NOAA Technical Memorandum ERL GLERL-42

A NUMERICAL MODEL OF COHESIVE SUSPENDED SEDIMENT DYNAMICS

Nathan Hawley

Great Lakes Environmental Research Laboratory
Ann Arbor, Michigan
February 1983

UNITED STATES DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
John V. Byrne, Administrator

Environmental Research Laboratories
George H. Ludwig, Director

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CONTENTS

A NUMERICAL MODEL OF COHESIVE SUSPENDED SEDIMENT DYNAMICS[1]

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This report documents a one-dimensional finite-difference computer program that models cohesive suspended sediment dynamics in a shear flow. The model is based on Smulchowski's geometrical collision formulas. User-supplied empirical constants are necessary to determine the collison efficiency and aggregate shear strength. The model does not include biological or chemical processes or lateral advection. At present, the model is designed to reflect conditions in the Great Lakes, but by changing the boundary conditions it could be modified for other environments.

1. INTRODUCTION

It has been well established that many toxic pollutants (PAH's, PCB's, heavy metals) have a strong tendency to adsorb onto suspended particulates (O'Connor and Connolly, 1980) and hence be transported with them. This results in the localized concentration of these substances on the lake bottom even when, as in the case of atmospherically derived materials, the initial loading is fairly uniform (Edgington and Robbins, 1976; Cahill, 1981). The actual pathways followed by the pollutants are as yet little known since determining them is complicated by the cohesive nature of the particulates. The size and fall velocity of these particles change with time since they are constantly forming into aggregates that may subsequently break up, depending upon the flow conditions. This behavior, when coupled with the complex nature of the deposition and resuspension processes associated with these materials, makes it extremely difficult to predict a priori their transport paths and depositional sites. It is hoped that the computer model presented here, which describes the aggregation and disaggregation of organo-mineral aggregates in a shear flow, will aid in predicting pollutant transport paths.

2. FORMULATION OF THE MODEL

The change in the number (n) or concentration (c) of particles of a given size (j) with time at any given elevation (z) can be expressed as

$$\frac{\partial n_j}{\partial t} = \underbrace{\frac{1}{2}\int_0^{j-1} \phi(i,j-i)di}_{(1)} - \underbrace{\int_0^{\infty} \phi(i,j)di}_{(2)} + \underbrace{\int_j^{\infty} \Psi(j,i)di}_{(3)} - \underbrace{\int_0^{j} \frac{i}{j}\Psi(i,j)di}_{(4)}$$

$$+ \underbrace{\frac{\partial}{\partial z}[W + Q]}_{(5)} + \underbrace{S_1}_{(6)} - \underbrace{S_2}_{(7)}, \qquad (1)$$

[1]GLERL Contribution No. 318.

where $\phi(i,j)$ is the rate of formation of (i+j)-sized particles due to collisions between i-sized and j-sized particles and $\Psi(i,j)$ is the rate of formation of i-sized particles due to the rupture of j-sized particles. Term 5 represents changes due to particle settling (W) and turbulent diffusion (Q), while terms 6 (source) and 7 (sink) are other processes affecting particle size. These might include particle precipitation and/or dissolution, longitudinal advective transport, and biological processes. In the present model, terms 6 and 7 are set equal to zero.

The processes responsible for interparticle collision are Brownian motion, turbulent shearing, and differential settling. Using geometrical concepts, Smulchowski (1917) determined the rates at which collisions occur due to each of these processes.

$$\beta_{BM} = \frac{2k\ T}{3\mu} \frac{(r_i + r_j)^2}{r_i\ r_j} c_i\ c_j \tag{2}$$

$$\beta_{TS} = \frac{4G}{3}(r_i + r_j)^3\ c_i\ c_j \tag{3}$$

$$\beta_{DS} = \pi(r_i + r_j)^2\ |\ W_i - W_j\ |\ c_i\ c_j \tag{4}$$

More recent research has shown that it is actually the interplay of inertial, hydrodynamic, and electrical forces that determines collision frequency. Honig et al. (1971) have shown that hydrodynamic considerations will virtually prohibit collisions if no electrical forces are present, while Schlamp et al. (1976) and Zeichner and Schowalter (1977, 1979) have shown that electrical forces considerably enhance collision rates. To be strictly correct, these forces should be considered in the model. To date, however, almost nothing is known about the electrical fields of natural organo-mineral aggregates, and the irregular shapes and porous nature of the flocs make it impossible to calculate hydrodynamic forces accurately. Instead, an efficiency factor, whose value is empirically determined, has been introduced into equations (2) through (4).

Examination of equations (2) through (4) reveals that, for different pairs of particles r_i and r_j, different collision mechanisms will be dominant. In general, Brownian motion is only important for very small particles ($r < 1\ \mu m$), while for the larger particles commonly found in the Great Lakes either turbulent shearing or differential settling is most important. To evaluate the relative importance of these terms, it is necessary to know both the fall velocity (W) of the particles and the fluid shear (G).

Since the present use of the model is concerned with the bottom boundary layer, the effect of the earth's rotation is neglected. Thus, the velocity profile is the logarithmic one characteristic of simple shear flows. The turbulent shear is then derived from the eddy dissipation.

$$G_z = \left(\frac{\tau_o \frac{du_z}{dz}}{\mu} \right)^{1/2} \tag{5}$$

If a hydraulically smooth boundary is assumed, then

$$u_z = u_* \left(\frac{1}{\kappa} \ln \left(\frac{z u_*}{\upsilon} \right) + 5.5 \right). \tag{6}$$

Differentiating gives

$$\frac{du_z}{dz} = \frac{u_*}{\kappa z} \tag{7}$$

Using the equations for open channel flow,

$$\tau_o = \rho u_*^2 (1 - z/D), \tag{8}$$

so the fluid shear can be specified completely if u_*, z, and D are known.

$$G_z = \left(\frac{u_*^3}{\upsilon \kappa z} (1 - z/D) \right)^{1/2} \tag{9}$$

Similarly, the turbulent diffusivity (Q) can be specified if u_* is known.

$$Q_z = \kappa u_* (1 - z/D) \tag{10}$$

In open channel flows, D is merely the total water depth. In other applications, where the assumption of a logarithmic velocity profile is valid, D must be suitably chosen. In the present implementation for the Great Lakes, D is the total water depth in non-stratified settings and the distance to the thermocline in stratified ones. If, for example, the model were used to investigate the region near the thermocline, a different D would be required. For applications in which the assumptions of a logarithmic layer and a smooth boundary are invalid, parts of subroutines FREQ and DIFADV must be rewritten to account for the changes in equations (9) and (10) and for differences in the calculation of the mass flux.

If the fall velocity (W) for a given particle-size class is known, then the relative importance of collisions due to turbulent shearing and differential settling can be determined for any pair of particles by using equations (3) and (4). For many particles, small mineral grains for instance, Stokes' Law,

$$W_i = \frac{2}{9}\left(\frac{r_i^2(\rho_i - \rho_f)g}{\mu}\right), \tag{11}$$

accurately predicts the particle fall velocity (density $\rho_i = 2.5$ mg mm^{-3}). The vertical distribution of such particles (or any others with a well-defined fall velocity) in open channel flow can be predicted using Rouse's Law,

$$C_z = C_a\left[\left(\frac{D - z}{D - a}\right)\frac{a}{z}\right]^{\frac{W}{\kappa\, u_*}} \tag{12}$$

where C_a is the concentration of particles measured near the bottom at height a. Equation (12), which balances the upward motion of particles due to turbulent diffusion and the downward motion of particles due to settling, fairly accurately predicts the vertical distribution of non-cohesive particles in a shear flow. For cohesive particles, however, aggregation and disaggregation are important. In addition, the size-fall velocity relationship is not one-to-one. Preliminary calculations have shown that observed particle-size distributions cannot be modeled with equation (12).

Experimental measurements of aggregate fall velocities (Chase, 1977, 1979; Kajihara, 1971; Kawana and Tanimoto, 1976, 1979) show a wide variability in fall velocities for any given aggregate size. Since Passarelli and Srivastava (1979) have shown that using a spectrum of fall velocities significantly increases the number of collisions due to differential settling, the model uses the empirical equations in Hawley (1982) to express the fall velocity distribution of the aggregates. The use of a distribution of velocities for each size class precludes simple comparison of the collision rates due to differential settling and turbulent shearing, but calculations using low shears ($G = 1\ s^{-1}$) show that differential settling is more important. In the model all three collision mechanisms are included in the calculations.

Electrical forces not only influence the collision frequency, they determine the strength of the aggregate, and hence its resistance to rupture. Rupture occurs only if the shear to which the particle is exposed exceeds its strength. Although several authors have considered the rupture problem (Firth and Hunter, 1976; Adler, 1979; Adler and Mills, 1979), all have assumed that the particle strength is known. However, calculation of the strength is impossible due to the complex composition of the aggregates and the minimal amount known about the primary bonding mechanism, interparticle bridging (Hall, 1974). The only experimental work on aggregate strength is that of Krone (1963), who measured the strengths of clay mineral aggregates. Krone presented his results as shear strength versus aggregate density. A regression line fitted to all of his data gives

$$St = 0.04\ \rho_a^{26.98}, \qquad (13)$$

where the aggregate strength (St) is in dynes per square centimeter and the density in grams per cubic centimeter. Preliminary tests showed that equation (13) gave aggregate strengths that were far too great, so the right side of the equation was multiplied by an empirical constant (SM) to reduce the values. SM commonly has a value of 0.07 to 0.01. The reason for the difference between the strengths measured by Krone and the ones needed in the model is probably that the bonds formed by double-layer contraction in Krone's clay aggregates are much stronger than bonds formed by interparticle bridging. Rupture occurs instantaneously in the model if the fluid shear exceeds the aggregate strength.

Studies by Quigley (1977) show that aggregate rupture occurs by either erosion of small bits of the floc by microturbulence or by large-scale division into two roughly equal-sized particles. The former is important only for very loosely-bound aggregates and is not included in the model.

Goren (1971) calculated the total shear stress on a doublet of equal-sized spheres to be

$$S = 6.12\ \mu\ \pi\ G\ r^2. \qquad (14)$$

The stress per unit area is then

$$S = 6.12\ \mu\ \pi\ G. \qquad (15)$$

Using a quite different approach, Matsuo and Unno (1981) determined that

$$S = 1.095\ \mu\ \pi\ G. \tag{16}$$

Since the only difference between equations (15) and (16) is the numerical constant and since Krone's aggregate strengths are multiplied by an empirical constant, it is immaterial which of the equations is used. The model uses equation (15).

In order to use both Krone's results and equations (2) through (4) in equation (1), it is necessary to relate aggregate size to aggregate density. It is also necessary to have a measure of particle size that is conserved when equation (1) is integrated over all particle sizes. Computer simulations of aggregate formation (Goodarz-nia, 1975, 1977; Tambo and Watanabe, 1979) show that aggregate density decreases with aggregate size due to the incorporation of increasing amounts of water into the larger flocs. This means that total aggregate mass is not a conservative quantity. What is conserved is the solid mass of the aggregates.

Tambo and Watanabe (1979) have proposed that aggregates be considered collections of small spherical primary particles with radius r_o. They found that the number of primary particles in an aggregate of radius r is

$$n = \left(\frac{r}{r_o}\right)^{2.1}. \tag{17}$$

If the primary particles have a density ρ_o, then the aggregate density is

$$\rho_a = \left(\frac{r_o}{r}\right)^{0.9} (\rho_o - \rho_f) + \rho_f. \tag{18}$$

Equations (18) and (13) can thus be used to determine aggregate strength as a function of size, while equation (17) allows a transformation from the physical radius of the aggregates to the number of primary particles they contain. This latter is a conserved quantity that can be used in equation (1).

3. IMPLEMENTATION OF THE MODEL

The program calculates particle-size distributions for up to 38 size classes at up to 15 elevations above the bottom. The upper boundary condition is that, above the uppermost level at which calculations are made, there is a constant sediment concentration. At the lower boundary there is zero flux (no sedimentation). Thus, because of particles passing through the upper boundary, the total mass in the system changes with time. The initial particle concentrations at each height are supplied by the user.

The grid scheme consists of alternating levels at which sediment fluxes and particle concentrations are calculated, concentrations calculated at the lowest level and fluxes at the highest. Thus the number of levels for each is equal with ZC(I) < ZF(I). The precise values may be specified by the user, but ZC(I) should be halfway between ZF(I - 1) and ZF(I). Since the values of ZF govern the maximum permissible time step (see below), these values should be chosen with care. Flux values are first computed from the initial sediment concentrations supplied by the user, and the values at each set of two adjacent levels are used to compute the new particle concentrations. These values are in turn used to compute the next flux values. Several iterations of this procedure (subroutine DIFADV) may be done between calls to subroutines COLLID and RUPTUR, which determine changes in particle-size distributions due to particle collisions and particle rupture.

The calculations are made with up to 38 size classes: 1-2 μm in diameter, 2-4 μm, and then every 4 μm up to 144 μm at up to 15 levels. The user is responsible for determining both how many and which levels are used, and for deciding how his observations will be mapped into the program. (See input descriptions for *cards* 13-20.)

Since in both COLLID and RUPTUR, it is the number of primary particles that is conserved, the result of a collision or rupture may not be an integral number of new particles. All aggregates in a given size class are assumed to have the same number of primary particles--the number in an aggregate whose physical size is the midpoint of the interval. The number of primary particles resulting from a collision (the total in the two previous particles) or rupture (one-half the number in the previous particle) is compared to the maximum number of primary particles in each size class until the proper class of the new particle is determined. Then the ratio of the number of primary particles in the new particle to the number of primary particles in a particle whose radius is the mean of the size class gives the number of new particles added to that size class. Only two particles may collide at once and rupture is always into two equal-sized particles.

In addition to the initial concentrations, shear velocity, and heights at which the fluxes and paticle concentrations are calculated, the user must also specify both the collision efficiency (EF) and strength multiplier (SM). Tests using data collected in Lake Michigan suggest that values of approximately 0.50 and 0.01 are appropriate, but these may vary in other applications. Although in the final analysis the values must be determined empirically in each application, some comments can be made about the effects of varying these coefficients.

As SM increases, the strength of all the aggregates increases, leading to fewer particle ruptures and hence an increase in the number of larger particles with time. Since the larger particles settle more quickly than the smaller ones, this leads to an increased mass concentration in the lowest levels of the model. Eventually, since deposition is not allowed, the excess mass criteria (value specified by the user) may be exceeded and the run will terminate. The smaller the value of SM, the smaller will be the largest particles resistant to rupture. These smaller particles settle more slowly and hence are more evenly distributed throughout the water column.

Increasing EF increases the number of particle collisions, resulting in the formation of more larger aggregates per unit time. Hence, increasing EF has an effect similar to increasing SM.

Changes in the shear velocity affect several different processes. First, an increase in u_* increases both the shear, leading to the rupture of smaller particles, and the diffusivity, leading to a more uniform vertical distribution of particles. Increasing u_* also will increase the number of collisions due to turbulent shearing, but since differential settling is the main mechanism of collision (by up to three orders of magnitude), this effect is minor. Thus, increasing u_* has an effect similar to decreasing SM or EF.

A set of termination criteria has been included in the model. One, the excess mass criteria (XM) has already been mentioned. If this user-supplied value is exceeded, the run is terminated and an error message printed. Similarly, if a negative concentration is found in DIFADV, RUPTUR, or COLLID, the run is terminated and an error message printed. Errors of this sort can be eliminated by reducing the time step. In general, the time step should be small enough so that

$$\Delta t < \frac{\Delta z}{W} \tag{19}$$

and

$$\Delta t < \frac{(\Delta z)^2}{2\kappa\, u_*\, z}. \tag{20}$$

Equation (19) is the limiting case when particle settling is more important than turbulent diffusion; equation (20) represents the opposite. The values of Δz and z represent the difference between two adjacent levels where flux calculations are made and the higher of those two levels. In the present implementation of the program, the maximum permissible value of Δt satisfying equation (19) is 150 s. Since the permissible values of Δt from equation (20) vary with u_*, which may be varied during a single run, the division by u_* is done in the program. The user should determine a Δt such that

$$\Delta t < \frac{(\Delta z)^2}{2\kappa\, z} \tag{21}$$

and enter this in the input data as TO. The program then divides TO by u_*, compares the result to 150 s, and uses the smaller value. If the values of either Δz or W are changed, part of the main program must be altered by the user.

The program will run KR iterations unless convergence is achieved. This criteria (CC) is the maximum allowable percentage deviation between the results of one iteration and the preceding one. Intermediate results are printed out every NL iterations.

4. STRUCTURE OF THE MODEL

The program consists of a main program and 10 subroutines.

The MAIN program reads in the control parameters, sets the time step, calls subroutines, checks for convergence and excess mass accumulation, and prints error messages.

Subroutine HEIGHT reads in the user-supplied heights at which fluxes and concentrations are calculated in subroutine DIFADV.

Subroutine PARPAR calculates particle parameters, including the mean and maximum sizes of the particles in each calculated size class, the particle density, and the number of primary particles in each size class. It also calculates the number and size of the particles that result from collisions and rupture. It calls subroutines FALVEL and SHSTRN.

