.22	0.43
6/5/1996	1.6864	7520.0	5.195	0.3	0.0038	0.45	0.37	0.59	199.84	0.72
4/21/1994	0.0910	2350.0	2.837	0.3	0.0038	0.45	0.69	0.59	178.00	4.65
6/5/1996	1.1860	7520.0	5.195	0.3	0.0038	0.51	0.40	0.75	199.84	0.72
5/22/1996	0.7906	5680.0	4.361	0.3	0.0038	0.48	0.39	0.76	191.00	6.63
5/22/1996	0.4916	5680.0	4.361	0.3	0.0038	0.56	0.66	4.00	191.00	6.63
5/15/1996	0.8571	9530.0	6.010	0.3	0.0038	0.45	0.69	0.64	203.00	7.61
5/15/1996	0.8424	9530.0	6.010	0.3	0.0038	0.41	0.74	0.51	203.00	7.61

Table C.32. Data from Dollar Creek, ID

Date	q_{hs} (tons/day-ft)	Q (cfs)	h (ft)	h_{hs} (ft)	Slope	Helley Smith d50 (mm)	Helley Smith d35 (mm)	Helley Smith d65 (mm)	W (ft)	Vmean (ft/s)
5/4/1992	0.2560	114.0	1.110	0.3	0.0146	1.70	1.25	2.30	25.00	3.41
5/22/1990	0.0234	67.0	0.958	0.3	0.0146	1.40	1.01	2.02	25.00	2.56
4/23/1990	0.1100	159.0	1.217	0.3	0.0146	1.20	0.86	1.60	25.00	4.08
6/16/1993	0.0640	104.0	1.082	0.3	0.0146	1.70	1.22	2.38	25.00	3.24
4/27/1990	0.0592	97.0	1.062	0.3	0.0146	1.90	1.33	2.71	25.00	3.12
4/17/1990	0.2148	136.0	1.166	0.3	0.0146	1.60	1.19	2.25	25.00	3.75
5/12/1993	0.0856	133.0	1.159	0.3	0.0146	0.70	0.53	1.01	25.00	3.71
5/6/1993	0.0564	50.0	0.884	0.3	0.0146	0.80	0.66	1.12	25.00	2.18
5/1/1990	0.0186	61.0	0.934	0.3	0.0146	1.20	0.87	1.77	25.00	2.43
4/20/1992	0.0299	59.0	0.925	0.3	0.0146	1.10	0.77	1.39	25.00	2.39
5/2/1990	0.0164	62.0	0.938	0.3	0.0146	1.20	0.82	1.69	25.00	2.45
4/12/1990	0.0528	82.0	1.013	0.3	0.0146	1.30	0.91	1.77	25.00	2.85
5/13/1991	0.0290	53.0	0.898	0.3	0.0146	1.40	1.05	1.88	25.00	2.25
4/7/1992	0.0344	38.0	0.819	0.3	0.0146	1.40	1.11	1.89	25.00	1.88
6/1/1993	0.2336	225.0	1.340	0.3	0.0146	1.70	1.22	2.38	25.00	4.93
5/17/1994	0.0356	65.0	0.950	0.3	0.0146	1.90	1.41	2.53	25.00	2.52
6/16/1993	0.0317	104.0	1.082	0.3	0.0146	1.80	1.28	2.49	25.00	3.24
4/14/1992	0.0253	56.0	0.912	0.3	0.0146	0.60	0.48	0.80	25.00	2.32
5/14/1991	0.0203	56.0	0.912	0.3	0.0146	0.80	0.64	1.09	25.00	2.32
6/9/1993	0.0940	139.0	1.173	0.3	0.0146	1.60	1.17	2.25	25.00	3.80
5/16/1991	0.0836	80.0	1.007	0.3	0.0146	1.30	0.97	1.68	25.00	2.82
5/28/1992	0.0086	35.0	0.801	0.3	0.0146	1.00	0.72	1.35	25.00	1.80
5/22/1991	0.3692	150.0	1.198	0.3	0.0146	1.50	1.02	2.22	25.00	3.96
4/4/1991	0.0023	16.0	0.644	0.3	0.0146	1.00	0.71	1.33	25.00	1.18
5/6/1991	0.0136	37.0	0.813	0.3	0.0146	1.40	1.02	1.95	25.00	1.86
5/29/1990	0.0728	106.0	1.088	0.3	0.0146	2.00	1.26	2.58	25.00	3.28
4/29/1991	0.0032	23.0	0.713	0.3	0.0146	0.80	0.62	1.06	25.00	1.43
4/13/1990	0.0138	69.0	1.042	0.3	0.0146	0.90	0.69	1.28	31.00	1.82
4/27/1993	0.0045	26.0	0.737	0.3	0.0146	1.30	0.96	1.73	25.00	1.53
4/9/1990	0.0200	51.0	0.889	0.3	0.0146	1.00	0.75	1.32	25.00	2.21
5/9/1994	0.0828	136.0	1.166	0.3	0.0146	1.30	0.97	1.82	25.00	3.75
4/27/1992	0.0238	76.0	0.992	0.3	0.0146	0.70	0.55	0.97	25.00	2.74
5/28/1991	0.0382	131.0	1.154	0.3	0.0146	1.00	0.73	1.44	25.00	3.68
5/4/1994	0.0071	55.0	0.907	0.3	0.0146	0.90	0.65	1.21	25.00	2.30
6/15/1993	0.0224	106.0	1.088	0.3	0.0146	1.00	0.71	1.40	25.00	3.28
5/14/1992	0.0107	76.0	0.859	0.3	0.0146	0.90	0.67	1.30	34.10	2.78
4/23/1991	0.0066	35.0	0.801	0.3	0.0146	1.00	0.71	1.39	25.00	1.80
5/26/1992	0.0080	39.0	0.825	0.3	0.0146	1.20	0.91	1.56	25.00	1.91
4/23/1992	0.0065	54.0	0.903	0.3	0.0146	1.10	0.74	1.50	25.00	2.28
5/19/1994	0.0148	52.0	0.893	0.3	0.0146	1.10	0.84	1.48	25.00	2.23
5/21/1992	0.0075	54.0	0.903	0.3	0.0146	1.20	0.88	1.62	25.00	2.28
5/6/1992	0.0296	139.0	1.173	0.3	0.0146	1.40	0.96	2.01	25.00	3.80
4/28/1992	0.0732	88.0	1.033	0.3	0.0146	1.30	0.92	1.85	25.00	2.96
5/25/1993	0.0972	221.0	1.334	0.3	0.0146	2.00	1.45	2.70	25.00	4.88
5/5/1994	0.0064	62.0	0.938	0.3	0.0146	1.20	0.88	1.62	25.00	2.45
6/12/1991	0.0099	67.0	0.915	0.3	0.0146	0.80	0.61	1.25	32.50	2.64
5/25/1994	0.0024	45.0	0.858	0.3	0.0146	1.20	0.78	1.99	25.00	2.06
5/23/1994	0.0096	52.0	0.893	0.3	0.0146	1.10	0.77	1.41	25.00	2.23
4/20/1993	0.0009	17.0	0.655	0.3	0.0146	0.50	0.43	0.71	25.00	1.22
5/9/1991	0.0334	80.0	1.007	0.3	0.0146	1.00	0.71	1.40	25.00	2.82
5/23/1991	0.0791	196.0	1.274	0.3	0.0146	1.30	0.88	1.76	35.00	3.35
4/21/1994	0.0102	85.0	1.024	0.3	0.0146	1.00	0.68	1.49	25.00	2.91
3/31/1992	0.0009	28.0	0.753	0.3	0.0146	0.60	0.43	0.79	25.00	1.60
5/11/1992	0.0205	88.0	1.033	0.3	0.0146	0.80	0.52	1.11	25.00	2.96
5/17/1994	0.0059	65.0	0.950	0.3	0.0146	1.00	0.73	1.37	25.00	2.52
5/18/1992	0.0121	62.0	0.938	0.3	0.0146	0.80	0.60	1.12	25.00	2.45
5/12/1992	0.0128	74.0	0.985	0.3	0.0146	0.70	0.55	0.98	25.00	2.70
4/19/1994	0.0082	57.0	0.916	0.3	0.0146	1.10	0.76	1.46	25.00	2.34
5/11/1994	0.0261	122.0	1.131	0.3	0.0146	1.10	0.72	1.50	25.00	3.54
5/20/1991	0.0488	96.0	1.059	0.3	0.0146	0.90	0.69	1.32	25.00	3.11
5/18/1994	0.0057	52.0	0.893	0.3	0.0146	1.00	0.71	1.32	25.00	2.23
5/18/1994	0.0042	52.0	0.893	0.3	0.0146	0.80	0.56	1.08	25.00	2.23
5/19/1994	0.0030	52.0	0.893	0.3	0.0146	1.10	0.79	1.64	25.00	2.23
4/11/1991	0.0003	15.0	0.632	0.3	0.0146	1.00	0.69	1.66	25.00	1.12
5/2/1994	0.0012	48.0	0.874	0.3	0.0146	0.70	0.52	0.82	25.00	2.14
5/24/1994	0.0025	50.0	0.884	0.3	0.0146	0.80	0.63	1.10	25.00	2.18
4/3/1990	0.0027	47.0	0.869	0.3	0.0146	1.80	1.09	2.61	25.00	2.11
6/9/1994	0.0005	28.0	0.753	0.3	0.0146	1.20	0.76	2.01	25.00	1.60
4/17/1991	0.0006	14.0	0.621	0.3	0.0146	1.20	0.86	1.58	25.00	1.10
6/2/1994	0.0007	39.0	0.788	0.3	0.0146	0.70	0.49	1.00	30.00	2.07
5/8/1991	0.0342	109.0	1.097	0.3	0.0146	1.20	0.78	2.06	25.00	3.33
5/1/1991	0.0007	24.0	0.721	0.3	0.0146	0.50	0.41	0.68	25.00	1.47
4/7/1994	0.0002	15.0	0.633	0.3	0.0146	1.40	0.96	1.98	25.00	1.14
5/10/1994	0.0032	160.0	1.220	0.3	0.0146	0.60	0.42	0.76	25.00	4.10
6/14/1994	0.0002	22.0	0.704	0.3	0.0146	0.80	0.51	1.07	25.00	1.40

Table C.33. Data from Fourth of July Creek, ID

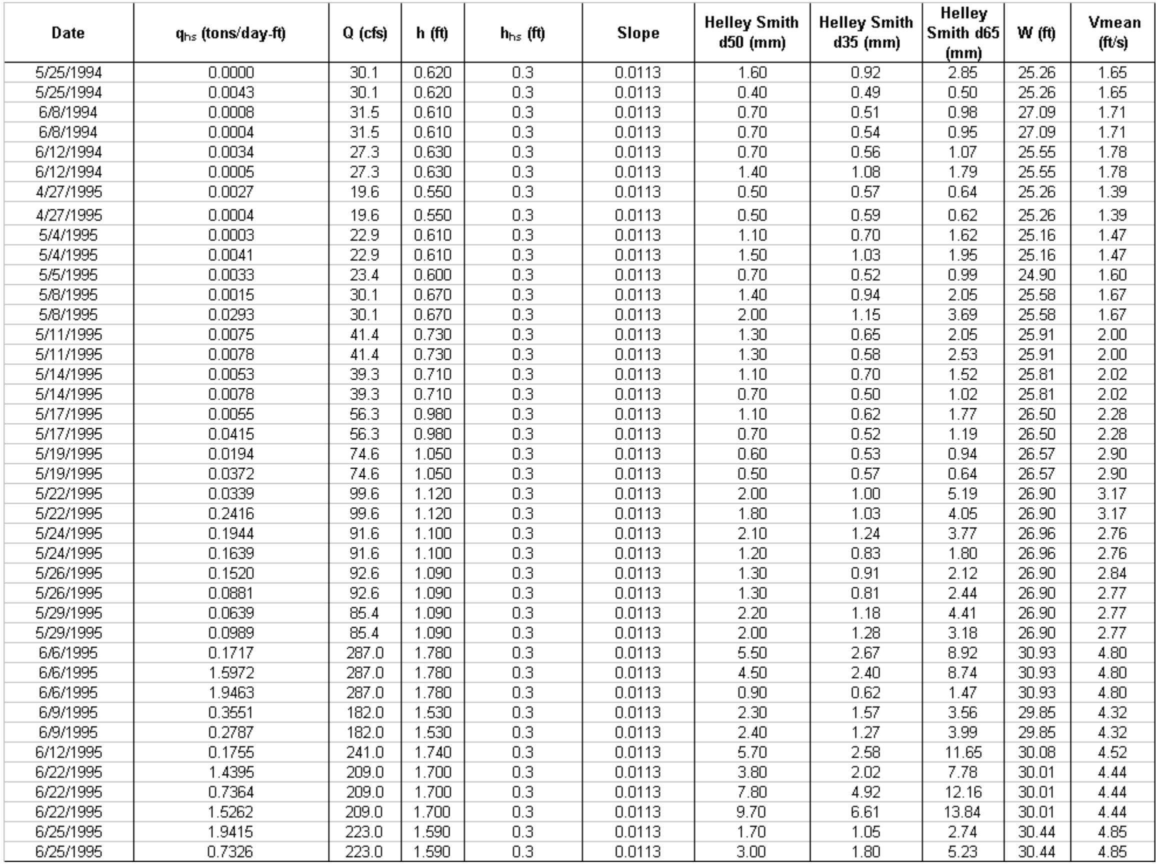


Date	q_{hs} (tons/day-ft)	Q (cfs)	h (ft)	h_{hs} (ft)	Slope	Helley Smith d50 (mm)	Helley Smith d35 (mm)	Helley Smith d65 (mm)	W (ft)	Vmean (ft/s)
7/5/1995	0.1526	94.6	1.280	0.3	0.0238	2.49	1.49	1.14	27.00	2.64
6/20/1995	0.1229	78.8	1.290	0.3	0.0238	1.28	0.88	1.91	23.60	2.46
6/5/1994	0.0123	24.5	0.850	0.3	0.0238	0.85	0.63	1.23	20.70	1.38
6/8/1995	0.0507	51.7	1.120	0.3	0.0238	0.99	0.76	1.30	22.30	2.18
6/9/1995	0.0274	46.2	1.060	0.3	0.0238	0.65	0.55	0.81	22.10	1.84
5/26/1995	0.0035	18.2	0.740	0.3	0.0238	0.67	0.49	0.97	20.70	1.19
6/20/1995	0.0737	78.8	1.290	0.3	0.0238	1.58	1.09	2.49	23.60	2.46
6/9/1995	0.0241	46.2	1.060	0.3	0.0238	1.16	0.90	1.46	22.10	1.84
6/7/1995	0.0590	61.6	1.130	0.3	0.0238	2.13	1.45	3.10	22.90	2.31
6/15/1995	0.1415	92.8	1.350	0.3	0.0238	0.90	0.67	1.22	23.60	2.69
5/23/1995	0.0031	16.7	0.710	0.3	0.0238	0.74	0.49	1.20	20.60	1.15
6/12/1994	0.0017	12.3	1.260	0.3	0.0238	0.74	0.63	0.88	21.20	0.66
5/26/1994	0.0033	23.4	0.840	0.3	0.0238	0.65	0.47	1.11	20.50	1.27
6/4/1995	0.0797	68.3	1.120	0.3	0.0238	1.39	0.88	2.74	23.60	2.49
6/6/1995	0.0498	75.8	1.110	0.3	0.0238	1.32	0.81	2.66	25.50	2.65
6/6/1995	0.0494	75.8	1.110	0.3	0.0238	1.30	0.92	1.86	25.50	2.65
6/15/1995	0.0915	92.8	1.350	0.3	0.0238	0.94	0.68	1.27	23.60	2.69
6/27/1995	0.3741	137.0	1.460	0.3	0.0238	3.11	1.59	0.36	27.80	3.37
7/5/1995	0.0315	94.6	1.280	0.3	0.0238	1.23	0.74	2.40	27.00	2.64
5/17/1994	0.0027	24.7	0.880	0.3	0.0238	0.64	0.50	0.88	20.70	1.23
6/5/1995	0.0801	84.0	1.220	0.3	0.0238	1.01	0.68	1.50	23.60	2.48
5/20/1994	0.0010	18.6	0.780	0.3	0.0238	1.16	0.87	1.65	20.30	1.23
5/26/1995	0.0012	18.2	0.740	0.3	0.0238	0.52	0.43	0.69	20.70	1.19
5/26/1994	0.0018	23.4	0.840	0.3	0.0238	0.55	0.43	0.68	20.50	1.27
6/8/1995	0.0143	51.7	1.120	0.3	0.0238	0.61	0.49	0.78	22.30	2.18
6/5/1995	0.0614	84.0	1.220	0.3	0.0238	0.99	0.66	1.61	23.60	2.48
6/27/1995	0.2065	137.0	1.460	0.3	0.0238	1.86	1.10	3.29	27.80	3.37
6/29/1995	0.0603	110.0	1.420	0.3	0.0238	1.09	0.66	1.99	27.20	2.87
6/7/1995	0.0165	61.6	1.130	0.3	0.0238	0.68	0.51	1.00	22.90	2.31
6/29/1995	0.0526	110.0	1.420	0.3	0.0238	0.85	0.57	1.35	27.20	2.87
6/26/1995	0.3318	123.0	1.430	0.3	0.0238	2.35	1.43	3.32	27.40	3.32
6/4/1995	0.0204	68.3	1.120	0.3	0.0238	0.59	0.47	0.78	23.60	2.49
6/26/1995	0.2212	123.0	1.430	0.3	0.0238	1.33	0.84	2.36	27.40	3.32
6/5/1994	0.0011	24.5	0.850	0.3	0.0238	0.58	0.45	0.77	20.70	1.38
5/28/1994	0.0009	26.7	0.890	0.3	0.0238	0.47	0.38	0.61	20.70	1.29
5/17/1994	0.0007	24.7	0.880	0.3	0.0238	0.57	0.44	0.76	20.70	1.23
5/23/1995	0.0004	16.7	0.710	0.3	0.0238	0.45	0.36	0.62	20.60	1.15
5/29/1995	0.0016	25.6	0.850	0.3	0.0238	0.53	0.42	0.69	21.00	1.39
6/26/1995	0.0956	123.0	1.430	0.3	0.0238	0.76	0.53	1.17	27.40	3.32
6/12/1994	0.0002	12.3	1.260	0.3	0.0238	0.52	0.44	0.60	21.20	0.66
6/10/1994	0.0002	20.2	0.790	0.3	0.0238	0.92	0.70	1.17	20.70	1.17
6/10/1994	0.0002	20.2	0.790	0.3	0.0238	0.65	0.47	0.85	20.70	1.17
5/29/1995	0.0007	25.6	0.850	0.3	0.0238	0.55	0.44	0.76	21.00	1.39
5/28/1994	0.0003	26.7	0.890	0.3	0.0238	0.46	0.37	0.57	20.70	1.29
5/15/1995	0.0001	8.0	0.570	0.3	0.0238	0.38	0.37	0.41	20.70	0.73
5/23/1994	0.0002	19.0	0.750	0.3	0.0238	0.42	0.39	0.53	20.30	1.11
5/23/1994	0.0001	19.0	0.750	0.3	0.0238	0.39	0.55	0.49	20.30	1.11

Table C.34. Data from Hawley Creek, ID

Date	q_{hs} (tons/day-ft)	Q (cfs)	h (ft)	h_{hs} (ft)	Slope	Helley Smith d50 (mm)	Helley Smith d35 (mm)	Helley Smith d65 (mm)	W (ft)	Vmean (ft/s)
3/29/1990	0.0521	9.8	0.497	0.3	0.0203	0.96	27.00	60.00	14.50	1.36
5/8/1990	0.0528	20.8	0.633	0.3	0.0203	2.16	27.00	60.00	17.80	1.85
4/12/1990	0.0375	16.0	0.583	0.3	0.0203	1.39	27.00	60.00	16.90	1.62
4/23/1990	0.0425	17.2	0.612	0.3	0.0203	1.05	27.00	60.00	17.00	1.65
4/25/1994	0.0700	23.5	0.600	0.3	0.0203	2.51	27.00	60.00	18.00	2.18
5/3/1990	0.0251	17.8	0.630	0.3	0.0203	1.15	27.00	60.00	16.00	1.77
4/28/1994	0.0523	21.3	0.639	0.3	0.0203	1.82	27.00	60.00	16.50	2.02
4/17/1990	0.0484	19.0	0.627	0.3	0.0203	1.31	27.00	60.00	17.00	1.79
4/6/1990	0.0481	17.4	0.583	0.3	0.0203	1.12	27.00	60.00	17.50	1.71
5/1/1992	0.0585	21.5	0.640	0.3	0.0203	1.04	27.00	60.00	17.10	1.97
5/5/1994	0.0205	20.0	0.586	0.3	0.0203	1.51	27.00	60.00	17.30	1.98
6/11/1996	0.0709	40.9	0.783	0.3	0.0203	1.36	27.00	60.00	19.90	2.62
6/21/1994	0.0127	16.5	0.550	0.3	0.0203	1.13	27.00	60.00	16.50	1.82
6/24/1996	0.0573	29.4	0.718	0.3	0.0203	1.42	27.00	60.00	19.20	2.13
5/2/1994	0.0183	20.3	0.586	0.3	0.0203	2.20	27.00	60.00	17.30	2.00
4/24/1992	0.0312	20.9	0.645	0.3	0.0203	0.88	27.00	60.00	17.00	1.91
6/4/1993	0.0354	31.3	0.702	0.3	0.0203	1.93	27.00	60.00	18.00	2.48
5/16/1990	0.0234	21.0	0.673	0.3	0.0203	1.50	27.00	60.00	17.00	1.83
4/26/1995	0.0529	17.8	0.592	0.3	0.0203	0.84	27.00	60.00	17.80	1.69
5/20/1996	0.0291	31.5	0.716	0.3	0.0203	1.35	27.00	60.00	19.70	2.23
6/5/1996	0.0655	40.2	0.762	0.3	0.0203	1.31	27.00	60.00	20.00	2.64
10/6/1994	0.0045	13.9	0.553	0.3	0.0203	1.01	27.00	60.00	18.20	1.38
4/18/1994	0.0288	22.0	0.617	0.3	0.0203	1.63	27.00	60.00	17.20	2.07
4/20/1994	0.0334	23.3	0.589	0.3	0.0203	1.79	27.00	60.00	17.80	2.22
5/19/1994	0.0182	22.9	0.602	0.3	0.0203	1.77	27.00	60.00	18.10	2.10
7/8/1996	0.0179	23.0	0.673	0.3	0.0203	1.13	27.00	60.00	18.20	1.88
5/28/1996	0.0247	35.7	0.720	0.3	0.0203	1.26	27.00	60.00	20.00	2.48
5/4/1993	0.0187	19.7	0.597	0.3	0.0203	0.87	27.00	60.00	17.80	1.85
5/23/1994	0.0113	20.3	0.592	0.3	0.0203	1.39	27.00	60.00	17.00	2.02
7/1/1996	0.0242	25.7	0.711	0.3	0.0203	1.38	27.00	60.00	18.10	1.99
5/12/1994	0.0119	20.3	0.601	0.3	0.0203	2.05	27.00	60.00	17.00	1.99
4/11/1994	0.0089	17.1	0.558	0.3	0.0203	0.48	27.00	60.00	16.60	1.85
5/16/1994	0.0098	21.0	0.615	0.3	0.0203	1.60	27.00	60.00	17.20	1.99
5/4/1995	0.0155	17.9	0.593	0.3	0.0203	0.86	27.00	60.00	17.80	1.69
5/4/1992	0.0290	18.5	0.599	0.3	0.0203	0.91	27.00	60.00	16.90	1.83
5/9/1994	0.0114	20.5	0.595	0.3	0.0203	1.38	27.00	60.00	17.20	2.00
6/13/1994	0.0066	18.8	0.571	0.3	0.0203	1.19	27.00	60.00	16.80	1.96
5/23/1995	0.0692	46.3	0.782	0.3	0.0203	1.93	27.00	60.00	22.10	2.68
5/19/1992	0.0192	17.4	0.596	0.3	0.0203	1.38	27.00	60.00	16.80	1.73
4/21/1993	0.0066	13.8	0.508	0.3	0.0203	0.78	27.00	60.00	16.50	1.65
5/26/1993	0.0335	37.5	0.710	0.3	0.0203	0.93	27.00	60.00	19.20	2.75
7/7/1994	0.0029	15.5	0.537	0.3	0.0203	0.78	27.00	60.00	16.70	1.73
6/13/1994	0.0053	18.8	0.571	0.3	0.0203	1.78	27.00	60.00	16.80	1.96
5/17/1993	0.0652	44.9	0.746	0.3	0.0203	1.92	27.00	60.00	19.50	3.09
5/9/1995	0.0167	23.7	0.620	0.3	0.0203	1.00	27.00	60.00	19.10	2.00
5/12/1993	0.0187	25.4	0.662	0.3	0.0203	0.85	27.00	60.00	18.40	2.09
5/26/1994	0.0046	19.9	0.599	0.3	0.0203	1.52	27.00	60.00	16.80	1.97
7/19/1995	0.0167	40.6	0.770	0.3	0.0203	4.51	27.00	60.00	20.30	2.60
8/2/1994	0.0019	14.8	0.529	0.3	0.0203	1.80	27.00	60.00	16.60	1.68
6/17/1996	0.0292	32.2	0.703	0.3	0.0203	1.43	27.00	60.00	19.50	2.35
6/10/1994	0.0032	18.5	0.586	0.3	0.0203	2.61	27.00	60.00	16.70	1.88
6/29/1995	0.0195	65.0	0.890	0.3	0.0203	3.69	27.00	60.00	23.00	3.18
7/20/1994	0.0021	13.2	0.521	0.3	0.0203	0.89	27.00	60.00	15.70	1.62
7/5/1995	0.0137	56.8	0.865	0.3	0.0203	1.71	27.00	60.00	22.50	2.92
7/7/1994	0.0013	15.5	0.537	0.3	0.0203	0.77	27.00	60.00	16.70	1.73
5/17/1995	0.0222	35.9	0.701	0.3	0.0203	1.19	27.00	60.00	20.20	2.54
6/2/1994	0.0069	20.4	0.582	0.3	0.0203	1.31	27.00	60.00	17.30	2.03
6/20/1995	0.0226	81.6	0.917	0.3	0.0203	1.75	27.00	60.00	25.30	3.52
10/6/1994	0.0008	13.9	0.553	0.3	0.0203	1.09	27.00	60.00	18.20	1.38
10/3/1995	0.0064	26.6	0.681	0.3	0.0203	1.16	27.00	60.00	19.20	2.03
5/26/1994	0.0026	19.9	0.599	0.3	0.0203	1.47	27.00	60.00	16.80	1.97
6/21/1994	0.0016	16.5	0.550	0.3	0.0203	1.48	27.00	60.00	16.50	1.82
6/29/1994	0.0054	15.1	0.549	0.3	0.0203	1.09	27.00	60.00	16.00	1.72
8/2/1994	0.0010	14.8	0.529	0.3	0.0203	1.48	27.00	60.00	16.60	1.68
6/29/1994	0.0051	15.1	0.549	0.3	0.0203	1.24	27.00	60.00	16.00	1.72
6/6/1994	0.0017	18.3	0.575	0.3	0.0203	1.52	27.00	60.00	16.70	1.90
6/2/1994	0.0038	20.4	0.582	0.3	0.0203	1.53	27.00	60.00	17.30	2.03
6/6/1994	0.0014	18.3	0.575	0.3	0.0203	1.90	27.00	60.00	16.70	1.90
6/8/1995	0.0223	89.0	0.946	0.3	0.0203	1.55	27.00	60.00	25.00	3.76
6/1/1995	0.0812	60.9	0.819	0.3	0.0203	0.68	27.00	60.00	23.40	3.17
7/20/1994	0.0004	13.2	0.521	0.3	0.0203	1.00	27.00	60.00	15.70	1.62
4/25/1996	0.0011	20.2	0.666	0.3	0.0203	0.61	27.00	60.00	17.50	1.73
6/13/1995	0.0135	94.6	0.988	0.3	0.0203	1.26	27.00	60.00	25.70	3.72
6/10/1994	0.0005	18.5	0.586	0.3	0.0203	0.84	27.00	60.00	16.70	1.88

Table C.35. Data from Herd Creek, ID



Date	q_{hs} (tons/day-ft)	Q (cfs)	h (ft)	h_{hs} (ft)	Slope	Helley Smith d50 (mm)	Helley Smith d35 (mm)	Helley Smith d65 (mm)	W (ft)	Vmean (ft/s)
5/25/1994	0.0000	30.1	0.620	0.3	0.0113	1.60	0.92	2.85	25.26	1.65
5/25/1994	0.0043	30.1	0.620	0.3	0.0113	0.40	0.49	0.50	25.26	1.65
6/8/1994	0.0008	31.5	0.610	0.3	0.0113	0.70	0.51	0.98	27.09	1.71
6/8/1994	0.0004	31.5	0.610	0.3	0.0113	0.70	0.54	0.95	27.09	1.71
6/12/1994	0.0034	27.3	0.630	0.3	0.0113	0.70	0.56	1.07	25.55	1.78
6/12/1994	0.0005	27.3	0.630	0.3	0.0113	1.40	1.08	1.79	25.55	1.78
4/27/1995	0.0027	19.6	0.550	0.3	0.0113	0.50	0.57	0.64	25.26	1.39
4/27/1995	0.0004	19.6	0.550	0.3	0.0113	0.50	0.59	0.62	25.26	1.39
5/4/1995	0.0003	22.9	0.610	0.3	0.0113	1.10	0.70	1.62	25.16	1.47
5/4/1995	0.0041	22.9	0.610	0.3	0.0113	1.50	1.03	1.95	25.16	1.47
5/5/1995	0.0033	23.4	0.600	0.3	0.0113	0.70	0.52	0.99	24.90	1.60
5/8/1995	0.0015	30.1	0.670	0.3	0.0113	1.40	0.94	2.05	25.58	1.67
5/8/1995	0.0293	30.1	0.670	0.3	0.0113	2.00	1.15	3.69	25.58	1.67
5/11/1995	0.0075	41.4	0.730	0.3	0.0113	1.30	0.65	2.05	25.91	2.00
5/11/1995	0.0078	41.4	0.730	0.3	0.0113	1.30	0.58	2.53	25.91	2.00
5/14/1995	0.0053	39.3	0.710	0.3	0.0113	1.10	0.70	1.52	25.81	2.02
5/14/1995	0.0078	39.3	0.710	0.3	0.0113	0.70	0.50	1.02	25.81	2.02
5/17/1995	0.0055	56.3	0.980	0.3	0.0113	1.10	0.62	1.77	26.50	2.28
5/17/1995	0.0415	56.3	0.980	0.3	0.0113	0.70	0.52	1.19	26.50	2.28
5/19/1995	0.0194	74.6	1.050	0.3	0.0113	0.60	0.53	0.94	26.57	2.90
5/19/1995	0.0372	74.6	1.050	0.3	0.0113	0.50	0.57	0.64	26.57	2.90
5/22/1995	0.0339	99.6	1.120	0.3	0.0113	2.00	1.00	5.19	26.90	3.17
5/22/1995	0.2416	99.6	1.120	0.3	0.0113	1.80	1.03	4.05	26.90	3.17
5/24/1995	0.1944	91.6	1.100	0.3	0.0113	2.10	1.24	3.77	26.96	2.76
5/24/1995	0.1639	91.6	1.100	0.3	0.0113	1.20	0.83	1.80	26.96	2.76
5/26/1995	0.1520	92.6	1.090	0.3	0.0113	1.30	0.91	2.12	26.90	2.84
5/26/1995	0.0881	92.6	1.090	0.3	0.0113	1.30	0.81	2.44	26.90	2.77
5/29/1995	0.0639	85.4	1.090	0.3	0.0113	2.20	1.18	4.41	26.90	2.77
5/29/1995	0.0989	85.4	1.090	0.3	0.0113	2.00	1.28	3.18	26.90	2.77
6/6/1995	0.1717	287.0	1.780	0.3	0.0113	5.50	2.67	8.92	30.93	4.80
6/6/1995	1.5972	287.0	1.780	0.3	0.0113	4.50	2.40	8.74	30.93	4.80
6/6/1995	1.9463	287.0	1.780	0.3	0.0113	0.90	0.62	1.47	30.93	4.80
6/9/1995	0.3551	182.0	1.530	0.3	0.0113	2.30	1.57	3.56	29.85	4.32
6/9/1995	0.2787	182.0	1.530	0.3	0.0113	2.40	1.27	3.99	29.85	4.32
6/12/1995	0.1755	241.0	1.740	0.3	0.0113	5.70	2.58	11.65	30.08	4.52
6/22/1995	1.4395	209.0	1.700	0.3	0.0113	3.80	2.02	7.78	30.01	4.44
6/22/1995	0.7364	209.0	1.700	0.3	0.0113	7.80	4.92	12.16	30.01	4.44
6/22/1995	1.5262	209.0	1.700	0.3	0.0113	9.70	6.61	13.84	30.01	4.44
6/25/1995	1.9415	223.0	1.590	0.3	0.0113	1.70	1.05	2.74	30.44	4.85
6/25/1995	0.7326	223.0	1.590	0.3	0.0113	3.00	1.80	5.23	30.44	4.85

Table C.36. Data from Johnson Creek, ID

Date	q_{hs} (tons/day-ft)	Q (cfs)	h (ft)	h_{hs} (ft)	Slope	Helley Smith d50 (mm)	Helley Smith d35 (mm)	Helley Smith d65 (mm)	W (ft)	Vmean (ft/s)
4/19/1994	0.0010	362.0	1.739	0.3	0.0040	0.53	0.38	0.81	85.94	2.44
4/19/1994	0.0012	362.0	1.739	0.3	0.0040	0.65	0.45	0.96	85.94	2.44
4/20/1994	0.0044	516.0	2.217	0.3	0.0040	0.52	0.40	0.69	67.31	3.46
4/20/1994	0.0040	516.0	2.217	0.3	0.0040	0.55	0.42	0.71	67.31	3.46
4/28/1994	0.0006	390.0	1.795	0.3	0.0040	0.74	0.58	0.94	86.20	2.54
4/28/1994	0.0002	390.0	1.795	0.3	0.0040	0.84	0.65	1.09	86.20	2.54
4/29/1994	0.0002	386.0	1.787	0.3	0.0040	0.65	0.49	0.86	86.16	2.53
4/29/1994	0.0007	386.0	1.787	0.3	0.0040	0.79	0.60	1.06	86.16	2.53
5/3/1994	0.0022	456.0	1.918	0.3	0.0040	0.85	0.65	1.14	86.74	2.77
5/3/1994	0.0015	456.0	1.918	0.3	0.0040	0.73	0.59	0.89	86.74	2.77
5/4/1994	0.0009	532.0	2.244	0.3	0.0040	0.77	0.58	1.04	67.63	3.51
5/4/1994	0.0017	532.0	2.244	0.3	0.0040	1.04	0.74	1.45	67.63	3.51
5/10/1994	0.0176	1150.0	3.060	0.3	0.0040	1.08	0.78	1.45	76.27	4.93
5/10/1994	0.0098	1150.0	3.060	0.3	0.0040	0.85	0.65	1.14	76.27	4.93
5/11/1994	0.0177	1270.0	3.184	0.3	0.0040	0.97	0.73	1.29	77.46	5.16
5/11/1994	0.0360	1270.0	3.184	0.3	0.0040	1.21	0.92	1.54	77.46	5.16
5/15/1994	0.0142	897.0	2.769	0.3	0.0040	1.20	0.89	1.57	73.37	4.42
5/15/1994	0.0016	897.0	2.769	0.3	0.0040	1.22	0.89	1.64	73.37	4.42
5/17/1994	0.0036	788.0	2.628	0.3	0.0040	0.95	0.69	1.27	71.90	4.18
5/17/1994	0.0042	788.0	2.628	0.3	0.0040	0.69	0.55	0.87	71.90	4.18
5/18/1994	0.0021	692.0	2.495	0.3	0.0040	0.91	0.65	1.23	70.46	3.94
5/18/1994	0.0065	692.0	2.495	0.3	0.0040	1.35	1.12	1.64	70.46	3.94
5/24/1994	0.0007	224.0	1.419	0.3	0.0040	0.93	0.68	1.22	84.31	1.89
5/24/1994	0.0013	224.0	1.419	0.3	0.0040	1.05	0.78	1.34	84.31	1.89
5/25/1994	0.0030	822.0	2.673	0.3	0.0040	0.88	0.66	1.17	72.38	4.25
5/25/1994	0.0032	822.0	2.673	0.3	0.0040	1.14	0.81	1.58	72.38	4.25
6/1/1994	0.0051	849.0	2.792	0.3	0.0040	1.10	0.79	1.42	72.00	4.10
6/1/1994	0.0040	849.0	2.792	0.3	0.0040	0.90	0.69	1.20	72.00	4.10
6/2/1994	0.0015	713.0	2.525	0.3	0.0040	1.05	0.78	1.40	70.79	3.99
6/2/1994	0.0048	713.0	2.525	0.3	0.0040	1.08	0.80	1.42	70.79	3.99
6/8/1994	0.0003	483.0	1.965	0.3	0.0040	0.62	0.45	0.84	86.94	2.85
6/8/1994	0.0002	483.0	1.965	0.3	0.0040	4.59	1.72	5.43	86.94	2.85
6/14/1994	0.0002	420.0	1.852	0.3	0.0040	0.79	0.56	1.12	86.45	2.65
6/14/1994	0.0002	420.0	1.852	0.3	0.0040	1.00	0.71	1.30	86.45	2.65
5/2/1995	0.0002	422.0	1.856	0.3	0.0040	0.77	0.58	1.04	86.47	2.65
5/2/1995	0.0011	422.0	1.856	0.3	0.0040	0.76	0.58	1.01	86.47	2.65
5/3/1995	0.0011	458.0	1.921	0.3	0.0040	0.74	0.59	0.94	86.75	2.77
5/3/1995	0.0008	458.0	1.921	0.3	0.0040	0.82	0.62	1.11	86.75	2.77
5/9/1995	0.0079	851.0	2.711	0.3	0.0040	1.01	0.75	1.33	72.77	4.32
5/9/1995	0.0063	851.0	2.711	0.3	0.0040	0.82	0.63	1.08	72.77	4.32
5/10/1995	0.0118	934.0	2.814	0.3	0.0040	1.05	0.77	1.38	73.83	4.50
5/10/1995	0.0104	934.0	2.814	0.3	0.0040	0.78	0.60	1.01	73.83	4.50
5/16/1995	0.0255	1220.0	3.133	0.3	0.0040	1.03	0.74	1.44	76.98	5.07
5/16/1995	0.0222	1220.0	3.133	0.3	0.0040	0.84	0.65	1.12	76.98	5.07
5/17/1995	0.0542	1450.0	3.358	0.3	0.0040	0.93	0.69	1.27	79.08	5.47
5/17/1995	0.0510	1450.0	3.358	0.3	0.0040	1.02	0.76	1.35	79.08	5.47
5/23/1995	0.0752	1870.0	3.720	0.3	0.0040	1.22	0.89	1.64	82.28	6.12
5/23/1995	0.0874	1870.0	3.720	0.3	0.0040	1.43	1.12	1.83	82.28	6.12
5/24/1995	0.1380	1920.0	3.760	0.3	0.0040	3.61	1.73	35.62	82.62	6.19
5/24/1995	0.0690	1920.0	3.760	0.3	0.0040	1.43	1.08	1.89	82.62	6.19
5/31/1995	0.0598	2140.0	4.059	0.3	0.0040	1.31	1.01	1.70	85.00	6.87
5/31/1995	0.0888	2140.0	4.059	0.3	0.0040	1.21	0.92	1.54	85.00	6.87
6/1/1995	0.0442	2190.0	3.964	0.3	0.0040	2.37	1.44	4.84	84.33	6.56
6/1/1995	0.0921	2190.0	3.964	0.3	0.0040	1.26	0.95	1.66	84.33	6.56
6/3/1995	0.2615	2870.0	4.419	0.3	0.0040	1.23	0.86	1.75	87.97	7.39
6/3/1995	0.2797	2870.0	4.419	0.3	0.0040	1.34	0.98	1.82	87.97	7.39
6/6/1995	0.0640	2170.0	3.949	0.3	0.0040	1.14	0.85	1.48	84.21	6.53
6/6/1995	0.0553	2170.0	3.949	0.3	0.0040	1.45	1.08	1.95	84.21	6.53
6/7/1995	0.0148	1730.0	3.606	0.3	0.0040	1.00	0.73	1.38	81.29	5.91
6/7/1995	0.0385	1730.0	3.606	0.3	0.0040	1.02	0.75	1.43	81.29	5.91
6/15/1995	0.1263	1880.0	3.728	0.3	0.0040	1.65	1.29	2.17	82.35	6.13
6/15/1995	0.0703	1880.0	3.728	0.3	0.0040	1.33	1.06	1.68	82.35	6.13
6/20/1995	0.0135	1440.0	3.200	0.3	0.0040	1.52	1.09	2.22	80.00	5.55
6/20/1995	0.0102	1440.0	3.200	0.3	0.0040	1.04	0.77	1.36	80.00	5.55
6/21/1995	0.0173	1340.0	3.254	0.3	0.0040	1.31	0.99	1.73	78.11	5.28
6/21/1995	0.0140	1340.0	3.254	0.3	0.0040	1.22	0.94	1.54	78.11	5.28
6/27/1995	0.0279	1660.0	3.625	0.3	0.0040	1.79	1.29	3.07	80.00	5.56
6/27/1995	0.0393	1660.0	3.625	0.3	0.0040	1.31	1.02	1.68	80.00	5.56
6/28/1995	0.0192	1600.0	3.494	0.3	0.0040	1.21	0.90	1.59	80.30	5.71
6/28/1995	0.0192	1600.0	3.494	0.3	0.0040	1.08	0.79	1.42	80.30	5.71
5/18/1997	0.3502	3450.0	4.759	0.3	0.0040	1.54	1.21	1.96	90.53	8.02
5/18/1997	0.4253	3450.0	4.759	0.3	0.0040	2.49	1.58	5.12	90.53	8.02

