Illinois Institute of

State Water Survey Division

SURFACE WATER SECTION

AT THE

UNIVERSITY OF ILLINOIS

SWS Contract Report 263

PHYSICAL CHARACTERISTICS OF BOTTOM SEDIMENTS IN THE ALTON POOL, ILLINOIS WATERWAY

Submitted to:
The Environmental Work Team
Master Plan Task Force
Upper Mississippi River Basin Commission

Submitted by:
Nani G. Bhowmik, Principal Investigator

Prepared by:
Donald Schnepper, Thomas Hill,
David Hullinger, and Ralph Evans
Water Quality Section

10 July 1981

CONTENTS

ABSTRACT

The physical characteristics of the bottom sediments in the Alton Pool (milepoint 0.0 to 80.2 of the Illinois Waterway) were documented in this study. Sediment was sampled from 4 depths across each of 41 main channel transects. Bottom materials in the deepest portions of the navigation channel consist mainly of sand, which is not a reliable habitat for benthic organisms. The lack of silt and clay in these deep portions may be related to navigation traffic. At shallower depths, the bottom sediments above milepoint 40.0 are about half sand and shells and half silt, and below milepoint 40.0 they are primarily silt. On the assumption that benthic organisms are related to silty bed materials and that silty materials are more easily dispersed by navigation traffic than sand, the critical area of the pool lies below milepoint 40.0. It is here that management practices to mitigate the influence of river traffic will be most productive.

INTRODUCTION

As part of an effort to evaluate the impact of navigation traffic on the Upper Mississippi River system, bottom sediments of the Alton Pool of the Illinois Waterway were collected and examined. This report outlines the procedures used for sample collection and examination and includes a limited discussion of the findings. The report is data oriented; the data will be useful to those persons with an interest in:

1) Bilogical habitat
2) Dislodgement of benthic organisms
3) Movement of suspended solids
4) Physical characteristics of bed material
5) Dispersion qualities of bed material

The Alton Pool is a navigation pool of the Illinois Waterway extending from the waterway's confluence with the Mississippi River (i.e., milepoint (MP) 0.0) to MP 80.2 at the LaGrange Lock and Dam. Like the other navigation pools in the waterway, it has a navigation channel not less than 300 feet wide. The width of the navigation channel varies from about 500 feet in the upper end to about 1300 feet in the lower end. The channel depth at mean pool elevation varies from 13.5 to 40.0 feet as shown in figure 1.

Bottom sediment samples were collected during June and July, 1980, at 41 transects in the main channel, 5 transects in side channels, and 1 location in a harbor area. In all, 182 bottom sediment samples were collected and examined for particle-size distribution and percent of organic and moisture contents.

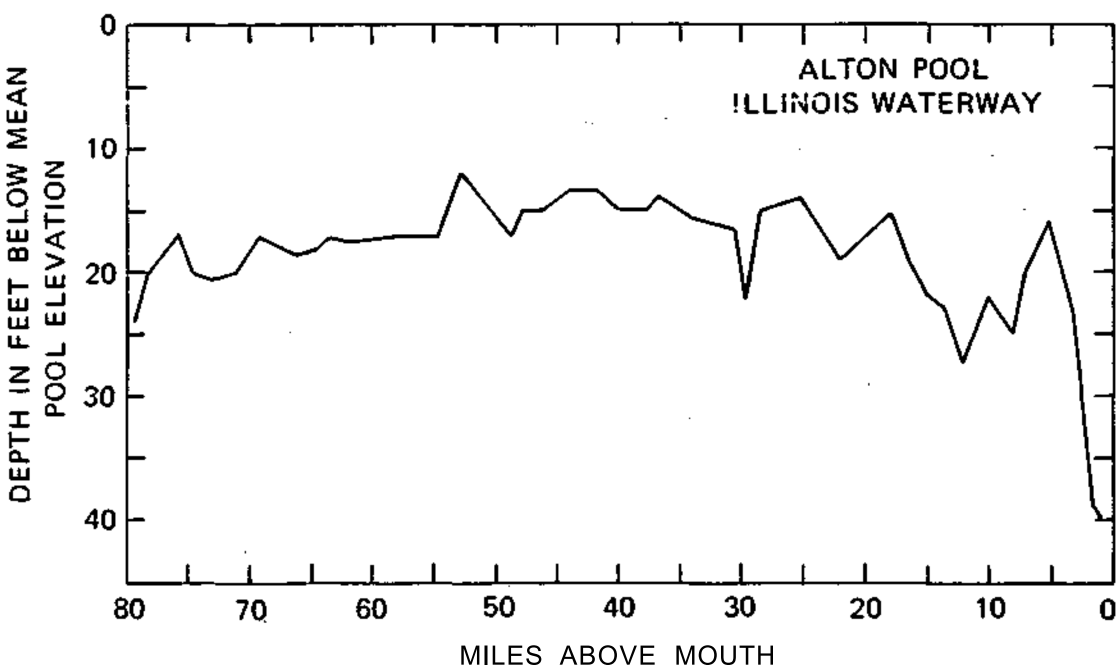


Figure 1. Channel depth at mean pool elevation in the Alton Pool, Illinois Waterway

METHODS OF SAMPLE COLLECTION

At each of the 41 main channel and 5 side channel transects, bottom sediment sampling was performed at 4 stations. The locations are designated as A, B, C, and D in this report. The positions of stations B, C, and D were fixed. As shown in figure 2, station C was at the maximum channel depth; stations B and D, located on either side of station C, were at one-half maximum water depth on the left and right of station C looking downstream. Station A represented a bottom sediment sample at a 2-ft depth from the mean pool elevation, and its location shifted from the left to right bank and vice versa depending on the direction of bends and the existence of a straight reach. The milepoints, location of station A (i.e., left or right bank looking downstream), and calculated water depths for all stations are given in table 1.

During most of the sample collections, the stage of the waterway was higher than normal. Rather than using flat pool elevations, reliance was placed on information provided by the U.S. Corps of Engineers to calculate those water depths that likely occur at mean pool elevation, which is the water elevation at the 50 percent point on an elevation-time duration graph. The following table provides the baseline elevations used here.

Area	MP	Mean pool elevation (feet)	Years of record
Meredosia	70.8	425.5	76
Valley City	61.3	422.5	
Florence	56.0	422.5	
Pearl	43.2	420.5	
Hardin	21.6	419.5	
Grafton	0.0	419.5	36

Each day before sampling commenced, information was obtained regarding the current pool elevation and its relationship to the mean pool

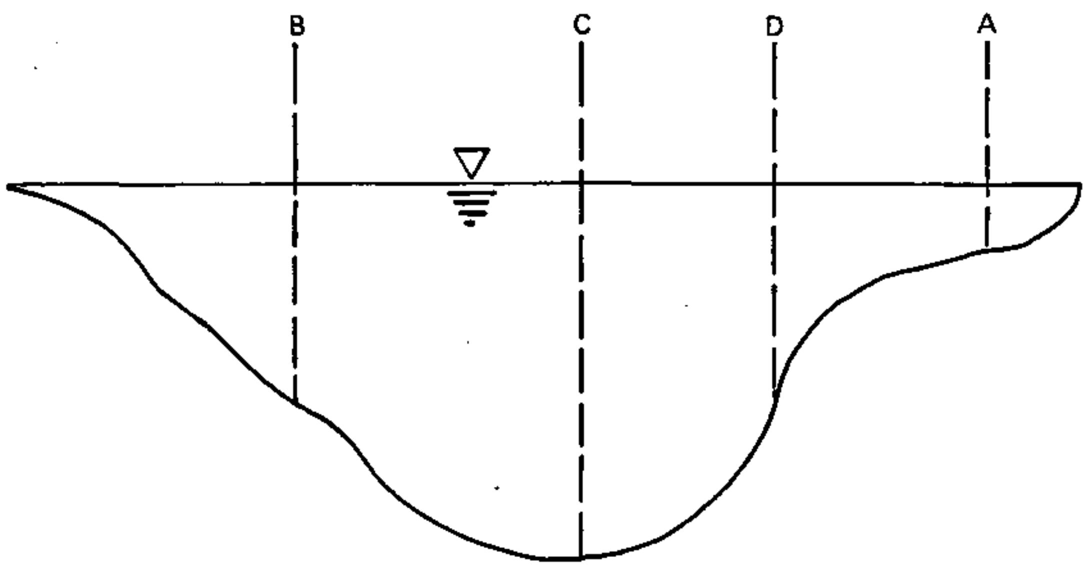


Figure 2. Sampling station locations on a transect, looking downstream

Table 1. Sediment Collection Stations

Milepoint	Main or side channel	Bank side of 2-ft sample*	Depth of samples (feet)**	Comment
79.3	MC	L	24, 12, 12, 2	
73.4	MC	L	20, 10, 10, 2	
76.0	MC	R	17, 8.5, 8.5, 2	
74.5	MC	L	20, 10, 10, 2	
73.0	MC	L	20.5, 10, 10, 2	
71.3	MC	L	20, 10, 10, 2	
69.0	MC	R	17, 8.5, 8.5, 2	
66.0	MC	L	18.5, 9, 9, 2	
64.4	MC	L	18, 9, 9, 2	
63.3	MC	L	17, 8.5, 8.5, 2	
61.6	MC	R	17.5, 8.5, 8.5, 2	
57.8	MC	L	17, 8.5, 8.5, 2	
54.8	MC	L	17, 8.5, 8.5, 2	
52.7	MC	L	12, 6, 6, 2	
48.6	MC	L	17, 8.5, 8.5, 2	
47.8	MC	R	15, 7.5, 7.5, 2	
46.1	MC	R	15, 7.5, 7.5, 2	
44.1	MC	L	13.5, 6.5, 6.5, 2	
41.4	MC	L	13.5, 6.5, 6.5, 2	
40.0	MC	R	15, 7.5, 7.5, 2	
37.9	MC	R	15, 7.5, 7.5, 2	
36.5	MC	R	14, 7, 7, 2	
34.2	MC	R	15.5, 7.5, 7.5, 2	
30.6	MC	L	16.5, 8, 8, 2	
29.3	MC	L	22, 11, 11, 2	
27.9	MC	L	15, 7.5, 7.5, 2	
27.9	SC	R	14.5, 7, 7, 2	Hurricane Chute
25.1	MC	L	14, 7, 7, 2	
25.1	SC	R	19.5, 10, 10, 2	Dark Chute
22.0	MC	R	19, 9.5, 9.5, 2	
18.9	MC	R	15, 7.5, 7.5, 2	
18.9	SC	R	12, 6, 6, 2	Mortland Chute
16.5	MC	R	19, 9.5, 9.5, 2	
14.6	MC	R	22, 11, 11, 2	
13.5	MC	R	23, 11.5, 11.5, 2	
13.5	SC	L	17, 8.5, 8.5, 2	Twelve Mile Chute
12.1	MC	L	27, 13.5, 13.5, 2	
10.3	MC	L	22, 11, 11, 2	
8.3	MC	L	25, 12.5, 12.5, 2	
7.2	MC	L	20, 10, 10, 2	
7.2	SC		5	Pere Marquette Harbor
5.2	MC	R	16, 8, 8, 2	
3.0	MC	R	23, 11.5, 11.5, 2	
1.5	MC	R	39, 19.5, 19.5, 2	
1.5	SC	R	8, 4, 4, 2	Mason's Chute
0.7	MC	L	40, 20, 20, 2	
0.2	MC	R	32, 25, 16, 2	

* Looking downstream
**Depths corrected to mean pool elevation

elevation. The maximum channel depth on the transect was determined (station C) and the water depth above the mean pool elevation was subtracted from the measured channel depth. This provided the calculated channel depth recorded here. This water depth was halved and the water depth above mean pool elevation was added to it to determine the proper sampling depths for stations B and D. The sampling depths for station A were similarly calculated for a mean 2-foot water depth.

Side channel transects were established at the same milepoint as corresponding main channel transects for comparative purposes. Where possible, all transects were located at or near daymarks or other permanent landmarks.

All bottom sediment samples were collected from a boat with a Ponar dredge attached to a motorized winch. The dredge was permitted to free-fall to the bottom and upon retrieval its contents were emptied onto a tiltable table. The bottom sediments were examined and their physical features noted. They were then mixed and placed in a wide mouth plastic quart bottle which was labelled and placed in an ice cooler. Attempts were made to collect 185 samples. In two instances bedrock was encountered, and in one instance a sample was lost. Thus, 182 samples were obtained for examination.

All cross sections at which transects were located are given in Appendix A.

DETERMINATION OF PARTICLE-SIZE DISTRIBUTION

The procedures used in determining the particle size distribution of the bottom sediments of the Alton Pool of the Illinois River follow closely che procedures described in the USGS publication titled "Laboratory Theory and Methods for Sediment Analysis," Book 5, Chapter Cl (Guy, 1969). The publication describes three methods of analysis for determining particle-size distribution. The procedure known as the Sieve-Pipet method was used to determine the particle-size distribution in this investigation.

There was some variation in preparing samples for analysis. The volume of the samples collected in the field appeared so large that only a portion of the total sample, after thorough mixing, could be adequately processed. However, this was found not to be the case. It was initially conceived that the samples should be oven-dried prior to sieving. Subsequent caking of silt and clay particles after oven-drying required a change in procedure. Only 16 samples (MP 79.3 to MP 74.5) were oven-dried prior to sieving; the remaining 167 samples were wet-sieved. Portions of samples from 92 locations (MP 79.3 to MP 34.2) were analyzed; total samples from 91 locations (MP 30.6 to MP 0.2) were examined.

The general procedure for particle-size analyses was as follows:

> The sample was washed through a 0.062 mm sieve using a nozzle that provided a fine droplet spray with a minimum amount of de-ionized water. The fine material washed- through the sieve was collected in a bucket and saved for the pipet portion of the analysis. Its volume was carefully measured and recorded.
>
> The material remaining on the sieve was transferred to aluminum pie pans, placed in a drying oven at 110°C, and allowed to dry overnight. The dried coarse material was sieved through a nest of sieves containing the following sizes: 3/8 inch, 4 mm, 2 mm, 1 mm, 0.5 mm, 0.25 mm, 0.125 mm, and 0.062 mm. The residue on each sieve was weighed on a scale having the sensitivity of ± 0.1 grams and the weight was recorded.
>
> At least a liter of sample was required for the pipet method. During the wet sieving of portions of samples, make-up de-ionized water was required to provide a liter volume; the

wet sieving of whole samples provided sufficient volume without make-up water. The fine material passing the 0.062 mm sieves, with its water, was poured into a liter graduate cylinder. To it was added 2.5 ml of a dispersing agent that contained 137.5 g/l sodium metaphosphate and 7.95 g/l sodium carbonate. The contents were stirred thoroughly with a plastic plunger.

A pipette was mounted on a modified point gage which allowed the depth of withdrawal to be set with accuracy. The pipette was connected to a vacuum source with a two-way glass stopcock. Twenty-five ml aliquots were withdrawn from the cylinder at the times and depths set forth in table 6 of the USGS publication previously mentioned. The 25 ml aliquot of sample was transferred to a 100 ml beaker, which had been tared, instead of evaporating dishes. The beakers containing the samples were placed in a drying oven (110°C) and the water allowed to evaporate. The residue was weighed and recorded. The times and depths of withdrawal were selected to permit size determinations as follows: 0.031 mm, 0.016 mm, 0.004 mm, and 0.002 mm.

Correction for dissolved solids was achieved by filtering 100 ml of the sample through a 0.45 micron filter and performing a dissolved solids determination on the filtrate. Periodic comparisons of the total sample with the summation of its size components showed a recovery of 95 to 100 percent of the silt-clay fraction.

The Wentworth classification system was used to define that portion of the sample, by weight, that is sand, silt, and clay. The particle-size classifications are as follows:

Size, mm	Classification
$\leq$ 2.0 but $\geq$ 0.062	Sand
$\leq$ 0.062 but $\geq$ 0.004	Silt
$\leq$ 0.004	Clay

All values obtained from the Sieve-Pipet method of analyses are plotted on the particle-size distribution graphs in Appendix B.

DETERMINATION OF ORGANIC AND MOISTURE CONTENTS

The bottom sediment sample was left undisturbed for at least 24 hours. Its supernatant water was decanted, the sample was mixed thoroughly, and about 15-25 g was weighed in a tared crucible. It was placed on a steam bath for 2.5-3.5 hours and then oven dried at 103° Celsius overnight. The loss of weight occurring during this procedure is the moisture content or liquidity of the sediments which is reported here as percent moisture content.

The oven-dried sample was placed in a muffle furnace for 1 hour at a temperature of 550° ± 50°Celsius. The loss of weight by ignition is reported as the percent organic content.

DISCUSSION

As mentioned earlier the principal purpose of this report was to provide a data base for those practitioners and researchers whose interests lie in the impact of navigation traffic in the Alton Pool of the Illinois Waterway on benthic habitats and bottom sediments. In the tabular data that follow, (M) is used to denote main channel stations and (S) is used to denote side channel stations. In one case, at MP 7.2, (S) is used to designate a harbor. Also in some of the tabular data the symbols d_{50}, d_{95}, and U are used. The d_{50} is the median diameter expressed in millimeters (mm) of the particles observed in the sample; d_{95} denotes that particle size for which 95 percent of the sample by weight is smaller. The uniformity coefficient, designated by U, is the ratio of d_{60} to d_{10}. For uniform particle size the value of U is close to unity; for a well-graded sample the value of U is higher than unity. For samples containing 10 percent or greater, by weight, of silt and clay a uniformity coefficient is not considered appropriate.

At 16 of the sampling stations in the main channel and two stations in side channels the bottom sediments consist mainly of mussel shells and shell fragments. Their locations are as follows:

	A	B	C	D
Channel MP	41.4	78.4	66.0	69.0
	37.9	41.4	57.8	*64.4
	--	--	22.0	*61.6
	--	--	14.6	54.8
	--	--	10.3	47.8
	--	--	--	41.4
	--	--	--	36.5
Hurricane Chute	--	--	27.9	--
Twelve Mile Chute	--	--	--	13.5

* Live mussels retrieved; also at MP 8.3D

A physical description of each sample collected is set forth in table 2. These descriptions were noted in the field at the time the dredge was emptied on the tiltable table. This qualitative information cannot stand alone; however, coupled with other data contained in this report, a better understanding of the nature of the bottom sediments in the Alton Pool is assured.

Some features of the sampling stations and bottom sediments are included in table 3. From these data a reasonable estimate of the composition of the bottom sediments in terms of sand, silt, and clay is possible. For example, the 41 samples collected from the maximum depth in the channel (station C) can be classified as follows:

- 70 percent of the samples are principally sand
- 18 percent of the samples are principally silt
- 12 percent of the samples are principally shells

The frequency distribution of the median diameter of the sand observed at station C is depicted in figure 3. Approximately 70 percent of the sand is in the range of 0.3 to 0.4 milliliters.

Table 2. Physical Description of Sediments

Station	
79.3 A	Gelatinous tan-gray silt
79.3 B	Coarse to fine clean sand with shell fragments
79.3 C	Some shells and detritus over clean medium sand
79.3 D	Some shells over dirty sand
78.4 A	Watery sandy clay with shell fragments
78.4 B	Thick layer of whole and broken shells
78.4 C	Clean medium sand
78.4 D	Clean medium sand
76.0 A	Clean medium to fine sand
76.0 B	Thin watery tan clay over pasty gray silt
76.0 C	Clean medium sand
76.0 D	Clean medium to fine sand on top of clayey silt
74.5 A	Thin layer of fine sand over gray compact silt
74.5 B	Watery tan clay over gray silt
74.5 C	Coarse to medium gray silt
74.5 D	Tan-gray pasty clayey silt
73.0 A	Coarse to fine silt with some clay and detritus
73.0 B	Fine sand on compact silt
73.0 C	Medium sand with some silt and shells
73.0 D	Compact tan-gray clayey silt
71.3 A	Fine watery sand on compact gray silt
71.3 B	Gelatinous gray silt and fine sand
71.3 C	Clean medium sand
71.3 D	Pasty tan-gray clayey silt
69.0 A	Watery fine sand with many sticks
69.0 B	Clean sand with a few whole and broken shells
69.0 C	Medium to coarse sand
69.0 D	Many large to small shells
66.0 A	Coarse and medium sand with shell fragments
66.0 B	Gravel, coarse to medium sand with shell fragments
66.0 C	Layer of shells over sand and gravel
66.0 D	Clean fine sand over gray silt
64.4 A	Clean medium sand and shells
64.4 B	Clean coarse and medium sand
64.4 C	Thin film of fine sand over gray silt
64.4 D	Thick layer of assorted shells over sand, live mussels
63.3 A	Gelatinous tan-gray clayey silt
63.3 B	Layer of sand on watery silt
63.3 C	Detritus on clean medium sand
63.3 D	Pasty tan-gray clayey silt
61.6 A	Hard pan tan-gray silt
61.6 B	Layer of fine sand over gray silt
61.6 C	Clean medium sand
61.6 D	Assorted live mussels and broken shells over silty sand
57.8 A	Fine sand and silt
57.8 B	Rather clean sand with some gravel
57.8 C	Large whole and broken shells on sandy silt
57.8 D	Crumbly tan-gray clayey silt

Table 2. Continued

Station	
54.8 A	Many twigs and shells embedded in silty sand
54.8 B	Assortment of shells over dirty sand
54.8 C	Clean coarse and medium sand
54.8 D	Layer of shells and rocks over sandy silt
52.7 A	Compact fine sandy silt
52.7 B	Sticks embedded in pasty sandy silt
52.7 C	Thin layer of detritus and shells on clean medium sand
52.7 D	Thin layer of clean sand over sandy silt
48.6 A	Pasty clayey silt
48.6 B	Detritus in crumbly sandy silt
48.6 C	Detritus on top of clean medium sand
48.6 D	Thin watery tan layer over gray clayey silt
47.8 A	Pasty sandy silt
47.8 B	Sand with some silt and clay
47.8 C	Clean medium sand
47.8 D	Thick layer of assorted shells and rocks
46.1 A	Clean medium sand
46.1 B	Clayey silt with some large and medium shells
46.1 C	Clean medium sand
46.1 D	Assorted shells on clayey silty sand
44.1 A	Thin layer of watery sand on gray silt
44.1 B	Thin layer of clean sand over pasty sandy silt
44.1 C	Shells with clean medium sand
44.1 D	Assorted shells on pasty clayey silt
41.4 A	Assorted shells over silt
41.4 B	Assorted shells over sand
41.4 C	Clean coarse and medium sand
41 .4 D	Shells over bedrock
40.0 A	Watery brown layer over pasty gray silt
40.0 B	Detritus embedded in sandy silt
40.0 C	Clean sand over silty sand
40.0 D	Pasty tan-gray silty sand
37.9 A	Assorted shells with some gravel over clean sand
37.9 B	Crumbly sandy silt
37.9 C	Clean medium sand
37.9 D	Many whole and broken shells over compact silt
36.5 A	Gelatinous sandy silt
36.5 B	Thin layer of sand over sandy silt
36.5 C	Clean medium to fine sand
36.5 D	Shells and gravel over sandy silt
34.2 A	Pasty tan-gray clayey silt
34.2 B	Compact clayey silt
34.2 C	Clean medium to coarse sand
34.2 D	Pasty clayey silt
30.6 A	Gelatinous gray silt
30.6 B	Watery tan clay over pasty gray silt
30.6 C	Clean medium sand and crushed shells
30.6 D	Thin brown watery layer over gray sandy silt

Table 2. Continued

station	
29.3 A	Compact gray silt
29.3 B	Watery brown sand over sandy gray silt
29.3 C	Thin layer of detritus over clean medium sand
29.3 D	Many shells with gravel on compact silt
27.9 A (M)	Pasty tan-gray clayey silt
27.9 B (M)	Water brown clay on gelatinous gray clay
27.9 C (M)	Thin layer of fine sand on compact clayey silt
27.9 D (M)	Watery clayey silt on clean fine sand
27.9 A (S)	Brown watery layer over gray silt
27.9 B (S)	Watery tan clay on gray silt embedded with sticks
27.9 C (S)	Thick layer of shells over dirty sand
27.9 D (S)	Thin layer of watery tan clay over pasty gray silt
25.1 A (M)	Watery tan layer over pasty gray silt
25.1 B (M)	Watery tan layer over pasty gray silt
25.1 C (M)	Clean fine sand with some detritus on top
25.1 D (M)	Compact gray silt
25.1 A (S)	Pasty tan-gray silt
25.1 B (S)	Soft tan layer over pasty gray silt
25.1 C (S)	Watery tan layer on pasty gray layer
25.1 D (S)	Small stones embedded in compact silt
22.0 A	Bedrock
22.0 B	Watery tan layer over sandy silt
22.0 C	Assorted shells on watery sandy silt.
22.0 D	Bedrock
18.9 A (M)	Watery tan layer on compact silt
18.9 B (M)	Small twigs embedded in tan-gray clayey silt
18.9 C (M)	Clean medium sand
18.9 D (M)	Thin watery tan layer over compact gray silt
18.9 A (S)	Thin watery tan layer on pasty gray silt
18.9 B (S)	Watery tan layer on pasty silt
18.9 C (S)	Watery sandy silt
18.9 D (S)	Watery tan layer over gray silt embedded with twigs
16.5 A	Thin watery clay layer over compact gray silt
16.5 B	Gelatinous clayey silt
16.5 C	Watery tan layer over silty sand
16.5 D	Water tan layer over compact gray silt
14.6 A	Thin watery tan layer on compact silt
14.6 B	Watery tan layer over silt embedded with some shells
14.6 C	Many assorted shells over silty sand
14.6 D	Pasty tan-gray clayey silt
13.5 A (M)	Gelatinous tan-gray silt
13.5 B (M)	Thin watery tan layer on gray silt
13.5 C (M)	Some gravel and shells on dirty sand
13.5 D (M)	Thin layer of watery silt on coarse sand
13.5 A (S)	Watery tan clay on sandy gray silt
13.5 B (S)	Watery tan layer over pasty gray silt
13.5 C (S)	Watery tan layer over clean medium sand
13.5 D (S)	Many shells over sandy silt

Table 2. Concluded

Station	
12.1 A	Pasty coarse to medium gray silt
12.1 B	Watery tan clay over pasty gray silt
12.1 C	Some broken shells and watery clay over sandy silt
12.1 D	Gelatinous tan-gray clayey silt
10.3 A	Pasty tan-gray silt
10.3 B	Thin layer of watery tan clay over pasty silt
10.3 C	Thick layer of assorted shells over silt
10.3 D	Crumbly orange-tan sandy clayey silt
8.3 A	Watery tan clay over pasty gray silt
8.3 B	Gelatinous tan-gray clayey silt
8.3 C	Some shells over crumbly tan-gray silt
8.3 D	Two live mussels over crumbly tan-gray silt
7.2 A (M)	Pasty tan-gray silt
7.2 B (M)	Watery tan clay over gray pasty silt
7.2 C (M)	Watery tan clay over sandy gray silt
7.2 D (M)	Pasty tan-gray clayey silt
7.2 A (S)	Gelatinous tan-gray clayey silt
5.2 A	One live mussel in pasty tan-gray silt
5.2 B	Watery tan clay over pasty gray silt
5.2 C	Assorted shells and gravel over silty sand
5.2 D	Some shells in silty sand
3.0 A	Watery tan clay over pasty gray silt
3.0 B	Crumbly tan-gray silt
3.0 C	Pasty sandy clayey silt
3.0 D	Gelatinous tan-gray clayey silt
1.5 A (M)	Thin layer of tan watery clay on gray silt
1.5 C (M)	Some large rocks and shells over silty sand
1.5 D (M)	Some leaf detritus over sandy clayey silt
1.5 A (S)	Tan-gray sandy silt with much detritus
1.5 B (S)	Gelatinous tan-gray silt with some detritus
1.5 C (S)	Watery tan clay over sandy silt
1.5 D (S)	Watery tan layer over silty sand
0.7 A	Pasty tan-gray silt
0.7 B	Watery tan layer over pasty gray silt
0.7 C	Watery tan-gray layer over clean sand
0.7 D	Watery tan clay over sand silt
0.2 A	Pasty clayey silt
0.2 B	Thin watery tan layer over clean coarse sand
0.2 C	Thin watery tan-gray layer over clean coarse sand
0.2 D	Pasty tan-gray clayey silt

Table 3. Features of Sampling Stations and Bottom Sediments

MP	Lateral sampling point	Main or side channel	Bank side of sample*	Sample depth (ft)**	Cross-sectional area (sq ft)***	50 (mm)	95 (mm)	U	Remarks
79.3	A	M	L	2	7,536	0.022	0.056	—	Silt
	B	M	L	12		0.37	0.94	2.47	Sand
	C	M		24		0.36	1.3	1.73	Sand
	D	M	R	12		0.34	2.8	4.00	Sand
78.4	A	M	L	2	5,347	0.16	4.0+	—	Clayey sand
	B	M	L	10		—		—	Shells
	C	M		20		0.35	0.88	2.24	Sand
	D	M	R	10		0.38	0.89	1.68	Sand
76.0	A	M	R	2	6,862	0.26	0.68	2.07	Sand
	B	M	L	8.5		0.0078	0.051	—	Clayey silt
	C	M		17		0.37	0.95	1.68	Sand
	D	M	R	8.5		0.32	0.76	2.69	Sand
74.5	A	M	L	2	7,122	0.024	0.29	—	Sandy silt
	B	M	L	10		0.015	0.056	—	Clayey silt
	C	M		20		0.030	0.060	—	Silt
	D	M	R	10		0.0052	0.031	--	Clayey silt
73.0	A	M	L	2	5,538	0.035	0.059	—	Silt
	B	M	L	10		0.031	0.12	—	Sandy silt
	C	M		20.5		0.37	6.8	2.59	Sand
	D	M	R	10		0.011	0.37	—	Clayey silt
71.3	A	M	L	2	6,870	0.048	9.1	--	Sandy silt
	B	M	L	10		0.036	0.23	—	Sandy silt
	C	M		20		0.33	1.0	2.77	Sand
	D	M	K	10		0.01	0.061	--	Clayey silt

*Looking downstream
**Depths corrected to mean pool elevation
***Within ± 0.1 mile of actual sampling station

Table 3. Continued

MP	Lateral sampling point	Main or side channel	Bank side of sample*	Sample depth (ft)**	Cross-sectional area (sq ft)***	d_{50} (mm)	d_{95} (mm)	U	Remarks
69.0	A	M	R	2	5,346	0.18	0.43	4.04	Sand
	B	M	L	8.5		0.35	1.9	3.38	Sand
	C	M		17		0.42	0.95	1.70	Sand
	D	M	R	8.5		—			Shells
66.0	A	M	L	2	5,687	0.56	3.9	2.68	Sand
	B	M	L	9		0.90	4.0+	4.48	Shelly sand
	C	M		18.5		—	--	—	Shells
	D	M	R	9		0.05	0.43	--	Silty sand
64.4	A	M	L	2	5,739	0.37	4.0+	2.33	Sand
	B	M	L	9		0.38	0.91	1.68	Sand
	C	M		18		0.022	0.17	—	Silt
	D	M	R	9		—	—	—	Shells
63.3	A	M	L	2	5,260	0.022	0.061	—	Clayey silt
	B	M	L	8.5		0.095	1.1	—	Silty sand
	C	M		17		0.35	2.0	2.35	Sand
	D	M	R	8.5		0.0075	0.07	~	Clayey silt
61.6	A	M	R	2	5,776	0.012	0.11	—	Clayey silt
	B	M	L	8.5		0.15	0.38	—	Silty sand
	C	M		17.5		0.34	0.82	2.11	Sand
	D	M	R	8.5		—	—	—	Shells
57.8	A	M	L	2	5,504	0.061	0.23	—	Silty sand
	B	M	L	8.5		0.33	4.0+	3.04	Sand
	C	M		17		—	—	—	Shells
	D	M	R	8.5		0.0097	0.041	—	Clayey silt
54.8	A	M	L	2	7,615	0.061	0.66	--	Silty sand
	B	M	L	8.5		0.34	4.0+	4.88	Sand
	C	M		17		0.38	1.0	2.0	Sand
	D	M	R	8.5		—		—	Shells

Table 3. Continued

MP	Lateral sampling point	Main or side channel	Bank side of sample*	Sample depth (ft)**	Cross-sectional area (sq ft)***	d_{50} (mm)	d_{95} (mm)	U	Remarks
52.7	A	M	L	2	7,488	0.030	0.22	—	Sandy silt
	B	M	L	6		0.032	0.19	—	Sandy silt
	C	M		12		0.38	0.97	2.63	Sand
	D	M	R	6		0.031	0.40	—	Sandy silt
48.6	A	M	L	2	6,562	0.023	0.13	—	Clayey silt
	B	M	L	8.5		0.043	0.48	--	Sandy silt
	C	M		17		0.38	2.0	2.15	Sand
	D	M	R	8.5		0.01	0.14	--	Clayey silt
47.8	A	M	R	2	7,780	0.021	1.1	--	Sandy silt
	B	M	L	7.5		0.20	0.73	—	Sand
	C	M		15		0.38	0.80	1.48	Sand
	D	M	R	7.5		_	_	_	Shells
46.1	A	M	R	2	5,590	0.34	0.54	1.54	Sand
	B	M	L	7.5		0.017	0.24	—	Clayey silt
	C	M		15		0.36	0.91	2.17	Sand
	D	M	R	7.5		0.056	4.0+	—	Silty sand
44.1	A	M	L	2	7,934	0.024	0.22	—	Silt
	B	M	L	6.5		0.031	0.43	—	Sandy silt
	C	M		13.5		0.68	4.0+	5.26	Shelly sand
	D	M	R	6.5		0.018	1.2	—	Clayey silt
41.4	A	M	L	2	8,244	—	—	—	Shells
	B	M	L	6.5		—	—	—	Shells
	C	M		13.5		0.59	6.2	2.57	Sand
	D	M	R	6.5		—	—	—	Shells
40.0	A	M	R	2	6,404	0.013	0.17	—	Clayey silt
	B	M	L	7.5		0.044	1.2	—	Sandy silt
	C	M		15		0.20	0.81	—	Silty sand
	D	M	R	7.5		0.066	2.9	—	silty sand

Table 3. Continued

MP	Lateral sampling point	Main or side channel	Bank side of sample*	Sample depth (ft)**	Cross-sectional area (sq ft)***	d_{50} (mm)	d_{95} (mm)	U	Remarks
37.9	A	M	R	2	6,944	- -	—	—	Shells
	B	M	L	7.5		0.027	0.72	—	Sandy silt
	C	M		15		0.35.	1.0	2.17	Sand
	D	M	R	7.5		0.031	3.6	--	Shelly silt
36.5	A	M	R	2	8,925	0.048	0.44	—	Sandy silt
	B	M	L	7		0.018	0.40	—	Sandy silt
	C	M		14		0.33	0.96	2.47	Sand
	D	M	R	7		_ _	_ _	_ _	Shells
34.2	A	M	R	2	8,902	0.029	0.095	- -	Clayey silt
	B	M	L	7.5		0.024	0.061	—	Clayey silt
	C	M		15.5		0.38	0.97	2.05	Sand
	D	M	R	7.5		0.031	0.61	—	Clayey silt
30.6	A	M	L	2	7,528	0.038	0.070	~	Silt
	B	M	L	8		0.027	0.12	--	Clayey silt
	C	M		16.5		0.36	0.95	2.11	Sand
	D	M	R	8		0.022	0.60	—	Sandy silt
29.3	A	M	L	2	9,546	0.031	0.083	~	Silt
	B	M	L	11		0.039	0.64	—	Sandy silt
	C	M		2 2		0.36	3.0	2.73	Sand
	D	M	R	11		0.027	4.0+	—	Shelly silt
27.9	A	M	L	2	5,470	0.015	0.055	—	Clayey silt
	B	M	L	7.5		0.013	0.20	--	Clayey silt
	C	M		15		0.0073	0.080	—	Clayey silt
	D	M	R	7.5		0.046	0.24	—	Silty sand
27.9	A	S	R	2		0.023	0.071	—	Clayey silt
	B	S	L	7		0.031	0.059	—	Clayey silt
	C	S		14.5		—	--	—	Shells
	D	S	R	7		0.020	0.061	—	Clayey silt

Table 3. Continued

MP	Lateral sampling point	Main or side channel	Bank side of sample*	Sample depth (ft)**	Cross-sectional area (sq ft)***	d_{50} (mm)	d_{95} (mm)	U	Remarks
25.1	A	M	L	2	5,880	0.054	0.45	—	Silty sand
	B	M	L	7		0.028	0.19	—	Clayey silt
	C	M		14		0.21	0.50	1.77	Sand
	D	M	R	7		0.031	0.15	—	Silt
25.1	A	S	R	2		0.039	0.062	—	Silt
	B	S	L	10		0.008	0.090	—	Clayey silt
	C	S		19.5		0.058	4.0+	—	Silty sand
	D	S	R	10		0.029	3.6	--	Silt
22.0	A	M	R	2	9,805	—	—	- -	Bedrock
	B	M	L	9.5		0.027	6.5	—	Sandy silt
	C	M		19		--	—	--	Shells
	D	M	R	9.5			--	—	Bedrock
18.9	A	M	R	2	9,352	0.028	0.061	—	Silt
	B	M	L	7.5		0.015	0.13	—	Clayey silt
	C	M		15		0.35	0.49	1.61	Sand
	D	M	R	7.5		0.026	0.091	—	Silt
18.9	A	S	R	2		0.022	0.080	—	Silt
	B	S	L	6		0.024	0.061	—	Silt
	C	S		12		0.037	0.44	—	Silt
	D	S	R	6		0.019	0.060	—	Silt
16.5	A	M	R	2	11,057	0.026	0.080	—	Silt
	B	M	L	9.5		0.0089	0.055	—	Clayey silt
	C	M		1 9		0.048	2.0	—	Silty sand
	D	M	R	9.5		0.012	0.34	--	Clayey silt
14.6	A	M	R	2	11,343	0.042	0.062	—	Silt
	B	M	L	11		0.026	0.43	—	Silt
	C	M		22		—	--	—	Shells
	D	M	R	11		0.0099	0.057	—	Clayey silt

Table 3. Continued

MP	Lateral sampling point	Main or side channel	Bank side of sample*	Sample depth (ft)**	Cross-sectional area (sq ft)***	d_{50} (mm)	d_{95} (mm)	U	Remarks
13.5	A	M	R	2	9,767	0.038	0.11	—	Silt
	B	M	L	11.5		0.038	0.12	—	Silt
	C	M		23		0.47	4.0+	6.32	Sand
	D	M	R	11.5		0.90	3.2	5.45	Sand
13.5	A	S	L	2		0.038	0.18	—	Silt
	B	S	L	8.5		0.037	0.18	—	Silt
	C	S		17	-	0.39	0.92	2.39	Sand
	D	S	R	8.5		—	--	—	Shells
12.1	A	M	L	2	12,358	0.041	0.062	—	Silt
	B	M	L	13.5		0.030	0.12	—	Silt
	C	M		27		0.017	8.9	~	Clayey silt
	D	M	R	13.5		0.0060	0.041	—	Clayey silt
10.3	A	M	L	2	12,447	0.035	0.061	—	Silt
	B	M	L	11		0.030	0.11	—	Silt
	C	M		2 2		—	—	—	Shells
	D	M	R	11		0.020	9.0	—	Silt
8.3	A	M	L	2	11,981	0.027	0.061	—	Silt
	B	M	L	12.5		0.020	0.070	—	Clayey silt
	C	M		25		0.0078	0.20	—	Clayey silt
	D	M	R	12.5		0.036	1.0	—	Silt
7.2	A	M	L	2	13,669	0.035	0.080	—	Silt
	B	M	L	10		0.023	0.11	—	Silt
	C	M		20		0.024	0.25	—	Silt
	D	M	R	10		0.013	0.060	—	Clayey silt
7.2	C	S		5		0.0052	0.037	—	Clayey silt

Table 3. Concluded

MP	Lateral sampling point	Main or side channel	Bank side of sample*	Sample depth (ft)**	Cross-sectional area (sq ft)***	50 (mm)	95 (mm)	U	Remarks
5.2	A	M	R	2	15,087	0.029	0.12	—	Silt
	B	M	L	8		0.018	0.061	—	Clayey silt
	C	M		16		0.84	4.0+	25.71	Shelly sand
	D	M	R	8		0.14	4.0+	—	Silty sand
3.0	A	M	R	2	13,725	0.017	0.061	—	Clayey silt
	B	M	L	11.5		0.027	4.2	—	Silt
	C	M		23		0.022	0.26	—	Sandy silt
	D	M	R	11.5		0.013	0.057	—	Clayey silt
1.5	A	M	R	2	17,065	0.038	0.096	—	Silt
	B	M	L	19.5		no data			
	C	M		39		0.13	1.8	—	Silty sand
	D	M	R	19.5		0.030	0.37	—	Clayey silt
1.5	A	S	R	2		0.058	0.23	—	Sandy silt
	B	S	L	4		0.041	0.12	—	Silty
	C	S		8		0.044	0.42	—	Sandy silt
	D	S	R	4		0.12	0.46	—	Silty sand
0.7	A	M	L	2	23,955	0.038	0.10	—	Silt
	B	M	L	20		0.041	0.10	—	Silt
	C	M		40		0.046	1.6		Sand
	D	M	R	20		0.043	0.21	—	Sandy silt
0.2	A	M	R	2	26,946	0.019	0.057	—	Clayey silt
	B	M	L	25		0.71	1.8	2.14	Sand
	C	M		32		0.70	2.2	2.55	Sand
	D	M	R	16		0.022	0.061	—	Clayey silt

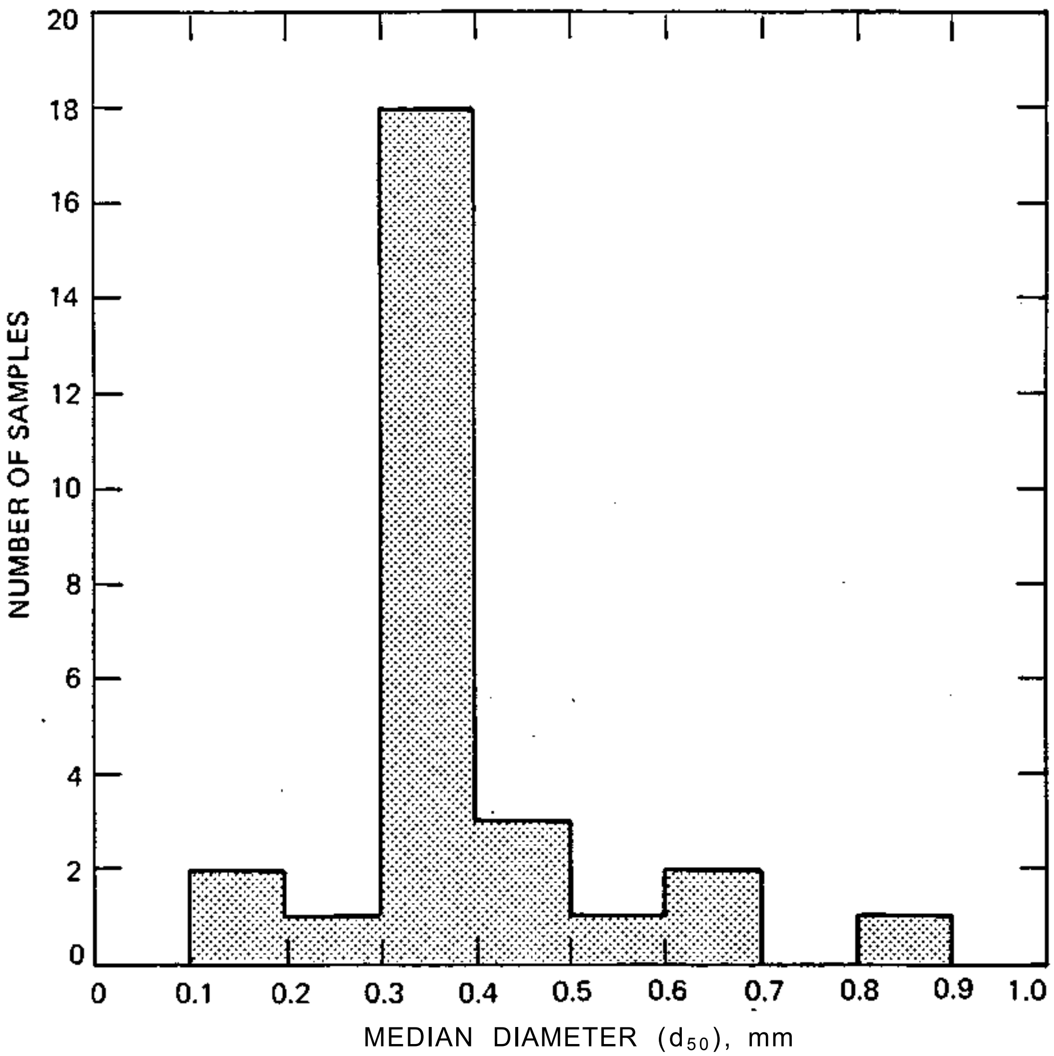


Figure 3. Frequency distribution of the median diameter of bottom sediment at sampling station C

A similar examination of bottom sediments at mid-depth (stations B and D) revealed the following:

B
- 72 percent of the samples are principally silt
- 23 percent of the samples are principally sand
- 5 percent of the samples are principally shells

D
- 70 percent of the samples are principally silt
- 13 percent of the samples are principally sand
- 17 percent of the samples are principally shells

Thus a situation exists whereby at maximum depth in the channel the bottom sediments consist principally of sand and at 1/2 maximum depth the bottom sediments are composed principally of silt.

At station A, the 2-ft depth station, the composition of the bottom sediments is similar to that observed at stations B and D. That is:

80 percent of the samples are principally silt
15 percent of the samples are principally sand
5 percent of the samples are principally shells

The composition of the bottom sediments along the main channel at sampling stations A, B, C, and D is shown in figures 4a through d, respectively. The composition of the bottom sediments in the side channels is shown in figure 5. With particular reference to station C (figure 4c) most of the silt within the deeper part of the channel is located in the downstream end of the pool. Upstream of MP 40 there are two segments (MP 74.5 and 64.4) that are not principally sand or shells. Downstream of MP 40 the bottom sediments of 6 of the 21 cross sections are composed of clayey silt. At the sides of the deep portion of the channel (stations A, B, and D) upstream of MP 40, about 50 percent of the cross sections have bottoms composed mostly of sand and shells. However, downstream of MP 40 a clayey silt bottom prevails.