Subroutine FALVEL calculates the distribution of fall velocities for each particle-size class. This subroutine uses the IMSL subroutine MDNOR. If this is not available, the subroutine must be rewritten. The user specifies what percentage of particles in each size interval fall at a Stokesian velocity (density ρ = 2.5 g cc^{-1}). The rest of the particles fall at various velocities up to 2500 $\mu m\ s^{-1}$. The distribution of these velocities is determined using Hawley's equations (1982).

Subroutine SHSTRN calculates the shear strength of particles in each size class.

Subroutine READ reads in user-supplied values of particle concentrations in various size classes, as well as the elevations at which they were measured and the TSM measurement. It calls subroutine CURVE.

Subroutine CURVE assigns as initial values the user-supplied observations to the elevations and size classes used in the calculations. How this assignment is done is up to the user.

Subroutine FREQ calculates the diffusivity, shear, and shear stress at each elevation, as well as the total collision kernel.

Subroutine DIFADV calculates changes in particle concentration due to turbulent diffusion and particle settling. A finite-difference technique is used with alternating levels at which concentrations and fluxes are calculated.

Subroutine COLLID calculates the changes in particle concentration due to interparticle collisions.

Subroutine RUPTUR calculates the changes in particle concentration due to particle rupture.

5. INPUT DATA

The input data are of two types--control parameters and observed sediment concentrations. Several sets of observations may be run with a single set of control parameters, and several sets of control parameters may be used in a single run. Note that, although the program uses the cgs system, many of the input parameters are in other units. IT IS IMPORTANT THAT YOU USE THE CORRECT UNITS!

1. Control cards

   a. Card 1 - Format-I2
      IP - the number of sets of control parameters to be read.

   b. Card 2 - Format-9(1X,F7.2)
      TO - basic time step (seconds).
      DE - total depth of flow (meters).
      SM - aggregate strength multiplier.
      VK - von Karman's constant.
      CC - convergence criteria (percent: 1 > CC > 0).
      EF - efficiency of particle collisions (percent: 1 > EF > 0).
      XM - excess mass criteria (milligrams per liter). If TMASS > XM, run is terminated.
      RHO - density of primary particles (grams per cubic centimeter).
      RO - radius of primary particles (microns).

   c. Card 3 - Format-8(2X,I6)
      KQ - number of elevations used in calculation; maximum is 15.
      NS - index of largest size class used; maximum is 38.
      KUS - number of shear velocities used; maximum is 5.
      KR - maximum number of iterations.
      NL - number of iterations between printouts; must be multiple of IT.
      IT - number of calls to DIFADV between calls to RUPTUR and COLLID.
      NR - number of sets of observations to be run using this set of control parameters.
      MS - index of smallest size class used in calculations; see card 13.

   d. Card 4 - Format-5F6.3
      USTAR - shear velocities (centimeters per second).

e. Card 5 (and 6) - Format-10(2X,F5.2)
   ZC(I) - heights at which sediment concentration calculations are made (meters); maximum of 15.

f. Card 7 (and 8) - Format-10(2X,F5.2)
   ZF(I) - heights at which flux calculations are made (meters); maximum of 15; ZF(I) > ZC(I).

g. Card 9 (and 10,11) - Format-13(1X,F4.2)
   SP - percent of particles in each size class used in the calculations that fall with a Stokes' velocity (1 > SP > 0).

2. Observations

a. Card 12 - Format-A8,2(1X,I2)
   TITLE - identification string.
   NZ - number of heights at which observations were made; maximum is 15.
   NC - number of size classes in which observations were made; maximum is 38.

b. Card 13 (and 14) - Format-21(1X,F3.0)
   SIZE - maximum and minimum diameters for the observed size classes (microns). There should be NC + 1 values. There are several restrictions on the possible classes used since these values are used to map the observations onto the size classes used in the program.

   i. For particles smaller than 4 μm, only two alternatives are permissible.
      a. Size classes of 1-2 μm and 2-4 μm; in this case MS = 1.
      b. A size class of 2-4 μm; in this case MS = 2.

   ii. For particles larger than 4 m, the boundaries between classes must be multiples of 4. If the smallest size is 4 μm or greater, then MS equals the minimum size divided by 4 plus 2; e.g., if the minimum size class is 8-16 μm, then MS = 4. The upper bound of the largest size class does not necessarily have to set the value of NS; this can be set to any value up to 38 (144 μm).

b. The next 2-5 cards are repeated NZ times, one set for each height.
   Card 15 - Format-2(F6.2,1X)
   HT - the elevation at which the observations were made (meters).
   WT - the TSM measured (milligrams per liter).

   Card 16 (17-19) - Format-10F8.2
   OBSED - the observed particle concentration for each size (particles per cubic centimeter; smallest size first). Note, only NC values are read.

c. Card 20 - Format-20(1X,I2)
   IHT - specifies the observed height from which observations are to be mapped as initial values onto the heights used in the calculations. These are not the actual heights but the index. (The maximum value is NZ.)

d. If multiple sets of observations are to be run using the same control parameters, cards 12-20 must be provided for each set.

3. If a second set of control parameters is used, then cards 2-20 must be provided and the observation cards repeated.

6. ACKNOWLEDGMENTS

This work was jointly supported by the Long Range Effects Research Program of the Office of Marine Pollution Assessment, NOAA, and the Great Lakes Environmental Research Laboratory, NOAA.

7. REFERENCES

Adler, P. M. (1979): A study of disaggregation effects in sedimentation. *Am. Inst. Chem. Eng. J.* 25:487-493.

Adler, P. M., and P. M. Mills (1979): Motion and rupture of a porous sphere in a linear flow field. *J. Rheology* 23:25-37.

Cahill, R. A. (1981): Geochemistry of recent Lake Michigan sediments, Illinois State Geol. Surv. Circ. #517, Illinois State Geol. Surv., Urbana, Ill., 94 pp.

Chase, R. R. P. (1977): Transport dynamics and kinematic behavior of aquatic particles. Ph.D. dissertation, University of Chicago, Chicago, Ill., 174 pp.

Chase, R. R. P. (1979): Settling behavior of natural aquatic particles. *Limnol. Oceanogr.* 24:417-426.

Edgington, D. A., and J. R. Robbins (1976): Records of lead deposition in Lake Michigan sediments since 1800. *Environ. Sci. Tech.* 10:226-274.

Firth, B. A., and R. J. Hunter (1976): Flow properties of coagulated colloidal suspensions. III. The elastic floc model. *J. Colloid Interface Sci.* 57:266-275.

Goodarz-nia, I. (1975): Floc simulation: Effect of particle size. *J. Colloid Interface Sci.* 52:29-40.

Goodarz-nia, I. (1977): Floc density, porosity, and void ratio in colloidal systems and aerosols. *J. Colloid Interface Sci.* 62:131-141.

Goren, S. L. (1971): The hydrodynamic forces on touching spheres along the line of centers exerted by a shear field. *J. Colloid Interface Sci.* 36:94-96.

Hall, D. G. (1974): The role of bridging in colloidal flocculation. *Colloid Polymer Sci.* 252:241-243.

Hawley, N. (1982): Setting velocity distribution of natural aggregates. *J. Geophys. Res.* 87:9489-9498.

Honig, E. P., Roebersen, G. J., and Wiersma, P. H. (1971): Effect of hydrodynamic interaction on the coagulation rate of hydrophobic colloids. *J. Colloid Interface Sci.* 36:97-109.

Kajihara, M. (1971): Settling velocity and porosity of large suspended particles. *J. Oceanogr. Soc. Japan* 27:158-162.

Kawana, K., and Tanimoto, T. (1976): Temporal variation of suspended matter near the sea bottom in Hiro Bay. *La Mer* 14:47-52.

Kawana, K., and Tanimoto, T. (1979): Suspended particles near the bottom in Osaka Bay. *J. Oceanogr. Soc. Japan* 35:75-81.

Krone, R. B. (1963): *A Study of Rheoogic Properties of Estuarial Sediments.* Hydraulic Engineering and Sanitation Engineeering Research Center, Berkeley, Calif., 110 pp.

Matsuo, T., and H. Unno (1981): Forces acting on a floc and strength of floc. *J. Environ. Eng. Div., ASCE* 101:527-545.

O'Connor, D. J., and Connolly, J. P. (1980): The effect of concentration of adsorbing solids on the partition coefficient. *Water Res.* 14:1517-1523.

Passarelli, R. E., Jr., and Srivastava, R. C. (1979): A new aspect of snowflake aggregation theory. *J. Atmos. Sci.* 36:484-493.

Quigley, J. E. (1977): Strength properties of liquid-borne flocculated matter. M.S. thesis, University of Delaware, Newark, Delaware, 100 pp.

Schlamp, R. J., Grover, S. N., and Pruppacher, H. R. (1976): A numerical investigation of the effect of electric charges and vertical external electric fields on the collision efficiency of cloud drops. *J. Atmos. Sci.* 33:1747-1755.

Smulchowski, M. (1917): Versuch einer mathematischen Theorie der Koagulationskinetik Kolloider Lösungen. *Z. Physik Chem.* 92:129.

Tambo, N., and Watanabe, Y. (1979): Physical characteristics of floc. I. The floc density function and aluminum floc. *Wat. Res.* 13:409-419.

Zeichner, G. R., and Schowalter, W. R. (1977): Use of trajectory analysis to study stability of colloidal dispersions in flow fields. *Am. Inst. Chem. Eng. J.* 23:243-254.

Zeichner, G. R., and Schowalter, W. R. (1979): Effects of hydrodynamic and colloidal forces on the coagulation of dispersions. *J. Colloid Interface Sci.* 71:237-253.