Table C.37. Data from Little Buckhorn Creek

Date	q_{hs} (tons/day-ft)	Q (cfs)	h (ft)	h_{hs} (ft)	Slope	Helley Smith d50 (mm)	Helley Smith d35 (mm)	Helley Smith d65 (mm)	W (ft)	Vmean (ft/s)
4/9/1990	0.0076	5.4	0.521	0.3	0.0509	0.76	0.60	0.96	9.95	1.77
4/16/1990	0.0136	9.9	0.699	0.3	0.0509	0.88	0.69	1.18	11.63	3.25
4/19/1990	0.0041	12.0	0.768	0.3	0.0509	0.77	0.61	0.98	12.22	3.94
4/23/1990	0.0475	19.0	0.959	0.3	0.0509	1.34	0.98	1.83	13.76	6.24
4/24/1990	0.0365	19.0	0.959	0.3	0.0509	0.75	0.59	0.96	13.76	6.24
4/26/1990	0.0562	14.0	0.827	0.3	0.0509	1.41	0.92	2.22	12.72	4.60
4/27/1990	0.0530	10.0	0.703	0.3	0.0509	1.63	1.09	2.39	11.66	3.28
5/2/1990	0.0119	8.6	0.653	0.3	0.0509	0.81	0.66	1.02	11.21	2.82
5/2/1990	0.0075	8.1	0.634	0.3	0.0509	1.07	0.78	1.45	11.04	2.66
5/4/1990	0.0080	8.3	0.642	0.3	0.0509	1.27	0.93	1.73	11.11	2.73
5/7/1990	0.0048	12.0	0.768	0.3	0.0509	0.85	0.61	1.31	12.22	3.94
5/22/1990	0.0034	9.4	0.682	0.3	0.0509	0.77	0.62	0.94	11.47	3.09
5/30/1990	0.0608	24.0	1.074	0.3	0.0509	1.45	1.01	2.11	14.61	7.88
6/1/1990	0.0885	21.0	1.007	0.3	0.0509	1.40	1.05	1.87	14.12	6.90
6/6/1990	0.0697	16.0	0.883	0.3	0.0509	1.58	1.25	1.99	13.16	5.25
4/3/1991	0.0003	2.4	0.456	0.3	0.0509	0.47	0.39	0.61	10.60	0.66
4/9/1991	0.0090	3.7	0.434	0.3	0.0509	0.97	0.73	1.31	9.02	1.21
4/23/1991	0.0087	3.2	0.404	0.3	0.0509	1.71	1.16	2.35	8.69	1.05
4/30/1991	0.0028	2.7	0.372	0.3	0.0509	1.21	0.88	1.61	8.32	0.89
5/8/1991	0.0770	11.0	0.736	0.3	0.0509	0.70	0.51	0.95	11.95	3.61
5/9/1991	0.0366	11.0	0.857	0.3	0.0509	0.88	0.67	1.27	14.00	0.99
5/15/1991	0.0063	7.3	0.603	0.3	0.0509	1.37	0.99	1.89	10.75	2.40
5/17/1991	0.0095	11.0	0.736	0.3	0.0509	1.36	0.90	2.05	11.95	3.61
5/20/1991	0.0269	12.0	0.768	0.3	0.0509	1.19	0.90	1.53	12.22	3.94
5/21/1991	0.0237	13.0	0.798	0.3	0.0509	1.19	0.86	1.61	12.48	4.27
5/23/1991	0.0150	15.0	1.030	0.3	0.0509	0.76	0.58	0.98	14.00	1.12
5/28/1991	0.0333	14.0	0.827	0.3	0.0509	1.57	1.09	2.28	12.72	4.60
5/29/1991	0.0167	14.0	0.827	0.3	0.0509	1.00	0.75	1.42	12.72	4.60
5/30/1991	0.0181	14.0	0.827	0.3	0.0509	0.87	0.65	1.24	12.72	4.60
6/4/1991	0.0677	18.0	0.934	0.3	0.0509	1.24	0.76	2.15	13.57	5.91
6/11/1991	0.0411	18.0	0.934	0.3	0.0509	1.39	0.98	1.95	13.57	5.91
4/7/1992	0.0010	4.1	0.456	0.3	0.0509	0.97	0.69	1.31	9.26	1.35
4/14/1992	0.0354	9.6	0.689	0.3	0.0509	1.10	0.79	1.57	11.54	3.15
4/20/1992	0.0313	12.0	0.768	0.3	0.0509	1.34	1.04	1.72	12.22	3.94
4/22/1992	0.0304	12.0	0.768	0.3	0.0509	1.57	1.13	2.16	12.22	3.94
4/27/1992	0.0617	9.8	0.696	0.3	0.0509	0.95	0.67	1.54	11.60	3.22
5/4/1992	0.0505	13.0	0.798	0.3	0.0509	1.92	1.48	2.41	12.48	4.27
5/6/1992	0.0842	15.0	0.855	0.3	0.0509	1.34	1.07	1.68	12.95	4.93
5/11/1992	0.0606	13.0	0.798	0.3	0.0509	1.07	0.77	1.49	12.48	4.27
5/13/1992	0.0059	12.0	0.771	0.3	0.0509	0.70	0.54	0.92	14.00	1.11
5/14/1992	0.0089	9.5	0.685	0.3	0.0509	0.70	0.55	0.89	11.51	3.12
5/18/1992	0.0750	13.0	0.798	0.3	0.0509	1.78	1.29	2.47	12.48	4.27
5/20/1992	0.0408	14.0	0.827	0.3	0.0509	1.09	0.79	1.48	12.72	4.60
5/21/1992	0.0193	13.0	0.798	0.3	0.0509	0.98	0.72	1.32	12.48	4.27
5/26/1992	0.0234	12.0	0.768	0.3	0.0509	1.01	0.77	1.40	12.22	3.94
4/21/1993	0.0084	7.8	0.623	0.3	0.0509	0.96	0.73	1.38	10.94	2.56
4/27/1993	0.0169	8.3	0.642	0.3	0.0509	1.35	1.08	1.68	11.11	2.73
5/6/1993	0.0134	10.0	0.703	0.3	0.0509	0.96	0.72	1.35	11.66	3.28
5/12/1993	0.0218	13.0	0.798	0.3	0.0509	0.87	0.66	1.20	12.48	4.27
5/18/1993	0.0691	24.0	1.074	0.3	0.0509	1.33	0.86	2.07	14.61	7.88
6/2/1993	0.3365	26.0	1.117	0.3	0.0509	1.47	1.07	2.04	14.92	8.54
6/15/1993	0.1041	21.0	1.007	0.3	0.0509	1.61	1.28	2.03	14.12	6.90
6/16/1993	0.0770	19.0	0.959	0.3	0.0509	1.68	1.26	2.31	13.76	6.24
4/6/1994	0.0040	2.5	0.359	0.3	0.0509	0.75	0.59	0.95	8.15	0.82
4/19/1994	0.0030	6.2	0.557	0.3	0.0509	0.89	0.66	1.20	10.31	2.04
4/21/1994	0.0069	7.8	0.623	0.3	0.0509	0.77	0.58	1.03	10.94	2.56
5/4/1994	0.0006	4.6	0.482	0.3	0.0509	0.87	0.65	1.13	9.54	1.51
5/5/1994	0.0004	4.6	0.482	0.3	0.0509	0.80	0.63	1.04	9.54	1.51
5/9/1994	0.0067	12.0	0.768	0.3	0.0509	0.87	0.64	1.23	12.22	3.94
5/10/1994	0.0188	13.0	0.798	0.3	0.0509	1.28	0.94	1.73	12.48	4.27
5/11/1994	0.0087	13.0	0.798	0.3	0.0509	1.04	0.74	1.42	12.48	4.27
5/17/1994	0.0018	9.5	0.685	0.3	0.0509	0.80	0.53	1.39	11.51	3.12
5/18/1994	0.0022	8.9	0.664	0.3	0.0509	0.79	0.61	1.03	11.31	2.92
5/23/1994	0.0014	7.8	0.623	0.3	0.0509	0.69	0.55	0.86	10.94	2.56
5/24/1994	0.0021	7.8	0.623	0.3	0.0509	0.99	0.74	1.27	10.94	2.56
5/25/1994	0.0008	9.4	0.682	0.3	0.0509	0.79	0.59	1.09	11.47	3.09
6/2/1994	0.0154	10.0	0.703	0.3	0.0509	1.64	1.25	2.18	11.66	3.28
6/2/1994	0.0065	10.0	0.703	0.3	0.0509	1.52	1.13	2.06	11.66	3.28
6/9/1994	0.0002	8.6	0.653	0.3	0.0509	0.86	0.62	1.13	11.21	2.82
6/14/1994	0.0002	6.9	0.587	0.3	0.0509	0.63	0.47	0.83	10.60	2.27

Table C.38. Data from Little Slate Creek, ID

Date	q_{hs} (tons/day-ft)	Q (cfs)	h (ft)	h_{hs} (ft)	Slope	Helley Smith d50 (mm)	Helley Smith d35 (mm)	Helley Smith d65 (mm)	W (ft)	Vmean (ft/s)
4/22/1994	0.0270	234.0	1.740	0.3	0.0268	0.77	0.71	1.26	44.75	3.09
4/22/1994	0.0927	234.0	1.740	0.3	0.0268	1.17	1.15	2.56	44.75	3.09
4/28/1994	0.0077	151.0	1.550	0.3	0.0268	0.48	0.41	0.70	45.00	2.17
4/28/1994	0.0084	151.0	1.550	0.3	0.0268	0.53	0.45	0.78	45.00	2.17
5/4/1994	0.0055	143.0	1.590	0.3	0.0268	0.72	0.67	1.24	44.70	2.10
5/4/1994	0.0037	143.0	1.590	0.3	0.0268	0.59	0.54	0.90	44.70	2.10
5/9/1994	0.0111	237.0	1.840	0.3	0.0268	0.53	0.46	0.80	44.30	2.84
5/9/1994	0.0150	237.0	1.840	0.3	0.0268	0.71	0.68	1.80	44.30	2.84
5/12/1994	0.0491	300.0	1.940	0.3	0.0268	0.66	0.61	1.44	45.00	3.58
5/12/1994	0.0222	300.0	1.940	0.3	0.0268	0.60	0.54	0.90	45.00	3.58
5/18/1994	0.0052	197.0	1.670	0.3	0.0268	0.56	0.49	0.79	45.00	2.73
5/18/1994	0.0041	197.0	1.670	0.3	0.0268	0.39	0.35	0.58	45.00	2.73
5/20/1994	0.0024	195.0	1.640	0.3	0.0268	0.52	0.44	0.72	44.30	2.56
5/20/1994	0.0063	195.0	1.640	0.3	0.0268	0.69	0.64	1.22	44.30	2.56
5/23/1994	0.0020	186.0	1.560	0.3	0.0268	0.48	0.40	0.68	44.10	2.55
5/23/1994	0.0020	186.0	1.560	0.3	0.0268	0.53	0.46	0.80	44.10	2.55
5/26/1994	0.0031	195.0	1.698	0.3	0.0268	0.53	0.45	0.75	42.67	2.70
5/26/1994	0.0039	195.0	1.698	0.3	0.0268	0.54	0.47	0.79	42.67	2.70
5/31/1994	0.0039	181.0	1.540	0.3	0.0268	0.45	0.38	0.62	44.00	2.51
5/31/1994	0.0031	181.0	1.540	0.3	0.0268	0.44	0.37	0.58	44.00	2.51
6/2/1994	0.0063	182.0	1.630	0.3	0.0268	0.66	0.61	1.00	44.00	2.50
6/2/1994	0.0030	182.0	1.630	0.3	0.0268	0.52	0.51	1.01	44.00	2.50
6/7/1994	0.0020	151.0	1.530	0.3	0.0268	0.63	0.58	0.97	43.00	2.28
6/7/1994	0.0023	151.0	1.530	0.3	0.0268	0.81	0.82	2.40	43.00	2.28
6/10/1994	0.0007	128.0	1.500	0.3	0.0268	0.55	0.50	0.82	43.00	1.96
6/10/1994	0.0006	128.0	1.500	0.3	0.0268	0.44	0.38	0.64	43.00	1.96
6/15/1994	0.0017	121.0	1.390	0.3	0.0268	0.81	0.77	1.45	43.00	2.01
6/15/1994	0.0012	121.0	1.390	0.3	0.0268	0.54	0.46	0.74	43.00	2.01
6/22/1994	0.0015	102.0	1.450	0.3	0.0268	0.51	0.43	0.71	42.50	1.67
6/22/1994	0.0037	102.0	1.450	0.3	0.0268	0.57	0.50	0.91	42.50	1.67
7/1/1994	0.0041	74.0	1.460	0.3	0.0268	0.63	0.58	0.79	36.00	1.34
7/1/1994	0.0087	74.0	1.460	0.3	0.0268	0.65	0.60	0.83	36.00	1.34
8/30/1994	0.0000	18.7	0.770	0.3	0.0268	0.42	0.38	0.74	33.75	0.75
9/28/1994	0.0003	18.7	0.810	0.3	0.0268	0.74	0.69	1.42	33.50	0.68
10/26/1994	0.0006	22.7	0.910	0.3	0.0268	0.75	0.69	1.22	34.50	0.73
3/29/1995	0.0149	58.6	1.040	0.3	0.0268	0.70	0.64	1.14	36.00	1.01
3/29/1995	0.0225	58.6	1.040	0.3	0.0268	0.77	0.69	1.02	36.00	1.01
4/7/1995	0.0014	81.6	1.340	0.3	0.0268	0.48	0.41	0.67	42.10	1.50
4/7/1995	0.0039	81.6	1.340	0.3	0.0268	0.73	0.68	1.14	42.10	1.50
4/12/1995	0.0046	66.8	1.200	0.3	0.0268	0.55	0.48	0.74	39.80	1.39
4/12/1995	0.0130	66.8	1.200	0.3	0.0268	0.62	0.57	0.86	39.80	1.39
4/18/1995	0.0020	70.5	1.280	0.3	0.0268	0.60	0.54	0.89	39.60	1.39
4/18/1995	0.0044	70.5	1.280	0.3	0.0268	0.97	0.87	1.49	39.60	1.39
4/27/1995	0.0043	88.8	1.360	0.3	0.0268	0.64	0.59	0.90	42.70	1.53
4/27/1995	0.0078	88.8	1.360	0.3	0.0268	0.69	0.64	1.02	42.70	1.53
5/1/1995	0.0029	124.0	1.490	0.3	0.0268	0.50	0.41	0.74	43.60	1.94
5/1/1995	0.0093	124.0	1.490	0.3	0.0268	0.53	0.45	0.95	43.60	1.94
5/3/1995	0.0118	167.0	1.630	0.3	0.0268	0.54	0.46	0.83	45.20	2.28
5/3/1995	0.0107	167.0	1.630	0.3	0.0268	0.51	0.42	0.68	45.20	2.28
5/18/1995	0.0452	316.0	2.230	0.3	0.0268	0.68	0.63	1.24	42.50	3.47
5/18/1995	0.0348	316.0	2.230	0.3	0.0268	0.74	0.69	1.28	42.50	3.47
5/24/1995	0.0227	303.0	1.890	0.3	0.0268	0.63	0.58	1.09	44.50	3.57
5/24/1995	0.0222	303.0	1.890	0.3	0.0268	0.56	0.47	0.92	44.50	3.57
6/1/1995	0.0229	327.0	1.920	0.3	0.0268	0.66	0.60	1.14	45.50	3.77
6/1/1995	0.0259	327.0	1.920	0.3	0.0268	0.70	0.65	1.19	45.50	3.77
6/6/1995	0.0380	348.0	2.050	0.3	0.0268	0.67	0.62	1.23	45.50	3.88
6/6/1995	0.0268	348.0	2.050	0.3	0.0268	0.58	0.52	0.91	45.50	3.88
6/8/1995	0.0235	307.0	1.820	0.3	0.0268	0.68	0.63	1.31	45.60	3.57
6/8/1995	0.0193	307.0	1.820	0.3	0.0268	0.64	0.59	1.15	45.60	3.57
6/14/1995	0.0153	282.0	1.780	0.3	0.0268	0.66	0.62	1.25	44.50	3.45
6/14/1995	0.0113	282.0	1.780	0.3	0.0268	0.59	0.52	0.90	44.50	3.45
6/19/1995	0.0314	325.0	1.890	0.3	0.0268	0.92	0.87	1.77	45.50	3.66
6/19/1995	0.0154	325.0	1.890	0.3	0.0268	0.62	0.56	0.98	45.50	3.66
6/26/1995	0.0096	247.0	1.780	0.3	0.0268	0.63	0.57	1.08	45.50	2.99
6/26/1995	0.0080	247.0	1.780	0.3	0.0268	0.61	0.55	0.95	45.50	2.99
7/5/1995	0.0053	189.0	1.600	0.3	0.0268	0.59	0.53	0.91	44.50	2.64
7/5/1995	0.0040	189.0	1.600	0.3	0.0268	0.52	0.43	0.75	44.50	2.64
7/11/1995	0.0220	186.0	1.590	0.3	0.0268	1.19	1.67	20.97	45.50	2.56
7/11/1995	0.0056	186.0	1.590	0.3	0.0268	0.53	0.45	0.78	45.50	2.56
7/20/1995	0.0056	97.8	1.520	0.3	0.0268	0.63	0.59	1.16	39.00	1.67
7/20/1995	0.0043	97.8	1.520	0.3	0.0268	0.47	0.39	0.66	39.00	1.67
8/2/1995	0.0026	57.1	1.250	0.3	0.0268	0.58	0.52	0.78	37.80	1.21
8/2/1995	0.0044	57.1	1.250	0.3	0.0268	0.62	0.56	0.86	37.80	1.21
8/24/1995	0.0001	39.6	1.140	0.3	0.0268	1.00	0.81	1.23	34.90	1.00
9/14/1995	0.0006	27.3	0.900	0.3	0.0268	0.56	0.50	0.73	35.00	0.87
4/6/1996	0.0037	99.3	1.380	0.3	0.0268	0.64	0.59	0.87	44.10	1.62
5/10/1996	0.0175	179.0	1.654	0.3	0.0268	0.54	0.46	0.84	42.25	2.57
5/17/1996	0.2239	557.0	2.430	0.3	0.0268	0.74	0.70	1.44	46.00	4.74
6/3/1996	0.0580	407.0	2.100	0.3	0.0268	0.58	0.52	0.97	46.00	4.21
6/10/1996	0.0816	461.0	2.250	0.3	0.0268	0.73	0.68	1.32	44.00	4.72
6/19/1996	0.0134	273.0	1.880	0.3	0.0268	0.61	0.57	1.23	43.00	3.44
6/25/1996	0.0491	224.0	1.710	0.3	0.0268	0.62	0.56	1.00	43.00	3.22
7/9/1996	0.0017	136.0	1.420	0.3	0.0268	0.45	0.39	0.69	42.00	2.24
7/23/1996	0.0079	79.3	1.410	0.3	0.0268	0.47	0.40	0.65	37.00	1.50
7/30/1996	0.0022	60.7	1.300	0.3	0.0268	0.46	0.39	0.62	33.00	1.46
10/25/1996	0.0003	41.6	1.130	0.3	0.0268	0.40	0.35	0.49	35.30	1.06
4/18/1997	0.0068	138.0	1.460	0.3	0.0268	0.60	0.56	0.80	45.50	2.11
4/29/1997	0.0258	221.0	1.770	0.3	0.0268	0.99	0.94	1.72	45.00	2.76
5/9/1997	0.0164	261.0	1.890	0.3	0.0268	0.54	0.46	0.80	45.00	3.14
5/16/1997	0.1872	647.0	2.210	0.3	0.0268	1.02	1.02	7.39	47.50	5.99
5/20/1997	0.0348	534.0	2.300	0.3	0.0268	0.42	0.37	0.62	46.00	4.99
5/29/1997	0.0492	503.0	2.110	0.3	0.0268	0.76	0.72	1.67	46.50	4.82
6/6/1997	0.0147	397.0	2.000	0.3	0.0268	0.61	0.55	0.91	46.50	4.24
6/12/1997	0.0497	522.0	2.150	0.3	0.0268	0.83	0.78	1.70	47.50	4.76
6/24/1997	0.0025	231.0	1.680	0.3	0.0268	0.54	0.47	0.91	44.50	3.07
7/24/1997	0.0463	108.0	1.450	0.3	0.0268	0.62	0.56	1.26	40.00	1.83

Table C.39. Data from Lolo Creek, ID

Date	q_{hs} (tons/day-ft)	Q (cfs)	h (ft)	h_{hs} (ft)	Slope	Helley Smith d50 (mm)	Helley Smith d35 (mm)	Helley Smith d65 (mm)	W (ft)	Vmean (ft/s)
3/29/1994	0.0027	77.8	1.180	0.3	0.0097	0.60	0.55	0.80	36.00	1.71
3/29/1994	0.0098	77.8	1.180	0.3	0.0097	0.61	0.56	0.78	36.00	1.71
4/5/1994	0.0184	152.0	1.573	0.3	0.0097	0.67	0.62	0.93	41.47	2.34
4/5/1994	0.0499	152.0	1.573	0.3	0.0097	0.94	0.84	1.57	41.47	2.34
4/19/1994	0.0468	320.0	2.630	0.3	0.0097	0.81	0.75	1.36	38.00	3.16
4/19/1994	0.0613	320.0	2.630	0.3	0.0097	0.82	0.74	1.25	38.00	3.16
4/22/1994	0.0942	340.0	2.710	0.3	0.0097	0.99	0.86	1.67	38.00	3.17
4/22/1994	0.0484	340.0	2.710	0.3	0.0097	0.82	0.74	1.28	38.00	3.17
4/26/1994	0.0263	237.0	2.210	0.3	0.0097	0.80	0.73	1.25	38.00	2.90
4/26/1994	0.0104	237.0	2.210	0.3	0.0097	0.69	0.64	1.08	38.00	2.90
4/29/1994	0.0064	180.0	1.870	0.3	0.0097	0.69	0.64	1.01	38.00	2.53
4/29/1994	0.0028	180.0	1.870	0.3	0.0097	0.59	0.56	0.88	38.00	2.53
5/3/1994	0.0048	151.0	1.740	0.3	0.0097	0.67	0.63	0.95	38.00	2.26
5/3/1994	0.0371	151.0	1.740	0.3	0.0097	0.73	0.66	0.98	38.00	2.26
5/6/1994	0.0106	154.0	1.720	0.3	0.0097	0.74	0.68	1.07	38.00	2.38
5/6/1994	0.0078	154.0	1.720	0.3	0.0097	0.72	0.66	0.98	38.00	2.38
5/10/1994	0.0219	183.0	1.910	0.3	0.0097	0.68	0.63	0.87	38.00	2.60
5/10/1994	0.0102	183.0	1.910	0.3	0.0097	0.71	0.66	1.05	38.00	2.60
5/13/1994	0.0046	164.0	1.730	0.3	0.0097	0.68	0.63	0.98	38.00	2.55
5/13/1994	0.0104	164.0	1.730	0.3	0.0097	0.72	0.66	0.99	38.00	2.55
5/18/1994	0.0125	124.0	1.570	0.3	0.0097	0.69	0.64	0.94	38.00	2.21
5/18/1994	0.0112	120.0	1.570	0.3	0.0097	0.68	0.62	1.00	38.00	2.21
5/21/1994	0.0104	126.0	1.570	0.3	0.0097	0.63	0.58	0.84	38.00	2.19
5/21/1994	0.0037	126.0	1.570	0.3	0.0097	0.59	0.54	0.82	38.00	2.19
5/25/1994	0.0022	87.0	1.300	0.3	0.0097	0.55	0.50	0.75	37.00	1.86
5/25/1994	0.0043	87.0	1.300	0.3	0.0097	0.64	0.60	0.85	37.00	1.86
5/27/1994	0.0031	79.8	1.230	0.3	0.0097	0.65	0.61	0.89	37.00	1.85
5/27/1994	0.0039	79.8	1.230	0.3	0.0097	0.67	0.63	0.95	37.00	1.85
6/9/1994	0.0068	63.6	1.000	0.3	0.0097	0.74	0.68	1.07	38.20	1.62
6/9/1994	0.0012	63.6	1.000	0.3	0.0097	0.64	0.60	0.96	38.20	1.62
6/13/1994	0.0011	69.1	1.020	0.3	0.0097	0.52	0.48	0.80	38.50	1.74
6/13/1994	0.0078	69.1	1.020	0.3	0.0097	0.93	0.83	1.62	38.50	1.74
6/17/1994	0.0085	117.0	1.430	0.3	0.0097	0.73	0.68	1.13	39.20	2.09
3/15/1995	0.0212	210.0	2.080	0.3	0.0097	0.78	0.71	1.25	38.00	2.65
3/15/1995	0.0096	210.0	2.080	0.3	0.0097	0.75	0.69	1.16	38.00	2.65
3/17/1995	0.0044	189.0	1.970	0.3	0.0097	0.65	0.60	0.99	38.00	2.50
3/17/1995	0.0025	189.0	1.970	0.3	0.0097	0.66	0.61	1.04	38.00	2.50
3/22/1995	0.0140	218.0	2.180	0.3	0.0097	0.79	0.74	1.40	38.00	2.64
3/22/1995	0.0229	218.0	2.180	0.3	0.0097	0.84	0.77	1.31	38.00	2.64
3/25/1995	0.0149	169.0	1.810	0.3	0.0097	0.75	0.69	1.17	38.00	2.43
3/25/1995	0.0068	169.0	1.810	0.3	0.0097	0.72	0.67	1.15	38.00	2.43
3/29/1995	0.0040	118.0	1.510	0.3	0.0097	0.70	0.64	1.02	37.00	2.04
3/29/1995	0.0021	118.0	1.510	0.3	0.0097	0.66	0.61	1.07	37.00	2.04
4/8/1995	0.0603	265.0	2.460	0.3	0.0097	0.79	0.73	1.29	38.00	2.85
4/8/1995	0.0529	265.0	2.460	0.3	0.0097	1.02	0.99	1.69	38.00	2.85
5/3/1995	0.0156	226.0	2.180	0.3	0.0097	0.92	0.89	1.65	38.00	2.75
5/3/1995	0.0129	226.0	2.180	0.3	0.0097	0.83	0.79	1.51	38.00	2.75
5/10/1995	0.0224	275.0	2.580	0.3	0.0097	0.69	0.64	1.04	38.00	2.87
5/10/1995	0.0332	275.0	2.580	0.3	0.0097	0.83	0.77	1.49	38.00	2.87
5/13/1995	0.0474	266.0	2.550	0.3	0.0097	0.92	0.86	1.89	38.00	2.84
5/13/1995	0.0149	266.0	2.550	0.3	0.0097	0.67	0.63	1.09	38.00	2.84
5/17/1995	0.0526	316.0	2.740	0.3	0.0097	1.18	1.26	2.55	38.00	2.98
5/17/1995	0.0945	316.0	2.740	0.3	0.0097	1.24	1.23	2.20	38.00	2.98
5/18/1995	0.0295	271.0	2.560	0.3	0.0097	1.00	0.94	1.88	38.00	2.84
5/18/1995	0.0191	271.0	2.560	0.3	0.0097	0.71	0.65	1.01	38.00	2.84
5/22/1995	0.0067	221.0	2.230	0.3	0.0097	0.73	0.69	2.18	38.00	2.66
5/22/1995	0.0071	221.0	2.230	0.3	0.0097	0.74	0.71	2.34	38.00	2.66
5/31/1995	0.0338	149.0	1.563	0.3	0.0097	1.10	2.05	4.48	41.37	2.31
5/31/1995	0.0578	149.0	1.563	0.3	0.0097	1.95	2.72	7.13	41.37	2.31
6/2/1995	0.0058	146.0	1.553	0.3	0.0097	0.95	1.42	3.37	41.27	2.29
6/2/1995	0.0195	146.0	1.553	0.3	0.0097	1.65	2.44	5.05	41.27	2.29
6/6/1995	0.0207	179.0	1.940	0.3	0.0097	0.99	0.93	2.83	38.00	2.45
6/6/1995	0.0079	179.0	1.940	0.3	0.0097	0.88	0.90	3.65	38.00	2.45
6/8/1995	0.0298	146.0	1.553	0.3	0.0097	1.26	2.06	3.66	41.27	2.29
6/8/1995	0.0346	146.0	1.553	0.3	0.0097	2.10	2.54	4.69	41.27	2.29
6/16/1995	0.0600	97.9	1.310	0.3	0.0097	1.56	2.66	6.71	37.00	2.04
6/16/1995	0.0376	97.9	1.310	0.3	0.0097	1.35	2.29	6.03	37.00	2.04
6/22/1995	0.0232	94.5	1.410	0.3	0.0097	1.17	1.96	4.39	37.00	1.90
6/22/1995	0.0524	94.5	1.410	0.3	0.0097	1.96	2.83	6.59	37.00	1.90
6/30/1995	0.0220	64.5	0.990	0.3	0.0097	1.01	1.00	3.49	37.00	1.78
6/30/1995	0.0484	64.5	0.990	0.3	0.0097	2.62	4.63	19.70	37.00	1.78
5/1/1997	0.0453	521.0	3.590	0.3	0.0097	0.77	0.71	1.22	36.00	4.13
5/1/1997	0.0778	521.0	3.590	0.3	0.0097	0.80	0.72	1.21	36.00	4.13
5/20/1997	0.0754	573.0	3.460	0.3	0.0097	1.01	0.91	1.77	37.00	4.91
5/20/1997	0.0622	573.0	3.460	0.3	0.0097	1.00	0.91	1.63	37.00	4.91

Table C.40. Data from Main Fork Red River, ID

Date	q_{hs} (tons/day-ft)	Q (cfs)	h (ft)	h_{hs} (ft)	Slope	Helley Smith d50 (mm)	Helley Smith d35 (mm)	Helley Smith d65 (mm)	W (ft)	Vmean (ft/s)
4/6/1994	0.0673	78.7	1.200	0.3	0.0065	1.21	0.86	1.68	30.90	2.17
4/6/1994	0.1110	78.7	1.200	0.3	0.0065	1.41	1.09	1.83	30.90	2.17
4/12/1994	0.0246	91.6	1.230	0.3	0.0065	0.81	0.66	0.99	31.40	2.22
4/12/1994	0.0072	91.6	1.230	0.3	0.0065	0.78	0.60	1.02	31.40	2.22
4/20/1994	0.1974	285.0	1.990	0.3	0.0065	1.15	0.84	1.59	34.50	4.75
4/20/1994	0.2243	285.0	1.990	0.3	0.0065	1.20	0.90	1.58	34.50	4.75
5/3/1994	0.0359	148.0	1.630	0.3	0.0065	2.29	1.16	2.96	32.30	3.00
5/3/1994	0.0288	148.0	1.630	0.3	0.0065	0.96	0.75	1.35	32.30	3.00
5/5/1994	0.3041	161.0	1.690	0.3	0.0065	1.60	1.10	2.46	32.00	3.03
5/5/1994	0.3097	161.0	1.690	0.3	0.0065	1.47	1.15	1.87	32.00	3.03
5/9/1994	0.0761	170.0	1.700	0.3	0.0065	1.62	1.21	2.22	32.70	3.14
5/9/1994	0.0419	170.0	1.700	0.3	0.0065	0.85	0.68	1.11	32.70	3.14
5/10/1994	0.1917	166.0	1.690	0.3	0.0065	2.79	1.54	61.50	32.60	3.09
5/10/1994	0.1488	166.0	1.690	0.3	0.0065	1.50	1.16	1.96	32.60	3.09
5/12/1994	0.0599	151.0	1.640	0.3	0.0065	1.34	1.05	1.71	32.20	2.85
5/12/1994	0.0274	151.0	1.640	0.3	0.0065	0.93	0.72	1.27	32.20	2.85
5/16/1994	0.0121	100.0	1.380	0.3	0.0065	1.33	1.11	1.59	31.60	2.33
5/16/1994	0.0136	100.0	1.380	0.3	0.0065	0.88	0.71	1.13	31.60	2.33
5/17/1994	0.1154	164.0	1.650	0.3	0.0065	1.36	1.09	1.69	32.40	3.02
5/17/1994	0.1343	164.0	1.650	0.3	0.0065	1.41	1.09	1.83	32.40	3.02
5/20/1994	0.3260	139.0	1.600	0.3	0.0065	1.26	0.98	1.62	31.90	2.83
5/20/1994	0.2533	139.0	1.600	0.3	0.0065	1.31	1.05	1.63	31.90	2.83
5/23/1994	0.1260	110.0	1.400	0.3	0.0065	1.05	0.77	1.57	31.90	2.42
5/23/1994	0.1508	110.0	1.400	0.3	0.0065	1.28	0.95	1.72	31.90	2.42
5/24/1994	0.0244	107.0	1.430	0.3	0.0065	1.22	0.94	1.57	31.60	2.35
5/24/1994	0.0402	107.0	1.430	0.3	0.0065	1.12	0.87	1.41	31.60	2.35
5/25/1994	0.0091	104.0	1.410	0.3	0.0065	0.89	0.65	1.20	31.50	2.32
5/25/1994	0.0195	104.0	1.410	0.3	0.0065	0.91	0.72	1.19	31.50	2.32
5/26/1994	0.0105	94.6	1.350	0.3	0.0065	2.08	1.44	2.64	31.40	2.21
5/26/1994	0.0117	94.6	1.350	0.3	0.0065	1.01	0.77	1.34	31.40	2.21
5/31/1994	0.0037	78.7	1.290	0.3	0.0065	0.50	0.40	0.66	31.00	1.96
5/31/1994	0.0165	78.7	1.290	0.3	0.0065	0.74	0.62	0.88	31.00	1.96
6/2/1994	0.0338	90.1	1.360	0.3	0.0065	0.83	0.68	1.02	31.40	2.20
6/2/1994	0.0280	90.1	1.360	0.3	0.0065	0.64	0.50	0.81	31.40	2.20
6/6/1994	0.0099	77.3	1.210	0.3	0.0065	0.81	0.68	0.96	31.00	1.98
6/6/1994	0.0166	77.3	1.210	0.3	0.0065	0.75	0.64	0.87	31.00	1.98
6/9/1994	0.0175	73.2	1.190	0.3	0.0065	0.92	0.71	1.24	30.90	1.92
6/9/1994	0.0039	73.2	1.190	0.3	0.0065	0.72	0.59	0.87	30.90	1.92
6/22/1994	0.0085	75.9	1.150	0.3	0.0065	0.88	0.64	1.19	31.10	2.12
6/22/1994	0.0033	75.9	1.150	0.3	0.0065	0.54	0.42	0.69	31.10	2.12
6/27/1994	0.0024	62.8	1.160	0.3	0.0065	0.59	0.44	0.82	30.80	1.84
6/27/1994	0.0009	62.8	1.160	0.3	0.0065	0.57	0.43	0.79	30.80	1.84
7/28/1994	0.0000	17.2	0.790	0.3	0.0065	0.62	0.52	0.75	28.50	0.75
8/30/1994	0.0000	10.4	0.620	0.3	0.0065	0.77	0.59	1.02	27.80	0.61
8/30/1994	0.0000	10.4	0.620	0.3	0.0065	0.79	0.62	1.02	27.80	0.61
9/20/1994	0.0000	9.9	0.600	0.3	0.0065	0.85	0.66	1.15	27.50	0.56
9/20/1994	0.0000	9.9	0.600	0.3	0.0065	0.61	0.51	0.73	27.50	0.56
4/3/1995	0.0082	44.7	1.070	0.3	0.0065	0.54	0.42	0.67	29.50	1.38
4/3/1995	0.0034	44.7	1.070	0.3	0.0065	0.56	0.44	0.70	29.50	1.38
4/12/1995	0.0048	79.6	1.290	0.3	0.0065	0.70	0.51	0.95	31.10	2.11
4/12/1995	0.0116	79.6	1.290	0.3	0.0065	1.38	1.12	1.70	31.10	2.11
4/17/1995	0.0058	78.2	1.280	0.3	0.0065	0.83	0.60	1.15	31.00	2.07
4/17/1995	0.0058	78.2	1.280	0.3	0.0065	1.01	0.70	1.49	31.00	2.07
4/27/1995	0.0323	90.3	1.320	0.3	0.0065	1.51	1.20	1.89	31.30	2.23
4/27/1995	0.0040	90.3	1.320	0.3	0.0065	1.18	0.74	1.63	31.30	2.23
5/5/1995	0.0582	216.0	1.870	0.3	0.0065	1.50	1.07	2.10	33.50	3.41
5/5/1995	0.0534	216.0	1.870	0.3	0.0065	0.94	0.69	1.35	33.50	3.41
5/8/1995	0.0689	353.0	1.950	0.3	0.0065	1.32	0.93	1.87	45.00	4.10
5/8/1995	0.0980	353.0	1.950	0.3	0.0065	1.31	1.00	1.73	45.00	4.10
5/11/1995	0.2320	327.0	1.940	0.3	0.0065	1.48	1.17	1.87	40.00	4.43
5/11/1995	0.0758	327.0	1.940	0.3	0.0065	1.11	0.84	1.41	40.00	4.43
5/12/1995	0.0295	321.0	1.800	0.3	0.0065	1.83	1.33	2.53	43.80	4.12
5/12/1995	0.0779	321.0	1.800	0.3	0.0065	1.52	1.19	1.92	43.80	4.12
5/16/1995	0.0274	192.0	1.760	0.3	0.0065	0.85	0.61	1.32	32.70	3.18
5/16/1995	0.0376	192.0	1.760	0.3	0.0065	1.72	0.79	3.02	32.70	3.18
5/17/1995	0.0240	199.0	1.850	0.3	0.0065	1.16	0.84	1.62	33.00	3.37
5/17/1995	0.0742	199.0	1.850	0.3	0.0065	1.44	1.09	1.92	33.00	3.37
5/24/1995	0.0613	138.0	1.610	0.3	0.0065	0.97	0.77	1.27	32.00	2.82
5/24/1995	0.1434	138.0	1.610	0.3	0.0065	1.43	1.16	1.76	32.00	2.82
5/25/1995	0.0349	130.0	1.580	0.3	0.0065	0.80	0.66	0.97	31.80	2.65
5/25/1995	0.0191	130.0	1.580	0.3	0.0065	0.80	0.65	0.98	31.80	2.65
6/1/1995	0.0456	100.0	1.380	0.3	0.0065	1.11	0.80	1.45	31.60	2.36
6/1/1995	0.0329	100.0	1.380	0.3	0.0065	1.17	0.89	1.51	31.60	2.36
6/8/1995	0.0245	131.0	1.550	0.3	0.0065	1.00	0.67	1.39	31.80	2.70
6/8/1995	0.0425	131.0	1.550	0.3	0.0065	2.59	1.24	37.51	31.80	2.70
6/13/1995	0.0057	91.1	1.330	0.3	0.0065	0.78	0.61	0.98	31.20	2.23
6/13/1995	0.0120	91.1	1.330	0.3	0.0065	1.17	0.88	1.47	31.20	2.23
6/22/1995	0.0033	91.8	1.430	0.3	0.0065	0.64	0.48	0.86	31.80	2.22
6/22/1995	0.0110	91.8	1.430	0.3	0.0065	1.06	0.77	1.33	31.80	2.22
6/30/1995	0.0014	47.4	1.080	0.3	0.0065	0.89	0.71	1.14	29.80	1.47
6/30/1995	0.0007	47.4	1.080	0.3	0.0065	0.57	0.43	0.77	29.80	1.47
7/3/1995	0.1226	165.0	1.770	0.3	0.0065	2.28	1.67	2.87	32.80	3.29
7/3/1995	0.0384	165.0	1.770	0.3	0.0065	1.48	1.09	2.00	32.80	3.29
7/24/1995	0.0020	36.0	1.000	0.3	0.0065	1.12	0.84	1.39	29.70	1.27
7/24/1995	0.0002	36.0	1.000	0.3	0.0065	0.84	0.59	1.21	29.70	1.27
8/3/1995	0.0006	25.3	0.910	0.3	0.0065	0.84	0.53	1.34	29.30	0.99
8/3/1995	0.0002	25.3	0.910	0.3	0.0065	2.30	1.61	2.95	29.30	0.99
10/11/1995	0.0002	21.1	0.810	0.3	0.0065	0.59	0.45	0.76	28.50	0.90
4/10/1996	0.4700	453.0	2.680	0.3	0.0065	1.42	1.07	1.89	40.00	4.00
4/24/1996	0.0521	278.0	1.750	0.3	0.0065	0.98	0.75	1.40	40.30	3.86
5/13/1996	0.0808	271.0	1.740	0.3	0.0065	1.28	0.97	1.66	40.00	3.87
5/16/1996	0.1833	487.0	2.860	0.3	0.0065	0.98	0.74	1.35	40.20	4.20
5/19/1996	0.5647	646.0	3.130	0.3	0.0065	1.50	1.13	2.00	40.20	4.82
6/11/1996	0.0244	145.0	1.580	0.3	0.0065	0.60	0.45	0.79	32.30	3.04
6/28/1996	0.0290	81.2	1.230	0.3	0.0065	1.33	1.01	1.75	31.00	2.14
3/28/1997	0.0214	114.0	1.440	0.3	0.0065	1.17	0.83	1.70	30.70	2.74
4/30/1997	0.0423	345.0	2.050	0.3	0.0065	0.70	0.58	0.85	38.50	4.16
5/10/1997	0.0527	393.0	2.340	0.3	0.0065	0.84	0.66	1.10	38.50	4.18
5/13/1997	0.1559	474.0	2.710	0.3	0.0065	1.22	0.91	1.59	39.50	4.42
6/9/1997	0.0165	147.0	1.460	0.3	0.0065	1.33	0.82	2.46	32.30	3.12
6/23/1997	0.0047	102.0	1.270	0.3	0.0065	0.58	0.45	0.74	31.60	2.54
7/27/1997	0.0017	59.7	1.010	0.3	0.0065	0.31	0.25	0.43	30.50	1.82