At MP 40 there is also a change of bottom sediment characteristics for that portion of the main channel at depths less than one-half the

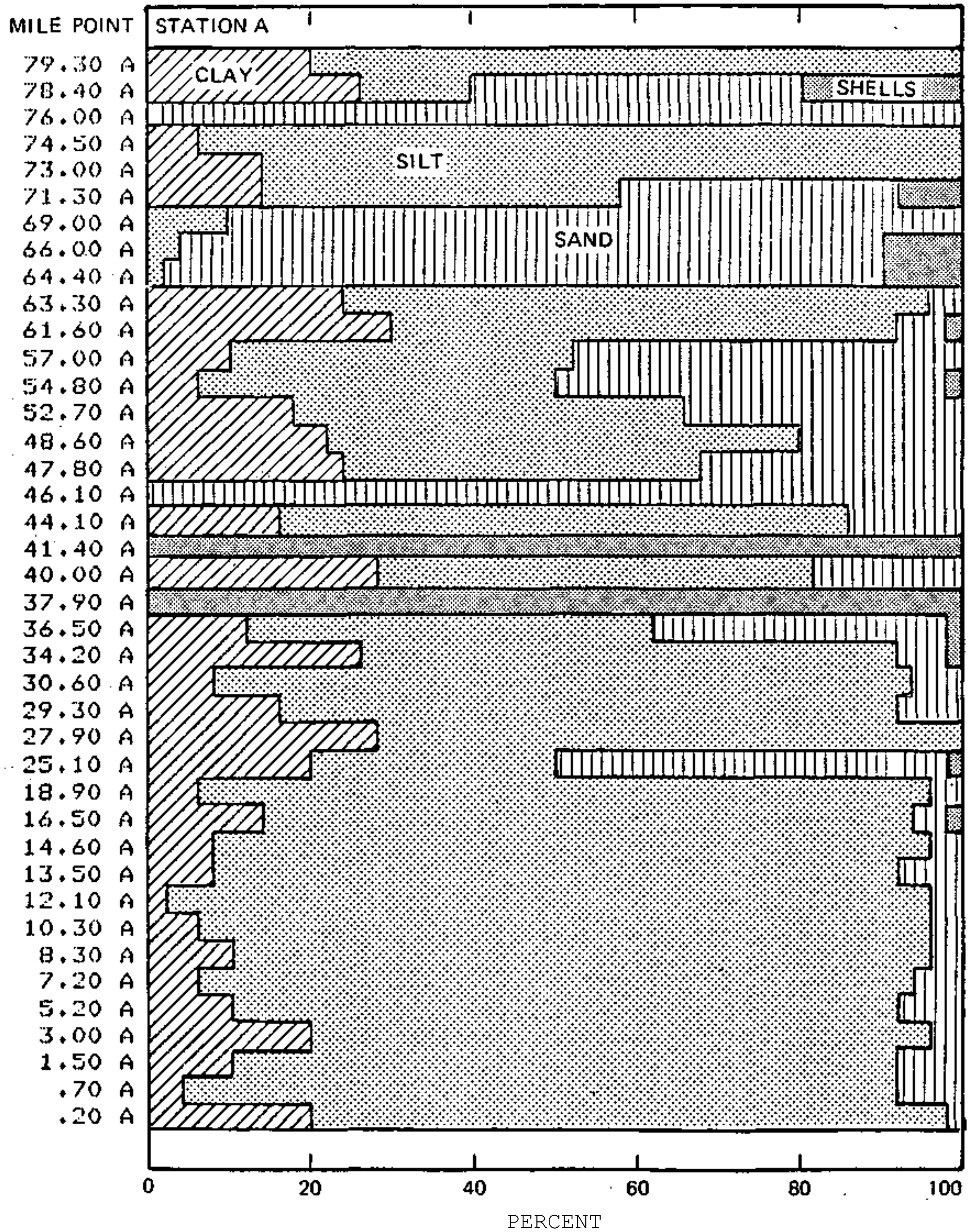


Figure 4a. Percent composition of bottom sediment in the main channel at sampling station A

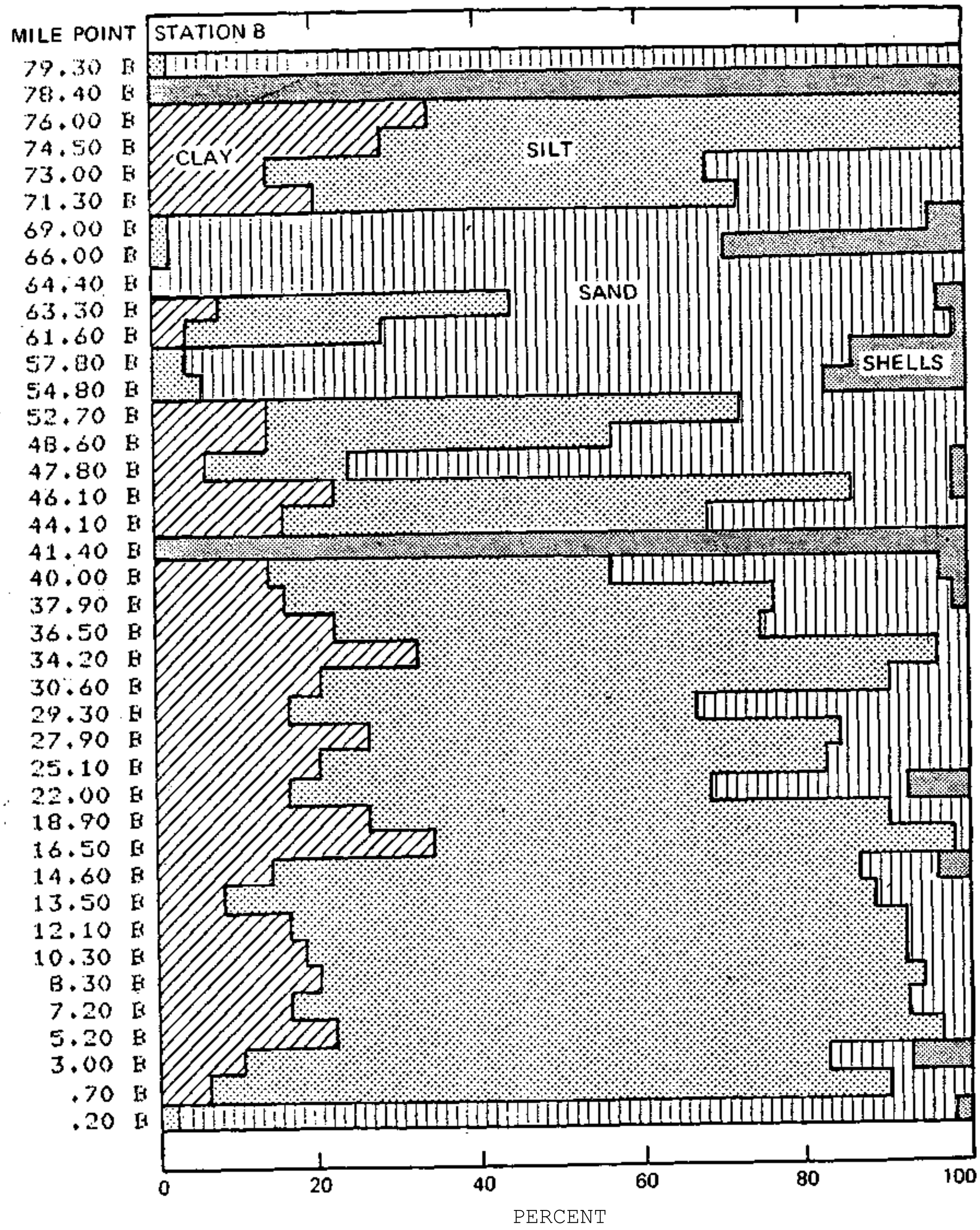


Figure 4b. Percent composition of bottom sediment in the main channel at sampling station B

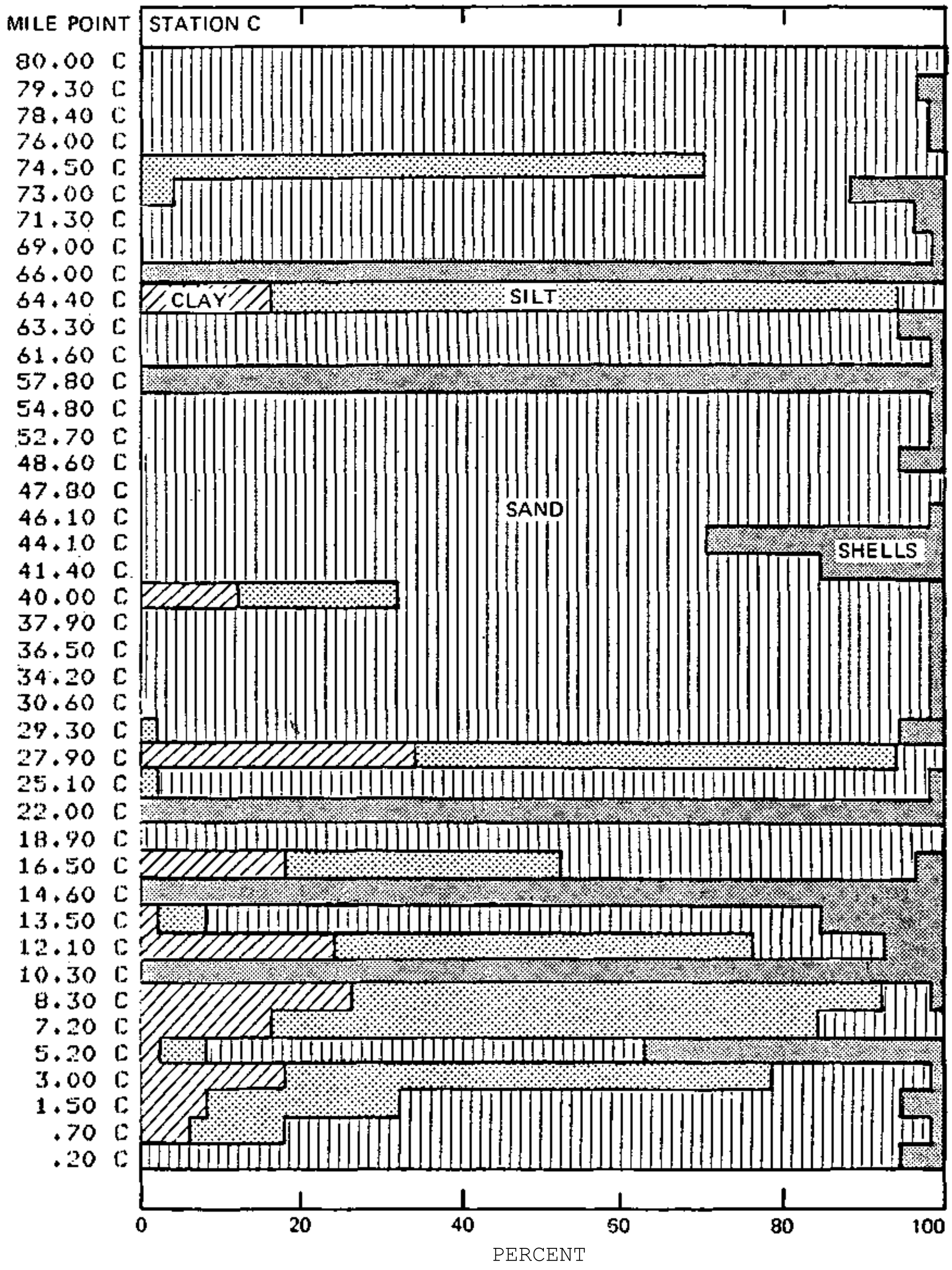


Figure 4c. Percent composition of bottom sediment in the main channel at sampling station C

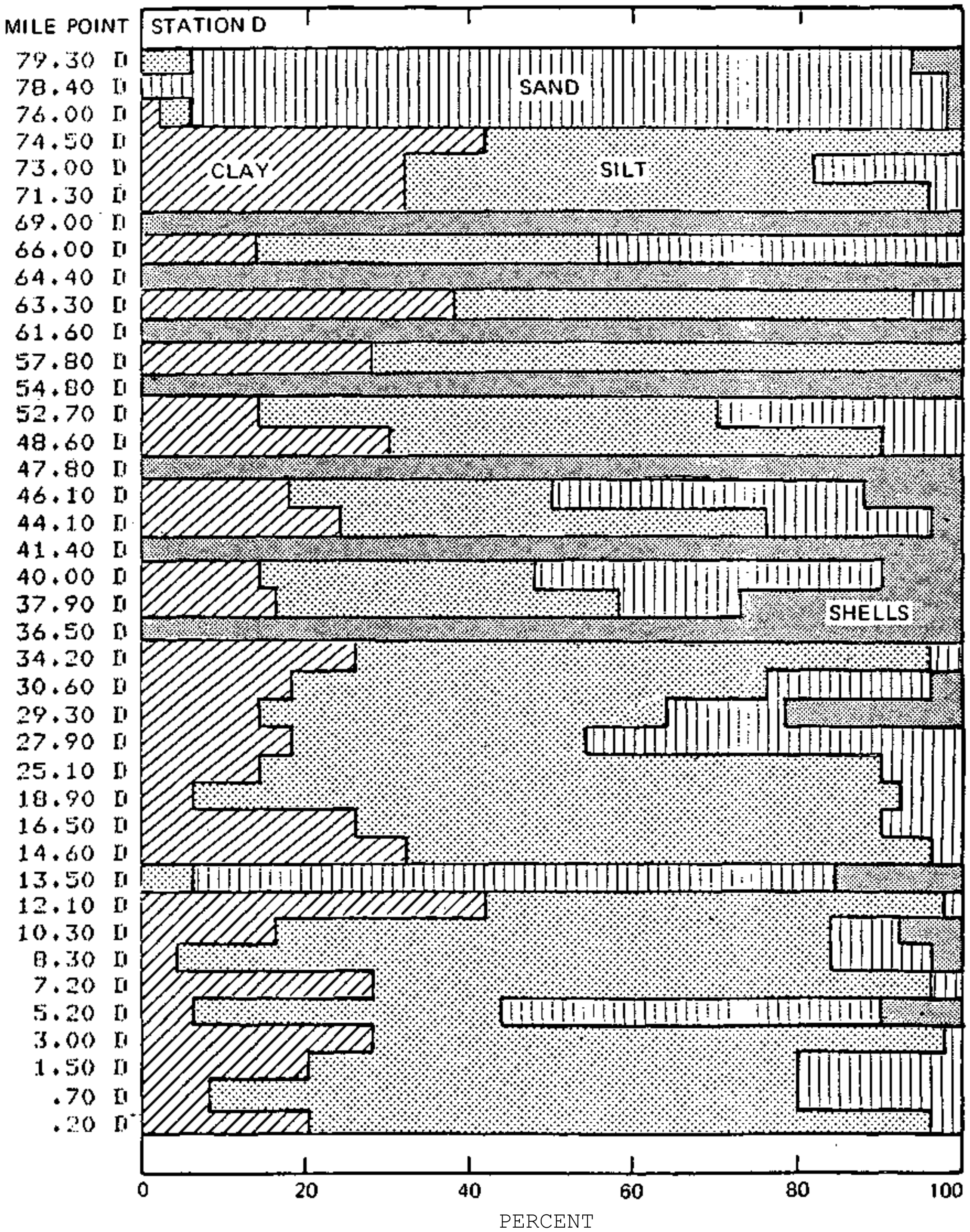


Figure 4d. Percent composition of bottom sediment in the main channel at sampling station D

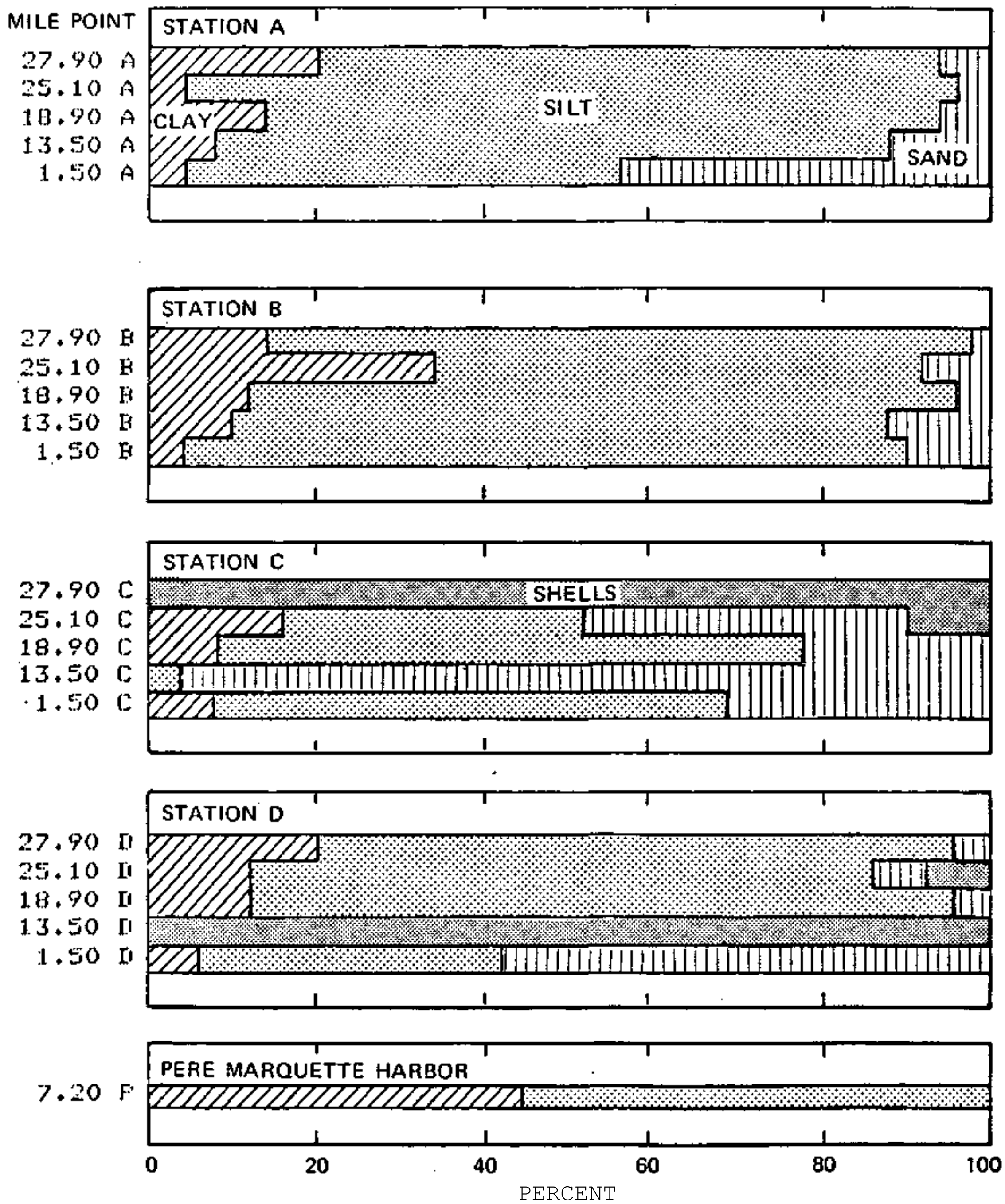


Figure 5. Percent composition of bottom sediment in side channels and Pere Marquette harbor

maximum. That is, downstream of MP 40 a silt bottom prevails, but upstream of MP 40 sand and shells make up about 50 percent of the bottom sediment.

The sampling locations for the five side channels and one harbor are shown in figures 6 through 11. Most of the bottom sediments in the chutes are composed of silt. As shown in figure 5, the channels of Dark Chute and Twelve Mile Chute have a sandy bottom; also the bottom at station D in Mason's Chute consists of at least 50 percent sand. The distribution of streamflow in these areas may contribute to the sandy conditions.

The percent solids and organic content of the bottom sediments are given in table 4. There are omissions at stations A, B, C, and D at some milepoints. Most of these are where the bottom sediments consist mainly of shells; three are omissions due to encountering bedrock and one lost sample. The frequency distributions of the percent organic content of the bottom sediments for each sampling station are shown in figure 12. As expected, the area of maximum depth, station C, generally displays less organic content than the other stations. Because the procedure for organic content determinations is one involving the reduction of combustibles, it is likely that the higher organic content of some of the samples may be due to the presence of coal particles, wood chips, etc. This is probably the case, particularly for station C where sand is prevalent.

SUMMARY

The physical characteristics of the bottom sediments of the Alton Pool throughout its 80-mile length have been documented. There has not

31

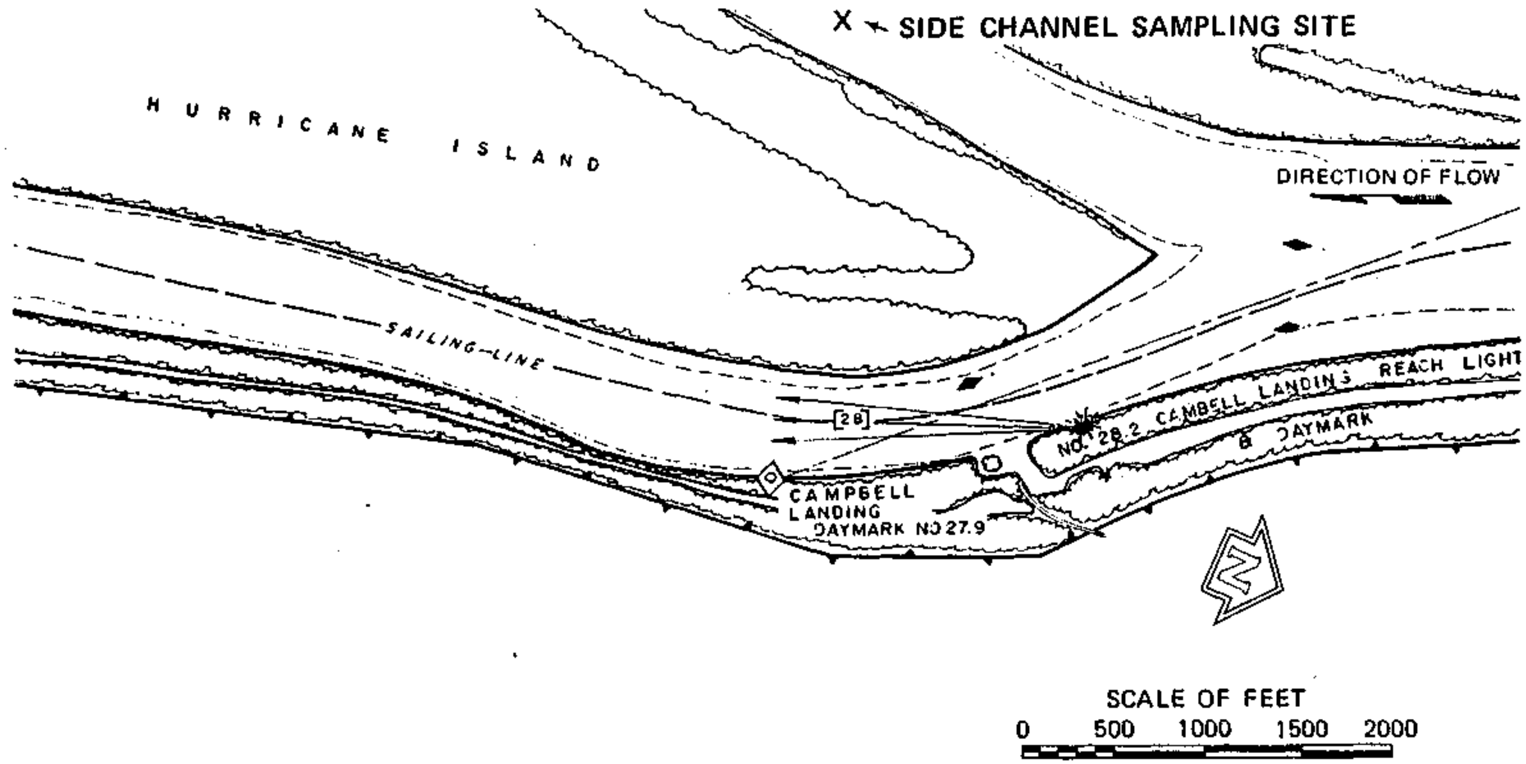


Figure 6. Side channel sampling site in Hurricane Chute, milepoint 27.9

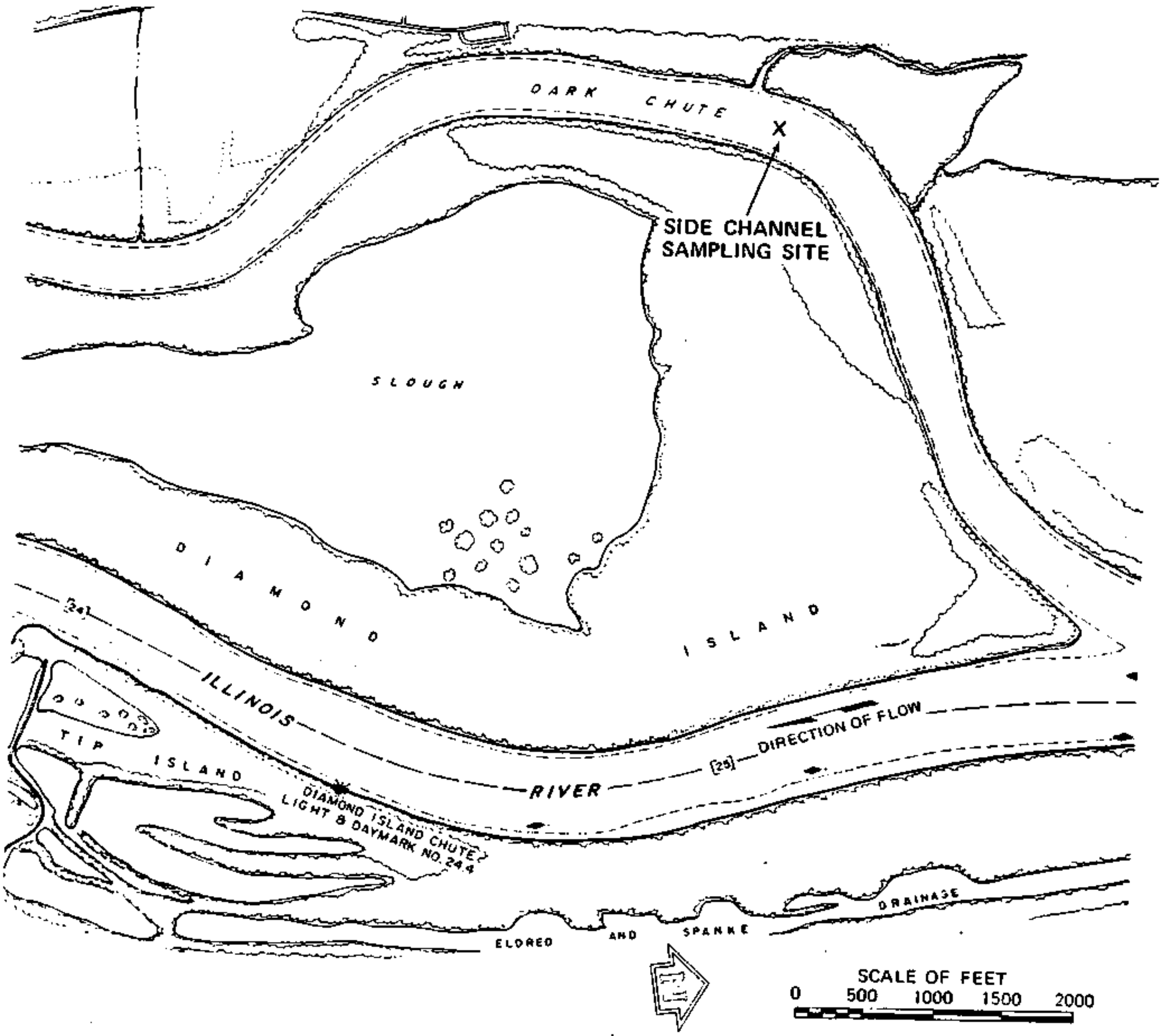


Figure 7. Side channel sampling site in Dark Chute, milepoint 25.1

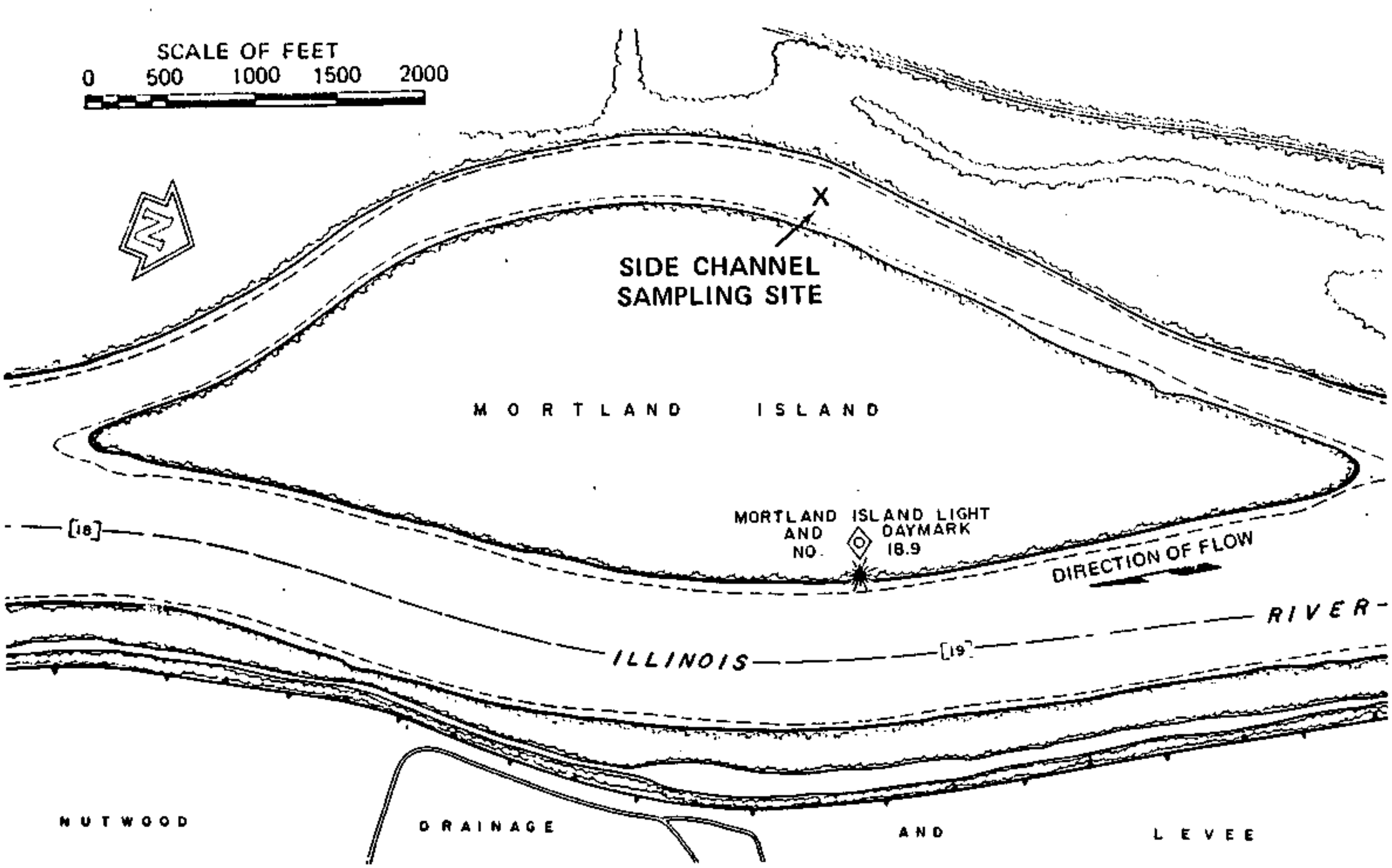


Figure 8. Side channel sampling site in Mortland Chute, milepoint 18.9

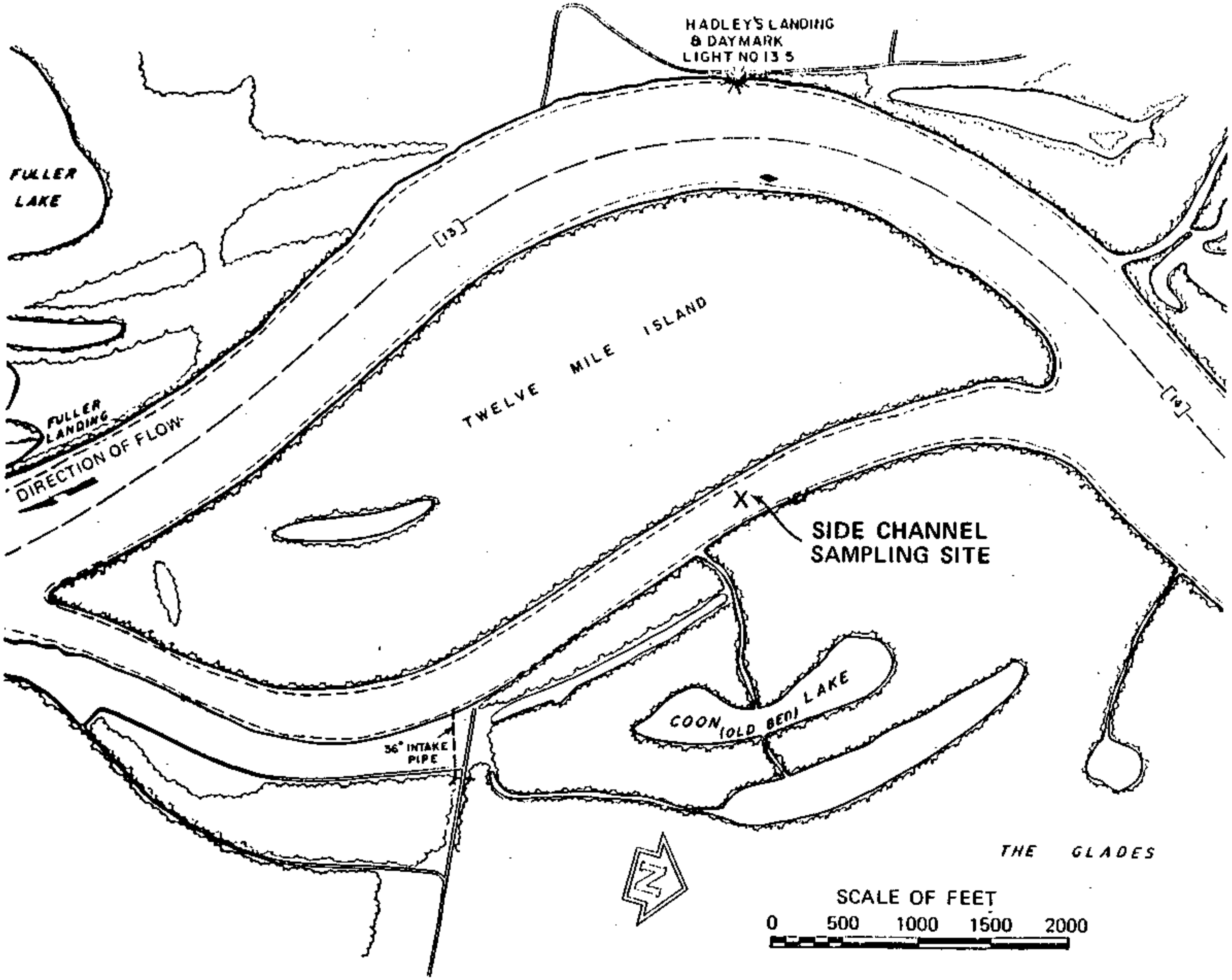


Figure 9. Side channel sampling site in Twelve Mile Chute, milepoint 13.5

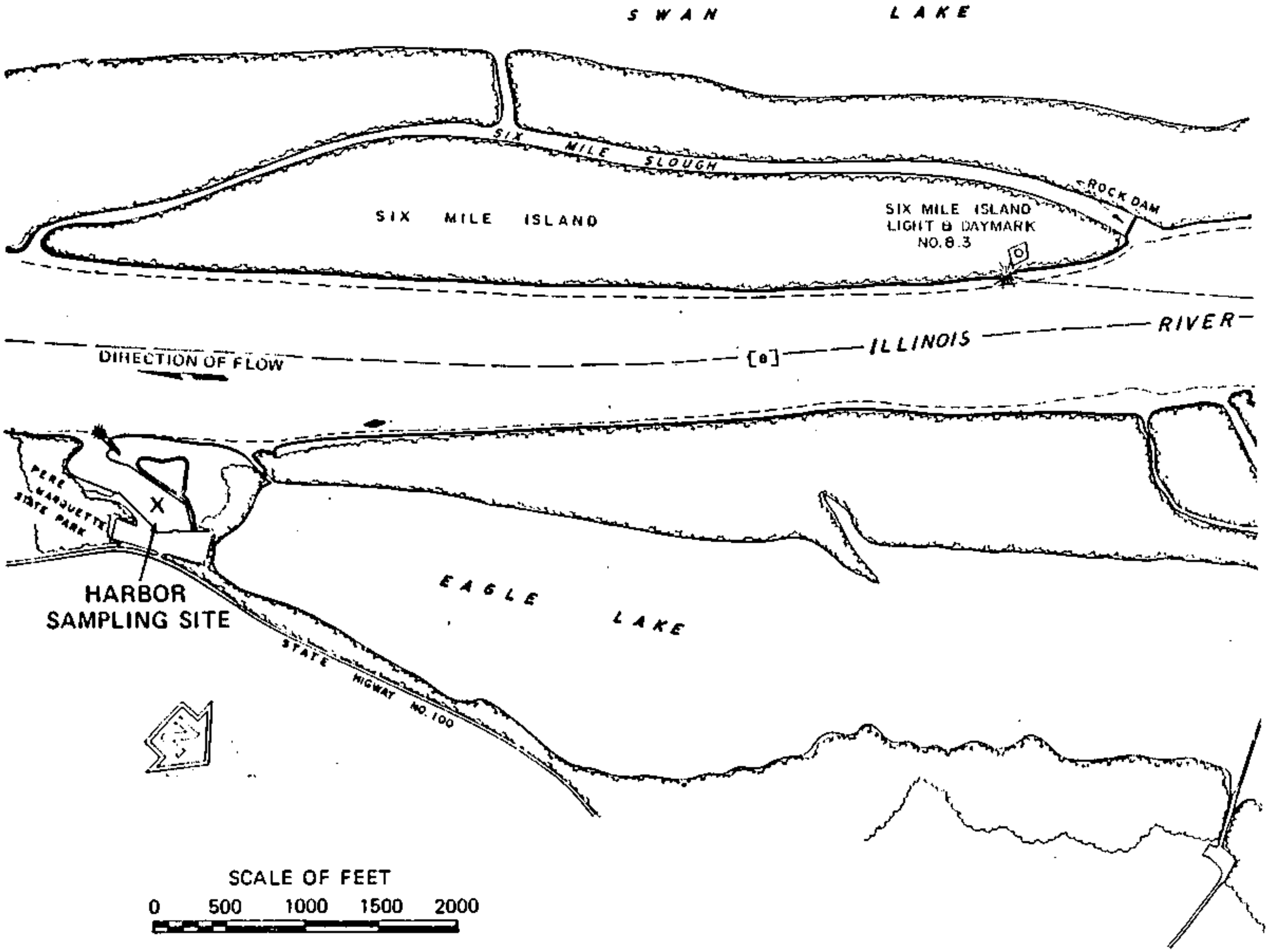


Figure 10. Harbor sampling site at Pere Marquette State Park, milepoint 1.5

36

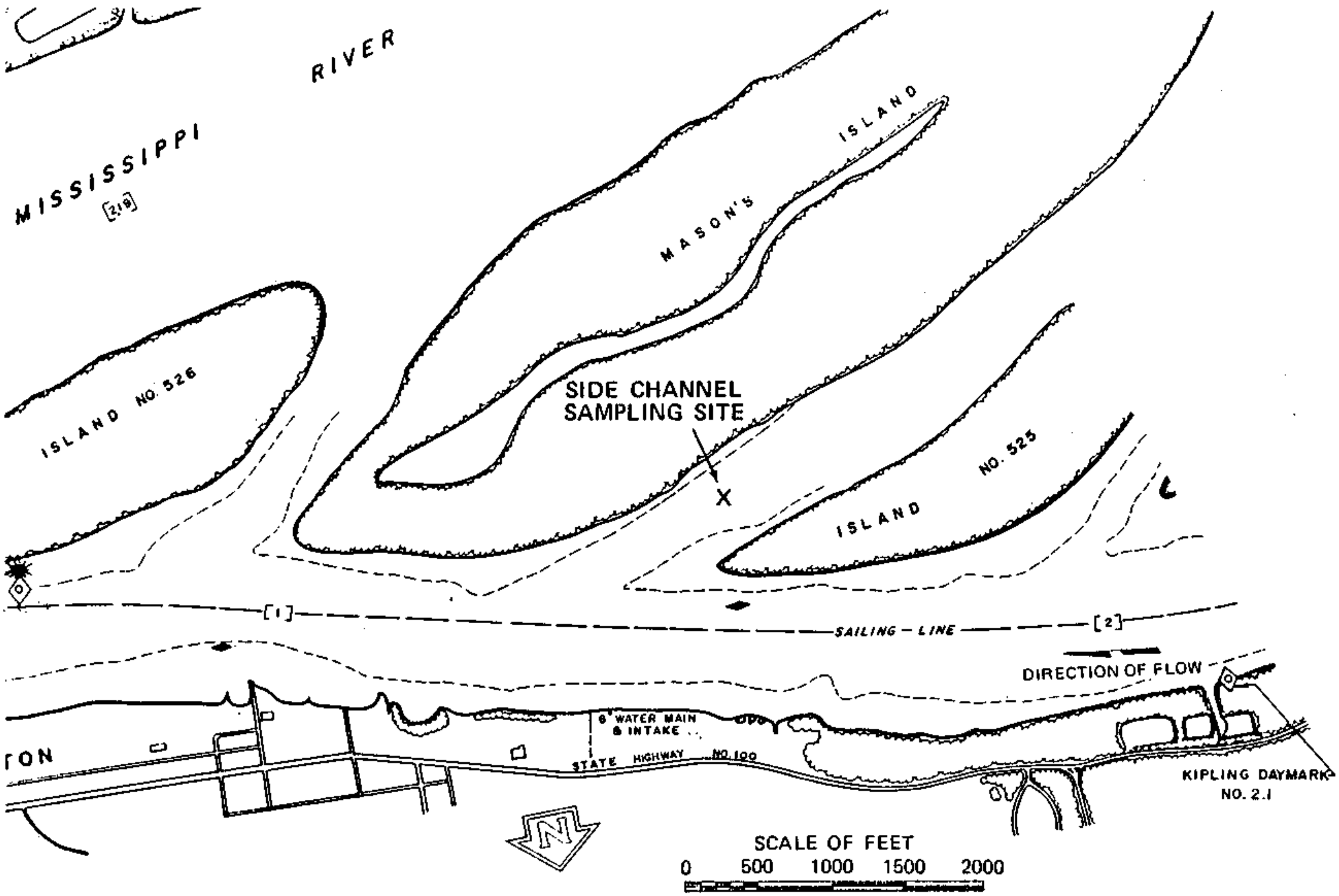


Figure 11. Side channel sampling site in Mason's Chute, milepoint 1.5

Table 4. Solids and Organic Content of Bottom Sediment

Sta.		% Solids	% Organic
79.3	A	66.7	3.37
	3	35.2	0.38
	C	73.1	4.07
	0	83.3	0.91
78.4	A	78.9	2.37
	C	33.1	0.44
	D	86.1	0.39
76.0	A	68.3	2.60
	3	69.0	3.33
	C	83.1	0.48
	D	75.1	1.96
74.5	A	62.5	3.87
	B	83.3	0.50
	C	82.4	0.51
	D	64.1	4.11
73.0	A	71.7	2.75
	B	70.7	3.16
	C	81.2	1.10
	D	70.5	3.50
71.3	A	70.0	3.21
	3	64.9	3.74
	C	83.8	0.28
	D	57.4	4.98
69.0	A	77.4	1.92
	B	82.5	0.70
	C	33.6	0.39
66.0	A	86.8	0.71
	B	88.0	0.76
	D	70.5	2.48
64.4	A	33.4	0.54
	3	33.1	0.32
	C	65.2	3.68
63.3	A	63.4	4.10
	B	76.1	1.63
	C	76.0	3.34
	D	62.3	4.49

Sta.		% Solids	% Organic
51.6	A	68.2	3.62
	B	80.8	1.26
	C	81.5	0.97
57.8	A	71.4	2.57
	B	83.1	0.66
	D	72.2	2.45
54.8	A	77.7	3.04
	B	82.7	1.01
	C	85.1	0.44
52.7	A	71.1	2.85
	B	71.7	2.72
	C	80.0	1.94
	D	73.4	2.46
48.6	A	64.9	3.39
	B	74.7	2.27
	C	75.2	7.09
	D	59.8	4.13
47.8	A	55.1	5.09
	B	79.8	1.40
	C	.85.2	0.29
46.1	A	84.9	0.34
	B	69.3	3.22
	C	80.1	1.63
	D	79.6	3.04
44.1	A	72.1	2.92
	B	71.8	2.59
	C	82.6	1.09
	D	65.4	3.85
41.4	C	76.8	4.13
40.0	A	63.0	3.95
	B	71.0	3.31
	C	78.1	2.11
	D	76.2	2.58
37.9	B	69.9	3.31
	C	82.7	0.55
	D	72.6	2.99

Sta.		% Solids	% Organic
36.5	A	74.2	2.59
	B	74.1	2.75
	C	84.5	0.60
34.2	A	65.3	3.74
	B	34.4	4.59
	C	83.7	0.67
	D	61.6	4.36
30.6	A	64.8	3.70
	B	60.2	4.38
	C	83.9	0.63
	D	70.1	2.64
29.3	A	62.4	3.65
	B	68.8	3.23
	C	79.7	3.01
	D	81.1	1.50
27.9	A	61.6	4.26
(M)	B	57.3	4.53
	C	69.4	5.84
	D	69.5	2.33
27.9	A	64.8	3.25
(S)	B	68.6	3.36
	D	64.0	3.70
25.1	A	71.5	3.66
(M)	B	65.2	3.50
	C	81.9	0.74
	D	74.8	2.53
25.1	A	72.3	2.35
(S)	B	56.9	4.63
	C	66.9	3.02
	D	73.3	3.39
22.0	B	65.5	3.30
18.9	A	69.2	2.95
(M)	B	52.1	5.26
	C	33.4	0.23
	D	70.4	2.64

Table 4. Concluded

Sta.		% SoLids	% Organic
18.9	A	66.4	3.01
(S)	B	60.6	3.92
	C	65.1	3.13
	D	59.3	3.50
16.5	A	64.5	3.40
	3	50.0	5.55
	C	62.6	5.79
	D	67.3	3.60
14.6	A	64.8	3.44
	5	67.1	3.21
	D	52.3	5.27
13.5	A	65.2	3.33
(M)	B	61.2	3.78
	C	36.4	0.64
	D	85.7	0.41
13.5	A	68.7	2.65
(S)	3	64.1	3.30
	C	81.2	0.90
12.1	A	72.3	2.26
	B	59.6	3.88
	C	63.9	3.43
	D	46.0	5.92
10.3	A	66.4	3.13
	B	56.7	4.27
	D	72.3	2.60
3.3	A	67.5	3.20
	B	54.6	4.64
	C	61.8	3.75
	0	72.8	2.04
7.2	A	69.2	2.96
(M)	B	58.9	4.23
	C	61.6	3.91
	D	59.7	4.07
7.2	C	46.3	5.69
(S)			
5.2	A	64.0	3.34
	B	56.6	4.18
	C	38.4	1.10
	D	85.8	2.82
3.0	A	63.7	3.48
	B	65.8	3.91
	C	61.0	3.75
	D	51.8	4.76
1.5	A	59.3	4.04
(M)	C	73.0	1.43
	D	50.3	4.81
1.5	A	76.4	1.76
(S)	B	69.1	2.66
	C	66.8	2.52
	D	72.6	2.78
0.7	A	72.5	2.03
	B	66.3	3.23
	C	72.0	5.29
	D	59.6	3.77
0.2	A	51.8	4.64
	B	84.1	0.39
	C	82.9	0.68
	D	49.4	5.28

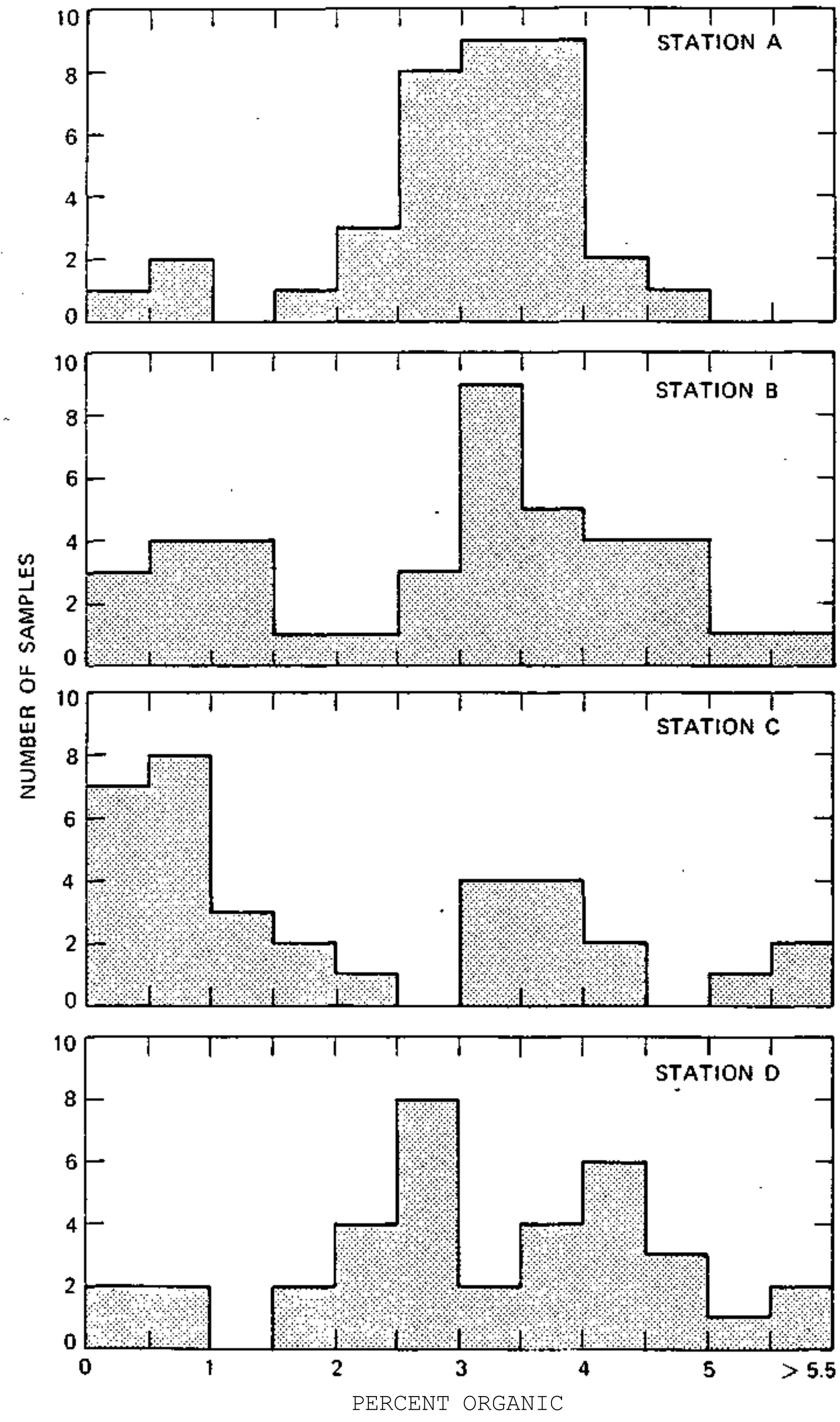


Figure 12. Percent organic content of bottom sediments in the Alton Pool, Illinois Waterway

been an attempt here to relate those characteristics to the description of the waterway in terras of channel geometry or streamflow. Nevertheless, certain features of the bottom sediments display some consistency in terms of water depth and length. Based solely on an examination of the data presented here and observations in other navigation pools of the waterway, the following points merit consideration:

With few exceptions, the bottom materials in the deeper portions of the navigation channel in the Alton Pool consist mainly of sand.