Appendix A--SYMBOLS

a - reference elevation

c - particle concentration

D - total fluid depth

g - acceleration due to gravity

G - fluid shear

i,j - size class indices

k - Boltzman's constant

n - number of particles

Q - diffusivity

r - particle radius

r_0 - primary particle radius

S - shear stress

St - aggregate shear strength

T - temperature

Δt - time step

u_z - flow velocity at height z

u_* - shear velocity

W - particle fall velocity

z - elevation

Δz - change in elevation

β_{BM} - collision rate due to Brownian motion

β_{DS} - collision rate due to turbulent shearing

β_{TS} - collision rate due to turbulent shearing

κ - von Karman's constant

μ - dynamic viscosity

υ - kinematic viscosity

ρ - density

ρ_0 - primary particle density

ρ_a - aggregate density

ρ_f - fluid density

τ_0 - shear stress

ϕ - collison kernel

Ψ - rupture kernel

Appendix B--PROGRAM LISTING

The following is a listing of the program as implemented on a CDC 170/750 using FORTRAN IV.

```
      PROGRAM CONCAL (OUTPUT,TAPE5,TAPE6)
C
C
C DIKENSIONED VARIABLESINCOMMON
C
C BM(J,K) COLLISION KERNEL FOR BROWNIAN NOTION BETUEEN J AND K-SIZED PARTICLES
C D(I,J,K) TOTAL COLLISION KERNEL AT HEIGHT I BETUEEN J AND K-SIZED PARTICLES
C DS(J.K) COLLISION KERNEL FOR DIFFERENTIAL SETTLING BETUEEN J AND K-SIZED
C   PARTICLES
C G(I) FLUID SHEAR AT HEIGHT I
C HRC(J,K) NUMBER OF PARTICLES FORMED BY THE COLLISION OF A J AND K-SIZED
C  PARTICLE
C HRR(J) NUMBER OF PARTICLES FORKED BY THE RUPTURE OF A J-SIZED PARTICLE
C IRC(J.K) SIZE OF PARTICLES RESULTING FROM COLLISION OF A J AND K-SIZED
C  PARTICLE
C ISR(J) PARTICLE SIZE RESULTING FROM RUPTURE OF A J-SIZED PARTICLE
C OBSED(L,M) OBSERVED PARTICLE CONCENTRATIONS AT L HEIGHTS INMSIZECLASSES
C Q(I) DIFFUSIVITY AT HEIGHT I
C SEDCON(I.J) CALCULATED PARTICLE CONCENTRATIONS FOR J SIZE CLASSES AT
C   I HEIGHTS
C SEDPAR(38,N) PHYSICAL PARAMETERS OF PARTICLES IN 38 SIZE CLASSES USED IN
C     THE CALCULATIONS. FOR N EQUAL TO
C     1. MEAN RADIUS OF PARTICLES IN THE INTERVAL
C   THE CALCULATIONS.  FOR EACH SIZE CLASS, THE PROPERTIES ARE
C   ASSIGNED AS FOLLOU. FOR N EQUAL TO
C     2. MAXIMUM DIAMETER OF PARTICLES IN THE INTERVAL
C     3. NUMBER OF PRIMARY PARTICLES IN A PARTICLE WITH THE MEAN RADIUS
C     4. DENSITY OF A PARTICLE WITH THE MAN RADIUS
C     5. SHEAR STRENGTH OF A PARTICLE WITH THE MEAN RADIUS
C     6. STOKES SETTLING VELOCITY OF A PARTICLE WITH THE MEAN RADIUS
C     7. NUMBER OF PRIMARY PARTICLES IN A PARTICLE YITH THE MAXIMUM DIAMETER
C     8. PARTICLE CONCENTRATION AT THE UPPER BOUNDARY
C SET;;) MEAN SETTLING VELOCITY OF J-SIZED PARTICLES
C SH(I) FLUID SHEAR STRESS AT HEIGHT I
C SIZE(M+1) MINIMUM AND MAXIMUM SIZES OF M OBSERVED SIZE CLASSES
C SP(J) PERCENT OF J-SIZED PARTICLES THAT FALL WITH A STOKES VELOCITY
C TMASS(I) TOTAL CALCULATED MASS AT HEIGHT I
C TPART(I) TOTAL CALCULATED NUMBER OF PRIMARY PARTICLES Al #EIGHT I
C TS(J,K) COLLISION KERNEL BETUEEN J AND K-SIZED PARTICLES
C USTAR(5) VECTOR OF SHEAR VELOCITIES USED
C VEL(16,J) VECTOR OF SETTLING VELOCITIES FOR J-SIZED PARTICLES; FIRST ENTRY
C   IS THE STOKES VELOCITY, THE REST ARE USED TO DETERMINE THE DISTRIBUTION
C UELPC(16,J) PERCENTAGE OF J-SIZED PARTICLES FALLING AT EACH VELOCITY IN
C   UEL
C WT(M) OBSERVED SEDIMENT MASS AT HEIGHT M
C ZC(I) HEIGHTS AT UHICH SEDIMENT CONCENTRATIONS ARE CALCULATED
C ZF(I) HEIGHTS AT UHICH FLUXES ARE CALCULATED
C
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C NON-DIMENSIONED VARIABLES IN COMMON
C  CC  CONVERGENCE  CRITERIA
C  DE  TOTAL  DEPTH  OF  FLOW
C  EF  EFFICIENCY  OF  PARTICLE  COLLISIONS  IN  PRODUCING  NEW  PARTICLES
C  IT  NUMBER  Of  ITERATIONS  Of  SUBROUTINE  DIFADV  BETWEEN  CALLS  TO  SUBROUTINES
C     COLLID  AND  RUPTUR
C  KO  NUMBER  OF  HEIGHTS  AT  WHICH  CALCULATIONS  ARE  MADE
C        MAXIMUM  VALUE  IS  15
C  KR  MAXIMUM  NUMBER  OF  ITERATIONS
C  KUS  NUnBER  OF  VALUES  OF  USTAR  SPECIFIED
C           MAXIMUM  VALUE  IS  5
C  KS  INDEX  OF  MINIMUM  SIZE  CLASS  USED  IN  THE  CALCULATIONS
C  NL  NUnBER  OF  ITERATIONS  BETUEEN  PRINTOUTS
C  NR  NUnBER  OF  SETS  OF  OBSERVATIONS  TO  BE  MODELED  USING  THE  SAHE  SET  OF
C     CONTROL  PARAMETERS
c  NS  INDEX  OF  MAXIMUM  SIZE  CLASS  USED  IN  THE  CALCULATIONS
C        MAXIMUM  VALUE  IS  38
C  RHO  DENSITY  OF  PRIMARY  PARTICLE
C  RO  RADIUS  OF  PRIMARY  PARTICLE
C  SM  STRENGTH  MULTIPLIER
C  T  TIME  STEP  USED  BETUEEN  CALLS  TO  SUBROUTINE  DIFADV
C  TO  BASIC  TIME  STEP  SUPPLIED  BY  USER
C  UK  VON  KARMANS  CONSTANT
c  xn  EXCESS  BASS  CRITERIA
C
C
C
C  VARIABLES  IN  MAIN  PROGRAM
C  IP  NUnBER  OF  SETS  OF  CONTROL  PARAMETERS  IN  INPUT  FILE
C  PCONC(I,J)  PREVIOUS  VALUES  OF  SEDCON;  USED  FOR  CONVERGENCE  TEST
C  PSED(I,M)  CALCULATED  PARTICLE  CONCENTRATIONS  AT  I  HEIGHTS  GROUPED  INTO
C     M  SIZE  CLASSES  CORRESPONDING  TO  THE  OBSERVED  SIZE  CLASSES
C
C
C
C
      DIMENSION USTAR(5),TPART(38),TMASS(38),SEDCON(16,38),
     1SIZE(38),SEDPAR(38,8),ZC(15),ZF(15),IHT(16),HT(15),
     2WT(15),OBSED(15,38),ISR(38),HRR(38),HRC(38,38),IRC(38,38),Q(15),
     6G(15),SH(15),D(15,38,38),DS(38,38),TS(38,38),BM(38,38),
     4SP(38),VELPC(38,16),VEL(38,16) ,SET(38)
      COMMON TO,DE,SM,VK,CC,EF,XM,RHO,RO,KQ,NS,KUS,KR,NL,IT,NR,MS,T,
     1USTAR,IRR,ICR,IDR,SEDCON,SIZE,SEDPAR,ZF,ZC,NZ,NC,IHT,HT,WT, SET,
     2OBSED,ISR,HRR,HRC,IRC,DS,TS,BM,D,Q,G,SH,SP,VEL,VELPC
      DIMENSION PCONC(15,38),PSED(15,38)
      READ(5,5555) IP
 5555 FORMAT(I2)
      DO 4 N=1,IP
      READ(5,1111) TO,DE,SM,VK,CC,EF,XM,RHO,RO
 1111 FORMAT(9(1X,F7.2))
      READ(5,2222)KQ,NS,KUS,KR,NL,IT,NR,MS
 2222 FORMAT(8(2X,I6))
      WRITE(6,24)
```

```
   24 FORMAT (1H0)
      WRITE(6,3333) TO,DE,SM,VK,CC,EF,XM,RHO,RO
      WRITE(6,4444) KQ,NS,KUS,KR,NL,IT,NR,MS
 3333 FORMAT(1X,"INPUT DATA",9(F8.2,2X))
 4444 FORMAT(1X,"INPUT DATA ",8(I6,2X))
      READ(5,6666) USTAR
 6666 FORMAT(5F6.3)
      WRITE(6,7777) (USTAR(MO),MO=1,KUS)
 7777 FORMAT(1X,"SHEAR VELOCITIES = ",5(F6.3,2X))
      WRITE(6,4445)
 4445 FORMAT(1H )
 4446 FORMAT(1H0)
      DE=DE*100.
      CALL HEIGHT
      WRITE(6,4446)
      CALL PARPAR
      WRITE(6,4446)
      DO 3 IL=1,NR
      CALL REID
      WRITE(6,4445)
      DO 2 K=1,KUS
      T=TO/USTAR(K)
      IF(T.GT.150.) T=150.
      WRITE(6,23) T
   25 FORMAT(1X,12HTIME STEP = ,F8.2,8H SECONDS)
   23 FORMAT(1H0,12HTIME STEP = ,F8.2,8H SECONDS)
      WRITE(6,4446)
      CALL FREQ(USTAR(K))
      WRITE(6,4446)
      IRR=0
      ICR=0
      IDR=0
      NCIT=IT
      NCL=NL
      DO 12 J=MS,NS
      DO 12 L=1,KQ
      PCONC(L,J)=SEDCON(L,J)
   12 CONTINUE
      DO 1 I=1,KR
      CALL DIFADV
  999 IF(IDR.EQ.1) GO TO 41
      IF(I.NE.NCIT) GO TO 1
      NCIT=NCIT+IT
      CALL COLLID
      IF(ICR.EQ.1 ) GO TO 41
      CALL RUPTUR
      IF(IRR.EQ.1) GO TO 40
      ISS=0
C CONVERGENCE TEST
      DO 31 L=1,KQ
      DO 31 J=MS,NS
      IF(PCONC(L,J).NE.0.) GO TO 35
      IF(ABS(SEDCON(L,J)).GT.CC) ISS=1
```

```
      GO TO 36
   35 IF(ABS((SEDCON(L,J)-PCONC(L,J))/PCONC(L,J)*ZC(L)/(T*VK
     1*USTAR(K))).GT.CC) ISS=1
   36 PCONC(L,J)=SEDCON(L,J)
   30 CONTINUE
      IF(ISS.EQ.1) GO TO 50
      WRITE(6,100) I
  100 FORMAT(1X,"STEADY-STATE AFTER ",I5," CYCLES")
      GO TO 60
   50 IF(I.NE.NCL) GO TO 1
      WRITE(6,52) I
   52 FORMAT(1X,"RESULTS AFTER ",I5," CYCLES")
      TMX=11100100.00
   60 DO 61 L=1,KQ
      DO 6(L)+SEDCON(L,J)*SEDPAR(J,3)
      TMASS(L)=TMASS(L)+TMX*SEDCON(L,J)*(SEDPAR(J,3)*(1.-SP(J))*RO**3+
     1SP(J)*SEDPAR(J,1)**3)
   62 CONTINUE
      NCI=NC+1
      M=2
      DO 70 J=MS,NS
      IF(SEDPAR(J,2).GT.SIZE(M))M=M+1
      IF(M.GT.NCI) GO TO 75
      PSED(L,M-1)=PSED(L,M-1)+SEDCON(L,J)
      GO TO 70
   75 CONTINUE
      PSED(L,NCI)=PSED(L,NCI)+SEDCON(L,J)
      M=NCI
   70 CONTINUE
      WRITE(6,200) ZC(L),TPART(L),TMASS(L)
  200 FORMAT(1X,"HEIGHT =",F8.2," (CM) TOTAL PRIMARY PARTICLES =",E12.6,
     1" TOTAL MASS =",F6.3,"MG/L")
   61 CONTINUE
      WRITE(6,4445)
      WRITE(6,775) (SIZE(LQ),LQ=1,NCI)
  775 FORMAT(1X,"PARTICLE CONCENTRATION5 FOR THE OBSERVED SIZES,"
     1"SMALLEST FIRST",/,1X,2X,"MIN DIAM= ",15(1X,F7.5),/)
      DO 778 L=1,KQ
      WRITE(6,201) ZC(L),(PSED(L,J),J=1,NCI)
  201 FORMAT(1X,"HT= ",16(1X,F7.2))
      IF(TMASS(L).LT.XM) GO TO 770
      WRITE(6,66)
   66 FORMAT(1X,"ERROR- MASS TOO GREAT')
      GO TO 2
  778 CONTINUE
      WRITE(6,4446)
   65 NCL=NCL+NL
      GO TO 1
   40 WRITE(6,650) I,IBR,ICR,IRR
  650 FORMAT(1X,"ERROR-NEGATIVE CONCENTRATION AFTER ",I5," CYCLES.",
     1/," ERROR OCCURS IN THE SUBROUTINE UITH A VALUE OF 1",/,
     2" DIFADV =",I2," COLLID =",I2," RUPTUR =",I2)
      WRITE (6,750)
```

```
  750 FORMAT(1X,"CALC. SED. CONC.  ,EACH COLUMN REPRESENTS A HEIGHT,
     1 LOUEST AT LEFT,  SMALLEST SIZE RANGE IS FIRST ROU.")
      DO 42 L=MS,NS
      URITE(6,752) (SEDCON(J,L),J=1,KQ)
  752 FORMAT(15(1X,F7.2))
   42 CONTINUE
      GO TO 2
    1 CONTINUE
    2 CONTINUE
    3 CONTINUE
    4 CONTINUE
      STOP
      END
      SUBROUTINE PARPAR
C
C
C VARIABLES IN PARPAR/
C SD SUM OF RADII OF J AND K-SIZED PARTICLES
C SEDINC  INCREMENT BETUEEN VALUES OF SEDPAR(J,1)
C SEDIN2  INCREMENT BETUEEN VALUES OF SEDPAR(J,2)
C
C
      DIMENSION USTAR(5),TPART(38),TMASS(38),SEDCON(16,38),
     1SIZE(38),SEDPAR(38,8),ZC(15),ZF(15),IHT(16),HT(15),
     2WT(15),OBSED(15,38),ISR(38),HRR(38),HRC(38,38),IRC(38,38),Q(15),
     6G(15),SH(15),D(15,38,38),DS(38,38),TS(38,38),BM(38,38),
     4SP(38),VELPC(38,16),VEL(38,16) ,SET(38)
      COMMON TO,DE,SM,VK,CC,EF,XM,RHO,RO,KQ,NS,KUS,KR,NL,IT,NR,MS,T,
     1USTAR,IRR,ICR,IDR,SEDCON,SIZE,SEDPAR,ZF,ZC,NZ,NC,IHT,HT,WT, SET,
     2OBSED,ISR,HRR,HRC,IRC,DS,TS,BM,D,Q,G, SH,SP,VEL,VELPC
      DATA BK/2.76E-12/
      F=1.33333
      RO=   RO/10000.
      SEDINC=0.0002
      SEDIN2=0.0004
      SEDPAR(1,1)=.000075
      SEDPAR(1,2)=.00002
      SEDPAR(2,1)=0.00015
      SEDPAR(3,1)=0.0003
      SEDPAR(2,2)=0.0004
      SEDPAR(3,2)=0.0008
      DO 4 J=4,38
      SEDPAR(J,1)=SEDPAR(J-1,1)+SEDINC
      SEDPAR(J,2)=SEDPAR(J-1,2)+SEDIN2
    4 CONTINUE
      WRITE (6,11)
   11 FORMAT(1X,"PHYSICAL PARAMETERS Of EACH SIZE CLASS",/,2X,
     1" MEAN  RAD(CM)    MAX DIAM(CM) =PRI PART(MEAN)  DENSITY',
     2"(G/CC)   STRENGTH(D/CM2) ST. VEL(CM/S)   PRI. PART(MAX)",
     3"  SIZE")
      DO 2 J=1,38
      SEDPAR(J,3)=(SEDPAR(J,1)/RO)**2.1
      SEDPAR(J,4)=(RHO-1.)*SEDPAR(J,3)*(RO/SEDPAR(J,1))**3 t1.1
```

```
      CALL SHSTR(J)
      SEDPAR(J,6)=SEDPAR(J,1)**2.0*14518.*(SEDPAR(J,4)-1.0)
      SEDPAR(J,7)=(SEDPAR(J,2)/(2.0*RO))**2.1
      WRITE(6,10)(SEDPAR(J,L),L=1,7),J
    2 CONTINUE
   10 FORMAT(1H ,7(E15.6,1X),3X,I3)
      CALL FALVEL
      DO 1 J=1,38
      DO 1 K=J,38
      SD=(SEDPAR(J,1)+SEDPAR(K,1))**2.0
      BM(J,K)=BK*SD/(SEDPAR(J,1)*SEDPAR(K,1))
      TS(J,K)=F *SD**1.5
    1 CONTINUE
  900 FORMAT(1X,4(E20.8,2X))
C THIS SECTION DETERMINES THE SIZE OF DAUGHTER PARTICLES
CPRODUCED BY FLOC RUPTURE
      ISR(1)=1
      HRR(1)=1.
      K=1
      DO 12 L-2,NS
      X=SEDPAR(L,3)/2.
      DO 20 J=K,NS
      IF(X.GT.SEDPAR(J,7)) GO TO 20
      ISR(L)=J
       HRR(L)=SEDPAR(L,3)/SEDPAR(J,3)
      GO TO 15
   20 CONTINUE
   15 K=J
   12 CONTINUE
C THIS SECTION DETERMINES THE SIZE OF DAUGHTERS
CPRODUCED BY FLOC COLLISION
      DO 50 J=1,NS
      DO 55 K=1,J
      X=SEDPAR(J,3)+SEDPAR(K,3)
      DO 60 L=J,NS
      IF(X.GT.SEDPAR(L,7)) GO TU 70
   75 HRC(J,K)=X/SEDPAR(L,3)
      IRC(J,K)=L
      60 TO 55
   70 IF(L.EQ.NS) GO TO 75
   60 CONTINUE
   55 CONTINUE
   51 CONTINUE
      RETURN
      END
      SUBROUTINE FREQ(US)
      DINENSIGN USTAR(5),TPART(38),TMASS(38),SEDCON(16,38),
     1SIZE(38),SEDPAR(38,8),ZC(15),ZF(15),IHT(16),HT(15),
     2WT(15),OBSED(15,38),ISR(38),HRR(38),HRC(38,38),IRC(38,38),Q(15),
     6G(15),SH(15),D(15,38,38),DS(38,38),TS(38,38),BM(38,38),
     4SP(38),VELPC(38,16),VEL(38,16) ,SET(38)
      COMMON TO,DE,SM,VK,CC,EF,XM,RHO,RO,KQ,NS,KUS,KR,NL,IT,NR,MS,T,
     1USTAR,IRR,ICR,IDR,SEDCON,SIZE,SEDPAR,ZF,ZC,NZ,NC,INT,HT,WT, SET,
```

```
     2OBSED,ISR,HRR,HRC,IRC,DS,TS,BM,D,Q,G,SH,SP,VEL,VELPC
      DO 10 I=1,KQ
      Q(I)=VK*US*(1.-ZF(I)/DE)*ZF(I)
      G(I)=SQRT(US**3/(.006*ZC(I)*(1.-ZC(I)/DE)))
      SH(I)=G(I)*.0918
      DO 1 J=MS,NS
      DO 1 K=J,NS
      D(I,J,K)=BM(J,K)+DS(J,K)+TS(J,K)*G(I)
      D(I,K,J)=D(I,J,K)
    1 CONTINUE
   10 CONTINUE
      WRITE(6,60) US
   60 FORMAT(1X,"SHEAR VELOCITY = ",F8.4," CM/S")
      WRITE(6,62)
   62 FORMAT(1X,2X,"HEIGHT(FLUX)",5X,"DIFFUSIVITY",
     13X,"HEIGHT(CON)",5X,"FLUID SHEAR",
     14X,"SHEAR STRESS")
      DO 80 I=1,KQ
      WRITE(6,61) ZF(I),Q(I),ZC(I),G(I),SH(I)
   61 FORMAT(7(1X,E15.8))
   80 CONTINUE
      RETURN
      END
      SUBROUTINE HEIGHT
C READ IN HEIGHTS IN METERS
      DIMENSION USTAR(5),TPART(38),TMASS(38),SEDCON(16,38),
     1SIZE(38),SEDPAR(38,8),ZC(15),ZF(15),INT(16),HT(15),
     2WT(15),OBSED(15,38),ISR(38),HRR(38),HRC(38,38),IRC(38,38),Q(15),
     6G(15),SH(15),D(15,38,38),DS(38,38),TS(38,38),BM(38,38),
     4SP(38),VELPC(38,16),VEL(38,16) ,SET(38)
      COMMON TO,DE,SM,VK,CC,EF,XM,RHO,RO,KQ,NS,KUS,KR,NL,IT,NR,MS,T,
     1USTAR,IRR,ICR,IDR,SEDCON,SIZE,SEDPAR,ZF,ZC,NZ,NC,INT,HT,WT, SET,
     2OBSED,ISR,HRR,HRC,IRC,DS,TS,BM,D,Q,G,SH,SP,VEL,VELPC
      READ(5,1) (ZC(I),I=1,KQ)
      READ(5,1) (ZF(I),I=1,KQ)
    1 FORMAT(10(2X,F5.2))
      DO 10 I=1,KQ
      ZC(I)=ZC(I)*100.
      ZF(I)=ZF(I)*100.
   10 CONTINUE
      WRITE(6,2)
    2 FORMAT(1X,"CONC. LEVELS ARE (IN CM)")
      WRITE(6,3) (ZC(I),I=1,KQ)
    3 FORMAT(1X,10(F8.2,2X))
      WRITE(6,4)
    4 FORMAT(1X,"FLUX LEVELS ARE(INCM)")
      WRITE(6,3) (ZF(I),I=1,KQ)
      RETURN
      END
      SUBROUTINE FALVEL
C
C
C VARIABLES IN FALVEL
```

```
C FACT(2,2) PARAMETERS USE6 TO CALCULATE AGGREGATE SETTLING VELOCITIES
C MEAN(2) MEAN AGGREGATE VELOCITIES FOR EACH SUBPOPULATION
C PC(2) PERCENTAGE OF AGGREGATES IN EACH SUBPOPULATION
C SIGMA(2) STANDARD DEVIATION OF VELOCITIES FOR EACH SUBPOPULATION
C
C
C THIS CALCULATES THE DISTRIBUTION OF FALL VELOCITIES FOR EACH
C PARTICLE SIZE. THE FIRST VALUE IS THE STOKES VALUE, THE REST ARE
C THE PERCENT THAT FALL AT THE RATES CALCULATED FROM HAWLEY(1982)
      DIMENSION USTAR(5),TPART(38),TMASS(38),SEDCON(16,38),
     1SIZE(38),SEDPAR(38,8),ZC(15),ZF(15),IHT(16),HT(15),
     2WT(15),OBSED(15,38),ISR(38),HRR(38),HRC(38,38),IRC(38,38),Q(15),
     6G(15),SH(15),D(15,38,38),DS(38,38),TS(38,38),BM(38,38),
     4SP(38),VELPC(38,16),VEL(38,16) ,SET(38)
      COMMON TO,DE,SM,VK,CC,EF,XM,RHO,RO,KQ,NS,KUS,KR,NL,IT,NR,MS,T,
     1USTAR,IRR,ICR,IDR,SEDCON,SIZE,SEDPAR,ZF,ZC,NZ,NC,IHT,HT,WT, SET,
     2OBSED,ISR,HRR,HRC,IRC,DS,TS,BM,D,Q,G,SH,SP,VEL,VELPC
      REAL MEAN(2)
      DIMENSION FACT(2,2),PRE(16),P(16),VELT(16),
     1SIGMA(2),Y(16),PC(2)
      DATA FACT,SIGMA,PC/1.483,9.138,.389,.693,.01,.0074,.9,.1/
      DATA VELT/0.,.01,.02,.03,.04,.05,.06,.07,.08,.09,.1,.13,.16,
     1.19,.22,.25/
      READ (5,1) (SP(JJ),JJ=MS,NS)
    1 FORMAT(13(1X,F4.2))
      WRITE(6,2)
    2 FORMAT(1X,"PCT OF MATERIAL WHICH NAVE STOKES VELOCITY IN EACH",
     1" SIZE CLASS,SMALLEST FIRST")
      WRITE(6,1)(SP(JJ),JJ=MS,NS)
      DO 9 J=MS,NS
      DO 9 K=MS,NS
      DS(J,K)=0.
    9 CONTINUE
      DO 10 K=MS,NS
      DO 8 J=1,16
      PRE(J)=0.
    B CONTINUE
      IF(SP(K).LT.1.0) GO TO 15
      DO 13 I=2,16
      VEL(K,I)=VELT(I)
      VELPC(K,I)=0.
   13 CONTINUE
      VEL(K,1)=SEDPAR(K,6)
      VELPC(K,1)=1.
      GO TO 10
   15 CONTINUE
      X=SEDPAR(K,1 )*20.
      DO 18 J=1,2
      MEAN(J)=FACT(J,1)*X**FACT(J,2) /10.
      DO  19  I=1,16
      Y(I)=(VELT(I)-MEAN(J))/SIGMA(J)
      CALL MDNOR(Y(I),P(I))
      PRE(I)=PRE(I)+P(I)*PC(J)
```

```
   19 CONTINUE
   18 CONTINUE
      VELPC(K,1)=SP(K)
      ZZ=1./(1.-PRE(1))
      DO 65 I=1,15
      P(I)=(PRE(I+1)-PRE(I))*ZZ
   65 CONTINUE
      DO 20 I=2,16
      VELPC(K,I)=(1.-SP(K))*P(I-1)
   20 CONTINUE
      VEL(K,1)=SEDPAR(K,6)
      DO 12 I=2,11
      VEL(K,I)=VELT(I)-.ØØ5
   12 CONTINUE
      DO 133 I=12,16
      VEL(K,I)=VELT(I)-.Ø15
  133 CONTINUE
   1Ø CONTINUE
      DO 31 L=MS,NS
      DO 35 J=MS,NS
      DO 4Ø I=1,16
      DO 45 K=1,16
      DS(L,J)=DS(L,J)+(SEDPAR(L,1)+SEDPAR(J,1))**2*3.1415926*
     1ABS(VEL(L,I)-VEL(J,K))*VELPC(L,I)*VELPC(J,K)
   45 CONTINUE
   4Ø CONTINUE
   35 CONTINUE
   3Ø CONTINUE
      DO 1ØØ L=MS,NS
      SET(L)=SEDPAR(L,6)*SP(L)
      DO 2ØØ I=2,16
      SET(L)=SET(L)+VEL(L,I)*VELPC(L,I)
  2ØØ CONTINUE
  1ØØ CONTINUE
      WRITE(6,98)
   98 FORMAT(1X,"AVERAGE FALL VELOCITY FOR EACH SIZE CLASS, SMALLEST"
     1" FIRST")
      WRITE(6,99) (SET(L),L=MS,NS)
   99 FORMAT(1Ø(1X,F1Ø.8))
      RETURN
      END
      SUBROUTINE READ
C
C
C VARIABLES IN READ
C TITLE- OBSERVATION IDENTIFICATION STRING
C
C
C THIS READS IN THE OBSERVATIONS
      DIMENSION USTAR(5),TPART(38),TMASS(38),SEDCON(16,38),
     1SIZE(38),SEDPAR(38,8),ZC(15),ZF(15),IHT(16),HT(15),
     2WT(15),OBSED(15,38),ISR(38),HRR(38),HRC(38,38),IRC(38,38),Q(15),
     6G(15),SH(15),D(15,38,38),DS(38,38),TS(38,38),BM(38,38),
```

```
     4SP(38),VELPC(38,16),VEL(38,16) ,SET(38)
      COMMON TO,DE,SM,VK,CC,EF,XM,RHO,RO,KQ,NS,KUS,KR,NL,IT,NR,MS,T,
     1USTAR,IRR,ICR,IDR,SEDCON,SIZE,SEDPAR,ZF,ZC,NZ,NC,INT,HT,WT, SET,
     2OBSED,ISR,HRR,HRC,IRC,DS,TS,BM,D,Q,G,SH,SP,VEL,VELPC
      READ(5,111) TITLE,NZ,NC
      NCI=NC+1
      WRITE(6,1Ø1) TITLE,NZ,NC
 1Ø2  FORMAT(1X,A8)
      READ(5,2) (SIZE(K),K=1,NCI)
      WRITE(6,2Ø2) (SIZE(K),K=1,NCI)
      WRITE(6,97)
  97  FORMAT(1H )
      DO 2ØØ L=1,NZ
      READ(5,3) HT(L),WT(L)
      READ(5,44) (OBSED(L,K),K=1,NC)
      WRITE(6,3Ø) HT(L),WT(L)
      WRITE(6,4Ø) (OBSED(L,K),K=1,NC)
 2ØØ  CONTINUE
      WRITE(6,97)
 111  FORMAT(A8,2(1X,I2))
   2  FORMAT(21(1X,F3.Ø))
   3  FORMAT(2(F6.2,1X))
  44  FORMAT(1ØF8.2)
 1Ø1  FORMAT(1H1,A8," NUMBER OF OBS. HTS.=",I2," NUMBER OF SIZES =",I2)
 2Ø2  FORMAT(1X,"MIN AND MAX DIAM. OF SIZE CLASSES (MICRONS)",/,21F4.Ø)
  4Ø  FORMAT(1X,"PART/CC PER SIZE CLASS-SMALLEST FIRST",/,1X,
     115(F6.Ø,2X),/,1X,15(F6.Ø,2X))
  3Ø  FORMAT(1X,"HEIGHT(M) =",F8.2,"WEIGHT (MG/L) =",F6.2)
      CALL CURVE
      RETURN
      END
      SUBROUTINE CURVE
      DIMENSION PS(16,38)
      DIMENSION USTAR(5),TPART(38),TMASS(38),SEDCON(16,38),
     1SIZE(38),SEDPAR(38,8),ZC(15),ZF(15),INT(16),HT(15),
     2WT(15),OBSED(15,38),ISR(38),HRR(38),HRC(38,38),IRC(38,38),Q(15),
     6G(15),SH(15),D(15,38,38),DS(38,38),TS(38,38),BM(38,38),
     4SP(38),VELPC(38,16),VEL(38,16) ,SET(38)
      COMMON TO,DE,SM,VK,CC,EF,XM,RHO,RO,KQ,NS,KUS,KR,NL,IT,NR,MS,T,
     1USTAR,IRR,ICR,IDR,SEDCON,SIZE,SEDPAR,ZF,ZC,NZ,NC,INT,HT,WT, SET,
     2OBSED,ISR,HRR,HRC,IRC,DS,TS,BM,D,Q,G,SH,SP,VEL,VELPC
C IF SIZE CLASSES LT 4-8 MICRONS IRE USED, THE CORRESPONDING OBSERVED
C VALUES RUST BE GIVEN EXPLICITLY.  THE ONLY PERRISSIBLE SIZE RANGES
C LESS THAN 4 MICRONS
C ARE 1-2 AND 2-4 MICRONS OR 2-4 MICRONS ONLY. ALL OTHER SIZE
C RANGES RUST HAVE BOUNDS EXACTLY DIVISIBLEBY4.
      LS=2
      IJ=3
      IF(MS.GE.3)GO TO 10
      DO 1 L=1,NZ
      IF(MS.EQ.2) GO TO 5
      PS(L,1)=OBSED(L,1)
      PS(L,2)=OBSED(L,2)
```

```
      LS=4
      GO TO 1
    5 PS(L,2)=OBSED(L,1)
  999 FORMAT(1X,F10.4,I3)
      LS=3
    1 CONTINUE
   10 CONTINUE
      NCI=NC+1
       DO 21 K=LS,NCI
      NI=(SIZE(K)-SIZE(K-1))/4
       IFINI.LE.1) GO TO 25
      DO 22 I=1,NI
      DO 11 L=1,NZ
      PS(L,IJ)=OBSED(L,K-1)/NI
   11 CONTINUE
      IJ=IJ+1
   22 CONTINUE
      60 TO 20
   25 CONTINUE
      DO 12 L=1,NZ
      PS(L,IJ)=OBSED(L,K-1)
   12 CONTINUE
      IJ=IJ+1
   20 CONTINUE
      DO 35 K=IJ,NS
      DO 35 L=1,NZ
      PS(L,K)=0.
   35 CONTINUE
      KQI=KQ+1
      READ(5,100) IHT
      DO 50 J=MS,NS
      DO 50 K=1,KQ
      SEDCON(K,J)=PS(IHT(K),J)
   50 CONTINUE
      DO 60 I=1,KQ
      WRITE(6,500) ZC(I),HT(IHT(I)),WT(IHT(I))
   60 CONTINUE
      WRITE(6,97)
   97 FORMAT(1H )
      WRITE (6,4) (ZC(L),L=1,KQ)
      DO 70 J=MS,NS
      WRITE(6,8) (SEDCON(I,J),I=1,KQ),J
      SEDPAR(J,8)=PS(IHT(KQI),J)
   70 CONTINUE
      WRITE(6,98) HT(IHT(KQI)),WT(IHT(KQI))
   98 FORMAT(1X," TOP BOUNDARY CUNC. EQUALS THAT OF OBSERVED VALUES AT",
     1F8.2," M WITH A UEIGHT OF ",F8.2," MG/L")
  100 FORMAT(20(1X,I2))
    4 FORMAT(1X,"OBSERVED SED. CONC. VALUES ARE ASSIGNED AS INITIAL",
     1" VALUES IN THE FOLLOUING WAY",/," SMALLEST SIZE CLASS IS THE ",
     2"FIRST ROW THE LOWEST ELEVATION IS THE FIRST COLUMN",
     3/,1X,15(F7.2,1X)," =HT",/,1X,120X,"SIZE")
  500 FORMAT(1X,"HT. =",F8.2," DATA FROM ",F8.2," M UT. IN MG/L =",
```

```
     1F6.3)
   8 FORMAT(1X,15(F7.2,1X),2X,I2)
     DO 600 M=1,NCI
     SIZE(M)=SIZE(M)/10000.
 600 CONTINUE
     RETURN
     END
     SUBROUTINE DIFADV
C
C
C VARIABLES IN DIFADV
C FLUX(I) SEDIMENT FLUX CALCULATED AT HEIGHT I
C
C
C CALCULATES VERTICAL TRANSPORT
     DIMENSION FLUX(20,38)
     DIMENSION USTAR(5),TPART(38),TMASS(38),SEDCON(16,38),
    1SIZE(38),SEDPAR(38,8),ZC(15),ZF(15),IHT(16),HT(15),
    2WT(15),OBSED(15,38),ISR(38),HRR(38),HRC(38,38),IRC(38,38),Q(15),
    6G(15),SH(15),D(15,38,38),DS(38,38),TS(38,38),BM(38,38),
    4SP(38),VELPC(38,16),VEL(38,16) ,SET(38)
     COMMON TO,DE,SM,VK,CC,EF,XM,RHO,RO,KQ,NS,KUS,KR,NL,IT,NR,MS,T,
    1USTAR,IRR,ICR,IDR,SEDCON,SIZE,SEDPAR,ZF,ZC,NZ,NC,IHT,HT,WT, SET,
    2OBSED,ISR,HRR,HRC,IRC,DS,TS,BM,D,Q,G,SH,SP,VEL,VELPC
     DO 1 L=MS,NS
     FLUX(KQ,L)=Q(KQ)*(SEDPAR(L,8)-SEDCON(KQ,L))/(2.*(ZF(KQ)-ZC(KQ)))+
    1SEDPAR(L,8)   *SET(L)
     KQL=KQ-1
     DO 2 I=1,KQL
     FLUX(I,L)=Q(I)*(SEDCON(I+1,L)-SEDCON(I,L))/(ZC(I+1)-ZC(I))+
    1SEDCON(I+1,L)*SET(L)
   2 CONTINUE
     SEDCON(1,L)=SEDCON(1,L)+T*FLUX(1,L)/(ZF(1)*.5)
     DO 3 K=2,KQ
     SEDCON(K,L)= SEDCON(K,L)+T*(FLUX(K,L)-FLUX(K-1,L))/( (ZF(K)-
    1ZF(K-1)))
     IF(SEDCON(K,L).LT.0.) IDR=1
   3 CONTINUE
   1 CONTINUE
     RETURN
     END
     SUBROUTINE COLLID
C CALCULATES CHANGES IN PARTICLE SIZE DUE TO COLLISION
     DIMENSION TX(38),TL(38) ,CH(16,38,38)
     DIMENSION USTAR(5),TPART(38),TMASS(38),SEDCON(16,38),
    1SIZE(38),SEDPAR(38,8),ZC(15),ZF(15),IHT(16),HT(15),
    2WT(15),OBSED(15,38),ISR(38),HRR(38),HRC(38,38),IRC(38,38),Q(15),
    6G(15),SH(15),D(15,38,38),DS(38,38),TS(38,38),BM(38,38),
    4SP(38),VELPC(38,16),VEL(38,16) ,SET(38)
     COMMON TO,DE,SM,VK,CC,EF,XM,RHO,RO,KQ,NS,KUS,KR,NL,IT,NR,MS,T,
    1USTAR,IRR,ICR,IDR,SEDCON,SIZE,SEDPAR,ZF,ZC,NZ,NC,IHT,HT,WT, SET,
    2OBSED,ISR,HRR,HRC,IRC,DS,TS,BM,D,Q,G,SH,SP,VEL,VELPC
     DO 1 J=MS,NS
```

```
      DO 1 K=MS,NS
      DO 11 I=1,KQ
      SC=SEDCON(I,J)*SEDCON(I,K)
      CH(I,J,K)=D(I,J,K)*T*SC*IT*EF
   11 CONTINUE
    1 CONTINUE
      DO 13 I=1,KQ
      DO 2 J=MS,NS
      TX(J)=Ø.
      TL(J)=Ø.
    2 CONTINUE
      DO 3 J=MS,NS
      DO 4 K=MS,J
      TN=1.
      IF(K.EQ.J) TN=Ø.5
      KRX=IRC(J,K)
      TX(KRX)=TX(KRX)+CH(I,J,K)*HRC(J,K)*TN
      TL(J)=TL(J)+CH(I,J,K)*TN
      TL(K)=TL(K)+CH(I,J,K)*TN
    4 CONTINUE
    3 CONTINUE
      DO 5 J=MS,NS
      SEDCON(I,J)=SEDCON(I,J)+TX(J)-TL(J)
    5 CONTINUE
   13 CONTINUE
      DO 8Ø I=1,KQ
      DO 8Ø L=MS,NS
      IF(SEDCON(I,L).LT.Ø.) ICR=1
   8Ø CONTINUE
      RETURN
      END
       SUBROUTINE RUPTUR
      DIMENSION USTAR(5),TPART(38),TMASS(38),SEDCON(16,38),
     1SIZE(38),SEDPAR(38,8),ZC(15),ZF(15),IHT(16),HT(15),
     2WT(15),OBSED(15,38),ISR(38),HRR(38),HRC(38,38),IRC(38,38),Q(15),
     6G(15),SH(15),D(15,38,38),DS(38,38),TS(38,38),BM(38,38),
     4SP(38),VELPC(38,16),VEL(38,16) ,SET(38)
      COMMON TO,DE,SM,VK,CC,EF,XM,RHO,RO,KQ,NS,KUS,KR,NL,IT,NR,MS,T,
     1USTAR,IRR,ICR,IDR,SEDCON,SIZE,SEDPAR,ZF,ZC,NZ,NC,INT,HT,WT, SET,
     2OBSED,ISR,HRR,HRC,IRC,DS,TS,BM,D,Q,G,SH,SP,VEL,VELPC
C CALCULATES CHANGES INSIZE DUE TO PARTICLE RUPTURE
      DIMENSION TX(38)
      DO 1 I=1,KQ
      DO 6 L=MS,NS
      TX(L)=Ø.
    6 CONTINUE
      DO 3 L=MS,NS
      IF(SEDPAR(L,5).GT.SH(I)) GO TO 3
      KRX=ISR(L)
      SEDCON(I,L)=Ø.
      TX(KRX)=TX(KRX)+SEDCON(I,L) *HRR(L)
    3 CONTINUE
      DO 8 L=MS,NS
```

```
      SEDCON(I,L)=SEDCON(I,L)+TX(L)
    G CONTINUE
    1 CONTINUE
      DO 2 I=1,KQ
      DO 2 L=MS,NS
      IF(SEDCON(I,L).LT.0.) IRR=1
    2 CONTINUE
      RETURN
      END
      SUBROUTINE SHSTR(J)
      DIMENSION USTAR(5),TPART(38),TMASS(38),SEDCON(16,38),
     1SIZE(38),SEDPAR(38,8),ZC(15),ZF(15),IHT(16),HT(15),
     2WT(15),OBSED(15,38),ISR(38),HRR(38),HRC(38,38),IRC(38,38),Q(15),
     6G(15),SH(15),D(15,38,38),DS(38,38),TS(38,38),BM(38,38),
     4SP(38),VELPC(38,16),VEL(38,16) ,SET(38)
      COMMON TO,DE,SM,VK,CC,EF,XM,RHO,RO,KQ,NS,KUS,KR,NL,IT,NR,MS,T,
     1USTAR,IRR,ICR,IDR,SEDCON,SIZE,SEDPAR,ZF,ZC,NZ,NC,IHT,HT,WT, SET,
     2OBSED,ISR,HRR,HRC,IRC,DS,TS,BM,D,Q,G,SH,SP,VEL,VELPC
      SEDPAR(J,5)=SEDPAR(J,4)**26.98*0.04*SM
      RETURN
      END
```