Table C.41. Data from Marsh Creek, ID

Date	q_{hs} (tons/day-ft)	Q (cfs)	h (ft)	h_{hs} (ft)	Slope	Helley Smith d50 (mm)	Helley Smith d35 (mm)	Helley Smith d65 (mm)	W (ft)	Vmean (ft/s)
5/17/1994	0.0677	243.0	1.900	0.3	0.0067	1.63	1.29	2.08	38.40	3.35
5/17/1994	0.0487	243.0	1.900	0.3	0.0067	2.22	1.59	3.82	38.40	3.35
5/17/1994	0.0651	243.0	1.900	0.3	0.0067	1.90	1.44	2.56	38.40	3.35
5/19/1994	0.0307	188.0	1.590	0.3	0.0067	22.65	2.11	25.12	38.40	3.11
5/19/1994	0.0230	188.0	1.590	0.3	0.0067	2.37	1.72	3.50	38.40	3.11
5/19/1994	0.0223	188.0	1.590	0.3	0.0067	1.96	1.52	2.75	38.40	3.11
5/27/1994	0.0615	239.0	1.760	0.3	0.0067	2.46	1.70	3.62	39.00	3.65
5/27/1994	0.0890	239.0	1.760	0.3	0.0067	1.66	1.28	2.19	39.00	3.65
5/30/1994	0.0422	174.0	1.560	0.3	0.0067	1.61	1.27	2.16	37.20	2.90
5/30/1994	0.0704	174.0	1.560	0.3	0.0067	1.64	1.29	2.11	37.20	2.90
6/5/1994	0.0143	153.0	1.520	0.3	0.0067	1.99	1.55	2.93	38.40	2.45
6/5/1994	0.0030	153.0	1.520	0.3	0.0067	1.50	1.12	2.23	38.40	2.45
6/9/1994	0.0061	119.0	1.350	0.3	0.0067	1.42	1.16	1.80	36.40	2.31
6/9/1994	0.0018	119.0	1.350	0.3	0.0067	1.47	1.20	1.83	36.40	2.31
6/11/1994	0.0019	96.3	1.330	0.3	0.0067	1.27	1.03	1.62	35.10	1.99
6/11/1994	0.0014	96.3	1.330	0.3	0.0067	0.97	0.72	1.26	35.10	1.99
5/8/1995	0.1326	188.0	1.280	0.3	0.0067	2.63	1.58	9.93	53.60	2.84
5/8/1995	0.2257	188.0	1.280	0.3	0.0067	5.12	2.49	9.50	53.60	2.84
5/10/1995	0.0501	221.0	1.110	0.3	0.0067	1.10	0.81	1.51	52.50	3.57
5/10/1995	0.0844	221.0	1.110	0.3	0.0067	1.41	1.04	2.06	52.50	3.57
5/11/1995	0.1244	280.0	1.250	0.3	0.0067	2.72	1.46	6.92	55.80	4.08
5/11/1995	0.1688	280.0	1.250	0.3	0.0067	1.51	1.06	2.10	55.80	4.08
5/12/1995	0.1130	268.0	1.210	0.3	0.0067	1.48	1.05	2.07	57.10	3.97
5/12/1995	0.1580	268.0	1.210	0.3	0.0067	1.74	1.21	2.62	57.10	3.97
5/16/1995	0.3888	346.0	1.320	0.3	0.0067	1.46	0.93	2.51	64.30	4.14
5/16/1995	0.4588	346.0	1.320	0.3	0.0067	1.88	1.20	3.25	64.30	4.14
5/21/1995	0.1304	509.0	1.620	0.3	0.0067	1.98	1.24	3.78	79.00	3.81
5/21/1995	0.1173	509.0	1.620	0.3	0.0067	3.10	1.52	9.52	79.00	3.81
5/22/1995	0.1116	521.0	1.700	0.3	0.0067	2.16	1.30	4.08	79.60	3.77
5/22/1995	0.1307	521.0	1.700	0.3	0.0067	2.08	1.32	3.75	79.60	3.77
5/24/1995	0.0792	510.0	1.630	0.3	0.0067	3.89	1.62	22.76	79.50	3.87
5/24/1995	0.0594	510.0	1.630	0.3	0.0067	1.95	1.36	2.94	79.50	3.87
5/26/1995	0.1112	489.0	1.520	0.3	0.0067	2.25	1.52	3.72	79.40	4.10
5/26/1995	0.1248	489.0	1.520	0.3	0.0067	2.43	1.63	3.89	79.40	4.10
5/28/1995	0.0366	421.0	1.600	0.3	0.0067	1.84	1.24	3.10	79.00	3.18
5/28/1995	0.0552	421.0	1.600	0.3	0.0067	2.08	1.40	3.45	79.00	3.18
5/29/1995	0.0359	474.0	1.580	0.3	0.0067	1.27	0.89	1.89	79.40	3.65
5/29/1995	0.1474	474.0	1.580	0.3	0.0067	1.92	1.32	2.95	79.40	3.65
5/30/1995	0.0776	582.0	1.740	0.3	0.0067	1.64	1.12	2.56	80.00	3.90
5/30/1995	0.0871	582.0	1.740	0.3	0.0067	2.29	1.46	3.97	80.00	3.90
6/4/1995	0.2703	821.0	3.000	0.3	0.0067	2.12	1.32	3.78	48.10	6.03
6/4/1995	0.1684	821.0	3.000	0.3	0.0067	1.85	1.24	2.98	48.10	6.03
6/6/1995	0.7027	821.0	3.060	0.3	0.0067	3.49	2.04	6.45	48.10	5.88
6/6/1995	0.8087	821.0	3.060	0.3	0.0067	3.42	2.44	4.98	48.10	5.88
6/8/1995	0.0649	569.0	1.830	0.3	0.0067	8.21	3.32	23.42	80.00	3.82
6/8/1995	0.2550	569.0	1.830	0.3	0.0067	23.36	8.81	25.67	80.00	3.82
6/8/1995	0.1613	569.0	1.830	0.3	0.0067	7.34	2.95	14.84	80.00	3.82
6/11/1995	0.1511	475.0	1.670	0.3	0.0067	2.11	1.32	3.58	79.40	3.78
6/11/1995	0.0893	475.0	1.670	0.3	0.0067	3.54	1.90	8.54	79.40	3.78
6/13/1995	0.1756	661.0	1.980	0.3	0.0067	3.65	1.62	14.55	82.00	4.11
6/13/1995	0.2110	661.0	1.980	0.3	0.0067	2.53	1.49	5.76	82.00	4.11
6/20/1995	0.0670	567.0	1.770	0.3	0.0067	1.61	1.10	2.46	80.20	3.94
6/20/1995	0.0894	567.0	1.770	0.3	0.0067	1.82	1.25	2.77	80.20	3.94
6/26/1995	0.0621	567.0	1.850	0.3	0.0067	1.97	1.26	3.12	80.50	3.83
6/26/1995	0.0718	567.0	1.850	0.3	0.0067	1.48	1.04	2.20	80.50	3.83
7/4/1995	0.0319	401.0	1.500	0.3	0.0067	1.70	1.13	2.53	78.60	3.63
7/4/1995	0.0198	401.0	1.500	0.3	0.0067	1.96	1.34	3.21	78.60	3.63

Table C.42. Data from Middle Fork Salmon River

Date	q_{hs} (tons/day-ft)	Q (cfs)	h (ft)	h_{hs} (ft)	Slope	Helley Smith d50 (mm)	Helley Smith d35 (mm)	Helley Smith d65 (mm)	W (ft)	Vmean (ft/s)
5/13/1997	2.3709	11700.0	5.820	0.3	0.0041	1.02	0.75	1.73	213.00	9.28
5/13/1997	4.2207	11700.0	5.820	0.3	0.0041	3.40	1.55	15.62	213.00	9.28
5/15/1997	7.0909	13500.0	6.271	0.3	0.0041	10.70	5.83	16.99	220.00	10.73
5/15/1997	8.2727	13500.0	6.271	0.3	0.0041	5.47	2.67	12.87	220.00	10.73
5/16/1997	9.9808	14600.0	6.229	0.3	0.0041	14.52	6.75	32.68	222.43	6.23
5/16/1997	6.8035	14400.0	6.192	0.3	0.0041	2.09	1.15	4.89	221.95	6.19
5/17/1997	3.1422	15300.0	6.432	0.3	0.0041	0.73	0.57	0.94	221.50	11.23
5/17/1997	7.5847	15300.0	6.432	0.3	0.0041	2.75	1.33	7.76	221.50	11.23
5/18/1997	18.4893	15000.0	6.302	0.3	0.0041	9.20	3.64	18.06	223.37	6.30
5/18/1997	10.9914	14800.0	6.265	0.3	0.0041	8.93	4.11	19.00	222.90	6.27
5/22/1997	3.8611	12300.0	5.783	0.3	0.0041	2.60	1.19	10.74	216.52	5.78
5/22/1997	8.0824	12300.0	5.783	0.3	0.0041	24.68	18.11	33.77	216.52	5.78
5/24/1997	1.1748	11300.0	5.575	0.3	0.0041	0.83	0.62	1.26	213.66	5.57
5/24/1997	1.9096	11300.0	5.575	0.3	0.0041	1.68	0.97	4.03	213.66	5.57
5/26/1997	2.5877	9810.0	5.289	0.3	0.0041	3.08	1.38	18.06	211.00	8.37
5/26/1997	0.8578	9910.0	5.289	0.3	0.0041	0.87	0.66	1.26	211.00	8.37
5/27/1997	1.4203	8850.0	4.871	0.3	0.0041	12.92	3.52	23.17	207.00	8.44
5/27/1997	1.0386	8930.0	4.871	0.3	0.0041	29.84	7.73	38.81	207.00	8.44
5/28/1997	1.9689	8330.0	4.885	0.3	0.0041	26.39	13.82	37.24	203.67	4.89
5/28/1997	8.0032	8330.0	4.885	0.3	0.0041	13.92	7.07	21.91	203.67	4.89
5/29/1997	0.4802	8830.0	5.010	0.3	0.0041	0.90	0.66	1.37	205.54	5.01
5/29/1997	2.9252	8900.0	5.027	0.3	0.0041	17.82	8.70	24.95	205.80	5.03
5/30/1997	1.0736	9890.0	5.153	0.3	0.0041	1.25	0.83	1.94	210.50	8.80
5/30/1997	3.5392	10000.0	5.153	0.3	0.0041	3.06	1.84	5.19	210.50	8.80
5/31/1997	5.3189	10900.0	5.488	0.3	0.0041	14.46	8.06	20.93	212.45	5.49
5/31/1997	6.8056	11100.0	5.532	0.3	0.0041	10.69	3.91	19.69	213.06	5.53
6/2/1997	1.6901	12100.0	5.742	0.3	0.0041	1.35	0.82	10.60	215.96	5.74
6/2/1997	4.7818	11900.0	5.701	0.3	0.0041	12.45	3.57	24.18	215.40	5.70
6/3/1997	9.1163	11200.0	5.588	0.3	0.0041	11.72	5.81	19.31	215.00	8.99
6/3/1997	1.4651	11200.0	5.588	0.3	0.0041	3.65	1.07	19.61	215.00	8.99
6/4/1997	2.0649	11600.0	5.638	0.3	0.0041	1.48	0.95	2.57	214.54	5.64
6/4/1997	9.6953	11600.0	5.638	0.3	0.0041	6.19	3.81	10.14	214.54	5.64
6/5/1997	2.5779	12000.0	5.722	0.3	0.0041	7.22	1.87	16.58	215.68	5.72
6/5/1997	7.7429	12000.0	5.722	0.3	0.0041	12.91	7.79	20.94	215.68	5.72
6/6/1997	1.1999	11200.0	5.553	0.3	0.0041	2.03	1.18	4.58	213.36	5.55
6/6/1997	5.4837	11200.0	5.553	0.3	0.0041	14.63	7.91	25.46	213.36	5.55
6/7/1997	1.8828	10900.0	5.488	0.3	0.0041	29.39	13.45	46.94	212.45	5.49
6/7/1997	1.9562	10800.0	5.466	0.3	0.0041	35.43	22.75	42.30	212.14	5.47
6/12/1997	0.8949	11600.0	5.638	0.3	0.0041	1.30	0.81	2.89	214.54	5.64
6/12/1997	2.1097	11500.0	5.617	0.3	0.0041	2.77	1.49	5.36	214.25	5.62
6/19/1997	0.3038	8800.0	5.002	0.3	0.0041	1.69	1.02	3.29	205.43	5.00
6/19/1997	0.1838	8700.0	4.978	0.3	0.0041	1.07	0.76	1.60	205.06	4.98
6/20/1997	0.2029	7830.0	4.616	0.3	0.0041	1.47	0.96	2.45	204.50	8.40
6/20/1997	0.1355	7830.0	4.616	0.3	0.0041	1.17	0.83	1.70	204.50	8.40
6/22/1997	0.0331	6510.0	4.390	0.3	0.0041	0.81	0.61	1.13	195.94	4.39
6/22/1997	0.0185	6490.0	4.385	0.3	0.0041	0.60	0.46	0.78	195.84	4.38
6/23/1997	0.0178	6000.0	4.210	0.3	0.0041	0.64	0.49	0.83	198.50	7.48
6/23/1997	0.0280	6020.0	4.210	0.3	0.0041	0.71	0.55	0.91	198.50	7.48
6/24/1997	0.1531	5380.0	3.864	0.3	0.0041	43.69	38.97	48.99	196.60	7.00
6/24/1997	0.0081	5290.0	3.864	0.3	0.0041	0.69	0.52	0.91	196.60	7.00
6/25/1997	0.0112	5000.0	3.916	0.3	0.0041	0.86	0.63	1.25	187.98	3.92
6/25/1997	0.0067	4980.0	3.910	0.3	0.0041	0.65	0.50	0.84	187.87	3.91
6/26/1997	0.0174	4790.0	3.987	0.3	0.0041	0.95	0.71	1.34	183.30	6.49
6/26/1997	0.0064	4920.0	3.987	0.3	0.0041	0.74	0.55	1.02	183.30	6.49

Table C.43. Data from North Fork Clear River

Date	q_{hs} (tons/day-ft)	Q (cfs)	h (ft)	h_{hs} (ft)	Slope	Helley Smith d50 (mm)	Helley Smith d35 (mm)	Helley Smith d65 (mm)	W (ft)	Vmean (ft/s)
4/20/1994	0.0948	10500.0	7.892	0.3	0.0005	0.72	0.56	0.93	265.69	5.08
4/20/1994	0.1177	10600.0	7.918	0.3	0.0005	0.71	0.54	0.94	265.90	5.11
4/23/1994	0.0575	11600.0	8.164	0.3	0.0005	0.65	0.50	0.84	268.00	5.38
4/23/1994	0.0324	11500.0	8.140	0.3	0.0005	0.60	0.46	0.79	267.80	5.36
4/25/1994	0.0678	11100.0	8.042	0.3	0.0005	0.70	0.55	0.89	266.97	5.25
4/25/1994	0.0552	9980.0	7.758	0.3	0.0005	0.72	0.57	0.92	264.51	4.94
4/28/1994	0.0102	6930.0	6.855	0.3	0.0005	0.64	0.50	0.81	256.25	4.00
4/28/1994	0.0137	6910.0	6.849	0.3	0.0005	0.68	0.54	0.84	256.19	4.00
5/2/1994	0.0051	5520.0	6.347	0.3	0.0005	0.63	0.48	0.84	251.23	3.51
5/2/1994	0.0030	5490.0	6.335	0.3	0.0005	0.53	0.41	0.68	251.11	3.50
5/5/1994	0.0089	5640.0	6.393	0.3	0.0005	0.68	0.52	0.88	251.70	3.56
5/5/1994	0.0067	5630.0	6.389	0.3	0.0005	0.67	0.53	0.85	251.66	3.55
5/9/1994	0.0097	8630.0	7.385	0.3	0.0005	0.71	0.52	0.98	261.19	4.54
5/9/1994	0.0352	8640.0	7.388	0.3	0.0005	0.84	0.61	1.19	261.22	4.54
5/11/1994	0.0070	8750.0	7.419	0.3	0.0005	0.65	0.51	0.82	261.50	4.58
5/11/1994	0.0217	8710.0	7.408	0.3	0.0005	0.71	0.54	0.95	261.40	4.57
5/14/1994	0.0089	7250.0	6.961	0.3	0.0005	0.97	0.69	1.38	257.26	4.11
5/14/1994	0.0045	7210.0	6.948	0.3	0.0005	0.66	0.52	0.83	257.14	4.10
5/17/1994	0.0016	5830.0	6.465	0.3	0.0005	0.55	0.42	0.73	252.43	3.63
5/17/1994	0.0027	5800.0	6.454	0.3	0.0005	0.79	0.62	1.02	252.31	3.62
5/18/1994	0.0064	6170.0	6.591	0.3	0.0005	0.82	0.61	1.11	253.68	3.75
5/18/1994	0.0043	6150.0	6.583	0.3	0.0005	0.73	0.56	0.95	253.60	3.74
5/23/1994	0.0032	5040.0	6.154	0.3	0.0005	0.88	0.68	1.17	249.25	3.34
5/23/1994	0.0007	5020.0	6.146	0.3	0.0005	1.41	1.12	1.79	249.16	3.33
5/26/1994	0.0017	4860.0	6.078	0.3	0.0005	0.71	0.57	0.87	248.46	3.27
5/26/1994	0.0051	4840.0	6.070	0.3	0.0005	0.89	0.69	1.20	248.37	3.26
5/31/1994	0.0013	3830.0	5.607	0.3	0.0005	0.77	0.61	0.99	243.37	2.85
5/31/1994	0.0014	3840.0	5.612	0.3	0.0005	0.98	0.71	1.33	243.42	2.85
6/3/1994	0.0007	3860.0	5.622	0.3	0.0005	0.48	0.38	0.65	243.53	2.86
6/3/1994	0.0009	3840.0	5.612	0.3	0.0005	0.67	0.52	0.87	243.42	2.85
6/6/1994	0.0032	3950.0	5.666	0.3	0.0005	1.17	0.83	1.63	244.02	2.90
6/6/1994	0.0016	3990.0	5.685	0.3	0.0005	0.54	0.38	0.86	244.24	2.92
6/13/1994	0.0006	3560.0	5.470	0.3	0.0005	0.47	0.36	0.70	241.82	2.73
6/13/1994	0.0011	3600.0	5.491	0.3	0.0005	0.76	0.60	0.97	242.06	2.75
5/1/1995	0.0016	4760.0	6.036	0.3	0.0005	0.63	0.48	0.82	248.01	3.23
5/1/1995	0.0018	4760.0	6.036	0.3	0.0005	0.83	0.64	1.10	248.01	3.23
5/4/1995	0.0248	6400.0	6.673	0.3	0.0005	1.28	0.90	1.77	254.48	3.83
5/4/1995	0.0089	6380.0	6.666	0.3	0.0005	0.63	0.48	0.83	254.42	3.82
5/8/1995	0.0400	8150.0	7.243	0.3	0.0005	0.75	0.59	0.97	259.89	4.39
5/8/1995	0.0412	8140.0	7.240	0.3	0.0005	0.84	0.60	1.17	259.87	4.39
5/11/1995	0.0485	9710.0	7.686	0.3	0.0005	0.71	0.54	0.92	263.88	4.86
5/11/1995	0.0652	9720.0	7.689	0.3	0.0005	0.74	0.55	0.98	263.91	4.86
5/15/1995	0.0248	7710.0	7.108	0.3	0.0005	0.77	0.59	1.00	258.64	4.26
5/15/1995	0.0599	7700.0	7.105	0.3	0.0005	1.18	0.82	1.69	258.61	4.25
5/18/1995	0.0358	8900.0	7.462	0.3	0.0005	16.70	1.43	20.30	261.89	4.62
5/18/1995	0.0508	8870.0	7.454	0.3	0.0005	0.80	0.62	1.06	261.81	4.61
5/22/1995	0.0183	8570.0	7.367	0.3	0.0005	0.70	0.54	0.91	261.03	4.52
5/22/1995	0.0303	8580.0	7.370	0.3	0.0005	0.91	0.71	1.21	261.06	4.53
5/25/1995	0.0204	8220.0	6.910	0.3	0.0005	0.74	0.57	0.96	259.00	4.56
5/25/1995	0.1004	8220.0	6.910	0.3	0.0005	1.14	0.84	1.51	259.00	4.56
5/30/1995	0.0346	8510.0	7.350	0.3	0.0005	0.91	0.70	1.22	260.87	4.51
5/30/1995	0.0134	8490.0	7.344	0.3	0.0005	0.66	0.51	0.86	260.82	4.50
6/2/1995	0.0211	8930.0	7.471	0.3	0.0005	0.73	0.57	0.94	261.97	4.63
6/2/1995	0.0099	8850.0	7.448	0.3	0.0005	0.83	0.62	1.14	261.76	4.61
6/4/1995	0.0273	9030.0	7.499	0.3	0.0005	0.83	0.64	1.15	262.22	4.66
6/4/1995	0.0230	9050.0	7.505	0.3	0.0005	0.69	0.54	0.88	262.27	4.67
6/5/1995	0.0510	9230.0	7.555	0.3	0.0005	1.09	0.77	1.64	262.72	4.72
6/5/1995	0.0307	9310.0	7.577	0.3	0.0005	0.85	0.63	1.27	262.92	4.74
6/7/1995	0.0289	7020.0	6.885	0.3	0.0005	1.22	0.87	1.70	256.54	4.03
6/7/1995	0.0148	7010.0	6.882	0.3	0.0005	0.81	0.63	1.05	256.51	4.03
6/15/1995	0.0127	5110.0	6.183	0.3	0.0005	0.80	0.63	1.03	249.55	3.36
6/15/1995	0.0063	5110.0	6.183	0.3	0.0005	0.81	0.62	1.06	249.55	3.36
6/19/1995	0.0030	4660.0	5.993	0.3	0.0005	0.79	0.62	1.03	247.56	3.19
6/19/1995	0.0042	4680.0	6.001	0.3	0.0005	0.74	0.59	0.94	247.65	3.20
6/22/1995	0.0076	4500.0	5.922	0.3	0.0005	0.87	0.67	1.15	246.80	3.13
6/22/1995	0.0049	4470.0	5.909	0.3	0.0005	0.87	0.65	1.18	246.66	3.11
12/1/1995	8.4678	33700.0	11.719	0.3	0.0005	5.28	1.50	13.69	294.05	9.93
12/1/1995	20.0964	34400.0	11.801	0.3	0.0005	3.61	1.64	11.39	294.58	10.04
12/4/1995	0.7634	14700.0	8.850	0.3	0.0005	0.81	0.62	1.11	279.00	5.79
12/4/1995	0.3620	14800.0	8.850	0.3	0.0005	0.68	0.54	0.86	279.00	5.79
5/17/1997	0.7416	32800.0	12.650	0.3	0.0005	19.90	1.30	36.83	298.00	8.62
5/17/1997	1.4195	32400.0	12.650	0.3	0.0005	3.78	1.56	13.31	298.00	8.62

Table C.44. Data from Rapid River, ID

Date	q_{hs} (tons/day-ft)	Q (cfs)	h (ft)	h_{hs} (ft)	Slope	Helley Smith d50 (mm)	Helley Smith d35 (mm)	Helley Smith d65 (mm)	W (ft)	Vmean (ft/s)
3/2/1994	0.0008	52.6	0.760	0.3	0.0122	1.13	0.69	1.98	46.40	1.51
4/7/1994	0.0011	55.3	0.720	0.3	0.0122	0.92	0.61	2.03	46.50	1.63
4/7/1994	0.0150	55.3	0.720	0.3	0.0122	1.45	0.87	2.71	46.50	1.63
5/10/1994	0.0403	342.0	1.660	0.3	0.0122	1.11	0.74	1.78	58.50	3.53
5/10/1994	0.0937	342.0	1.660	0.3	0.0122	1.30	0.86	2.01	58.50	3.53
5/11/1994	0.0655	342.0	1.680	0.3	0.0122	1.68	1.03	3.09	58.50	3.49
5/11/1994	0.1231	342.0	1.680	0.3	0.0122	2.21	1.20	6.68	58.50	3.49
5/19/1994	0.0072	235.0	1.480	0.3	0.0122	1.52	0.86	3.62	53.80	2.96
5/19/1994	0.0046	235.0	1.480	0.3	0.0122	0.79	0.60	1.03	53.80	2.96
5/25/1994	0.0123	252.0	1.380	0.3	0.0122	1.33	0.87	2.05	57.00	3.20
5/25/1994	0.0147	252.0	1.380	0.3	0.0122	1.13	0.78	1.75	57.00	3.20
5/27/1994	0.0191	289.0	1.440	0.3	0.0122	1.23	0.75	2.19	59.30	3.49
5/27/1994	0.0093	289.0	1.440	0.3	0.0122	0.64	0.47	0.87	59.30	3.49
6/1/1994	0.0060	248.0	1.440	0.3	0.0122	1.15	0.78	1.73	55.00	3.21
6/1/1994	0.0017	248.0	1.440	0.3	0.0122	0.67	0.50	0.90	55.00	3.21
6/3/1994	0.0041	226.0	1.310	0.3	0.0122	0.80	0.60	1.13	54.10	3.17
6/3/1994	0.0029	226.0	1.310	0.3	0.0122	1.36	0.84	2.13	54.10	3.17
7/24/1994	0.0068	81.2	0.920	0.3	0.0122	2.08	1.37	3.05	48.40	1.93
7/24/1994	0.0084	81.2	0.920	0.3	0.0122	1.55	1.13	2.16	48.40	1.93
8/24/1994	0.0004	63.8	0.860	0.3	0.0122	0.82	0.58	1.26	46.70	1.59
6/7/1994	0.0176	223.0	1.480	0.3	0.0122	1.52	1.01	2.40	52.00	2.90
6/7/1994	0.0041	223.0	1.480	0.3	0.0122	1.55	0.96	2.74	52.00	2.90
6/9/1994	0.0117	185.0	1.320	0.3	0.0122	1.46	1.00	2.16	52.00	2.75
6/9/1994	0.0024	185.0	1.320	0.3	0.0122	0.98	0.64	1.50	52.00	2.75
6/14/1994	0.0024	191.0	1.370	0.3	0.0122	1.32	0.87	1.91	50.00	2.81
6/14/1994	0.0086	191.0	1.370	0.3	0.0122	1.24	0.90	1.70	50.00	2.81
6/29/1994	0.0022	135.0	1.230	0.3	0.0122	1.10	0.74	1.81	48.00	2.33
6/29/1994	0.0024	135.0	1.230	0.3	0.0122	1.08	0.77	1.61	48.00	2.33
10/25/1994	0.0053	53.7	0.830	0.3	0.0122	2.88	1.39	7.95	45.80	1.40
12/5/1994	0.0001	32.3	0.630	0.3	0.0122	1.19	1.02	1.39	44.00	1.18
2/24/1995	0.0170	62.4	0.990	0.3	0.0122	3.61	2.02	5.24	45.00	1.38
2/24/1995	0.0309	62.4	0.990	0.3	0.0122	4.44	2.30	6.12	45.00	1.38
3/30/1995	0.0053	91.4	1.000	0.3	0.0122	1.09	0.79	1.46	48.80	1.86
3/30/1995	0.0033	91.4	1.000	0.3	0.0122	1.25	0.83	1.87	48.80	1.86
4/13/1995	0.0403	160.0	1.260	0.3	0.0122	1.69	1.21	2.68	52.80	2.37
4/13/1995	0.0508	160.0	1.260	0.3	0.0122	1.95	1.30	3.35	52.80	2.37
4/20/1995	0.0062	121.0	1.110	0.3	0.0122	1.23	0.91	1.60	51.20	2.11
4/20/1995	0.0027	121.0	1.110	0.3	0.0122	1.02	0.73	1.45	51.20	2.11
4/26/1995	0.0029	118.0	1.120	0.3	0.0122	1.35	0.89	2.03	51.20	2.12
4/26/1995	0.0118	118.0	1.120	0.3	0.0122	1.31	0.97	1.74	51.20	2.12
5/12/1995	0.0267	373.0	1.610	0.3	0.0122	0.89	0.59	1.46	59.20	3.89
5/12/1995	0.0213	373.0	1.610	0.3	0.0122	1.10	0.69	1.86	59.20	3.89
5/15/1995	0.0221	346.0	1.500	0.3	0.0122	1.24	0.80	1.96	59.40	3.87
5/15/1995	0.0079	346.0	1.500	0.3	0.0122	1.15	0.77	1.71	59.40	3.87
5/25/1995	0.1906	527.0	1.860	0.3	0.0122	1.56	0.97	2.65	61.90	4.66
5/25/1995	0.0843	527.0	1.860	0.3	0.0122	1.50	0.88	3.25	61.90	4.66
5/30/1995	0.2177	638.0	2.230	0.3	0.0122	5.87	1.95	20.70	58.80	4.86
5/30/1995	0.1338	638.0	2.230	0.3	0.0122	2.19	1.34	3.79	58.80	4.86
5/10/1995	0.0209	346.0	1.695	0.3	0.0122	1.62	0.86	4.32	56.33	3.68
5/10/1995	0.0790	346.0	1.695	0.3	0.0122	2.95	1.59	7.82	56.33	3.68
5/23/1995	0.1045	516.0	1.870	0.3	0.0122	1.85	1.09	3.67	62.00	4.57
5/23/1995	0.1613	516.0	1.870	0.3	0.0122	1.04	0.64	1.81	62.00	4.57
6/12/1995	0.1231	557.0	1.900	0.3	0.0122	1.52	0.89	2.97	62.00	4.86
6/12/1995	0.0902	557.0	1.900	0.3	0.0122	1.24	0.80	1.88	62.00	4.86
6/7/1995	0.0841	584.0	1.930	0.3	0.0122	1.31	0.85	1.95	63.70	4.89
6/7/1995	0.5086	584.0	1.930	0.3	0.0122	6.69	2.86	16.40	63.70	4.89
6/17/1995	0.4475	878.0	2.440	0.3	0.0122	1.70	0.98	3.24	61.00	5.63
6/17/1995	0.7443	878.0	2.440	0.3	0.0122	2.11	1.20	4.06	61.00	5.63
6/20/1995	0.1110	597.0	1.900	0.3	0.0122	37.20	13.89	40.32	61.60	5.19
6/20/1995	0.3101	597.0	1.900	0.3	0.0122	4.80	2.37	8.68	61.60	5.19
6/23/1995	0.0633	500.0	2.000	0.3	0.0122	0.91	0.58	1.51	55.00	4.46
6/23/1995	0.0756	500.0	2.000	0.3	0.0122	0.93	0.56	1.57	55.00	4.46
6/27/1995	0.4623	640.0	1.990	0.3	0.0122	1.75	1.13	2.95	62.30	5.34
6/27/1995	0.1576	640.0	1.990	0.3	0.0122	1.85	1.20	3.19	62.30	5.34
6/29/1995	0.0867	555.0	2.070	0.3	0.0122	1.07	0.71	1.59	57.00	4.95
6/29/1995	0.0686	555.0	2.070	0.3	0.0122	0.96	0.60	1.56	57.00	4.95
7/6/1995	0.0175	453.0	1.780	0.3	0.0122	1.32	0.80	2.40	60.70	4.29
7/6/1995	0.0288	453.0	1.780	0.3	0.0122	1.65	1.08	2.72	60.70	4.29
7/10/1995	0.0967	442.0	1.740	0.3	0.0122	1.98	1.35	3.11	60.50	4.35
7/10/1995	0.0177	442.0	1.740	0.3	0.0122	1.39	0.87	2.20	60.50	4.35
8/3/1995	0.0667	189.0	1.380	0.3	0.0122	6.03	2.04	16.73	52.90	2.61
8/3/1995	0.0067	189.0	1.380	0.3	0.0122	1.45	0.88	2.70	52.90	2.61
7/21/1995	0.0043	271.0	1.520	0.3	0.0122	0.73	0.50	1.09	56.00	3.27
7/21/1995	0.0130	271.0	1.520	0.3	0.0122	1.58	1.05	2.39	56.00	3.27
8/23/1995	0.0069	134.0	1.170	0.3	0.0122	2.06	1.10	3.73	51.10	2.24
8/23/1995	0.0280	134.0	1.170	0.3	0.0122	4.72	2.66	7.42	51.10	2.24
9/12/1995	0.0041	99.2	1.060	0.3	0.0122	2.21	1.23	4.07	49.20	2.00
10/5/1995	0.0019	84.0	0.970	0.3	0.0122	1.95	1.25	2.71	48.80	1.86
11/29/1995	0.0314	106.0	1.040	0.3	0.0122	1.12	0.80	1.52	49.40	1.99
3/6/1996	0.0084	89.6	0.940	0.3	0.0122	0.89	0.63	1.39	49.10	1.93
4/12/1996	0.0321	237.0	1.380	0.3	0.0122	2.56	1.53	4.18	58.20	3.05
4/30/1996	0.0066	233.0	1.440	0.3	0.0122	0.68	0.51	0.92	58.20	2.79
5/16/1996	3.4639	986.0	2.400	0.3	0.0122	8.89	4.47	14.47	63.80	6.48
5/23/1996	0.1538	572.0	1.950	0.3	0.0122	1.39	0.84	2.46	61.00	4.97
5/29/1996	0.1180	589.0	1.970	0.3	0.0122	3.62	2.19	7.08	61.00	4.89
6/3/1996	0.9388	709.0	2.130	0.3	0.0122	8.96	3.67	19.05	60.50	5.33
6/10/1996	1.6508	946.0	2.430	0.3	0.0122	8.45	4.99	13.90	63.00	6.27
6/27/1996	0.0467	472.0	1.820	0.3	0.0122	0.49	0.40	0.70	61.00	4.38
7/16/1996	0.0084	299.0	1.450	0.3	0.0122	1.13	0.77	1.64	58.50	3.53
8/15/1996	0.0011	137.0	1.170	0.3	0.0122	0.78	0.57	1.12	50.50	2.33
10/2/1996	0.0011	96.6	1.067	0.3	0.0122	0.77	0.61	0.99	48.27	1.90
2/25/1997	0.0003	87.0	0.980	0.3	0.0122	0.41	0.32	0.54	46.20	1.91
5/2/1997	0.0179	275.0	1.480	0.3	0.0122	0.52	0.41	0.71	58.50	3.19
5/17/1997	7.2093	1300.0	2.710	0.3	0.0122	7.58	3.92	13.08	64.50	7.20
5/23/1997	1.2180	837.0	2.490	0.3	0.0122	4.79	2.70	8.17	61.00	5.61
6/3/1997	0.3904	942.0	2.420	0.3	0.0122	5.19	2.48	11.50	62.50	6.09
6/5/1997	0.4540	935.0	2.410	0.3	0.0122	3.48	2.27	5.31	63.00	6.23
6/19/1997	0.0560	691.0	2.080	0.3	0.0122	1.99	1.26	3.07	62.00	5.47
7/3/1997	0.0044	380.0	1.600	0.3	0.0122	1.32	0.79	2.60	59.00	4.04
9/30/1997	0.0039	118.0	1.190	0.3	0.0122	2.23	1.41	2.79	48.00	2.07

Table C.45. Data from South Fork Payette River, ID

Date	q_{hs} (tons/day-ft)	Q (cfs)	h (ft)	h_{hs} (ft)	Slope	Helley Smith d50 (mm)	Helley Smith d35 (mm)	Helley Smith d65 (mm)	W (ft)	Vmean (ft/s)
4/18/1994	0.0333	846.0	1.630	0.3	0.0040	0.43	0.35	0.54	163.41	3.20
4/18/1994	0.0771	846.0	1.630	0.3	0.0040	9.54	1.25	18.60	163.41	3.20
4/20/1994	0.1878	1270.0	1.858	0.3	0.0040	0.64	0.51	0.80	178.39	3.86
4/20/1994	0.2848	1270.0	1.858	0.3	0.0040	0.71	0.59	0.86	178.39	3.86
4/25/1994	0.0946	1180.0	1.910	0.3	0.0040	0.73	0.56	0.96	167.00	3.76
4/25/1994	0.0280	1180.0	1.910	0.3	0.0040	0.64	0.54	0.77	167.00	3.76
4/27/1994	0.0353	925.0	1.677	0.3	0.0040	0.75	0.58	0.97	166.59	3.33
4/27/1994	0.1195	925.0	1.677	0.3	0.0040	1.04	0.76	1.57	166.59	3.33
5/2/1994	0.1837	721.0	1.548	0.3	0.0040	1.80	1.06	16.07	157.86	2.97
5/2/1994	0.4067	721.0	1.548	0.3	0.0040	8.76	1.78	21.07	157.86	2.97
5/4/1994	0.1755	721.0	1.548	0.3	0.0040	1.59	1.02	4.17	157.86	2.97
5/4/1994	0.0798	721.0	1.548	0.3	0.0040	0.98	0.74	1.37	157.86	2.97
5/9/1994	0.2187	1710.0	2.044	0.3	0.0040	0.56	0.43	0.72	190.23	4.43
5/9/1994	0.1404	1710.0	2.044	0.3	0.0040	1.36	0.82	32.13	190.23	4.43
5/11/1994	0.3391	2110.0	2.187	0.3	0.0040	0.61	0.48	0.77	199.07	4.88
5/11/1994	0.4350	2110.0	2.187	0.3	0.0040	0.73	0.57	0.93	199.07	4.88
5/14/1994	0.3612	2150.0	2.201	0.3	0.0040	1.18	0.77	36.35	199.88	4.92
5/14/1994	0.3537	2150.0	2.201	0.3	0.0040	1.25	0.78	32.13	199.88	4.92
5/16/1994	0.0882	1630.0	2.013	0.3	0.0040	0.64	0.53	0.78	188.27	4.33
5/16/1994	0.0961	1630.0	2.013	0.3	0.0040	0.69	0.57	0.83	188.27	4.33
5/17/1994	0.0919	1500.0	1.960	0.3	0.0040	0.65	0.53	0.79	184.92	4.17
5/17/1994	0.1168	1500.0	1.960	0.3	0.0040	0.83	0.65	1.12	184.92	4.17
5/23/1994	0.0312	1040.0	1.742	0.3	0.0040	0.78	0.58	1.07	170.86	3.52
5/23/1994	0.0431	1040.0	1.742	0.3	0.0040	1.28	1.05	1.56	170.86	3.52
5/25/1994	0.0827	1250.0	1.848	0.3	0.0040	0.84	0.64	1.14	177.78	3.83
5/25/1994	0.0911	1250.0	1.848	0.3	0.0040	0.99	0.72	1.50	177.78	3.83
5/31/1994	0.1294	1520.0	1.968	0.3	0.0040	0.72	0.56	0.93	185.45	4.19
5/31/1994	0.0836	1520.0	1.968	0.3	0.0040	0.64	0.50	0.82	185.45	4.19
6/2/1994	0.2765	1550.0	1.981	0.3	0.0040	1.96	0.92	20.34	186.24	4.23
6/2/1994	0.1256	1550.0	1.981	0.3	0.0040	0.68	0.55	0.84	186.24	4.23
6/6/1994	0.0741	1310.0	1.876	0.3	0.0040	0.73	0.59	0.90	179.59	3.91
6/6/1994	0.0590	1310.0	1.876	0.3	0.0040	0.69	0.55	0.86	179.59	3.91
6/13/1994	0.1600	1050.0	1.747	0.3	0.0040	0.99	0.75	1.38	171.21	3.53
6/13/1994	0.1781	1050.0	1.747	0.3	0.0040	1.30	0.87	2.03	171.21	3.53
5/1/1995	0.0553	1230.0	1.838	0.3	0.0040	0.78	0.63	0.97	177.17	3.80
5/1/1995	0.2049	1230.0	1.838	0.3	0.0040	1.13	0.84	1.46	177.17	3.80
5/2/1995	0.0508	1330.0	1.885	0.3	0.0040	0.72	0.58	0.89	180.18	3.94
5/2/1995	0.0411	1330.0	1.885	0.3	0.0040	0.68	0.55	0.84	180.18	3.94
5/8/1995	0.3472	1680.0	2.033	0.3	0.0040	0.96	0.74	1.26	189.51	4.39
5/8/1995	0.1604	1680.0	2.033	0.3	0.0040	0.90	0.68	1.21	189.51	4.39
5/9/1995	0.2239	1780.0	2.491	0.3	0.0040	0.79	0.65	0.96	163.00	4.33
5/9/1995	0.2429	1780.0	2.491	0.3	0.0040	0.88	0.69	1.19	163.00	4.33
5/16/1995	0.3070	2140.0	2.197	0.3	0.0040	0.74	0.59	0.92	199.68	4.91
5/16/1995	0.5158	2140.0	2.197	0.3	0.0040	0.83	0.65	1.10	199.68	4.91
5/17/1995	1.0414	2490.0	2.858	0.3	0.0040	0.95	0.73	1.30	169.00	5.05
5/17/1995	1.7219	2490.0	2.858	0.3	0.0040	1.23	0.86	1.78	169.00	5.05
5/22/1995	0.8397	3050.0	2.463	0.3	0.0040	0.83	0.67	1.07	215.56	5.78
5/23/1995	1.2108	3050.0	2.463	0.3	0.0040	0.98	0.73	1.78	215.56	5.78
5/23/1995	2.8670	3050.0	2.463	0.3	0.0040	5.39	1.45	16.92	215.56	5.78
5/25/1995	1.5843	2790.0	2.393	0.3	0.0040	1.07	0.80	1.56	211.45	5.55
5/25/1995	1.0404	2790.0	2.393	0.3	0.0040	0.75	0.61	0.91	211.45	5.55
5/30/1995	1.8210	3290.0	2.524	0.3	0.0040	0.98	0.72	1.85	219.12	5.99
5/30/1995	2.3686	3290.0	2.524	0.3	0.0040	1.17	0.81	1.78	219.12	5.99
5/31/1995	1.7756	3630.0	3.724	0.3	0.0040	51.33	1.10	32.93	156.00	6.47
6/3/1995	0.9544	4160.0	2.722	0.3	0.0040	39.09	28.29	50.10	230.51	6.67
6/4/1995	0.7096	4210.0	2.732	0.3	0.0040	37.09	22.28	51.12	231.10	6.71
6/4/1995	0.6750	4210.0	2.732	0.3	0.0040	20.54	12.79	29.26	231.10	6.71
6/5/1995	1.2333	4710.0	2.833	0.3	0.0040	63.79	38.69	78.72	236.77	7.07
6/5/1995	0.9629	4710.0	2.833	0.3	0.0040	1.17	0.72	27.36	236.77	7.07
6/14/1995	0.1085	3930.0	2.672	0.3	0.0040	22.70	16.76	30.73	227.69	6.50
6/14/1995	0.5182	3930.0	2.672	0.3	0.0040	0.99	0.69	19.17	227.69	6.50
6/19/1995	0.7382	3710.0	2.623	0.3	0.0040	0.75	0.61	0.91	224.88	6.33
6/19/1995	1.6142	3710.0	2.623	0.3	0.0040	1.89	0.99	10.41	224.88	6.33
6/20/1995	0.6933	3200.0	2.501	0.3	0.0040	0.81	0.63	1.07	217.81	5.91
6/20/1995	1.0652	3200.0	2.501	0.3	0.0040	1.75	0.90	11.16	217.81	5.91
6/26/1995	0.8171	3640.0	2.607	0.3	0.0040	22.58	2.97	36.33	223.95	6.27
6/26/1995	0.6966	3640.0	2.607	0.3	0.0040	1.71	0.82	28.38	223.95	6.27
6/27/1995	0.6243	4310.0	2.753	0.3	0.0040	22.44	1.00	66.68	232.28	6.78
6/27/1995	0.7922	4310.0	2.753	0.3	0.0040	1.95	0.92	18.01	232.28	6.78
5/17/1997	3.2147	6390.0	3.125	0.3	0.0040	1.14	0.85	1.54	252.90	8.14
5/17/1997	3.8790	6390.0	3.125	0.3	0.0040	0.97	0.75	1.34	252.90	8.14