Other portions of the navigaton channel bottom, with few exceptions, consist mainly of silt.

The absence of silt and clay in the deeper portion of the channel may be the result of navigation traffic.

3ased on observations in other navigation pools of the Illinois Waterway, a sandy bottom is not a reliable habitat for benthic organisms (Butts et al., 1981; Evans et al., 1981).

Above milepoint 40.0 about 50 percent of the sampling stations have bottom materials consisting mainly of sand and shells. This includes areas other than the deeper portion. 3elow milepoint 40.0 a silt bottom prevails other than in the deeper portion of the channel.

On the assumption that benthic organisms are related to silty bed material and that silty bed material is more subject to dispersal than sand, the critical area of the pool lies below milepoint 40.0 (Butts et al,, 1981; Evans et al., 1981).

Management practices designed to mitigate the influence of navigation traffic on sediment dispersal and benthic organism dislodgement will be more productive in the waterway below milepoint 40.0.

ACKNOWLEDGMENTS

This study was funded by the Upper Mississippi River Basin Commission and conducted as part of the work of the Water Quality Section of the

Illinois State Water Survey, Stanley A. Changnon, Jr., Chief. The original manuscript was typed by Linda Johnson, illustrations were prepared by John Brother, final editing was done by J. L. Ivens, and camera-ready copy was prepared by Pamela Lovett.

REFERENCES

3utts, Thomas, Donald Roseboom, Thomas Hill, Shunndar Lin, Davis Beuscher, Richard Twait, and Ralph Evans, 1981. Water quality assessment and waste assimilative analysis of the LaGrange Pool, Illinois River, Contract Report in press.

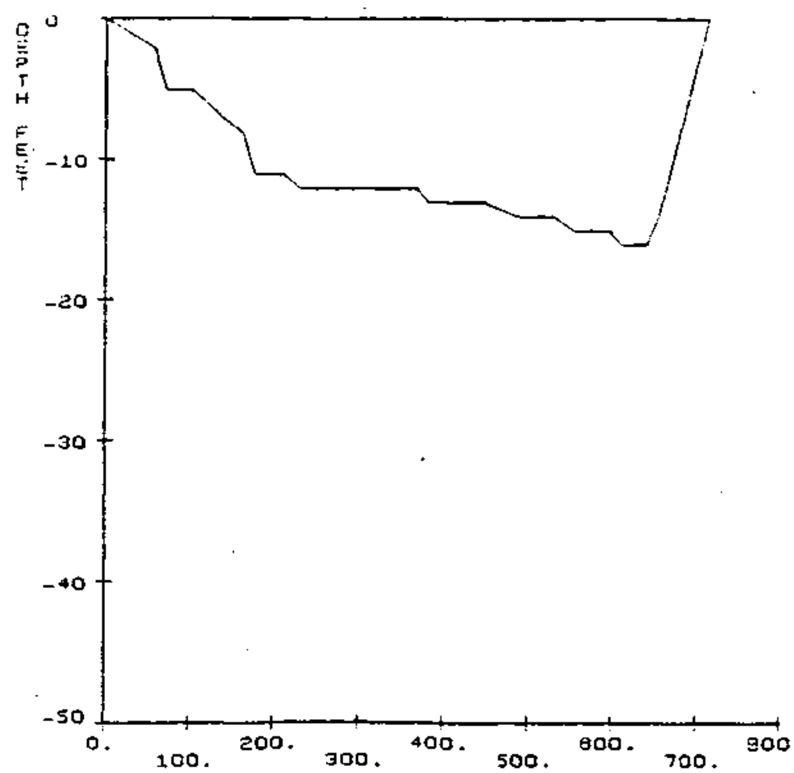
Evans, Ralph, Thomas Hill, Donald Schnepper, and David Hullinger, 1981. Waste from the water treatment plant at Alton and its impact on the Mississippi River, Contract Report, work in progress.

Guy, Harold P., 1969. Laboratory theory and methods for sediment ananlysis, Book 5, Chapter Cl, Techniques of Water-Resources Investigations of the United States Geological Survey.

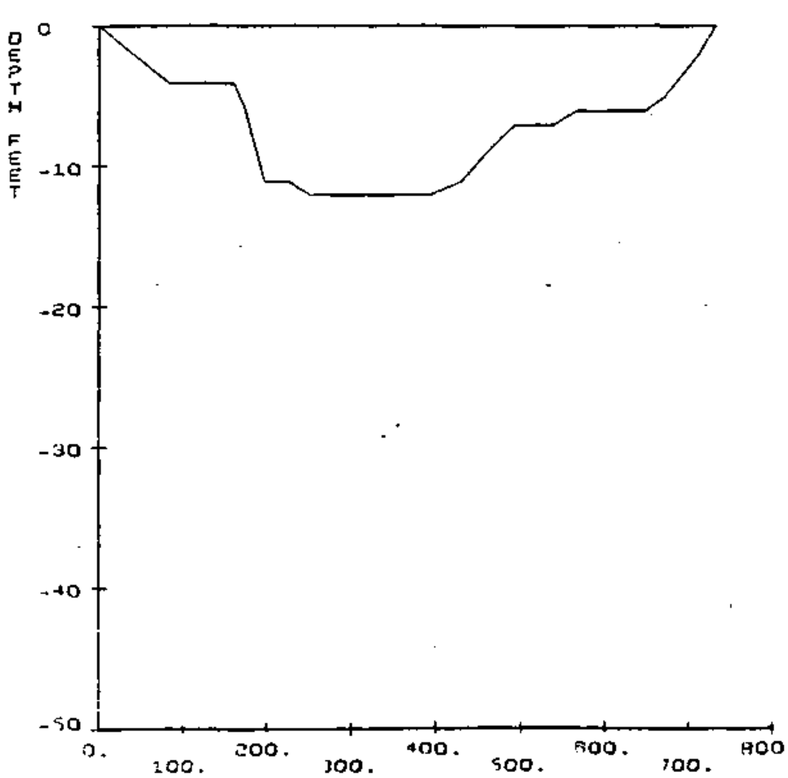
APPENDICES

APPENDIX A

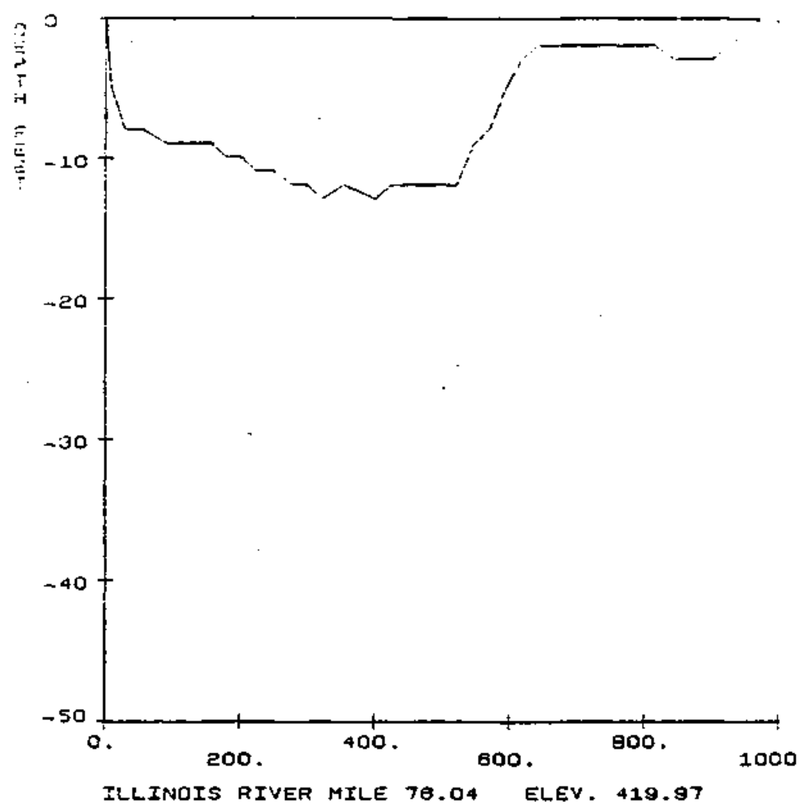
Channel Cross Sections at Sampling Transects

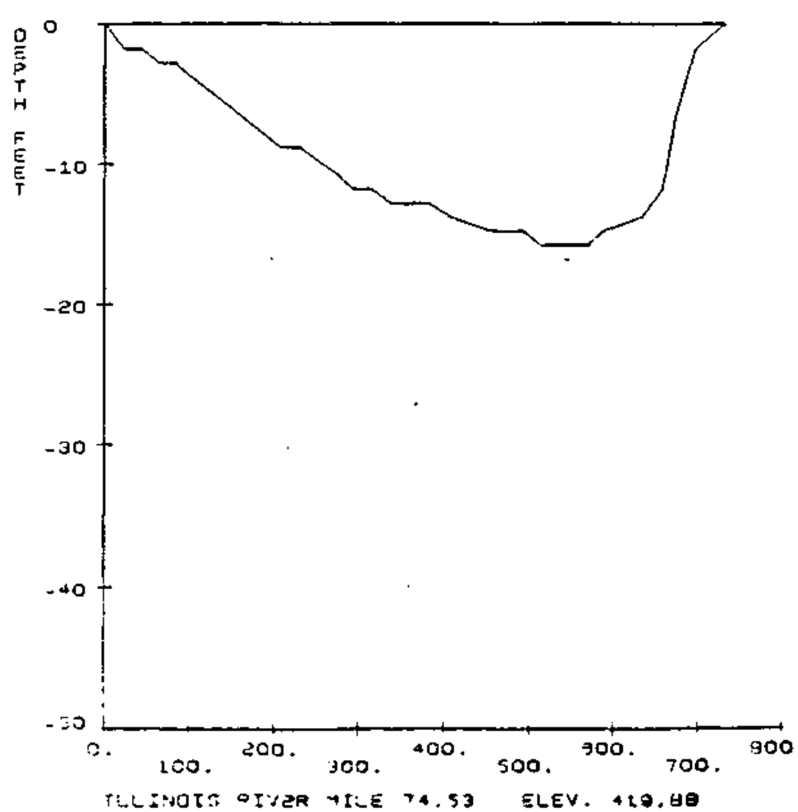


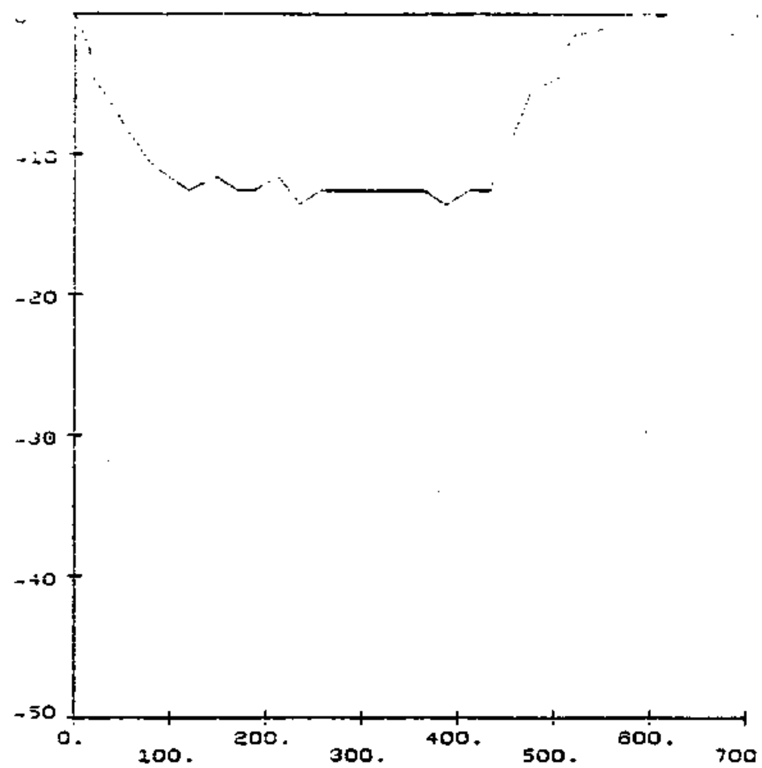
ILLINOIS RIVER MILE 79.28 ELEV. 420.17



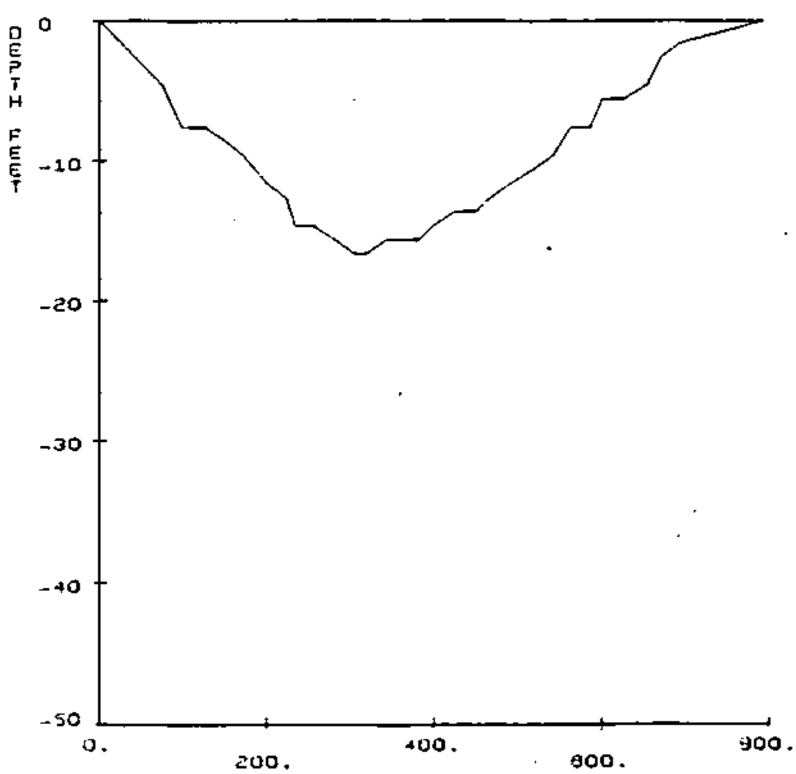
ILLINOIS RIVER MILE 78.30 ELEV. 420.11


DEPTH FEET
0
-10
-20
-30
-40
-50
0.
200.
400.
600.
800.
1000.
ILLINOIS RIVER MILE 76.04 ELEV. 419.97

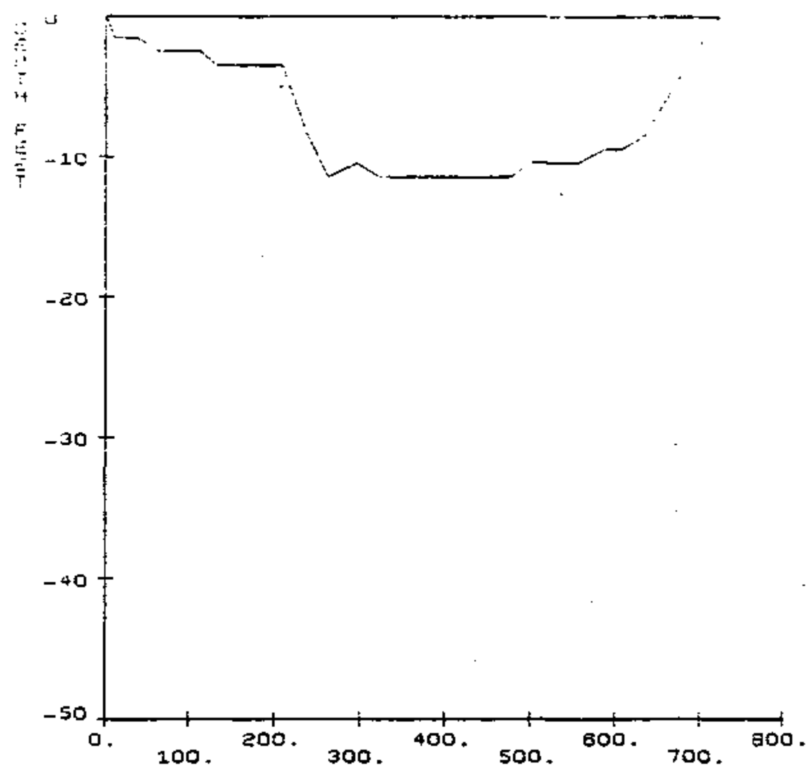

DEPTH FEET
0
-10
-20
-30
-40
-50
0.
100.
200.
300.
400.
500.
600.
700.
800.
ILLINOIS RIVER MILE 74.53 ELEV. 419.88



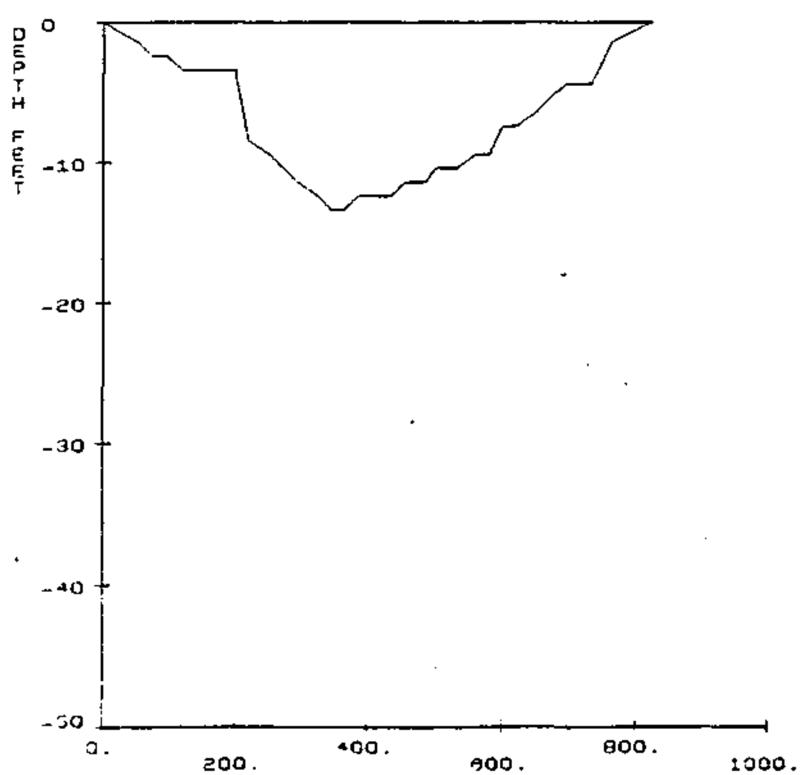
ILLINOIS RIVER MILE 73.09   ELEV. 419.85



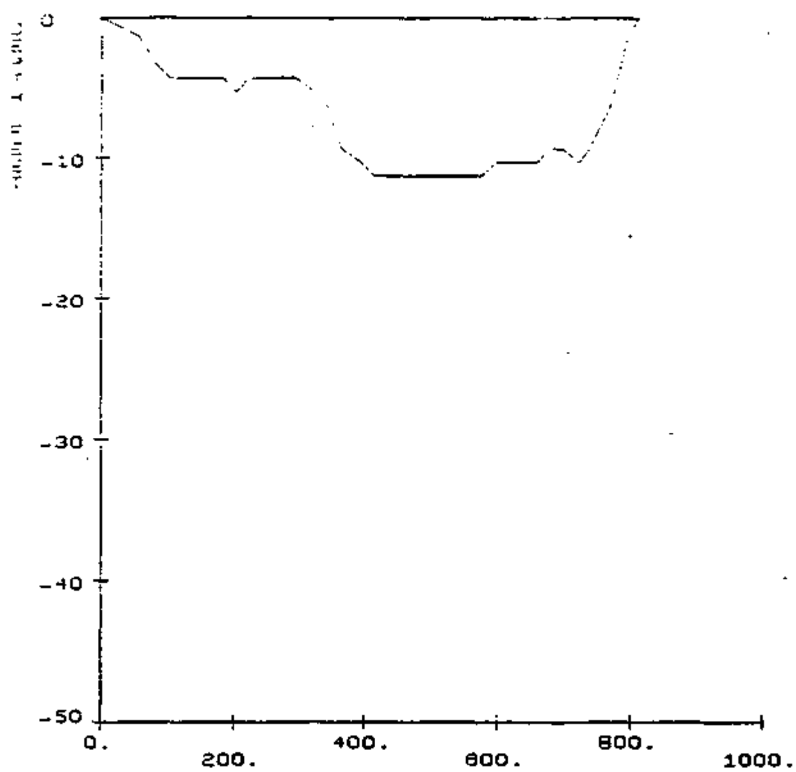
ILLINOIS RIVER MILE 71.29   ELEV. 419.87



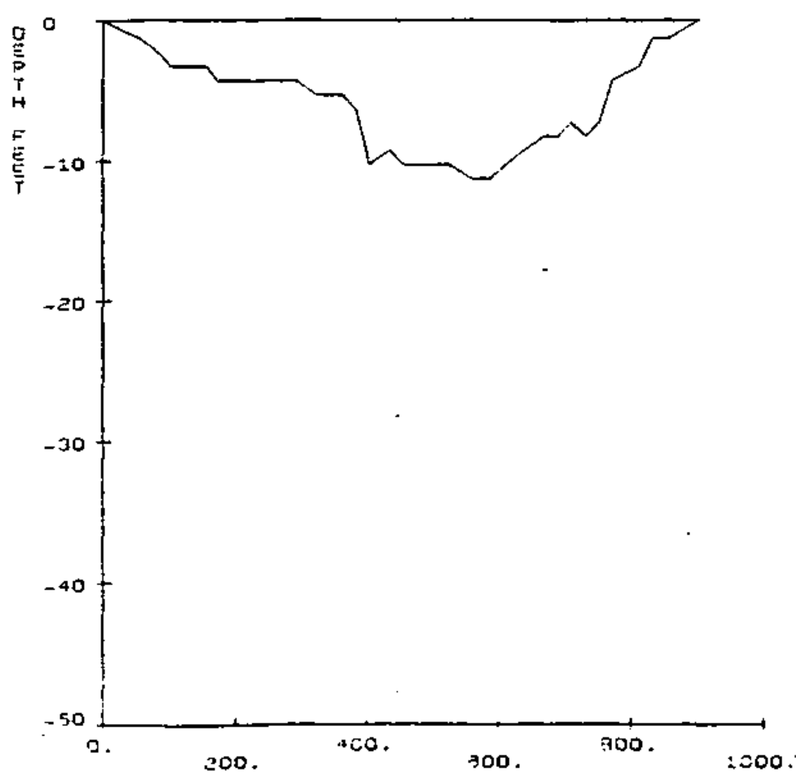
ILLINOIS RIVER MILE 69.03 ELEV. 419.57



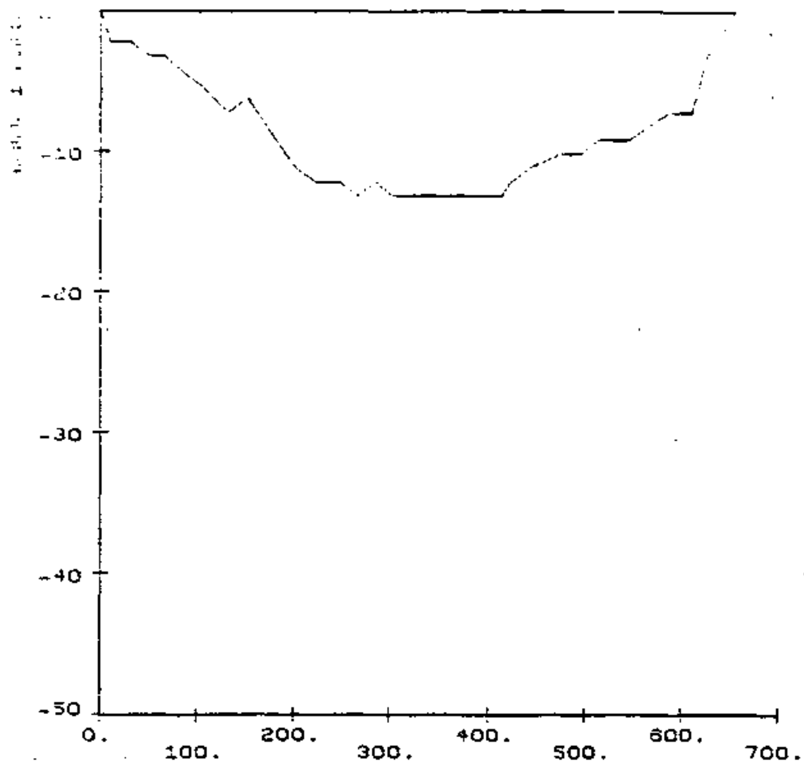
ILLINOIS RIVER MILE 65.92 ELEV. 419.42



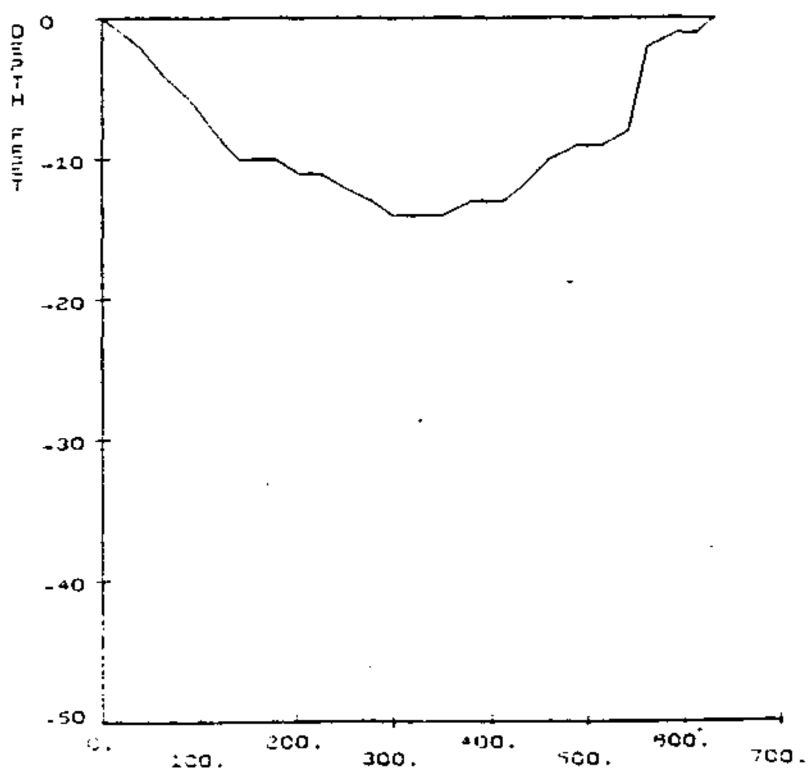
ILLINOIS RIVER MILE 84.37   ELEV. 419.35



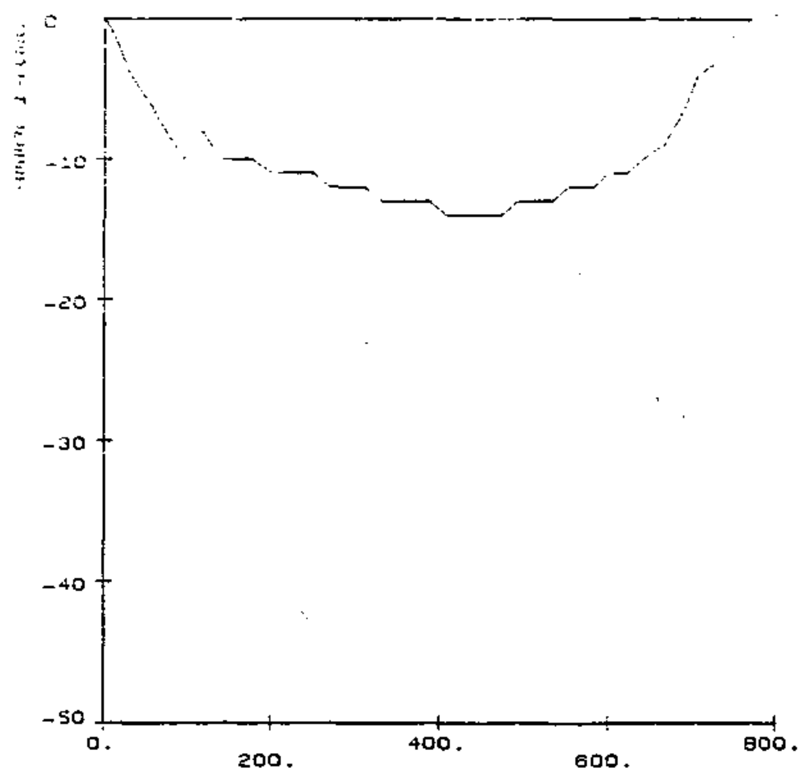
ILLINOIS RIVER MILE 83.45   ELEV. 419.30



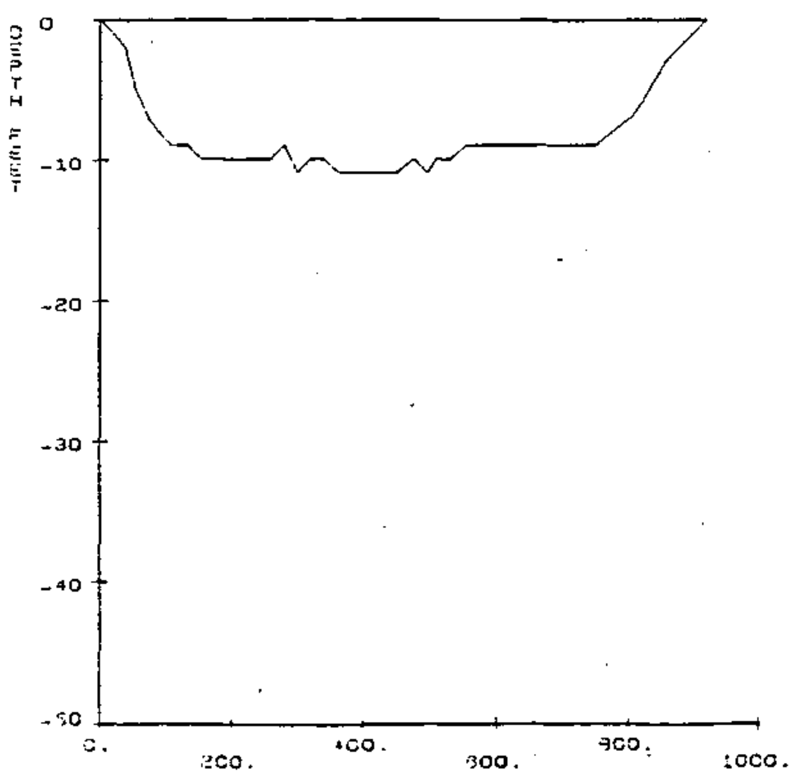
ILLINOIS RIVER MILE 81.55   ELEV. 419.21



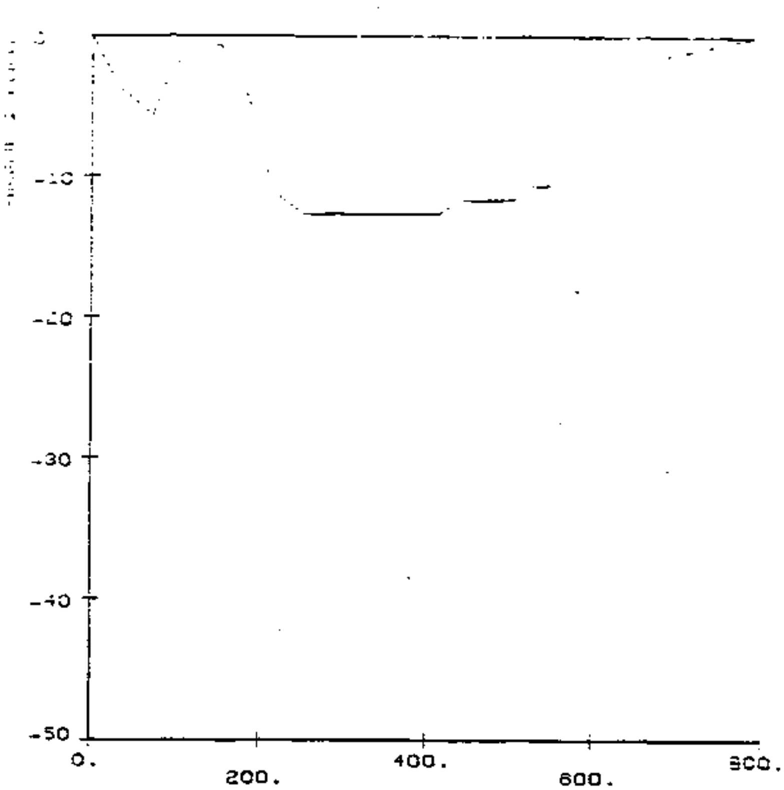
ILLINOIS RIVER MILE 57.98   ELEV. 419.10



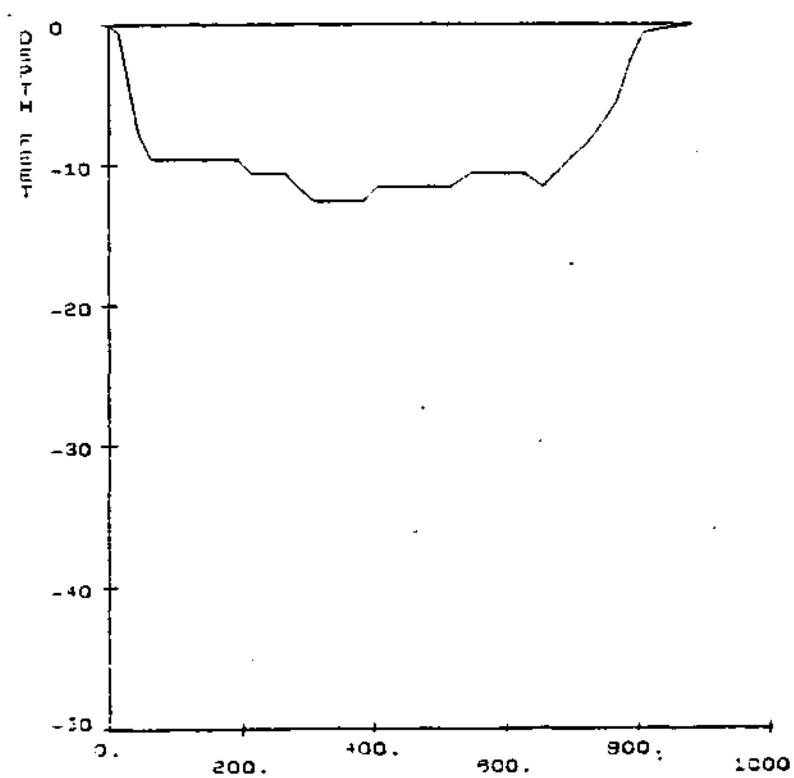
ILLINOIS RIVER MILE 54.71 ELEV. 419.00



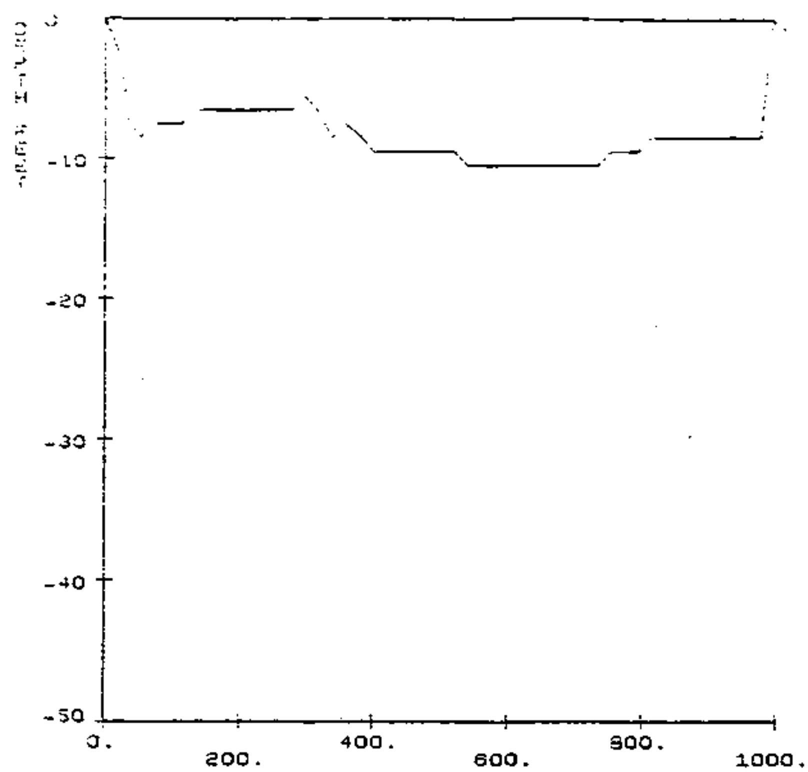
ILLINOIS RIVER MILE 52.68 ELEV. 418.33



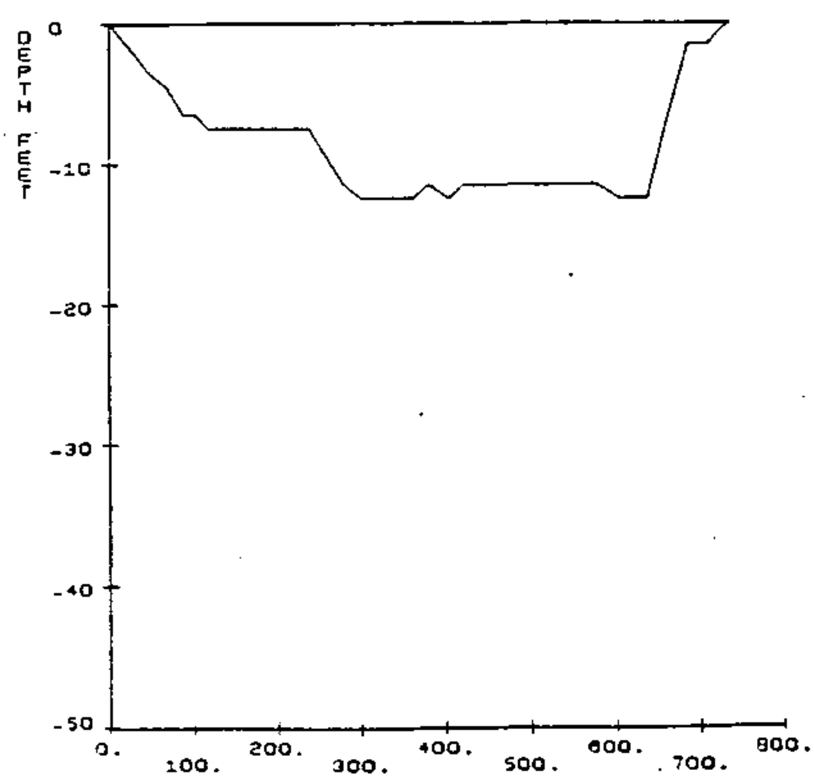
ILLINOIS RIVER MILE 46.15 ELEV. 419.70



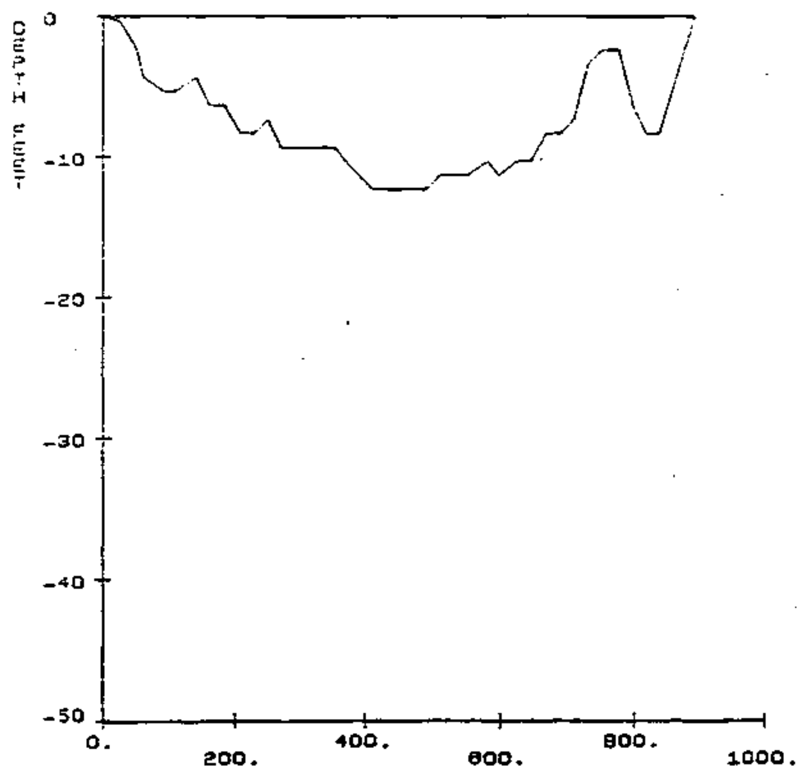
ILLINOIS RIVER MILE 44.08 ELEV. 419.63



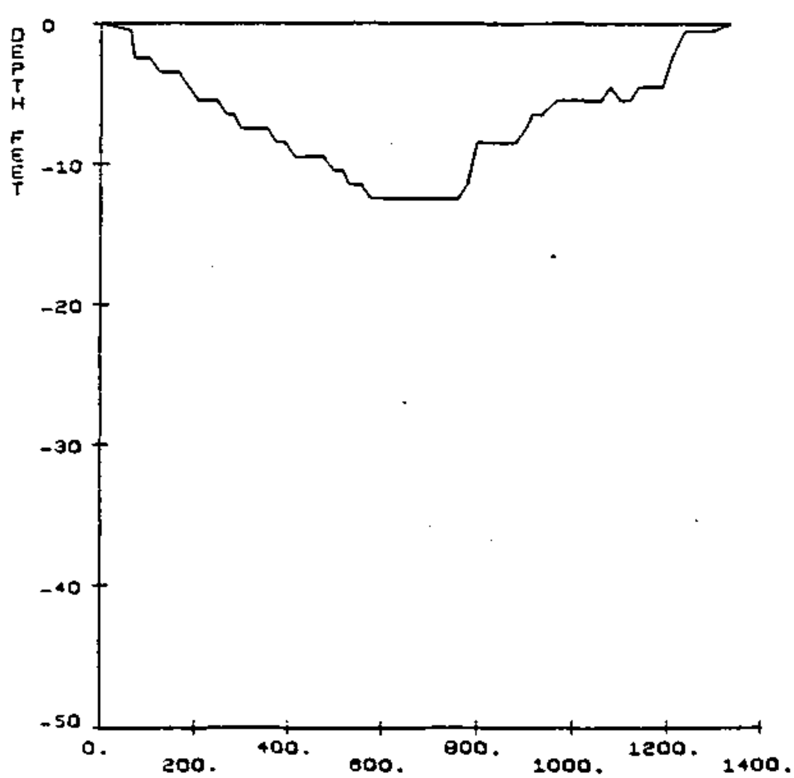
ILLINOIS RIVER MILE 41.41   ELEV. 418.55



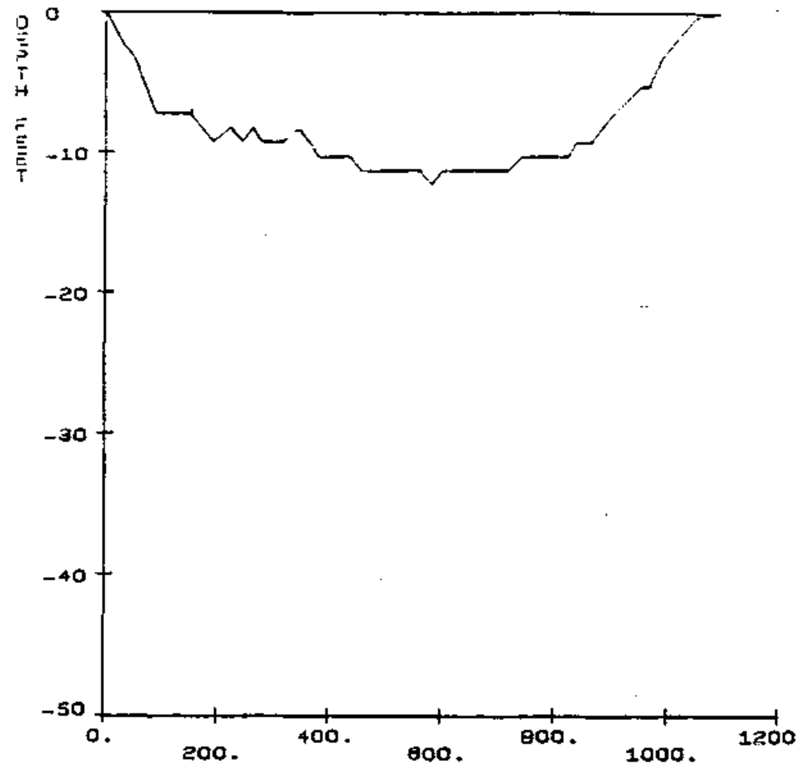
ILLINOIS RIVER MILE 40.07   ELEV. 418.51