Appendix C--SAMPLE INPUT DECK

```
2
  30.00   45.00   0.01   0.40   1.11   0.50   5.01   2.65   0.75
     15      38      2     48     24     12      1      2
 .100 0.1500
  0.14  0.49  1.00  1.70  2.61  3.70  5.01  6.48  8.13  10.00
 12.05 14.25 16.65 20.00 25.01
  0.28  1.70  1.31  2.11  3.10  4.30  5.70  7.26  9.01  11.10
 13.10 15.40 17.91 22.11 27.91
1.00 0.80 0.70 0.60 0.50 0.40 0.30 0.20 0.10 0.10 0.10 0.10 0.00
0.00 a.00 0.00 0.00 0.00 0.00 0.00
0.00
ST.GHHDM  7 12
  2  4  8 12 16 20 24 28 32 40 48 56 64
 1.00   3.75
 2953.11 1344.00 668.00 338.00 167.00 94.01 58.00 38.00 21.01 6.00
   2.00    1.00
 2.60   3.25
 3081.00 1318.00 574.00 265.10 123.01 66.00 42.01 28.00 12.10 2.00
   1.00
 5.50   2.8
 2742.00 1003.00 401.00 182.00 88.01 53.01 36.01 25.01 8.10 1.00
0.000
 10.00  2.70
 2391.00 749.11 281.00 125.00 62.10 37.10 26.01 19.00 7.10 1.10
0.000
 Ib.65  2.50
 2441.10 847.00 298.00 119.01 55.00 33.01 25.01 19.00 5.00 1.00
  0.00
 25.00  1.30
 1532.00 427.11 167.00 78.00 41.00 26.00 19.01 15.00 3.00 1.01
  0.00
 45.00  1.00
 1869.00 590.00 226.01 96.01 44.10 25.00 18.00 14.00 5.00 1.01
  0.00
01 01 01 02 02 03 03 04 04 04 05 05 05 06 06 07
  30.00   25.00   0.01   0.40   0.01   0.50   5.00   2.65   0.75
     13      38      2     48     24     12      1      2
 .100 0.15
  0.14  0.49  1.00  1.70  2.60  3.70  5.00  6.48  8.13  10.01
 12.05 14.25 16.65 20.00 25.00
  0.28  5.70  1.30  2.11  3.10  4.30  5.70  7.26  9.10  11.01
 13.10 15.41 17.91 22.111 27.90
1.00 5.80 0.70 0.60 0.50 0.40 0.30 0.20 0.11 0.10 0.10 0.11 0.00
0.00 0.00 0.00 0.00 0.00 0.00 0.00
0.00
ST.GH23M6  12
  2  4  8 12 lb 20 24 28 32 40 48 56 64
 1.00  3.3
 2813.00 852.11 300.00 133.01 66.01 42.00 29.00 23.10 15.00 4.00
   2.00    1.00
 2.60   2.60
 2428.00 672.00 244.00 109.00 56.00 35.00 25.10 20.00 13.10 3.01
   1.00    1.00
```