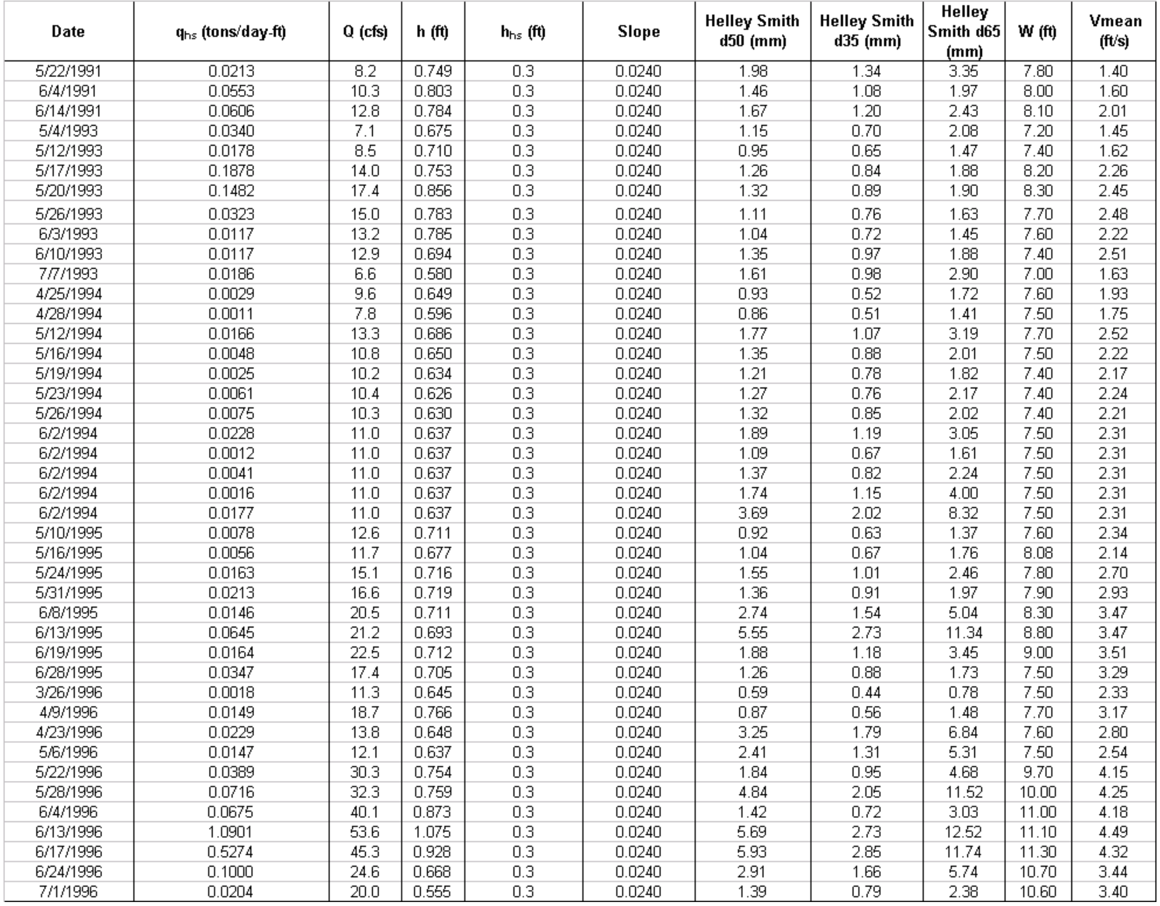
Table C.46. Data from South Fork Red River, ID

Date	q_{hs} (tons/day-ft)	Q (cfs)	h (ft)	h_{hs} (ft)	Slope	Helley Smith d50 (mm)	Helley Smith d35 (mm)	Helley Smith d65 (mm)	W (ft)	Vmean (ft/s)
4/5/1994	0.0057	37.9	0.860	0.3	0.0146	1.13	0.85	1.46	26.80	1.64
4/5/1994	0.0013	37.9	0.860	0.3	0.0146	0.66	0.53	0.83	26.80	1.64
4/13/1994	0.0014	43.1	0.880	0.3	0.0146	0.62	0.47	0.82	26.70	1.83
4/13/1994	0.0013	43.1	0.880	0.3	0.0146	0.70	0.54	0.90	26.70	1.83
4/21/1994	0.1045	150.0	1.620	0.3	0.0146	1.18	0.89	1.53	29.00	3.08
4/21/1994	0.1331	150.0	1.620	0.3	0.0146	1.12	0.84	1.50	29.00	3.08
4/26/1994	0.0538	134.0	1.580	0.3	0.0146	1.21	0.88	1.63	29.00	2.88
4/26/1994	0.0410	134.0	1.580	0.3	0.0146	1.39	0.92	2.24	29.00	2.88
5/2/1994	0.0183	97.3	1.380	0.3	0.0146	1.25	0.86	1.86	27.50	2.79
5/2/1994	0.0293	97.3	1.380	0.3	0.0146	1.38	0.99	1.93	27.50	2.79
5/4/1994	0.0017	88.6	1.390	0.3	0.0146	0.71	0.56	0.90	27.60	2.42
5/4/1994	0.0019	88.6	1.390	0.3	0.0146	0.70	0.57	0.86	27.60	2.42
5/9/1994	0.0359	101.0	1.440	0.3	0.0146	1.18	0.86	1.64	28.10	2.65
5/9/1994	0.0142	101.0	1.440	0.3	0.0146	1.14	0.83	1.62	28.10	2.65
5/12/1994	0.0110	102.0	1.370	0.3	0.0146	0.83	0.69	1.03	27.90	2.61
5/12/1994	0.0322	102.0	1.370	0.3	0.0146	1.34	1.08	1.66	27.90	2.61
5/16/1994	0.0127	71.1	1.240	0.3	0.0146	1.09	0.82	1.45	27.30	2.04
5/16/1994	0.0034	71.1	1.240	0.3	0.0146	0.91	0.71	1.26	27.30	2.04
5/17/1994	0.0081	92.0	1.350	0.3	0.0146	0.99	0.74	1.46	27.70	2.58
5/17/1994	0.0034	92.0	1.350	0.3	0.0146	0.80	0.63	1.03	27.70	2.58
5/20/1994	0.0663	90.3	1.370	0.3	0.0146	3.17	2.17	4.71	27.30	2.39
5/20/1994	0.0284	90.3	1.370	0.3	0.0146	1.37	1.07	1.76	27.30	2.39
5/23/1994	0.0037	69.7	1.230	0.3	0.0146	1.14	0.81	1.61	27.10	2.08
5/23/1994	0.0010	69.7	1.230	0.3	0.0146	0.72	0.57	0.90	27.10	2.08
5/24/1994	0.0003	68.2	1.230	0.3	0.0146	0.61	0.48	0.76	27.30	2.00
5/25/1994	0.0003	65.4	1.210	0.3	0.0146	0.71	0.55	0.93	27.10	1.90
5/25/1994	0.0004	65.4	1.210	0.3	0.0146	0.89	0.66	1.19	27.10	1.90
6/1/1994	0.0033	75.7	1.270	0.3	0.0146	1.12	0.85	1.40	27.10	2.07
6/1/1994	0.0124	75.7	1.270	0.3	0.0146	1.36	1.09	1.71	27.10	2.07
6/14/1994	0.0002	47.6	1.060	0.3	0.0146	0.58	0.43	0.76	27.00	1.67
6/14/1994	0.0004	47.6	1.060	0.3	0.0146	0.80	0.62	1.04	27.00	1.67
6/27/1994	0.0168	44.2	1.010	0.3	0.0146	0.90	0.71	1.20	26.80	1.57
6/27/1994	0.0014	44.2	1.010	0.3	0.0146	0.53	0.40	0.65	26.80	1.57
7/12/1994	0.0021	22.5	0.720	0.3	0.0146	1.10	0.85	1.37	26.60	1.18
7/12/1994	0.0002	22.5	0.720	0.3	0.0146	0.78	0.53	1.16	26.60	1.18
7/28/1994	0.0001	12.8	0.560	0.3	0.0146	0.58	0.44	0.75	26.20	0.89
7/28/1994	0.0001	12.8	0.560	0.3	0.0146	1.27	0.77	2.29	26.20	0.89
8/29/1994	0.0003	7.3	0.520	0.3	0.0146	1.26	0.90	1.69	24.80	0.55
8/29/1994	0.0007	7.3	0.520	0.3	0.0146	0.79	0.61	1.05	24.80	0.55
9/20/1994	0.0003	5.9	0.430	0.3	0.0146	1.33	1.18	1.50	24.40	0.56
9/20/1994	0.0001	5.9	0.430	0.3	0.0146	0.71	0.50	1.00	24.40	0.56
4/5/1995	0.0089	39.2	1.150	0.3	0.0146	0.93	0.72	1.28	21.50	1.68
4/5/1995	0.0021	39.2	1.150	0.3	0.0146	1.05	0.76	1.40	21.50	1.68
4/13/1995	0.0019	62.6	1.150	0.3	0.0146	0.64	0.50	0.83	27.10	2.02
4/13/1995	0.0072	62.6	1.150	0.3	0.0146	1.16	0.80	1.67	27.10	2.02
4/20/1995	0.0101	51.9	1.090	0.3	0.0146	1.02	0.77	1.30	26.80	1.89
4/20/1995	0.0034	51.9	1.090	0.3	0.0146	0.99	0.76	1.30	26.80	1.89
4/25/1995	0.0072	54.4	1.090	0.3	0.0146	0.80	0.63	1.02	26.80	1.87
4/25/1995	0.0036	54.4	1.090	0.3	0.0146	0.84	0.65	1.10	26.80	1.87
5/3/1995	0.0519	126.0	1.470	0.3	0.0146	1.06	0.76	1.42	28.30	2.95
5/3/1995	0.0551	126.0	1.470	0.3	0.0146	1.12	0.82	1.47	28.30	2.95
5/10/1995	0.0156	230.0	1.810	0.3	0.0146	1.08	0.79	1.44	34.50	3.89
5/10/1995	0.0130	230.0	1.810	0.3	0.0146	0.90	0.70	1.20	34.50	3.89
5/12/1995	0.0281	227.0	1.790	0.3	0.0146	1.97	1.35	3.36	34.50	3.78
5/12/1995	0.0345	227.0	1.790	0.3	0.0146	1.70	1.19	2.59	34.50	3.78
5/16/1995	0.0143	170.0	1.699	0.3	0.0146	1.12	0.81	1.49	28.58	3.49
5/16/1995	0.0228	170.0	1.699	0.3	0.0146	1.29	0.92	1.80	28.58	3.49
5/18/1995	0.0269	186.0	1.650	0.3	0.0146	1.28	0.91	1.75	29.00	3.37
5/18/1995	0.0707	186.0	1.650	0.3	0.0146	1.65	1.19	2.48	29.00	3.37
5/23/1995	0.0232	162.0	1.700	0.3	0.0146	1.34	1.02	1.76	29.00	3.21
5/23/1995	0.0421	162.0	1.700	0.3	0.0146	1.54	1.13	2.16	29.00	3.21
5/25/1995	0.0133	140.0	1.580	0.3	0.0146	1.63	1.16	2.44	29.00	3.08
5/25/1995	0.0538	140.0	1.580	0.3	0.0146	1.61	1.24	2.14	29.00	3.08
5/31/1995	0.0076	115.0	1.530	0.3	0.0146	1.47	1.04	2.21	28.10	2.70
5/31/1995	0.0093	115.0	1.530	0.3	0.0146	1.41	1.01	1.98	28.10	2.70
6/6/1995	0.0225	125.0	1.640	0.3	0.0146	1.54	1.16	2.05	28.50	2.76
6/6/1995	0.0226	125.0	1.640	0.3	0.0146	1.44	1.02	2.11	28.50	2.76
6/14/1995	0.0260	88.1	1.380	0.3	0.0146	1.21	0.93	1.54	27.40	2.27
6/14/1995	0.0047	88.1	1.380	0.3	0.0146	0.99	0.74	1.34	27.40	2.27
6/20/1995	0.0017	76.3	1.310	0.3	0.0146	0.77	0.61	0.98	27.40	2.14
6/20/1995	0.0024	76.3	1.310	0.3	0.0146	1.19	0.90	1.52	27.40	2.14
7/6/1995	0.0004	43.8	1.070	0.3	0.0146	0.66	0.51	0.85	26.90	1.54
7/6/1995	0.0028	43.8	1.070	0.3	0.0146	1.10	0.86	1.35	26.90	1.54
7/17/1995	0.0003	30.4	0.930	0.3	0.0146	1.32	1.03	1.69	26.70	1.23
7/17/1995	0.0001	30.4	0.930	0.3	0.0146	1.00	0.66	1.52	26.70	1.23
7/31/1995	0.0002	21.6	0.720	0.3	0.0146	0.84	0.59	1.47	26.80	1.14
7/31/1995	0.0000	21.6	0.720	0.3	0.0146	0.71	0.52	0.97	26.80	1.14
8/7/1995	0.0004	18.8	0.710	0.3	0.0146	0.84	0.59	1.47	26.80	0.95
8/7/1995	0.0004	18.8	0.710	0.3	0.0146	1.42	0.69	2.27	26.80	0.95
8/15/1995	0.0001	19.0	0.670	0.3	0.0146	0.71	0.52	0.97	26.60	0.85
4/3/1996	0.0221	54.8	1.090	0.3	0.0146	1.00	0.78	1.27	27.10	1.84
4/11/1996	0.0426	302.0	2.000	0.3	0.0146	1.04	0.77	1.53	34.00	4.28
5/14/1996	0.0320	253.0	1.870	0.3	0.0146	1.23	0.86	1.77	32.80	3.81
5/17/1996	0.0806	389.0	2.260	0.3	0.0146	2.31	1.31	4.53	35.00	4.79
5/28/1996	0.0050	268.0	2.072	0.3	0.0146	0.75	0.58	0.96	29.20	4.41
6/17/1996	0.0076	105.0	1.240	0.3	0.0146	0.98	0.74	2.06	27.90	3.01
4/10/1997	0.0249	34.9	0.760	0.3	0.0146	0.96	0.74	1.32	26.90	1.69
5/2/1997	0.0067	99.2	1.450	0.3	0.0146	1.20	0.86	1.65	32.50	2.57
5/9/1997	0.0851	357.0	1.990	0.3	0.0146	1.33	0.90	2.00	34.20	4.54
5/11/1997	0.1072	328.0	2.130	0.3	0.0146	2.70	1.66	4.48	34.90	4.49
5/13/1997	0.1499	458.0	2.280	0.3	0.0146	1.46	0.95	2.34	34.50	5.29
6/6/1997	0.0151	170.0	1.610	0.3	0.0146	1.67	1.04	2.80	28.70	3.49
7/27/1997	0.0079	37.4	0.750	0.3	0.0146	0.82	0.66	1.04	27.00	1.83

Table C.47. Data from South Fork Salmon River, ID

Date	q_{hs} (tons/day-ft)	Q (cfs)	h (ft)	h_{hs} (ft)	Slope	Helley Smith d50 (mm)	Helley Smith d35 (mm)	Helley Smith d65 (mm)	W (ft)	Vmean (ft/s)
4/18/1985	0.0785	1270.0	4.270	0.3	0.0025	0.76	0.59	0.97	107.00	2.78
4/30/1985	0.0058	776.0	3.710	0.3	0.0025	0.73	0.57	0.93	103.00	2.03
4/30/1985	0.0121	776.0	3.710	0.3	0.0025	0.84	0.67	1.06	103.00	2.03
5/1/1985	0.0082	953.0	4.060	0.3	0.0025	0.62	0.48	0.81	103.00	2.28
5/2/1985	0.0738	1320.0	4.540	0.3	0.0025	0.99	0.71	1.38	107.00	2.72
5/7/1985	0.1111	1320.0	4.520	0.3	0.0025	0.92	0.72	1.22	108.00	2.70
5/8/1985	0.0468	1530.0	4.720	0.3	0.0025	0.66	0.52	0.83	109.00	2.98
5/9/1985	0.1019	1450.0	4.690	0.3	0.0025	0.76	0.63	0.92	108.00	2.87
5/15/1985	0.0562	1070.0	4.140	0.3	0.0025	0.80	0.65	0.98	105.00	2.46
5/16/1985	0.0086	1050.0	4.130	0.3	0.0025	0.60	0.46	0.78	106.00	2.40
5/17/1985	0.0500	1210.0	4.380	0.3	0.0025	0.89	0.69	1.18	106.00	2.61
5/21/1985	0.4636	1870.0	5.090	0.3	0.0025	0.91	0.71	1.25	110.00	3.34
5/22/1985	0.6875	2040.0	5.260	0.3	0.0025	0.93	0.73	1.24	112.00	3.46
5/22/1985	1.2857	2040.0	5.260	0.3	0.0025	0.79	0.63	0.97	112.00	3.46
5/23/1985	0.2035	2240.0	5.420	0.3	0.0025	0.68	0.56	0.84	113.00	3.65
5/23/1985	0.7115	2240.0	5.420	0.3	0.0025	1.02	0.76	1.32	113.00	3.65
5/29/1985	1.9725	1820.0	4.990	0.3	0.0025	1.49	1.16	1.92	109.00	3.35
5/29/1985	1.7248	1820.0	4.990	0.3	0.0025	1.64	1.30	2.10	109.00	3.35
5/30/1985	1.2963	1600.0	4.740	0.3	0.0025	1.51	1.17	1.95	108.00	3.13
5/31/1985	1.2407	1420.0	4.500	0.3	0.0025	1.66	1.28	2.18	108.00	2.92
6/5/1985	0.4259	1360.0	4.440	0.3	0.0025	1.52	1.19	1.95	108.00	2.83
6/6/1985	0.8545	1610.0	4.750	0.3	0.0025	1.48	1.18	1.86	110.00	3.08
6/7/1985	0.2182	1610.0	4.770	0.3	0.0025	1.05	0.79	1.40	110.00	3.12
6/11/1985	0.0943	1160.0	4.190	0.3	0.0025	0.82	0.67	1.02	106.00	2.61
6/12/1985	0.2358	1170.0	4.270	0.3	0.0025	1.11	0.85	1.43	106.00	2.58
6/17/1985	0.0752	841.0	3.770	0.3	0.0025	1.12	0.87	1.41	105.00	2.12
6/18/1985	0.1714	877.0	3.770	0.3	0.0025	1.00	0.79	1.34	105.00	2.21
6/19/1985	0.0962	804.0	3.670	0.3	0.0025	1.17	0.88	1.54	104.00	2.10
6/25/1985	0.0436	514.0	3.140	0.3	0.0025	1.02	0.79	1.40	101.00	1.62
6/26/1985	0.0882	490.0	3.060	0.3	0.0025	1.09	0.80	1.50	102.00	1.57
7/9/1985	0.0120	266.0	2.410	0.3	0.0025	1.49	1.28	1.75	100.00	1.10
7/10/1985	0.0058	258.0	2.350	0.3	0.0025	1.02	0.76	1.30	100.00	1.10
7/17/1985	0.0015	214.0	2.190	0.3	0.0025	1.18	0.87	1.57	99.00	0.99
7/18/1985	0.0002	211.0	2.160	0.3	0.0025	0.84	0.65	1.09	99.00	0.99
7/23/1985	0.0002	186.0	2.050	0.3	0.0025	0.59	0.46	0.77	99.00	0.92
7/30/1985	0.0016	185.0	2.030	0.3	0.0025	0.82	0.67	1.03	98.00	0.93
8/20/1985	0.0006	137.0	1.890	0.3	0.0025	1.12	0.82	1.53	97.00	0.75
4/22/1986	0.2243	1490.0	4.720	0.3	0.0025	0.96	0.75	1.26	107.00	2.95
4/23/1986	0.3604	1930.0	5.200	0.3	0.0025	2.02	1.34	2.73	111.00	3.34
4/24/1986	0.2569	1710.0	4.910	0.3	0.0025	0.78	0.63	0.97	109.00	3.20
4/25/1986	0.3364	1610.0	4.920	0.3	0.0025	0.94	0.72	1.24	107.00	3.06
4/29/1986	0.2075	1120.0	4.060	0.3	0.0025	1.01	0.78	1.30	106.00	2.60
5/20/1986	0.3727	1790.0	4.930	0.3	0.0025	0.82	0.65	1.03	110.00	3.30
5/21/1986	0.9469	2240.0	5.420	0.3	0.0025	0.83	0.65	1.11	113.00	3.66
5/22/1986	0.6696	1920.0	5.170	0.3	0.0025	0.76	0.62	0.95	112.00	3.32
5/23/1986	0.4495	1750.0	4.920	0.3	0.0025	0.79	0.63	0.99	109.00	3.26
5/26/1986	1.4956	2310.0	5.380	0.3	0.0025	1.52	1.03	2.23	113.00	3.80
5/27/1986	2.4870	3230.0	6.290	0.3	0.0025	1.16	0.82	1.62	115.00	4.47
5/29/1986	3.9478	4300.0	7.370	0.3	0.0025	1.06	0.75	1.55	115.00	5.08
5/30/1986	4.9924	5260.0	7.546	0.3	0.0025	1.41	1.02	1.94	116.98	5.94
6/2/1986	5.4263	4360.0	7.008	0.3	0.0025	1.66	1.16	2.38	115.73	5.36
6/3/1986	4.5785	4390.0	7.020	0.3	0.0025	1.67	1.13	2.43	121.00	5.16
6/6/1986	5.5009	2900.0	5.968	0.3	0.0025	1.77	1.31	2.43	113.07	4.28
6/7/1986	4.4248	2740.0	5.720	0.3	0.0025	1.58	1.18	2.17	113.00	4.24
6/8/1986	8.8791	3220.0	6.219	0.3	0.0025	1.77	1.34	2.46	113.75	4.54
6/10/1986	5.5135	2230.0	5.320	0.3	0.0025	1.58	1.18	2.15	111.00	3.78
6/24/1986	0.1359	891.0	3.790	0.3	0.0025	1.04	0.82	1.34	103.00	2.28
4/19/1994	0.0195	645.0	3.301	0.3	0.0025	0.63	0.49	0.81	103.79	1.88
4/19/1994	0.0148	645.0	3.301	0.3	0.0025	1.11	0.81	1.38	103.79	1.88
4/20/1994	0.0611	823.0	3.633	0.3	0.0025	1.15	0.87	1.43	105.24	2.14
4/20/1994	0.0516	823.0	3.633	0.3	0.0025	0.83	0.63	1.12	105.24	2.14
4/28/1994	0.0221	611.0	3.231	0.3	0.0025	0.99	0.77	1.28	103.47	1.82
4/28/1994	0.0198	611.0	3.231	0.3	0.0025	1.23	0.99	1.52	103.47	1.82
4/29/1994	0.0074	579.0	3.163	0.3	0.0025	0.87	0.68	1.15	103.15	1.77
4/29/1994	0.0106	579.0	3.163	0.3	0.0025	1.21	0.97	1.49	103.15	1.77
5/3/1994	0.0042	536.0	3.068	0.3	0.0025	1.04	0.79	1.30	102.70	1.69
5/3/1994	0.0125	536.0	3.068	0.3	0.0025	1.16	0.90	1.44	102.70	1.69
5/4/1994	0.0019	575.0	3.154	0.3	0.0025	0.54	0.42	0.69	103.11	1.76
5/4/1994	0.0225	575.0	3.154	0.3	0.0025	1.02	0.76	1.37	103.11	1.76
5/10/1994	0.0131	1370.0	4.441	0.3	0.0025	0.62	0.49	0.77	108.34	2.84
5/10/1994	0.0622	1370.0	4.441	0.3	0.0025	0.75	0.61	0.93	108.34	2.84
5/11/1994	0.0482	1490.0	4.590	0.3	0.0025	0.73	0.54	0.98	108.86	2.97
5/11/1994	0.0344	1490.0	4.590	0.3	0.0025	0.71	0.57	0.88	108.86	2.97
5/15/1994	0.0080	1090.0	4.059	0.3	0.0025	0.85	0.65	1.14	106.94	2.50
5/15/1994	0.0153	1090.0	4.059	0.3	0.0025	1.07	0.77	1.52	106.94	2.50
5/17/1994	0.0031	931.0	3.814	0.3	0.0025	0.68	0.50	0.92	105.98	2.29
5/17/1994	0.0640	931.0	3.814	0.3	0.0025	1.03	0.81	1.30	105.98	2.29
5/18/1994	0.0129	824.0	3.635	0.3	0.0025	0.94	0.75	1.20	105.25	2.15
5/18/1994	0.0053	824.0	3.635	0.3	0.0025	0.84	0.68	1.06	105.25	2.15
5/24/1994	0.0028	802.0	3.596	0.3	0.0025	0.69	0.53	0.89	105.09	2.11
5/24/1994	0.0044	802.0	3.596	0.3	0.0025	0.75	0.60	0.93	105.09	2.11
5/25/1994	0.0051	897.0	3.759	0.3	0.0025	1.05	0.73	1.42	105.76	2.25
5/25/1994	0.0025	897.0	3.759	0.3	0.0025	0.59	0.45	0.77	105.76	2.25
6/1/1994	0.0142	968.0	3.873	0.3	0.0025	1.43	1.17	1.75	106.22	2.34
6/1/1994	0.0088	968.0	3.873	0.3	0.0025	0.62	0.50	0.76	106.22	2.34
6/2/1994	0.0026	868.0	3.710	0.3	0.0025	0.74	0.55	1.01	105.56	2.21
6/2/1994	0.0053	868.0	3.710	0.3	0.0025	1.04	0.75	1.34	105.56	2.21
6/8/1994	0.0005	588.0	3.182	0.3	0.0025	0.56	0.43	0.72	103.24	1.78
6/8/1994	0.0045	588.0	3.182	0.3	0.0025	1.29	1.08	1.54	103.24	1.78
6/14/1994	0.0083	484.0	2.947	0.3	0.0025	1.01	0.79	1.27	102.10	1.60
6/14/1994	0.0057	484.0	2.947	0.3	0.0025	1.01	0.76	1.31	102.10	1.60
5/2/1995	0.0341	988.0	3.904	0.3	0.0025	0.95	0.76	1.22	106.34	2.37
5/2/1995	0.0238	988.0	3.904	0.3	0.0025	0.98	0.76	1.26	106.34	2.37
5/3/1995	0.0107	1030.0	3.969	0.3	0.0025	1.66	1.22	2.28	106.59	2.43
5/3/1995	0.0215	1030.0	3.969	0.3	0.0025	1.33	1.09	1.61	106.59	2.43
5/9/1995	0.0534	1690.0	4.824	0.3	0.0025	0.92	0.68	1.28	109.65	3.18
5/9/1995	0.0428	1690.0	4.824	0.3	0.0025	1.04	0.73	1.45	109.65	3.18
5/10/1995	0.1264	1710.0	4.910	0.3	0.0025	1.31	0.98	1.74	110.00	3.31
5/10/1995	0.1045	1710.0	4.910	0.3	0.0025	1.23	0.95	1.56	110.00	3.31
5/16/1995	1.2035	1700.0	4.835	0.3	0.0025	1.60	1.31	1.96	109.68	3.19
5/16/1995	2.2428	1700.0	4.835	0.3	0.0025	1.65	1.31	2.12	109.68	3.19
5/17/1995	3.1365	1880.0	5.031	0.3	0.0025	1.69	1.33	2.20	110.31	3.38
5/17/1995	1.3144	1880.0	5.031	0.3	0.0025	1.42	1.12	1.81	110.31	3.38
5/23/1995	1.4082	2530.0	5.655	0.3	0.0025	1.11	0.84	1.47	112.20	3.97
5/23/1995	0.9359	2530.0	5.655	0.3	0.0025	1.21	0.94	1.53	112.20	3.97
5/24/1995	1.6232	2500.0	5.629	0.3	0.0025	1.38	1.10	1.73	112.12	3.95
5/24/1995	2.6578	2500.0	5.629	0.3	0.0025	1.30	1.03	1.65	112.12	3.95
5/31/1995	0.2342	2930.0	5.992	0.3	0.0025	0.85	0.63	1.16	113.14	4.31
5/31/1995	0.2333	2930.0	5.992	0.3	0.0025	0.91	0.66	1.30	113.14	4.31
6/1/1995	0.4166	3110.0	6.134	0.3	0.0025	1.22	0.90	1.62	113.52	4.45
6/1/1995	0.1947	3110.0	6.134	0.3	0.0025	0.98	0.73	1.29	113.52	4.45
6/3/1995	0.8568	3360.0	6.324	0.3	0.0025	1.38	1.02	1.86	114.03	4.64
6/3/1995	1.7014	3360.0	6.324	0.3	0.0025	1.49	1.10	2.04	114.03	4.64
6/6/1995	1.9353	2940.0	6.000	0.3	0.0025	2.29	1.63	3.03	113.16	4.31
6/6/1995	2.9515	2940.0	6.000	0.3	0.0025	1.62	1.24	2.17	113.16	4.31
6/7/1995	2.1213	2350.0	5.493	0.3	0.0025	1.92	1.46	2.52	111.73	3.82
6/7/1995	1.6648	2350.0	5.493	0.3	0.0025	1.69	1.29	2.33	111.73	3.82
6/15/1995	0.2476	2410.0	5.548	0.3	0.0025	0.88	0.68	1.17	111.89	3.87
6/15/1995	0.0879	2410.0	5.548	0.3	0.0025	0.78	0.61	1.00	111.89	3.87
6/20/1995	0.1035	1830.0	4.978	0.3	0.0025	0.98	0.75	1.34	110.14	3.33
6/20/1995	0.0999	1830.0	4.978	0.3	0.0025	1.66	1.09	2.48	110.14	3.33
6/21/1995	0.1421	1710.0	4.860	0.3	0.0025	1.12	0.86	1.44	107.00	3.25
6/21/1995	0.2411	1710.0	4.860	0.3	0.0025	1.05	0.79	1.49	107.00	3.25
6/27/1995	0.1174	2020.0	5.175	0.3	0.0025	1.15	0.83	1.53	110.77	3.51
6/27/1995	0.1327	2020.0	5.175	0.3	0.0025	0.98	0.72	1.37	110.77	3.51
5/18/1997	8.9113	5050.0	7.425	0.3	0.0025	1.35	1.00	1.83	116.71	5.81
5/18/1997	8.1830	5050.0	7.425	0.3	0.0025	1.58	1.17	2.18	116.71	5.81

Table C.48. Data from Squaw Creek from USFS, ID

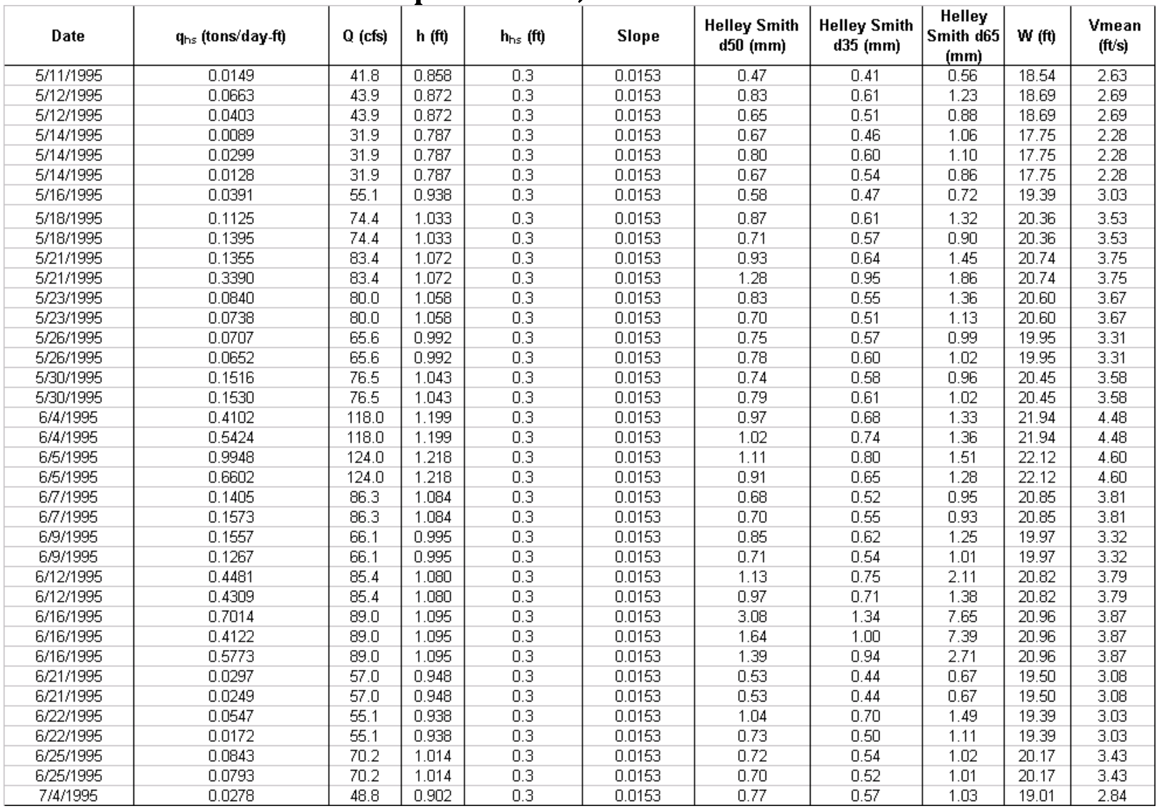


Date	q_{hs} (tons/day-ft)	Q (cfs)	h (ft)	h_{hs} (ft)	Slope	Helley Smith d50 (mm)	Helley Smith d35 (mm)	Helley Smith d65 (mm)	W (ft)	Vmean (ft/s)
5/22/1991	0.0213	8.2	0.749	0.3	0.0240	1.98	1.34	3.35	7.80	1.40
6/4/1991	0.0553	10.3	0.803	0.3	0.0240	1.46	1.08	1.97	8.00	1.60
6/14/1991	0.0606	12.8	0.784	0.3	0.0240	1.67	1.20	2.43	8.10	2.01
5/4/1993	0.0340	7.1	0.675	0.3	0.0240	1.15	0.70	2.08	7.20	1.45
5/12/1993	0.0178	8.5	0.710	0.3	0.0240	0.95	0.65	1.47	7.40	1.62
5/17/1993	0.1878	14.0	0.753	0.3	0.0240	1.26	0.84	1.88	8.20	2.26
5/20/1993	0.1482	17.4	0.856	0.3	0.0240	1.32	0.89	1.90	8.30	2.45
5/26/1993	0.0323	15.0	0.783	0.3	0.0240	1.11	0.76	1.63	7.70	2.48
6/3/1993	0.0117	13.2	0.785	0.3	0.0240	1.04	0.72	1.45	7.60	2.22
6/10/1993	0.0117	12.9	0.694	0.3	0.0240	1.35	0.97	1.88	7.40	2.51
7/7/1993	0.0186	6.6	0.580	0.3	0.0240	1.61	0.98	2.90	7.00	1.63
4/25/1994	0.0029	9.6	0.649	0.3	0.0240	0.93	0.52	1.72	7.60	1.93
4/28/1994	0.0011	7.8	0.596	0.3	0.0240	0.86	0.51	1.41	7.50	1.75
5/12/1994	0.0166	13.3	0.686	0.3	0.0240	1.77	1.07	3.19	7.70	2.52
5/16/1994	0.0048	10.8	0.650	0.3	0.0240	1.35	0.88	2.01	7.50	2.22
5/19/1994	0.0025	10.2	0.634	0.3	0.0240	1.21	0.78	1.82	7.40	2.17
5/23/1994	0.0061	10.4	0.626	0.3	0.0240	1.27	0.76	2.17	7.40	2.24
5/26/1994	0.0075	10.3	0.630	0.3	0.0240	1.32	0.85	2.02	7.40	2.21
6/2/1994	0.0228	11.0	0.637	0.3	0.0240	1.89	1.19	3.05	7.50	2.31
6/2/1994	0.0012	11.0	0.637	0.3	0.0240	1.09	0.67	1.61	7.50	2.31
6/2/1994	0.0041	11.0	0.637	0.3	0.0240	1.37	0.82	2.24	7.50	2.31
6/2/1994	0.0016	11.0	0.637	0.3	0.0240	1.74	1.15	4.00	7.50	2.31
6/2/1994	0.0177	11.0	0.637	0.3	0.0240	3.69	2.02	8.32	7.50	2.31
5/10/1995	0.0078	12.6	0.711	0.3	0.0240	0.92	0.63	1.37	7.60	2.34
5/16/1995	0.0056	11.7	0.677	0.3	0.0240	1.04	0.67	1.76	8.08	2.14
5/24/1995	0.0163	15.1	0.716	0.3	0.0240	1.55	1.01	2.46	7.80	2.70
5/31/1995	0.0213	16.6	0.719	0.3	0.0240	1.36	0.91	1.97	7.90	2.93
6/8/1995	0.0146	20.5	0.711	0.3	0.0240	2.74	1.54	5.04	8.30	3.47
6/13/1995	0.0645	21.2	0.693	0.3	0.0240	5.55	2.73	11.34	8.80	3.47
6/19/1995	0.0164	22.5	0.712	0.3	0.0240	1.88	1.18	3.45	9.00	3.51
6/28/1995	0.0347	17.4	0.705	0.3	0.0240	1.26	0.88	1.73	7.50	3.29
3/26/1996	0.0018	11.3	0.645	0.3	0.0240	0.59	0.44	0.78	7.50	2.33
4/9/1996	0.0149	18.7	0.766	0.3	0.0240	0.87	0.56	1.48	7.70	3.17
4/23/1996	0.0229	13.8	0.648	0.3	0.0240	3.25	1.79	6.84	7.60	2.80
5/6/1996	0.0147	12.1	0.637	0.3	0.0240	2.41	1.31	5.31	7.50	2.54
5/22/1996	0.0389	30.3	0.754	0.3	0.0240	1.84	0.95	4.68	9.70	4.15
5/28/1996	0.0716	32.3	0.759	0.3	0.0240	4.84	2.05	11.52	10.00	4.25
6/4/1996	0.0675	40.1	0.873	0.3	0.0240	1.42	0.72	3.03	11.00	4.18
6/13/1996	1.0901	53.6	1.075	0.3	0.0240	5.69	2.73	12.52	11.10	4.49
6/17/1996	0.5274	45.3	0.928	0.3	0.0240	5.93	2.85	11.74	11.30	4.32
6/24/1996	0.1000	24.6	0.668	0.3	0.0240	2.91	1.66	5.74	10.70	3.44
7/1/1996	0.0204	20.0	0.555	0.3	0.0240	1.39	0.79	2.38	10.60	3.40