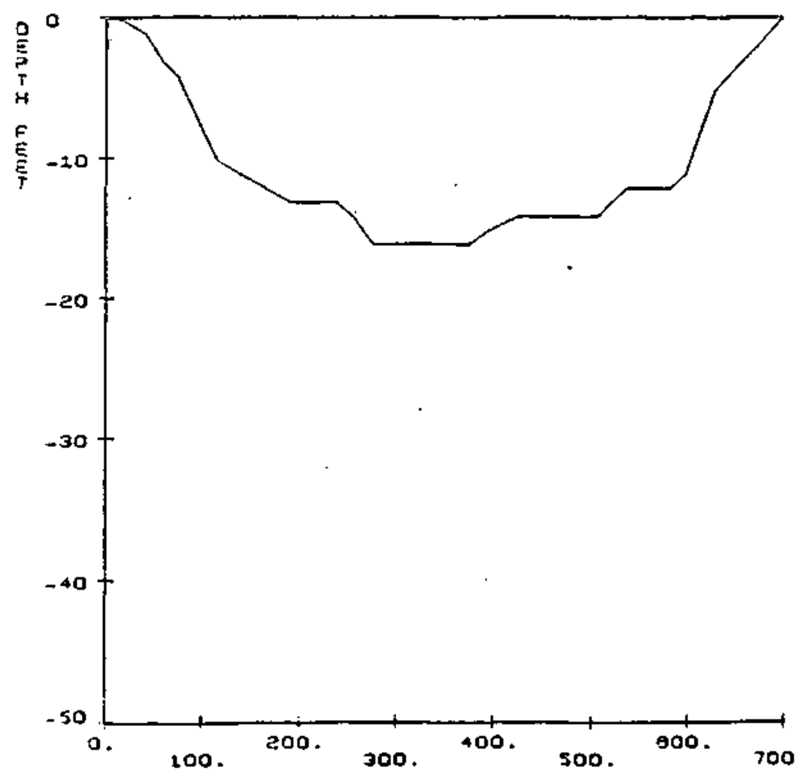
ILLINOIS RIVER MILE 37.87 ELEV. 418.44



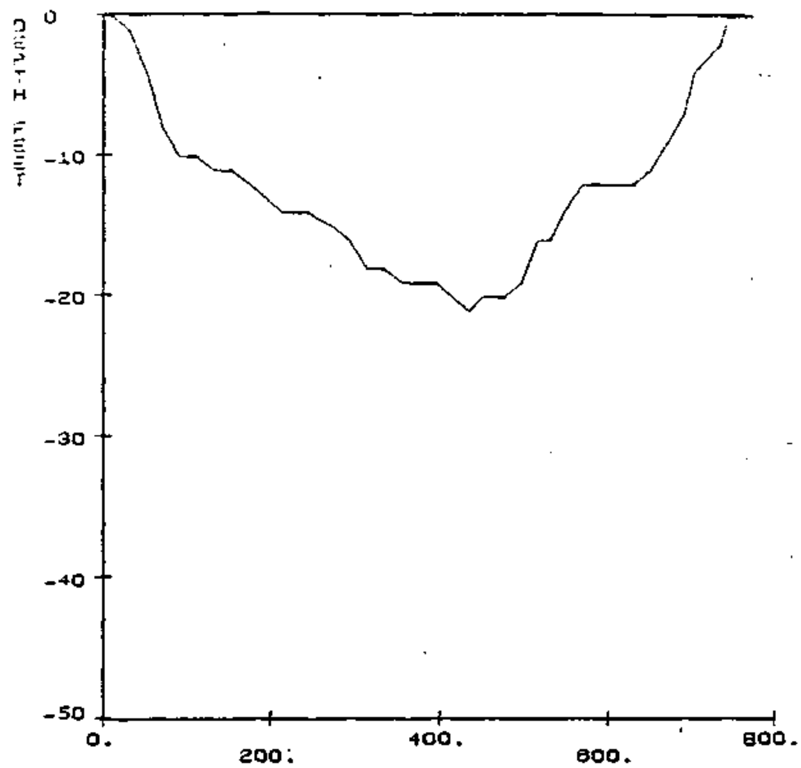
ILLINOIS RIVER MILE 36.44 ELEV. 418.40



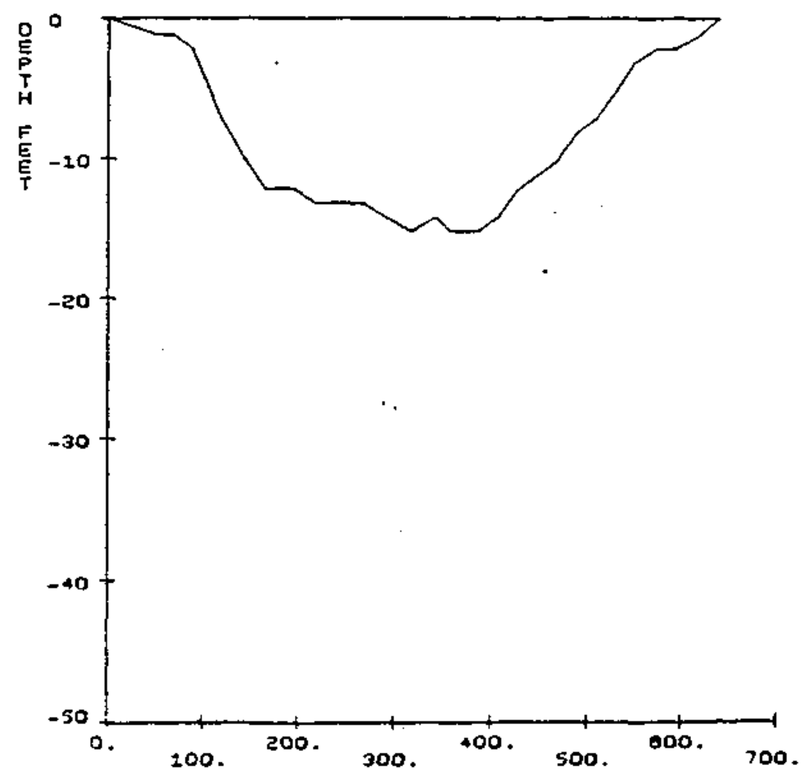
ILLINOIS RIVER MILE 34.18 ELEV. 418.33



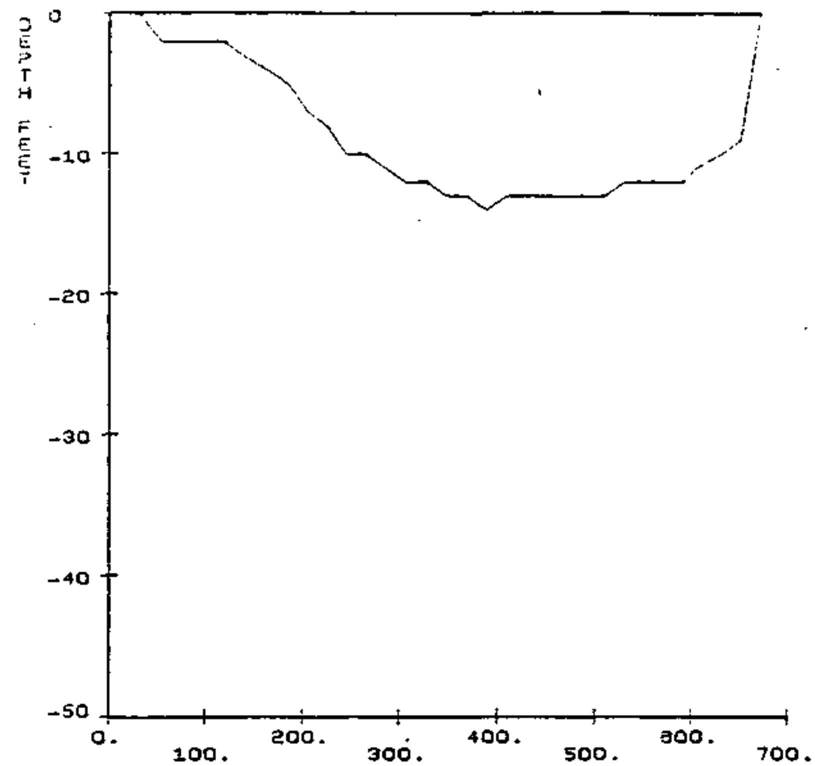
ILLINOIS RIVER MILE 30.53 ELEV. 418.24



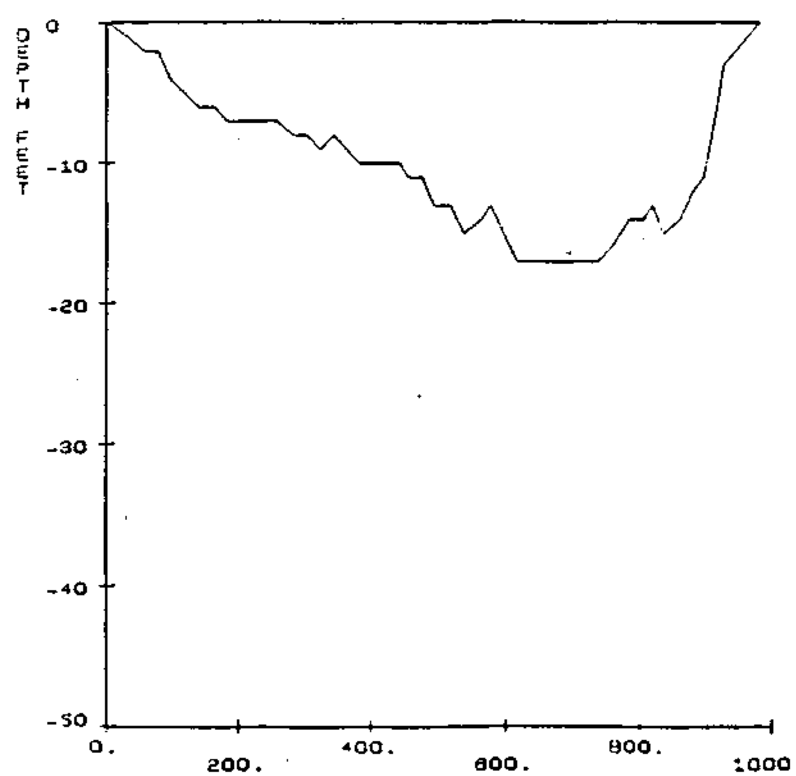
ILLINOIS RIVER MILE 29.38 ELEV. 418.22



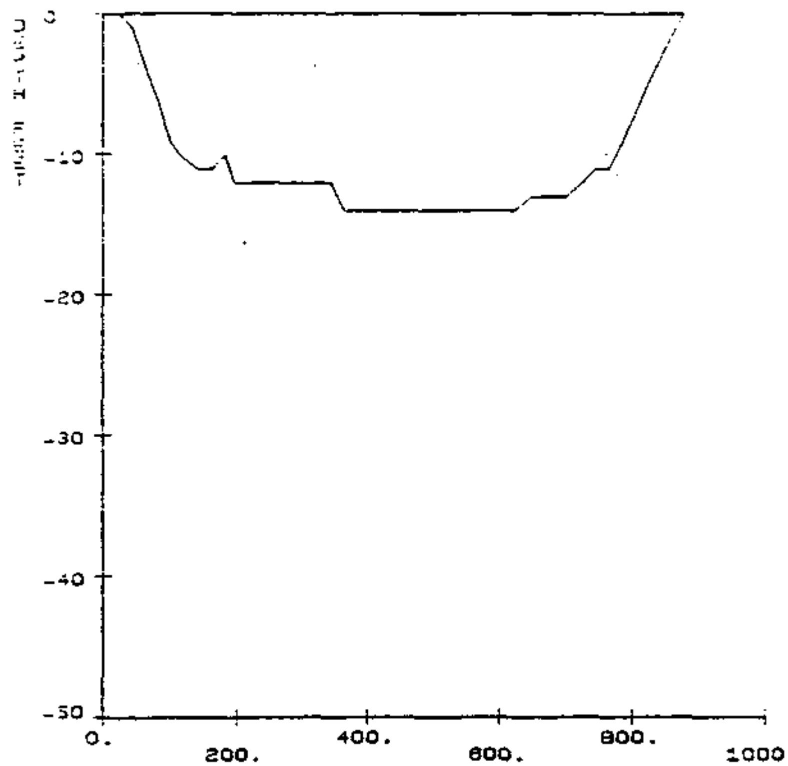
ILLINOIS RIVER MILE 27.88 ELEV. 418.21



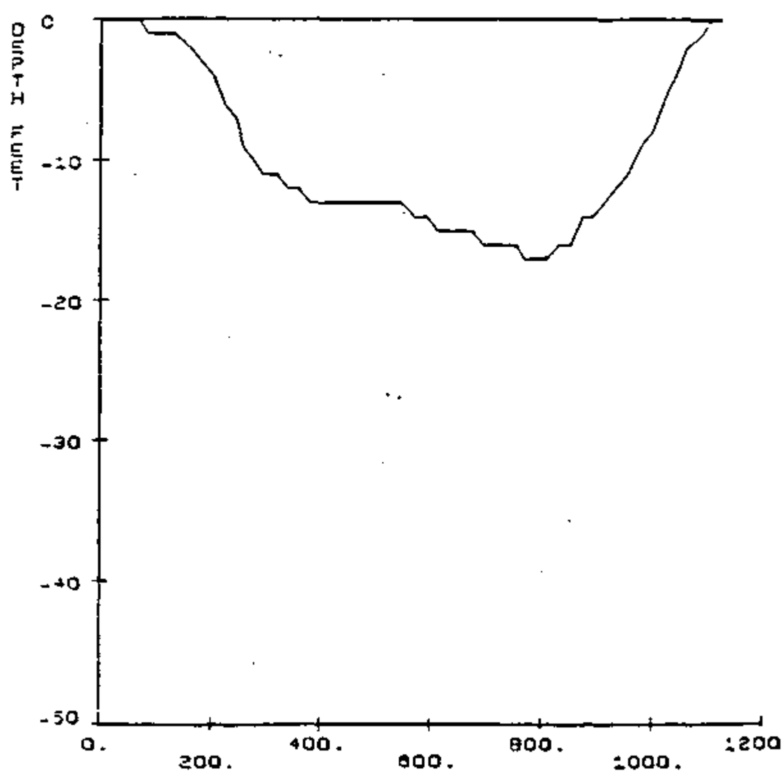
ILLINOIS RIVER MILE 25.01 ELEV. 418.17



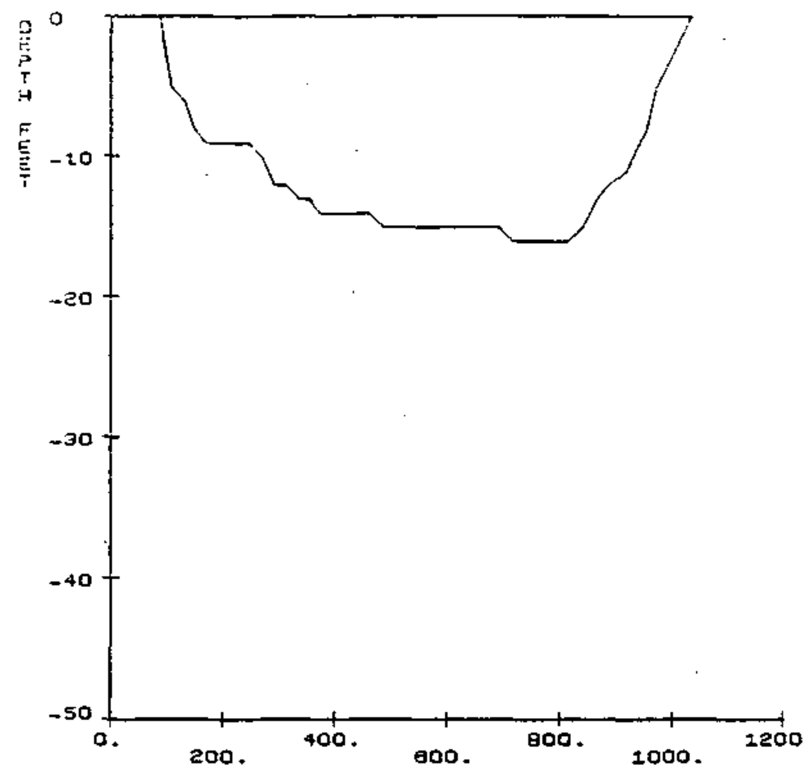
ILLINOIS RIVER MILE 21.92 ELEV. 418.13



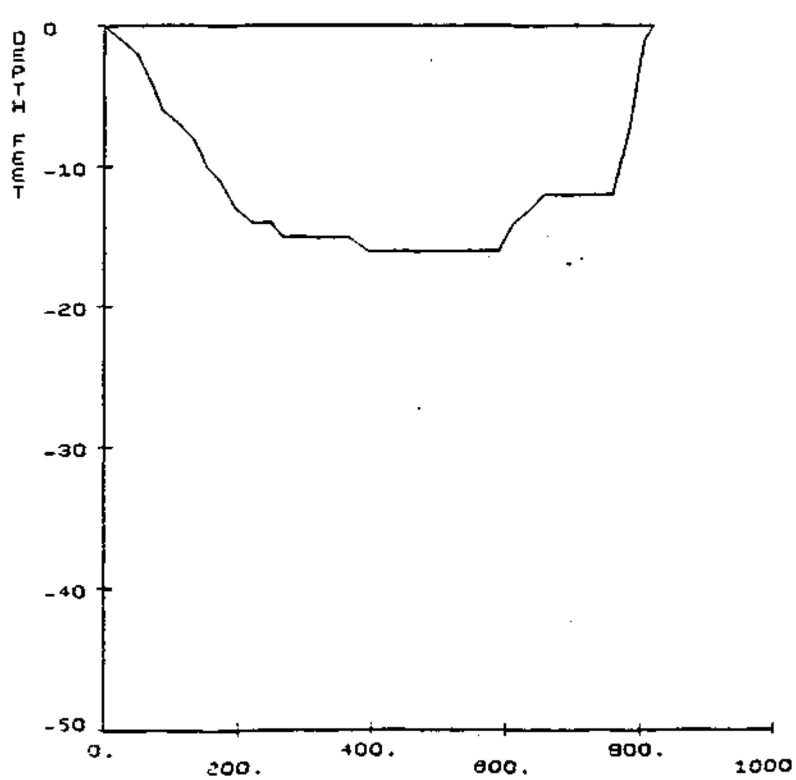
ILLINOIS RIVER MILE 18.87 ELEV. 418.12



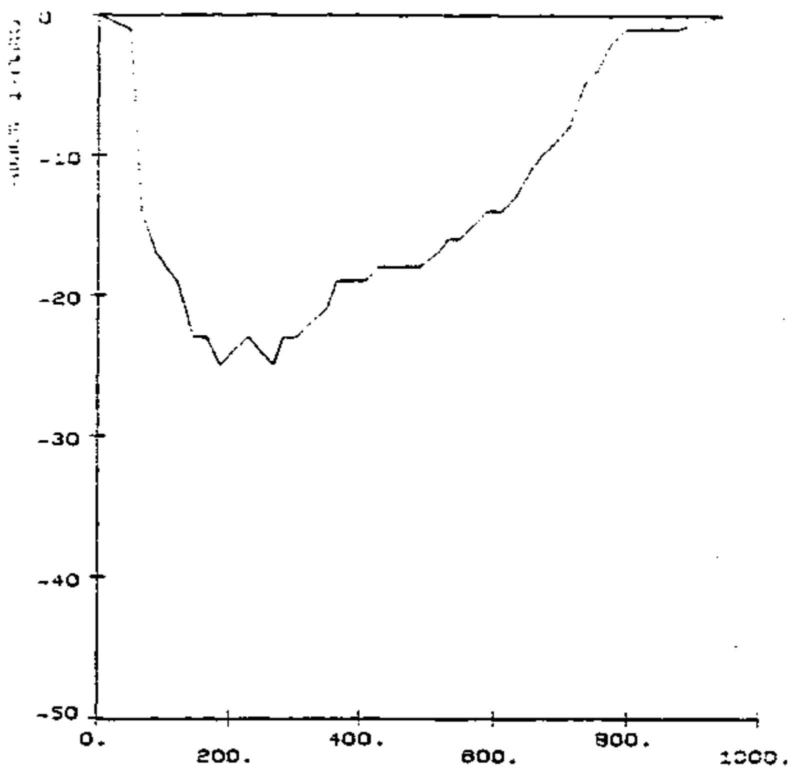
ILLINOIS RIVER MILE 18.54 ELEV. 418.11



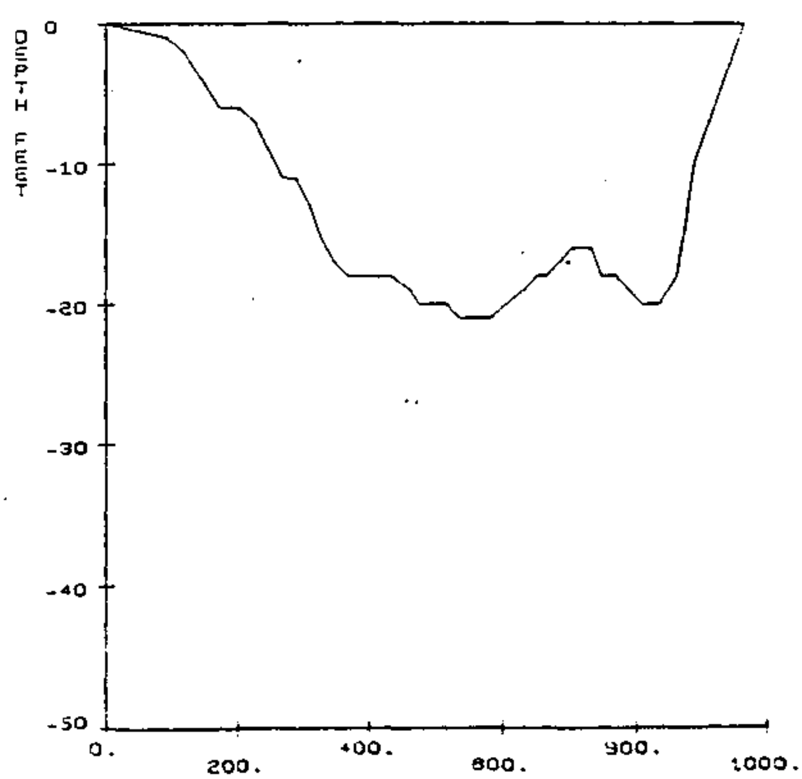
ILLINOIS RIVER MILE 14.81 ELEV. 418.10



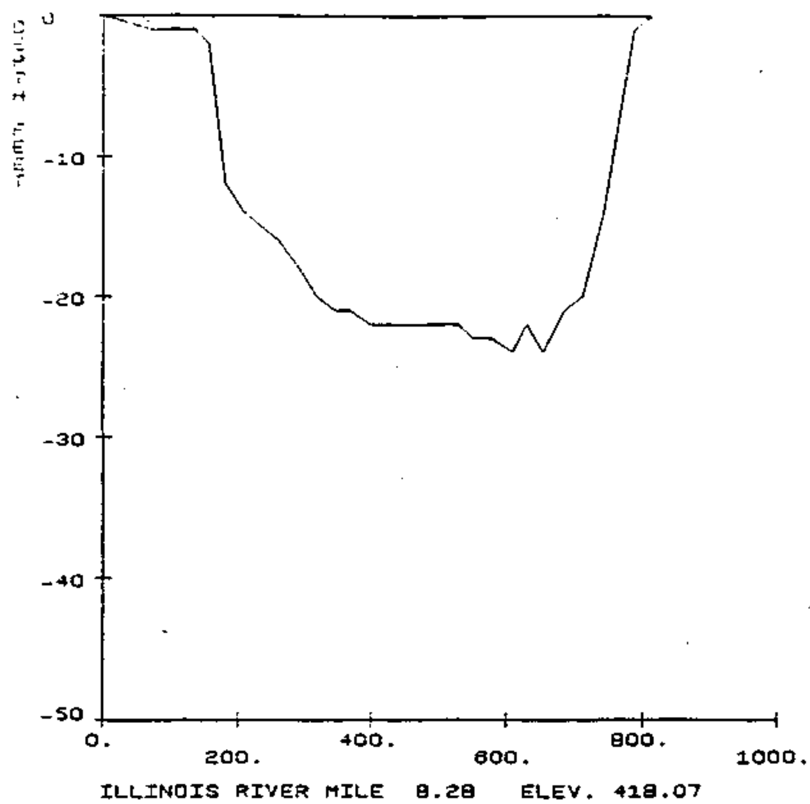
ILLINOIS RIVER MILE 13.46 ELEV. 418.10

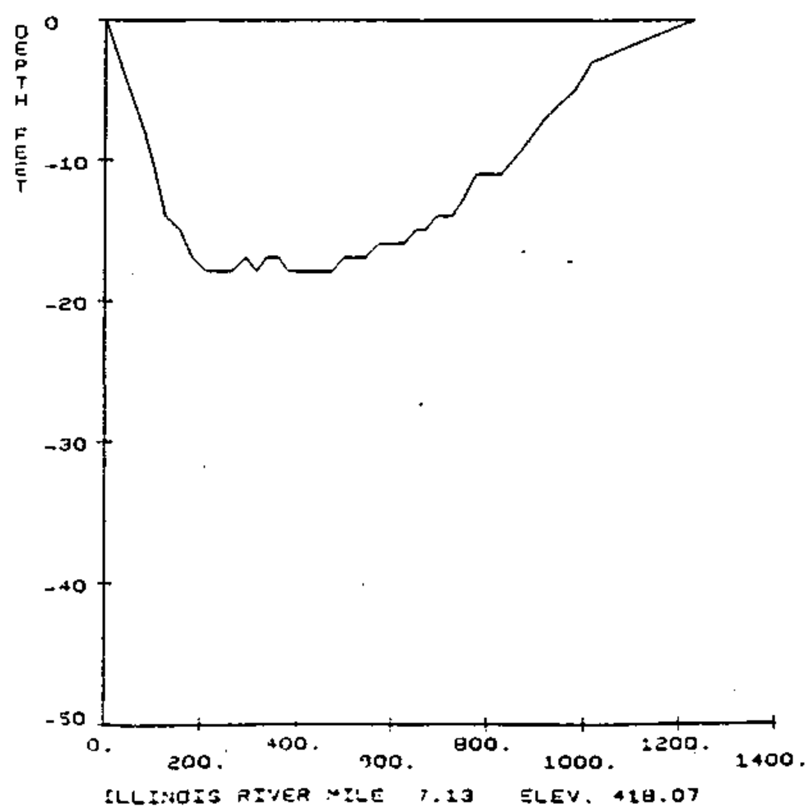


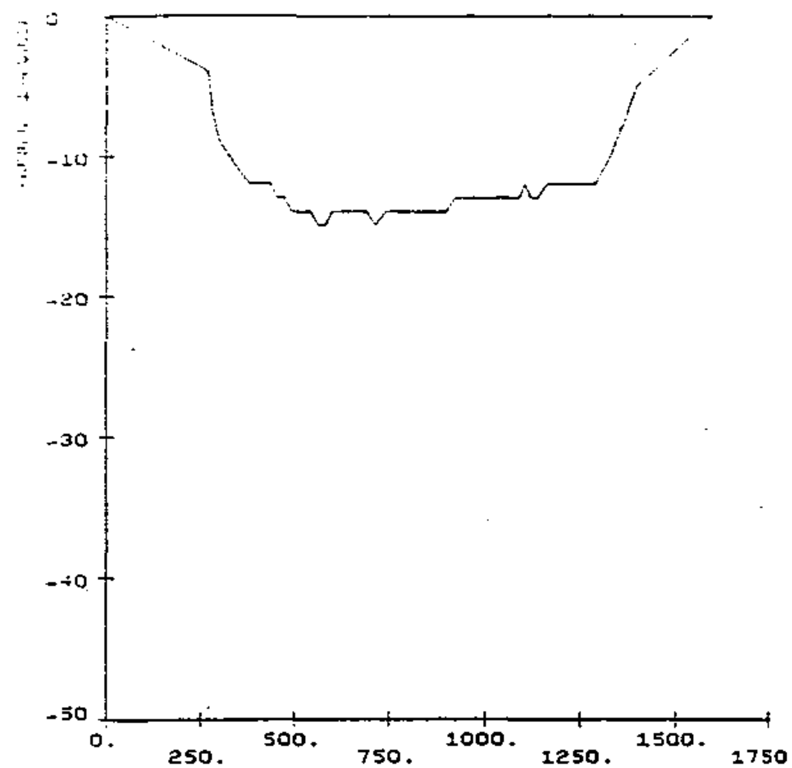
ILLINOIS RIVER MILE 12.10   ELEV. 418.09



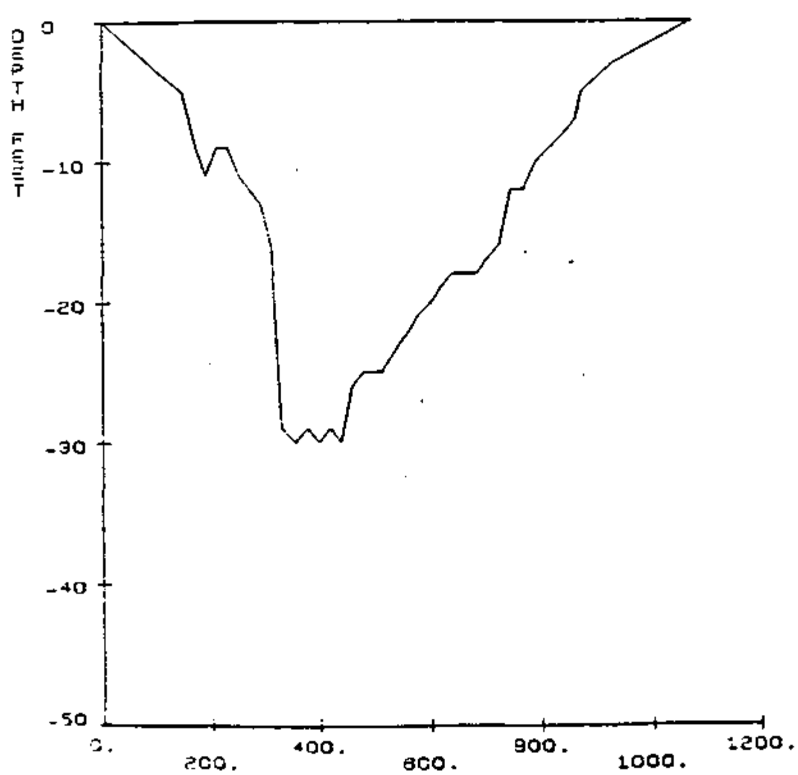
ILLINOIS RIVER MILE 10.35   ELEV. 418.08