5.00 1.85
1750.00 511.11 210.00 116.11 59.10 40.00 29.01 23.01 15.01 4.11

1.00

10.00 1.91.
589.00 201.00 117.11 63.11 38.10 24.01 16.00 12.01 7.01 2.00

1.00

16.65 1.35
660.00 229.11 133.00 82.00 49.10 31.10 19.00 13.00 7.00 3.00

1.00 1.11

25.11 0.95
842.00 292.11 161.11 97.11 58.00 37.81 25.00 19.01 7.01 3.11

1.01

01 01 01 02 12 03 03 04 14 I4 05 15 05 06 06 17

Appendix D--SAMPLE OUTPUT

The following output was generated by the input file listed in appendix C.

```
INPUT DATA   30.00     45.00      .01      .40      .01      .50     5.00     1.15      .75
INPUT DATA     15        38        2       48       24       12        1        2
SHEAR  VELOCITIES  =  .100  .150

CONC. LEVELS ARE(IN CM)
   14.00    49.00   100.00   170.00   260.00   370.00   500.00   648.00   813.00  1000.00
 1205.00  1425.00  1665.00  2000.00  2500.00
FLUX LEVELS ARE(IN CM)
   28.00    70.00   130.00   210.00   310.00   430.00   570.00   726.11   900.00  1100.00
 1310.00  1540.00  1790.00  2210.00  2790.00
```

PHYSICAL PARAMETERS OF EACH SIZE CLASS

MEAN RAD(CM)	MAX DIAM(CM)	=PRI PART(MEAN)	DENSITY(G/CC)	STRENGTH(D/CM2)	ST. VEL(CM/S)	PRI. PART(MAX)	SIZE
.750000E-04	.200000E-04	.100000E+01	.265000E+01	.105011E+09	.134745E-03	.145335E-01	1
.150000E-03	.400000E-03	.428709E+01	.188421E+01	.105942E+05	.288833E-03	.784394E+01	2
.300000E-03	.800000E-03	.183792E+02	.147384E+01	.140228E+02	.619126E-03	.336277E+02	3
.500000E-03	.120000E-02	.537290E+02	.129920E+01	.466731E+00	.108596E-02	.787932E+02	4
.700000E-03	.160000E-02	.108912E+03	.122103E+01	.874852E-01	.157237E-02	.144165E+03	5
.900000E-03	.200000E-02	.184621E+03	.117629E+01	.319529E-01	.207306E-02	.230341E+03	6
.110000E-02	.240000E-02	.281382E+03	.114716E+01	.162443E-01	.258510E-02	.337794E+03	7
.130000E-02	.280000E-02	.399625E+03	.112662E+01	.997651E-02	.310659E-02	.466918E+03	8
.150000E-02	.320000E-02	.539713E+03	.111132E+01	.689852E-02	.363619E-02	.618050E+03	9
.170000E-02	.360000E-02	.701963E+03	.109946E+01	.516474E-02	.417292E-02	.791407E+03	10
.190000E-02	.400000E-02	.886653E+03	.108998E+01	.408926E-02	.471601E-02	.987494E+03	11
.210000E-02	.440000E-02	.109404E+04	.108223E+01	.337307E-02	.526486E-02	.120631E+04	12
.230000E-02	.480000E-02	.132434E+04	.107577E+01	.286962E-02	.581898E-02	.144815E+04	13
.250000E-02	.520000E-02	.157778E+04	.107029E+01	.250040E-02	.637793E-02	.171323E+04	14
.270000E-02	.560000E-02	.185454E+04	.106559E+01	.222023E-02	.694138E-02	.200172E+04	15
.290000E-02	.600000E-02	.215480E+04	.106150E+01	.200166E-02	.750903E-02	.231380E+04	16
.310000E-02	.640000E-02	.247874E+04	.105792E+01	.182715E-02	.808060E-02	.264964E+04	17
.330000E-02	.680000E-02	.282651E+04	.105475E+01	.168509E-02	.865588E-02	.300938E+04	18
.350000E-02	.720000E-02	.319826E+04	.105193E+01	.156751E-02	.923466E-02	.339318E+04	19
.370000E-02	.760000E-02	.359414E+04	.104939E+01	.146880E-02	.981675E-02	.380117E+04	20
.390000E-02	.800000E-02	.401427E+04	.104711E+01	.138488E-02	.104020E-01	.423348E+04	21
.410000E-02	.840000E-02	.445879E+04	.104503E+01	.131278E-02	.109903E-01	.469024E+04	22
.430000E-02	.880000E-02	.492782E+04	.104314E+01	.125022E-02	.115814E-01	.517156E+04	23
.450000E-02	.920000E-02	.542148E+04	.104141E+01	.119547E-02	.121753E-01	.567757E+04	24
.470000E-02	.960000E-02	.593987E+04	.103982E+01	.114721E-02	.127718E-01	.620838E+04	25
.490000E-02	.100000E-01	.648311E+04	.103836E+01	.110436E-02	.133709E-01	.676407E+04	26
.510000E-02	.104000E-01	.705129E+04	.103700E+01	.106609E-02	.139725E-01	.734477E+04	27
.530000E-02	.108000E-01	.764453E+04	.103574E+01	.103171E-02	.145764E-01	.795057E+04	28
.550000E-02	.112000E-01	.826291E+04	.103457E+01	.100068E-02	.151826E-01	.858156E+04	29
.570000E-02	.116000E-01	.890653E+04	.103348E+01	.972524E-03	.157909E-01	.923783E+04	30
.590000E-02	.120000E-01	.957548E+04	.103245E+01	.946881E-03	.164015E-01	.991948E+04	31
.610000E-02	.124000E-01	.102698E+05	.103150E+01	.923429E-03	.170141E-01	.106266E+05	32
.630000E-02	.128000E-01	.109897E+05	.103059E+01	.901905E-03	.176287E-01	.113592E+05	33
.650000E-02	.132000E-01	.117352E+05	.102975E+01	.882083E-03	.182453E-01	.121175E+05	34
.670000E-02	.136000E-01	.125063E+05	.102894E+01	.863772E-03	.188638E-01	.129015E+05	35
.690000E-02	.140000E-01	.133031E+05	.102819E+01	.846808E-03	.194841E-01	.137113E+05	36
.710000E-02	.144000E-01	.141258E+05	.102747E+01	.831048E-03	.201062E-01	.145469E+05	37
.730000E-02	.148000E-01	.149744E+05	.102679E+01	.816371E-03	.207301E-01	.154084E+05	38

```
PCT OF MATERIAL WHICH HAVE STOKES VELOCITY IN EACH SIZE CLASS,SMALLEST FIRST
1.00  .80  .70  .60  .50  .40  .30  .20  .10  .10  .10  .10 0.00
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
AVERAGE FALL VELOCITY FOR EACH SIZE CLASS, SMALLEST FIRST
 .00028883  .00477494  .00862034  .01301755  .01786086  .02308019  .02862576  .03446303  .04059559  .04286228
 .04507364  .04694879  .05312594  .05470589  .05662377  .05872900  .06052989  .06192611  .06325723  .06485758
 .06668784  .06836915  .06968760  .07081282  .07205604  .07357712  .07520979  .07663727  .07775887  .07874954
 .07986295  .08122705  .08271267  .08403285  .08495291  .08518695  .08410542

1ST.GMHDM NUMBER OF OBS. HTS.= 7 NUMBER OF SIZES =12
 MIN AND MAX DIAM. OF SIZE CLASSES (MICRONS)
  2.  4.  8. 12. 16. 20. 24. 28. 32. 40. 48. 56. 64.
```

HEIGHT(M) = 1.00WEIGHT (MG/L) = 3.75
PART/CC PER SIZE CLASS-SMALLEST FIRST
2953. 1344. 668. 338. 167. 94. 58. 38. 21. 6. 2. 1.
HEIGHT(M) = 2.60WEIGHT (MG/L) = 3.25
PART/CC PER SIZE CLASS-SMALLEST FIRST
3081. 1318. 574. 265. 123. 66. 42. 28. 12. 2. 1. 0.
HEIGHT(M) = 5.00WEIGHT (MG/L) = 2.80
PART/CC PER SIZE CLASS-SMALLEST FIRST
2749. 1003. 401. 182. 88. 53. 36. 25. 8. 1. 0. 0.
HEIGHT(M) = 10.00WEIGHT (MG/L) = 2.70
PART/CC PER SIZE CLASS-SMALLEST FIRST
2391. 749. 281. 125. 62. 37. 26. 19. 7. 1. 0. 0.
HEIGHT(M) = 16.65WEIGHT (MG/L) = 2.50
PART/CC PER SIZE CLASS-SMALLEST FIRST
2441. 847. 298. 119. 55. 33. 25. 19. 5. 1. 0. 0.
HEIGHT(M) = 25.00WEIGHT (MG/L) = 1.30
PART/CC PER SIZE CLASS-SMALLEST FIRST
1532. 427. 167. 78. 41. 26. 19. 15. 3. 1. 0. 0.
HEIGHT(M) = 45.00WEIGHT (MG/L) = 1.00
PART/CC PER SIZE CLASS-SMALLEST FIRST
1869. 590. 226. 96. 44. 25. 18. 14. 5. 1. 0. 0.

HT. =14.00 DATA FROM 1.00 M WT. IN MG/L = 3.750
HT. =49.00 DATA FROM 1.00 M WT. IN MG/L = 3.750
HT. =100.00 DATA FROM 1.00 M WT. IN MG/L = 3.750
HT. =170.00 DATA FROM 2.60 M WT. IN MG/L = 3.250
HT. =260.00 DATA FROM 2.60 M WT. IN MG/L = 3.250
HT. =370.00 DATA FROM 5.00 M WT. IN MG/L = 2.800
HT. =500.00 DATA FROM 5.00 M WT. IN MG/L = 2.800
HT. =648.00 DATA FROM 10.00 M WT. IN MG/L = 2.700
HT. =813.00 DATA FROM 10.00 M WT. IN MG/L = 2.700
HT. =1000.00 DATA FROM 10.00 M WT. IN MG/L = 2.700
HT. =1205.00 DATA FROM 16.65 M WT. IN MG/L = 2.500
HT. =1425.00 DATA FROM 16.65 M WT. IN MG/L = 2.500
HT. =1665.00 DATA FROM 16.65 M WT. IN MG/L = 2.500
HT. =2000.00 DATA FROM 25.00 M WT. IN MG/L = 1.300
HT. =2500.00 DATA FROM 25.00 M WT. IN MG/L = 1.300

OBSERVED SED. CONC. VALUES ARE ASSIGNED AS INITIAL VALUES IN THE FOLLOWING WAY
SMALLEST SIZE CLASS IS THE FIRST ROW THE LOWEST ELEVATION IS THE FIRST COLUMN

14.00	49.00	100.00	170.00	260.00	370.00	500.00	648.00	813.00	1000.00	1205.00	1425.00	1665.00	2000.00	2500.00	=HT SIZE
		2953.00	3081.00												2
1344.00	1344.00	1344.00	1318.00	1318.00	1003.00	1003.00	2749.00	2749.00	2749.00	2847.00	2847.00	2847.00	1427.00	1427.00	3
668.00	668.00	668.00	574.00	574.00	401.00	401.00	281.00	281.00	281.00	298.00	298.00	298.00	167.00	167.00	4
338.00	338.00	338.00	265.00	265.00	182.00	182.00	125.00	125.00	125.00	119.00	119.00	119.00	78.00	78.00	5
167.00	167.00	167.00	123.00	123.00	88.00	88.00	62.00	62.00	62.00	55.00	55.00	55.00	41.00	41.00	6
94.00	94.00	94.00	66.00	66.00	53.00	53.00	37.00	37.00	37.00	33.00	33.00	33.00	26.00	26.00	7
58.00	58.00	58.00	42.00	42.00	36.00	36.00	26.00	26.00	26.00	25.00	25.00	25.00	19.00		8
38.00	38.00	38.00	28.00	28.00	25.00	25.00	19.00	19.00	19.00	19.00	19.00	19.00	15.00	15.00	9
10.50	10.50	10.50	6.00	6.00	4.00	4.00	3.50	3.50	3.50	2.50	2.50	2.50	1.50	1.50	10
10.50	10.50	10.50	6.00	6.00	4.00	4.00	3.50	3.50	3.50	2.50	2.50	2.50	1.50	1.50	11
3.00	3.00	3.00	1.00	1.00	.50	.50	.50	.50	.50	.50	.50	.50	.50	.50	12
3.00	3.00	3.00	1.00	1.00	.50	.50	.50	.50	.50	.50	.50	.50	.50	.50	13
1.00	1.00	1.00	.50	.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14
1.00	1.00	1.00	.50	.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15
.50	.50	.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16
.50	.50	.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	28
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	32
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	34
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	35
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	36
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	37
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	38

TOP BOUNDARY CONC. EQUALS THAT OF OBSERVED VALUES AT 45.00 M WITH A WEIGHT OF 1.00 MG/L

TIME STEP = 150.00 SECONDS

SHEAR VELOCITY = .1000 CM/S

HEIGHT(FLUX)	DIFFUSIVITY	HEIGHT(CON)	FLUID SHEAR	SHEAR STRESS
.28000000E+02	.11130311E+01	.14000000E+02	.10927907E+00	.10031818E-01
.70000000E+02	.27564444E+01	.49000000E+02	.58641328E-01	.53032739E-02
.13000000E+03	.50497778E+01	.10000000E+03	.41286141E-01	.37900678E-02
.21000000E+03	.80080000E+01	.17000000E+03	.31919952E-01	.29302515E-02
.31000000E+03	.11545778E+02	.26000000E+03	.26083209E-01	.23944386E-02
.43000000E+03	.15556444E+02	.37000000E+03	.22154132E-01	.20337493E-02
.57000000E+03	.19912000E+02	.50000000E+03	.19364917E-01	.17776994E-02
.72600000E+03	.24354880E+02	.64800000E+03	.17334048E-01	.15912656E-02
.90000000E+03	.28800000E+02	.81300000E+03	.15817899E-01	.14520031E-02
.11000000E+04	.33244444E+02	.10000000E+04	.14638501E-01	.13438144E-02
.13100000E+04	.37145778E+02	.12050000E+04	.13743881E-01	.12616883E-02
.15400000E+04	.40519111E+02	.14250000E+04	.13082798E-01	.12010009E-02
.17900000E+04	.43119111E+02	.16650000E+04	.12605120E-01	.11571500E-02
.22100000E+04	.44985778E+02	.20000000E+04	.12247449E-01	.11243158E-02
.27900000E+04	.42400000E+02	.25000000E+04	.12247449E-01	.11243158E-02