Table C.49. Data from Squaw Creek from USGS, ID

Date	q_{hs} (tons/day-ft)	Q (cfs)	h (ft)	h_{hs} (ft)	Slope	Helley Smith d50 (mm)	Helley Smith d35 (mm)	Helley Smith d65 (mm)	W (ft)	Vmean (ft/s)
5/17/1994	0.0086	29.6	0.860	0.3	0.0100	0.66	0.53	0.87	22.80	1.50
5/17/1994	0.0030	29.6	0.860	0.3	0.0100	0.88	0.64	1.17	22.80	1.50
5/20/1994	0.0019	28.6	0.890	0.3	0.0100	0.93	0.69	1.25	22.30	1.44
5/20/1994	0.0021	28.6	0.890	0.3	0.0100	1.01	0.73	1.41	22.30	1.44
5/25/1994	0.0000	24.9	0.850	0.3	0.0100	0.46	0.36	0.67	22.50	1.31
5/25/1994	0.0008	24.9	0.850	0.3	0.0100	0.60	0.46	0.80	22.50	1.31
5/27/1994	0.0020	27.9	0.870	0.3	0.0100	0.54	0.44	0.67	22.50	1.44
5/27/1994	0.0024	27.9	0.870	0.3	0.0100	0.53	0.43	0.65	22.50	1.44
6/9/1994	0.0001	17.0	0.790	0.3	0.0100	0.50	0.41	0.76	21.00	1.03
6/12/1994	0.0002	14.1	0.750	0.3	0.0100	0.89	0.55	1.25	20.80	0.90
6/12/1994	0.0001	14.1	0.750	0.3	0.0100	0.61	0.52	0.74	20.80	0.90
4/26/1995	0.0337	28.3	1.020	0.3	0.0100	0.70	0.56	0.97	22.00	1.26
4/26/1995	0.0402	28.3	1.020	0.3	0.0100	0.63	0.51	0.83	22.00	1.26
4/29/1995	0.0175	32.6	1.030	0.3	0.0100	0.66	0.54	0.83	23.30	1.36
4/29/1995	0.0175	32.6	1.030	0.3	0.0100	0.84	0.67	1.05	23.30	1.36
5/4/1995	0.0266	34.3	1.070	0.3	0.0100	0.62	0.53	0.75	23.60	1.36
5/4/1995	0.0173	34.3	1.070	0.3	0.0100	0.68	0.54	0.90	23.60	1.36
5/5/1995	0.0022	35.7	1.080	0.3	0.0100	0.44	0.39	0.49	23.90	1.38
5/5/1995	0.0102	35.7	1.080	0.3	0.0100	0.61	0.50	0.78	23.90	1.38
5/6/1995	0.0431	48.8	1.230	0.3	0.0100	0.61	0.49	0.79	24.60	1.61
5/6/1995	0.0882	48.8	1.230	0.3	0.0100	0.58	0.48	0.70	24.60	1.61
5/8/1995	0.0069	51.0	1.250	0.3	0.0100	0.45	0.40	0.50	24.90	1.63
5/9/1995	0.0166	55.1	1.200	0.3	0.0100	0.57	0.46	0.70	25.60	1.79
5/9/1995	0.0248	55.1	1.200	0.3	0.0100	0.81	0.59	1.11	25.60	1.79
5/12/1995	0.0332	76.6	1.350	0.3	0.0100	0.51	0.44	0.62	26.10	2.16
5/12/1995	0.0414	76.6	1.350	0.3	0.0100	0.56	0.47	0.68	26.10	2.16
5/14/1995	0.0086	61.9	1.300	0.3	0.0100	0.68	0.53	0.93	24.80	1.92
5/14/1995	0.0073	61.9	1.300	0.3	0.0100	0.45	0.40	0.52	24.80	1.92
5/16/1995	0.0265	84.0	1.430	0.3	0.0100	0.65	0.50	0.91	25.90	2.27
5/16/1995	0.0216	84.0	1.430	0.3	0.0100	0.71	0.52	1.07	25.90	2.27
5/18/1995	0.0825	115.0	1.510	0.3	0.0100	2.09	1.11	4.40	28.00	2.70
5/18/1995	0.0529	115.0	1.510	0.3	0.0100	1.90	1.06	3.33	28.00	2.70
5/19/1995	0.3152	138.0	1.630	0.3	0.0100	2.68	1.65	5.61	28.20	2.99
5/19/1995	0.0855	138.0	1.630	0.3	0.0100	7.69	1.51	22.84	28.20	2.99
5/19/1995	0.1652	138.0	1.630	0.3	0.0100	1.71	1.06	3.79	28.20	2.99
5/21/1995	0.1267	156.0	1.560	0.3	0.0100	4.05	1.70	10.79	30.30	3.29
5/21/1995	0.0686	156.0	1.560	0.3	0.0100	1.41	0.90	2.42	30.30	3.29
5/22/1995	0.0577	154.0	1.580	0.3	0.0100	1.58	0.93	2.77	30.50	3.18
5/22/1995	0.1131	154.0	1.580	0.3	0.0100	4.30	2.20	9.22	30.50	3.18
5/23/1995	0.0406	161.0	1.580	0.3	0.0100	0.89	0.65	1.28	30.30	3.36
5/23/1995	0.0370	161.0	1.580	0.3	0.0100	0.70	0.54	0.94	30.30	3.36
5/24/1995	0.0532	138.0	1.620	0.3	0.0100	1.90	1.10	4.45	29.70	2.87
5/24/1995	0.0872	138.0	1.620	0.3	0.0100	3.88	1.87	11.29	29.70	2.87
5/29/1995	0.0489	128.0	1.540	0.3	0.0100	1.93	1.17	3.32	28.40	2.93
5/29/1995	0.1539	128.0	1.540	0.3	0.0100	10.29	3.21	23.78	28.40	2.93
5/29/1995	0.0268	128.0	1.540	0.3	0.0100	1.76	0.99	3.54	28.40	2.93
6/4/1995	0.5119	267.0	1.520	0.3	0.0100	1.06	0.72	1.90	46.10	3.80
6/4/1995	0.5900	267.0	1.520	0.3	0.0100	1.17	0.82	1.95	46.10	3.80
6/7/1995	0.1805	200.0	1.270	0.3	0.0100	1.00	0.66	2.00	44.60	3.51
6/7/1995	0.1471	200.0	1.270	0.3	0.0100	0.84	0.63	1.19	44.60	3.51
6/11/1995	0.1435	150.0	1.100	0.3	0.0100	0.95	0.62	2.41	42.30	3.22
6/11/1995	0.3310	150.0	1.100	0.3	0.0100	1.59	0.88	5.65	42.30	3.22
6/11/1995	0.4846	150.0	1.100	0.3	0.0100	1.31	0.86	2.17	42.30	3.22
6/14/1995	0.4283	252.0	1.490	0.3	0.0100	0.74	0.57	1.06	45.30	3.74
6/14/1995	0.5541	252.0	1.490	0.3	0.0100	0.99	0.71	2.24	45.30	3.74
6/16/1995	0.6058	235.0	1.420	0.3	0.0100	1.45	0.91	3.09	44.90	3.69
6/16/1995	0.4098	235.0	1.420	0.3	0.0100	0.84	0.63	1.18	44.90	3.69
6/21/1995	0.0374	154.0	1.130	0.3	0.0100	0.57	0.47	0.70	43.10	3.15
6/21/1995	0.0787	154.0	1.130	0.3	0.0100	0.87	0.62	1.40	43.10	3.15
6/23/1995	0.1200	147.0	1.090	0.3	0.0100	0.65	0.53	0.84	42.60	3.19
6/23/1995	0.1521	147.0	1.090	0.3	0.0100	0.79	0.59	1.15	42.60	3.19
7/3/1995	0.0429	132.0	1.070	0.3	0.0100	0.80	0.59	1.23	41.70	2.98
7/3/1995	0.0381	132.0	1.070	0.3	0.0100	1.54	1.00	2.19	41.70	2.98

Table C.50. Data from Thompson Creek, ID



Date	q_{hs} (tons/day-ft)	Q (cfs)	h (ft)	h_{hs} (ft)	Slope	Helley Smith d50 (mm)	Helley Smith d35 (mm)	Helley Smith d65 (mm)	W (ft)	Vmean (ft/s)
5/11/1995	0.0149	41.8	0.858	0.3	0.0153	0.47	0.41	0.56	18.54	2.63
5/12/1995	0.0663	43.9	0.872	0.3	0.0153	0.83	0.61	1.23	18.69	2.69
5/12/1995	0.0403	43.9	0.872	0.3	0.0153	0.65	0.51	0.88	18.69	2.69
5/14/1995	0.0089	31.9	0.787	0.3	0.0153	0.67	0.46	1.06	17.75	2.28
5/14/1995	0.0299	31.9	0.787	0.3	0.0153	0.80	0.60	1.10	17.75	2.28
5/14/1995	0.0128	31.9	0.787	0.3	0.0153	0.67	0.54	0.86	17.75	2.28
5/16/1995	0.0391	55.1	0.938	0.3	0.0153	0.58	0.47	0.72	19.39	3.03
5/18/1995	0.1125	74.4	1.033	0.3	0.0153	0.87	0.61	1.32	20.36	3.53
5/18/1995	0.1395	74.4	1.033	0.3	0.0153	0.71	0.57	0.90	20.36	3.53
5/21/1995	0.1355	83.4	1.072	0.3	0.0153	0.93	0.64	1.45	20.74	3.75
5/21/1995	0.3390	83.4	1.072	0.3	0.0153	1.28	0.95	1.86	20.74	3.75
5/23/1995	0.0840	80.0	1.058	0.3	0.0153	0.83	0.55	1.36	20.60	3.67
5/23/1995	0.0738	80.0	1.058	0.3	0.0153	0.70	0.51	1.13	20.60	3.67
5/26/1995	0.0707	65.6	0.992	0.3	0.0153	0.75	0.57	0.99	19.95	3.31
5/26/1995	0.0652	65.6	0.992	0.3	0.0153	0.78	0.60	1.02	19.95	3.31
5/30/1995	0.1516	76.5	1.043	0.3	0.0153	0.74	0.58	0.96	20.45	3.58
5/30/1995	0.1530	76.5	1.043	0.3	0.0153	0.79	0.61	1.02	20.45	3.58
6/4/1995	0.4102	118.0	1.199	0.3	0.0153	0.97	0.68	1.33	21.94	4.48
6/4/1995	0.5424	118.0	1.199	0.3	0.0153	1.02	0.74	1.36	21.94	4.48
6/5/1995	0.9948	124.0	1.218	0.3	0.0153	1.11	0.80	1.51	22.12	4.60
6/5/1995	0.6602	124.0	1.218	0.3	0.0153	0.91	0.65	1.28	22.12	4.60
6/7/1995	0.1405	86.3	1.084	0.3	0.0153	0.68	0.52	0.95	20.85	3.81
6/7/1995	0.1573	86.3	1.084	0.3	0.0153	0.70	0.55	0.93	20.85	3.81
6/9/1995	0.1557	66.1	0.995	0.3	0.0153	0.85	0.62	1.25	19.97	3.32
6/9/1995	0.1267	66.1	0.995	0.3	0.0153	0.71	0.54	1.01	19.97	3.32
6/12/1995	0.4481	85.4	1.080	0.3	0.0153	1.13	0.75	2.11	20.82	3.79
6/12/1995	0.4309	85.4	1.080	0.3	0.0153	0.97	0.71	1.38	20.82	3.79
6/16/1995	0.7014	89.0	1.095	0.3	0.0153	3.08	1.34	7.65	20.96	3.87
6/16/1995	0.4122	89.0	1.095	0.3	0.0153	1.64	1.00	7.39	20.96	3.87
6/16/1995	0.5773	89.0	1.095	0.3	0.0153	1.39	0.94	2.71	20.96	3.87
6/21/1995	0.0297	57.0	0.948	0.3	0.0153	0.53	0.44	0.67	19.50	3.08
6/21/1995	0.0249	57.0	0.948	0.3	0.0153	0.53	0.44	0.67	19.50	3.08
6/22/1995	0.0547	55.1	0.938	0.3	0.0153	1.04	0.70	1.49	19.39	3.03
6/22/1995	0.0172	55.1	0.938	0.3	0.0153	0.73	0.50	1.11	19.39	3.03
6/25/1995	0.0843	70.2	1.014	0.3	0.0153	0.72	0.54	1.02	20.17	3.43
6/25/1995	0.0793	70.2	1.014	0.3	0.0153	0.70	0.52	1.01	20.17	3.43
7/4/1995	0.0278	48.8	0.902	0.3	0.0153	0.77	0.57	1.03	19.01	2.84

Table C.51. Data from Trapper Creek, ID

Date	q_{hs} (tons/day-ft)	Q (cfs)	h (ft)	h_{hs} (ft)	Slope	Helley Smith d50 (mm)	Helley Smith d35 (mm)	Helley Smith d65 (mm)	W (ft)	Vmean (ft/s)
4/7/1994	0.0109	6.8	0.472	0.3	0.0414	1.74	0.82	2.81	16.05	0.89
4/7/1994	0.0050	6.8	0.472	0.3	0.0414	0.49	0.40	0.72	16.05	0.89
4/7/1994	0.0188	6.8	0.472	0.3	0.0414	2.36	0.97	3.69	16.05	0.89
4/13/1994	0.0492	8.1	0.506	0.3	0.0414	2.01	0.86	2.66	16.25	0.98
4/13/1994	0.0102	8.1	0.506	0.3	0.0414	1.85	0.91	2.64	16.25	0.98
4/13/1994	0.0024	8.1	0.506	0.3	0.0414	0.96	0.69	2.14	16.25	0.98
4/22/1994	0.0677	63.5	1.139	0.3	0.0414	2.58	0.92	4.36	18.89	2.95
4/22/1994	0.1726	63.5	1.139	0.3	0.0414	3.88	2.64	7.18	18.89	2.95
4/27/1994	0.0061	46.9	1.011	0.3	0.0414	1.07	0.70	2.37	18.48	2.51
4/27/1994	0.0078	46.9	1.011	0.3	0.0414	1.40	0.78	2.51	18.48	2.51
5/4/1994	0.0456	25.8	0.799	0.3	0.0414	4.23	2.70	7.12	17.69	1.82
5/4/1994	0.0376	25.8	0.799	0.3	0.0414	2.87	2.04	4.07	17.69	1.82
5/4/1994	0.0707	25.8	0.799	0.3	0.0414	4.76	2.98	7.76	17.69	1.82
5/5/1994	0.0026	30.4	0.852	0.3	0.0414	2.18	0.89	3.54	17.90	1.99
5/5/1994	0.0586	30.4	0.852	0.3	0.0414	3.73	2.75	5.59	17.90	1.99
5/9/1994	0.0402	34.7	0.898	0.3	0.0414	3.33	2.25	5.01	18.08	2.13
5/9/1994	0.0436	34.7	0.898	0.3	0.0414	2.93	2.01	4.54	18.08	2.13
5/11/1994	0.0226	32.5	0.875	0.3	0.0414	2.51	1.44	3.44	17.99	2.06
5/11/1994	0.1495	32.5	0.875	0.3	0.0414	3.72	2.75	5.26	17.99	2.06
5/12/1994	0.0059	29.7	0.845	0.3	0.0414	2.95	2.03	4.44	17.87	1.96
5/12/1994	0.0181	29.7	0.845	0.3	0.0414	3.46	2.27	6.29	17.87	1.96
5/16/1994	0.0090	20.6	0.731	0.3	0.0414	2.13	0.97	2.92	17.40	1.61
5/16/1994	0.0009	20.6	0.731	0.3	0.0414	1.33	0.68	2.86	17.40	1.61
5/17/1994	0.0363	29.7	0.845	0.3	0.0414	3.03	2.27	4.07	17.87	1.96
5/17/1994	0.0304	29.7	0.845	0.3	0.0414	3.25	2.31	4.69	17.87	1.96
5/20/1994	0.0442	25.5	0.795	0.3	0.0414	3.23	2.20	4.98	17.68	1.81
5/20/1994	0.0685	25.5	0.795	0.3	0.0414	3.74	2.44	6.29	17.68	1.81
5/23/1994	0.0484	26.5	0.807	0.3	0.0414	3.19	2.28	4.76	17.73	1.85
5/23/1994	0.0609	26.5	0.807	0.3	0.0414	3.15	2.35	4.40	17.73	1.85
5/24/1994	0.0125	24.6	0.784	0.3	0.0414	2.64	2.09	3.35	17.63	1.78
5/24/1994	0.0085	24.6	0.784	0.3	0.0414	2.73	2.19	3.40	17.63	1.78
5/25/1994	0.0415	22.8	0.761	0.3	0.0414	3.22	2.40	4.47	17.53	1.70
5/25/1994	0.0362	22.8	0.761	0.3	0.0414	2.73	2.11	3.52	17.53	1.70
5/26/1994	0.0028	21.2	0.739	0.3	0.0414	2.21	1.18	2.77	17.44	1.64
5/26/1994	0.0010	21.2	0.739	0.3	0.0414	2.08	0.95	2.63	17.44	1.64
6/1/1994	0.0093	17.5	0.686	0.3	0.0414	1.30	0.78	2.34	17.20	1.48
6/1/1994	0.0126	17.5	0.686	0.3	0.0414	2.46	1.69	3.19	17.20	1.48
6/2/1994	0.0174	15.1	0.647	0.3	0.0414	2.71	2.06	3.57	17.01	1.37
6/2/1994	0.0025	15.1	0.647	0.3	0.0414	0.92	0.70	1.73	17.01	1.37
6/8/1994	0.0054	12.5	0.601	0.3	0.0414	2.12	1.22	2.63	16.78	1.24
6/8/1994	0.0022	12.5	0.601	0.3	0.0414	1.41	0.78	2.56	16.78	1.24
6/8/1994	0.0049	12.5	0.601	0.3	0.0414	2.16	0.95	3.08	16.78	1.24
6/9/1994	0.0020	11.0	0.571	0.3	0.0414	2.03	0.95	3.07	16.62	1.15
6/9/1994	0.0031	11.0	0.571	0.3	0.0414	2.08	0.92	3.00	16.62	1.15
6/9/1994	0.0003	11.0	0.571	0.3	0.0414	3.14	1.76	6.54	16.62	1.15
6/22/1994	0.0636	19.0	0.708	0.3	0.0414	2.58	1.49	3.59	17.30	1.55
6/22/1994	0.0254	19.0	0.708	0.3	0.0414	2.36	1.55	2.99	17.30	1.55
6/22/1994	0.0578	19.0	0.708	0.3	0.0414	2.59	1.95	3.38	17.30	1.55
6/28/1994	0.0004	12.2	0.595	0.3	0.0414	0.77	0.56	1.14	16.75	1.22
6/28/1994	0.0057	12.2	0.595	0.3	0.0414	1.03	0.73	1.95	16.75	1.22
6/28/1994	0.0004	12.2	0.595	0.3	0.0414	0.97	0.70	1.85	16.75	1.22
7/13/1994	0.0009	6.5	0.465	0.3	0.0414	0.90	0.70	1.42	16.00	0.87
7/13/1994	0.0020	6.5	0.465	0.3	0.0414	0.78	0.63	0.97	16.00	0.87
7/13/1994	0.0007	6.5	0.465	0.3	0.0414	1.11	0.77	2.10	16.00	0.87
8/8/1994	0.0008	4.4	0.396	0.3	0.0414	0.98	0.72	2.10	15.53	0.70
8/8/1994	0.0003	4.4	0.396	0.3	0.0414	1.68	0.88	2.45	15.53	0.70
8/8/1994	0.0005	4.4	0.396	0.3	0.0414	2.22	1.29	2.94	15.53	0.70
8/29/1994	0.0010	2.1	0.296	0.3	0.0414	0.46	0.37	0.66	14.72	0.47
8/29/1994	0.0011	2.1	0.296	0.3	0.0414	1.32	0.85	2.24	14.72	0.47
8/29/1994	0.0011	2.1	0.296	0.3	0.0414	2.25	1.07	3.17	14.72	0.47
9/20/1994	0.0003	1.7	0.273	0.3	0.0414	2.71	2.38	3.07	14.50	0.42
9/20/1994	0.0001	1.7	0.273	0.3	0.0414	2.00	0.87	3.00	14.50	0.42
9/20/1994	0.0000	1.7	0.273	0.3	0.0414	0.96	0.53	1.86	14.50	0.42
4/6/1995	0.0044	12.0	0.610	0.3	0.0414	1.72	1.31	2.35	17.10	1.13
4/6/1995	0.0099	12.0	0.610	0.3	0.0414	1.50	1.21	1.86	17.10	1.13
4/12/1995	0.0050	12.0	0.600	0.3	0.0414	1.96	1.48	2.60	17.20	1.14
4/12/1995	0.0019	12.0	0.600	0.3	0.0414	2.24	1.70	2.83	17.20	1.14
4/20/1995	0.0006	9.5	0.560	0.3	0.0414	1.57	1.22	2.03	17.00	1.05
4/20/1995	0.0006	9.5	0.560	0.3	0.0414	2.11	1.53	2.80	17.00	1.05
4/26/1995	0.0084	11.4	0.570	0.3	0.0414	2.19	1.61	2.86	17.10	1.19
4/26/1995	0.0030	11.4	0.570	0.3	0.0414	2.22	1.63	3.09	17.10	1.19
5/1/1995	0.0142	22.8	0.780	0.3	0.0414	1.80	1.27	2.61	18.00	1.63
5/1/1995	0.0035	22.8	0.780	0.3	0.0414	2.03	1.51	2.89	18.00	1.63
5/9/1995	0.1519	81.0	1.230	0.3	0.0414	3.64	2.26	7.08	20.80	3.00
5/9/1995	0.2250	81.0	1.230	0.3	0.0414	6.07	3.09	13.69	20.80	3.00
5/11/1995	0.1067	81.5	1.870	0.3	0.0414	3.34	2.31	5.46	20.90	2.79
5/11/1995	0.0986	81.5	1.870	0.3	0.0414	3.05	2.15	4.50	20.90	2.79
5/15/1995	0.0299	43.5	0.982	0.3	0.0414	2.63	1.83	3.72	18.38	2.41
5/15/1995	0.0299	43.5	0.982	0.3	0.0414	2.27	1.65	3.05	18.38	2.41
5/17/1995	0.0514	53.0	1.160	0.3	0.0414	2.86	2.10	3.91	18.50	2.48
5/17/1995	0.0218	53.0	1.160	0.3	0.0414	2.34	1.66	3.18	18.50	2.48
5/22/1995	0.0106	53.0	1.140	0.3	0.0414	2.17	1.61	2.84	18.50	2.49
5/22/1995	0.0092	53.0	1.140	0.3	0.0414	2.51	1.82	3.39	18.50	2.49
5/24/1995	0.0344	46.8	1.080	0.3	0.0414	3.25	2.27	5.36	18.30	2.24
5/24/1995	0.0127	46.8	1.080	0.3	0.0414	2.42	1.75	3.27	18.30	2.24
5/30/1995	0.0016	33.5	0.960	0.3	0.0414	1.96	1.44	2.61	18.10	1.99
5/30/1995	0.0036	33.5	0.960	0.3	0.0414	2.50	1.96	3.16	18.10	1.99
6/7/1995	0.0308	40.8	1.020	0.3	0.0414	3.10	1.98	6.89	18.20	1.97
6/7/1995	0.0190	40.8	1.020	0.3	0.0414	2.50	1.84	3.30	18.20	1.97
6/14/1995	0.0149	25.1	0.840	0.3	0.0414	3.81	2.84	5.72	18.10	1.53
6/14/1995	0.0033	25.1	0.840	0.3	0.0414	2.04	1.51	2.81	18.10	1.53
6/19/1995	0.0134	18.1	0.740	0.3	0.0414	2.89	2.18	3.83	18.00	1.36
6/19/1995	0.0151	18.1	0.740	0.3	0.0414	2.83	2.06	3.91	18.00	1.36
7/5/1995	0.0002	10.5	0.610	0.3	0.0414	1.26	0.95	1.66	17.10	1.02
7/5/1995	0.0002	10.5	0.610	0.3	0.0414	1.41	1.04	1.93	17.10	1.02
7/18/1995	0.0002	7.3	0.530	0.3	0.0414	0.96	0.72	1.76	16.70	0.77
8/3/1995	0.0001	4.3	0.490	0.3	0.0414	1.41	1.04	1.93	15.30	0.56
8/3/1995	0.0002	4.3	0.490	0.3	0.0414	2.94	2.18	3.97	15.30	0.56
8/8/1995	0.0001	4.5	0.500	0.3	0.0414	2.00	1.31	3.00	15.40	0.57
8/8/1995	0.0001	4.5	0.500	0.3	0.0414	1.00	0.65	1.50	15.40	0.57
8/14/1995	0.0001	3.5	0.470	0.3	0.0414	2.00	1.31	3.00	14.80	0.49
8/14/1995	0.0004	3.5	0.470	0.3	0.0414	2.19	1.53	2.93	14.80	0.49
4/12/1996	0.1364	64.5	1.260	0.3	0.0414	3.56	2.35	6.15	18.40	2.67
5/15/1996	0.4157	98.6	1.490	0.3	0.0414	2.95	2.06	4.36	21.70	3.10
5/21/1996	0.0491	84.0	1.350	0.3	0.0414	7.45	2.95	23.45	21.20	2.84
6/13/1996	0.0099	26.7	0.860	0.3	0.0414	0.84	0.60	1.81	18.00	1.75
6/25/1996	0.0015	12.5	0.630	0.3	0.0414	0.76	0.57	1.07	17.70	1.12
4/11/1997	0.0006	6.4	0.520	0.3	0.0414	0.90	0.55	2.50	15.70	0.69
5/7/1997	0.1341	45.7	0.910	0.3	0.0414	3.29	2.17	5.37	18.20	2.50
6/11/1997	0.0095	49.0	0.880	0.3	0.0414	2.80	1.77	4.10	18.20	2.87
6/22/1997	0.0098	22.5	0.720	0.3	0.0414	3.86	2.14	7.18	15.80	2.04
8/18/1997	0.0002	4.0	0.360	0.3	0.0414	1.19	0.82	1.95	15.80	0.68

Table C.52. Data from Valley Creek, ID 1

Date	q_{hs} (tons/day-ft)	Q (cfs)	h (ft)	h_{hs} (ft)	Slope	Helley Smith d50 (mm)	Helley Smith d35 (mm)	Helley Smith d65 (mm)	W (ft)	Vmean (ft/s)
4/19/1994	0.0109	246.0	1.546	0.3	0.0040	0.67	0.47	0.95	74.13	2.15
4/19/1994	0.0123	246.0	1.546	0.3	0.0040	0.61	0.48	0.78	74.13	2.15
4/21/1994	0.1192	285.0	1.643	0.3	0.0040	1.29	0.98	1.68	74.92	2.32
4/21/1994	0.0622	285.0	1.643	0.3	0.0040	1.30	1.00	1.68	74.92	2.32
4/26/1994	0.0139	221.0	1.479	0.3	0.0040	1.00	0.76	1.33	73.56	2.03
4/26/1994	0.0041	221.0	1.479	0.3	0.0040	1.17	0.94	1.42	73.56	2.03
4/28/1994	0.0069	169.0	1.324	0.3	0.0040	1.18	0.83	1.70	72.16	1.77
4/28/1994	0.0136	169.0	1.324	0.3	0.0040	1.35	1.11	1.63	72.16	1.77
5/3/1994	0.0194	166.0	1.315	0.3	0.0040	1.61	1.16	2.34	72.06	1.75
5/3/1994	0.0165	166.0	1.315	0.3	0.0040	1.20	0.88	1.60	72.06	1.75
5/5/1994	0.0123	185.0	1.375	0.3	0.0040	1.41	1.13	1.77	72.63	1.85
5/5/1994	0.0061	185.0	1.375	0.3	0.0040	1.99	1.40	2.73	72.63	1.85
5/10/1994	0.0947	336.0	1.758	0.3	0.0040	0.99	0.73	1.42	75.82	2.52
5/10/1994	0.2335	336.0	1.758	0.3	0.0040	1.44	1.04	2.01	75.82	2.52
5/12/1994	0.4188	408.0	1.904	0.3	0.0040	1.67	1.20	2.36	76.89	2.79
5/12/1994	0.2666	408.0	1.904	0.3	0.0040	1.51	1.14	2.01	76.89	2.79
5/15/1994	0.0457	353.0	1.794	0.3	0.0040	1.33	0.92	1.88	76.09	2.59
5/15/1994	0.0297	353.0	1.794	0.3	0.0040	1.88	1.35	2.85	76.09	2.59
5/17/1994	0.0245	319.0	1.721	0.3	0.0040	1.42	0.93	2.22	75.53	2.46
5/17/1994	0.0393	319.0	1.721	0.3	0.0040	1.80	1.34	2.61	75.53	2.46
5/18/1994	0.0767	294.0	1.664	0.3	0.0040	1.60	1.22	2.13	75.09	2.36
5/18/1994	0.0525	294.0	1.664	0.3	0.0040	1.44	1.08	1.91	75.09	2.36
5/24/1994	0.0942	221.0	1.479	0.3	0.0040	1.42	1.09	1.85	73.56	2.03
5/24/1994	0.0794	221.0	1.479	0.3	0.0040	1.32	1.02	1.71	73.56	2.03
5/26/1994	0.1481	253.0	1.564	0.3	0.0040	1.97	1.52	2.57	74.28	2.18
5/26/1994	0.1817	253.0	1.564	0.3	0.0040	2.08	1.61	2.69	74.28	2.18
6/1/1994	0.1530	336.0	1.758	0.3	0.0040	1.57	1.23	2.00	75.82	2.52
6/1/1994	0.0729	336.0	1.758	0.3	0.0040	1.98	1.40	2.85	75.82	2.52
6/3/1994	0.0406	295.0	1.666	0.3	0.0040	0.93	0.70	1.49	75.11	2.36
6/3/1994	0.0172	295.0	1.666	0.3	0.0040	1.72	0.99	3.61	75.11	2.36
6/6/1994	0.0231	264.0	1.592	0.3	0.0040	1.25	0.90	1.74	74.51	2.23
6/6/1994	0.0107	264.0	1.592	0.3	0.0040	1.33	1.05	1.67	74.51	2.23
6/13/1994	0.0160	253.0	1.564	0.3	0.0040	1.38	1.00	1.91	74.28	2.18
6/13/1994	0.0069	253.0	1.564	0.3	0.0040	2.36	1.67	3.15	74.28	2.18
5/2/1995	0.0300	268.0	1.601	0.3	0.0040	2.00	1.31	3.22	74.59	2.24
5/2/1995	0.0040	268.0	1.601	0.3	0.0040	1.54	1.08	2.21	74.59	2.24
5/3/1995	0.0780	277.0	1.623	0.3	0.0040	1.23	0.93	1.58	74.77	2.28
5/3/1995	0.0199	277.0	1.623	0.3	0.0040	1.72	1.11	2.61	74.77	2.28
5/9/1995	0.0962	372.0	1.833	0.3	0.0040	2.11	1.55	2.98	76.38	2.66
5/9/1995	0.1401	372.0	1.833	0.3	0.0040	2.57	1.75	3.74	76.38	2.66
5/10/1995	0.1538	396.0	1.881	0.3	0.0040	1.11	0.81	1.47	76.72	2.75
5/10/1995	0.2203	396.0	1.881	0.3	0.0040	1.61	1.20	2.26	76.72	2.75
5/17/1995	0.0911	541.0	2.139	0.3	0.0040	1.10	0.72	1.58	78.46	3.23
5/17/1995	0.0870	541.0	2.139	0.3	0.0040	0.91	0.62	1.34	78.46	3.23
5/18/1995	0.1475	558.0	2.166	0.3	0.0040	1.28	0.89	1.75	78.64	3.28
5/18/1995	0.1704	558.0	2.166	0.3	0.0040	1.28	0.90	1.77	78.64	3.28
5/23/1995	0.3686	680.0	2.350	0.3	0.0040	1.50	1.11	2.03	79.77	3.64
5/23/1995	0.4601	680.0	2.350	0.3	0.0040	2.01	1.35	2.83	79.77	3.64
5/24/1995	0.4160	686.0	2.359	0.3	0.0040	1.40	1.02	1.93	79.82	3.65
5/24/1995	0.3984	686.0	2.359	0.3	0.0040	1.47	1.10	1.97	79.82	3.65
5/31/1995	0.1294	756.0	2.455	0.3	0.0040	1.11	0.79	1.57	80.38	3.84
5/31/1995	0.2327	756.0	2.455	0.3	0.0040	1.55	1.09	2.31	80.38	3.84
6/1/1995	0.2150	766.0	2.468	0.3	0.0040	1.48	0.97	2.37	80.45	3.87
6/1/1995	0.1765	766.0	2.468	0.3	0.0040	1.49	1.00	2.36	80.45	3.87
6/4/1995	0.1856	893.0	2.629	0.3	0.0040	1.76	1.15	2.80	81.35	4.19
6/4/1995	0.1561	893.0	2.629	0.3	0.0040	1.75	1.20	2.85	81.35	4.19
6/5/1995	0.3954	1030.0	2.789	0.3	0.0040	2.15	1.42	3.32	82.19	4.51
6/5/1995	0.1764	1030.0	2.789	0.3	0.0040	1.43	1.02	2.00	82.19	4.51
6/6/1995	0.0981	1030.0	2.789	0.3	0.0040	1.25	0.89	1.71	82.19	4.51
6/6/1995	0.1716	1030.0	2.789	0.3	0.0040	1.60	1.10	2.47	82.19	4.51
6/13/1995	0.2501	756.0	2.455	0.3	0.0040	1.38	1.05	1.81	80.38	3.84
6/13/1995	0.1617	756.0	2.455	0.3	0.0040	1.61	1.09	2.63	80.38	3.84
6/20/1995	0.0604	839.0	2.563	0.3	0.0040	1.16	0.84	1.61	80.98	4.05
6/20/1995	0.1182	839.0	2.563	0.3	0.0040	1.66	1.16	2.53	80.98	4.05
6/27/1995	0.8502	847.0	2.573	0.3	0.0040	2.82	2.03	3.91	81.04	4.07
6/27/1995	0.7120	847.0	2.573	0.3	0.0040	2.43	1.72	3.30	81.04	4.07
6/28/1995	0.5366	907.0	2.646	0.3	0.0040	2.16	1.47	3.41	81.44	4.22
6/28/1995	0.9025	907.0	2.646	0.3	0.0040	2.25	1.53	3.37	81.44	4.22
5/18/1997	1.0486	1420.0	3.183	0.3	0.0040	2.39	1.53	3.86	84.11	5.32
5/18/1997	1.0693	1390.0	3.155	0.3	0.0040	5.55	3.21	10.66	83.98	5.27
6/7/1997	0.2511	1230.0	3.000	0.3	0.0040	1.54	1.22	1.95	83.24	4.94

Table C.53. Data from Valley Creek, ID 2

Date	q_{hs} (tons/day-ft)	Q (cfs)	h (ft)	h_{hs} (ft)	Slope	Helley Smith d50 (mm)	Helley Smith d35 (mm)	Helley Smith d65 (mm)	W (ft)	Vmean (ft/s)
6/7/1997	0.2234	1230.0	3.000	0.3	0.0040	2.92	1.82	5.08	83.24	4.94
5/10/1994	0.0420	320.0	1.723	0.3	0.0040	1.29	0.96	1.71	75.55	2.46
5/10/1994	0.1235	320.0	1.723	0.3	0.0040	1.82	1.40	2.49	75.55	2.46
5/10/1994	0.0290	320.0	1.723	0.3	0.0040	1.33	1.04	1.70	75.55	2.46
5/15/1994	0.0412	358.0	1.804	0.3	0.0040	1.92	1.39	2.70	76.16	2.61
5/15/1994	0.1074	358.0	1.804	0.3	0.0040	1.46	1.17	1.83	76.16	2.61
5/16/1994	0.0922	304.0	1.687	0.3	0.0040	1.95	1.42	2.87	75.27	2.40
5/16/1994	0.0030	304.0	1.687	0.3	0.0040	0.80	0.63	1.04	75.27	2.40
5/16/1994	0.0270	304.0	1.687	0.3	0.0040	2.46	1.74	3.44	75.27	2.40
5/17/1994	0.0026	324.0	1.732	0.3	0.0040	1.23	0.90	1.65	75.62	2.48
5/17/1994	0.0041	324.0	1.732	0.3	0.0040	1.20	0.92	1.52	75.62	2.48
5/20/1994	0.0013	248.0	1.551	0.3	0.0040	1.03	0.80	1.27	74.18	2.16
5/20/1994	0.0042	248.0	1.551	0.3	0.0040	1.66	1.22	2.36	74.18	2.16
5/23/1994	0.0043	220.0	1.476	0.3	0.0040	1.58	1.25	1.99	73.54	2.03
5/23/1994	0.0038	220.0	1.476	0.3	0.0040	1.14	0.88	1.44	73.54	2.03
5/26/1994	0.0771	248.0	1.551	0.3	0.0040	3.32	2.19	4.72	74.18	2.16
5/26/1994	0.0054	248.0	1.551	0.3	0.0040	1.81	1.25	2.82	74.18	2.16
5/28/1994	0.0969	345.0	1.777	0.3	0.0040	1.16	0.91	1.46	75.96	2.56
5/28/1994	0.0712	345.0	1.777	0.3	0.0040	1.54	1.20	1.97	75.96	2.56
6/3/1994	0.0071	238.0	1.525	0.3	0.0040	2.26	1.66	3.16	73.96	2.11
6/3/1994	0.0018	238.0	1.525	0.3	0.0040	1.07	0.82	1.34	73.96	2.11
6/8/1994	0.0017	220.0	1.476	0.3	0.0040	1.21	0.89	1.62	73.54	2.03
6/8/1994	0.0016	220.0	1.476	0.3	0.0040	2.97	1.98	4.29	73.54	2.03
6/10/1994	0.0021	193.0	1.399	0.3	0.0040	1.21	0.99	1.48	72.85	1.89
6/10/1994	0.0009	193.0	1.399	0.3	0.0040	1.36	1.11	1.65	72.85	1.89
4/23/1995	0.0015	219.0	1.474	0.3	0.0040	0.73	0.55	0.96	73.52	2.02
4/23/1995	0.0169	219.0	1.474	0.3	0.0040	1.26	0.97	1.63	73.52	2.02
4/30/1995	0.1419	239.0	1.528	0.3	0.0040	2.17	1.53	3.17	73.98	2.12
4/30/1995	0.1365	239.0	1.528	0.3	0.0040	1.88	1.39	2.69	73.98	2.12
5/3/1995	0.2280	267.0	1.599	0.3	0.0040	1.72	1.26	2.42	74.57	2.24
5/3/1995	0.1837	267.0	1.599	0.3	0.0040	1.92	1.47	2.59	74.57	2.24
5/4/1995	0.1965	278.0	1.626	0.3	0.0040	1.52	1.14	2.02	74.79	2.29
5/4/1995	0.1052	278.0	1.626	0.3	0.0040	1.90	1.40	2.61	74.79	2.29
5/6/1995	0.1224	384.0	1.857	0.3	0.0040	1.69	1.20	2.54	76.55	2.70
5/6/1995	0.1176	384.0	1.857	0.3	0.0040	1.96	1.34	2.90	76.55	2.70
5/8/1995	0.0849	343.0	1.773	0.3	0.0040	1.66	1.24	2.32	75.93	2.55
5/8/1995	0.0341	343.0	1.773	0.3	0.0040	1.30	0.99	1.70	75.93	2.55
5/9/1995	0.2382	375.0	1.839	0.3	0.0040	1.75	1.32	2.44	76.42	2.67
5/9/1995	0.2460	375.0	1.839	0.3	0.0040	1.64	1.27	2.21	76.42	2.67
5/10/1995	0.1199	380.0	1.849	0.3	0.0040	1.76	1.28	2.51	76.49	2.69
5/10/1995	0.1280	380.0	1.849	0.3	0.0040	2.00	1.46	2.75	76.49	2.69
5/11/1995	0.0223	450.0	1.983	0.3	0.0040	1.54	0.99	2.40	77.43	2.94
5/11/1995	0.0465	450.0	1.983	0.3	0.0040	1.93	1.27	2.89	77.43	2.94
5/15/1995	0.1004	388.0	1.865	0.3	0.0040	1.43	1.14	1.79	76.61	2.72
5/15/1995	0.0337	388.0	1.865	0.3	0.0040	1.87	1.34	2.78	76.61	2.72
5/15/1995	0.0265	388.0	1.865	0.3	0.0040	2.82	2.01	3.95	76.61	2.72
5/17/1995	0.4232	517.0	2.099	0.3	0.0040	1.81	1.26	2.71	78.21	3.16
5/17/1995	0.2749	517.0	2.099	0.3	0.0040	2.38	1.55	3.53	78.21	3.16
5/19/1995	0.5880	552.0	2.157	0.3	0.0040	1.40	1.05	1.88	78.58	3.26
5/19/1995	0.6567	552.0	2.157	0.3	0.0040	2.81	1.88	4.15	78.58	3.26
5/21/1995	0.8965	604.0	2.238	0.3	0.0040	1.91	1.39	2.81	79.09	3.42
5/21/1995	0.3920	604.0	2.238	0.3	0.0040	2.02	1.36	3.07	79.09	3.42
5/22/1995	0.2986	636.0	2.286	0.3	0.0040	1.55	1.01	2.45	79.38	3.51
5/22/1995	0.6614	636.0	2.286	0.3	0.0040	1.51	1.05	2.23	79.38	3.51
5/24/1995	0.4667	625.0	2.270	0.3	0.0040	2.06	1.39	2.95	79.28	3.48
5/24/1995	0.2914	625.0	2.270	0.3	0.0040	1.98	1.32	2.89	79.28	3.48
5/28/1995	0.5359	532.0	2.124	0.3	0.0040	1.58	1.16	2.20	78.37	3.20
5/28/1995	0.4964	532.0	2.124	0.3	0.0040	1.80	1.26	2.66	78.37	3.20
5/29/1995	0.3108	577.0	2.196	0.3	0.0040	1.72	1.27	2.46	78.83	3.34
5/29/1995	0.4554	577.0	2.196	0.3	0.0040	2.10	1.49	2.85	78.83	3.34
5/30/1995	0.2392	641.0	2.294	0.3	0.0040	1.42	1.00	2.02	79.43	3.53
5/30/1995	0.4054	641.0	2.294	0.3	0.0040	3.04	1.93	4.50	79.43	3.53
6/2/1995	0.9746	779.0	2.486	0.3	0.0040	2.48	1.69	3.55	80.55	3.90
6/2/1995	0.9361	779.0	2.486	0.3	0.0040	3.13	2.13	4.65	80.55	3.90
6/5/1995	0.3357	890.0	2.626	0.3	0.0040	2.48	1.47	3.99	81.33	4.18
6/5/1995	0.2017	890.0	2.626	0.3	0.0040	1.48	1.01	2.25	81.33	4.18
6/7/1995	0.0913	773.0	2.478	0.3	0.0040	1.60	1.12	2.33	80.51	3.89
6/7/1995	0.2087	773.0	2.478	0.3	0.0040	2.71	1.70	4.27	80.51	3.89
6/9/1995	0.7154	720.0	2.406	0.3	0.0040	3.65	2.25	5.73	80.09	3.75
6/9/1995	0.6804	720.0	2.406	0.3	0.0040	1.88	1.36	2.82	80.09	3.75
6/12/1995	0.3408	620.0	2.262	0.3	0.0040	1.67	1.19	2.42	79.24	3.47
6/23/1995	0.4529	577.0	2.196	0.3	0.0040	4.03	2.75	5.34	78.83	3.34
6/23/1995	0.8017	577.0	2.196	0.3	0.0040	2.78	1.88	4.06	78.83	3.34
6/23/1995	0.4859	577.0	2.196	0.3	0.0040	2.49	1.70	3.64	78.83	3.34
6/28/1995	0.6546	815.0	2.532	0.3	0.0040	2.03	1.43	3.03	80.81	3.99
6/28/1995	0.4368	815.0	2.532	0.3	0.0040	1.88	1.33	2.91	80.81	3.99
7/5/1995	0.2657	598.0	2.229	0.3	0.0040	1.68	1.23	2.43	79.03	3.40
7/5/1995	0.4138	598.0	2.229	0.3	0.0040	1.72	1.28	2.48	79.03	3.40