DEPTH FEET
0
-10
-20
-30
-40
-50
0.
200.
400.
600.
800.
1000.
ILLINOIS RIVER MILE 8.28 ELEV. 418.07

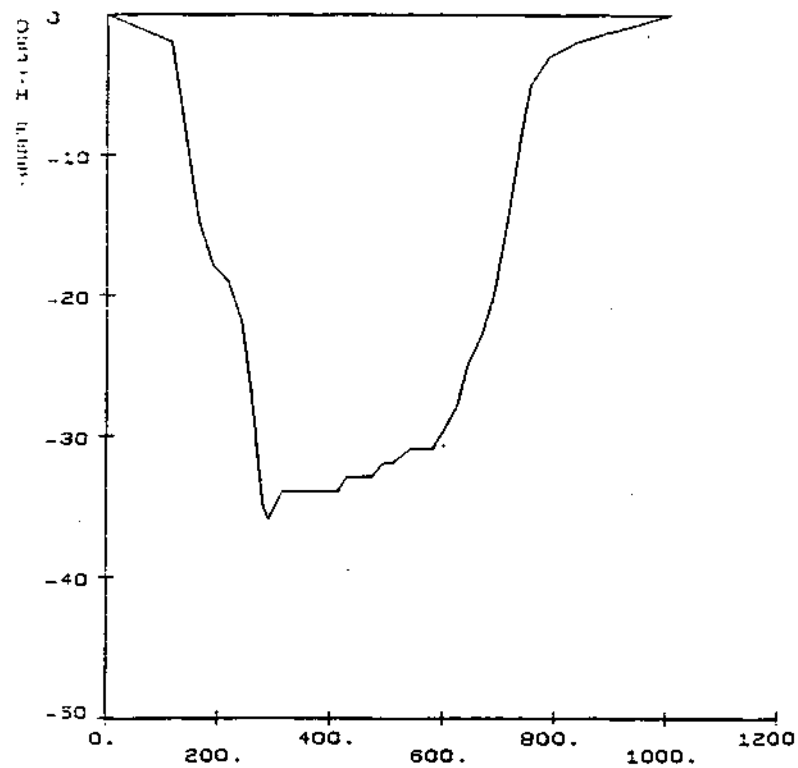

DEPTH FEET
0
-10
-20
-30
-40
-50
0.
200.
400.
600.
800.
1000.
1200.
1400.
ILLINOIS RIVER MILE 7.13 ELEV. 418.07



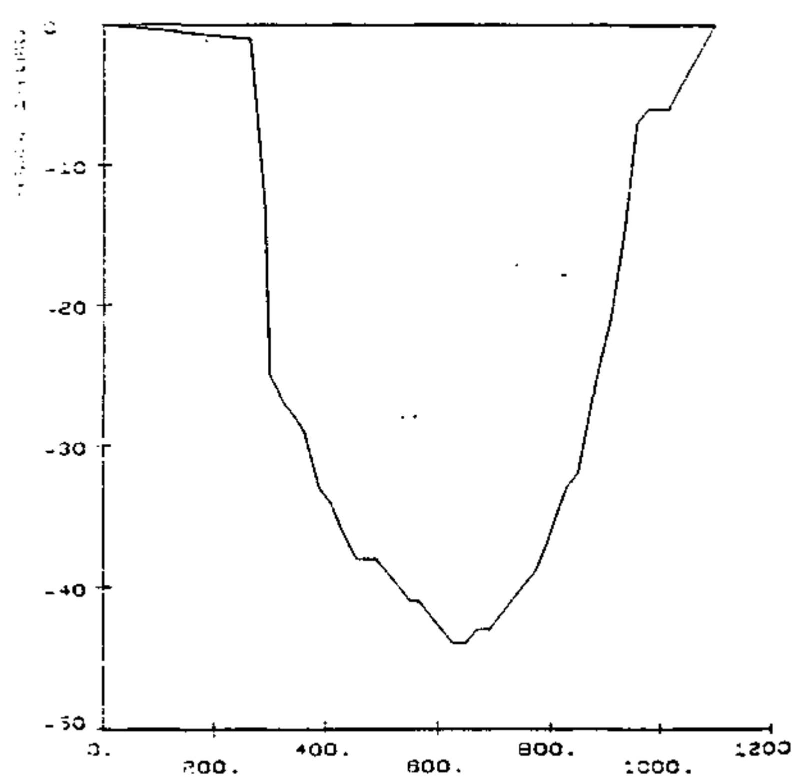
ILLINOIS RIVER MILE 5.13 ELEV. 418.08



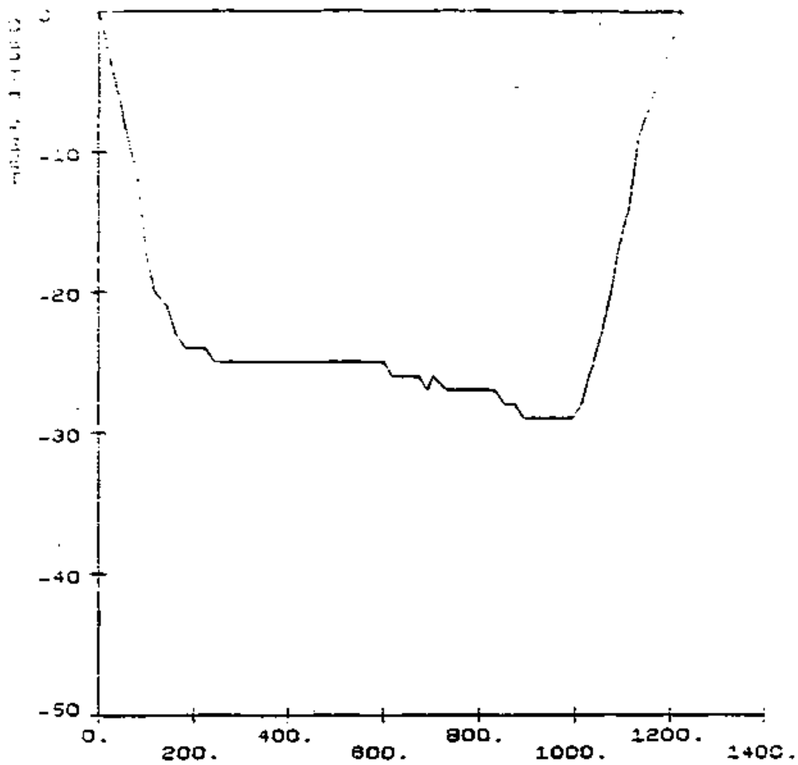
ILLINOIS RIVER MILE 2.91 ELEV. 418.05



ILLINOIS RIVER MILE 1.57 ELEV. 418.05



ILLINOIS RIVER MILE .78 ELEV. 418.04



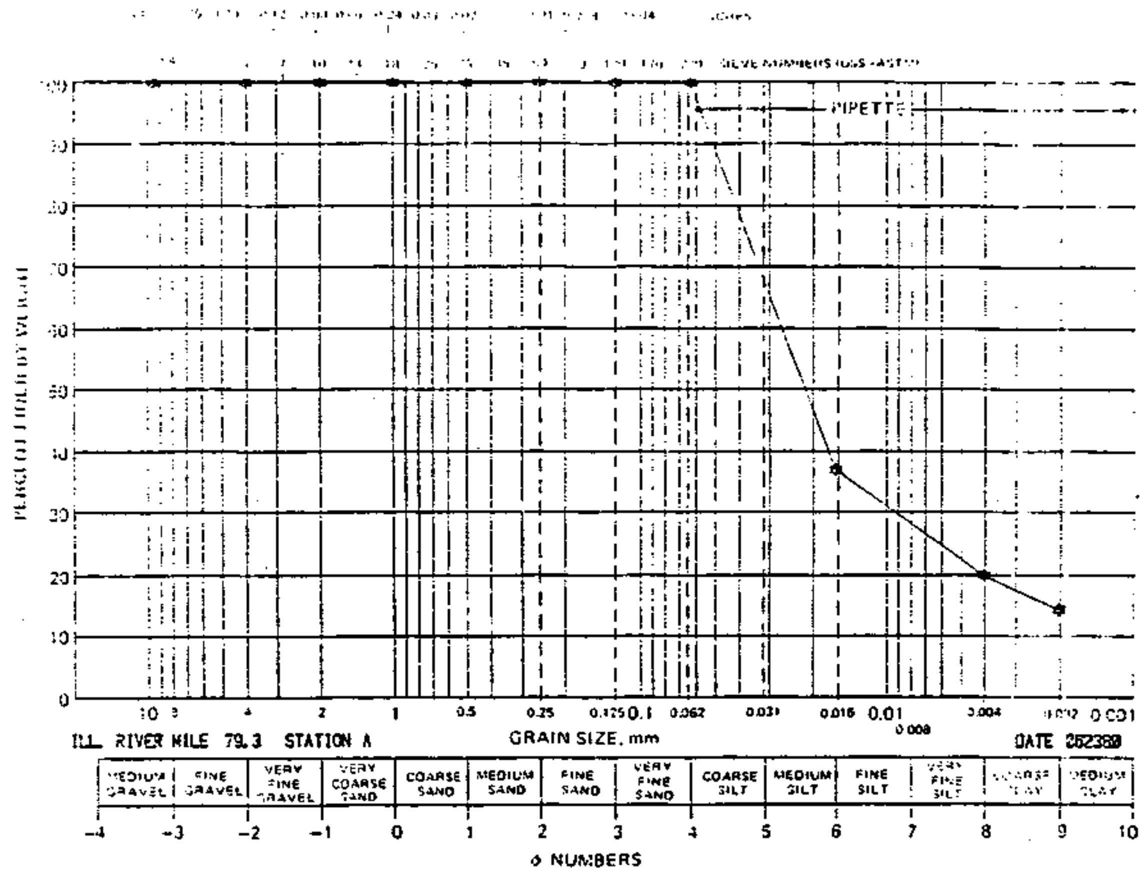
ILLINOIS RIVER MILE .22 ELEV. 418.04

APPENDIX B

Particle-Size Distribution Graphs

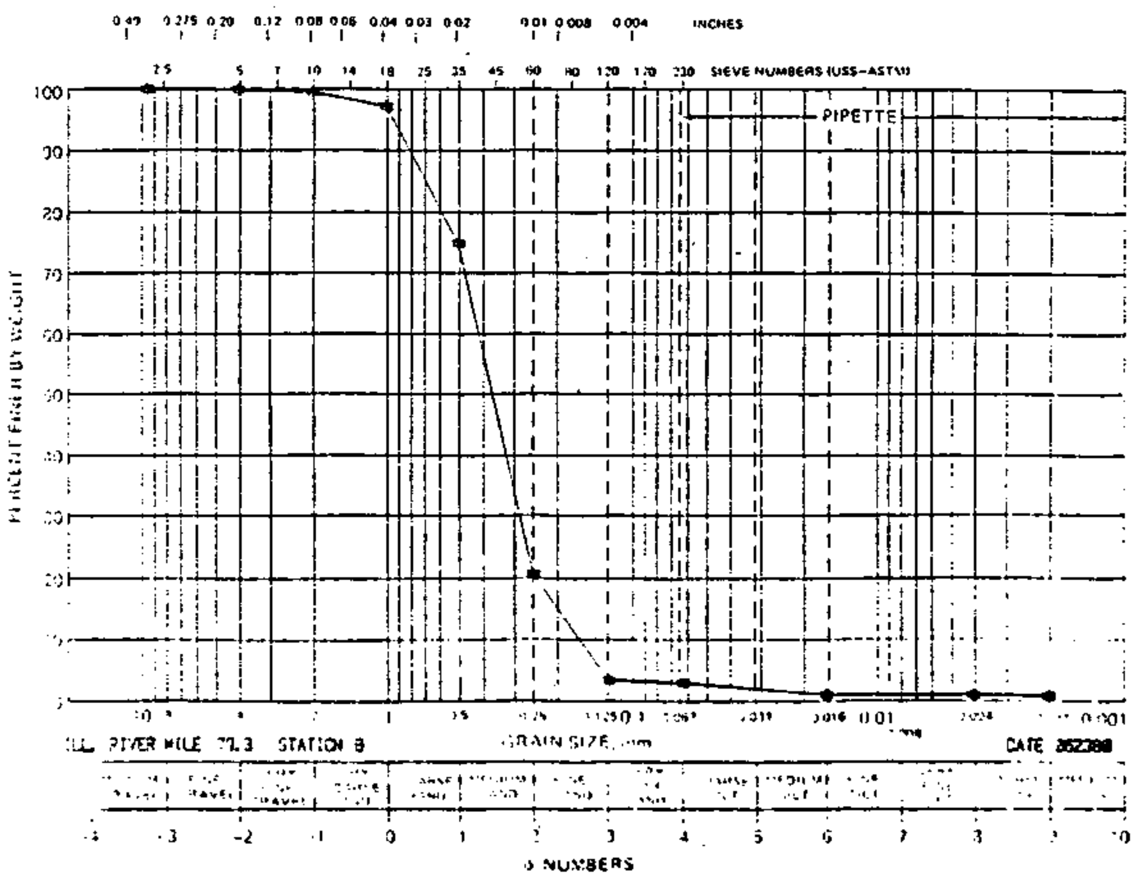
ILLINOIS STATE WATER SURVEY

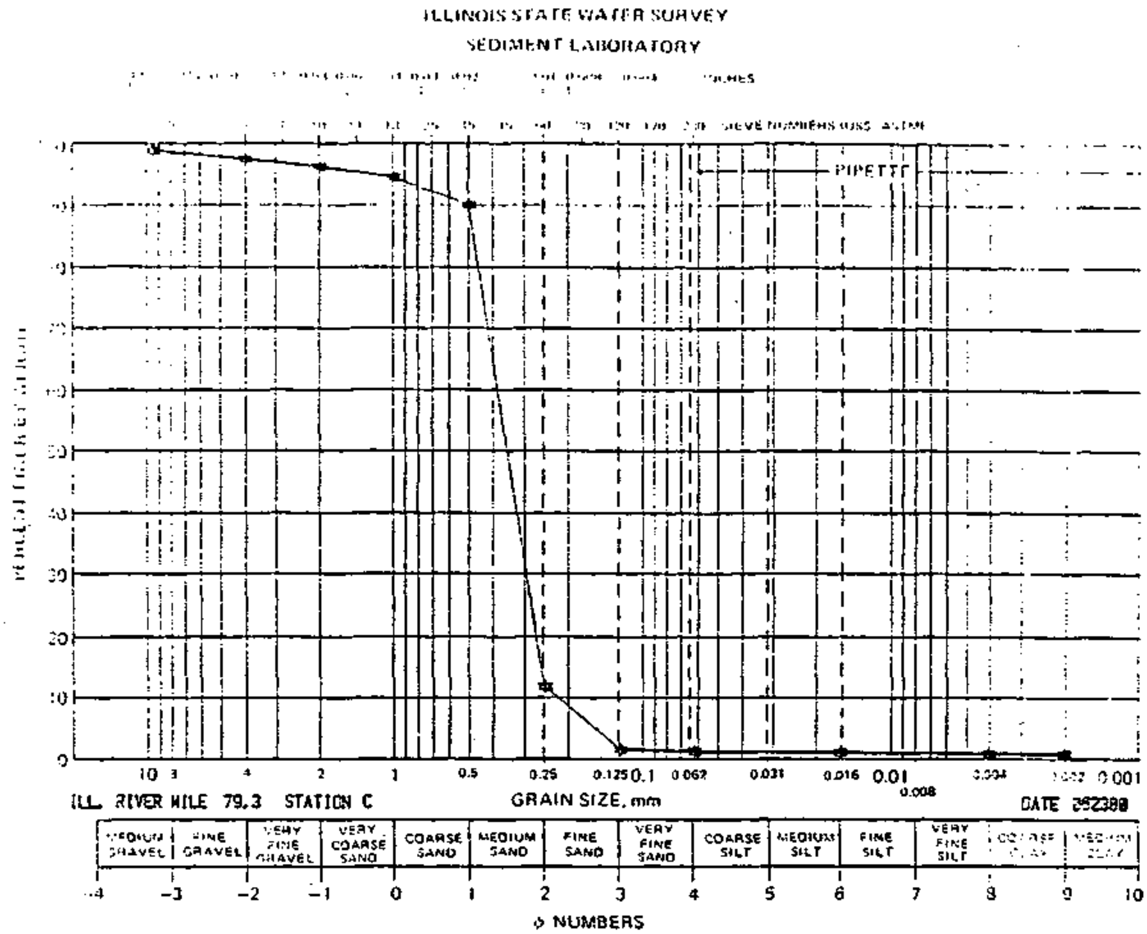
SEDIMENT LABORATORY

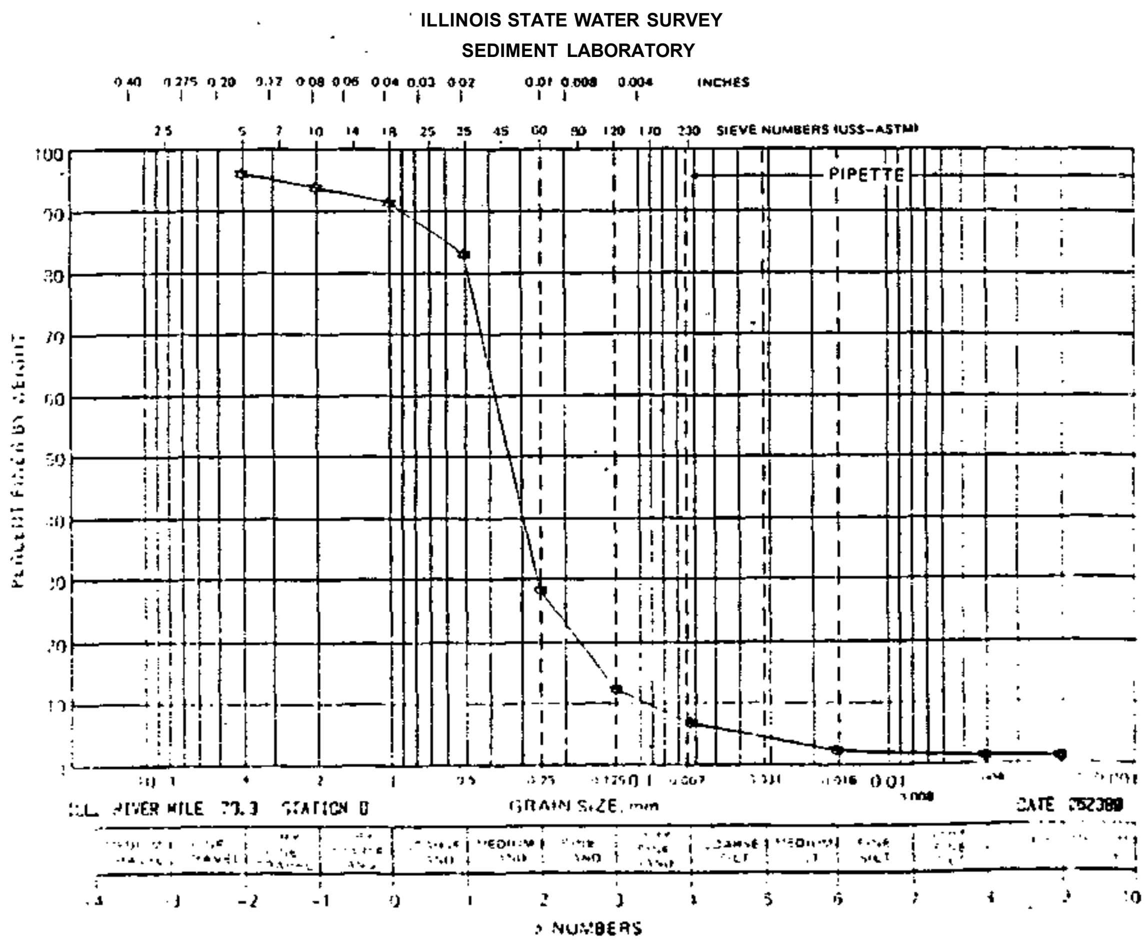


ILLINOIS STATE WATER SURVEY

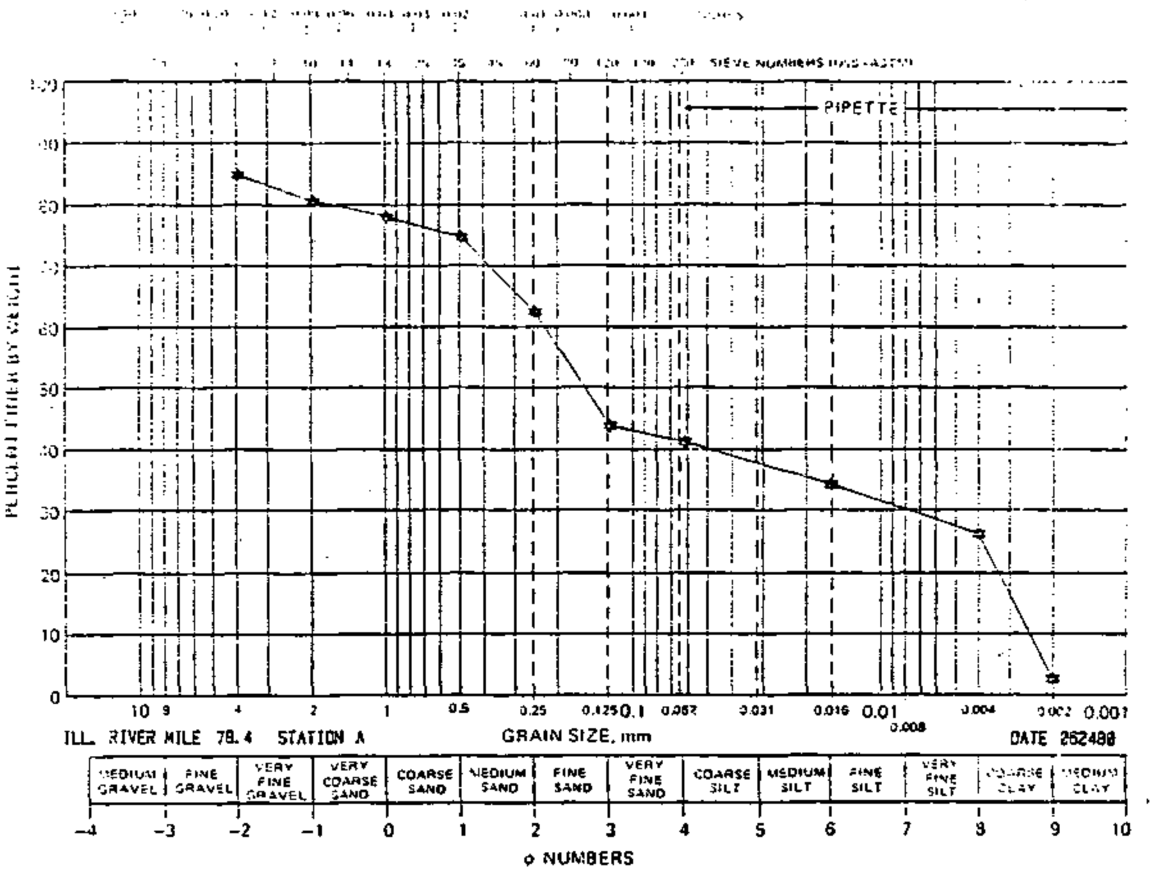
SEDIMENT LABORATORY



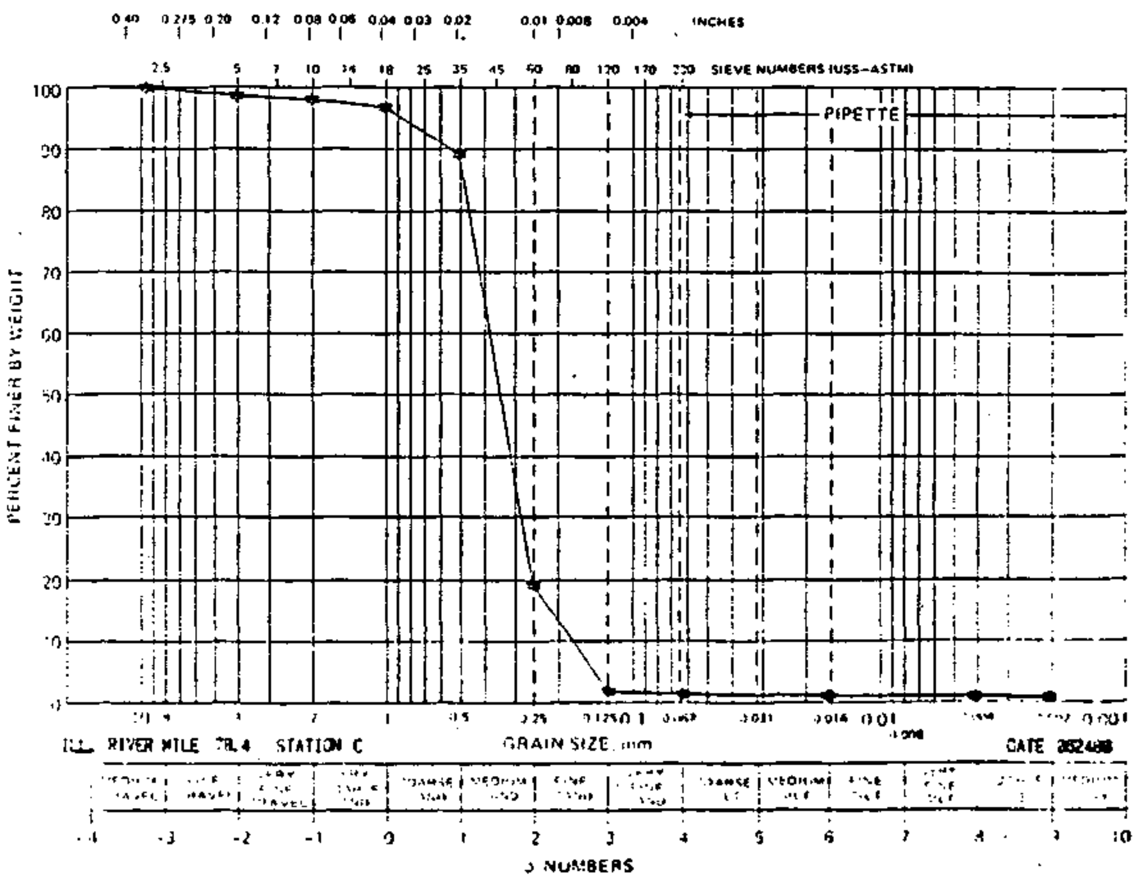

ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY
INCHES
SIEVE NUMBERS (USS-ASTM)
PIPETTE
PERCENT FINER BY WEIGHT
GRAIN SIZE, mm
ILL. RIVER MILE 79.3 STATION C
DATE 252388
MEDIUM GRAVEL
FINE GRAVEL
VERY FINE GRAVEL
VERY COARSE SAND
COARSE SAND
MEDIUM SAND
FINE SAND
VERY FINE SAND
COARSE SILT
MEDIUM SILT
FINE SILT
VERY FINE SILT
φ NUMBERS


ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY
INCHES
SIEVE NUMBERS (USS-ASTM)
PIPETTE
PERCENT FINER BY WEIGHT
GRAIN SIZE, mm
ILL. RIVER MILE 79.3 STATION B
DATE 252388
MEDIUM SAND
COARSE SILT
FINE SILT
φ NUMBERS

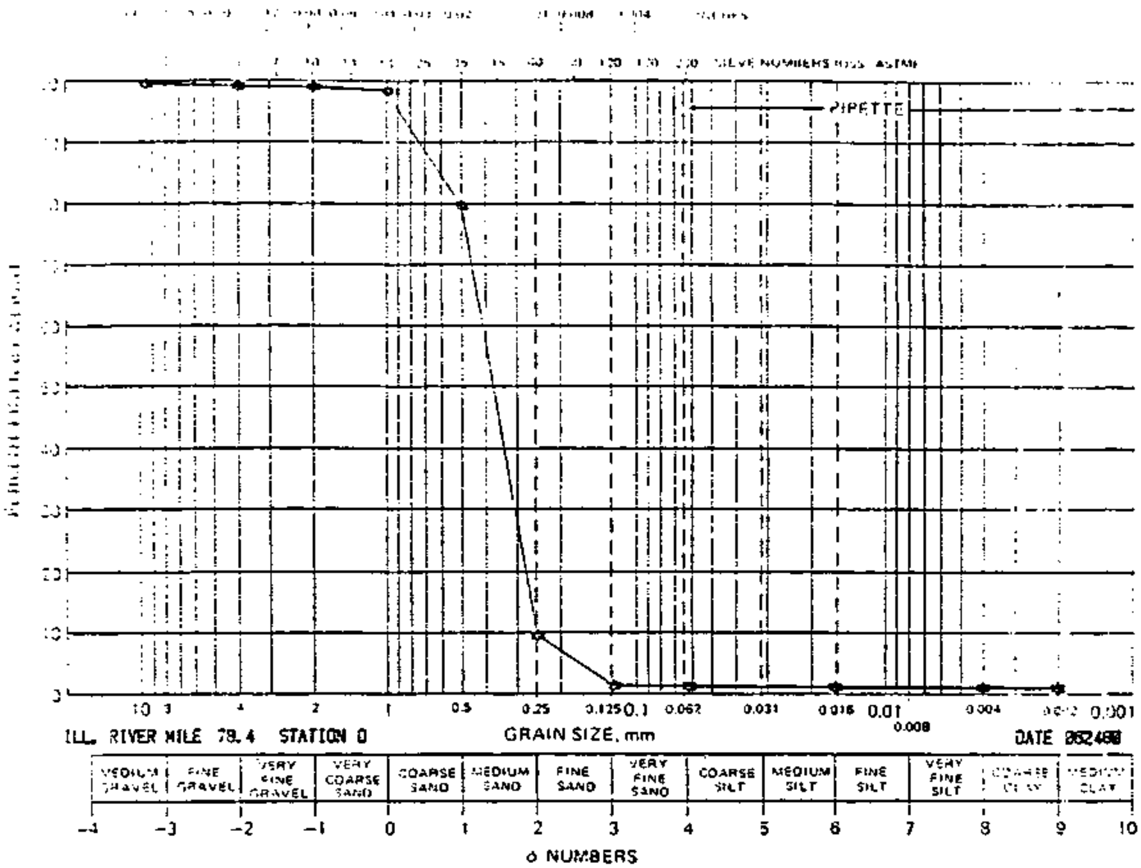
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



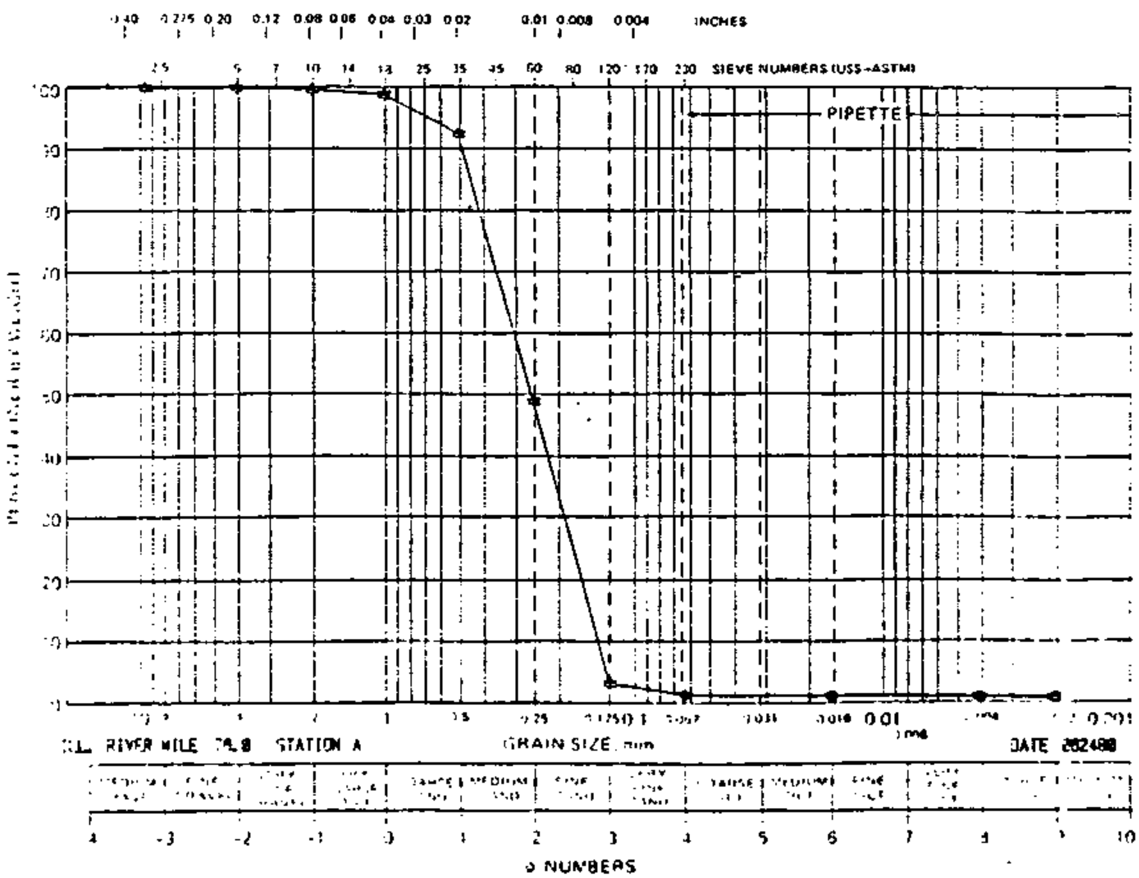
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY

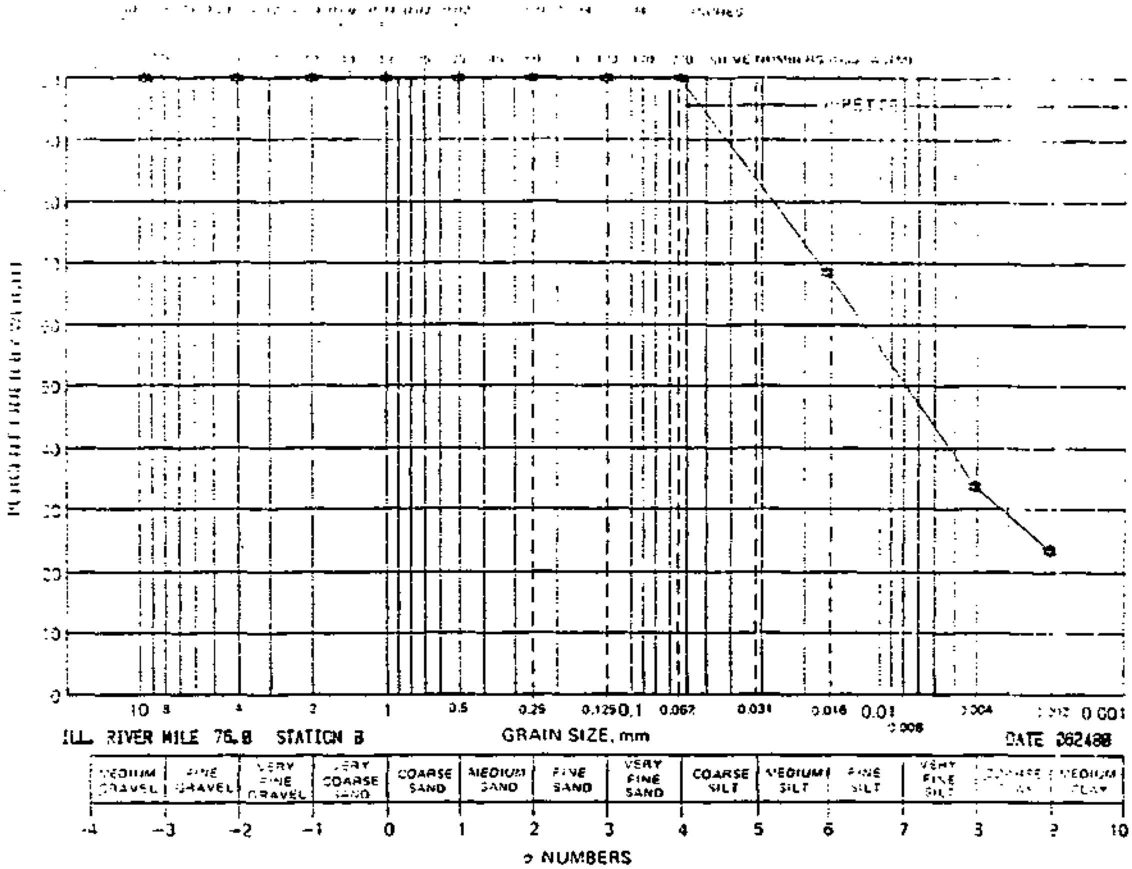


ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



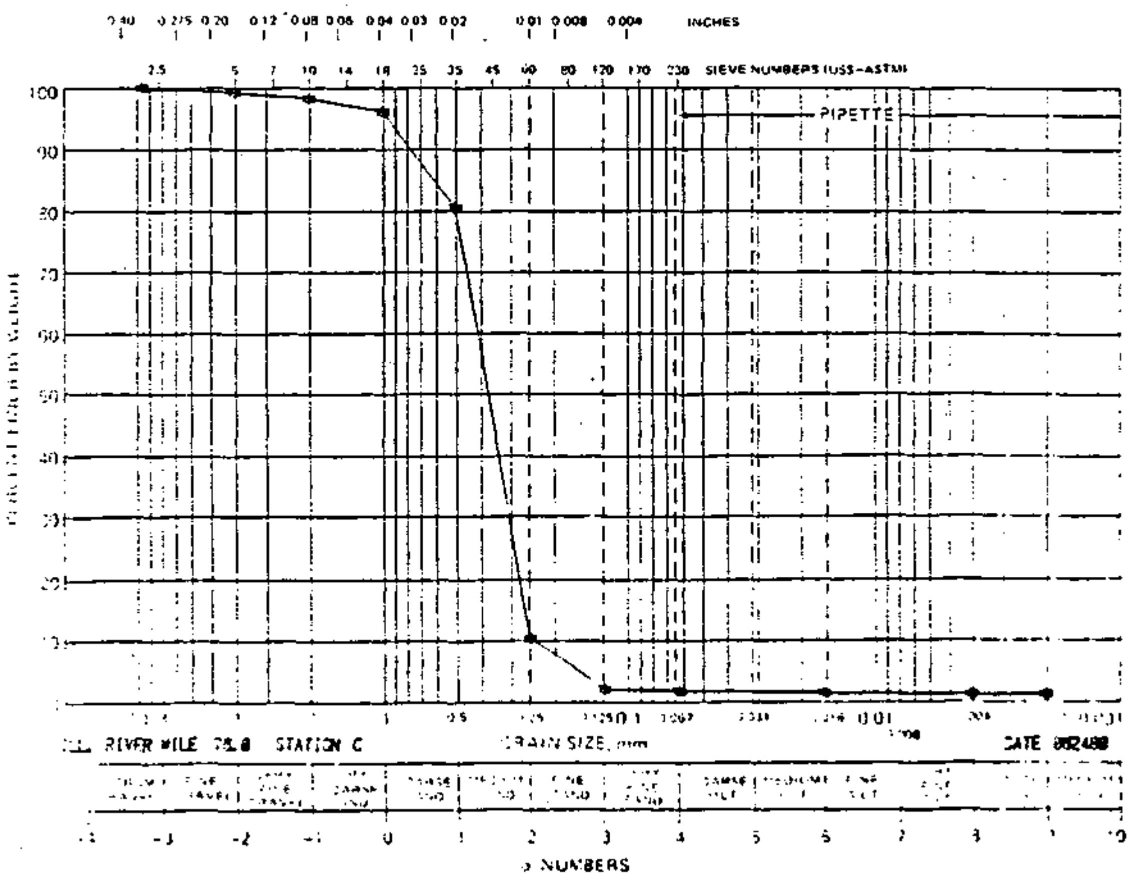
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY

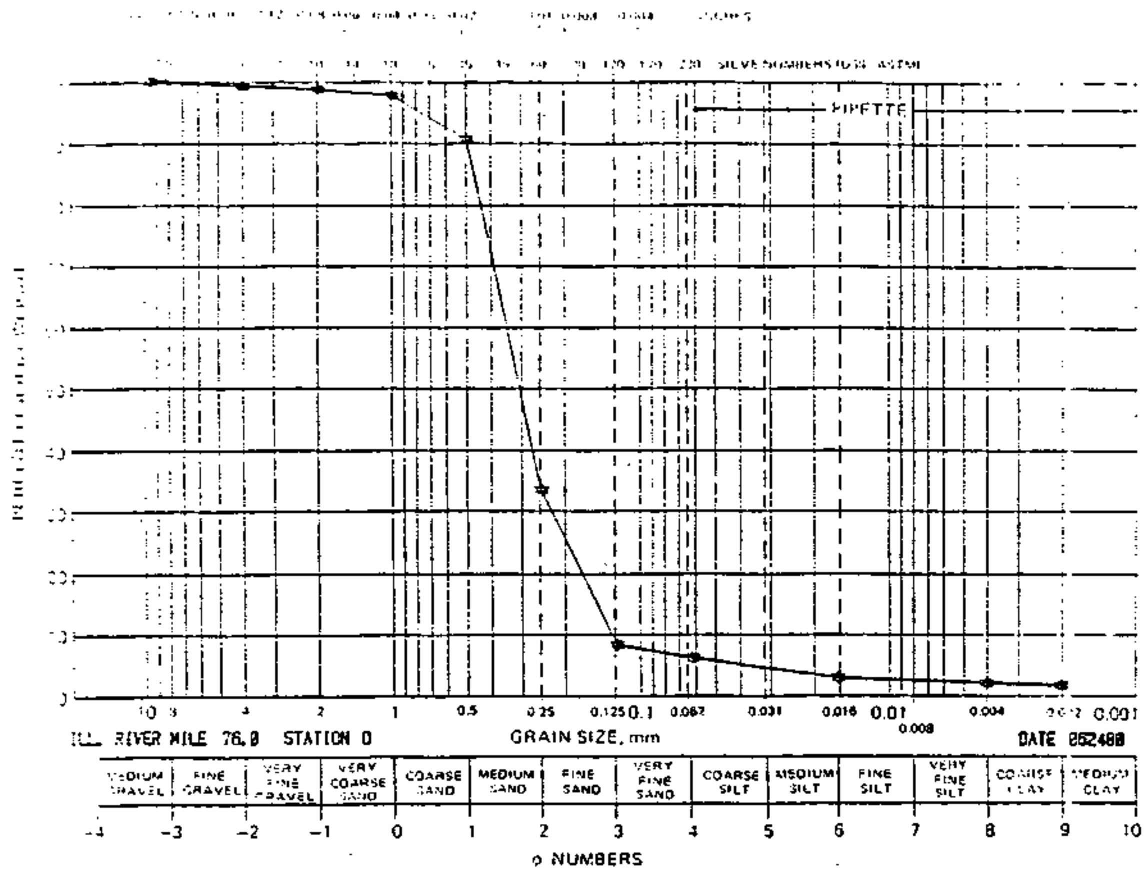


ILLINOIS STATE WATER SURVEY

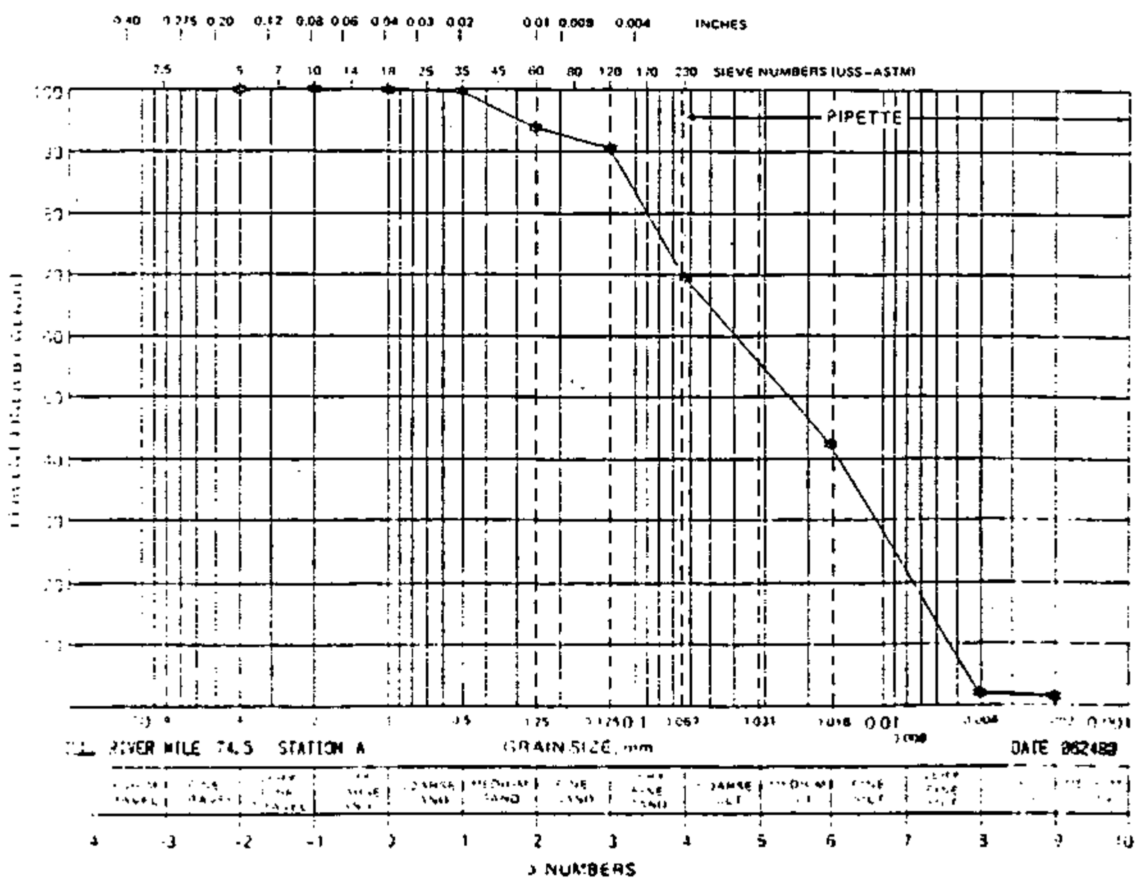
SEDIMENT LABORATORY



ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY

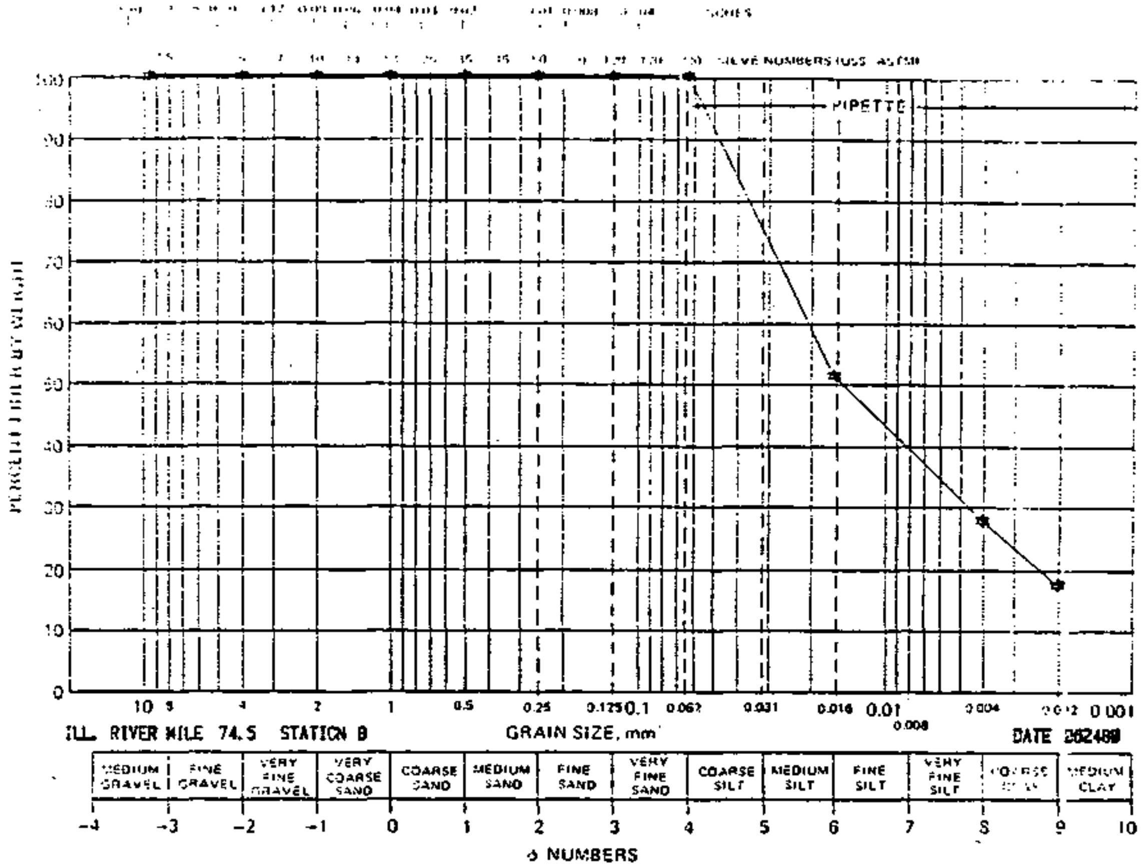


ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



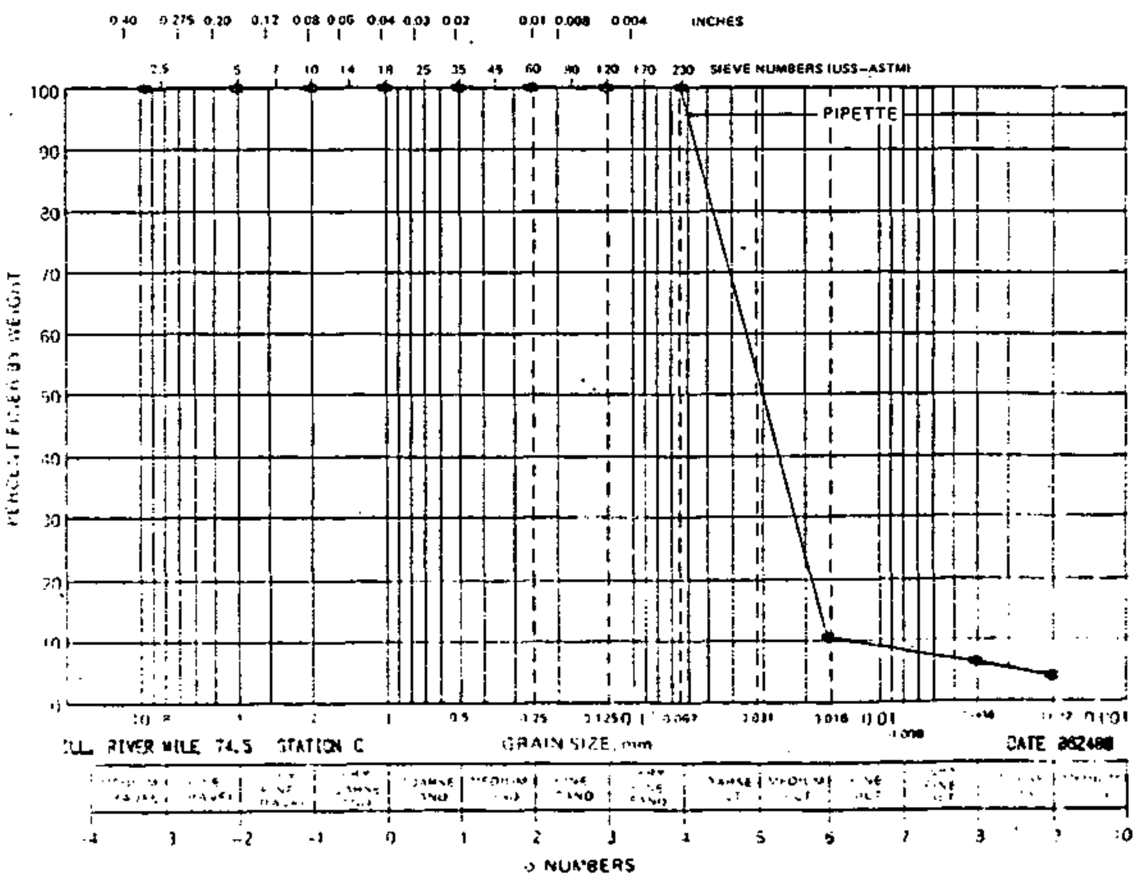
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY



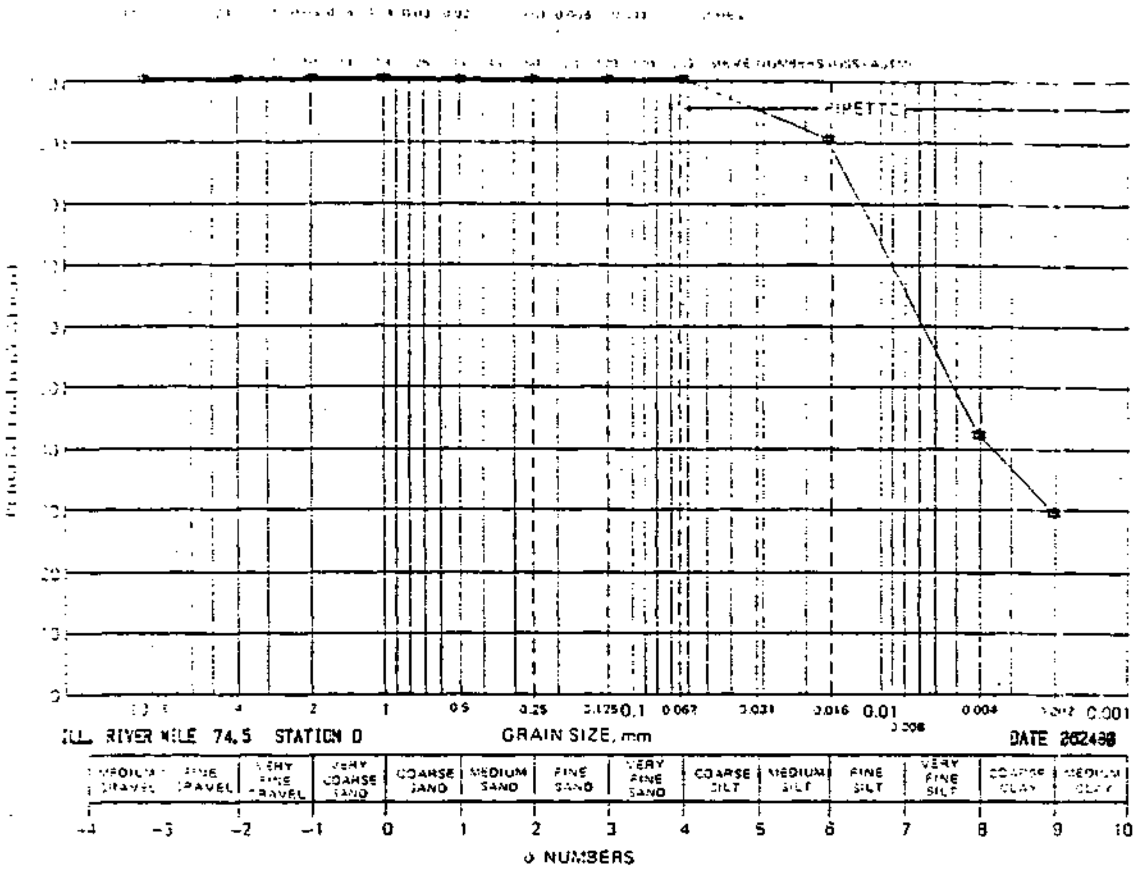
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY



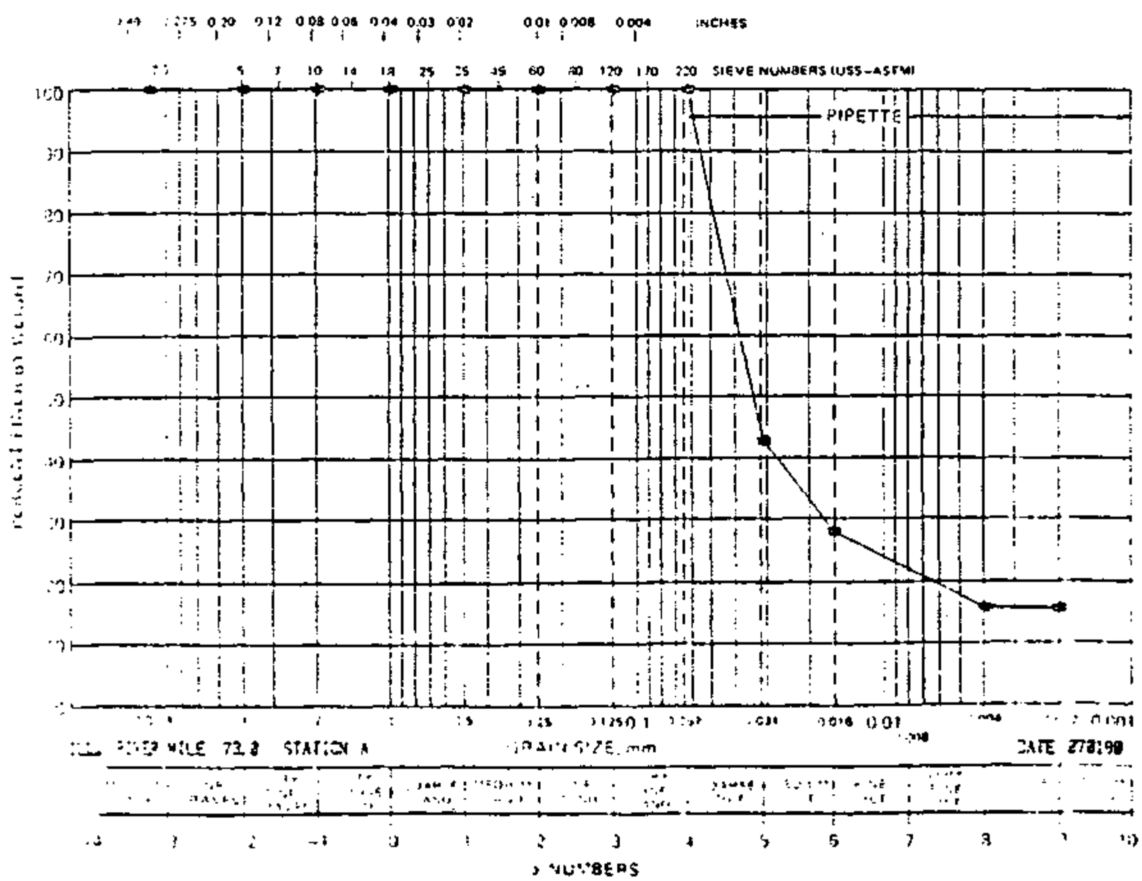
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY



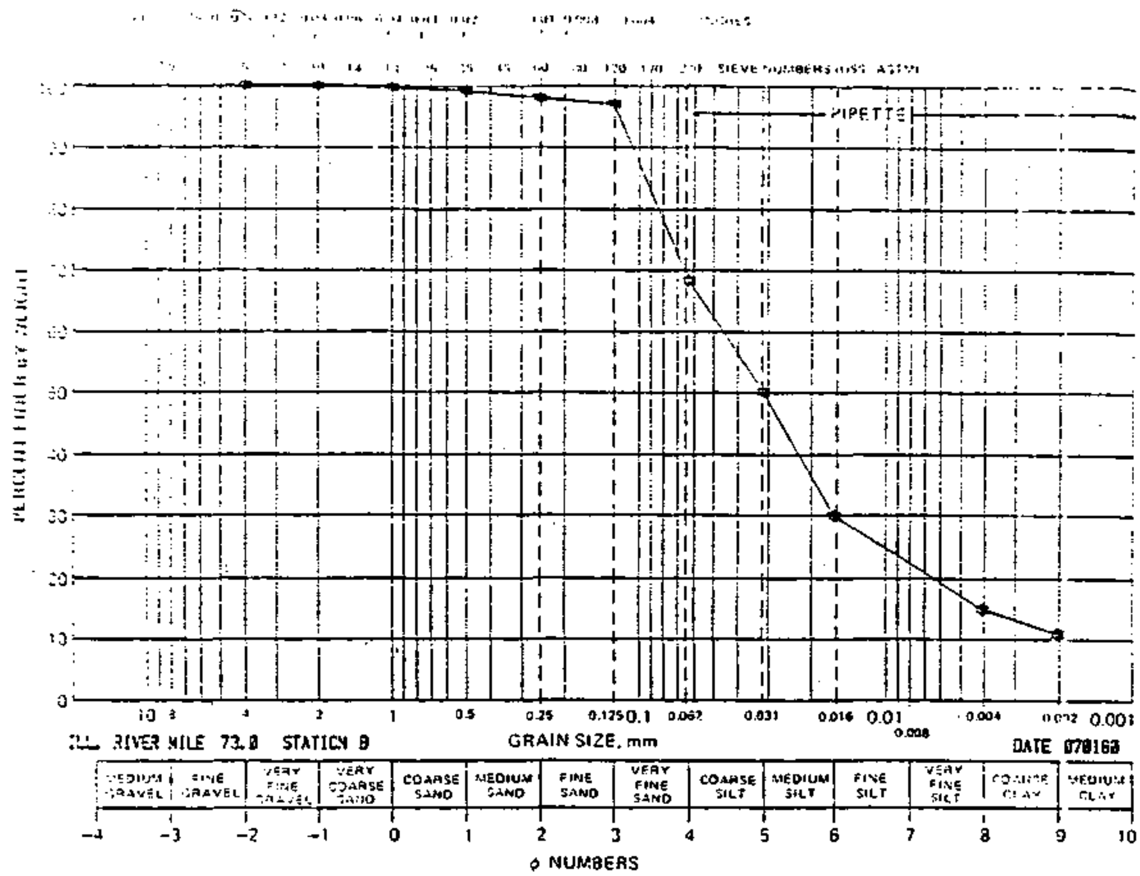
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY



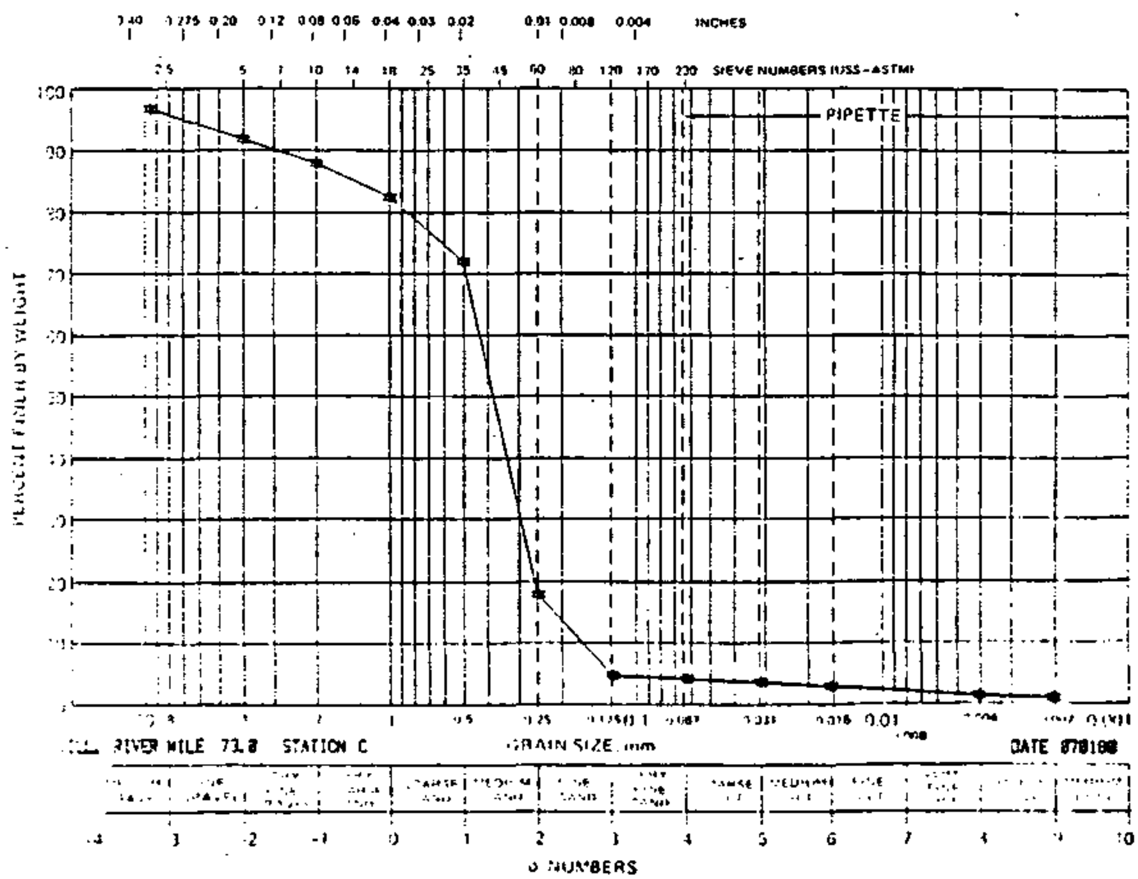
ILLINOIS STATE WATER SURVEY

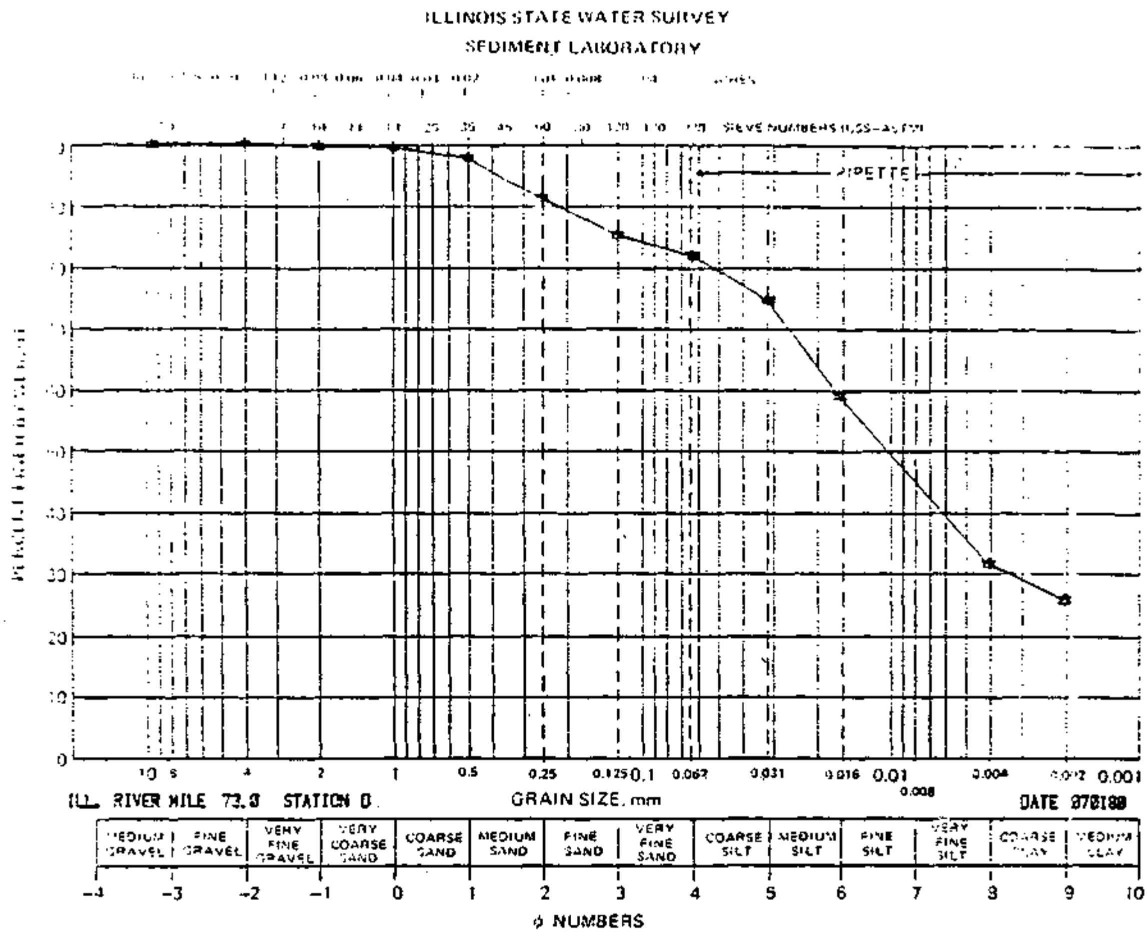
SEDIMENT LABORATORY

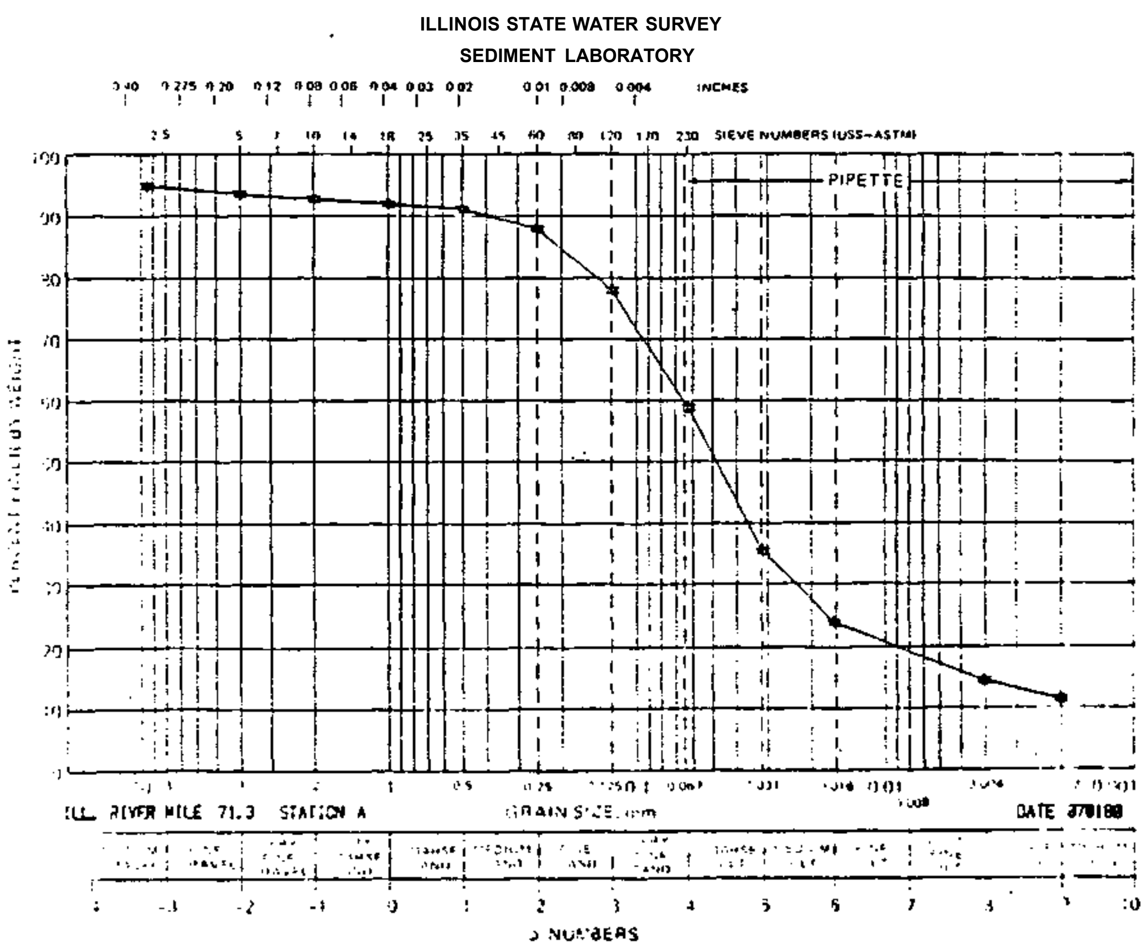


ILLINOIS STATE WATER SURVEY

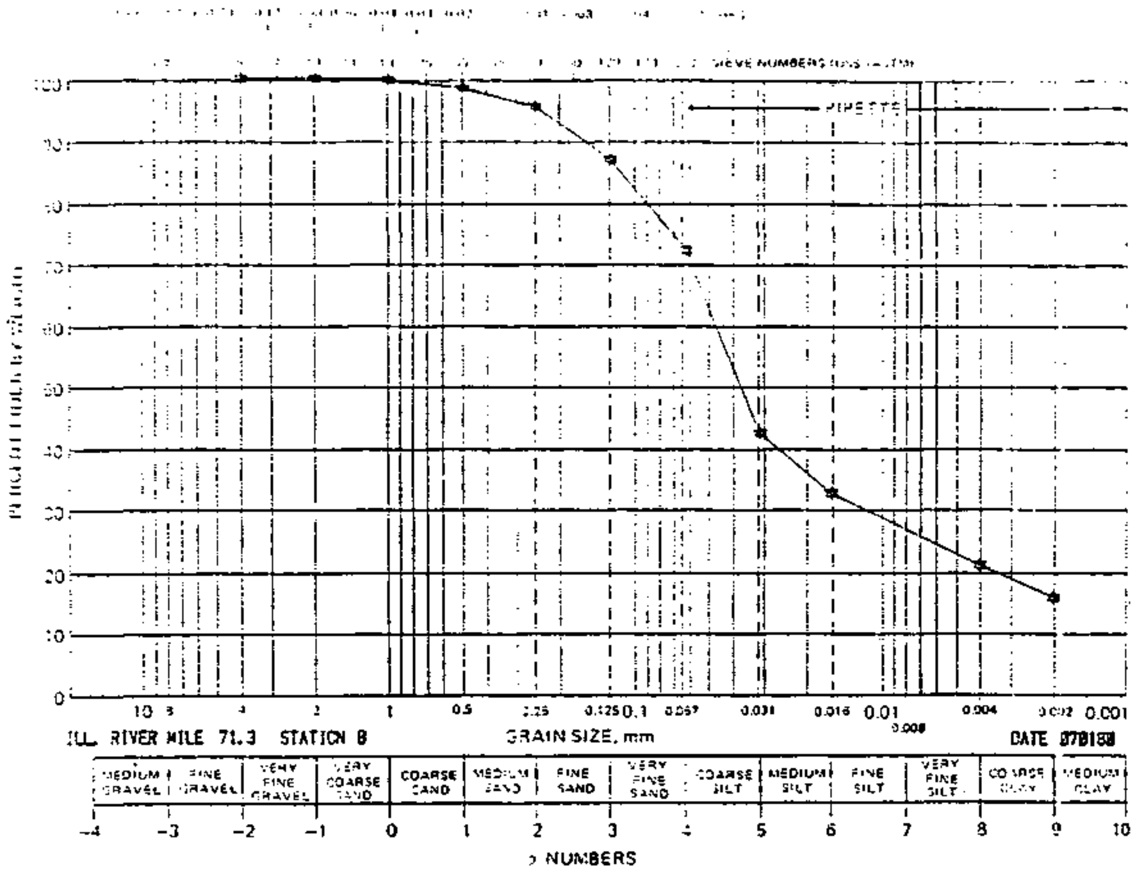
SEDIMENT LABORATORY



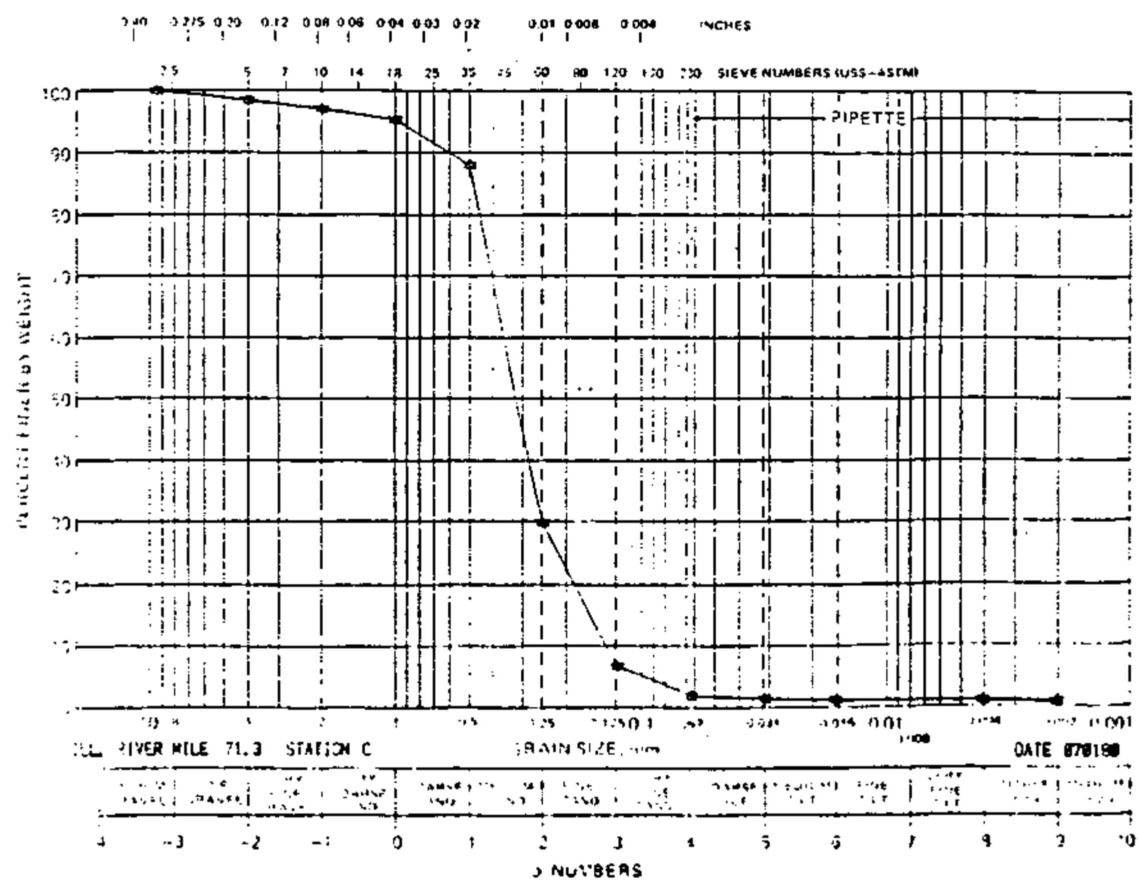

ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY
SIEVE NUMBERS (USS-ASTM)
PIPETTE
GRAIN SIZE, mm
ILL. RIVER MILE 73.0 STATION D
DATE 870188
MEDIUM GRAVEL
FINE GRAVEL
VERY FINE GRAVEL
VERY COARSE SAND
COARSE SAND
MEDIUM SAND
FINE SAND
VERY FINE SAND
COARSE SILT
MEDIUM SILT
FINE SILT
VERY FINE SILT
ϕ NUMBERS


ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY
INCHES
SIEVE NUMBERS (USS-ASTM)
PIPETTE
ILL. RIVER MILE 71.3 STATION A
DATE 870188
ϕ NUMBERS

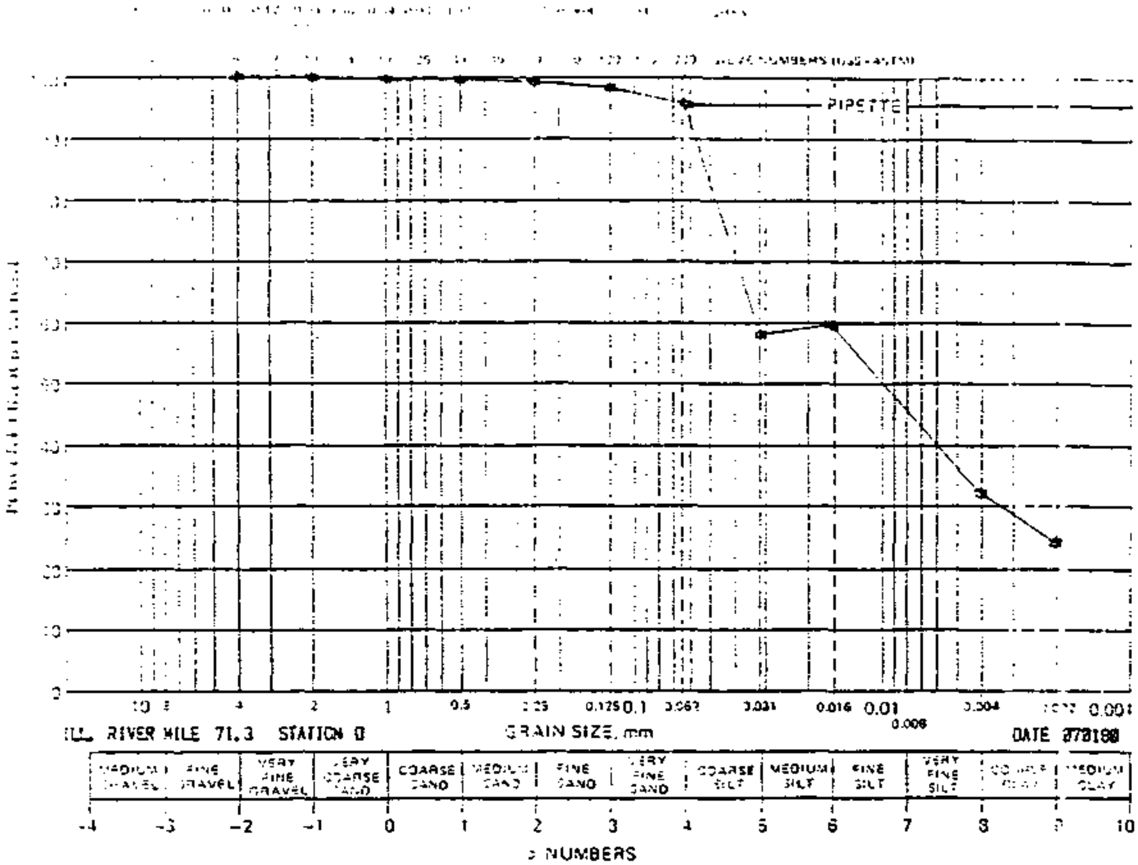
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



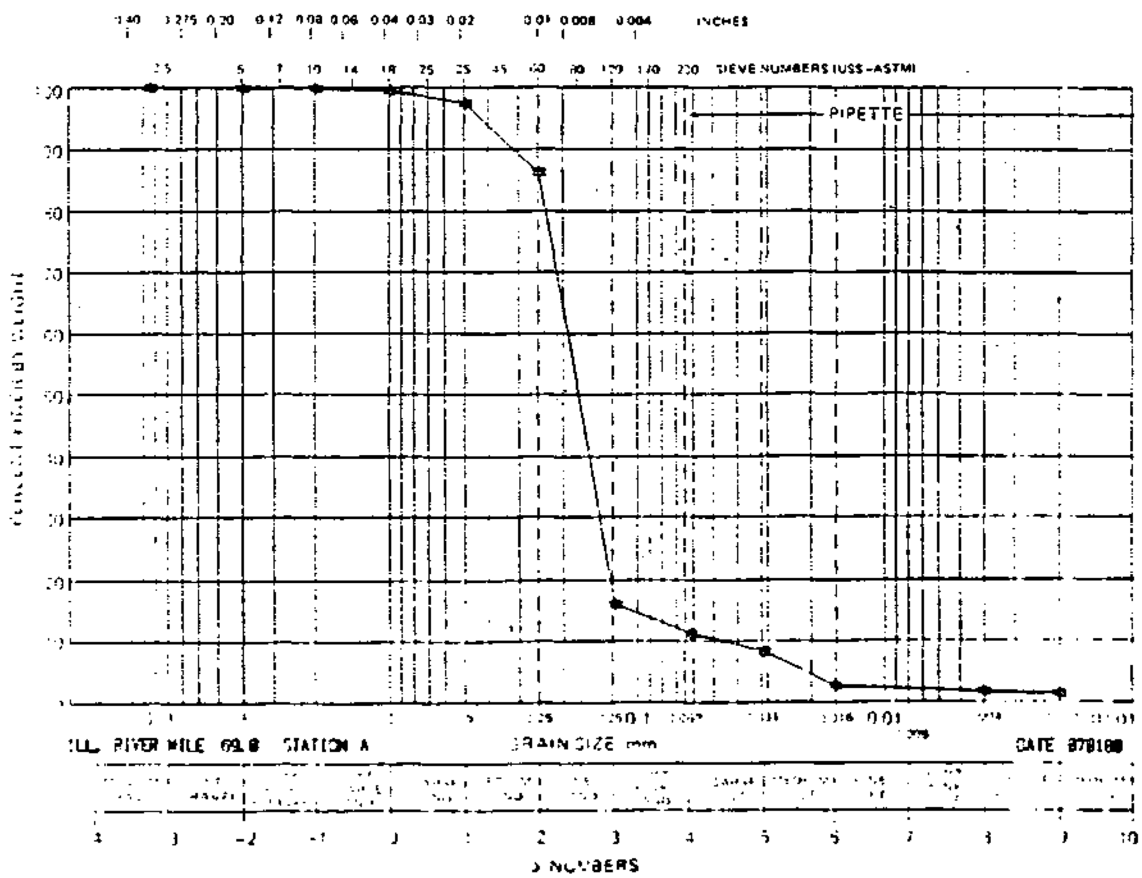
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



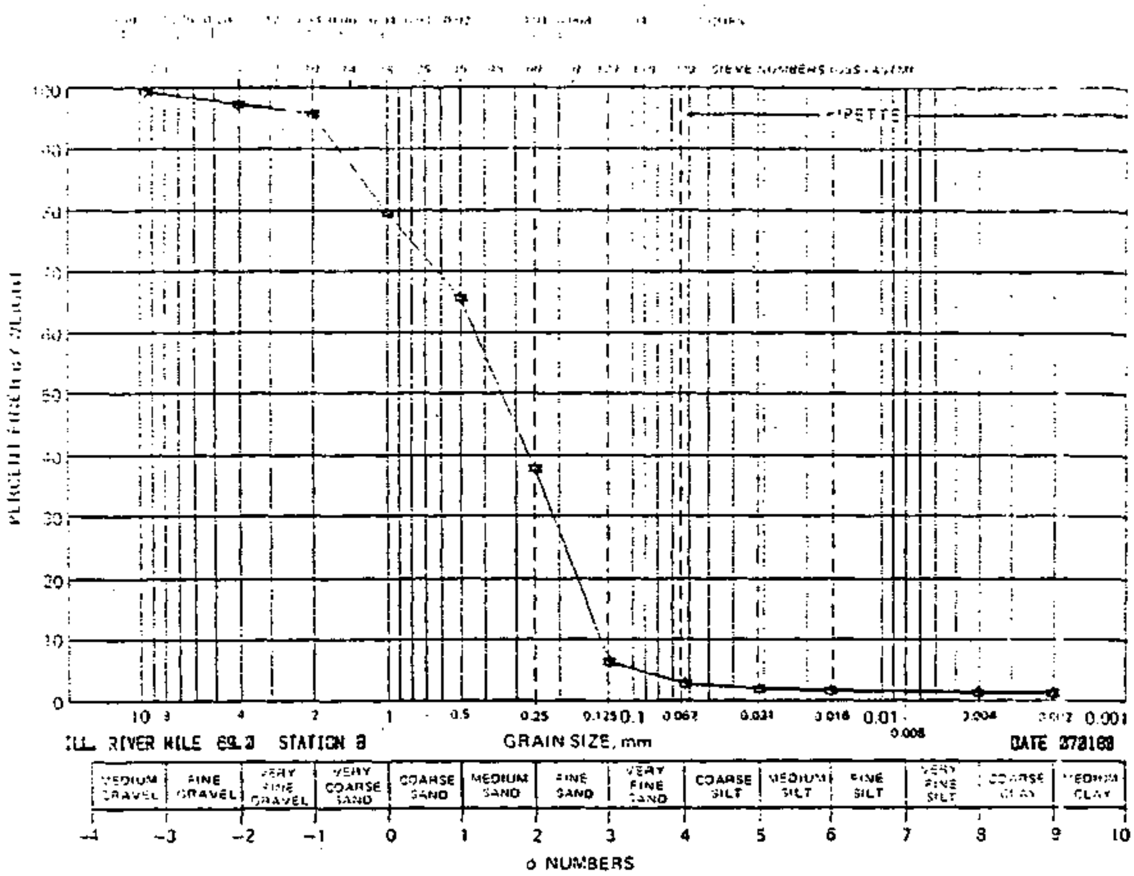
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



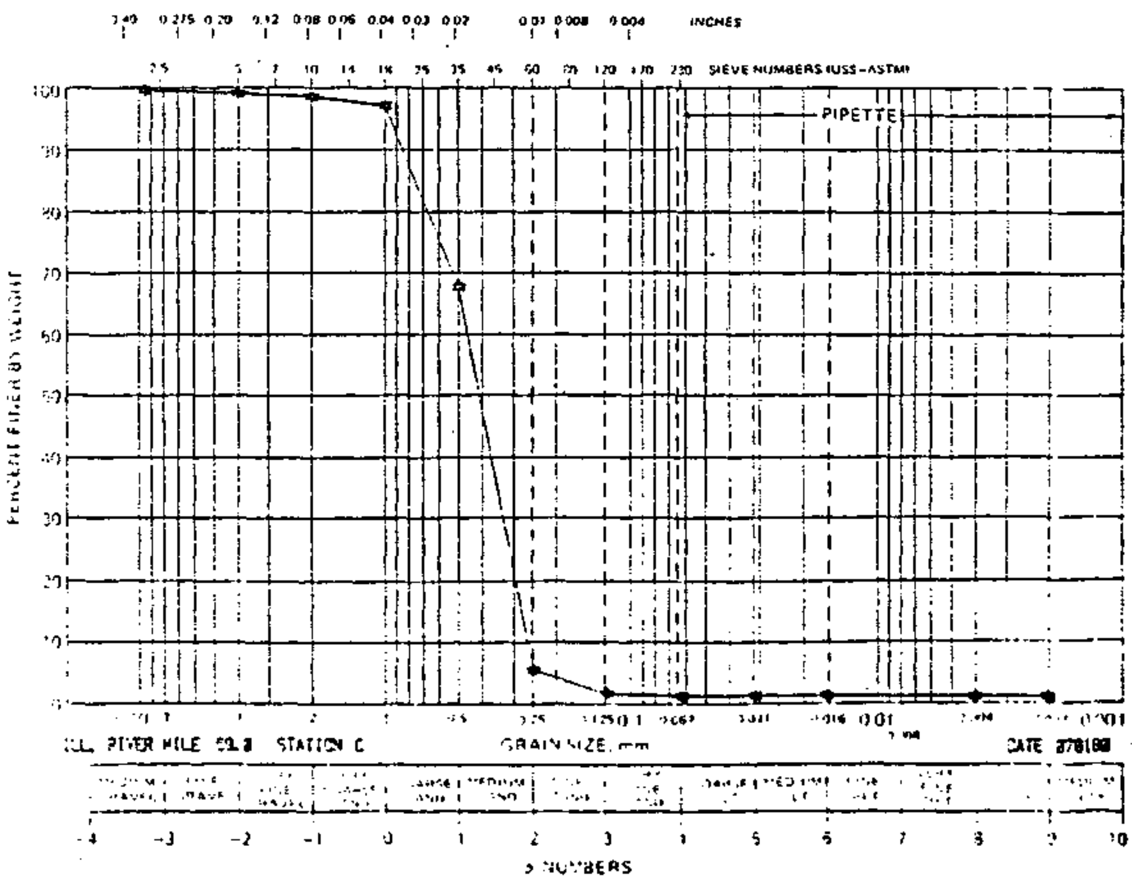
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



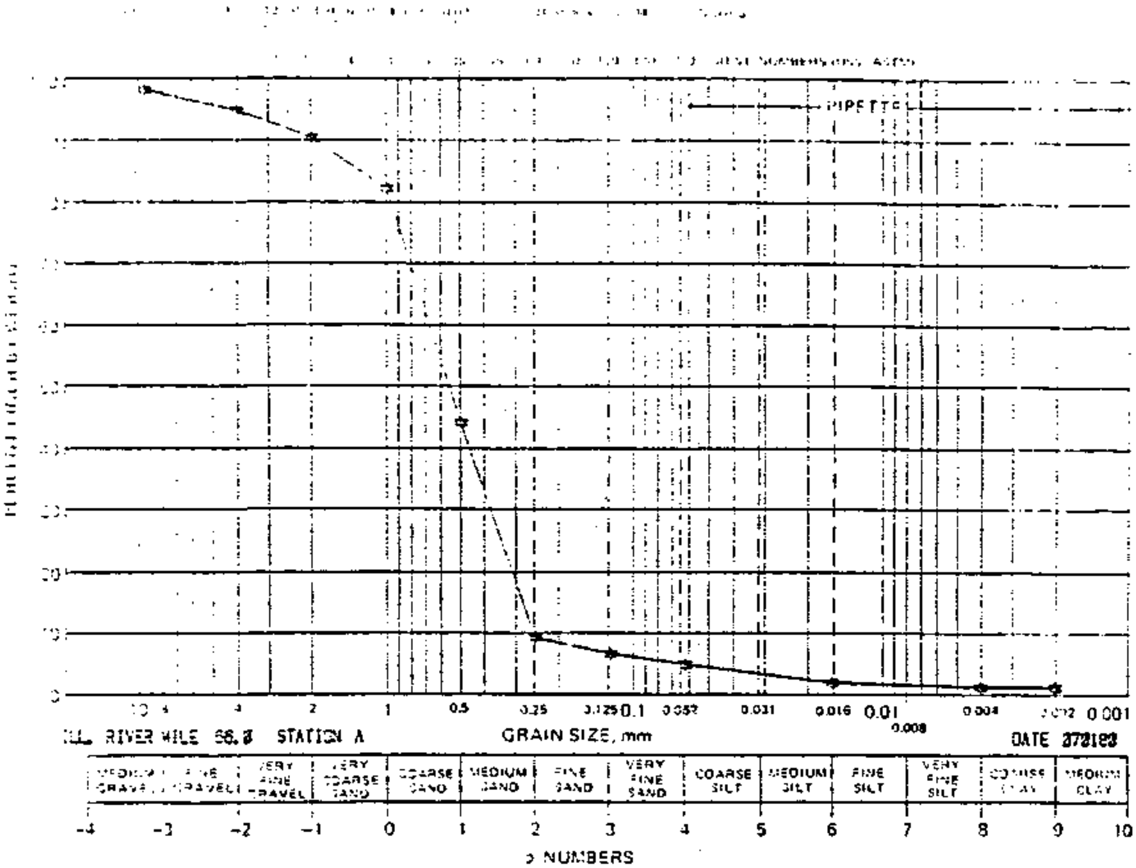
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



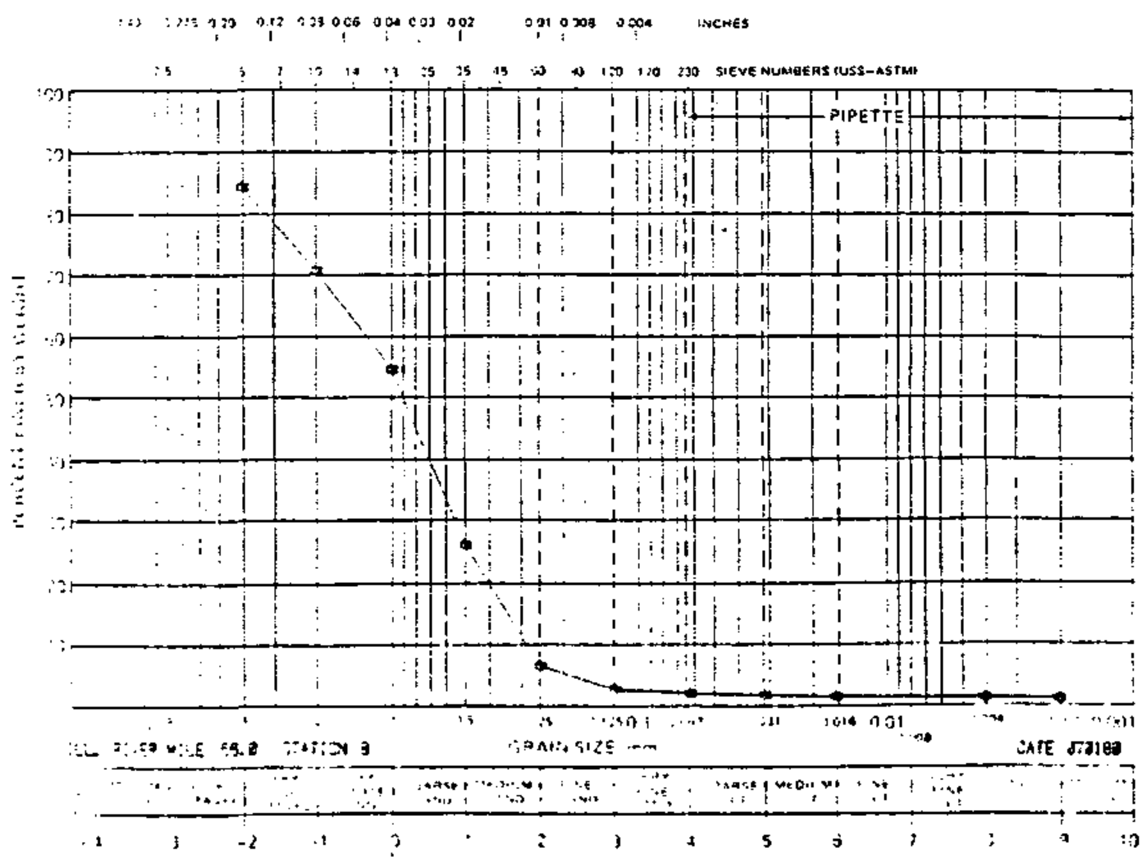
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY

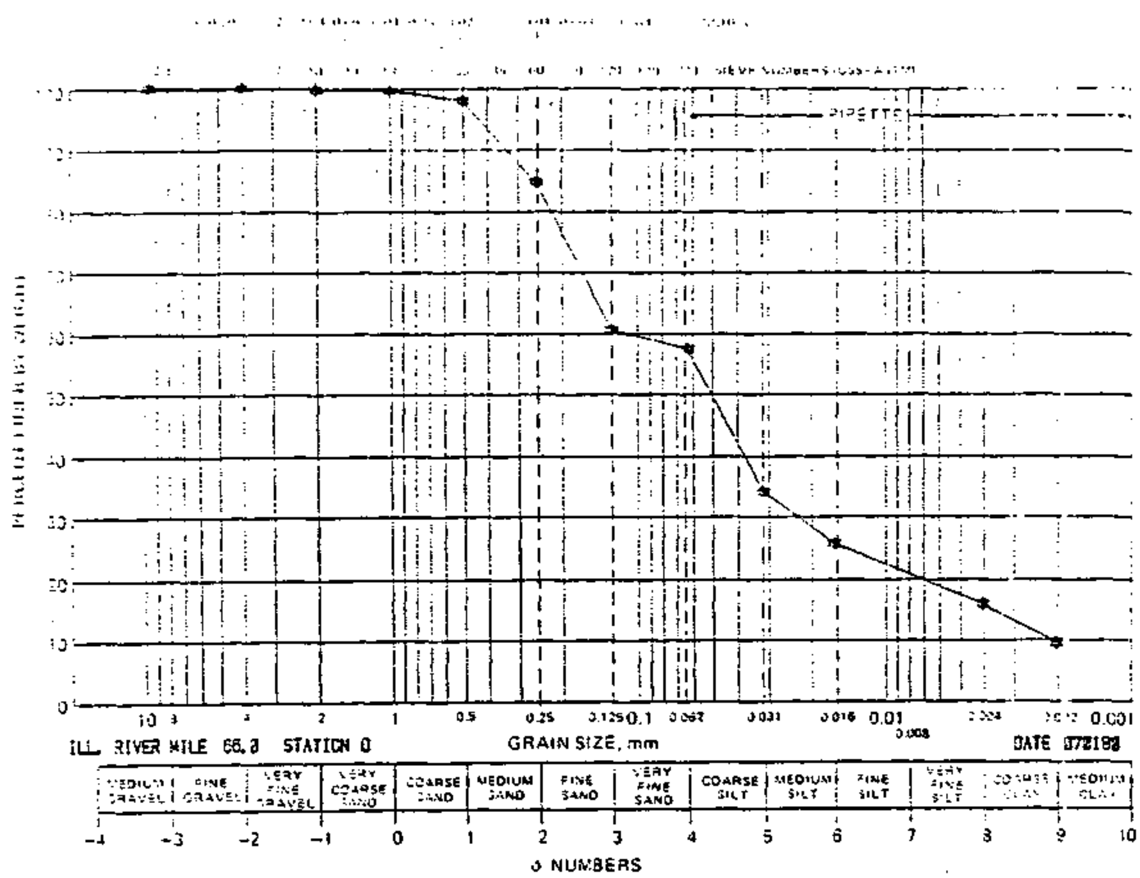


ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



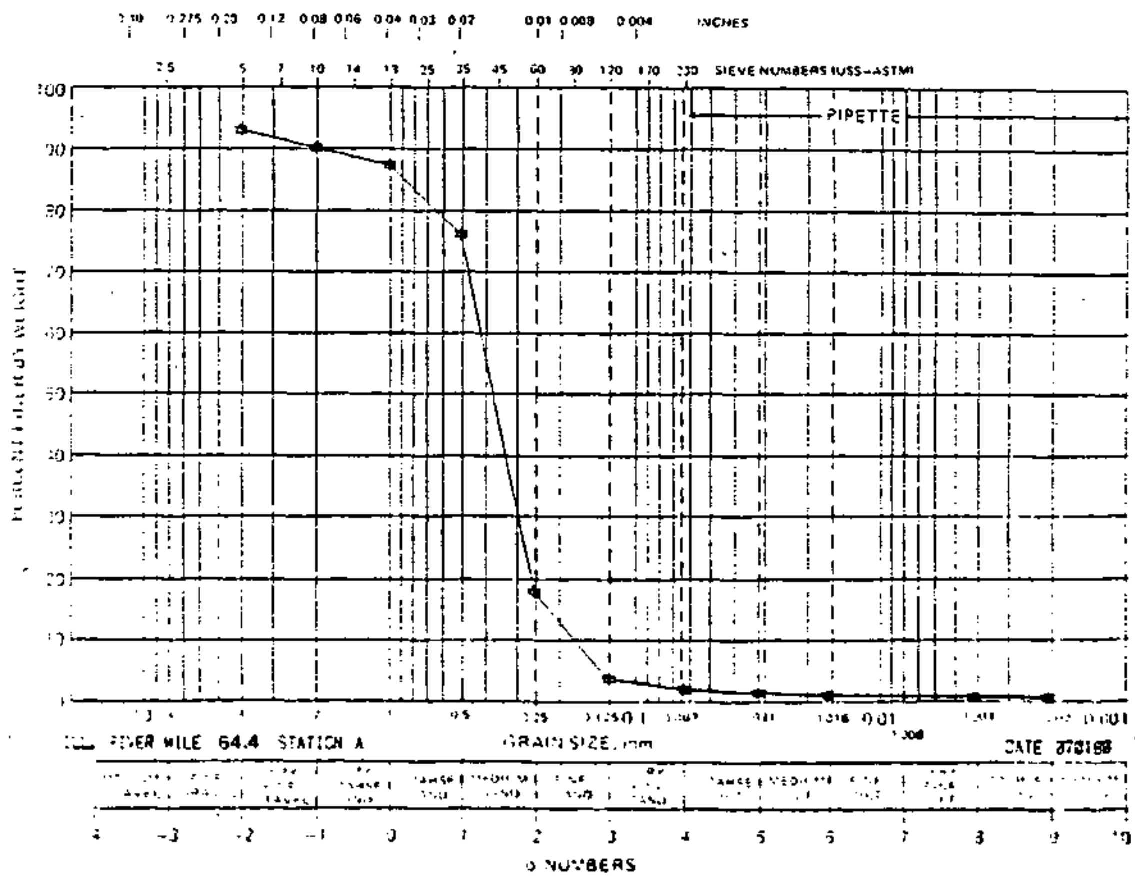
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY



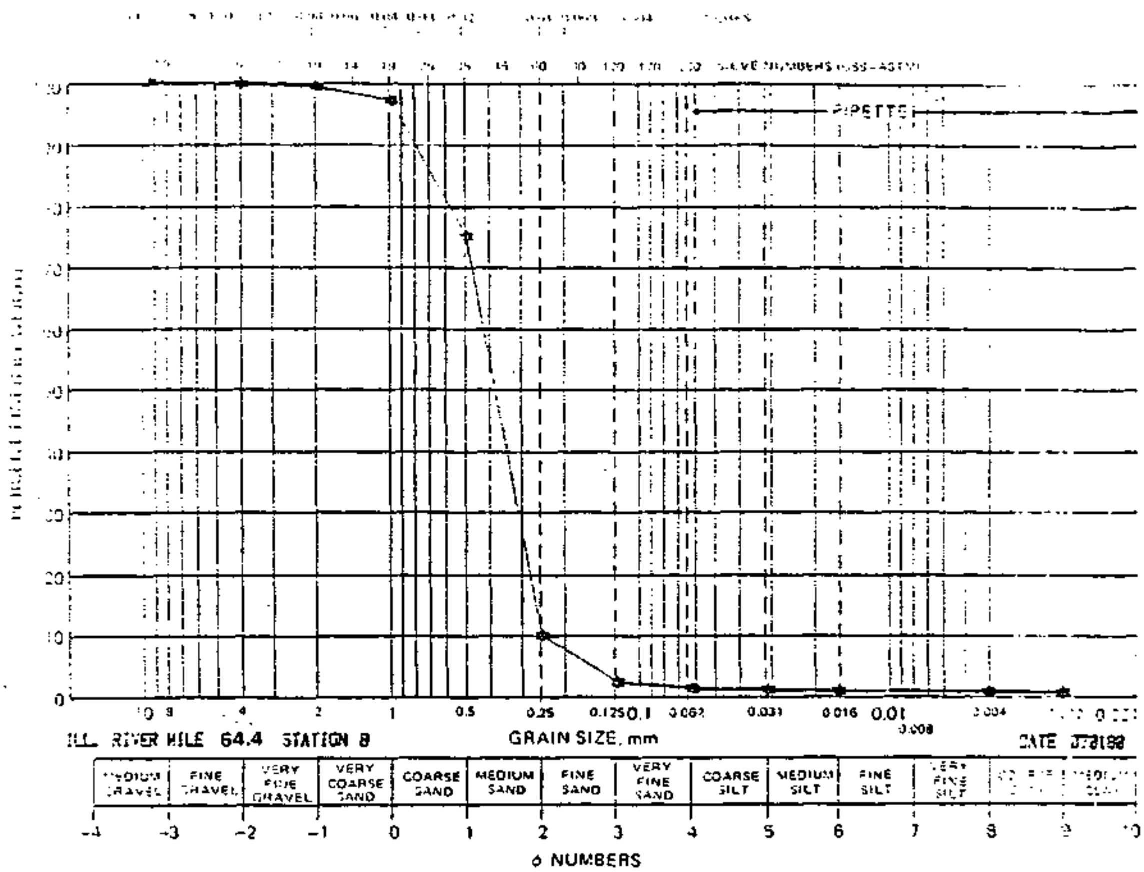
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY



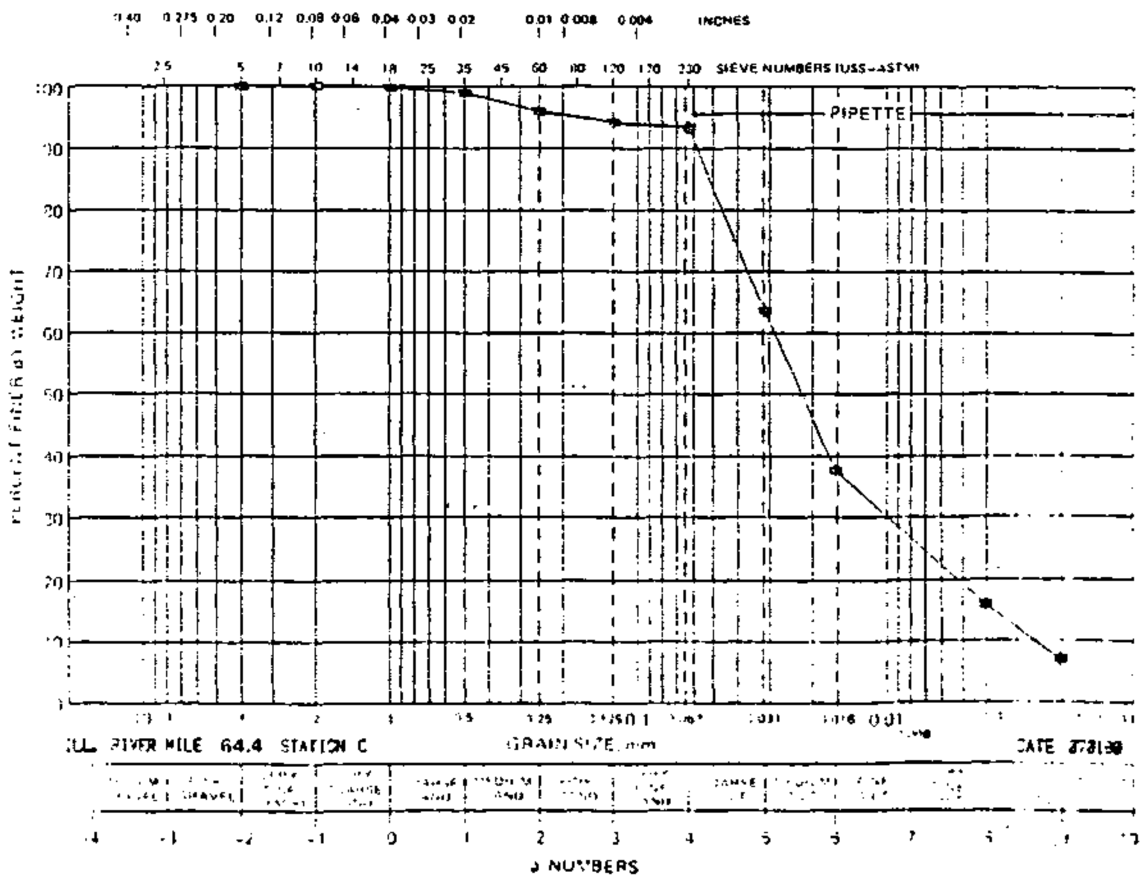
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY

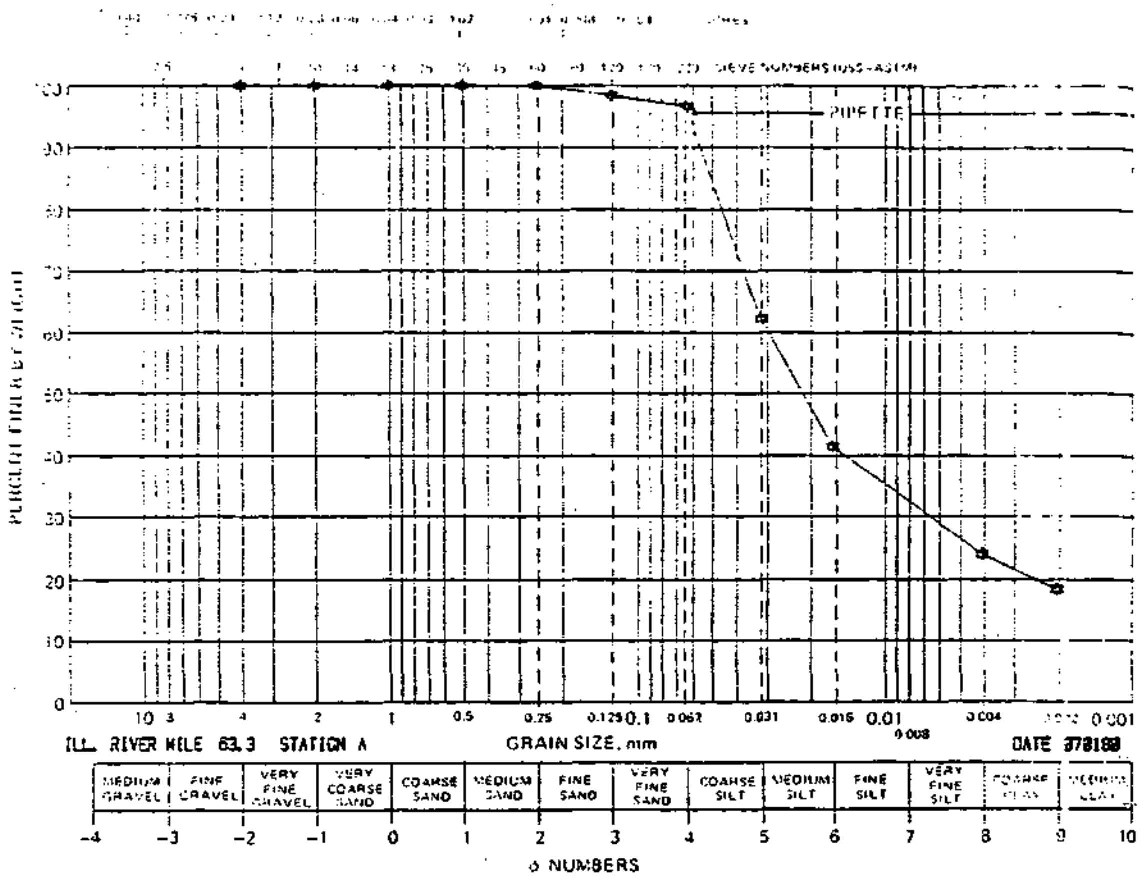


ILLINOIS STATE WATER SURVEY

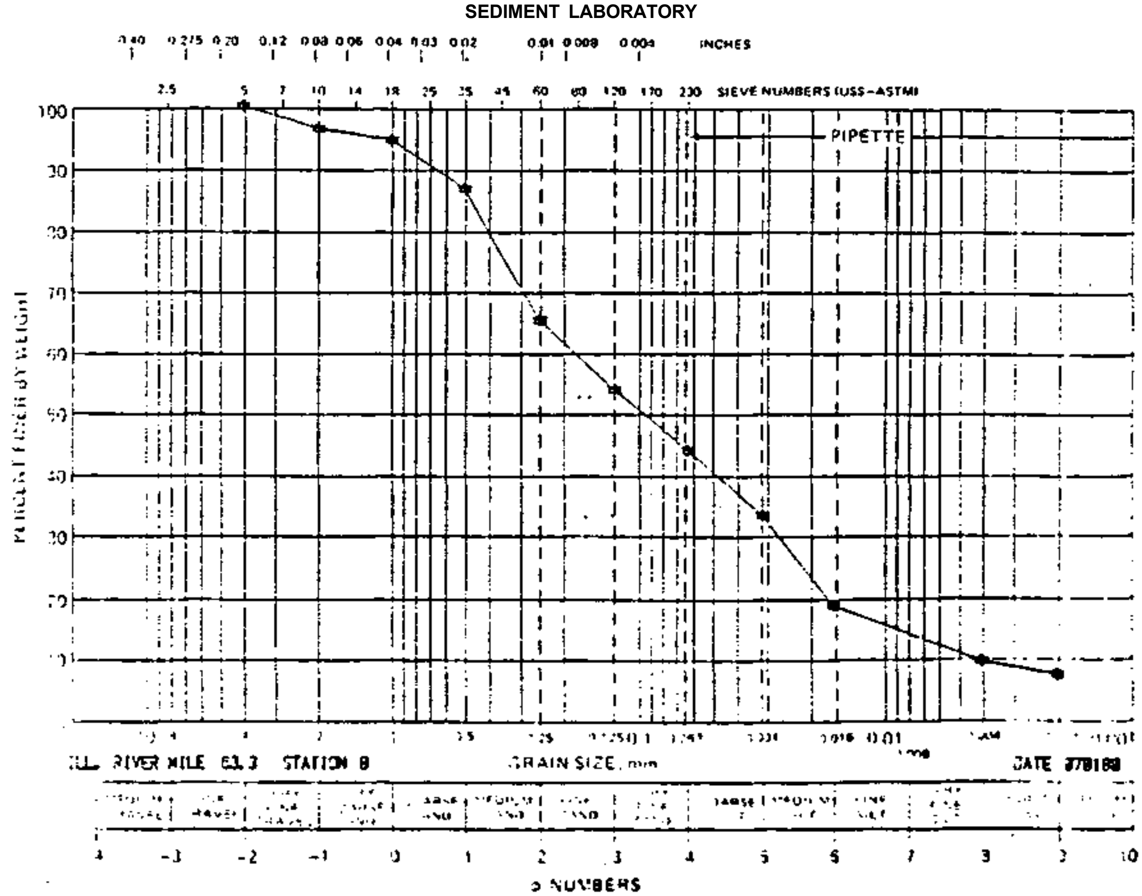
SEDIMENT LABORATORY



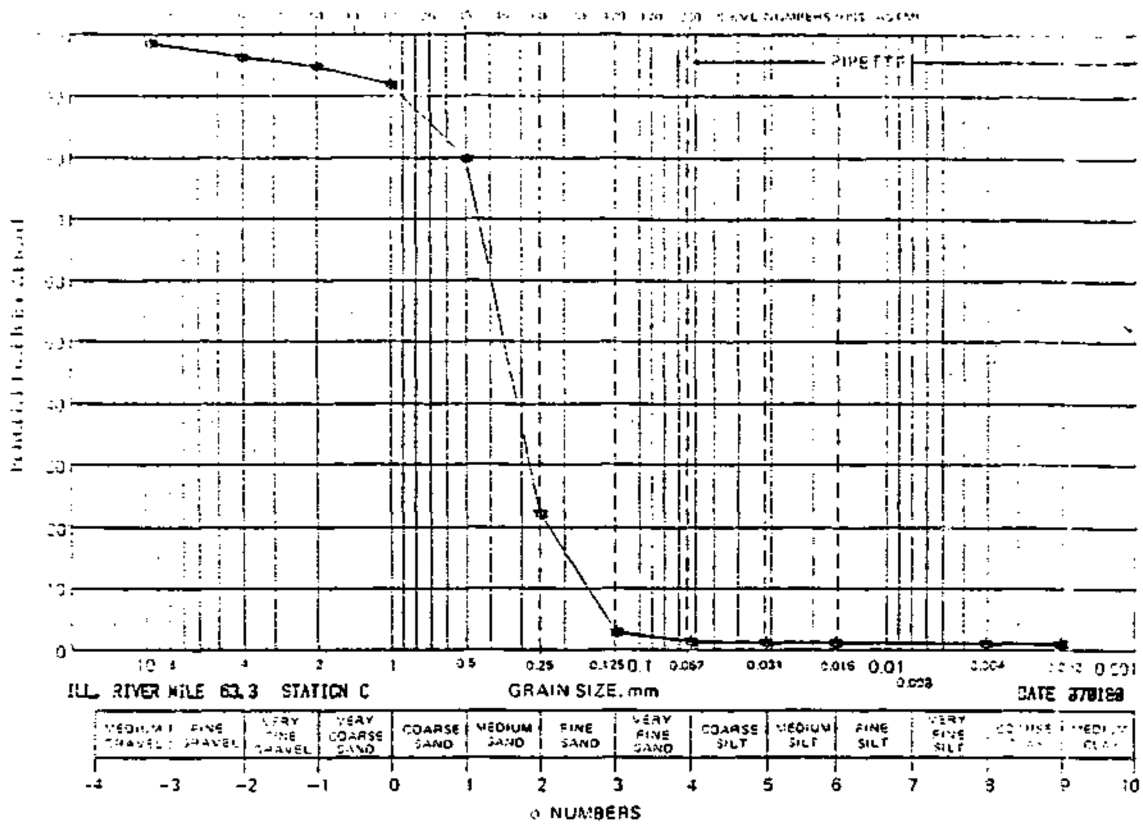
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



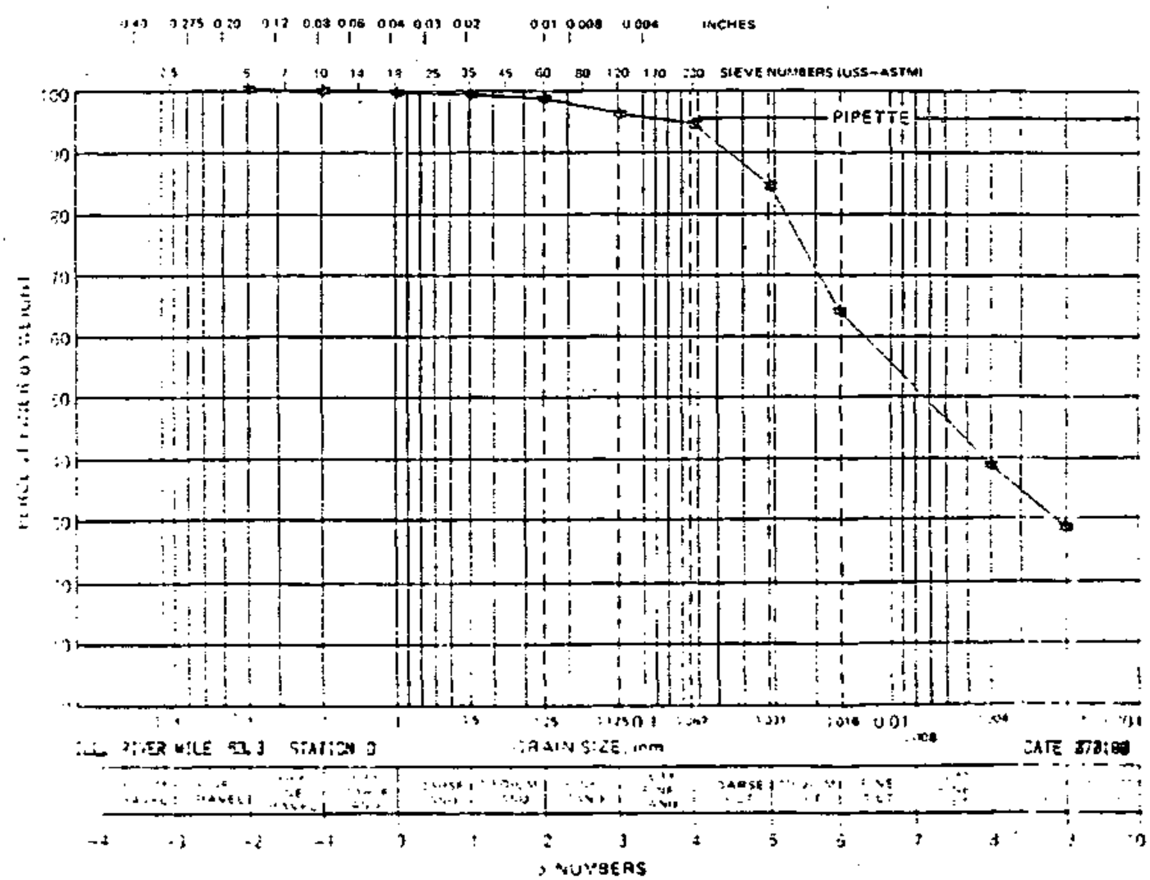
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



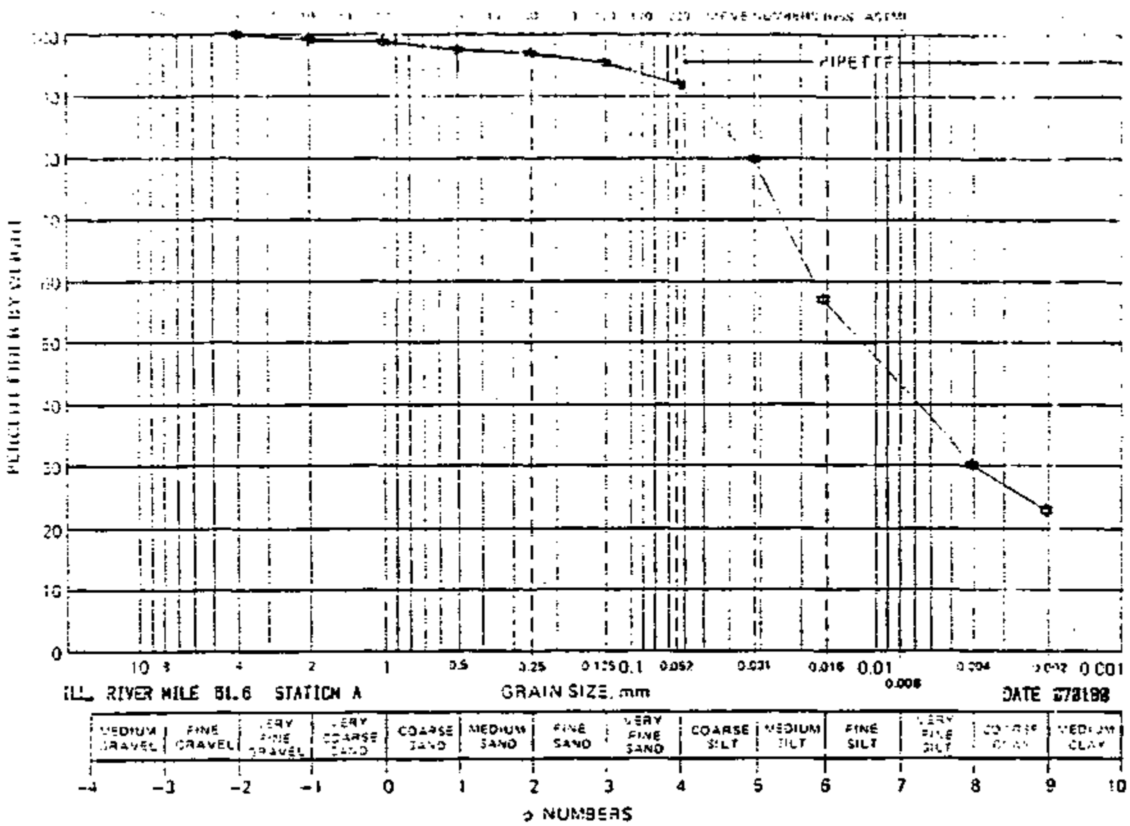
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



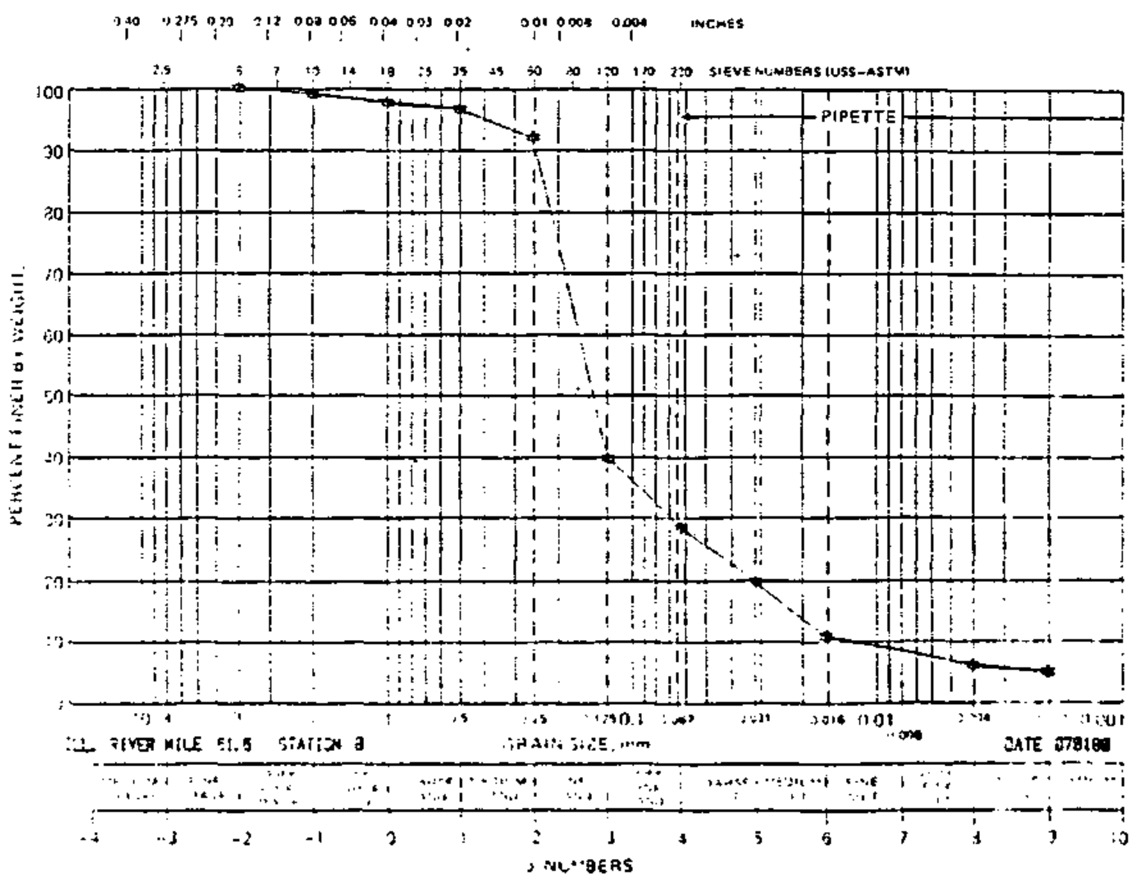
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



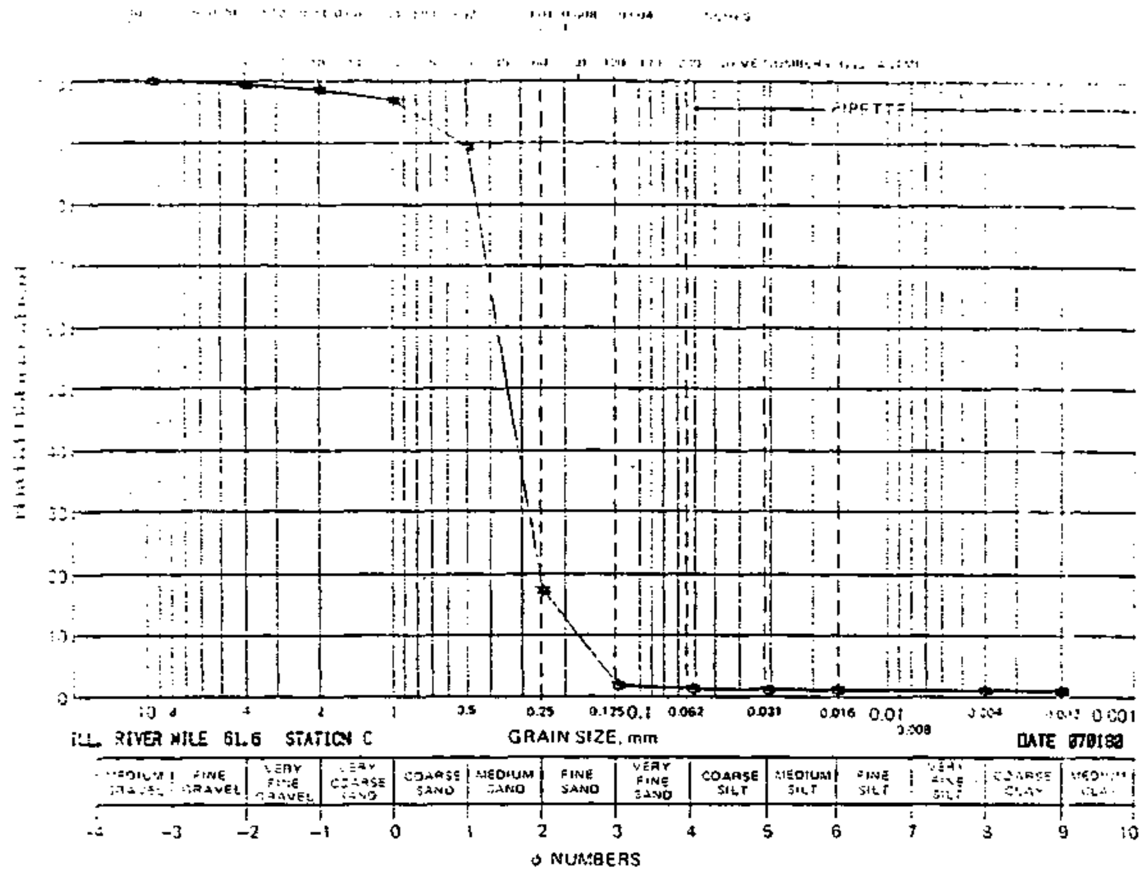
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



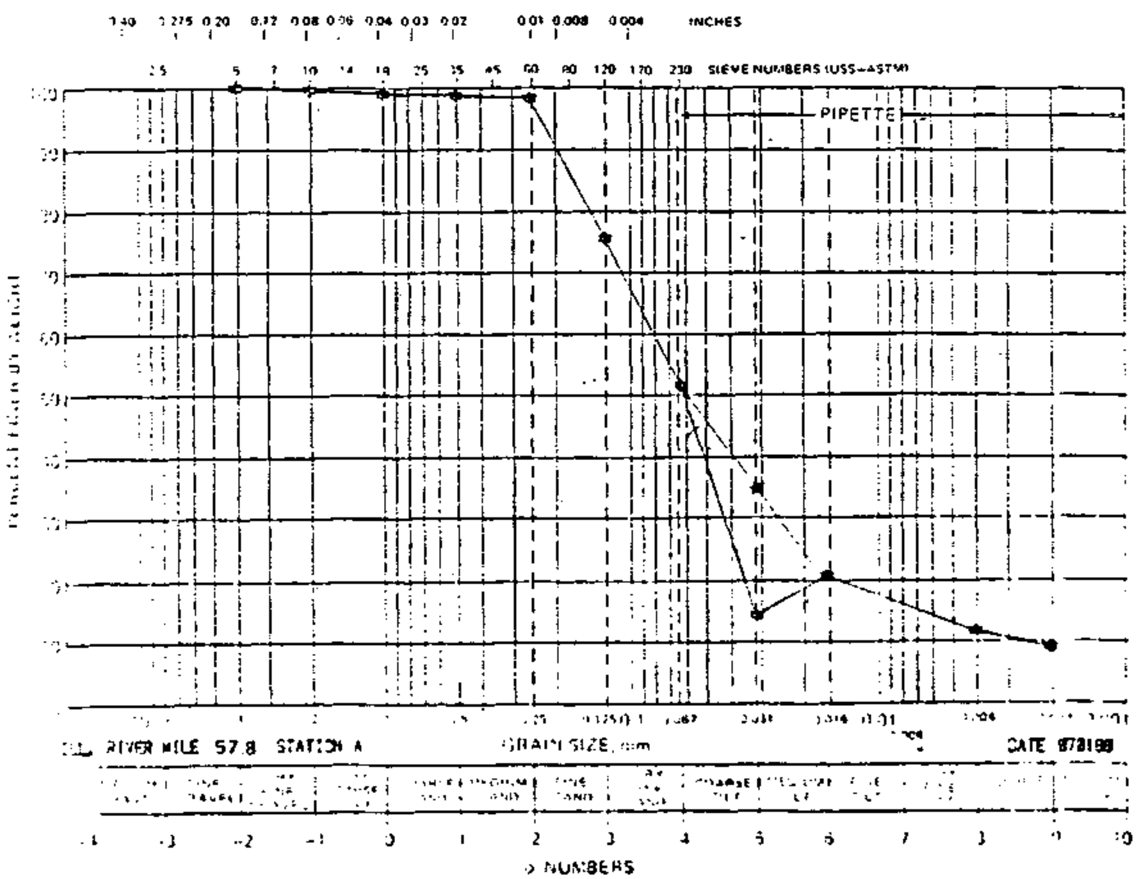
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



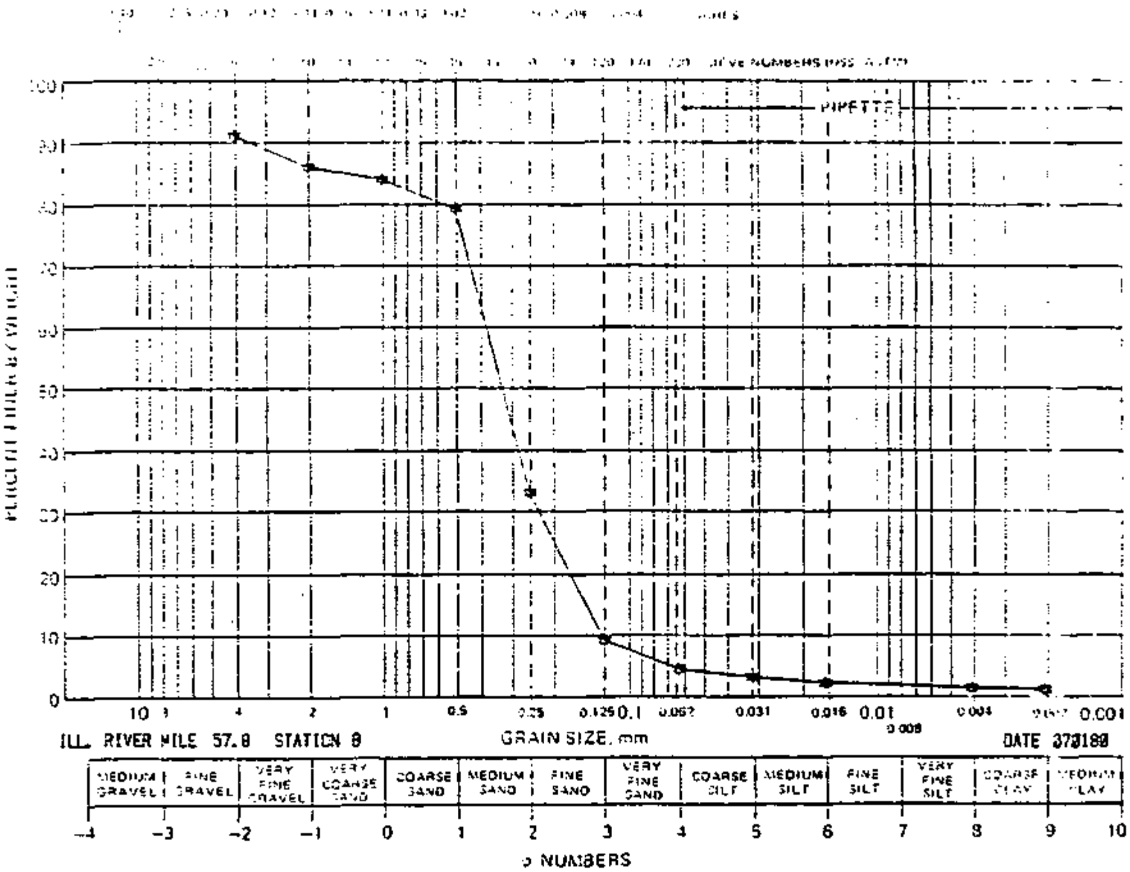
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



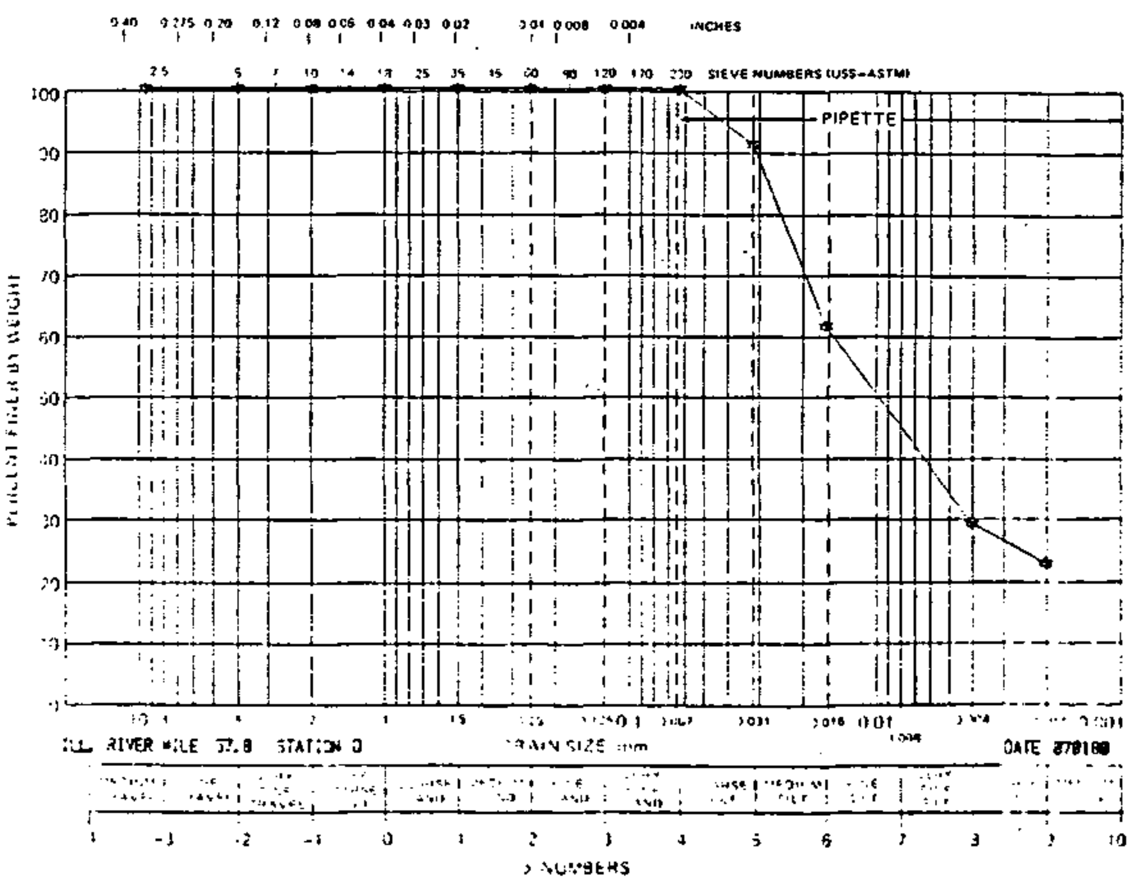
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY

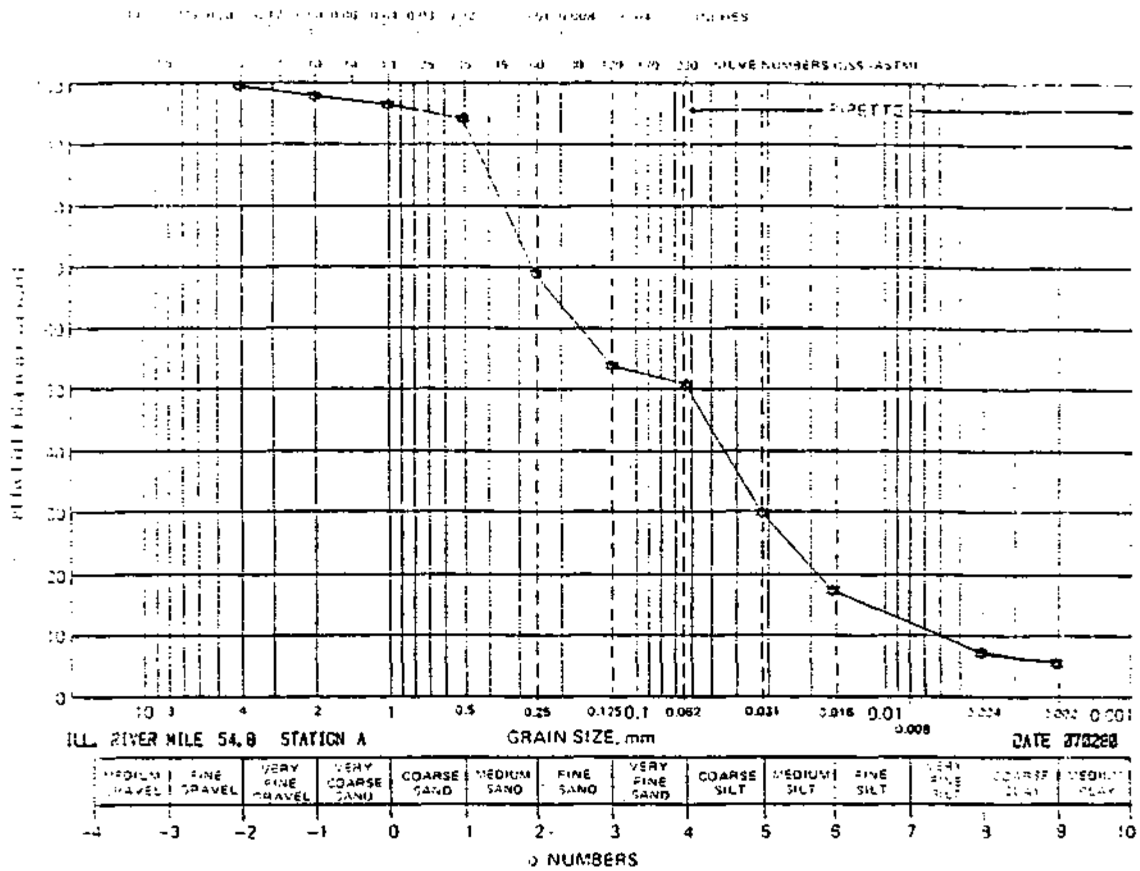


ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



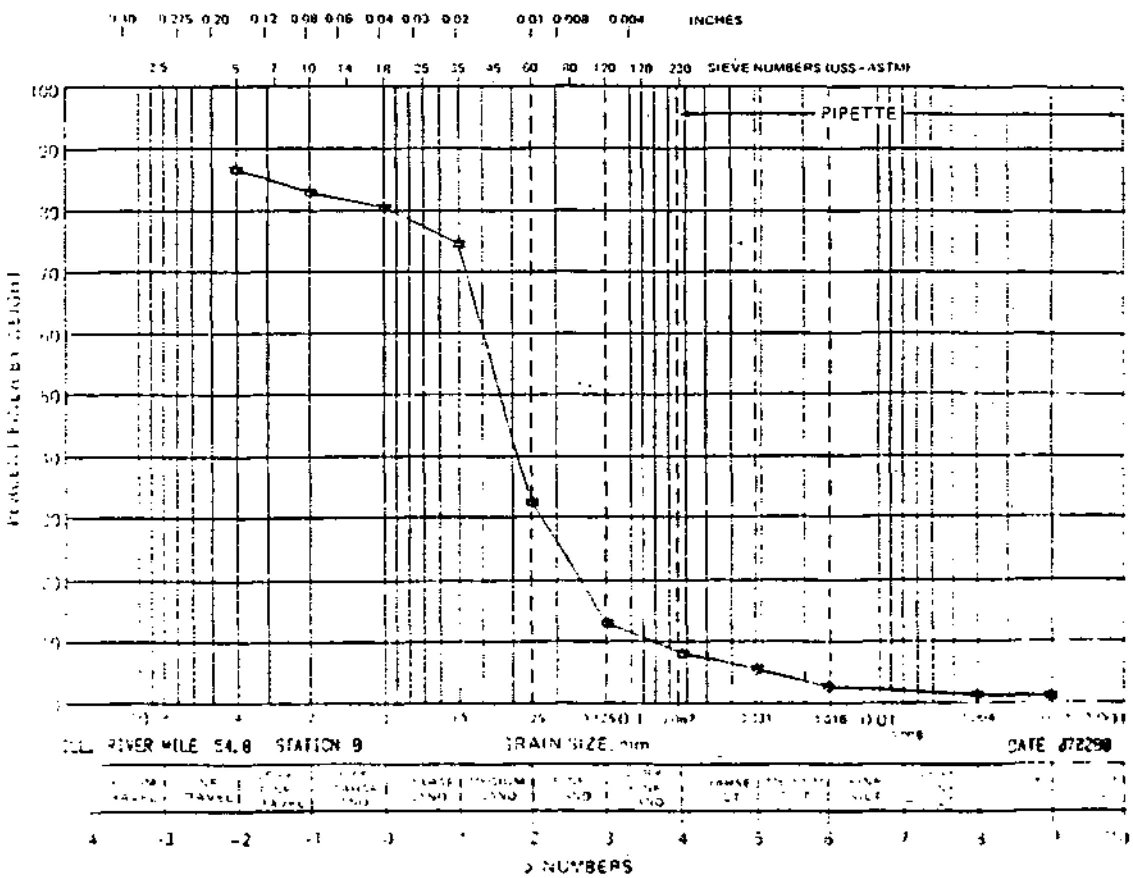
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY

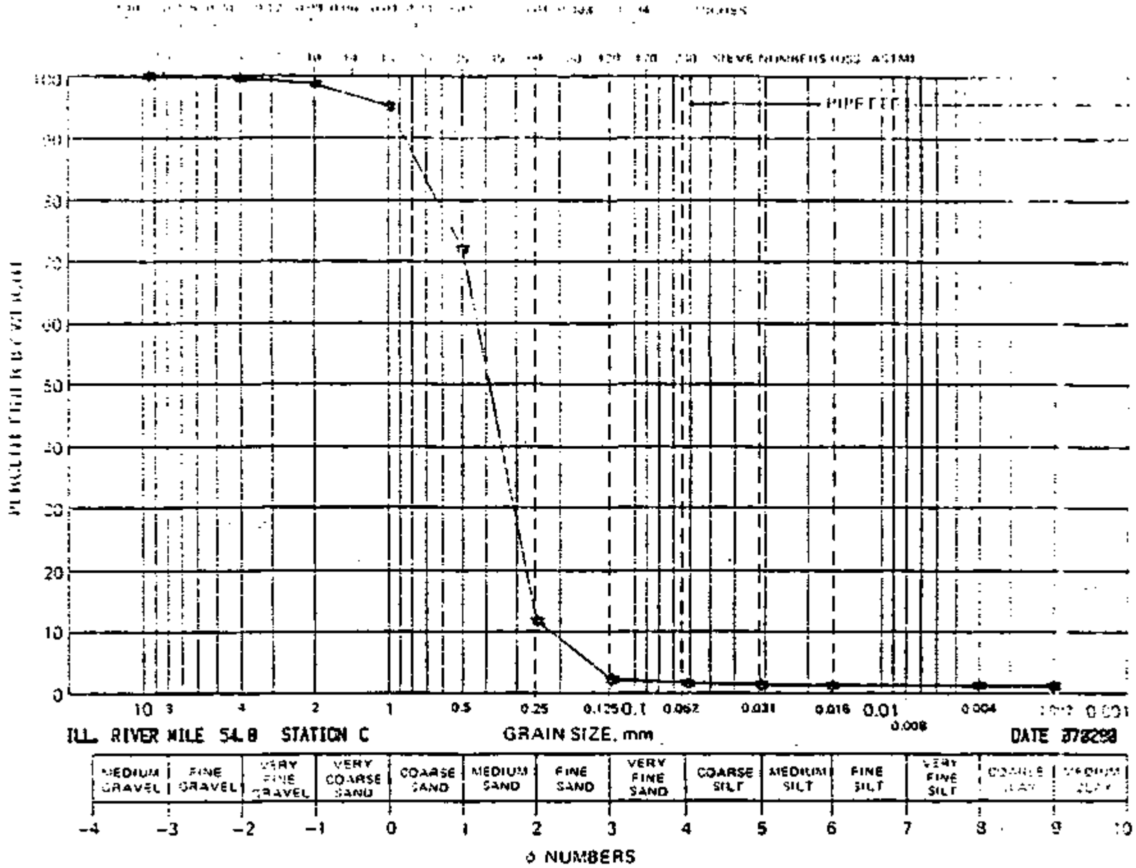


ILLINOIS STATE WATER SURVEY

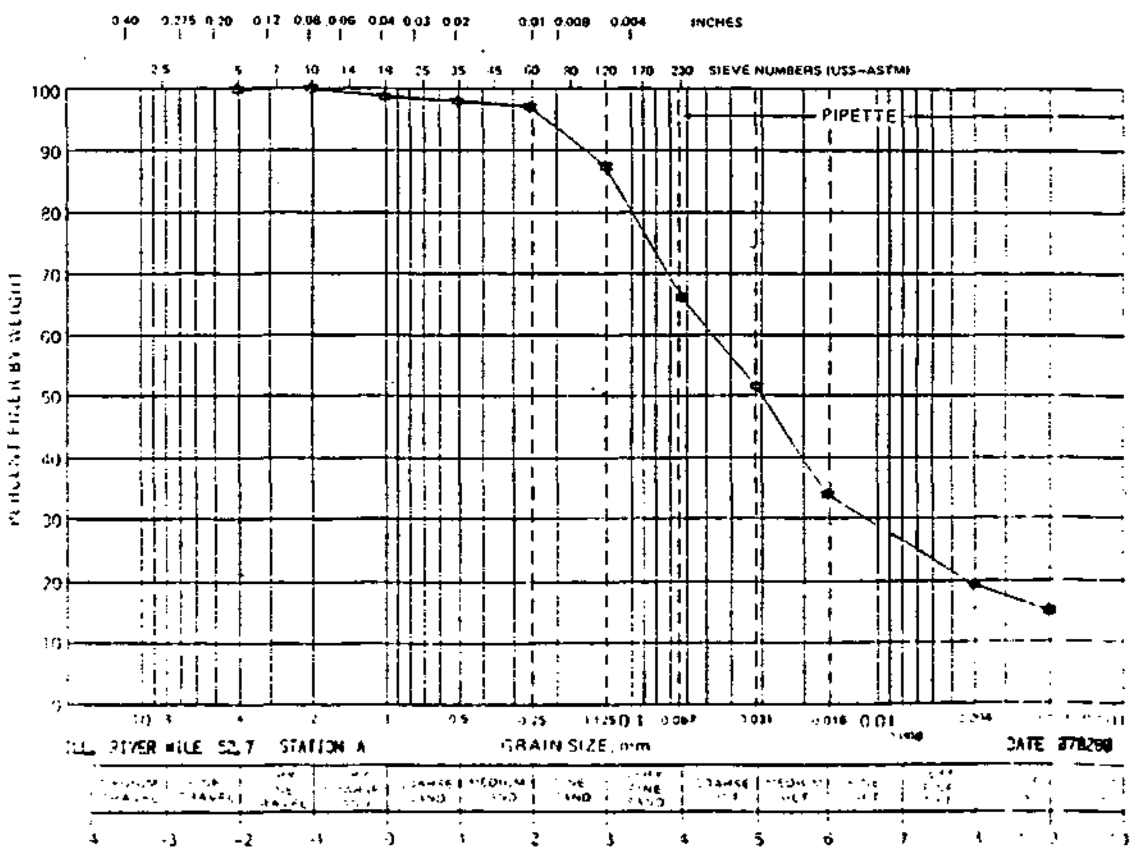
SEDIMENT LABORATORY



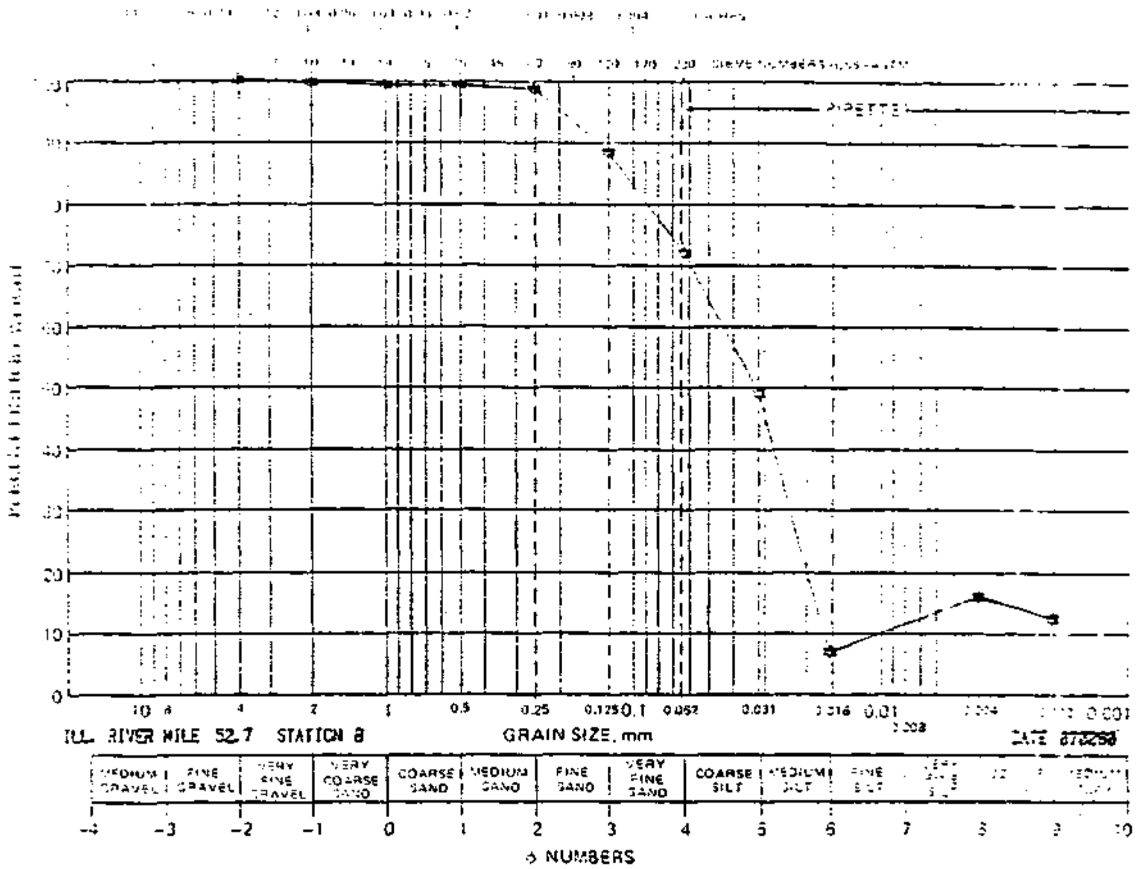
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



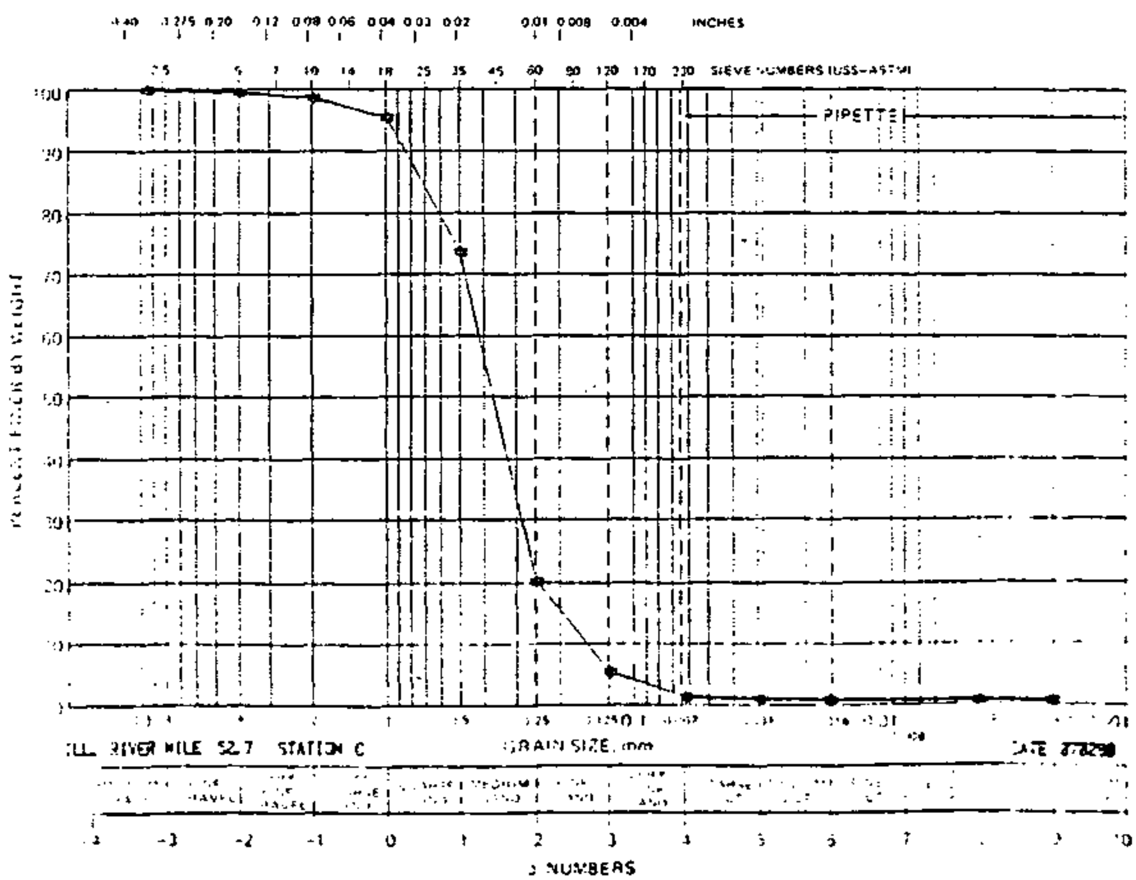
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



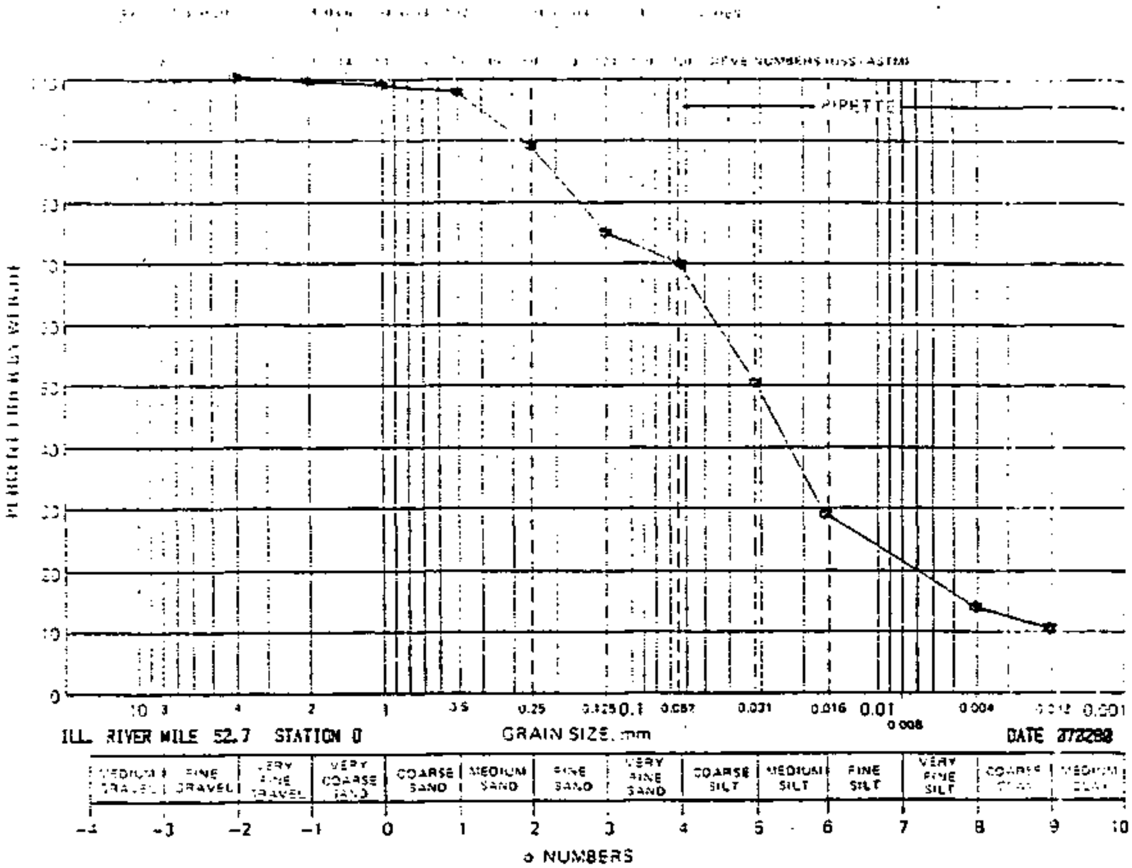
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