RESULTS AFTER 24 CYCLES

HEIGHT = 14.00 (CM) TOTAL PRIMARY PARTICLES = .193658E+06 TOTAL MASS = 4.060MG/L
HEIGHT = 49.00 (CM) TOTAL PRIMARY PARTICLES = .204026E+06 TOTAL MASS = 4.128MG/L
HEIGHT = 100.00 (CM) TOTAL PRIMARY PARTICLES = .186668E+06 TOTAL MASS = 3.595MG/L
HEIGHT = 170.00 (CM) TOTAL PRIMARY PARTICLES = .167223E+06 TOTAL MASS = 3.174MG/L
HEIGHT = 260.00 (CM) TOTAL PRIMARY PARTICLES = .152722E+06 TOTAL MASS = 2.864MG/L
HEIGHT = 370.00 (CM) TOTAL PRIMARY PARTICLES = .139138E+06 TOTAL MASS = 2.591MG/L
HEIGHT = 500.00 (CM) TOTAL PRIMARY PARTICLES = .127219E+06 TOTAL MASS = 2.357MG/L
HEIGHT = 648.00 (CM) TOTAL PRIMARY PARTICLES = .117254E+06 TOTAL MASS = 2.165MG/L
HEIGHT = 813.00 (CM) TOTAL PRIMARY PARTICLES = .109298E+06 TOTAL MASS = 2.013MG/L
HEIGHT = 1000.00 (CM) TOTAL PRIMARY PARTICLES = .102762E+06 TOTAL MASS = 1.888MG/L
HEIGHT = 1205.00 (CM) TOTAL PRIMARY PARTICLES = .970701E+05 TOTAL MASS = 1.782MG/L
HEIGHT = 1425.00 (CM) TOTAL PRIMARY PARTICLES = .914348E+05 TOTAL MASS = 1.678MG/L
HEIGHT = 1665.00 (CM) TOTAL PRIMARY PARTICLES = .853714E+05 TOTAL MASS = 1.569MG/L
HEIGHT = 2000.00 (CM) TOTAL PRIMARY PARTICLES = .778347E+05 TOTAL MASS = 1.435MG/L
HEIGHT = 2500.00 (CM) TOTAL PRIMARY PARTICLES = .724027E+05 TOTAL MASS = 1.339MG/L

PARTICLE CONCENTRATIONS FOR THE OBSERVED SIZES,SMALLEST FIRST

MIN DIAM=	.00020	.00040	.00080	.00120	.00160	.00200	.00240	.00280	.00320	.00400	.00480	.00560	.00640
HT= 14.00	2419.40	1233.43	657.28	348.73	207.23	174.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HT= 49.00	2541.14	1153.60	565.67	278.79	152.33	114.11	67.02	44.76	0.00	0.00	0.00	0.00	0.00
HT= 100.00	2575.65	1089.41	505.12	237.50	123.38	86.59	50.54	33.08	22.33	0.00	0.00	0.00	0.00
HT= 170.00	2577.30	1032.48	458.24	208.93	105.35	71.11	42.64	27.93	18.48	3.50	0.00	0.00	0.00
HT= 260.00	2553.03	975.68	417.29	186.39	92.49	61.10	37.80	25.04	16.22	4.29	.37	0.00	0.00
HT= 370.00	2507.86	917.50	379.60	167.06	82.30	53.80	34.19	23.03	14.37	3.83	.50	0.00	0.00
HT= 500.00	2450.12	861.34	345.64	150.25	73.84	48.07	31.27	21.47	12.75	3.37	.43	.04	0.00
HT= 648.00	2389.82	813.06	317.39	136.29	66.93	43.54	28.94	20.25	11.40	2.96	.36	.04	.00
HT= 813.00	2331.98	775.15	295.41	125.19	61.41	39.96	27.10	19.31	10.29	2.64	.31	.03	.00
HT= 1000.00	2271.95	744.33	278.07	116.26	56.90	37.05	25.58	18.53	9.33	2.38	.26	.02	.00
HT= 1205.00	2199.55	713.93	263.10	108.89	53.20	34.68	24.28	17.84	8.48	2.17	.23	.02	.00
HT= 1425.00	2102.49	675.03	247.27	102.08	49.95	32.59	23.06	17.14	7.69	2.00	.21	.02	.00
HT= 1665.00	1974.09	622.44	228.69	95.20	46.92	30.64	21.81	16.39	6.96	1.84	.19	.01	.00
HT= 2000.00	1790.36	546.37	204.21	87.13	43.55	28.41	20.30	15.45	6.23	1.69	.17	.01	.00
HT= 2500.00	1656.43	492.63	189.65	82.95	41.36	26.40	18.82	14.45	5.81	1.55	.13	.01	.00

RESULTS AFTER 48 CYCLES

HEIGHT = 14.00 (CM) TOTAL PRIMARY PARTICLES = .172110E+06 TOTAL MASS = 3.628MG/L
HEIGHT = 49.00 (CM) TOTAL PRIMARY PARTICLES = .181641E+06 TOTAL MASS = 3.608MG/L
HEIGHT = 100.00 (CM) TOTAL PRIMARY PARTICLES = .167523E+06 TOTAL MASS = 3.220MG/L
HEIGHT = 170.00 (CM) TOTAL PRIMARY PARTICLES = .152035E+06 TOTAL MASS = 2.867MG/L
HEIGHT = 260.00 (CM) TOTAL PRIMARY PARTICLES = .141862E+06 TOTAL MASS = 2.628MG/L
HEIGHT = 370.00 (CM) TOTAL PRIMARY PARTICLES = .131980E+06 TOTAL MASS = 2.420MG/L
HEIGHT = 500.00 (CM) TOTAL PRIMARY PARTICLES = .123224E+06 TOTAL MASS = 2.244MG/L
HEIGHT = 648.00 (CM) TOTAL PRIMARY PARTICLES = .115265E+06 TOTAL MASS = 2.092MG/L
HEIGHT = 813.00 (CM) TOTAL PRIMARY PARTICLES = .108158E+06 TOTAL MASS = 1.959MG/L
HEIGHT = 1000.00 (CM) TOTAL PRIMARY PARTICLES = .101601E+06 TOTAL MASS = 1.838MG/L
HEIGHT = 1205.00 (CM) TOTAL PRIMARY PARTICLES = .956552E+05 TOTAL MASS = 1.730MG/L
HEIGHT = 1425.00 (CM) TOTAL PRIMARY PARTICLES = .902863E+05 TOTAL MASS = 1.634MG/L
HEIGHT = 1665.00 (CM) TOTAL PRIMARY PARTICLES = .853902E+05 TOTAL MASS = 1.548MG/L
HEIGHT = 2000.00 (CM) TOTAL PRIMARY PARTICLES = .800697E+05 TOTAL MASS = 1.456MG/L
HEIGHT = 2500.00 (CM) TOTAL PRIMARY PARTICLES = .757410E+05 TOTAL MASS = 1.385MG/L

PARTICLE CONCENTRATIONS FOR THE OBSERVED SIZES, SMALLEST FIRST

MIN DIAM=	.00020	.00040	.00080	.00120	.00160	.00200	.00240	.00280	.00320	.00400	.00480	.00560	.00640
HT= 14.00	2119.33	1047.35	554.44	289.16	180.56	174.7'	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HT= 49.00	2223.27	976.32	475.27	229.49	131.83	114.51	62.13	41.22	0.00	0.00	0.00	8.8,	0.00
HT= 100.00	2257.61	922.46	424.94	195.30	106.34	86.17	46.86	30.44	22.71	0.00	,.00	0.00	0.00
HT= 170.00	2271.18	879.47	388.50	172.74	90.80	70.05	39.69	25.77	19.64	4.43	0.00	0.00	0.00
HT= 260.00	2270.31	842.09	359.48	156.23	81.28	59.83	35.41	23.25	17.99	5.92	.64	0.00	0.00
HT= 370.00	2256.78	817.36	334.68	143.08	72.46	52.73	32.37	21.55	16.57	5.6,	.96	0.00	0.00
HT= 500.00	2231.61	774.05	112.65	131.97	66.24	47.42	29.92	20.24	15.19	5.23	92	.13	0.00
HT= 648.00	2196.18	742.12	293.04	122.45	61.13	43.29	27.90	19.19	13.90	4.17	.84	.13	.01
HT= 813.00	2151.32	711.1,	275.44	114.17	16.83	39.94	26.22	18.32	12.71	4.3'	.76	.12	.01
HT= 1000.00	2095.39	679.54	259.03	106.74	53.06	37.18	24.73	17.5,	11.65	3.87	.67	.10	.01
HT= 1205.00	2029.22	647.33	243.97	100.25	49.83	34.65	23.41	16.83	10.69	3.48	.59	.09	.01
HT= 1425.00	1955.27	614.60	211.21	P4.67	17.1'	32.58	22.25	16.19	9.84	3.15	.52	.07	.01
HT= 1665.00	1876.16	581.66	217.70	89.97	44.80	30.76	21.18	15.58	9.07	2.85	.45	.06	.01
HT= 2000.00	1779.23	543.45	204.69	85.53	42.56	28.79	20.00	14.89	8.23	2.52	.38	.05	.00
HT= 2500.00	1712.02	520.44	199.24	84.45	41.33	26.82	18.76	14.18	7.23	2.07	.26	.03	.00

TIME STEP = 150.00 SECONDS

SHEAR VELOCITY = .1500 CM/S

HEIGHT(FLUX)	DIFFUSIVITY	HEIGHT(CON)	FLUID SHEAR	SHEAR STRESS
.28000000E+02	.16695467E+01	.14000000E+02	.20075847E+00	.10429627E-01
.70000000E+02	.41346667E+01	.49000000E+02	.10773100E+00	.90897056E-02
.13000000E+03	.75746667E+01	.10000000E+03	.75847485E-01	.69627991E-02
.21000000E+03	.12012000E+02	.17000000E+03	.58640695E-01	.53832150E-02
.31000000E+03	.17318667E+02	.26000000E+03	.47917916E-01	.43908646E-02
.43000000E+03	.23334667E+02	.37000000E+03	.40699740E-01	.37362361E-02
.57000000E+03	.29868000E+02	.50000000E+03	.35575624E-01	.32658423E-02
.72600000E+03	.36532320E+02	.64800000E+03	.31844679E-01	.29233415E-02
.90000000E+03	.43200000E+02	.81300000E+03	.29059335E-01	.26676470E-02
.11000000E+04	.49866667E+02	.10000000E+04	.26892644E-01	.24687447E-02
.13100000E+04	.55718667E+02	.12050000E+04	.25249122E-01	.23170694E-02
.15400000E+04	.60778667E+02	.14250000E+04	.24034635E-01	.22063795E-02
.17900000E+04	.64678667E+02	.16650000E+04	.23157084E-01	.21258203E-02
.22100000E+04	.67478667E+02	.20000000E+04	.22500000E-01	.20655000E-02
.27900000E+04	.63612000E+02	.25000000E+04	.22500000E-01	.20655000E-02

RESULTS AFTER 24 CYCLES
HEIGHT = 14.00 (CM) TOTAL PRIMARY PARTICLES = .100715E+06 TOTAL MASS = 1.989MG/L
HEIGHT = 49.00 (CM) TOTAL PRIMARY PARTICLES = .133453E+06 TOTAL MASS = 2.743MG/L
HEIGHT = 100.00 (CM) TOTAL PRIMARY PARTICLES = .115954E+06 TOTAL MASS = 2.352MG/L
HEIGHT = 170.00 (CM) TOTAL PRIMARY PARTICLES = .114908E+06 TOTAL MASS = 2.283MG/L
HEIGHT = 260.00 (CM) TOTAL PRIMARY PARTICLES = .112626E+06 TOTAL MASS = 2.175MG/L
HEIGHT = 370.00 (CM) TOTAL PRIMARY PARTICLES = .111670E+06 TOTAL MASS = 2.105MG/L
HEIGHT = 500.00 (CM) TOTAL PRIMARY PARTICLES = .109940E+06 TOTAL MASS = 2.036MG/L
HEIGHT = 648.00 (CM) TOTAL PRIMARY PARTICLES = .105042E+06 TOTAL MASS = 1.932MG/L
HEIGHT = 813.00 (CM) TOTAL PRIMARY PARTICLES = .102018E+06 TOTAL MASS = 1.860MG/L
HEIGHT = 1000.00 (CM) TOTAL PRIMARY PARTICLES = .981117E+05 TOTAL MASS = 1.772MG/L
HEIGHT = 1205.00 (CM) TOTAL PRIMARY PARTICLES = .936078E+05 TOTAL MASS = 1.687MG/L
HEIGHT = 1425.00 (CM) TOTAL PRIMARY PARTICLES = .898663E+05 TOTAL MASS = 1.613MG/L
HEIGHT = 1665.00 (CM) TOTAL PRIMARY PARTICLES = .860194E+05 TOTAL MASS = 1.545MG/L
"EIGHT = 2000.00 (CM) TOTAL PRIMARY PARTICLES = .817678E+05 TOTAL MASS = 1.474MG/L
HEIGHT = 2500.00 (CM) TOTAL PRIMARY PARTICLES = .778574E+05 TOTAL MASS = 1.415MG/L

PARTICLE CONCENTRATIONS FOR THE OBSERVED SIZES, SMALLEST FIRST

MIN DIAM=	.00020	.00040	.00080	.00120	.00160	.00200	.00240	.00280	.00320	.00400	.00480	.00560	.00640
HT= 14.00	1999.30	898.74	454.91	227.74	142.89	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
HT= 49.00	2029.71	837.89	397.39	186.51	109.30	90.87	54.90	0.00	0.00	0.00	0.10	0.00	0.00
HT= 100.00	2040.18	798.46	362.97	163.60	91.77	74.20	11.52	0.00	0.00	0.00	0.10	0.10	0.10
HT= 170.00	2043.63	767.11	337.2,	117.61	81.22	64.19	37.46	18.55	0.00	0.00	0.00	0.00	0.00
HT= 260.00	2041.21	73P.84	316.12	135.39	71.87	57.12	13.66	18.76	8.02	0.00	0.01	0.01	0.00
HT= 370.00	2032.30	714.64	297.91	125.48	65.46	51.52	30.91	18.8,	14.22	0.00	0.00	0.00	0.00
HT= 500.00	2016.31	690.36	281.61	117.13	61.31	46.83	28.69	18.51	14.56	3.28	0.00	0.00	0.00
HT= 648.00	1993.29	666.7,	266.93	110.00	56.12	42.92	26.84	17.96	14.39	3.48	0.10	0.10	0.10
HT= 813.00	1963.80	643.65	253.62	113.84	52.64	39.68	25.29	17.31	13.84	4.89	0.00	0.01	0.10
HT= 1000.00	1927.66	620.34	241.21	98.38	49.64	36.91	23.92	16.64	13.07	4.83	.52	0.00	0.00
HT= 1205.00	1887.06	597.80	230.13	93.71	47.13	31.19	22.73	16.03	12.22	4.59	.54	0.00	0.00
HT=							21.70	15.49	11.37	4.25	.76	0.10	0.10
HT= 1665.00	1845.07 1804.45	576.93 558.45	220.62 212.83	89.96 87.07	45.08 43.45	32.65 30.97	20.79	15.01	11.53	3.85	.71	0.00	0.00
HT= 2000.00	1760.64	540.26	205.86	84.80	41.98	29.13	19.79	14.50	9.48	3.11	.60	0.01	0.00
HT= 2511.1,	1744.77	536.19	205.39	85.63	II.46	27.15	18.74	14.02	7.96	2.49	.38	0.00	0.00