Table C.54. Data from West Fork Buckhorn Creek, ID

Date	q_{hs} (tons/day-ft)	Q (cfs)	h (ft)	h_{hs} (ft)	Slope	Helley Smith d50 (mm)	Helley Smith d35 (mm)	Helley Smith d65 (mm)	W (ft)	Vmean (ft/s)
4/9/1990	0.0189	39.0	1.066	0.3	0.0320	1.92	1.29	2.81	22.48	1.63
4/13/1990	0.0860	42.0	1.080	0.3	0.0320	1.66	1.15	2.36	22.80	1.71
4/16/1990	0.2104	65.0	1.170	0.3	0.0320	2.09	1.48	2.80	24.81	2.25
4/24/1990	0.1144	119.0	1.307	0.3	0.0320	1.63	1.18	2.29	27.88	3.28
4/24/1990	0.1399	113.0	1.295	0.3	0.0320	1.57	1.20	2.10	27.60	3.17
4/27/1990	0.1375	71.0	1.189	0.3	0.0320	1.74	1.30	2.36	25.23	2.37
5/4/1990	0.0095	49.0	1.111	0.3	0.0320	2.19	1.34	3.20	23.49	1.88
5/22/1990	0.0190	50.0	1.115	0.3	0.0320	1.40	1.04	1.90	23.58	1.91
5/30/1990	0.2697	153.0	1.368	0.3	0.0320	2.10	1.48	2.76	29.26	3.83
6/1/1990	0.0772	110.0	1.288	0.3	0.0320	2.42	1.58	3.60	27.46	3.12
4/9/1991	0.0028	21.0	0.951	0.3	0.0320	0.76	0.57	0.99	19.95	1.11
4/15/1991	0.0025	12.0	0.859	0.3	0.0320	0.96	0.73	1.31	17.90	0.78
4/23/1991	0.0107	23.0	0.967	0.3	0.0320	1.66	1.20	2.33	20.30	1.17
4/30/1991	0.0028	21.0	0.951	0.3	0.0320	1.01	0.76	1.35	19.95	1.11
5/9/1991	0.0286	82.0	1.221	0.3	0.0320	1.38	1.05	1.82	25.94	2.60
5/15/1991	0.0270	49.0	1.111	0.3	0.0320	1.89	1.38	2.55	23.49	1.88
5/17/1991	0.0195	72.0	1.192	0.3	0.0320	1.22	0.89	1.63	25.30	2.39
5/20/1991	0.0072	79.0	1.212	0.3	0.0320	1.35	1.02	1.79	25.76	2.54
5/21/1991	0.0354	73.0	1.195	0.3	0.0320	1.81	1.34	2.49	25.37	2.41
5/23/1991	0.0247	107.0	1.062	0.3	0.0320	1.28	0.94	1.72	29.75	3.61
5/28/1991	0.0211	95.0	1.254	0.3	0.0320	1.37	1.01	1.86	26.69	2.85
5/29/1991	0.0331	91.0	1.244	0.3	0.0320	1.93	1.36	2.67	26.47	2.77
5/30/1991	0.0098	94.0	1.252	0.3	0.0320	1.52	1.11	2.11	26.64	2.83
6/4/1991	0.0597	133.0	1.334	0.3	0.0320	1.49	1.16	1.93	28.48	3.51
6/11/1991	0.0387	126.0	1.321	0.3	0.0320	1.69	1.26	2.33	28.19	3.39
4/7/1992	0.0333	34.0	1.039	0.3	0.0320	1.70	1.17	2.41	21.89	1.50
4/14/1992	0.0702	59.0	1.149	0.3	0.0320	1.92	1.25	2.99	24.35	2.11
4/20/1992	0.0635	60.0	1.153	0.3	0.0320	2.05	1.34	3.07	24.43	2.14
4/22/1992	0.2427	58.0	1.146	0.3	0.0320	1.81	1.24	2.86	24.27	2.09
4/27/1992	0.0137	61.0	1.156	0.3	0.0320	1.27	0.94	1.70	24.50	2.16
5/4/1992	0.0929	82.0	1.221	0.3	0.0320	1.97	1.32	2.76	25.94	2.60
5/6/1992	0.1348	113.0	1.295	0.3	0.0320	1.60	1.13	2.35	27.60	3.17
5/11/1992	0.0315	81.0	1.218	0.3	0.0320	1.16	0.82	1.60	25.88	2.58
5/13/1992	0.0109	63.0	1.163	0.3	0.0320	0.93	0.69	1.27	24.66	2.20
5/14/1992	0.0105	61.0	1.156	0.3	0.0320	1.58	1.07	2.40	24.50	2.16
5/18/1992	0.0076	77.0	1.207	0.3	0.0320	1.25	0.87	1.76	25.63	2.50
5/20/1992	0.0174	93.0	1.249	0.3	0.0320	1.11	0.81	1.48	26.58	2.81
5/26/1992	0.0038	77.0	1.207	0.3	0.0320	1.55	1.12	2.17	25.63	2.50
4/13/1993	0.0077	30.0	1.016	0.3	0.0320	0.60	0.46	0.78	21.37	1.39
4/24/1993	0.0445	33.0	1.033	0.3	0.0320	1.99	1.40	2.87	21.76	1.47
4/27/1993	0.0160	40.0	1.070	0.3	0.0320	2.50	2.01	3.09	22.59	1.66
5/6/1993	0.0078	67.0	1.176	0.3	0.0320	1.00	0.76	1.45	24.95	2.29
5/12/1993	0.0680	114.0	1.297	0.3	0.0320	1.31	0.88	1.95	27.65	3.19
6/9/1993	0.0137	131.0	1.330	0.3	0.0320	1.59	1.16	2.19	28.40	3.48
6/15/1993	0.1343	112.0	1.292	0.3	0.0320	1.86	1.35	2.59	27.55	3.15
6/16/1993	0.0431	127.0	1.322	0.3	0.0320	1.61	1.17	2.27	28.23	3.41
4/18/1994	0.0008	33.0	1.033	0.3	0.0320	1.02	0.72	1.25	21.76	1.47
4/19/1994	0.0034	42.0	1.080	0.3	0.0320	0.77	0.53	1.14	22.80	1.71
4/21/1994	0.0080	79.0	1.212	0.3	0.0320	0.93	0.69	1.35	25.76	2.54
5/2/1994	0.0012	29.0	1.009	0.3	0.0320	1.58	1.15	2.18	21.23	1.36
5/4/1994	0.0012	37.0	1.055	0.3	0.0320	1.43	1.01	2.01	22.25	1.58
5/5/1994	0.0007	41.0	1.075	0.3	0.0320	1.59	1.20	2.12	22.69	1.68
5/9/1994	0.0195	127.0	1.322	0.3	0.0320	1.23	0.90	1.65	28.23	3.41
5/10/1994	0.0145	151.0	1.365	0.3	0.0320	1.28	0.95	1.69	29.19	3.80
5/11/1994	0.0159	134.0	1.336	0.3	0.0320	1.52	1.15	2.01	28.52	3.53
5/17/1994	0.0316	79.0	1.212	0.3	0.0320	1.85	1.31	2.55	25.76	2.54
5/17/1994	0.0290	79.0	1.212	0.3	0.0320	1.96	1.45	2.79	25.76	2.54
5/18/1994	0.0214	67.0	1.176	0.3	0.0320	2.24	1.57	3.06	24.95	2.29
5/18/1994	0.0083	67.0	1.176	0.3	0.0320	2.16	1.67	2.68	24.95	2.29
5/19/1994	0.0027	62.0	1.160	0.3	0.0320	1.61	1.18	2.20	24.58	2.18
5/23/1994	0.0014	52.0	1.123	0.3	0.0320	1.56	1.17	2.08	23.76	1.95
5/24/1994	0.0012	56.0	1.138	0.3	0.0320	1.24	0.96	1.58	24.10	2.05
5/25/1994	0.0162	64.0	1.167	0.3	0.0320	1.24	0.97	1.57	24.73	2.22
5/25/1994	0.0032	64.0	1.167	0.3	0.0320	1.31	1.01	1.70	24.73	2.22
6/2/1994	0.0032	73.0	1.195	0.3	0.0320	1.30	0.96	1.76	25.37	2.41
6/9/1994	0.0017	41.0	1.075	0.3	0.0320	1.39	1.06	1.83	22.69	1.68
6/14/1994	0.0094	40.0	1.070	0.3	0.0320	1.47	1.10	1.95	22.59	1.66

Table C.55. Data from Coleman Lab Data

Run	Discharge (cms)	Se	d50	h (m)	y (m)	a(m)	Velocity (m/s)	Sediment Concentration		
								Total (m^3/m^3)	Total (mg/L)	Ln C
2	0.064	0.002	0.105	0.171	0	0.00021	0		2252.5	
				0.165	0.006		0.705	8.50E-04	2252.5	7.719796
				0.159	0.012		0.768	6.40E-04	1696	7.436028
				0.153	0.018		0.817	5.20E-04	1378	7.228388
				0.147	0.024		0.852	4.20E-04	1113	7.014814
				0.141	0.03		0.883	3.70E-04	980.5	6.888063
				0.125	0.046		0.938	2.80E-04	742	6.609349
				0.102	0.069		0.975	2.40E-04	636	6.455199
				0.08	0.091		1.03	1.40E-04	371	5.916202
				0.049	0.122		1.049	8.10E-05	214.65	5.369009
				0.034	0.137		1.043	6.50E-05	172.25	5.148947
				0.019	0.152		1.03	5.00E-05	132.5	4.886583
				0.009	0.162		1.023	3.00E-05	79.5	4.375757
					0.171		1.023		79.5	4.375757
3	0.064	0.002	0.105	0.172	0	0.00021	0		4505	
					0.006		0.68	1.70E-03	4505	8.412943
					0.012		0.738	1.20E-03	3180	8.064636
					0.018		0.795	9.70E-04	2570.5	7.851856
					0.024		0.836	7.60E-04	2014	7.607878
					0.03		0.87	6.80E-04	1802	7.496652
					0.046		0.922	5.30E-04	1404.5	7.247437
					0.069		0.963	3.90E-04	1033.5	6.940706
					0.091		1.025	2.50E-04	662.5	6.496021
					0.122		1.048	1.50E-04	397.5	5.985195
					0.137		1.039	1.10E-04	291.5	5.67504
					0.152		1.028	7.30E-05	193.45	5.265019
					0.162		1.02	4.80E-05	127.2	4.845761
					0.172		1.02		127.2	4.845761
4	0.064	0.002	0.105	0.171	0	0.00021	0		7420	
					0.006		0.665	2.80E-03	7420	8.911934
					0.012		0.74	1.90E-03	5035	8.524169
					0.018		0.802	1.50E-03	3975	8.28778
					0.024		0.829	1.20E-03	3180	8.064636
					0.03		0.863	1.00E-03	2650	7.882315
					0.046		0.922	7.50E-04	1987.5	7.594633
					0.069		0.965	5.90E-04	1563.5	7.354682
					0.091		1.023	3.70E-04	980.5	6.888063
					0.122		1.049	2.20E-04	583	6.368187
					0.137		1.048	1.40E-04	371	5.916202
					0.152		1.033	1.00E-04	265	5.57973
					0.162		1.024	5.60E-05	148.4	4.999911
					0.171		1.024		148.4	4.999911

Table C.56. Data from Coleman Lab Data

Run	Discharge (cms)	Se	d50	h (m)	y (m)	a(m)	Velocity (m/s)	Sediment Concentration		
								Total (m^3/m^3)	Total (mg/L)	Ln C
5	0.064	0.002	0.105	0.171	0	0.00021	0		10600	
					0.006		0.662	4.00E-03	10600	9.268609
					0.012		0.717	2.60E-03	6890	8.837826
					0.018		0.788	1.90E-03	5035	8.524169
					0.024		0.814	1.60E-03	4240	8.352319
					0.03		0.852	1.40E-03	3710	8.218787
					0.046		0.911	1.10E-03	2915	7.977625
					0.069		0.968	7.80E-04	2067	7.633854
					0.091		1.028	5.00E-04	1325	7.189168
					0.122		1.038	2.80E-04	742	6.609349
					0.137		1.047	2.00E-04	530	6.272877
					0.152		1.03	1.30E-04	344.5	5.842094
					0.162		1.027	8.60E-05	227.9	5.428907
					0.171		1.027		227.9	5.428907
6	0.064	0.002	0.105	0.17	0	0.00021	0		13515	
					0.006		0.652	5.10E-03	13515	9.511555
					0.012		0.727	3.20E-03	8480	9.045466
					0.018		0.766	2.40E-03	6360	8.757784
					0.024		0.805	2.00E-03	5300	8.575462
					0.03		0.848	1.70E-03	4505	8.412943
					0.046		0.905	1.20E-03	3180	8.064636
					0.069		0.951	9.60E-04	2544	7.841493
					0.091		1.037	6.20E-04	1643	7.404279
					0.122		1.054	3.40E-04	901	6.803505
					0.137		1.049	2.30E-04	609.5	6.412639
					0.152		1.026	1.40E-04	371	5.916202
					0.162		1.031	7.70E-05	204.05	5.318365
					0.17		1.031		204.05	5.318365
7	0.064	0.002	0.105	0.17	0	0.00021	0		16430	
					0.006		0.639	6.20E-03	16430	9.706864
					0.012		0.709	4.00E-03	10600	9.268609
					0.018		0.77	3.20E-03	8480	9.045466
					0.024		0.804	2.50E-03	6625	8.798606
					0.03		0.849	2.10E-03	5565	8.624252
					0.046		0.924	1.50E-03	3975	8.28778
					0.069		0.962	1.20E-03	3180	8.064636
					0.091		1.03	7.60E-04	2014	7.607878
					0.122		1.061	4.30E-04	1139.5	7.038345
					0.137		1.051	3.00E-04	795	6.678342
					0.152		1.04	1.80E-04	477	6.167516
					0.162		1.027	1.10E-04	291.5	5.67504
					0.17		1.027		291.5	5.67504

Table C.57. Data from Enoree River

Sample Number	Temp F	Total Depth	y	Velocity (ft/sec)	Concentration in ppm by grain size (ppm)							Total C (ppm)
					0.074	0.124	0.175	0.246	0.351	0.495	0.701	
E (2-19-40 at 2:40)	43.16		0	0								836.55
		5	**0.1**	0	2.45	8.1	33	86	285	422	**0**	836.55
			0.15	1.87	2.4	8.5	45.3	67.1	130.9	82.2	0	336.4
			0.45	2.3	2.3	3.8	16.8	43.8	95.4	88.7	0	250.8
			0.75	2.15	1.4	5.5	16.8	32.6	65.3	58.5	0	180.1
			1.35	2.9	1.5	4.8	13.1	26.4	38.1	30.5	0	114.4
			1.95	2.85	2.2	5.3	13.6	17.8	27.5	20.4	0	86.8
			2.55	3.25	7.1	10.3	15.5	13.5	10.3	10.5	0	67.2
			3.15	3.63	2.8	3.9	9.3	10	10.2	7.5	0	43.7
			5	3.63								43.7
E (2-19-40 at 16:25)	45.86		0	0								153.79
		4.7	**0.094**	0	0.88	2.81	6.6	21.5	66	56	0	153.79
			0.15	2.08	0.7	2.1	3.9	13.7	26.6	29.2	0	76.2
			0.45	2.05	1	2.7	5.8	10.9	20.4	15.7	0	56.5
			0.75	1.9	0.8	3	6.3	7.5	18.9	22.4	0	58.9
			1.35	2.55	0.8	1.4	3.4	6.2	11.2	14.1	0	37.1
			1.95	2.33	0.6	0.9	3.2	5.7	8.8	6.2	0	25.4
			2.55	2.75	0.6	2.1	3.6	4.5	8	4.9	0	23.7
			3.15	2.72	1.3	2.3	4.2	3.6	4.5	2.2	0	18.1
			3.75	2.1	1	2.3	4.2	2.4	1.3	0.7	0	11.9
			4.7	2.1								11.900
E (2-19-40 at 17:00)	45.86		0	0								587.8
		4.2	**0.084**	0	1.4	4.4	20	67	225	270	0	587.8
			0.15	1.85	3	5	16.9	61.1	160	160	0	406
			0.45	1.85	0.9	1.9	9.8	27.6	58.2	57.5	0	155.9
			0.75	1.87	1.1	2.9	7.7	15.7	35.8	33.2	0	96.4
			1.35	2.77	0.8	3.8	6.6	13.6	27	13.5	0	65.3
			1.95	2.65	0.6	1.3	6.1	10.4	9.1	14.1	0	41.6
			2.55	2.96	0.9	2.1	2.2	10.4	13.1	6.2	0	34.9
			3.15	3.38	1.2	1.9	4.1	4.4	4.9	0.7	0	17.2
			3.75	2.77	0.5	2	1.9	3.6	3.2	2.8	0	14
			4.2	2.77								14
E (2-19-40 at 17:07)	45.86		0	0								186.09
		5.15	**0.103**	0	0.64	3.95	12	25.5	42	57	45	186.09
			0.15	0.59	0.5	3	8.7	22.3	25.5	46.4	36.3	142.7
			0.45	1.59	1.4	4	9	15.6	21.2	21.8	10.9	83.9
			0.75	1.52	1	2.9	9	11	16.4	16.5	4	60.8
			1.95	2.04	0.5	1.4	3.7	3.9	3.1	4.4	2.8	19.8
			2.55	2.4	0.7	2	4.8	5.5	5.4	6.8	7.2	32.4
			3.15	2.67	0.6	1.3	3.9	5.2	7.7	9	0	27.7
			3.75	2.1	0.3	2.2	4.1	5.7	6.4	0	0	18.7
			5.15	2.1								18.7
E (7-7-41 at 15:20)	75.2		0	0								52.82
		3.7	**0.074**	0	2.72	5	7.1	12	26	0	0	52.82
			0.15	0.79	3.2	5.8	6.4	7.4	8.9	0	0	31.7
			0.45	1.11	2.2	4.3	7.9	6	7.2	0	0	27.6
			0.75	1.26	1.6	2.8	4	6.1	4.9	0	0	19.4
			1.35	1.77	1.1	2.1	2.7	2.2	2.8	0	0	10.9
			1.95	1.62	2.3	3.5	4.8	1.8	1.7	0	0	14.1
			2.55	1.74	2.5	4.2	2.4	1.9	0.5	0	0	11.5
			3.45	1.7	2.1	2.3	2.5	0.7	0.4	0	0	8
			3.7	1.7								8
E (7-7-41 at 16:07)	75.2		0	0								311.35
		3	**0.06**	0	2.55	8.6	23.2	50	79	148	0	311.35
			0.15	0.9	1.4	6.7	15.8	31.4	39	21.7	0	116
			0.45	2	1.1	2.5	4	11.4	19.1	11.3	0	49.4
			0.75	1.89	3.3	5.9	8.5	10.8	7.6	12.2	0	48.3
			1.35	2.48	1.9	2.7	2.8	4.4	2.2	3.3	0	17.3
			1.95	2.4	1.8	2.8	3.2	4.3	2.1	0.5	0	14.7
			2.55	1.76	1.4	1.9	1.6	2.3	1.4	0	0	8.6
			3	1.76								8.6

Table C.58. Data from Middle Rio Grande

Date	Reach	Temp °F	Q (cfs)	Slope (ft/ft)	V_{mean} (ft/sec)	W (ft)	Horizon	D_{mean} (ft)	y	avg V	Concentration, ppm of indicated sizes					Bed Composition ... Percent Finer then Indicated					d_{35} (mm)	d_{50} (mm)	d_{65} (mm)	d_s (mm) Suspended
											<0.0625	0.625-0.125	0.125-0.25	0.25-0.50	Total*	0.062 mm	0.125 mm	0.25 mm	0.5 mm	1 mm				
								2.56	**0**	0					2870									
6/2/1953	Bernalillo A-2	71	2150	0.0008	3.11	270	A		0.275862	2.422667	1300	726	637	207	2870	0.7	4.1	27.8	86.6	97.9	0.27	0.32	0.37	0.0625
							B		0.807571	2.983333	1310	569	396	85	2360									
							C		1.236715	3.018667	1240	500	284	63	2087									
							D		1.706667	3.282	1240	398	239	58	1935									
							E		2.265487	3.268	1150	309	168	23	1650									
									2.56	3.268					1650									
								2.48	0	0					1791									
6/4/1953	Bernalillo A-2	62	2090	0.0008	3.12	270	A		0.318766	3.16	840	489	403	59	1791	0.5	3.7	34.1	74.3	91	0.25	0.33	0.42	0.0625
							B		0.777429	3.59	1070	381	156	16	1623									
							C		1.271795	3.67	907	386	261	27	1581									
							D		1.69863	3.673333	861	287	169	13	1330									
							E		2.156522	3.513333	837	291	169	33	1330									
									2.48	3.513333					1330									
								2.36	0	0					1660									
6/4/1953	Bernalillo C	71	2070	0.0008	2.33	376	A		0.317204	1.506667	895	355	334	76	1660	0.3	1.8	16.9	57.8	87.8	0.35	0.42	0.6	0.0625
							B		0.766234	2.41	830	314	208	18	1370									
							C		1.191919	2.62	775	248	117	9	1149									
							D		1.583893	2.906667	734	248	124	15	1121									
							E		2.034483	2.876667	753	191	81	5	1030									
									2.36	2.876667					1030									
								2.47	0	0					1590									
6/4/1953	Bernalillo E	70	1780	0.0008	2.69	268	A		0.371988	3.096667	774	334	434	48	1590	0.6	4.5	43.7	94.8	99	0.23	0.26	0.31	0.0625
							B		0.815182	3.313333	827	222	291	40	1380									
							C		1.253807	3.42	821	238	258	34	1351									
							D		1.691781	3.376667	763	189	165	14	1131									
							E		2.09322	3.32	675	156	120	6	957									
									2.47	3.32					957									

Table C.59. Data from Mississippi River – Union Point 1

Date	Location	Gage	Temp (°C)	Discharge (cfs)	Distance from Refernce Point (ft)	h (ft)	y (ft)	Velocity (ft/s)	Suspended Sediment Grain Size				Sediment Concentration (ppm)			
									0.062	0.125	0.25	0.425	Sand	Fine	Total	Ln C
27-Feb-98	Union Point	Knox Landing	9	1,010,854	1,066	66	66	**4.43**							349	
							59.4	4.43	1.5%	20.4%	82.7%	98.8%	135.9	213.1	349	5.855072
							46.2	4.06	11.4%	63.6%	88.6%	93.2%	11.5	236.2	247.7	5.512218
							33	4.46	1.6%	44.0%	94.8%	96.4%	68.6	212.5	281.1	5.63871
							19.8	4.18	4.5%	44.9%	100.0%	1000.0%	58.2	263.9	322.1	5.774862
							6.6	3.88	1.1%	17.4%	95.3%	99.4%	214.7	209.1	423.8	6.049262
							1.3	2.59	1.4%	22.0%	97.2%	99.0%	270	263.8	533.8	6.280021
							0	*1.17*							533.8	
27-Feb-98	Union Point	Knox Landing	9	1,010,854	1,658	66	66	**8.67**							228	
							59.4	8.67	4.4%	33.0%	70.3%	97.8%	19.2	208.8	228	5.429346
							46.2	8.4	4.7%	48.1%	94.6%	97.3%	48.1	203.4	251.5	5.527443
							33	8.65	2.8%	28.7%	97.2%	98.8%	103.3	197.7	301	5.70711
							19.8	7.25	2.2%	21.6%	96.4%	99.0%	147	202.3	349.3	5.855931
							6.6	6.68	1.1%	18.0%	96.6%	98.6%	304	249	553	6.315358
							1.3	5.57	0.2%	6.8%	93.3%	99.2%	995.4	245.7	1241.1	7.123753
							0	*3.05*							1241.1	
27-Feb-98	Union Point	Knox Landing	9	1,010,854	2,256	66	66	**6.93**							210.6	
							59.4	6.93	5.6%	46.3%	90.4%	93.2%	25.6	185	210.6	5.349961
							46.2	6.49	6.6%	25.4%	88.5%	92.6%	26.7	215.5	242.2	5.489764
							33	6.52	2.7%	24.3%	82.2%	93.6%	88.1	207.9	296	5.690359
							19.8	5.05	1.6%	16.2%	91.5%	98.7%	195.3	196.5	391.8	5.970752
							6.6	4.25	1.1%	11.7%	75.5%	99.6%	259.6	190.5	450.1	6.10947
							1.3	3.43	0.6%	11.5%	84.7%	99.0%	288.5	216.7	505.2	6.224954
							0	*1.54*							505.2	
27-Feb-98	Union Point	Knox Landing	9	1,010,854	2,941	56	56	**7.08**							228.3	
							50.4	7.08	6.3%	35.8%	87.4%	92.6%	22.3	206	228.3	5.430661
							39.2	7.59	7.3%	40.9%	87.8%	97.6%	31.8	207.5	239.3	5.477718
							28	7.51	1.9%	38.3%	89.0%	98.1%	29	194.7	223.7	5.410306
							16.8	6.39	2.5%	29.2%	66.3%	93.8%	65.9	223.3	289.2	5.667118
							5.6	6.5	4.4%	32.4%	76.4%	94.2%	61.5	223.8	285.3	5.653541
							1.1	3.92	2.1%	11.8%	44.9%	94.9%	118.3	226.8	345.1	5.843834
							0	*1.72*	2.1%	11.8%	44.9%	94.9%	118.3	226.8	345.1	
23-Mar-98	Union Point	Knox Landing	9	1,063,325	1,020	63	63	**4.75**							278.8	
							56.7	4.75	6.0%	41.8%	85.1%	100.0%	15.9	262.9	278.8	5.630495
							44.1	4.63	7.5%	51.2%	96.7%	100.0%	29.1	279.1	308.2	5.730749
							31.5	4.58	5.8%	49.6%	95.0%	98.3%	31.6	277.4	309	5.733341
							18.9	4.44	2.1%	21.8%	96.6%	98.9%	128.8	318	446.8	6.102111
							6.3	3.47	1.8%	18.9%	96.7%	99.3%	1985.4	294	2279.4	7.731668
							1.3	3.02	0.8%	12.4%	98.1%	99.5%	620.7	271.3	892.0	6.793466
							0	*2.47*							892.0	
23-Mar-98	Union Point	Knox Landing	9	1,063,325	1,755	67	67	**7.01**							260.3	
							60.3	7.01	9.6%	59.0%	89.2%	92.8%	14.6	245.7	260.3	5.561835
							46.9	7.59	10.8%	52.2%	94.1%	98.0%	26.6	221.7	248.3	5.514638
							33.5	6.82	4.0%	49.2%	95.2%	97.6%	22.1	245.8	267.9	5.590614
							20.1	7.03	1.2%	13.2%	96.1%	99.4%	242.1	240.1	482.2	6.178359
							6.7	6.27	0.9%	12.7%	96.7%	99.2%	273.3	245.9	519.2	6.252289
							1.3	5.62	1.4%	17.0%	96.1%	99.3%	256.5	272	528.5	6.270043
							0	*4.93*							528.5	
23-Mar-98	Union Point	Knox Landing	9	1,063,325	2,274	80	80	**7.71**							272.4	
							72	7.71	4.2%	30.5%	95.5%	99.0%	42.4	230	272.4	5.607272
							56	8.22	4.2%	25.1%	87.9%	98.8%	55.6	260	315.6	5.754476
							40	7.2	5.2%	27.0%	88.0%	97.8%	55.2	254	309.2	5.733988
							24	6.04	2.6%	18.4%	85.8%	99.0%	104.5	219.5	324	5.780744
							8	4.74	1.2%	10.9%	87.3%	99.1%	220.4	253.5	473.9	6.160996
							1.6	3.55	0.4%	4.1%	79.1%	99.1%	878	238	1116.0	7.017506
							0	*1.07*							1116.0	
23-Mar-98	Union Point	Knox Landing	9	1,063,325	3,091	60	60	**3.66**							243.4	
							54	3.66	7.3%	51.2%	95.9%	98.4%	16.7	226.7	243.4	5.494706
							42	3.86	9.7%	41.4%	84.1%	95.9%	27.6	247.5	275.1	5.617135
							30	3.75	7.4%	30.5%	81.1%	100.0%	43.7	265.6	309.3	5.734312
							18	3.47	4.7%	49.3%	91.9%	97.2%	53.1	273.6	326.7	5.789042
							6	3.36	7.2%	30.4%	80.9%	99.0%	58.3	293.6	351.9	5.863347
							1.2	1.5	2.2%	16.5%	61.8%	94.2%	118.9	288	406.9	6.008567
							0	*0.96*							406.9	

Table C.60. Data from Mississippi River – Union Point 2

Date	Location	Gage	Temp (°C)	Discharge (cfs)	Distance from Refernce Point (ft)	h (ft)	y (ft)	Velocity (ft/s)	Suspended Sediment Grain Size				Sediment Concentration (ppm)			
									0.062	0.125	0.25	0.425	Sand	Fine	Total	Ln C
10-Apr-98	Union Point	Knox Landing	16	1,107,752	1,075	69	69	**4.62**							180.6	
						6.9	62.1	4.62	1.7%	47.5%	92.4%	93.2%	23.9	156.7	180.6	5.196285
						20.7	48.3	4.07	2.1%	51.1%	100.0%	100.0%	10	179.7	189.7	5.245444
						34.5	34.5	3.43	4.6%	53.8%	100.0%	100.0%	25.6	252.7	278.3	5.6287
						48.3	20.7	3.91	3.0%	47.7%	98.3%	100.0%	34.98	157.8	192.78	5.26155
						62.1	6.9	3.49	0.5%	16.8%	97.9%	100.0%	131.1	183.5	314.6	5.751302
						67.6	1.4	2.72	0.7%	20.5%	95.7%	97.3%	131	213.8	344.8	5.842965
							0	*2.21*							344.8	
10-Apr-98	Union Point	Knox Landing	16	1,107,752	1,643	70	70	**7.44**							174.6	
						7	63	7.44	4.1%	49.3%	97.3%	100.0%	18.9	155.7	174.6	5.162498
						21	49	7.93	9.9%	67.0%	100.0%	100.0%	14.1	169.2	183.3	5.211124
						35	35	7.31	1.7%	44.1%	100.0%	100.0%	24.4	185.6	210	5.347108
						49	21	7.31	0.6%	25.7%	97.6%	98.5%	109.9	158.3	268.2	5.591733
						63	7	5.98	0.2%	18.6%	96.2%	98.5%	251.3	166.4	417.7	6.034763
						68.6	1.4	4.92	0.4%	33.4%	97.9%	99.5%	203.3	175.9	379.2	5.938064
							0	*4.92*							379.2	
10-Apr-98	Union Point	Knox Landing	16	1,107,752	2,224	81	81	**7.1**							145.9	
						8.1	72.9	7.1	13.9%	52.8%	93.1%	100.0%	8.2	137.7	145.9	4.982921
						24.3	56.7	6.98	0.2%	17.5%	87.6%	97.3%	67.5	150.8	218.3	5.38587
						40.5	40.5	6.58	2.7%	27.8%	89.3%	100.0%	37.6	143.8	181.4	5.200705
						56.7	24.3	5.58	1.2%	18.0%	89.9%	98.5%	85.1	189.6	274.7	5.61568
						72.9	8.1	4.11	0.4%	8.2%	86.2%	99.0%	205.7	167.8	373.5	5.922918
						79.4	1.6	3.04	0.0%	7.7%	74.9%	91.8%	209	307.8	516.8	6.247656
							0	*2.61*							516.8	
10-Apr-98	Union Point	Knox Landing	16	1,107,752	2,943	60	60	**6.4**							152.2	
						6	54	6.4	4.4%	46.2%	90.1%	100.0%	11.3	140.9	152.2	5.025195
						18	42	6.16	0.0%	39.8%	82.8%	100.0%	22	177.8	199.8	5.297317
						30	30	6.23	0.7%	18.4%	54.3%	100.0%	60.7	170.9	231.6	5.445012
						42	18	6.99	1.5%	25.0%	63.1%	95.5%	48.8	159.7	208.5	5.339939
						54	6	5.15	2.2%	26.8%	65.4%	99.6%	38.2	155.8	194	5.267858
						58.8	1.2	3.11	1.4%	18.5%	46.4%	91.4%	75.8	148.9	224.7	5.414766
							0	*3.11*							224.7	
17-Apr-98	Union Point	Knox Landing	16	1,069,422	1,040	69	69	**4.22**							366.2	
						6.9	62.1	4.22	5.5%	49.8%	96.0%	100.0%	52.1	314.1	366.2	5.90318
						20.7	48.3	3.85	2.9%	52.5%	97.1%	98.6%	47.4	278.4	325.8	5.786284
						34.5	34.5	3.29	3.5%	52.8%	91.4%	95.7%	65.9	261.2	327.1	5.790266
						48.3	20.7	4.02	1.9%	47.3%	94.9%	98.1%	62.2	297	359.2	5.883879
						62.1	6.9	3.5	0.9%	19.9%	95.3%	99.7%	156.9	307.6	464.5	6.140962
						67.6	1.4	2.32	1.6%	22.8%	96.7%	99.0%	178.4	300.2	478.6	6.170865
							0	*2.14*							478.6	
17-Apr-98	Union Point	Knox Landing	16	1,069,422	1,648	71	71	**7.16**							303.2	
						7.1	63.9	7.16	3.3%	72.0%	95.8%	100.0%	44.3	258.9	303.2	5.714393
						21.3	49.7	6.67	16.6%	56.6%	94.3%	100.0%	18.7	222.7	241.4	5.486455
						35.5	35.5	6.43	1.2%	20.8%	96.2%	99.2%	111.3	293.8	405.1	6.004134
						49.7	21.3	5.78	3.1%	24.8%	93.6%	98.6%	112.5	268.1	380.6	5.941749
						63.9	7.1	4.07	1.7%	16.7%	94.7%	97.6%	207	297.2	504.2	6.222973
						69.6	1.4	3.37	0.6%	17.2%	93.5%	98.7%	231.2	254.9	486.1	6.186414
							0	*2.74*							486.1	
17-Apr-98	Union Point	Knox Landing	16	1,069,422	2,247	69	69	**8.6**							303.7	
						6.9	62.1	8.6	10.5%	50.9%	100.0%	100.0%	13.1	290.6	303.7	5.71604
						20.7	48.3	8.01	5.8%	36.8%	86.0%	100.0%	26	245.4	271.4	5.603594
						34.5	34.5	7.99	1.5%	13.1%	81.9%	100.0%	99.4	272.7	372.1	5.919163
						48.3	20.7	7.96	1.7%	8.5%	77.5%	99.2%	151.6	325.3	476.9	6.167307
						62.1	6.9	7.98	1.2%	8.4%	75.7%	98.9%	193.5	275.1	468.6	6.14975
						67.6	1.4	5.63	0.3%	5.7%	76.5%	99.2%	347.7	252.9	600.6	6.397929
							0	*4.6*							600.6	
17-Apr-98	Union Point	Knox Landing	16	1,069,422	2,966	57	57	**7.1**							299	
						5.7	51.3	7.1	4.0%	46.0%	86.0%	100.0%	18.6	280.4	299	5.700444
						17.1	39.9	6.46	4.6%	37.6%	81.5%	95.4%	38.8	299.5	338.3	5.823933
						28.5	28.5	5.04	9.4%	31.2%	81.9%	100.0%	42.7	331.5	374.2	5.92479
						39.9	17.1	4.32	3.4%	12.6%	63.2%	97.9%	85	306.6	391.6	5.970241
						51.3	5.7	3.92	1.9%	14.9%	51.2%	95.1%	117.3	296.5	413.8	6.025383
						55.9	1.1	3.79	0.9%	13.5%	40.6%	92.0%	207.3	276.9	484.2	6.182498
							0	*3.79*							484.2	

Table C.61. Data from Mississippi River – Union Point 3

Date	Location	Gage	Temp (°C)	Discharge (cfs)	Distance from Refernce Point (ft)	h (ft)	y (ft)	Velocity (ft/s)	Suspended Sediment Grain Size				Sediment Concentration (ppm)			
									0.062	0.125	0.25	0.425	Sand	Fine	Total	Ln C
8-May-98	Union Point	Knox Landing	19	1,219,937	1,094	73	73	**5.2**							148.4	
						7.3	65.7	5.2	4.0%	46.6%	100.0%	100.0%	27.5	120.9	148.4	4.999911
						21.9	51.1	4.24	0.8%	30.6%	97.5%	100.0%	76	138.5	214.5	5.36831
						36.5	36.5	3.65	1.9%	40.2%	97.3%	100.0%	53.1	13.43	66.53	4.197653
						51.1	21.9	3.26	0.0%	28.2%	96.7%	100.0%	60.2	184.1	244.3	5.498397
						65.7	7.3	3.22	0.2%	28.2%	97.1%	98.9%	103.2	151.1	254.3	5.538515
						71.5	1.5	2.38	0.8%	27.9%	95.5%	99.7%	125.1	138.4	263.5	5.574053
							0	*0.95*							263.5	
8-May-98	Union Point	Knox Landing	19	1,219,937	1,652	72	72	**7.61**							119.5	
						7.2	64.8	7.61	4.4%	67.4%	95.6%	100.0%	16.4	103.1	119.5	4.783316
						21.6	50.4	7.44	1.7%	28.6%	94.5%	100.0%	71.7	128	199.7	5.296816
						36	36	7.49	0.4%	29.9%	97.5%	100.0%	68.5	157	225.5	5.41832
						50.4	21.6	6.72	1.2%	27.8%	96.6%	100.0%	91.3	143.8	235.1	5.460011
						64.8	7.2	6.79	0.8%	18.3%	96.1%	98.9%	204.6	139.1	343.7	5.839769
						70.6	1.4	4.35	0.5%	8.6%	97.3%	99.7%	1131.4	214.6	1346.0	7.204893
							0	*1.23*							1346.0	
8-May-98	Union Point	Knox Landing	19	1,219,937	2,276	72	72	**9.89**							246.3	
						7.2	64.8	9.89	0.9%	16.9%	88.6%	100.0%	109.9	136.4	246.3	5.50655
						21.6	50.4	9.23	3.6%	34.7%	87.4%	100.0%	28.5	116.4	144.9	4.976044
						36	36	9.42	2.8%	21.4%	77.2%	97.2%	46.8	141	187.8	5.235378
						50.4	21.6	9.77	0.3%	7.6%	89.0%	98.9%	158.3	130.1	288.4	5.664348
						64.8	7.2	9.02	0.3%	6.7%	85.6%	99.2%	427.9	139.9	567.8	6.341769
						70.6	1.4	6.36	0.1%	7.9%	55.4%	96.0%	212.2	115.9	328.1	5.793318
							0	*2.92*							328.1	
8-May-98	Union Point	Knox Landing	19	1,219,937	2,959	58	58	**6.8**							139.3	
						5.8	52.2	6.8	2.9%	45.1%	88.2%	100.0%	18	121.3	139.3	4.93663
						17.4	40.6	7.07	1.4%	24.2%	61.1%	95.4%	51	115.9	166.9	5.117395
						29	29	7	3.1%	28.6%	78.6%	100.0%	29.7	175.1	204.8	5.322034
						40.6	17.4	5.84	2.2%	17.7%	51.0%	94.8%	82.3	127.4	209.7	5.345678
						52.2	5.8	7.66	3.0%	18.2%	51.3%	100.0%	57.1	131.7	188.8	5.240688
						56.8	1.2	4.78	0.3%	5.4%	25.5%	89.1%	324.7	110.2	434.9	6.075116
							0	*4.67*							434.9	
9-Jun-98	Union Point	Knox Landing	26	735,773	1,047	57	57	**4.15**							236.4	
						5.7	51.3	4.15	8.0%	59.8%	100.0%	100.0%	13.4	223	236.4	5.465525
						17.1	39.9	3.19	0.0%	48.2%	91.1%	100.0%	18.9	296.7	315.6	5.754476
						28.5	28.5	3.71	0.0%	72.2%	100.0%	100.0%	9.8	246.3	256.1	5.545568
						39.9	17.1	3.25	3.2%	68.8%	100.0%	100.0%	14.6	238.3	252.9	5.532994
						51.3	5.7	2.53	6.2%	36.9%	93.8%	98.5%	36.1	295	331.1	5.80242
						55.9	1.1	1.04	0.0%	32.5%	93.6%	94.3%	64.9	333.2	398.1	5.986703
							0	*1.04*							398.1	
9-Jun-98	Union Point	Knox Landing	26	735,773	1,613	60	60	**5.89**							244.5	
						6	54	5.89	1.8%	34.1%	95.9%	100.0%	28	216.5	244.5	5.499215
						18	42	5.3	0.6%	41.3%	97.7%	100.0%	24	201.6	225.6	5.418764
						30	30	5.27	2.6%	24.4%	94.6%	98.6%	77.1	240.3	317.4	5.760163
						42	18	4.86	0.4%	15.3%	95.0%	100.0%	114.1	257.3	371.4	5.91728
						54	6	3.56	1.9%	24.4%	94.9%	99.5%	68.6	246.4	315	5.752573
						58.8	1.2	2.39	0.5%	13.1%	95.4%	99.1%	153.4	252.1	405.5	6.005121
							0	*1.93*							405.5	
9-Jun-98	Union Point	Knox Landing	26	735,773	2,235	63	63	**6.3**							231.4	
						6.3	56.7	6.3	13.3%	66.7%	100.0%	100.0%	5.1	226.3	231.4	5.444148
						18.9	44.1	6	6.3%	57.5%	93.8%	100.0%	12.6	227.5	240.1	5.481056
						31.5	31.5	5.52	2.7%	33.3%	88.0%	100.0%	19.3	252	271.3	5.603225
						44.1	18.9	5.57	0.2%	10.2%	67.4%	99.1%	156.6	232.2	388.8	5.963065
						56.7	6.3	4.07	0.3%	8.4%	63.4%	100.0%	121	224.1	345.1	5.843834
						61.7	1.3	3.55	0.1%	1.2%	46.1%	96.2%	958.4	245.5	1203.9	7.093322
							0	*2.99*							1203.9	
9-Jun-98	Union Point	Knox Landing	26	735,773	2,923	46	46	**4.7**							362.3	
						4.6	41.4	4.7	1.4%	8.5%	51.1%	98.2%	91.7	270.6	362.3	5.892473
						13.8	32.2	5.04	6.5%	43.6%	80.4%	100.0%	9.5	242.6	252.1	5.529826
						23	23	4.89	1.7%	48.7%	90.6%	100.0%	21.8	233.4	255.2	5.542048
						32.2	13.8	4.32	1.8%	55.8%	93.8%	100.0%	21.2	239.8	261	5.56452
						41.4	4.6	3.91	0.0%	34.1%	65.9%	100.0%	33.6	275.1	308.7	5.73237
						45.1	0.9	3.11	0.2%	25.3%	53.0%	96.1%	55.4	239.1	294.5	5.685279
							0	*2.61*							294.5	
3-Aug-98	Union Point	Knox Landing	31	571,934	1,030	47	47	**4.4**							226.2	
						4.7	42.3	4.4	0.0%	25.6%	84.6%	100.0%	10.7	215.5	226.2	5.42142
						14.1	32.9	4.52	0.0%	50.6%	96.2%	100.0%	13.5	193.2	206.7	5.331268
						23.5	23.5	3.39	0.0%	53.8%	93.6%	100.0%	17	202.9	219.9	5.393173
						32.9	14.1	3.58	0.0%	42.4%	95.9%	100.0%	30.4	188.8	219.2	5.389985
						42.3	4.7	2.46	0.0%	22.9%	96.3%	98.6%	105.9	189.1	295	5.686975
						46.1	0.9	1.2	0.2%	15.7%	96.5%	98.9%	197	198.2	395.2	5.979392
							0	*1.2*							395.2	
3-Aug-98	Union Point	Knox Landing	31	571,934	1,625	50	50	**6.03**							202.6	
						5	45	6.03	0.0%	37.6%	97.2%	100.0%	19	183.6	202.6	5.311234
						15	35	5.48	3.2%	29.9%	92.3%	97.3%	30.4	186.5	216.9	5.379436
						25	25	5.75	1.0%	25.8%	93.3%	100.0%	30.7	182.6	213.3	5.3627
						35	15	5.11	0.3%	12.5%	86.2%	99.0%	102.9	179.8	282.7	5.644386
						45	5	4.66	0.3%	10.1%	87.8%	100.0%	123.2	224.5	347.7	5.85134
						49	1	2.29	0.4%	6.7%	86.2%	99.4%	363.4	207.6	571.0	6.347389
							0	*2.29*							571.0	
3-Aug-98	Union Point	Knox Landing	31	571,934	2,229	50	50	**6.12**							184.1	
						5	45	6.12	3.9%	38.2%	88.2%	100.0%	12.6	171.5	184.1	5.215479
						15	35	5.95	1.7%	41.4%	70.7%	100.0%	13.9	221.1	235	5.459586
						25	25	5.31	2.1%	33.0%	67.0%	100.0%	14.8	185.4	200.2	5.299317
						35	15	5.68	1.9%	22.9%	63.8%	100.0%	35.7	200	235.7	5.46256
						45	5	4.81	0.2%	6.3%	28.3%	96.3%	149.1	178.6	327.7	5.792099
						49	1	2.47	0.6%	6.6%	30.0%	96.8%	175.5	188.5	364.0	5.897154
							0	*2.47*							364.0	
3-Aug-98	Union Point	Knox Landing	31	571,934	2,901	41	41	**4.54**							189.8	
						4.1	36.9	4.54	0.0%	48.1%	66.7%	100.0%	4.4	185.4	189.8	5.245971
						12.3	28.7	4.55	7.9%	63.2%	89.5%	100.0%	5.9	184	189.9	5.246498
						20.5	20.5	4.27	3.2%	29.4%	90.3%	100.0%	9	183.8	192.8	5.261653
						28.7	12.3	4.28	4.5%	71.2%	92.4%	95.5%	9.4	178.4	187.8	5.235378
						36.9	4.1	2.69	6.4%	55.3%	78.7%	100.0%	7.5	182	189.5	5.244389
						40.2	0.8	2.39	2.5%	34.0%	60.4%	84.9%	42.9	226.1	269.0	5.594711
							0	*0.22*							269.0	