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RESULTS AFTER    48 CYCLES
HEIGHT =    14.00 (CM)  TOTAL PRIMARY PARTICLES = .912136E+05 TOTAL MASS = 1.798MG/L
HEIGHT =    49.00 (CM)  TOTAL PRIMARY PARTICLES = .119742E+06 TOTAL MASS = 2.455MG/L
HEIGHT =   100.00 (CM)  TOTAL PRIMARY PARTICLES = .104293E+06 TOTAL MASS = 2.111MG/L
HEIGHT =   170.00 (CM)  TOTAL PRIMARY PARTICLES = .102827E+06 TOTAL MASS = 2.043MG/L
HEIGHT =   260.00 (CM)  TOTAL PRIMARY PARTICLES = .101237E+06 TOTAL MASS = 1.959MG/L
HEIGHT =   370.00 (CM)  TOTAL PRIMARY PARTICLES = .101220E+06 TOTAL MASS = 1.912MG/L
HEIGHT =   500.00 (CM)  TOTAL PRIMARY PARTICLES = .100951E+06 TOTAL MASS = 1.873MG/L
HEIGHT =   648.00 (CM)  TOTAL PRIMARY PARTICLES = .978156E+05 TOTAL MASS = 1.800MG/L
HEIGHT =   813.00 (CM)  TOTAL PRIMARY PARTICLES = .964456E+05 TOTAL MASS = 1.757MG/L
HEIGHT =  1000.00 (CM)  TOTAL PRIMARY PARTICLES = .941912E+05 TOTAL MASS = 1.696MG/L
HEIGHT =  1205.00 (CM)  TOTAL PRIMARY PARTICLES = .910682E+05 TOTAL MASS = 1.634MG/L
HEIGHT =  1425.00 (CM)  TOTAL PRIMARY PARTICLES = .885408E+05 TOTAL MASS = 1.579MG/L
HEIGHT =  1665.00 (CM)  TOTAL PRIMARY PARTICLES = .855896E+05 TOTAL MASS = 1.527MG/L
HEIGHT =  2000.00 (CM)  TOTAL PRIMARY PARTICLES = .821385E+05 TOTAL MASS = 1.471MG/L
HEIGHT =  2500.00 (CM)  TOTAL PRIMARY PARTICLES = .785376E+05 TOTAL MASS = 1.421MG/L
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PARTICLE CONCENTRATIONS FOR THE OBSERVED SIZES,SMALLEST FIRST

HT=IN D	14.00	1863.62	813.95	410.35	240.12	180.40	.00200	.00240	.00280	.00320	.00400	.00480	.00560	.00640
							0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HT=	49.00	1884.16	755.85	356.94	165.45	99.15	77.68	51.18		0.00	0.00	0.00	0.00	0.00
HT=	100.00	1887.99	719.25	325.89	145.11	83.14	64.25	40.66	0.00	0.00	0.00	0.00	0.00	0.00
HT=	170.00	1885.77	690.81	313.24	131.04	72.75	56.72	35.20	14.87	0.00	0.00	0.00	0.00	0.00
HT=	260.00	1879.31	666.81	285.22	120.61	65.36	51.6,	31.84	15.47	1.12	0.00	0.01	8.1,	0.00
HT=	370.00	1869.01	645.43	270.11	112.19	59.78	47.69	29.4,	15.99	II.13	0.00	0.00	0.00	0.00
HT=	500.00	1855.04	625.68	256.96	1'5.64	55.40	44.25	27.44	16.22	13.34	3.08	0.00	0.00	0.00
HT=											3.43	0.00	0.00	0.00
HT= .	648.00 813.00	1837.92 1818.28	687.32 590.15	245.44 235.27	100.04 95.34	51.88 49.12	41.23 38.59	25.79 21.39	16.17 15.94	13.70 13.66	5.02	0.00	0.00	0.00
HT=	1000.00	1796.29	573.76	226.1'	91.31	46.61	36.23	21.15	15.60	11.11	5.19	.57	0.00	0.00
HT=	1205.00	1773.70	558.95	218.25	88.05	44.65	34.18	22.09	15.21	12.15	5.14	.62	0.00	0.00
HT=	1425.00	1752.48	546.31	211.88	85.58	43.13	32.42	21.18	14.84	12.15	4.90	.92	0.00	0.00
HT=	1665.00	1734.61	536.41	207.10	83.91	41.99	30.87	20.38	14.50	11.26	4.52	.89	0.00	0.00
HT=	2000.00	1720.39	518.85	211.56	83.1,	41.08	29.16	19.52	14.14	10.14	3.91	.77	0.00	0.00
HT=	2500.00	1735.98	535.15	205.92	85.21	41.13	27.25	18.63	13.85	8.17	2.84	.49	0.00	0.00

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INPUT DATA   30.00   25.00   .01   .40   .01   .50   5.00   2.61   .75
INPUT DATA   13   38   2   48   24   12   ,   2
SHEAR VELOCITIES =.100   .150
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CONC. LEVELS ARE (IN CM)
14.00 49.00 100.00 170.00 260.00 370.00 500.00 648.00 813.00 1000.00
1205.00 1425.00 1665.00
FLUX LEVELS ARE (IN CM)
28.00 70.00 130.00 210.00 310.00 430.00 570.00 726.00 900.00 1100.00
1310.00 1540.00 1790.00

PHYSICAL PARAMETERS OF EACH SIZE CLASS

MEAN RAD(CM)	MAX DIAM(CM)	*PRI PART(MEAN)	DENSITY(G/CC)	STRENGTH(D/CM2)	ST. VEL(CM/S)	PRI. PART(MAX)	SIZE
.750000E-04	.200000E-04	.100000E+01	.265000E+01	.105011E+09	.134745E-03	.145335E-01	1
.150000E-03	.400000E-03	.428709E+01	.188421E+01	.105942E+05	.288833E-03	.784394E+01	2
.300000E-03	.800000E-03	.183792E+02	.147384E+01	.140228E+02	.619126E-03	.336277E+02	3
.500000E-03	.120000E-02	.537290E+02	.129920E+01	.466731E+00	.108596E-02	.787932E+02	4
.700000E-03	.160000E-02	.108912E+03	.122103E+01	.874852E-01	.157237E-02	.144145E+03	5
.900000E-03	.200000E-02	.184621E+03	.117629E+01	.319529E-01	.207306E-02	.230341E+03	6
.110000E-02	.240000E-02	.281382E+03	.114716E+01	.162443E-01	.258510E-02	.337794E+03	7
.130000E-02	.280000E-02	.399625E+03	.112662E+01	.997651E-02	.310659E-02	.466918E+03	8
.150000E-02	.320000E-02	.539713E+03	.111132E+01	.689852E-02	.363619E-02	.618050E+03	9
.170000E-02	.360000E-02	.701963E+03	.109946E+01	.516474E-02	.417292E-02	.791407E+03	10
.190000E-02	.400000E-02	.886653E+03	.108998E+01	.408926E-02	.471601E-02	.987494E+03	11
.210000E-02	.440000E-02	.109404E+04	.108223E+01	.337307E-02	.526486E-02	.120631E+04	12
.230000E-02	.480000E-02	.132434E+04	.107577E+01	.286962E-02	.581898E-02	.144015E+04	13
.250000E-02	.520000E-02	.157778E+04	.107029E+01	.250040E-02	.637793E-02	.171123E+04	14
.270000E-02	.560000E-02	.185454E+04	.106559E+01	.222023E-02	.694138E-02	.200172E+04	15
.290000E-02	.600000E-02	.215480E+04	.106150E+01	.200166E-02	.750903E-02	.231380E+04	16
.310000E-02	.640000E-02	.247874E+04	.105792E+01	.182715E-02	.808060E-02	.264964E+04	17
.330000E-02	.680000E-02	.282651E+04	.105475E+01	.168509E-02	.865588E-02	.300938E+04	18
.350000E-02	.720000E-02	.319826E+04	.105193E+01	.156751E-02	.923466E-02	.339318E+04	19
.370000E-02	.760000E-02	.359414E+04	.104939E+01	.146880E-02	.981675E-02	.380117E+04	20
.390000E-02	.800000E-02	.401427E+04	.104711E+01	.138488E-02	.104020E-01	.423348E+04	21
.410000E-02	.840000E-02	.445879E+04	.104503E+01	.131278E-02	.109903E-01	.469024E+04	22
.430000E-02	.880000E-02	.492782E+04	.104314E+01	.125022E-02	.115814E-01	.517156E+04	23
.450000E-02	.920000E-02	.542148E+04	.104141E+01	.119547E-02	.121753E-01	.567757E+04	24
.470000E-02	.960000E-02	.593987E+04	.103982E+01	.114721E-02	.127718E-01	.620838E+04	25
.490000E-02	.100000E-01	.648311E+04	.103836E+01	.110436E-02	.133709E-01	.676407E+04	26
.510000E-02	.104000E-01	.705129E+04	.103700E+01	.106609E-02	.139725E-01	.734477E+04	27
.530000E-02	.108000E-01	.764453E+04	.103574E+01	.103171E-02	.145764E-01	.795057E+04	28
.550000E-02	.112000E-01	.826291E+04	.103457E+01	.100068E-02	.151826E-01	.858156E+04	29
.570000E-02	.116000E-01	.890653E+04	.103348E+01	.972524E-03	.157909E-01	.923783E+04	30
.590000E-02	.120000E-01	.957548E+04	.103245E+01	.946881E-03	.164015E-01	.991948E+04	31
.610000E-02	.124000E-01	.102698E+05	.103150E+01	.923429E-03	.170141E-01	.106266E+05	32
.630000E-02	.128000E-01	.109897E+05	.103059E+01	.901905E-03	.176287E-01	.113592E+05	33
.650000E-02	.132000E-01	.117352E+05	.102975E+01	.882083E-03	.182453E-01	.121175E+05	34
.670000E-02	.136000E-01	.125063E+05	.102894E+01	.863772E-03	.188638E-01	.129015E+05	35
.690000E-02	.140000E-01	.133031E+05	.102819E+01	.846808E-03	.194841E-01	.137113E+05	36
.710000E-02	.144000E-01	.141258E+05	.102747E+01	.831048E-03	.201062E-01	.145469E+05	37
.730000E-02	.148000E-01	.149744E+05	.102679E+01	.816371E-03	.207301E-01	.154084E+05	38

PCT OF MATERIAL WHICH HAVE STOKES VELOCITY IN EACH SIZE CLASS,SMALLEST FIRST
1.00 .80 .70 .60 .50 .40 .30 .20 .10 .10 .10 .10 0.00
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
AVERAGE FALL VELOCITY FOR EACH SIZE CLASS, SMALLEST FIRST
.00028883 .00477494 .00862034 .01301755 .01786086 .02308019 .02862576 .03446303 .04059559 .04284228
.04507364 .04694879 .05312594 .05470589 .05662377 .05872900 .06052989 .06192611 .06325723 .06485758
.06668784 .06836915 .06968760 .07081282 .07205604 .07357712 .07520979 .07663727 .07775887 .07874954
.07986295 .08122705 .08271267 .08403285 .08495291 .08518695 .08410542

1ST.GH23M NUMBER OF OBS. HTS.= 6 NUMBER OF SIZES =12
MIN AND MAX DIAM. OF SIZE CLASSES (MICRONS)
2. 4. 8. 12. 16. 20. 24. 28. 32. 40. 48. 56. 64.

HEIGHT(M) = 1.00WEIGHT (MG/L) = 3.30
PART/CC PER SIZE CLASS-SMALLEST FIRST
2813. 852. 300. 133. 66. 42. 29. 23. 15. 4. 2. 1.
HEIGHT(M) = 2.60WEIGHT (MG/L) = 2.60
PART/CC PER SIZE CLASS-SMALLEST FIRST
2428. 672. 244. 109. 56. 35. 25. 20. 13. 3. 1. 1.
HEIGHT(M) = 5.00WEIGHT (MG/L) = 1.85

PART/CC PER 501. SIZE CLASS-SMALLEST 210. 106. FIRST 59. 4,. 29. 23. 15. 4. 1. 0.
HEIGHT(M) = 10.00WEIGHT (MG/L) = .90
PART/CC PER SIZE CLASS-SMALLEST FIRST
589. 201. 107. 63. 38. 24. 16. 12. 7. 2. 1. 0.
HEIGHT(M) = 16.65WEIGHT (MG/L) = .35
PART/CC PER SIZE CLASS-SMALLEST FIRST
660. 229. 133. 82. 49. 31. 19. 13. 7. 3. 1. 1.
HEIGHT(M) = 25.00WEIGHT (MG/L) = .95
PART/CC PER SIZE CLASS-SMALLEST FIRST
842. 292. 161. 97. 58. 37. 25. 19. 7. 3. 1. 0.

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HT. =   14.00 DATA FROM     1.00 M  WT. IN MG/L = 3.300
HT. =   49.00 DATA FROM     1.00 M  WT. IN MG/L = 3.300
HT. =  100.00 DATA FROM     1.00 M  WT. IN MG/L = 3.300
HT. =  170.00 DATA FROM     2.60 M  WT. IN MG/L = 2.600
HT. =  260.00 DATA FROM     2.60 M  WT. IN MG/L = 2.600
HT. =  370.00 DATA FROM     5.00 M  WT. IN MG/L = 1.850
HT. =  500.00 DATA FROM     5.00 M  WT. IN MG/L = 1.850
HT. =  648.00 DATA FROM    10.00 M  WT. IN MG/L =  .900
HT. =  813.00 DATA FROM    10.00 M  WT. IN MG/L =  .900
HT. = 1000.00 DATA FROM    10.00 M  WT. IN MG/L =  .900
HT. = 1205.00 DATA FROM    16.65 M  WT. IN MG/L =  .350
HT. = 1425.00 DATA FROM    16.65 M  WT. IN MG/L =  .350
HT. = 1665.00 DATA FROM    16.65 M  WT. IN MG/L =  .350
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OBSERVED SED. CONC. VALUES ARE ASSIGNED AS INITIAL VALUES IN THE FOLLOWING WAY
SMALLEST SIZE CLASS IS THE FIRST ROW THE LOWEST ELEVATION IS THE FIRST COLUMN

14.00	49.00	100.00	170.00	260.00	370.00	500.00	648.00	813.00	1000.00	1205.00	1425.00	1665.00	
2813.00	2813.00	2813.00	2428.00	2428.00	1750.00	1750.00	589.00	589.00	589.00	660.00	660.00	660.00	0.00
852.00	852.00	852.00	672.00	672.00	501.00	501.00	201.00	201.00	201.00	229.00	229.00	229.00	0.00
300.00	300.00	300.00	244.00	244.00	210.00	210.00	107.00	107.00	107.00	133.00	133.00	133.00	0.00
133.00	133.00	133.00	109.00	109.00	106.00	106.00	63.00	63.00	63.00	82.00	82.00	82.00	0.00
66.00	66.00	66.11	56.00	56.00	59.00	59.00	38.00	38.00	38.00	49.00	49.00	49.00	0.00
42.00	42.00	42.00	35.00	35.00	40.00	40.00	24.00	24.00	24.00	31.00	31.00	31.00	0.00
29.00	29.00	29.00	25.00	25.00	29.00	29.00	16.1,	16.00	16.00	19.00	19.00	19.00	0.00
23.00	23.00	23.00	20.00	20.00	23.00	23.11	12.00	12.00	12.00	13.1,	13.00	13.00	0.00
7.5,	7.50	7.5,	6.50	6.50	7.50	7.50	3.5,	3.50	3.50	3.50	3.51	3.50	0.00
7.51	7.50	7.50	6.50	6.50	7.51	7.50	3.5,	3.50	3.50	3.50	3.50	3.5,	0.00
2.00	2.00	2.00	1.50	1.50	2.1'	2.00	1.00	1.00	1.00	1.50	1.50	1.50	0.00
2.00	2.1,	2.00	1.50	1.50	2.00	2.00	1.00	1.00	1.00	1.50	1.50	1 .50	0.00
1.00	1.00	1.00	.50	.50	.50	.50	.50	.50	.50	.50	.50	.50	0.00
1.00	1.00	1.00	.50	.50	.50	.50	.50	.50	.50	.50	.50	.50	0.00
.50	.50	.50	.50	.50	0.00	0.00	0.00	0.00	0.00	.50	.50	.50	0.00
.50	.50	.50	.50	.50	0.00	0.00	0.00	0.00	0.00	.50	.50	.50	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.8,	0.00
,.'I	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	1.1,	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.8'
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	1.1'	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TOP BOUNDARY CONC. EQUALS THAT OF OBSERVED VALUES AT 25.00 M WITH A WEIGHT OF .95 MG/L

TIME STEP = 150.00 SECONDS

SHEAR VELOCITY = .1000 CM/S

HEIGHT(FLUX)	DIFFUSIVITY	HEIGHT(CON)	FLUID SHEAR	SHEAR STRESS
.28000000E+02	.11074560E+01	.14000000E+02	.10941574E+00	.10044365E-01
.70000000E+02	.27216000E+01	.49000000E+02	.58901273E-01	.54071369E-02
.13000000E+03	.49296000E+01	.10000000E+03	.41666667E-01	.38250000E-02
.21000000E+03	.76944000E+01	.17000000E+03	.32433361E-01	.29773026E-02
.31000000E+03	.10862400E+02	.26000000E+03	.26747531E-01	.24554233E-02
.43000000E+03	.14241600E+02	.37000000E+03	.22993428E-01	.21107967E-02
.57000000E+03	.17601600E+02	.50000000E+03	.20412415E-01	.18738597E-02
.72600000E+03	.20606784E+02	.64800000E+03	.18633155E-01	.17105236E-02
.90000000E+03	.23040000E+02	.81300000E+03	.17429766E-01	.16000525E-02
.11000000E+04	.24640000E+02	.10000000E+04	.16666667E-01	.15300000E-02
.13100000E+04	.24942400E+02	.12050000E+04	.16340524E-01	.15006601E-02
.15400000E+04	.23654400E+02	.14250000E+04	.16492357E-01	.15139983E-02
.17900000E+04	.20334400E+02	.16650000E+04	.17311872E-01	.15892298E-02