Table C.62. Data from Mississippi River – Line 13 1

Date	Location	Gage	Temp (°C)	Discharge (cfs)	Distance from Refernce Point	h (ft)	y (ft)	Velocity (ft/s)	Suspended Sediment Grain Size Analysis				Sediment Concentration (ppm)			
									0.062	0.125	0.25	0.425	Sand	Fine	Total	Ln C
27-Feb-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	9	857,119	1,793	107	107	**7.19**							253.4	
						10.7	96.3	7.19	6.6%	41.1%	90.0%	95.3%	42.3	211.1	253.4	5.534969
						32.1	74.9	6.88	2.6%	33.9%	92.7%	96.5%	58.4	199.4	257.8	5.552184
						53.5	53.5	6.75	4.9%	38.6%	94.8%	98.1%	55.7	206.4	262.1	5.568726
						74.9	32.1	7.2	6.4%	43.1%	97.2%	98.0%	47.4	185.5	232.9	5.450609
						96.3	10.7	6.28	1.7%	17.6%	73.1%	89.8%	154.4	194.3	348.7	5.854212
						104.9	2.1	6.09	2.7%	27.5%	83.5%	94.3%	92	185.7	277.7	5.626541
							0								277.7	
27-Feb-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	9	857,119	2,115	97	97	**8.95**							219.8	
						9.7	87.3	8.95	5.2%	27.0%	87.8%	94.8%	20.5	199.3	219.8	5.392718
						29.1	67.9	9.21	2.3%	35.4%	93.2%	96.8%	43.8	178.1	221.9	5.402227
						48.5	48.5	9.09	1.6%	23.6%	89.5%	96.9%	122	243.3	365.3	5.900719
						67.9	29.1	8.26	2.3%	22.1%	89.1%	96.6%	103.4	232.9	336.3	5.818004
						87.3	9.7	5.78	1.6%	22.9%	89.3%	97.3%	107.6	205	312.6	5.744924
						95.1	1.9	3.1	2.2%	15.7%	67.7%	91.6%	213.1	240	453.1	6.116113
							0								453.1	
27-Feb-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	9	857,119	2,449	89	89	**7.52**							223.5	
						8.9	80.1	7.52	10.1%	38.4%	79.7%	89.9%	24.5	199	223.5	5.409411
						26.7	62.3	8.02	2.2%	22.3%	88.6%	97.3%	49.1	188.1	237.2	5.468904
						44.5	44.5	8.67	4.7%	33.8%	97.4%	100.0%	84.5	204.9	289.4	5.66781
						62.3	26.7	7.55	0.9%	14.5%	96.7%	99.4%	265.6	187.5	453.1	6.116113
						80.1	8.9	6.08	0.4%	12.3%	94.8%	99.0%	569.3	256.2	825.5	6.715989
						87.2	1.8	3.72	0.8%	12.8%	93.5%	99.7%	557.2	218.2	775.4	6.653379
							0								775.4	
27-Feb-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	9	857,119	2,916	70	70	**5.19**							236	
						7.0	63	5.19	8.8%	40.1%	78.8%	91.2%	26.9	209.1	236	5.463832
						21.0	49	5.21	4.9%	39.4%	91.1%	97.8%	54.3	187.2	241.5	5.486869
						35	35	4.79	1.7%	29.1%	97.4%	98.5%	115.5	225.1	340.6	5.830709
						49	21	4.67	1.6%	29.4%	97.3%	98.5%	303.8	308.3	612.1	6.416896
						63	7	3.66	1.7%	29.3%	97.2%	99.1%	199.2	215.3	414.5	6.027073
						68.6	1.4	2.81	4.7%	33.1%	96.0%	97.7%	164.8	262.8	427.6	6.058188
							0								427.6	6.1
23-Mar-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	9	855,124	1,785	107	107	**6.56**							255	
						10.7	96.3	6.56	8.2%	40.1%	92.3%	97.8%	31	224	255	5.541264
						32.1	74.9	6.9	4.3%	31.6%	94.8%	97.0%	42.2	233.5	275.7	5.619313
						53.5	53.5	8.29	4.7%	27.1%	94.2%	98.1%	62.7	243.6	306.3	5.724565
						74.9	32.1	7.19	5.4%	27.1%	93.0%	98.7%	59.2	227.6	286.8	5.658785
						96.3	10.7	6.58	2.9%	22.4%	80.7%	95.8%	79.4	240.6	320	5.768321
						104.9	2.1	5.74	5.4%	26.4%	91.0%	98.0%	87.7	254.1	341.8	5.834226
							0								341.8	
23-Mar-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	9	855,124	2,068	95	95	**7.99**							293.1	
						9.5	85.5	7.99	3.9%	22.4%	92.3%	98.8%	67.7	225.4	293.1	5.680514
						28.5	66.5	7.07	5.1%	29.9%	90.4%	98.4%	53.4	237.2	290.6	5.671948
						47.5	47.5	6.75	1.8%	15.8%	89.9%	99.1%	133.9	241.7	375.6	5.928525
						66.5	28.5	5.24	0.4%	6.8%	91.8%	97.0%	334.1	217.6	551.7	6.313004
						85.5	9.5	5.43	5.3%	27.8%	94.4%	98.6%	103.4	279.3	382.7	5.947251
						93.1	1.9	4.38	5.2%	23.5%	92.4%	98.6%	85.7	240.1	325.8	5.786284
							0								325.8	
23-Mar-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	9	855,124	2,459	87	87	**8.89**							271.6	
						8.7	78.3	8.89	12.1%	38.5%	93.4%	96.7%	19.7	251.9	271.6	5.60433
						26.1	60.9	8.62	4.5%	26.7%	92.2%	96.7%	59.8	262.3	322.1	5.774862
						43.5	43.5	8.08	8.6%	50.3%	94.0%	96.7%	24.1	234.8	258.9	5.556442
						60.9	26.1	7.9	3.6%	39.1%	98.2%	100.0%	41.1	233.8	274.9	5.616407
						78.3	8.7	6.87	1.2%	13.5%	97.3%	99.4%	260.8	233.5	494.3	6.203143
						85.3	1.7	6.27	1.1%	12.5%	97.8%	99.0%	365	302.1	667.1	6.50294
							0								667.1	
23-Mar-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	9	855,124	2,890	75	75	**5.57**							285	
						7.5	67.5	5.57	6.5%	50.0%	90.9%	95.5%	34	251	285	5.652489
						22.5	52.5	5.45	7.1%	41.8%	92.9%	95.5%	32.5	255	287.5	5.661223
						37.5	37.5	5.02	4.5%	26.4%	91.9%	96.7%	59.2	256.9	316.1	5.756059
						52.5	22.5	4.28	2.7%	23.1%	96.8%	99.0%	145.1	256.5	401.6	5.995457
						67.5	7.5	4.26	1.7%	22.0%	96.6%	99.0%	175.6	231.5	407.1	6.009059
						73.5	1.5	1.83	0.8%	14.8%	94.9%	98.6%	352	287.2	639.2	6.460217
							0								639.2	

Table C.63. Data from Mississippi River – Line 13 2

Date	Location	Gage	Temp (°C)	Discharge (cfs)	Distance from Refernce Point	h (ft)	y (ft)	Velocity (ft/s)	Suspended Sediment Grain Size Analysis				Sediment Concentration (ppm)			
									0.062	0.125	0.25	0.425	Sand	Fine	Total	Ln C
10-Apr-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	16	910,249	1,801	110	110	**9.24**							175.3	
						11.0	99	9.24	3.7%	39.3%	98.2%	100.0%	28.2	147.1	175.3	5.166499
						33.0	77	8.95	2.0%	32.4%	93.9%	100.0%	38.2	132.3	170.5	5.138735
						55	55	9.12	1.9%	40.7%	93.1%	100.0%	29.9	119.8	149.7	5.008633
						77	33	8.31	2.2%	38.5%	85.6%	100.0%	23.4	155.6	179	5.187386
						99	11	8.92	0.8%	43.0%	97.5%	100.0%	26	148.6	174.6	5.162498
						107.8	2.2	8.13	0.8%	33.8%	95.8%	100.0%	50.1	155.5	205.6	5.325933
							0								205.6	
10-Apr-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	16	910,249	2,072	100	100	**10.03**							155.4	
						10.0	90	10.03	2.2%	45.9%	100.0%	100.0%	25.4	130	155.4	5.046002
						30.0	70	8.95	0.9%	36.0%	94.3%	100.0%	33	153.5	186.5	5.228431
						50	50	8.74	0.8%	17.5%	79.2%	95.0%	20.6	189.6	210.2	5.348059
						70	30	6.97	0.8%	23.2%	90.8%	99.2%	52.1	141.3	193.4	5.264761
						90	10	6.73	0.2%	10.2%	69.6%	97.3%	198.2	112.4	310.6	5.738506
						98.0	2	5.84	0.6%	18.1%	87.3%	97.9%	166	143.3	309.3	5.734312
							0								309.3	
10-Apr-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	16	910,249	2,433	92	92	**7**							143.3	
						9.2	82.8	7	5.9%	74.5%	100.0%	100.0%	9.5	133.8	143.3	4.96494
						27.6	64.4	7.29	3.8%	64.1%	92.3%	100.0%	11.2	140.7	151.9	5.023222
						46	46	7.26	1.1%	45.9%	97.8%	100.0%	37.5	155.4	192.9	5.262172
						64.4	27.6	7.69	0.4%	14.4%	91.6%	98.6%	155.3	148.9	304.2	5.717685
						82.8	9.2	7.28	0.4%	13.9%	93.4%	99.6%	193.9	152	345.9	5.84615
						90.2	1.8	4.8	0.5%	14.9%	94.8%	99.3%	181	129.4	310.4	5.737862
							0								310.4	
10-Apr-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	16	910,249	2,869	76	76	**3.3**							189.5	
						7.6	68.4	3.3	2.4%	57.1%	100.0%	100.0%	16.7	172.8	189.5	5.244389
						22.8	53.2	3.43	5.6%	62.7%	97.6%	100.0%	16.1	150.3	166.4	5.114395
						38	38	2.95	0.0%	33.2%	98.4%	100.0%	50.2	152	202.2	5.309257
						53.2	22.8	3.12	1.1%	22.8%	95.5%	99.0%	116.4	131.5	247.9	5.513025
						68.4	7.6	2.82	0.3%	16.9%	97.3%	99.5%	175.1	117.6	292.7	5.679148
						74.5	1.5	2.81	0.4%	12.4%	95.4%	99.5%	319.5	159.8	479.3	6.172327
							0								479.3	
17-Apr-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	16	898,752	1,786	110	110	**6.24**							294.7	
						11.0	99	6.24	3.5%	33.6%	93.0%	100.0%	25.1	269.6	294.7	5.685958
						33.0	77	5.16	1.5%	24.8%	88.5%	94.8%	46.2	266.2	312.4	5.744284
						55	55	4.44	1.8%	35.4%	94.5%	98.2%	33.3	288.2	321.5	5.772998
						77	33	3.92	1.0%	28.5%	88.6%	100.0%	51.3	303.6	354.9	5.871836
						99	11	5.13	0.6%	23.1%	88.6%	95.8%	57.8	267.2	325	5.783825
						107.8	2.2	4	0.6%	19.8%	88.8%	100.0%	83.6	275.3	358.9	5.883044
							0								358.9	
17-Apr-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	16	898,752	2,098	105	105	**9.73**							305.2	
						10.5	94.5	9.73	2.1%	28.6%	92.1%	97.9%	44.3	260.9	305.2	5.720967
						31.5	73.5	9.8	0.9%	19.6%	92.2%	100.0%	66.1	264	330.1	5.799396
						52.5	52.5	9.82	0.3%	19.9%	93.8%	100.0%	75.8	297.9	373.7	5.923453
						73.5	31.5	8.8	1.0%	12.9%	84.1%	97.3%	141.1	256.9	398	5.986452
						94.5	10.5	7.8	0.6%	15.4%	90.4%	99.4%	125.6	271	396.6	5.982928
						102.9	2.1	7.48	0.3%	8.3%	83.5%	98.5%	269.2	286.3	555.5	6.319869
							0								555.5	
17-Apr-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	16	898,752	2,454	91	91	**7.32**							284.9	
						9.1	81.9	7.32	11.0%	57.5%	83.6%	100.0%	13.6	271.3	284.9	5.652138
						27.3	63.7	7.32	17.8%	32.0%	93.2%	96.8%	51.7	259.5	311.2	5.740436
						45.5	45.5	7.32	4.5%	40.3%	91.5%	96.5%	74.7	267.8	342.5	5.836272
						63.7	27.3	7.34	3.2%	22.6%	94.9%	100.0%	82.5	287.4	369.9	5.913233
						81.9	9.1	6.85	0.1%	8.4%	91.2%	99.6%	368.1	283	651.1	6.478663
						89.2	1.8	4.7	0.6%	10.9%	94.1%	99.5%	361.1	268.6	629.7	6.445244
							0								629.7	
17-Apr-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	16	898,752	2,834	77	77	**5.49**							306.7	
						7.7	69.3	5.49	15.1%	54.7%	100.0%	100.0%	12.9	293.8	306.7	5.72587
						23.1	53.9	5.74	1.3%	26.6%	88.6%	100.0%	54.7	251.6	306.3	5.724565
						38.5	38.5	5.21	2.2%	26.8%	95.9%	100.0%	74	295.4	369.4	5.91188
						53.9	23.1	5.16	3.1%	31.6%	96.0%	100.0%	93.1	275.2	368.3	5.908898
						69.3	7.7	3.88	6.6%	30.6%	96.7%	100.0%	43.5	366.1	409.6	6.015181
						75.5	1.5	2.39	1.7%	14.7%	86.4%	96.4%	214	277.3	491.3	6.197055
							0								491.3	

Table C.64. Data from Mississippi River – Line 13 3

Date	Location	Gage	Temp (°C)	Discharge (cfs)	Distance from Refernce Point	h (ft)	y (ft)	Velocity (ft/s)	Suspended Sediment Grain Size Analysis				Sediment Concentration (ppm)			
									0.062	0.125	0.25	0.425	Sand	Fine	Total	Ln C
8-May-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	19	1,120,828	1,787	114	114	9.21							138.7	
						11.4	102.6	9.21	3.6%	32.9%	97.0%	100.0%	27.4	111.3	138.7	4.932313
						34.2	79.8	9.67	0.7%	32.5%	90.7%	100.0%	31.8	144.4	176.2	5.17162
						57	57	9.86	0.6%	29.9%	93.2%	98.1%	44.6	108.7	153.3	5.032397
						79.8	34.2	10.06	3.1%	15.1%	62.2%	100.0%	134.1	124.8	258.9	5.556442
						102.6	11.4	7.81	0.5%	28.7%	89.1%	100.0%	64.7	111.3	176	5.170484
						111.7	2.3	7.14	0.4%	14.1%	76.5%	98.3%	172.3	122.6	294.9	5.686636
							0								294.9	
8-May-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	19	1,120,828	2,032	102	102	11.15							211.8	
						10.2	91.8	11.15	0.7%	21.6%	89.7%	97.9%	77.9	133.9	211.8	5.355642
						30.6	71.4	10.78	1.5%	22.1%	91.2%	100.0%	63	121.8	184.8	5.219274
						51	51	10.16	4.0%	27.9%	87.2%	100.0%	43.1	121.3	164.4	5.102302
						71.4	30.6	8.81	0.5%	17.4%	78.9%	97.8%	95.8	128.2	224	5.411646
						91.8	10.2	7.82	1.5%	10.9%	71.1%	97.0%	204.5	132.3	336.8	5.819489
						100.0	2	5.7	0.3%	17.7%	90.5%	99.5%	143.5	126.4	269.9	5.598052
							0								269.9	
8-May-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	19	1,120,828	2,456	87	87	8.73							161.6	
						8.7	78.3	8.73	1.2%	33.8%	96.9%	100.0%	42.1	119.5	161.6	5.085124
						26.1	60.9	8.5	7.4%	66.2%	97.1%	100.0%	16	136.1	152.1	5.024538
						43.5	43.5	8.74	0.0%	27.0%	95.3%	100.0%	62.1	131.2	193.3	5.264243
						60.9	26.1	9.37	4.2%	63.9%	87.5%	100.0%	13.6	125.1	138.7	4.932313
						78.3	8.7	9.02	0.7%	11.1%	94.7%	98.9%	227.7	153.2	380.9	5.942537
						85.3	1.7	7.61	2.7%	11.1%	96.4%	99.6%	427.6	130.8	558.4	6.325076
							0								558.4	
8-May-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	19	1,120,828	2,855	81	81	5.23							137.1	
						8.1	72.9	5.23	18.2%	55.4%	100.0%	100.0%	16.1	121	137.1	4.920711
						24.3	56.7	5.16	7.1%	47.6%	100.0%	100.0%	15	183.7	198.7	5.291796
						40.5	40.5	5.8	1.2%	24.1%	95.2%	100.0%	57.1	152.1	209.2	5.343291
						56.7	24.3	6.01	14.0%	38.3%	92.6%	100.0%	67.7	180	247.7	5.512218
						72.9	8.1	5.02	6.5%	18.2%	98.9%	100.0%	215.9	145.5	361.4	5.889985
						79.4	1.6	3.31	2.2%	30.3%	96.7%	99.3%	160.1	125.8	285.9	5.655642
							0								285.9	
9-Jun-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	26	566,002	1,771	99	99	4.71							274.7	
						9.9	89.1	4.71	5.5%	65.8%	74.0%	91.8%	21.4	253.3	274.7	5.61568
						29.7	69.3	4.78	3.3%	34.1%	89.0%	100.0%	13.8	218	231.8	5.445875
						49.5	49.5	4.95	5.0%	40.6%	90.1%	100.0%	14.9	219.6	234.5	5.457456
						69.3	29.7	5.17	5.6%	42.3%	87.3%	100.0%	12.98	227.6	240.58	5.483053
						89.1	9.9	4.08	3.0%	56.8%	90.5%	100.0%	29.2	239	268.2	5.591733
						97.0	2	3.09	5.3%	30.3%	85.5%	100.0%	16.4	242	258.4	5.554509
							0								258.4	
9-Jun-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	26	566,002	2,089	94	94	5.12							238	
						9.4	84.6	5.12	5.5%	51.6%	93.4%	100.0%	14.3	223.7	238	5.472271
						28.2	65.8	3.68	2.0%	28.1%	74.7%	100.0%	41.3	229.1	270.4	5.599902
						47	47	4.85	0.9%	34.5%	83.9%	100.0%	46.1	257.7	303.8	5.71637
						65.8	28.2	4.43	1.4%	13.3%	63.4%	98.7%	162.4	252.5	414.9	6.028038
						84.6	9.4	3.4	0.3%	8.1%	55.6%	96.3%	254.1	256.5	510.6	6.235587
						92.1	1.9	3.37	0.4%	20.1%	62.6%	99.0%	180.5	244.8	425.3	6.052795
							0								425.3	
9-Jun-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	26	566,002	2,476	81	81	7.33							216.9	
						8.1	72.9	7.33	1.3%	28.9%	80.3%	100.0%	11.8	205.1	216.9	5.379436
						24.3	56.7	7.31	20.5%	46.4%	90.7%	96.7%	18.8	234.2	253	5.533389
						40.5	40.5	6.82	2.3%	29.7%	95.6%	99.0%	52.9	222.5	275.4	5.618225
						56.7	24.3	6	1.3%	21.7%	90.6%	98.1%	124	261.9	385.9	5.955578
						72.9	8.1	5.65	0.5%	7.5%	83.8%	99.1%	373	270.1	643.1	6.4663
						79.4	1.6	4.31	0.1%	6.9%	80.4%	99.2%	589.6	259.9	849.5	6.744648
							0								849.5	
9-Jun-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	26	566,002	2,855	69	69	4.03							339.3	
						6.9	62.1	4.03	0.0%	28.0%	52.0%	100.0%	10.9	328.4	339.3	5.826885
						20.7	48.3	4.4	6.7%	53.3%	84.4%	100.0%	7.9	231.3	239.2	5.4773
						34.5	34.5	4.31	8.4%	70.2%	92.4%	92.4%	18.1	228.3	246.4	5.506956
						48.3	20.7	4.04	3.3%	61.7%	85.0%	100.0%	23.5	315	338.5	5.824524
						62.1	6.9	3.6	0.0%	53.5%	91.0%	94.8%	42.4	275.6	318	5.762051
						67.6	1.4	2.47	0.4%	38.6%	97.2%	98.7%	171.5	259.5	431	6.066108
							0								431.0	
3-Aug-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	31	459,967	1,791	88	88	2.49							219	
						8.8	79.2	2.49	9.8%	36.6%	95.1%	100.0%	10.9	208.1	219	5.389072
						26.4	61.6	3.16	6.2%	65.4%	98.8%	100.0%	10.8	181	191.8	5.256453
						44	44	3.18	14.3%	40.8%	93.9%	100.0%	6.5	179.4	185.9	5.225209
						61.6	26.4	2.91	8.2%	45.9%	90.2%	100.0%	8.2	181	189.2	5.242805
						79.2	8.8	3.37	5.0%	48.8%	86.3%	97.5%	12.1	189.5	201.6	5.306286
						86.2	1.8	1.56	0.5%	28.3%	57.7%	97.6%	63.1	203.7	266.8	5.586499
							0								266.8	
3-Aug-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	31	459,967	2,076	83	83	5.69							217.9	
						8.3	74.7	5.69	2.9%	55.9%	92.6%	100.0%	14.1	203.8	217.9	5.384036
						24.9	58.1	5.2	6.2%	46.4%	85.7%	98.2%	18	186.1	204.1	5.31861
						41.5	41.5	5.28	4.2%	27.6%	85.9%	99.5%	31	196.8	227.8	5.428468
						58.1	24.9	4.67	2.5%	29.4%	88.6%	100.0%	27.3	180	207.3	5.334167
						74.7	8.3	4.16	0.0%	19.1%	68.4%	100.0%	53.3	191.2	244.5	5.499215
						81.3	1.7	3.54	0.6%	12.8%	66.9%	99.1%	137.2	205.2	342.4	5.83598
							0								342.4	
3-Aug-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	31	459,967	2,474	73	73	8.17							218	
						7.3	65.7	8.17	1.5%	51.8%	94.2%	100.0%	22.7	195.3	218	5.384495
						21.9	51.1	7.71	2.4%	57.3%	95.7%	97.6%	24.9	188.2	213.1	5.361762
						36.5	36.5	7.63	0.7%	29.0%	94.2%	98.6%	63	190.6	253.6	5.535758
						51.1	21.9	6.44	0.5%	27.8%	95.7%	100.0%	101.2	198.3	299.5	5.702114
						65.7	7.3	5.89	0.4%	25.7%	95.8%	99.5%	117.8	200.9	318.7	5.76425
						71.5	1.5	5.65	0.0%	17.6%	91.4%	98.6%	308.8	221.1	529.9	6.272688
							0								529.9	
3-Aug-98	Line 13 D/S of Hydro Intake Ch	Knox Landing	31	459,967	2,881	57	57	4.87							191.1	
						5.7	51.3	4.87	3.5%	29.4%	95.3%	98.8%	13.5	177.6	191.1	5.252797
						17.1	39.9	5.41	4.2%	21.1%	97.2%	100.0%	10.7	184.8	195.5	5.27556
						28.5	28.5	4.93	2.2%	23.6%	93.3%	96.6%	20	202.4	222.4	5.404478
						39.9	17.1	4.71	2.1%	55.7%	97.7%	99.0%	66.3	200.5	266.8	5.586499
						51.3	5.7	3.72	0.9%	58.8%	98.5%	100.0%	82.5	198.1	280.6	5.63693
						55.9	1.1	3.12	0.5%	40.5%	96.4%	97.5%	121.2	225.7	346.9	5.849037
							0								346.9	

Table C.65. Data from Mississippi River – Line 6 1

Date	Location	Gage	Temp (°C)	Discharge (cfs)	Distance from Refernce Point	h (ft)	y (ft)	Velocity (ft/s)	Suspended Sediment Grain Size Analysis				Sediment Concentration (ppm)			
									0.062	0.125	0.25	0.425	Sand	Fine	Total	Ln C
27-Feb-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	9	783,520	3,211	48	48	**4.82**							293	
						4.80	43.2	4.82	3.4%	65.5%	89.7%	94.8%	22.3	270.7	293	5.680173
						14.40	33.6	4.43	2.4%	44.3%	95.7%	98.5%	61.3	185.8	247.1	5.509793
						24.00	24	4.48	2.2%	34.4%	90.6%	97.8%	58.2	247.3	305.5	5.72195
						33.60	14.4	4.27	4.3%	68.1%	95.7%	100.0%	40.6	338.1	378.7	5.936744
						43.20	4.8	3.83	0.7%	22.1%	89.3%	100.0%	225.1	268.1	493.2	6.200915
						47.00	1	2.54	0.7%	38.1%	94.9%	98.2%	217.6	257.8	475.4	6.164157
							0	*2.03*							475.4	
27-Feb-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	9	783,520	3,811	76	76	**6.98**							221.5	
						7.60	68.4	6.98	1.6%	34.2%	89.1%	96.7%	30.9	190.6	221.5	5.400423
						22.80	53.2	6.63	4.8%	46.7%	97.9%	99.2%	51.4	188.8	240.2	5.481472
						38.00	38	6.77	1.7%	30.1%	97.0%	98.7%	117.1	191.3	308.4	5.731398
						53.20	22.8	5.78	1.4%	23.4%	95.8%	99.3%	155.1	233.6	388.7	5.962808
						68.40	7.6	5	0.4%	14.1%	96.2%	99.2%	360.6	239.2	599.8	6.396596
						74.50	1.5	3.69	0.6%	15.3%	96.9%	99.1%	536.3	231.6	767.9	6.64366
							0	*2.79*							767.9	
27-Feb-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	9	783,520	4,090	89	89	**7.21**							222.4	
						8.90	80.1	7.21	2.5%	54.6%	94.9%	97.8%	42.1	180.3	222.4	5.404478
						26.70	62.3	6.35	5.8%	73.5%	94.9%	97.6%	67.8	202.3	270.1	5.598792
						44.50	44.5	6.81	3.4%	21.6%	100.0%	100.0%	145.8	245.7	391.5	5.969986
						62.30	26.7	6.61	2.4%	32.1%	96.2%	98.1%	93.8	199.2	293	5.680173
						80.10	8.9	4.37	1.1%	15.6%	96.0%	99.0%	322.2	219	541.2	6.293789
						87.20	1.8	3.07	4.2%	11.9%	95.0%	99.0%	471.1	234.3	705.4	6.558765
							0	*1.46*							705.4	
27-Feb-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	9	783,520	4,718	90	90	**3.92**							224.4	
						9.00	81	3.92	5.0%	65.0%	90.0%	95.0%	14.4	210	224.4	5.41343
						27.00	63	5.09	4.8%	38.0%	88.9%	98.1%	42.6	202.9	245.5	5.503297
						45.00	45	4.39	4.4%	48.4%	95.2%	97.2%	32.8	171.3	204.1	5.31861
						63.00	27	3.42	7.2%	49.6%	93.5%	96.4%	29.9	203	232.9	5.450609
						81.00	9	2.9	14.4%	34.6%	89.4%	94.2%	36	274.1	310.1	5.736895
						88.20	1.8	2.33	1.2%	17.4%	68.6%	99.4%	149.4	206	355.4	5.873244
							0	*1.15*							355.4	5.9
23-Mar-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	9	844,513	3,218	52	52	**3.44**							288.1	
						5.20	46.8	3.44	7.9%	40.5%	92.9%	96.8%	30.3	257.8	288.1	5.663308
						15.60	36.4	3.44	6.3%	36.8%	95.3%	100.0%	37.9	231.9	269.8	5.597681
						26.00	26	3.08	2.8%	19.4%	91.2%	98.9%	109.4	239.4	348.8	5.854499
						36.40	15.6	2.58	2.1%	18.3%	91.0%	99.2%	137.3	227.3	364.6	5.898801
						46.80	5.2	2.09	1.1%	9.1%	81.3%	97.7%	435.6	332.7	768.3	6.64418
						51.00	1	1.34	0.7%	8.4%	81.7%	98.5%	460	290.3	750.3	6.620473
							0	*0.44*							750.3	
23-Mar-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	9	844,513	3,825	89	89	**6.46**							290.3	
						8.90	80.1	6.46	5.9%	32.3%	96.8%	100.0%	43.7	246.6	290.3	5.670915
						26.70	62.3	6.68	3.8%	26.5%	94.8%	97.3%	71.7	253.4	325.1	5.784133
						44.50	44.5	6.23	3.4%	22.4%	97.4%	99.3%	107.9	219.9	327.8	5.792404
						62.30	26.7	6.01	1.8%	15.2%	98.4%	100.0%	252.5	271.7	524.2	6.261873
						80.10	8.9	4.28	1.0%	12.7%	97.6%	99.5%	406	253.4	659.4	6.49133
						87.20	1.8	3.05	0.6%	7.4%	96.8%	99.6%	690.5	290	980.5	6.888063
							0	*3.01*							980.5	
23-Mar-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	9	844,513	4,010	95	95	**5.82**							286.5	
						9.50	85.5	5.82	4.3%	24.3%	94.4%	98.4%	58.2	228.3	286.5	5.657739
						28.50	66.5	6.07	12.2%	43.5%	91.3%	100.0%	21.8	232.6	254.4	5.538908
						47.50	47.5	6.78	3.9%	24.6%	93.9%	98.4%	51.7	229.7	281.4	5.639777
						66.50	28.5	6.3	3.6%	24.6%	95.0%	97.9%	57.1	237.5	294.6	5.685619
						85.50	9.5	5.09	0.9%	8.9%	81.0%	97.6%	163.4	223.7	387.1	5.958683
						93.10	1.9	2.99	5.7%	31.9%	96.1%	97.8%	162.7	359.9	522.6	6.258816
							0	*2.48*							522.6	
23-Mar-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	9	844,513	4,743	89	89	**2.86**							407.8	
						8.90	80.1	2.86	1.0%	9.3%	94.1%	99.5%	165.8	242	407.8	6.010777
						26.70	62.3	2.98	11.1%	37.0%	81.5%	100.0%	14.2	340	354.2	5.869862
						44.50	44.5	3.75	11.5%	42.3%	94.6%	100.0%	12	324.3	336.3	5.818004
						62.30	26.7	3.65	5.5%	38.2%	93.6%	89.1%	24.7	319.4	344.1	5.840932
						80.10	8.9	3.15	3.5%	26.7%	90.4%	98.0%	56.1	210.3	266.4	5.584999
						87.20	1.8	2.41	4.5%	40.2%	93.8%	97.3%	28.3	244.5	272.8	5.608739
							0	*2.08*							272.8	

Table C.66. Data from Mississippi River – Line 6 2

Date	Location	Gage	Temp (°C)	Discharge (cfs)	Distance from Refernce Point	h (ft)	y (ft)	Velocity (ft/s)	Suspended Sediment Grain Size Analysis				Sediment Concentration (ppm)			
									0.062	0.125	0.25	0.425	Sand	Fine	Total	Ln C
10-Apr-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	16	856,512	3,203	49	49	**4.14**							112.8	
						4.90	44.1	4.14	0.0%	38.2%	94.1%	100.0%	34.3	78.5	112.8	4.725616
						14.70	34.3	4.05	3.5%	36.4%	94.8%	100.0%	25.1	149.9	175	5.164786
						24.50	24.5	3.92	0.0%	26.7%	94.1%	97.5%	43	157.1	200.1	5.298817
						34.30	14.7	2.99	2.0%	25.9%	97.2%	99.3%	73.3	150.9	224.2	5.412539
						44.10	4.9	2.19	0.5%	15.9%	95.7%	99.2%	161.3	128	289.3	5.667464
						48.00	1	1.98	0.2%	12.8%	93.0%	99.4%	220.5	119.7	340.2	5.829534
							0	*1.98*							340.2	
10-Apr-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	16	856,512	3,778	80	80	**6.45**							95	
						8.00	72	6.45	5.0%	51.5%	94.1%	100.0%	13.8	81.2	95	4.553877
						24.00	56	6.94	5.4%	28.2%	97.1%	100.0%	55	132.4	187.4	5.233245
						40.00	40	6.73	1.0%	24.7%	97.8%	100.0%	80.8	103.1	183.9	5.214392
						56.00	24	6.67	0.8%	15.8%	95.9%	99.6%	237.5	124.6	362.1	5.89192
						72.00	8	6.46	0.3%	10.9%	95.0%	99.7%	416.8	117.6	534.4	6.281145
						78.40	1.6	4.09	0.1%	10.4%	96.5%	99.6%	382.1	127.8	509.9	6.234215
							0	*3.98*							509.9	
10-Apr-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	16	856,512	4,095	100	100	**7.15**							126.7	
						10.00	90	7.15	1.7%	30.4%	99.7%	100.0%	37.6	89.1	126.7	4.841822
						30.00	70	7.71	0.9%	33.3%	100.0%	100.0%	32.6	91.9	124.5	4.824306
						50.00	50	6.66	1.2%	24.4%	97.2%	98.8%	96	61.1	157.1	5.056883
						70.00	30	4.82	1.5%	13.9%	93.9%	100.0%	132.6	71.9	204.5	5.320568
						90.00	10	4.88	0.5%	13.7%	94.7%	98.3%	200.9	65.3	266.2	5.584248
						98.00	2	3.12	0.2%	5.2%	89.1%	99.2%	395	83.9	478.9	6.171492
							0	*1.88*							478.9	
10-Apr-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	16	856,512	4,676	96	96	**3.99**							84.3	
						9.60	86.4	3.99	2.8%	63.4%	93.0%	100.0%	10.3	74	84.3	4.434382
						28.80	67.2	3.27	4.1%	41.8%	100.0%	100.0%	26.4	104.8	131.2	4.876723
						48.00	48	3.19	1.7%	30.7%	94.7%	100.0%	42.4	92.2	134.6	4.902307
						67.20	28.8	3.43	0.9%	19.2%	91.5%	97.0%	76.2	56.3	132.5	4.886583
						86.40	9.6	3.08	0.8%	23.8%	91.7%	100.0%	68	52.9	120.9	4.794964
						94.10	1.9	2.35	0.5%	6.2%	57.1%	100.0%	265.3	128.3	393.6	5.975335
							0	*1.03*							393.6	
17-Apr-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	16	793,350	3,159	48	48	**4.68**							372.1	
						4.80	43.2	4.68	2.3%	43.0%	100.0%	100.0%	39.2	332.9	372.1	5.919163
						14.40	33.6	4.49	8.5%	35.4%	96.9%	100.0%	44.2	348.1	392.3	5.972027
						24.00	24	3.83	1.8%	18.7%	93.4%	100.0%	111.5	303.7	415.2	6.02876
						33.60	14.4	3.49	0.2%	15.5%	91.0%	99.0%	132.2	310.8	443	6.09357
						43.20	4.8	3.07	1.0%	14.8%	89.8%	97.8%	171.8	299.9	471.7	6.156343
						47.00	1	2	0.6%	9.9%	86.7%	98.8%	263.2	294.8	558	6.324359
							0	*1.92*							558.0	
17-Apr-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	16	793,350	3,826	92	92	**6.2**							284.8	
						9.20	82.8	6.2	3.6%	46.1%	98.2%	100.0%	25.7	259.1	284.8	5.651787
						27.60	64.4	5.79	1.8%	22.3%	97.1%	100.0%	81.7	320.7	402.4	5.997447
						46.00	46	5.74	2.5%	28.6%	97.2%	100.0%	49.9	267.6	317.5	5.760478
						64.40	27.6	5.66	0.7%	17.4%	94.0%	99.0%	98.9	305.1	404	6.001415
						82.80	9.2	3.81	0.2%	10.5%	93.5%	99.5%	212.3	283.9	496.2	6.206979
						90.20	1.8	1.98	0.5%	9.8%	94.9%	99.6%	254.3	261.4	515.7	6.245525
							0	*1.91*							515.7	
17-Apr-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	16	793,350	4,131	97	97	**5.44**							311.4	
						9.70	87.3	5.44	14.6%	36.0%	100.0%	100.0%	15.5	295.9	311.4	5.741078
						29.10	67.9	5.19	0.8%	23.6%	94.3%	100.0%	48	281.1	329.1	5.796362
						48.50	48.5	5.7	4.4%	22.4%	97.6%	100.0%	47.7	280	327.7	5.792099
						67.90	29.1	5.34	2.5%	25.5%	96.7%	100.0%	45	267.7	312.7	5.745244
						87.30	9.7	4.73	3.4%	8.7%	74.8%	100.0%	150.9	304.8	455.7	6.121835
						95.10	1.9	3.09	0.5%	9.2%	77.6%	100.0%	158.3	262.3	420.6	6.041682
							0	*2.21*							420.6	
17-Apr-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	16	793,350	4,695	92	92	**3.78**							283.6	
						9.20	82.8	3.78	3.2%	33.9%	72.6%	88.7%	18.1	265.5	283.6	5.647565
						27.60	64.4	3.55	6.8%	44.1%	100.0%	100.0%	18.4	246.7	265.1	5.580107
						46.00	46	3.84	3.4%	37.1%	92.1%	100.0%	25	293.3	318.3	5.762994
						64.40	27.6	3.81	1.3%	41.3%	100.0%	100.0%	21.9	289.1	311	5.739793
						82.80	9.2	3.26	6.4%	37.6%	100.0%	100.0%	37.6	210.5	248.1	5.513832
						90.20	1.8	2.08	6.2%	51.4%	93.8%	100.0%	47.3	317	364.3	5.897978
							0	*2.01*							364.3	

Table C.67. Data from Mississippi River – Line 6 3

Date	Location	Gage	Temp (°C)	Discharge (cfs)	Distance from Refernce Point	h (ft)	y (ft)	Velocity (ft/s)	Suspended Sediment Grain Size Analysis				Sediment Concentration (ppm)			
									0.062	0.125	0.25	0.425	Sand	Fine	Total	Ln C
9-Jun-98	Union Point	Knox Landing	26	504,817	3,197	32	32	**3.64**							274.7	
						3.20	28.8	3.64	6.0%	62.7%	100.0%	100.0%	21.4	253.3	274.7	5.61568
						9.60	22.4	3.49	7.7%	56.9%	100.0%	100.0%	13.8	218	231.8	5.445875
						16.00	16	3.45	1.9%	51.4%	90.5%	95.2%	14.9	219.6	234.5	5.457456
						22.40	9.6	3.05	6.6%	51.5%	94.6%	100.0%	12.9	227.6	240.5	5.48272
						28.80	3.2	2.53	1.9%	47.2%	84.9%	100.0%	29.2	239	268.2	5.591733
						31.40	0.6	1.64	11.6%	50.9%	95.5%	100.0%	16.4	242	258.4	5.554509
							0	*1.53*							258.4	
9-Jun-98	Union Point	Knox Landing	26	504,817	3,786	70	70	**5.46**							238	
						7.00	63	5.46	5.6%	48.9%	91.1%	93.3%	14.3	223.7	238	5.472271
						21.00	49	5.27	5.0%	52.8%	94.4%	100.0%	41.3	229.1	270.4	5.599902
						35.00	35	4.89	0.4%	42.0%	91.8%	94.4%	46.1	257.7	303.8	5.71637
						49.00	21	4.18	4.4%	28.8%	90.7%	97.8%	162.4	252.5	414.9	6.028038
						63.00	7	4.38	1.3%	22.6%	91.2%	98.1%	254.1	256.5	510.6	6.235587
						68.60	1.4	3.22	0.5%	6.0%	71.9%	97.1%	180.5	244.8	425.3	6.052795
							0	*2.78*							425.3	
9-Jun-98	Union Point	Knox Landing	26	504,817	4,093	83	83	**6.37**							216.9	
						8.30	74.7	6.37	3.2%	45.0%	92.4%	98.4%	11.8	205.1	216.9	5.379436
						24.90	58.1	6	0.6%	50.4%	72.8%	79.6%	18.8	234.2	253	5.533389
						41.50	41.5	5.7	1.2%	45.0%	84.9%	97.3%	52.9	222.5	275.4	5.618225
						58.10	24.9	5.93	1.9%	32.9%	94.0%	99.2%	124	261.9	385.9	5.955578
						74.70	8.3	4.75	2.0%	38.8%	90.1%	96.7%	373	270.1	643.1	6.4663
						81.30	1.7	3.7	0.2%	9.8%	74.4%	97.3%	589.6	259.9	849.5	6.744648
							0	*1.51*							849.5	
9-Jun-98	Union Point	Knox Landing	26	504,817	4,703	84	84	**2.74**							339.3	
						8.40	75.6	2.74	0.9%	6.3%	79.1%	99.5%	10.9	328.4	339.3	5.826885
						25.20	58.8	2.59	3.9%	69.0%	96.1%	100.0%	7.9	231.3	239.2	5.4773
						42.00	42	2.38	35.2%	70.4%	93.5%	100.0%	18.1	228.3	246.4	5.506956
						58.80	25.2	2.88	8.8%	72.1%	95.6%	100.0%	23.5	315	338.5	5.824524
						75.60	8.4	2.87	12.9%	43.9%	81.9%	96.6%	42.4	275.6	318	5.762051
						82.30	1.7	2.12	2.0%	35.2%	95.7%	99.3%	171.5	259.5	431	6.066108
							0	*1.45*							431.0	
3-Aug-98	Union Point	Knox Landing	31	384,264	3,204	21	21	**3.65**							187	
						2.10	18.9	3.65	13.3%	73.3%	100.0%	100.0%	2.1	184.9	187	5.231109
						6.30	14.7	3.65	2.6%	50.6%	87.0%	90.9%	13.1	191.5	204.6	5.321057
						10.50	10.5	2.97	2.1%	57.4%	91.5%	100.0%	8.9	197.2	206.1	5.328361
						14.70	6.3	2.73	6.5%	62.3%	88.3%	100.0%	11.8	191.9	203.7	5.316648
						18.90	2.1	2.82	4.1%	51.0%	87.8%	100.0%	13.6	212.1	225.7	5.419207
						20.60	0.4	3.57	2.7%	47.3%	86.5%	100.0%	19.8	223	242.8	5.492238
							0	*2.03*							242.8	
3-Aug-98	Union Point	Knox Landing	31	384,264	3,785	56	56	**4.52**							209.8	
						5.60	50.4	4.52	3.0%	53.5%	90.9%	100.0%	15.1	194.7	209.8	5.346155
						16.80	39.2	4.2	3.6%	57.1%	97.6%	100.0%	25.3	192.8	218.1	5.384954
						28.00	28	2.92	1.1%	41.4%	93.4%	93.4%	28.7	191.4	220.1	5.394082
						39.20	16.8	3.07	0.6%	28.5%	95.6%	98.7%	82.5	193	275.5	5.618588
						50.40	5.6	3.05	2.1%	28.6%	91.7%	97.6%	58.5	199.2	257.7	5.551796
						54.90	1.1	0.93	0.4%	6.8%	70.5%	95.6%	436.1	203.4	639.5	6.460687
							0	*0.93*							639.5	
3-Aug-98	Union Point	Knox Landing	31	384,264	4,108	76	76	**3.79**							235.1	
						7.60	68.4	3.79	0.6%	32.2%	79.4%	95.0%	34.5	200.6	235.1	5.460011
						22.80	53.2	3.17	0.6%	59.3%	95.2%	100.0%	27.9	199.6	227.5	5.42715
						38.00	38	3.7	0.4%	45.1%	91.9%	96.5%	44.2	190.1	234.3	5.456602
						53.20	22.8	3.07	0.2%	38.3%	94.3%	97.9%	88	214.8	302.8	5.713073
						68.40	7.6	2.12	0.5%	29.1%	90.5%	96.0%	107.9	228.9	336.8	5.819489
						74.50	1.5	1.9844	0.2%	7.8%	76.2%	96.4%	728.7	226.8	955.5	6.862235
							0	*1.24575*							955.5	
3-Aug-98	Union Point	Knox Landing	31	384,264	4,669	79	79	**2.27**							609.7	
						7.90	71.1	2.27	0.8%	2.3%	20.2%	41.0%	396.7	213	609.7	6.412967
						23.70	55.3	1.94	8.1%	40.7%	90.7%	100.0%	24.2	234.8	259	5.556828
						39.50	39.5	1.7	3.3%	60.3%	94.2%	100.0%	20.4	982.9	1003.3	6.91105
						55.30	23.7	0.98	0.0%	63.0%	95.1%	100.0%	12.3	193.4	205.7	5.326419
						71.10	7.9	0.93	3.5%	60.5%	100.0%	100.0%	15.5	198.9	214.4	5.367843
						77.40	1.6	1.5006	3.3%	59.4%	96.7%	100.0%	28.5	208.4	236.9	5.467638
							0	*1.5006*							236.9	

Table C.68. Data from Mississippi River – Tarbert Landing 1

Date	Location	Gage	Temp (°C)	Discharge (cfs)	Distance from Refernce Point (ft)	h (ft)	y (ft)	Velocity (ft/s)	Suspended Sediment Grain Size Analysis (mm) Percent Finer				Sediment Concentration (ppm)			
									0.062	0.125	0.25	0.425	Sand	Fine	Total	Ln C
27-Feb-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	9	783,520	3,211	48	48	**4.82**							293	
						4.80	43.2	4.82	3.4%	65.5%	89.7%	94.8%	22.3	270.7	293	5.680173
						14.40	33.6	4.43	2.4%	44.3%	95.7%	98.5%	61.3	185.8	247.1	5.509793
						24.00	24	4.48	2.2%	34.4%	90.6%	97.8%	58.2	247.3	305.5	5.72195
						33.60	14.4	4.27	4.3%	68.1%	95.7%	100.0%	40.6	338.1	378.7	5.936744
						43.20	4.8	3.83	0.7%	22.1%	89.3%	100.0%	225.1	268.1	493.2	6.200915
						47.00	1	2.54	0.7%	38.1%	94.9%	98.2%	217.6	257.8	475.4	6.164157
							0	*2.03*							475.4	
27-Feb-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	9	783,520	3,811	76	76	**6.98**							221.5	
						7.60	68.4	6.98	1.6%	34.2%	89.1%	96.7%	30.9	190.6	221.5	5.400423
						22.80	53.2	6.63	4.8%	46.7%	97.9%	99.2%	51.4	188.8	240.2	5.481472
						38.00	38	6.77	1.7%	30.1%	97.0%	98.7%	117.1	191.3	308.4	5.731398
						53.20	22.8	5.78	1.4%	23.4%	95.8%	99.3%	155.1	233.6	388.7	5.962808
						68.40	7.6	5	0.4%	14.1%	96.2%	99.2%	360.6	239.2	599.8	6.396596
						74.50	1.5	3.69	0.6%	15.3%	96.9%	99.1%	536.3	231.6	767.9	6.64366
							0	*2.79*							767.9	
27-Feb-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	9	783,520	4,090	89	89	**7.21**							222.4	
						8.90	80.1	7.21	2.5%	54.6%	94.9%	97.8%	42.1	180.3	222.4	5.404478
						26.70	62.3	6.35	5.8%	73.5%	94.9%	97.6%	67.8	202.3	270.1	5.598792
						44.50	44.5	6.81	3.4%	21.6%	100.0%	100.0%	145.8	245.7	391.5	5.969986
						62.30	26.7	6.61	2.4%	32.1%	96.2%	98.1%	93.8	199.2	293	5.680173
						80.10	8.9	4.37	1.1%	15.6%	96.0%	99.0%	322.2	219	541.2	6.293789
						87.20	1.8	3.07	4.2%	11.9%	95.0%	99.0%	471.1	234.3	705.4	6.558765
							0	*1.46*							705.4	
27-Feb-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	9	783,520	4,718	90	90	**3.92**							224.4	
						9.00	81	3.92	5.0%	65.0%	90.0%	95.0%	14.4	210	224.4	5.41343
						27.00	63	5.09	4.8%	38.0%	88.9%	98.1%	42.6	202.9	245.5	5.503297
						45.00	45	4.39	4.4%	48.4%	95.2%	97.2%	32.8	171.3	204.1	5.31861
						63.00	27	3.42	7.2%	49.6%	93.5%	96.4%	29.9	203	232.9	5.450609
						81.00	9	2.9	14.4%	34.6%	89.4%	94.2%	36	274.1	310.1	5.736895
						88.20	1.8	2.33	1.2%	17.4%	68.6%	99.4%	149.4	206	355.4	5.873244
							0	*1.15*							355.4	5.9
23-Mar-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	9	844,513	3,218	52	52	**3.44**							288.1	
						5.20	46.8	3.44	7.9%	40.5%	92.9%	96.8%	30.3	257.8	288.1	5.663308
						15.60	36.4	3.44	6.3%	36.8%	95.3%	100.0%	37.9	231.9	269.8	5.597681
						26.00	26	3.08	2.8%	19.4%	91.2%	98.9%	109.4	239.4	348.8	5.854499
						36.40	15.6	2.58	2.1%	18.3%	91.0%	99.2%	137.3	227.3	364.6	5.898801
						46.80	5.2	2.09	1.1%	9.1%	81.3%	97.7%	435.6	332.7	768.3	6.64418
						51.00	1	1.34	0.7%	8.4%	81.7%	98.5%	460	290.3	750.3	6.620473
							0	*0.44*							750.3	
23-Mar-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	9	844,513	3,825	89	89	**6.46**							290.3	
						8.90	80.1	6.46	5.9%	32.3%	96.8%	100.0%	43.7	246.6	290.3	5.670915
						26.70	62.3	6.68	3.8%	26.5%	94.8%	97.3%	71.7	253.4	325.1	5.784133
						44.50	44.5	6.23	3.4%	22.4%	97.4%	99.3%	107.9	219.9	327.8	5.792404
						62.30	26.7	6.01	1.8%	15.2%	98.4%	100.0%	252.5	271.7	524.2	6.261873
						80.10	8.9	4.28	1.0%	12.7%	97.6%	99.5%	406	253.4	659.4	6.49133
						87.20	1.8	3.05	0.6%	7.4%	96.8%	99.6%	690.5	290	980.5	6.888063
							0	*3.01*							980.5	
23-Mar-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	9	844,513	4,010	95	95	**5.82**							286.5	
						9.50	85.5	5.82	4.3%	24.3%	94.4%	98.4%	58.2	228.3	286.5	5.657739
						28.50	66.5	6.07	12.2%	43.5%	91.3%	100.0%	21.8	232.6	254.4	5.538908
						47.50	47.5	6.78	3.9%	24.6%	93.9%	98.4%	51.7	229.7	281.4	5.639777
						66.50	28.5	6.3	3.6%	24.6%	95.0%	97.9%	57.1	237.5	294.6	5.685619
						85.50	9.5	5.09	0.9%	8.9%	81.0%	97.6%	163.4	223.7	387.1	5.958683
						93.10	1.9	2.99	5.7%	31.9%	96.1%	97.8%	162.7	359.9	522.6	6.258816
							0	*2.48*							522.6	
23-Mar-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	9	844,513	4,743	89	89	**2.86**							407.8	
						8.90	80.1	2.86	1.0%	9.3%	94.1%	99.5%	165.8	242	407.8	6.010777
						26.70	62.3	2.98	11.1%	37.0%	81.5%	100.0%	14.2	340	354.2	5.869862
						44.50	44.5	3.75	11.5%	42.3%	94.6%	100.0%	12	324.3	336.3	5.818004
						62.30	26.7	3.65	5.5%	38.2%	93.6%	89.1%	24.7	319.4	344.1	5.840932
						80.10	8.9	3.15	3.5%	26.7%	90.4%	98.0%	56.1	210.3	266.4	5.584999
						87.20	1.8	2.41	4.5%	40.2%	93.8%	97.3%	28.3	244.5	272.8	5.608739
							0	*2.08*							272.8	

Table C.69. Data from Mississippi River – Tarbert Landing 2

Date	Location	Gage	Temp (°C)	Discharge (cfs)	Distance from Refernce Point (ft)	h (ft)	y (ft)	Velocity (ft/s)	Suspended Sediment Grain Size Analysis (mm) Percent Finer				Sediment Concentration (ppm)			
									0.062	0.125	0.25	0.425	Sand	Fine	Total	Ln C
10-Apr-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	16	856,512	3,203	49	49	**4.14**							112.8	
						4.90	44.1	4.14	0.0%	38.2%	94.1%	100.0%	34.3	78.5	112.8	4.725616
						14.70	34.3	4.05	3.5%	36.4%	94.8%	100.0%	25.1	149.9	175	5.164786
						24.50	24.5	3.92	0.0%	26.7%	94.1%	97.5%	43	157.1	200.1	5.298817
						34.30	14.7	2.99	2.0%	25.9%	97.2%	99.3%	73.3	150.9	224.2	5.412539
						44.10	4.9	2.19	0.5%	15.9%	95.7%	99.2%	161.3	128	289.3	5.667464
						48.00	1	1.98	0.2%	12.8%	93.0%	99.4%	220.5	119.7	340.2	5.829534
							0	*1.98*							340.2	
10-Apr-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	16	856,512	3,778	80	80	**6.45**							95	
						8.00	72	6.45	5.0%	51.5%	94.1%	100.0%	13.8	81.2	95	4.553877
						24.00	56	6.94	5.4%	28.2%	97.1%	100.0%	55	132.4	187.4	5.233245
						40.00	40	6.73	1.0%	24.7%	97.8%	100.0%	80.8	103.1	183.9	5.214392
						56.00	24	6.67	0.8%	15.8%	95.9%	99.6%	237.5	124.6	362.1	5.89192
						72.00	8	6.46	0.3%	10.9%	95.0%	99.7%	416.8	117.6	534.4	6.281145
						78.40	1.6	4.09	0.1%	10.4%	96.5%	99.6%	382.1	127.8	509.9	6.234215
							0	*3.98*							509.9	
10-Apr-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	16	856,512	4,095	100	100	**7.15**							126.7	
						10.00	90	7.15	1.7%	30.4%	99.7%	100.0%	37.6	89.1	126.7	4.841822
						30.00	70	7.71	0.9%	33.3%	100.0%	100.0%	32.6	91.9	124.5	4.824306
						50.00	50	6.66	1.2%	24.4%	97.2%	98.8%	96	61.1	157.1	5.056883
						70.00	30	4.82	1.5%	13.9%	93.9%	100.0%	132.6	71.9	204.5	5.320568
						90.00	10	4.88	0.5%	13.7%	94.7%	98.3%	200.9	65.3	266.2	5.584248
						98.00	2	3.12	0.2%	5.2%	89.1%	99.2%	395	83.9	478.9	6.171492
							0	*1.88*							478.9	
10-Apr-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	16	856,512	4,676	96	96	**3.99**							84.3	
						9.60	86.4	3.99	2.8%	63.4%	93.0%	100.0%	10.3	74	84.3	4.434382
						28.80	67.2	3.27	4.1%	41.8%	100.0%	100.0%	26.4	104.8	131.2	4.876723
						48.00	48	3.19	1.7%	30.7%	94.7%	100.0%	42.4	92.2	134.6	4.902307
						67.20	28.8	3.43	0.9%	19.2%	91.5%	97.0%	76.2	56.3	132.5	4.886583
						86.40	9.6	3.08	0.8%	23.8%	91.7%	100.0%	68	52.9	120.9	4.794964
						94.10	1.9	2.35	0.5%	6.2%	57.1%	100.0%	265.3	128.3	393.6	5.975335
							0	*1.03*							393.6	
17-Apr-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	16	793,350	3,159	48	48	**4.68**							372.1	
						4.80	43.2	4.68	2.3%	43.0%	100.0%	100.0%	39.2	332.9	372.1	5.919163
						14.40	33.6	4.49	8.5%	35.4%	96.9%	100.0%	44.2	348.1	392.3	5.972027
						24.00	24	3.83	1.8%	18.7%	93.4%	100.0%	111.5	303.7	415.2	6.02876
						33.60	14.4	3.49	0.2%	15.5%	91.0%	99.0%	132.2	310.8	443	6.09357
						43.20	4.8	3.07	1.0%	14.8%	89.8%	97.8%	171.8	299.9	471.7	6.156343
						47.00	1	2	0.6%	9.9%	86.7%	98.8%	263.2	294.8	558	6.324359
							0	*1.92*							558.0	
17-Apr-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	16	793,350	3,826	92	92	**6.2**							284.8	
						9.20	82.8	6.2	3.6%	46.1%	98.2%	100.0%	25.7	259.1	284.8	5.651787
						27.60	64.4	5.79	1.8%	22.3%	97.1%	100.0%	81.7	320.7	402.4	5.997447
						46.00	46	5.74	2.5%	28.6%	97.2%	100.0%	49.9	267.6	317.5	5.760478
						64.40	27.6	5.66	0.7%	17.4%	94.0%	99.0%	98.9	305.1	404	6.001415
						82.80	9.2	3.81	0.2%	10.5%	93.5%	99.5%	212.3	283.9	496.2	6.206979
						90.20	1.8	1.98	0.5%	9.8%	94.9%	99.6%	254.3	261.4	515.7	6.245525
							0	*1.91*							515.7	
17-Apr-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	16	793,350	4,131	97	97	**5.44**							311.4	
						9.70	87.3	5.44	14.6%	36.0%	100.0%	100.0%	15.5	295.9	311.4	5.741078
						29.10	67.9	5.19	0.8%	23.6%	94.3%	100.0%	48	281.1	329.1	5.796362
						48.50	48.5	5.7	4.4%	22.4%	97.6%	100.0%	47.7	280	327.7	5.792099
						67.90	29.1	5.34	2.5%	25.5%	96.7%	100.0%	45	267.7	312.7	5.745244
						87.30	9.7	4.73	3.4%	8.7%	74.8%	100.0%	150.9	304.8	455.7	6.121835
						95.10	1.9	3.09	0.5%	9.2%	77.6%	100.0%	158.3	262.3	420.6	6.041682
							0	*2.21*							420.6	
17-Apr-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	16	793,350	4,695	92	92	**3.78**							283.6	
						9.20	82.8	3.78	3.2%	33.9%	72.6%	88.7%	18.1	265.5	283.6	5.647565
						27.60	64.4	3.55	6.8%	44.1%	100.0%	100.0%	18.4	246.7	265.1	5.580107
						46.00	46	3.84	3.4%	37.1%	92.1%	100.0%	25	293.3	318.3	5.762994
						64.40	27.6	3.81	1.3%	41.3%	100.0%	100.0%	21.9	289.1	311	5.739793
						82.80	9.2	3.26	6.4%	37.6%	100.0%	100.0%	37.6	210.5	248.1	5.513832
						90.20	1.8	2.08	6.2%	51.4%	93.8%	100.0%	47.3	317	364.3	5.897978
							0	*2.01*							364.3	

Table C.70. Data from Mississippi River – Tarbert Landing 3

Date	Location	Gage	Temp (°C)	Discharge (cfs)	Distance from Refernce Point (ft)	h (ft)	y (ft)	Velocity (ft/s)	Suspended Sediment Grain Size Analysis (mm) Percent Finer				Sediment Concentration (ppm)			
									0.062	0.125	0.25	0.425	Sand	Fine	Total	Ln C
9-Jun-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	26	504,817	3,197	32	32	**3.64**							274.7	
						3.20	28.8	3.64	6.0%	62.7%	100.0%	100.0%	21.4	253.3	274.7	5.61568
						9.60	22.4	3.49	7.7%	56.9%	100.0%	100.0%	13.8	218	231.8	5.445875
						16.00	16	3.45	1.9%	51.4%	90.5%	95.2%	14.9	219.6	234.5	5.457456
						22.40	9.6	3.05	6.6%	51.5%	94.6%	100.0%	12.9	227.6	240.5	5.48272
						28.80	3.2	2.53	1.9%	47.2%	84.9%	100.0%	29.2	239	268.2	5.591733
						31.40	0.6	1.64	11.6%	50.9%	95.5%	100.0%	16.4	242	258.4	5.554509
							0	*1.53*							258.4	
9-Jun-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	26	504,817	3,786	70	70	**5.46**							238	
						7.00	63	5.46	5.6%	48.9%	91.1%	93.3%	14.3	223.7	238	5.472271
						21.00	49	5.27	5.0%	52.8%	94.4%	100.0%	41.3	229.1	270.4	5.599902
						35.00	35	4.89	0.4%	42.0%	91.8%	94.4%	46.1	257.7	303.8	5.71637
						49.00	21	4.18	4.4%	28.8%	90.7%	97.8%	162.4	252.5	414.9	6.028038
						63.00	7	4.38	1.3%	22.6%	91.2%	98.1%	254.1	256.5	510.6	6.235587
						68.60	1.4	3.22	0.5%	6.0%	71.9%	97.1%	180.5	244.8	425.3	6.052795
							0	*2.78*							425.3	
9-Jun-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	26	504,817	4,093	83	83	**6.37**							216.9	
						8.30	74.7	6.37	3.2%	45.0%	92.4%	98.4%	11.8	205.1	216.9	5.379436
						24.90	58.1	6	0.6%	50.4%	72.8%	79.6%	18.8	234.2	253	5.533389
						41.50	41.5	5.7	1.2%	45.0%	84.9%	97.3%	52.9	222.5	275.4	5.618225
						58.10	24.9	5.93	1.9%	32.9%	94.0%	99.2%	124	261.9	385.9	5.955578
						74.70	8.3	4.75	2.0%	38.8%	90.1%	96.7%	373	270.1	643.1	6.4663
						81.30	1.7	3.7	0.2%	9.8%	74.4%	97.3%	589.6	259.9	849.5	6.744648
							0	*1.51*							849.5	
9-Jun-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	26	504,817	4,703	84	84	**2.74**							339.3	
						8.40	75.6	2.74	0.9%	6.3%	79.1%	99.5%	10.9	328.4	339.3	5.826885
						25.20	58.8	2.59	3.9%	69.0%	96.1%	100.0%	7.9	231.3	239.2	5.4773
						42.00	42	2.38	35.2%	70.4%	93.5%	100.0%	18.1	228.3	246.4	5.506956
						58.80	25.2	2.88	8.8%	72.1%	95.6%	100.0%	23.5	315	338.5	5.824524
						75.60	8.4	2.87	12.9%	43.9%	81.9%	96.6%	42.4	275.6	318	5.762051
						82.30	1.7	2.12	2.0%	35.2%	95.7%	99.3%	171.5	259.5	431	6.066108
							0	*1.45*							431.0	
3-Aug-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	31	384,264	3,204	21	21	**3.65**							187	
						2.10	18.9	3.65	13.3%	73.3%	100.0%	100.0%	2.1	184.9	187	5.231109
						6.30	14.7	3.65	2.6%	50.6%	87.0%	90.9%	13.1	191.5	204.6	5.321057
						10.50	10.5	2.97	2.1%	57.4%	91.5%	100.0%	8.9	197.2	206.1	5.328361
						14.70	6.3	2.73	6.5%	62.3%	88.3%	100.0%	11.8	191.9	203.7	5.316648
						18.90	2.1	2.82	4.1%	51.0%	87.8%	100.0%	13.6	212.1	225.7	5.419207
						20.60	0.4	3.57	2.7%	47.3%	86.5%	100.0%	19.8	223	242.8	5.492238
							0	*2.03*							242.8	
3-Aug-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	31	384,264	3,785	56	56	**4.52**							209.8	
						5.60	50.4	4.52	3.0%	53.5%	90.9%	100.0%	15.1	194.7	209.8	5.346155
						16.80	39.2	4.2	3.6%	57.1%	97.6%	100.0%	25.3	192.8	218.1	5.384954
						28.00	28	2.92	1.1%	41.4%	93.4%	93.4%	28.7	191.4	220.1	5.394082
						39.20	16.8	3.07	0.6%	28.5%	95.6%	98.7%	82.5	193	275.5	5.618588
						50.40	5.6	3.05	2.1%	28.6%	91.7%	97.6%	58.5	199.2	257.7	5.551796
						54.90	1.1	0.93	0.4%	6.8%	70.5%	95.6%	436.1	203.4	639.5	6.460687
							0	*0.93*							639.5	
3-Aug-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	31	384,264	4,108	76	76	**3.79**							235.1	
						7.60	68.4	3.79	0.6%	32.2%	79.4%	95.0%	34.5	200.6	235.1	5.460011
						22.80	53.2	3.17	0.6%	59.3%	95.2%	100.0%	27.9	199.6	227.5	5.42715
						38.00	38	3.7	0.4%	45.1%	91.9%	96.5%	44.2	190.1	234.3	5.456602
						53.20	22.8	3.07	0.2%	38.3%	94.3%	97.9%	88	214.8	302.8	5.713073
						68.40	7.6	2.12	0.5%	29.1%	90.5%	96.0%	107.9	228.9	336.8	5.819489
						74.50	1.5	1.9844	0.2%	7.8%	76.2%	96.4%	728.7	226.8	955.5	6.862235
							0	*1.24575*							955.5	
3-Aug-98	Line 6 D/S of Auziliary Intake Channel	Knox Landing	31	384,264	4,669	79	79	**2.27**							609.7	
						7.90	71.1	2.27	0.8%	2.3%	20.2%	41.0%	396.7	213	609.7	6.412967
						23.70	55.3	1.94	8.1%	40.7%	90.7%	100.0%	24.2	234.8	259	5.556828
						39.50	39.5	1.7	3.3%	60.3%	94.2%	100.0%	20.4	982.9	1003.3	6.91105
						55.30	23.7	0.98	0.0%	63.0%	95.1%	100.0%	12.3	193.4	205.7	5.326419
						71.10	7.9	0.93	3.5%	60.5%	100.0%	100.0%	15.5	198.9	214.4	5.367843
						77.40	1.6	1.5006	3.3%	59.4%	96.7%	100.0%	28.5	208.4	236.9	5.467638
							0	*1.5006*							236.9	

Appendix D – Computer Solution to q_s/q_t

USING SERIES EXPANSION

```
Sub Einstein_Integral()

Dim i, j

For i = 1 To 42
   For j = 1 To 4
   Workbooks("Qs-Qt vs rouse - Series Expansion.xls").Activate
   Sheets("Sheet1").Select
   Range("A4").Select

      Ro = ActiveCell.Offset(i, 1)
   Range("B2").Select
      E = ActiveCell.Offset(1, j + (3 * (j - 1)))

   Workbooks("EinsteinIntegralComputations.xls").Activate
   Sheets("Einstein Calculator").Select
   Range("C17").Select

   ActiveCell(1, 1).Value = Ro
   ActiveCell(2, 1).Value = E

   Range("C32").Select
   J1 = ActiveCell.Offset(0, 0).Value
   J2 = ActiveCell.Offset(1, 0).Value


   Workbooks("Qs-Qt vs rouse - Series Expansion.xls").Activate
   Sheets("Sheet1").Select
   Range("C5").Select

   ActiveCell(i, j + (3 * (j - 1))).Value = J1
   ActiveCell(i, j + 1 + (3 * (j - 1))).Value = J2


   qs = (0.216 * E ^ (Ro - 1) / (1 - E) ^ Ro) * (J1 * (Log(60 / E)) + J2)
   qt = 1 + (0.216 * E ^ (Ro - 1) / (1 - E) ^ Ro) * (J1 * (Log(60 / E)) + J2)

   ActiveCell(i, j + 2 + (3 * (j - 1))).Value = qs
   ActiveCell(i, j + 3 + (3 * (j - 1))).Value = qs / qt

   Next
Next
End Sub
```

USING TRAPIZODAL RULE

```
Sub Integration()

Dim Ro, w, h, ds, E, step, dy, y, y1
Dim qs As Double, qb As Double
Dim i As Integer, j As Integer

step = 10000

For j = 1 To 141

  Sheets("Trap Program").Select
  Range("A1").Select

  Ro = ActiveCell.Offset(j, 0).Value
  h = ActiveCell.Offset(j, 2).Value
  ds = ActiveCell.Offset(j, 3).Value
  Ct = ActiveCell.Offset(j, 5).Value

    a = 2 * ds
    hprime = a * 10
    dy = (hprime - a) / step
    y = a
    y1 = a + dy
    qs = 0

  For i = 1 To step - 1
    rect = (((h - y) / y) ^ Ro * Log(30 * y / ds))
    trap = (((h - y1)/y1)^Ro * Log(30 * y1/ds) - (((h - y)/y)^Ro * Log(30 *y / ds)))
    qs = qs + Ct * (rect + trap * 0.5) * dy
    y = y1
    y1 = y1 + dy
  Next i

       dy = (h - hprime) / step
        y = hprime
       y1 = hprime + dy

       For i = 1 To step - 1
         rect = (((h - y) / y) ^ Ro * Log(30 * y / ds))
         trap = (((h-y1)/y1)^Ro * Log(30*y1/ds) - (((h-y)/y) ^ Ro * Log(30*y/ds)))
         qs = qs + Ct * (rect + trap * 0.5) * dy
         y = y1
         y1 = y1 + dy
       Next i
```

```
    qt = 1 + qs
    Sheets("Trap Program").Select
     Range("G2").Select
     ActiveCell(j, 1).Value = qs
     ActiveCell(j, 2).Value = qt
     ActiveCell(j, 3) = qs / qt

Next j

End Sub
```

Appendix E – Computer Solution to q_m/q_t

Sub Einstein_Integral()

```
Dim i, j

For i = 1 To 80
   For j = 1 To 4
   Workbooks("MeasuredvsTotal.xls").Activate
   Sheets("Program").Select
   Range("A4").Select

   Ro = ActiveCell.Offset(i, 2)
   Range("C2").Select
   A = ActiveCell.Offset(0, j + (6 * (j - 1)))
   E = ActiveCell.Offset(1, j + (6 * (j - 1)))

   Workbooks("EinsteinIntegralComputations.xls").Activate
   Sheets("Einstein Calculator").Select
   Range("C17").Select

   ActiveCell(1, 1).Value = Ro
   ActiveCell(2, 1).Value = A

   Range("C32").Select
   Ja1 = ActiveCell.Offset(0, 0).Value
   Ja2 = ActiveCell.Offset(1, 0).Value


   Workbooks("MeasuredvsTotal.xls").Activate
   Sheets("Program").Select
   Range("C5").Select

   ActiveCell(i, j + 1 + (6 * (j - 1))).Value = Ja1
   ActiveCell(i, j + 2 + (6 * (j - 1))).Value = Ja2


 Workbooks("EinsteinIntegralComputations.xls").Activate
   Sheets("Einstein Calculator").Select
   Range("C17").Select

   ActiveCell(1, 1).Value = Ro
   ActiveCell(2, 1).Value = E

   Range("C32").Select
   Je1 = ActiveCell.Offset(0, 0).Value
   Je2 = ActiveCell.Offset(1, 0).Value
```

```
    Workbooks("MeasuredvsTotal.xls").Activate
    Sheets("Program").Select
    Range("E5").Select

    ActiveCell(i, j + 1 + (6 * (j - 1))).Value = Je1
    ActiveCell(i, j + 2 + (6 * (j - 1))).Value = Je2

    qm = (0.216 * E ^ (Ro - 1) / (1 - E) ^ Ro) * (Ja1 * (Log(60 / E)) + Ja2)
    qt = 1 + (0.216 * E ^ (Ro - 1) / (1 - E) ^ Ro) * (Je1 * (Log(60 / E)) + Je2)

    ActiveCell(i, j + 3 + (6 * (j - 1))).Value = qm
    ActiveCell(i, j + 4 + (6 * (j - 1))).Value = qt
    ActiveCell(i, j + 5 + (6 * (j - 1))).Value = qm / qt

    Next

Next

End Sub
```

Appendix F – Calculation of Total Sediment Discharge

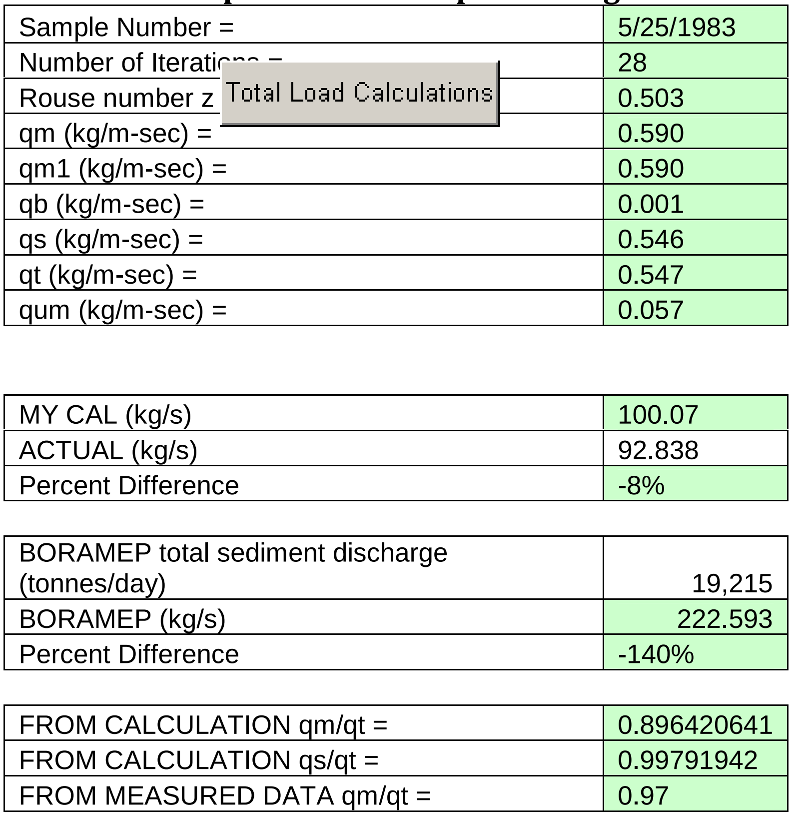
Numerous calculations can be made at the same time, this sample input and output sheet only shows a single datum.

Table F.1. Input Sheet of Proposed Program

UNITS	SI UNITS
Sample Number =	5/25/1983
measured suspended sediment concentration Cm (mg/L) =	164
flow rate (cms) =	547
flow depth h (m) =	1.7
unmeasured depth dn (m) =	0.08
Slope =	0.001200
representative particle size ds (mm) =	0.544
d35 (mm) =	0.585
d65 (mm) =	0.522
cross sectional width W (m) =	183
average velocity Vmean (m/s) =	1.8
Temperature (C) =	6.5
density water ρ (kg/m3) =	999.588
density of sediment ρs (kf/m3) =	2648.909
gravity g (m/s2) =	9.810
unit measured suspended sediment discharge qm (kg/m-s) =	0.590
(RS)m (m) =	0.00047
Shear Velocity u* (m/s) =	0.141
Viscosity v (m2/s) =	1.813E-06
Fall Velocity ω (m/s) =	0.017
Rouse number =	0.503
representative particle size from suspended sediment d50ss (mm) =	0.196

The input can handle both SI and English Units. The variables in green are calculated automatically.

Table F.2 – Output Sheet of Proposed Program



Sample Number =	5/25/1983
Number of Iterations =	28
Rouse number z	0.503
qm (kg/m-sec) =	0.590
qm1 (kg/m-sec) =	0.590
qb (kg/m-sec) =	0.001
qs (kg/m-sec) =	0.546
qt (kg/m-sec) =	0.547
qum (kg/m-sec) =	0.057

MY CAL (kg/s)	100.07
ACTUAL (kg/s)	92.838
Percent Difference	-8%

BORAMEP total sediment discharge (tonnes/day)	19,215
BORAMEP (kg/s)	222.593
Percent Difference	-140%

FROM CALCULATION qm/qt =	0.896420641
FROM CALCULATION qs/qt =	0.99791942
FROM MEASURED DATA qm/qt =	0.97

The variables in green are calculated automatically. The quantities not highlighted (Actual Total Sediment Discharge and BORAMEP Total Sediment Discharge) must be manually inputted

```
Dim Units As String
Dim i, j, k As Integer
Dim Cm, Q, h, dn, a, ds, d35, d65, W, Vmean, T, densityW, densityS, g, qm, RSm, ustar,
vis, fall, z, psi1, psi2, psi, phi, qb, qb1, qb2, qm1, qs As Double
```

Sub Input_Values()

Input_Values allows the known data to be recorded and used to determine the load

```
 Workbooks("BedLoadVariation.xls").Activate
 Sheets("Input Data").Select
 Range("B1").Select
```

This program can calculate load in English and SI Units. Therefore it is important to identify the system of units.

```
 Units = ActiveCell.Offset(0, 0).Value
```

Data necessary for load calculations

```
 Cm = ActiveCell.Offset(2, j).Value
 Q = ActiveCell.Offset(3, j).Value
 h = ActiveCell.Offset(4, j).Value
 dn = ActiveCell.Offset(5, j).Value
 S = ActiveCell.Offset(6, j).Value
 ds = ActiveCell.Offset(7, j).Value
 d35 = ActiveCell.Offset(8, j).Value
 d65 = ActiveCell.Offset(9, j).Value
 W = ActiveCell.Offset(10, j).Value
 Vmean = ActiveCell.Offset(11, j).Value
 T = ActiveCell.Offset(12, j).Value
 densityW = ActiveCell.Offset(13, j).Value
 densityS = ActiveCell.Offset(14, j).Value
 g = ActiveCell.Offset(15, j).Value
 qm = ActiveCell.Offset(16, j).Value
 RSm = ActiveCell.Offset(17, j).Value
 ustar = ActiveCell.Offset(18, j).Value
 vis = ActiveCell.Offset(19, j).Value
 fall = ActiveCell.Offset(20, j).Value
 z = ActiveCell.Offset(21, j).Value
```

Converting particle data which is measured in mm into feet or meters based on the system of units

---

```
  If Units = "SI UNITS" Then
    ds = ds / 1000
    d35 = d35 / 1000
    d65 = d65 / 1000
    Else
    ds = ds / 304.8
    d35 = d35 / 304.8
    d65 = d65 / 304.8
  End If

End Sub
```

Sub BedLoad()

In determining the suspended load the Rouse number and the unit bed load discharge are unknown factors. The bedload can be determined using the Einstein bed load function. The rouse number is determined based on fitting the concentration profile to the measured sediment load.

The concentration of the measured zone is determined using a depth integrated sampler. In order to determine the rouse number the bisection method is used until the estimated Rouse number proves a good estimate of the measured load.
qm = [0.216*qb(E)^(z-1)/(1-E)^z]{[ln(60/E)]J1a+J2a}

```
qb1 = 0
qb2 = 40
qm1 = 0
Eprime = dn / h
E = 2 * ds / h

Workbooks("EinsteinIntegralComputations.xls").Activate
      Sheets("Einstein Calculator").Select
      Range("C17").Select

          ActiveCell(1, 1).Value = z
          ActiveCell(2, 1).Value = Eprime
          Range("C32").Select
          J1a = ActiveCell.Offset(0, 0).Value
          J2a = ActiveCell.Offset(1, 0).Value

For i = 1 To 20000

   qb = (qb1 + qb2) / 2
    qm1 = (0.216 * qb * E ^ (z - 1) / (1 - E) ^ z) * (Log(30 * h / d65) * J1a + J2a)

   deltaqm = (qm1 - qm)
      If deltaqm > 0.00001 Then
         qb2 = qb
      End If
      If deltaqm < -0.00001 Then
         qb1 = qb
      End If
      If Abs(deltaqm) < 0.00001 Then
         Exit For
      End If
   Count = i
Next
```

Store Data from the bisection method.

```
Workbooks("BedLoadVariation.xls").Activate
Sheets("Results").Select
Range("B1").Select

   ActiveCell(2, j + 1).Value = Count
   ActiveCell(3, j + 1).Value = z
   ActiveCell(4, j + 1).Value = qm
   If J1a = 0 And J2a = 0 Then
      qm1 = qm
   End If

   ActiveCell(5, j + 1).Value = qm1
   If J1a = 0 And J2a = 0 Then
      qb = 0
   End If
   ActiveCell(6, j + 1).Value = qb
```

Determining the unit suspended sediment discharge

```
 Workbooks("EinsteinIntegralComputations.xls").Activate
 Sheets("Einstein Calculator").Select
 Range("C17").Select

    ActiveCell(1, 1).Value = z
    ActiveCell(2, 1).Value = E

      Range("C32").Select
      J1e = ActiveCell.Offset(0, 0).Value
      J2e = ActiveCell.Offset(1, 0).Value

If J1a = 0 And J2a = 0 Then
   qs = qm

   Else
   qs = (0.216 * qb * E ^ (z - 1) / (1 - E) ^ z) * (Log(30 * h / d65) * J1e + J2e)
End If
```

Store data from the suspended sediment analysis.

```
   Workbooks("BedLoadVariation.xls").Activate
   Sheets("Results").Select
   Range("B1").Select

      ActiveCell(7, j + 1).Value = qs

End Sub
```

```
Sub TotalLoad()
 Workbooks("BedLoadVariation.xls").Activate
 Sheets("Input Data").Select
   Range("E1").Select
   Extent = ActiveCell.Offset(0, 0).Value


For j = 0 To (Extent - 1)

Call Input_Values
Call BedLoad

qt = qb + qs
qum = qt - qm
```

Store Data from the total load analysis.

```
   Workbooks("BedLoadVariation.xls").Activate
   Sheets("Results").Select
   Range("B1").Select

      ActiveCell(8, j + 1).Value = qt
      ActiveCell(9, j + 1).Value = qum

Next


End Sub
```

Appendix G – Computer Solution based on Bins

Procedure

The following procedure outlines the method used to determine total sediment discharge based on dividing the sample into bins.

1. Based on the percent of sediment within each bin, div e the measured suspended sediment concentration.
2. Determine the representative particle size per each bin based on the geometric mean
3. Calculate Total Sediment discharge:
    a. In cases where suspended sediment is measured calculate total sediment discharge based on the following approach: Assume that the rouse number is known as $Ro = \frac{\omega}{0.4u_*}$ and the bed discharge is determined based on the measured sediment discharge. Then the suspended sediment discharge is determined by integrating the concentration profile from h to 2ds. The total sediment discharge is calculated by adding the bed discharge and suspended sediment discharge.
    b. In cases were the program could not calculate a bed discharge based on the bisection method, where the material found in the bed was not measured in suspension, or when the Rouse number was greater than 5 the Einstein Bed Load equation is used. The calculated bed discharge is then multiplied by the percent of material found in the bed of that size.

4. Sum up all sediment discharges to determine the total sediment discharge.

Sample Input Data

A sample input data sheet is shown in Table G.1. The data are from September 27th 1984, where the measured suspended sediment concentration was 50.5 kg/s.

Table G.1. Input Data Summary from 9/27/1984

Sample Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
measured suspended sediment concentration Cm (mg/L) =	42.6	7.98	7.98	7.98	13.3	7.98	3.99	10.6	27.9	2.66	0	0	0	0	0	0	0
flowrate (cms) =	212																
flow depth h (m) =	1.7																
unmeasured depth dn (m) =	0.3																
Slope =	0.00039																
representative particle size ds (mm) =	0.00141421	0.00282843	0.00565685	0.01131371	0.02262742	0.04454211	0.08625543	0.17320508	0.35355339	0.70710678	1.41421356	2.82842712	5.65685425	11.3137085	22.627417	45.254834	90.509668
d35 (mm) =	0.59375																
d65 (mm) =	0.90625																
cross sectional width W (m) =	101																
average velocity Vmean (m/s) =	1.2																
Temperature (C) =	4																