RESULTS AFTER 24 CYCLES

HEIGHT = 14.00 (CM) TOTAL PRIMARY PARTICLES = .107303E+06 TOTAL MASS = 2.104MG/L
HEIGHT = 49.00 (CM) TOTAL PRIMARY PARTICLES = .114790E+06 TOTAL MASS = 2.252MG/L
HEIGHT = 100.00 (CM) TOTAL PRIMARY PARTICLES = .107862E+06 TOTAL MASS = 2.003MG/L
HEIGHT = 170.00 (CM) TOTAL PRIMARY PARTICLES = .987402E+05 TOTAL MASS = 1.811MG/L
HEIGHT = 260.00 (CM) TOTAL PRIMARY PARTICLES = .931529E+05 TOTAL MASS = 1.685MG/L
HEIGHT = 370.00 (CM) TOTAL PRIMARY PARTICLES = .863654E+05 TOTAL MASS = 1.553MG/L
HEIGHT = 500.00 (CM) TOTAL PRIMARY PARTICLES = .794270E+05 TOTAL MASS = 1.429MG/L
HEIGHT = 648.00 (CM) TOTAL PRIMARY PARTICLES = .734158E+05 TOTAL MASS = 1.324MG/L
HEIGHT = 813.00 (CM) TOTAL PRIMARY PARTICLES = .691255E+05 TOTAL MASS = 1.251MG/L
HEIGHT = 1000.00 (CM) TOTAL PRIMARY PARTICLES = .670954E+05 TOTAL MASS = 1.219MG/L
HEIGHT = 1205.00 (CM) TOTAL PRIMARY PARTICLES = .675418E+05 TOTAL MASS = 1.235MG/L
HEIGHT = 1425.00 (CM) TOTAL PRIMARY PARTICLES = .700155E+05 TOTAL MASS = 1.292MG/L
HEIGHT = 1665.00 (CM) TOTALPRIMARY PARTICLES = .742677E+05 TOTAL MASS = 1.389MG/L

PARTICLE CONCENTRATIONS FOR THE OBSERVED SIZES,SMALLEST FIRST

MIN DIAM=	.00020	.00040	.00080	.00120	.00160	.00200	.00240	.00280	.00320	.00400	.00480	.00560	.00640
HT= 14.00	2204.71	785.89	338.62	177.05	109.47	91.69	0.00	0.00	0.00	0.00	0.00	0.01	0.00
HT= 49.00	2225.25	705.35	280.41	135.37	76.99	58.46	37.97	30.83	0.00	0.00	0.00	0.01	0.00
HT= 100.00	2144.09	639.70	246.18	114.89	62.86	45.24	29.48	23.05	15.98	0.00	0.00	0.00	0.00
HT= 170.00	1998.84	576.16	220.67	102.40	55.36	38.71	25.86	19.83	14.32	2.85	0.00	0.01	0.00
HT= 260.00	1799.55	510.36	198.63	93.50	50.81	34.99	23.79	18.03	13.33	4.36	.67	0.01	0.00
HT= 370.00	1560.83	442.21	177.93	86.20	47.55	32.44	22.16	16.63	12.30	4.24	1.24	0.00	0.00
HT= 500.00	1305.45	375.00	158.49	79.89	44.98	30.46	20.70	15.37	11.18	4.01	1.28	.23	0.00
HT= 648.00	1066.79	315.27	141.85	74.88	43.09	28.98	19.48	14.28	10.14	3.76	1.28	.44	0.00
HT= 813.00	873.26	268.73	129.74	71.76	42.11	28.15	18.68	13.50	9.31	3.58	1.27	.52	.08
HT= 1000.00	739.21	238.18	123.20	70.97	42.25	28.14	18.43	13.17	8.76	3.52	1.26	.59	.13
HT= 1205.00	675.97	225.97	122.93	72.74	43.64	29.01	18.88	13.43	8.53	3.55	1.27	.61	.14
HT= 1425.00	671.44	229.37	127.94	76.69	46.14	30.65	20.04	14.36	8.50	3.61	1.27	.54	.12
HT= 1665.00	718.69	247.79	138.37	83.10	49.97	33.07	21.97	16.08	8.52	3.60	1.24	.37	.06

RESULTS AFTER 48 CYCLES

HEIGHT = 14.00 (CM) TOTAL PRIMARY PARTICLES = .103696E+06 TOTAL MASS = 2.158MG/L
HEIGHT = 49.00 (CM) TOTAL PRIMARY PARTICLES = .108372E+06 TOTAL MASS = 2.166MG/L
HEIGHT = 100.00 (CM) TOTAL PRIMARY PARTICLES = .997742E+05 TOTAL MASS = 1.885MG/L
HEIGHT = 170.00 (CM) TOTAL PRIMARY PARTICLES = .909870E+05 TOTAL MASS = 1.680MG/L
HEIGHT = 260.00 (CM) TOTAL PRIMARY PARTICLES = .865227E+05 TOTAL MASS = 1.572MG/L
HEIGHT = 370.00 (CM) TOTAL PRIMARY PARTICLES = .818939E+05 TOTAL MASS = 1.460MG/L
HEIGHT = 500.00 (CM) TOTAL PRIMARY PARTICLES = .779183E+05 TOTAL MASS = 1.387MG/L
HEIGHT = 648.00 (CM) TOTAL PRIMARY PARTICLES = .747449E+05 TOTAL MASS = 1.327MG/L
HEIGHT = 813.00 (CM) TOTAL PRIMARY PARTICLES = .724770E+05 TOTAL MASS = 1.287MG/L
HEIGHT = 1000.00 (CM) TOTAL PRIMARY PARTICLES =.712590E+05 TOTAL MASS = 1.271MG/L
HEIGHT = 1205.00 (CM) TOTAL PRIMARY PARTICLES =.712562E+05 TOTAL MASS = 1.284MG/L
HEIGHT = 1425.00 (CM) TOTAL PRIMARY PARTICLES =.726867E+05 TOTAL MASS = 1.327MG/L
HEIGHT = 1665.00 (CM) TOTAL PRIMARY PARTICLES =.756610E+05 TOTAL MASS = 1.408MG/L

PARTICLE CONCENTRATIONS FOR THE OBSERVED SIZES,SMALLEST FIRST

MIN DIAM=	.00020	.00040	.00080	.00120	.00160	.00200	.00240	.00280	.00320	.00400	.00480	.00560	.00640
HT= 14.00	1770.29	652.53	303.83	167.70	111.40	102.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HT= 49.00	1789.19	585.43	250.65	127.30	77.54	64.84	36.67	28.53	0.00	0.00	0.00	0.00	0.00
HT= 100.00	1736.90	533.15	219.19	106.81	61.99	48.65	28.05	21.03	14.50	0.00	0.00	0.00	0.00
HT= 170.00	1643.98	485.27	196.30	94.13	53.31	40.07	24.30	17.90	13.18	3.06	0.01	0.00	0.00
HT= 260.00	1519.66	438.80	177.95	85.56	48.07	35.11	22.28	16.25	12.58	4.70	.76	0.00	0.00
HT= 370.00	1373.59	393.35	162.46	79.43	44.77	32.09	20.93	15.17	12.01	4.80	1.43	0.00	0.00
HT= 500.00	1217.19	349.96	149.26	74.98	42.68	30.21	19.98	14.40	11.42	4.78	1.53	.32	0.00
HT= 648.00	1065.45	311.09	138.55	71.96	41.51	29.13	19.36	13.89	10.86	4.68	1.50	.57	0.00
HT= 813.00	930.77	278.77	130.61	70.28	41.12	28.68	19.09	13.67	10.39	4.56	1.59	.61	.12
HT= 1000.00	820.66	254.30	125.76	70.05	41.51	28.81	19.21	13.76	10.03	4.45	1.57	.61	.19
HT= 1205.00	749.42	240.89	124.97	71.63	42.86	29.59	19.78	14.25	9.77	4.33	1.54	.56	.17
HT= 1425.00	722.32	239.86	128.82	75.38	45.35	31.03	20.85	15.19	9.50	4.18	1.47	.47	.14
HT= 1665.00	744.80	253.32	138.58	82.17	49.46	33.28	22.49	16.62	9.09	3.90	1.35	.31	.05

TIME STEP = 150.00 SECONDS

SHEAR VELOCITY = .1500 CM/S

HEIGHT(FLUX)	DIFFUSIVITY	HEIGHT(CON)	FLUID SHEAR	SHEAR STRESS
.28000000E+02	.16611840E+01	.14000000E+02	.20100955E+00	.18452677E-01
.70000000E+02	.40824000E+01	.49000000E+02	.10820855E+00	.99335448E-02
.13000000E+03	.73944000E+01	.10000000E+03	.76546554E-01	.70269737E-02
.21000000E+03	.11541600E+02	.17000000E+03	.59583889E-01	.54698010E-02
.31000000E+03	.16293600E+02	.26000000E+03	.49138352E-01	.45109007E-02
.43000000E+03	.21362400E+02	.37000000E+03	.42241624E-01	.38777811E-02
.57000000E+03	.26402400E+02	.50000000E+03	.37500000E-01	.34425000E-02
.72600000E+03	.30910176E+02	.64800000E+03	.34231291E-01	.31424325E-02
.90000000E+03	.34560000E+02	.81300000E+03	.32020525E-01	.29394842E-02
.11000000E+04	.36960000E+02	.10000000E+04	.30618622E-01	.28107895E-02
.13100000E+04	.37413600E+02	.12050000E+04	.30019459E-01	.27557863E-02
.15400000E+04	.35481600E+02	.14250000E+04	.30298394E-01	.27813925E-02
.17900000E+04	.30501600E+02	.16650000E+04	.31803939E-01	.29196016E-02

RESULTS AFTER 24 CYCLES

HEIGHT = 14.00 (CM) TOTAL PRIMARY PARTICLES = .617598E+05 TOTAL MASS = 1.219MG/L
HEIGHT = 49.00 (CM) TOTAL PRIMARY PARTICLES = .810334E+05 TOTAL MASS = 1.664MG/L
HEIGHT = 100.00 (CM) TOTAL PRIMARY PARTICLES = .699318E+05 TOTAL MASS = 1.419MG/L
HEIGHT = 170.00 (CM) TOTAL PRIMARY PARTICLES = .699715E+05 TOTAL MASS = 1.393MG/L
HEIGHT = 260.00 (CM) TOTAL PRIMARY PARTICLES = .690285E+05 TOTAL MASS = 1.340MG/L
HEIGHT = 370.00 (CM) TOTAL PRIMARY PARTICLES = .696174E+05 TOTAL MASS = 1.321MG/L
HEIGHT = 500.00 (CM) TOTAL PRIMARY PARTICLES = .673071E+05 TOTAL MASS = 1.273MG/L
HEIGHT = 648.00 (CM) TOTAL PRIMARY PARTICLES = .681526E+05 TOTAL MASS = 1.274MG/L
HEIGHT = 813.00 (CM) TOTAL PRIMARY PARTICLES = .671616E+05 TOTAL MASS = 1.258MG/L
HEIGHT = 1000.00 (CM) TOTAL PRIMARY PARTICLES = .685606E+05 TOTAL MASS = 1.282MG/L
HEIGHT = 1205.00 (CM) TOTAL PRIMARY PARTICLES = .691682E+05 TOTAL MASS = 1.301MG/L
HEIGHT = 1425.00 (CM) TOTAL PRIMARY PARTICLES = .706943E+05 TOTAL MASS = 1.342MG/L
HEIGHT = 1665.00 (CM) TOTAL PRIMARY PARTICLES = .716747E+05 TOTAL MASS = 1.384MG/L

PARTICLE CONCENTRATIONS FOR THE OBSERVED SIZES,SMALLEST FIRST

MIN DIAM=	.00020	.00040	.00080	.00120	.00160	.00200				.00400	.00480	.00560	.00640
HT=										0.00	0.00	0.00	0.00
HT= 49.00	1449.98 1444.42	517.95 474.25	248.38 213.58	139.50 112.38	94.71 71.19	55.15 0.00	.00240 34.41	.00280 0.00	.00320 0.00	0.00	0.00	0.00	0.00
HT= 100.00	1411.16	442.03	192.84	98.08	59.66	45.17	27.50	16.00	16.00	0.00	0.00	0.00	0.00
HT= 170.00	1358.36	412.36	177.07	88.52	52.50	39.56	24.09	12.90	0.00	0.00	0.00	0.00	0.00
HT= 260.00	1289.42	383.51	164.12	81.68	47.74	35.93	22.19	13.41	5.28	0.00	0.00	0.00	8.1
HT= 370.00	1208.39	355.35	153.19	76.69	44.55		21.02	13.79	10.06	0.00	0.00	0.00	0.00
HT=										0.00	0.00	0.00	0.00
HT= 648.00	1031.32	328.44 304.06	144.06 136.85	73.15	42.50 41.39	33.34 30.32	20.28	14.02 13.96	10.72 11.01	2.49	0.00	0.00	0.00
HT= 813.00	948.13	283.30	131.71	70.92	41.11	29.77	19.87	14.12	11.01	2.78	0.00	0.00	0.00
HT= 1000.00	874.32	266.88	128.85	70.28	41.64	29.80	19.99	14.39	10.80	4.27	0.00	0.00	0.00
HT= 1205.00	819.28	257.08	129.04 132.83	72.28 76.24	43.14 45.73	30.45 31.70	20.56 21.50	14.93	10.47	1.33	0.00	0.00	0.00
HT= 1425.00	788.15	263.47	141.30	82.87	49.77	33.65	22.85	15.76	9.99	4.12	0.00	0.00	0.00
1665.00								16.94	9.32	2.34	0.00	0.00	0.00

RESULTS AFTER 48 CYCLES

HEIGHT = 14.00 (CM) TOTAL PRIMARY PARTICLES = .575624E+05 TOTAL MASS = 1.149MG/L
HEIGHT = 49.00 (CM) TOTAL PRIMARY PARTICLES = .757329E+05 TOTAL MASS = 1.567MG/L
HEIGHT = 100.00 (CM) TOTAL PRIMARY PARTICLES = .656273E+05 TOTAL MASS = 1.343MG/L
HEIGHT = 170.00 (CM) TOTAL PRIMARY PARTICLES = .654851E+05 TOTAL MASS = 1.315MG/L
HEIGHT = 260.00 (CM) TOTAL PRIMARY PARTICLES = .652398E+05 TOTAL MASS = 1.278MG/L
HEIGHT = 370.00 (CM) TOTAL PRIMARY PARTICLES = .665713E+05 TOTAL MASS = 1.275MG/L
HEIGHT = 500.00 (CM) TOTAL PRIMARY PARTICLES = .654928E+05 TOTAL MASS = 1.247MG/L
HEIGHT = 648.00 (CM) TOTAL PRIMARY PARTICLES = .672369E+05 TOTAL MASS = 1.264MG/L
HEIGHT = 813.00 (CM) TOTAL PRIMARY PARTICLES = .672189E+05 TOTAL MASS = 1.262MG/L
HEIGHT = 1000.00 (CM) TOTAL PRIMARY PARTICLES = .689108E+05 TOTAL MASS = 1.291MG/L
HEIGHT = 1205.00 (CM) TOTAL PRIMARY PARTICLES = .698927E+05 TOTAL MASS = 1.315MG/L
HEIGHT = 1425.00 (CM) TOTAL PRIMARY PARTICLES = .714940E+05 TOTAL MASS = 1.356MG/L

PARTICLE CONCENTRATIONS FOR THE OBSERVED SIZES,SMALLEST FIRST

MIN DIAM=	.00020	.00040	.00080	.00120	.00160	.00200	.00240	.00280	.00320	.00400	.00480	.00560	.00640
HT= 14.00	1243.97	452.83	228.07	132.60	93.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HT= 49.00	1241.24	415.23	196.22	106.74	69.96	49.90	34.17	0.00	0.00	0.00	0.00	0.00	0.00
HT= 100.00	1220.78	389.63	178.06	93.43	58.71	41.55	27.43	0.00	0.00	0.00	0.00	0.00	0.00
HT= 170.00	1188.27	367.58	164.89	84.78	51.81	37.23	24.17	10.82	0.00	0.00	0.00	0.00	0.00
HT= 260.00	1145.90	347.19	154.58	78.78	47.29	34.67	22.42	11.67	4.72	0.00	0.00	0.00	0.00
HT= 370.00	1096.00	327.97	146.27	74.56	44.31	32.95	21.37	12.49	9.14	0.00	0.00	0.00	0.00
HT= 500.00	1041.16	309.95	139.60	71.71	42.43	31.71	20.72	13.15	10.07	0.00	0.00	0.00	0.00
HT= 648.00	985.16	293.78	134.56	70.07	41.44	30.90	20.38	13.66	10.69	2.29	0.00	0.00	0.00
HT= 813.00	931.31	280.01	131.19	69.56	41.24	30.51	20.32	14.10	10.98	2.64	0.00	0.00	0.00
HT= 1000.00	881.57	269.09	129.68	70.27	41.83	30.56	20.54	14.59	11.00	3.89	0.00	0.00	0.00
HT= 1205.00	841.70	262.58	130.62	72.49	43.35	31.11	21.05	15.21	10.77	4.04	0.00	0.00	0.00
HT= 1425.00	815.77	261.63	134.54	76.53	45.91	32.20	21.88	16.02	10.27	3.95	0.00	0.00	0.00
HT= 1665.00	807.62	267.89	142.47	83.09	49.88	33.93	23.06	17.10	9.49	2.38	0.00	0.00	0.00