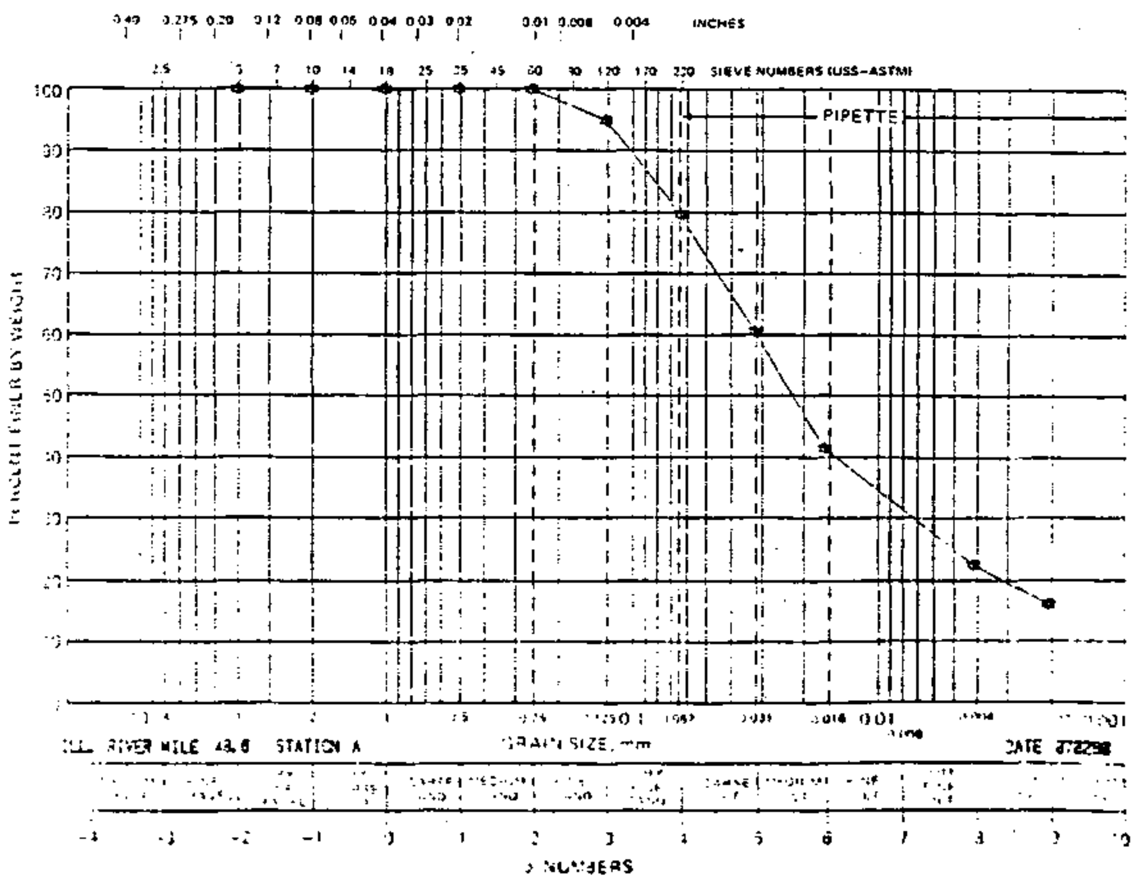
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY

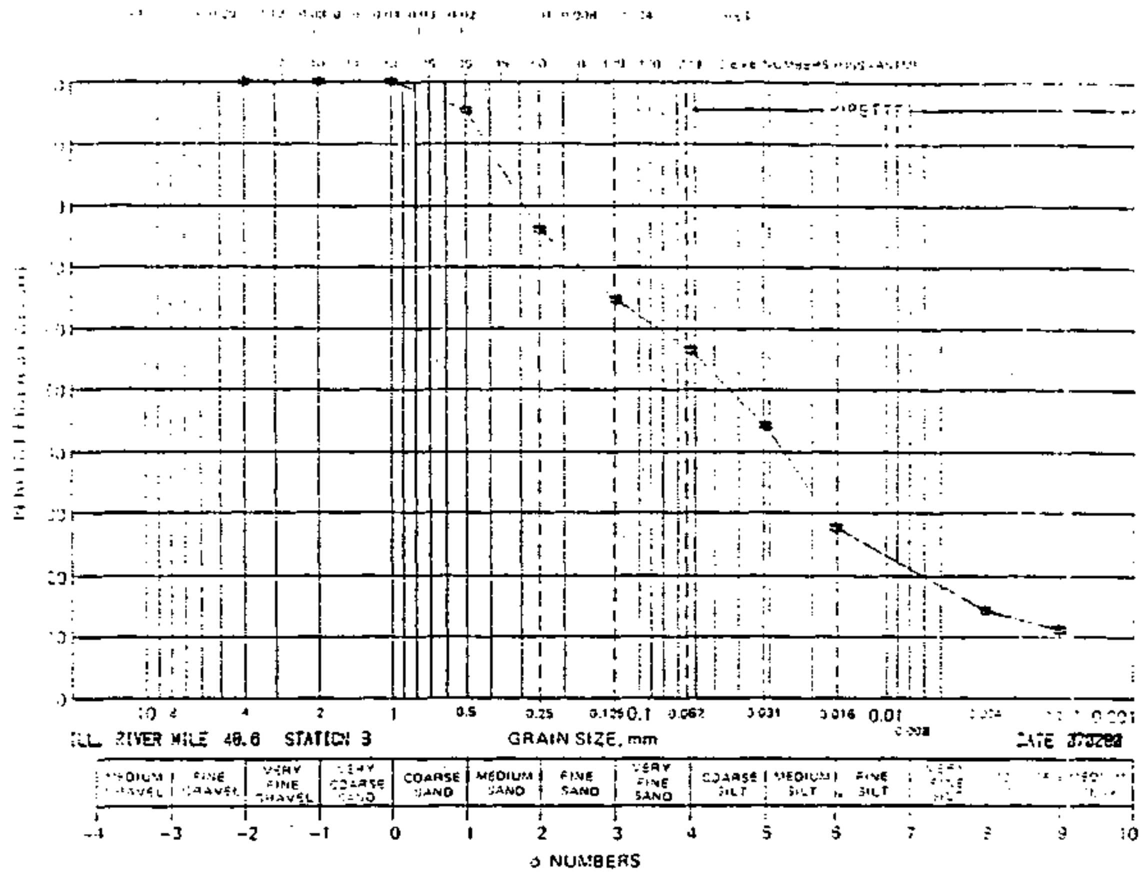


ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



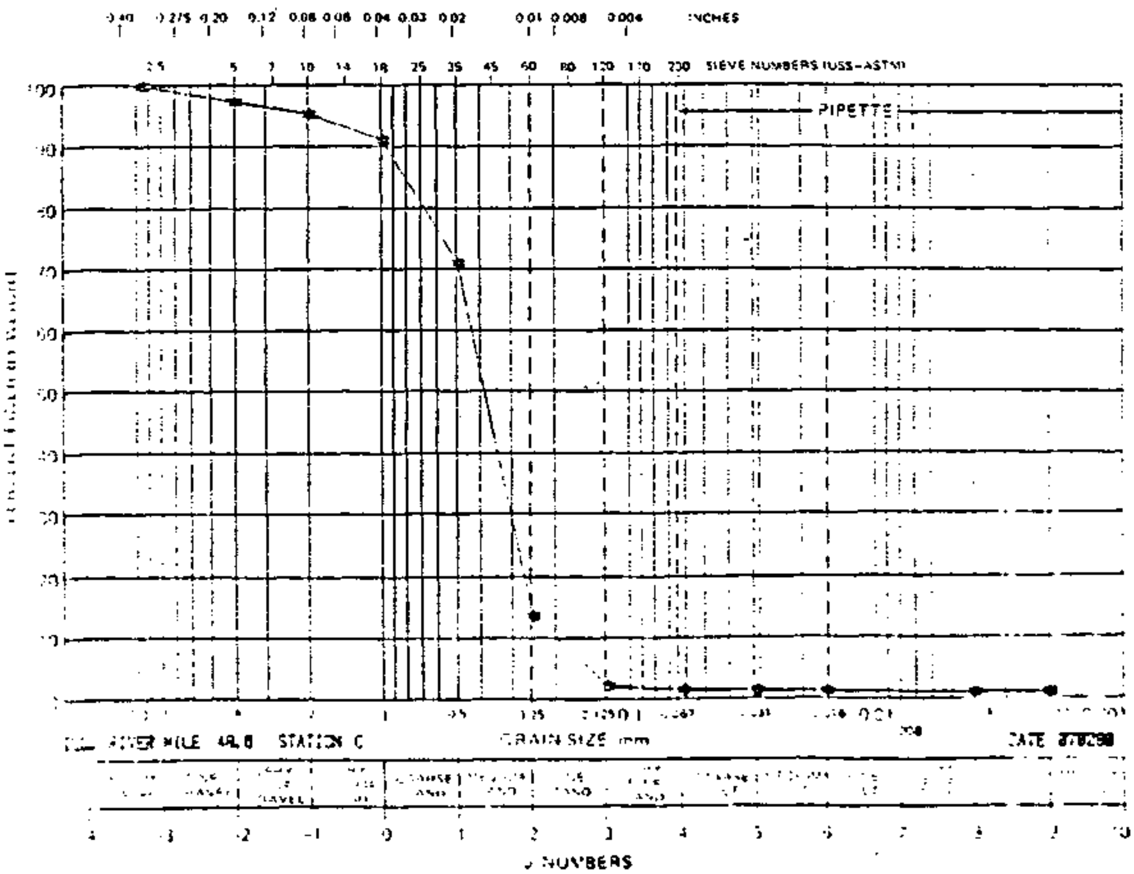
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY



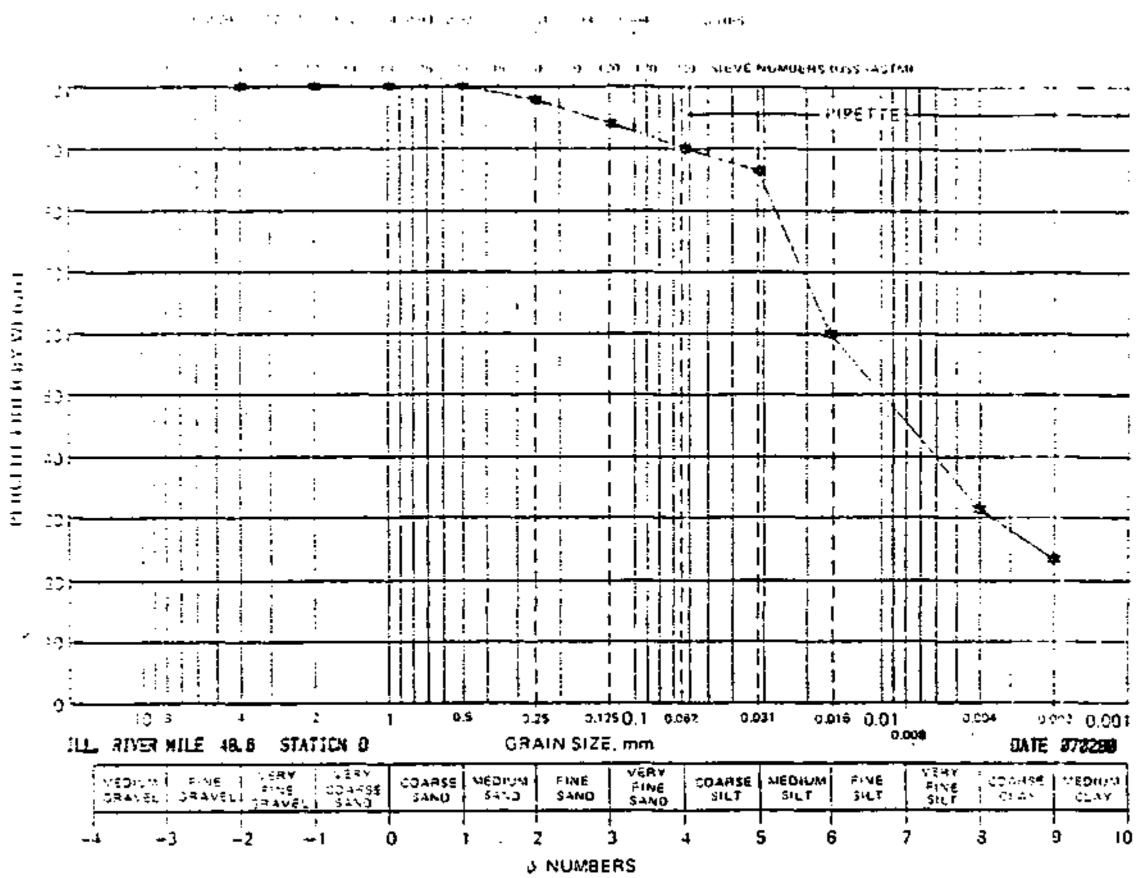
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY



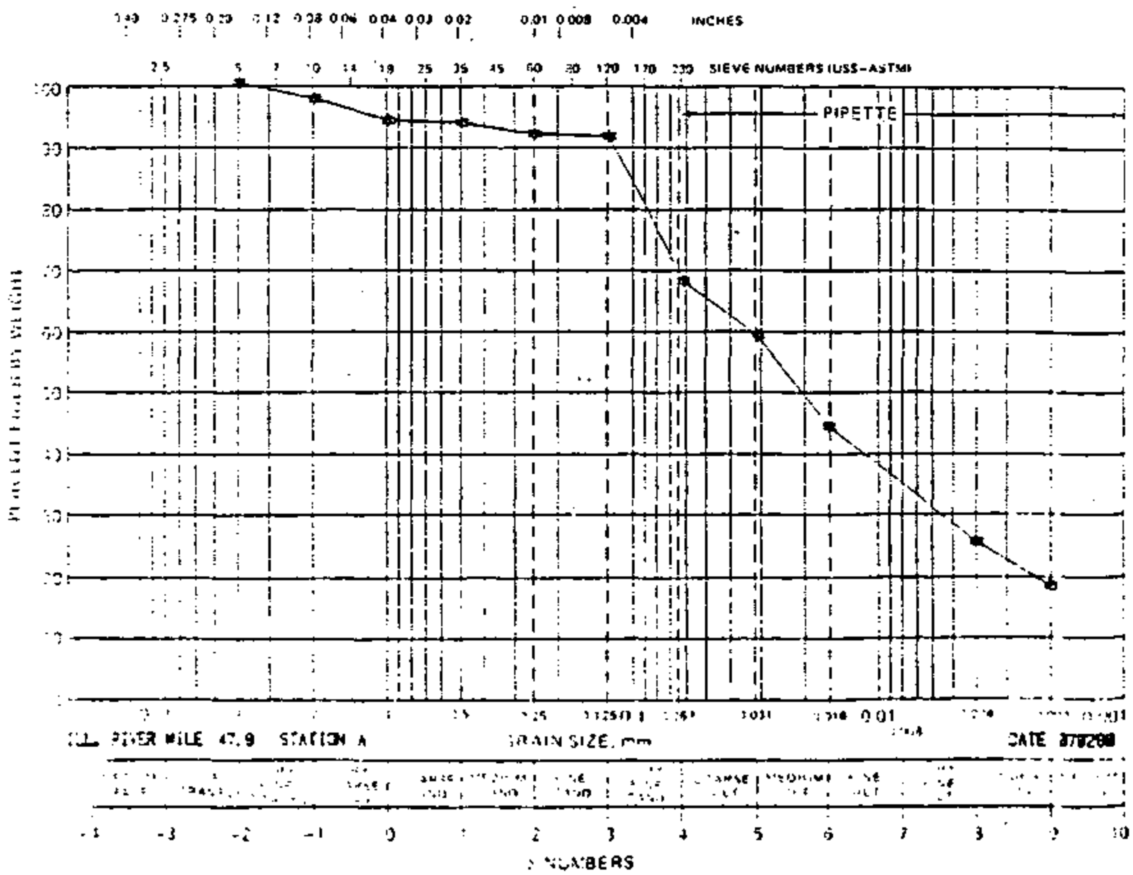
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY



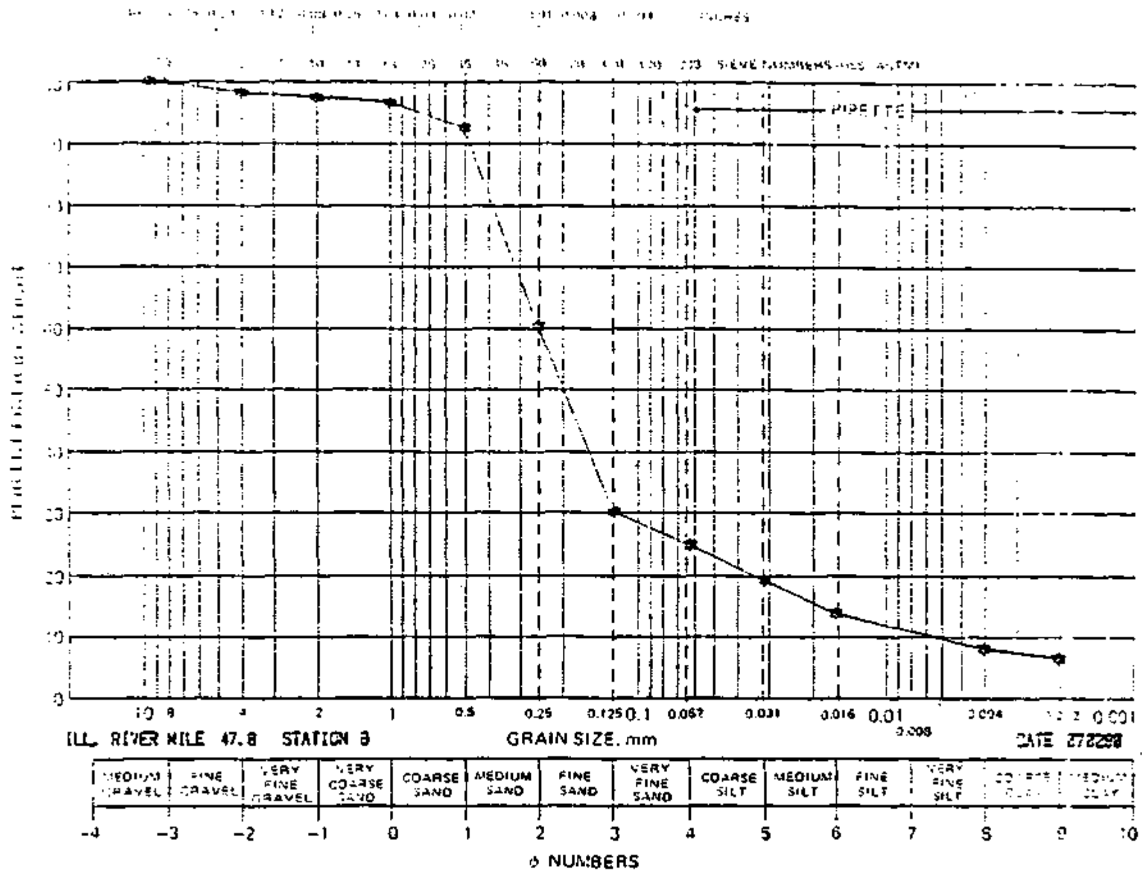
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY



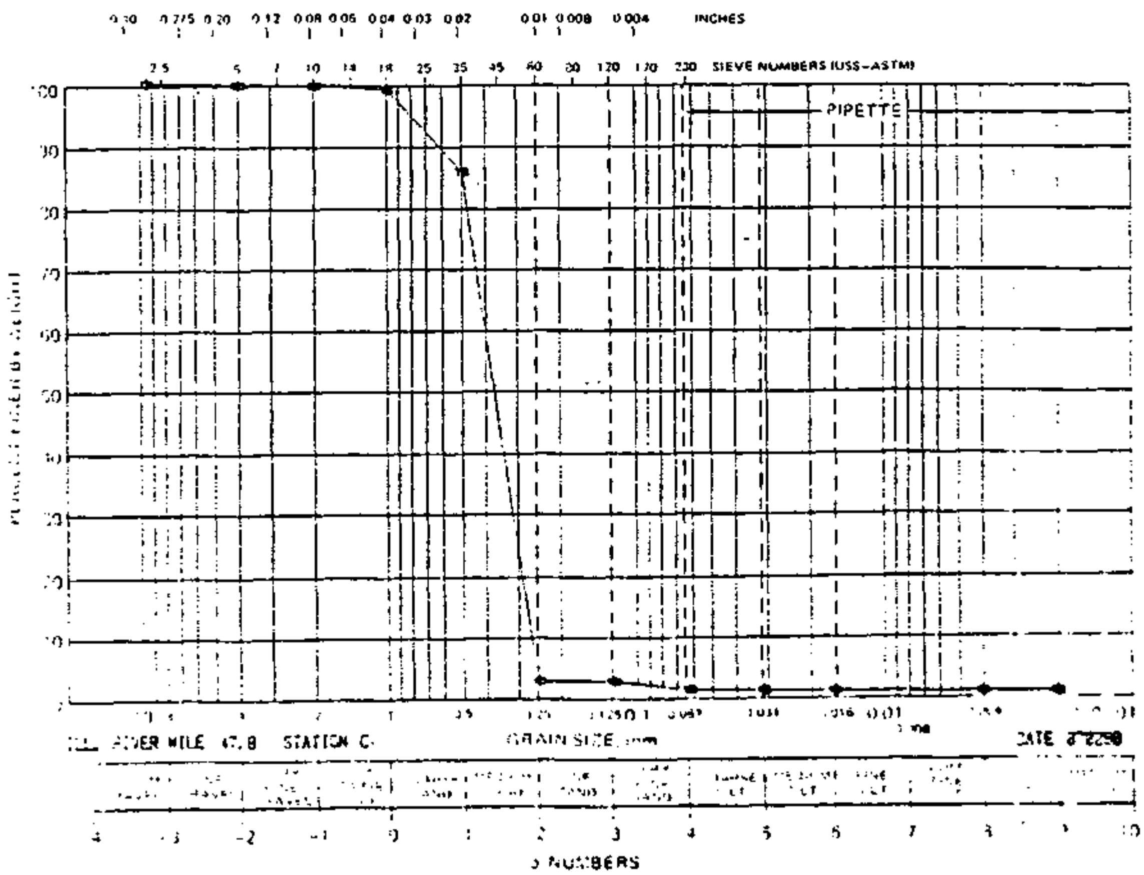
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY



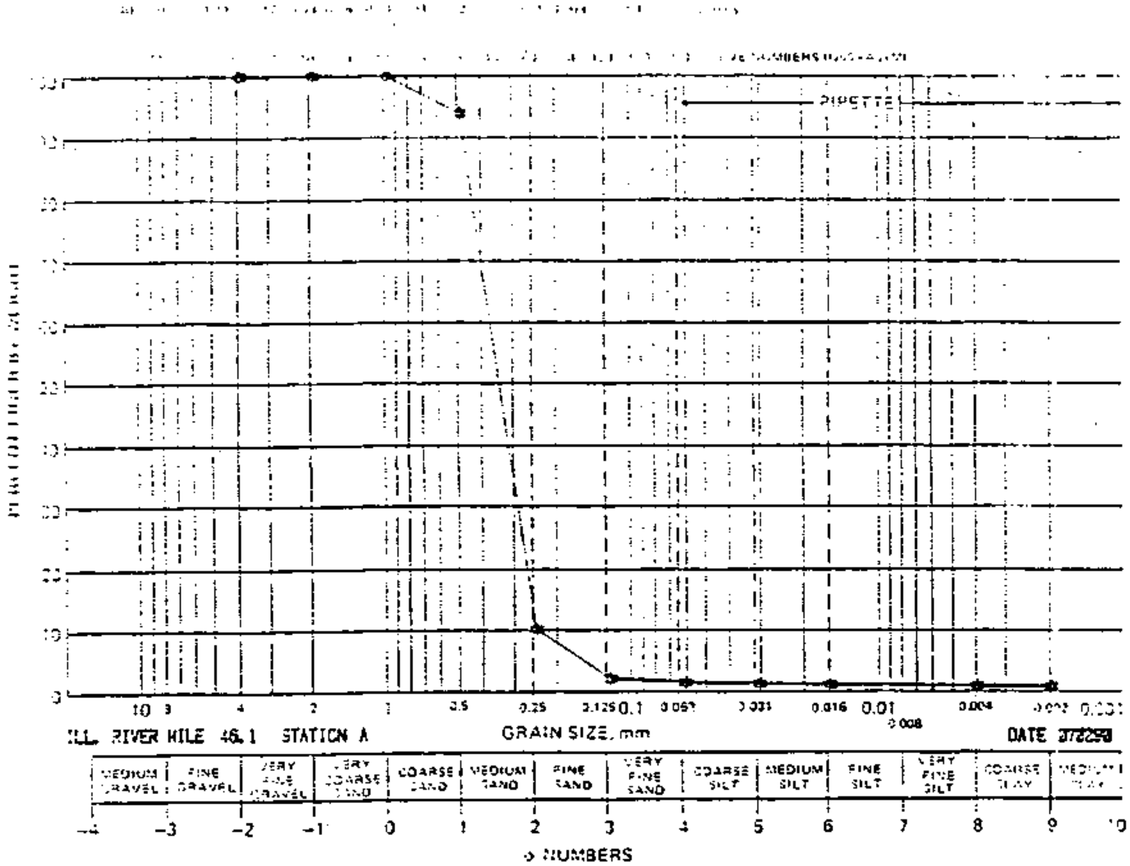
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY



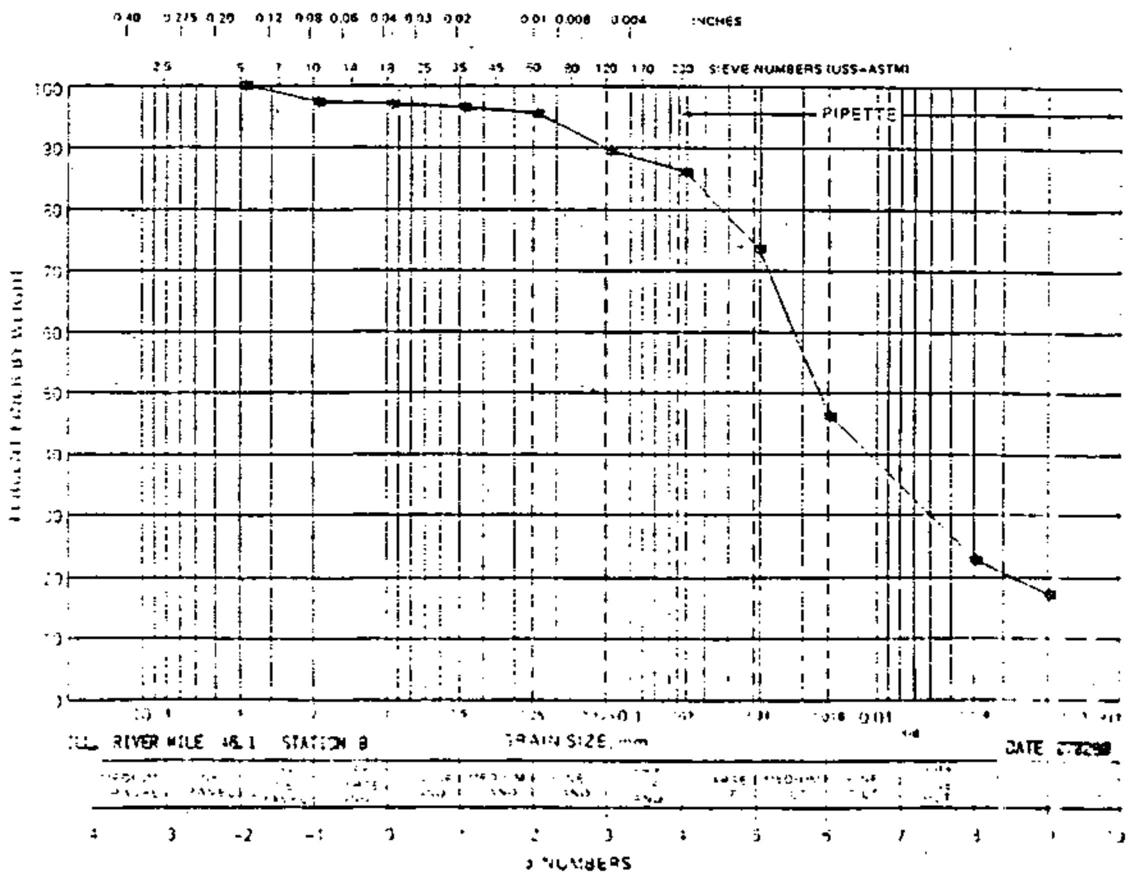
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY

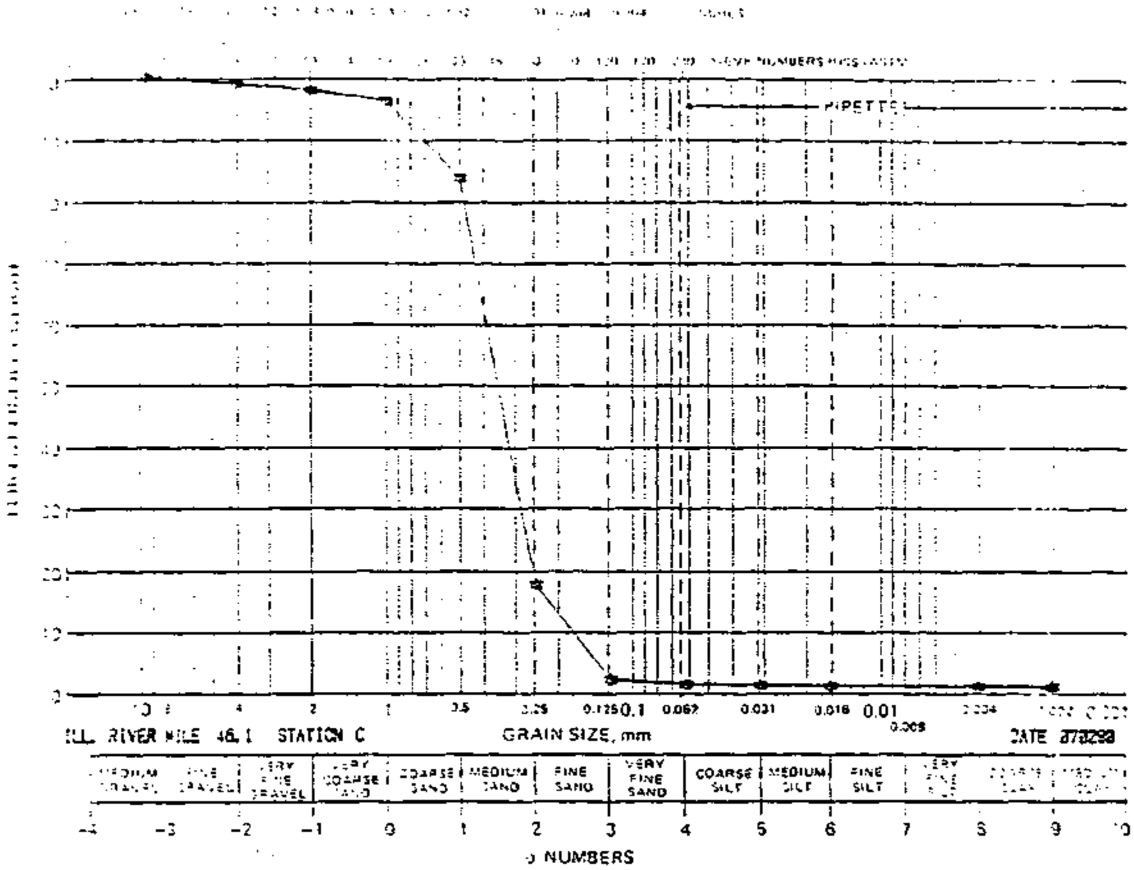


ILLINOIS STATE WATER SURVEY

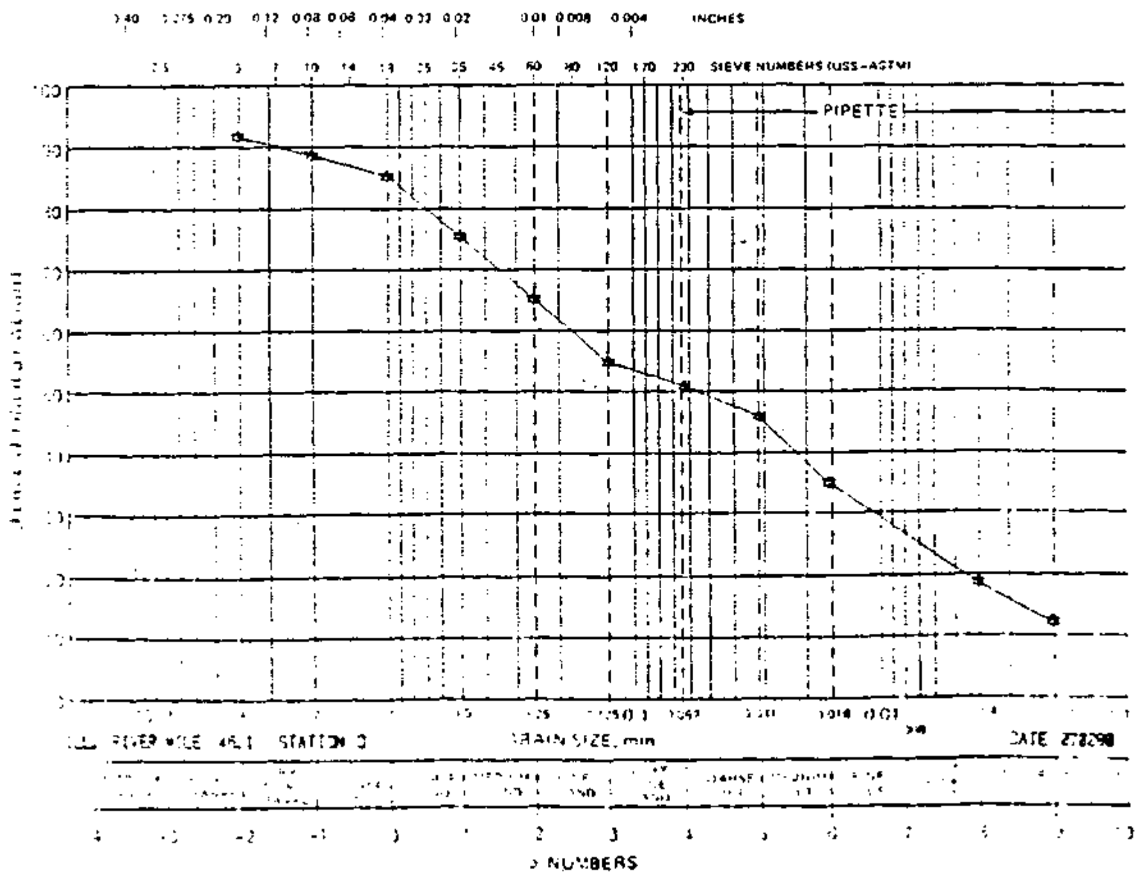
SEDIMENT LABORATORY



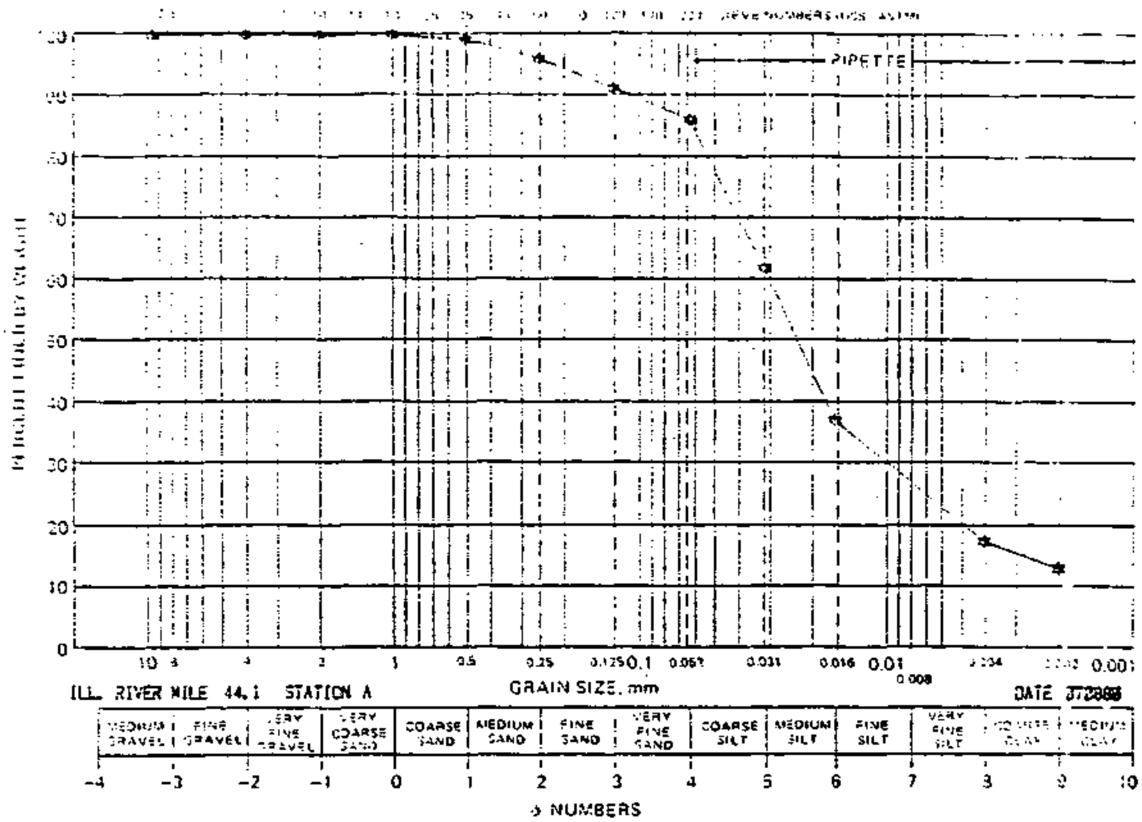
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



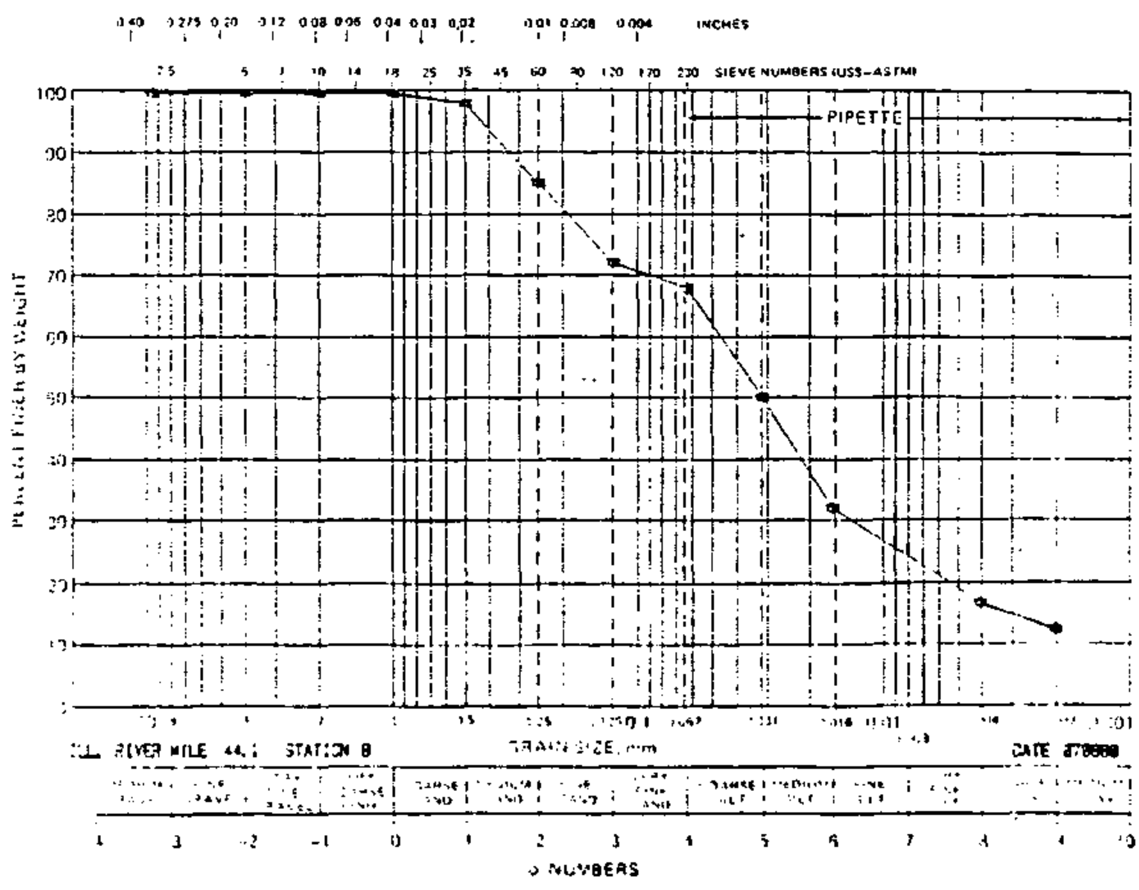
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY

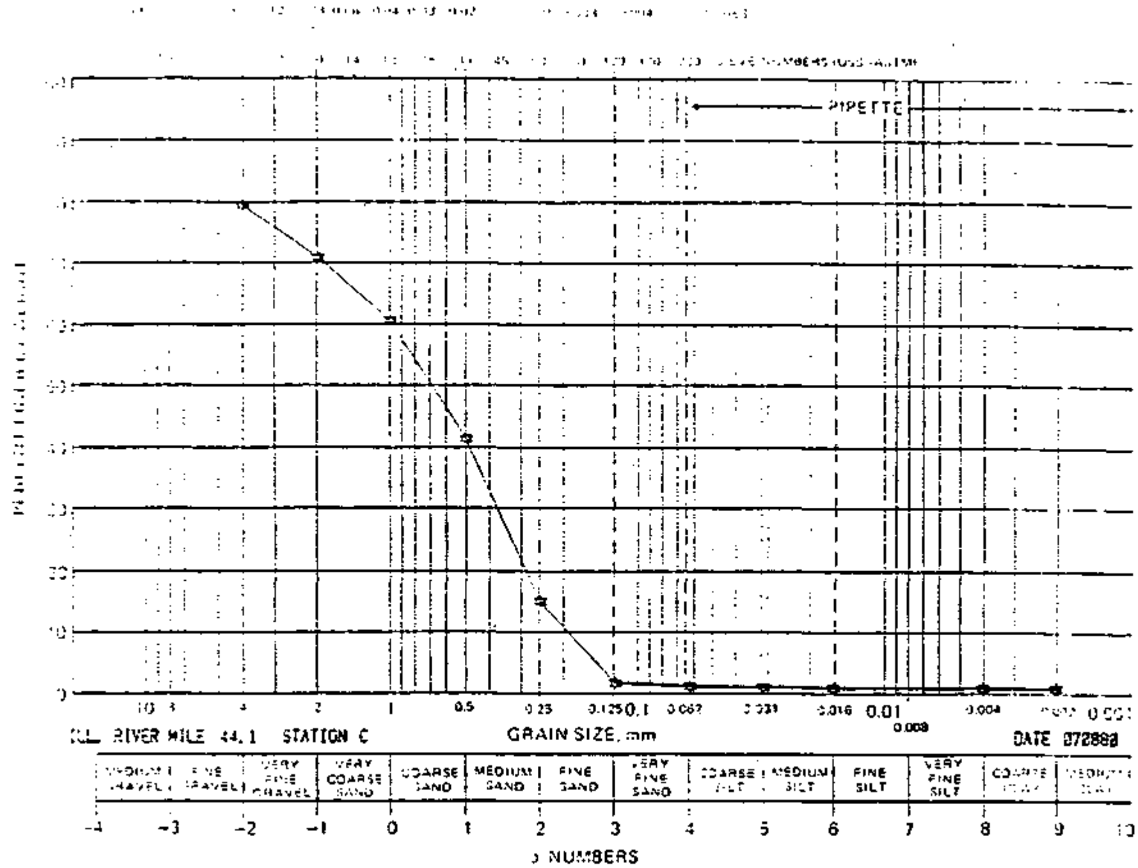


ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



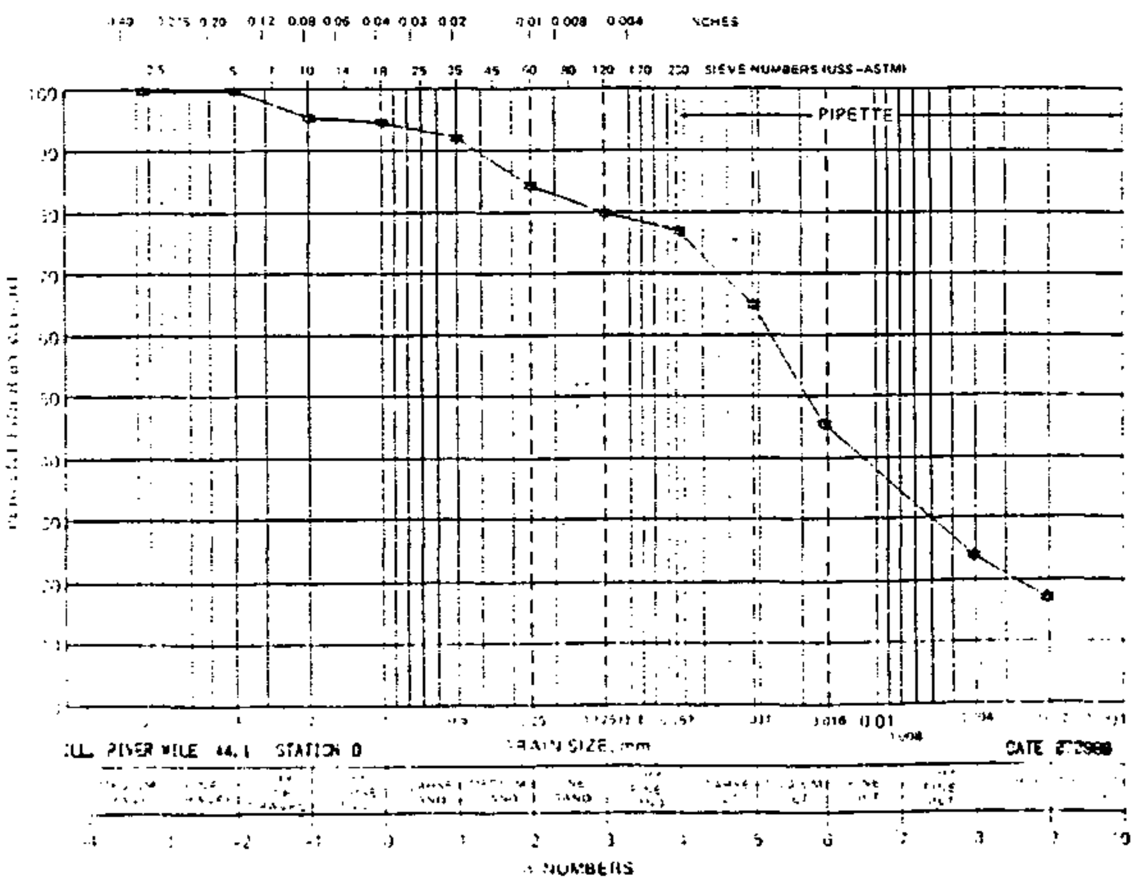
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY

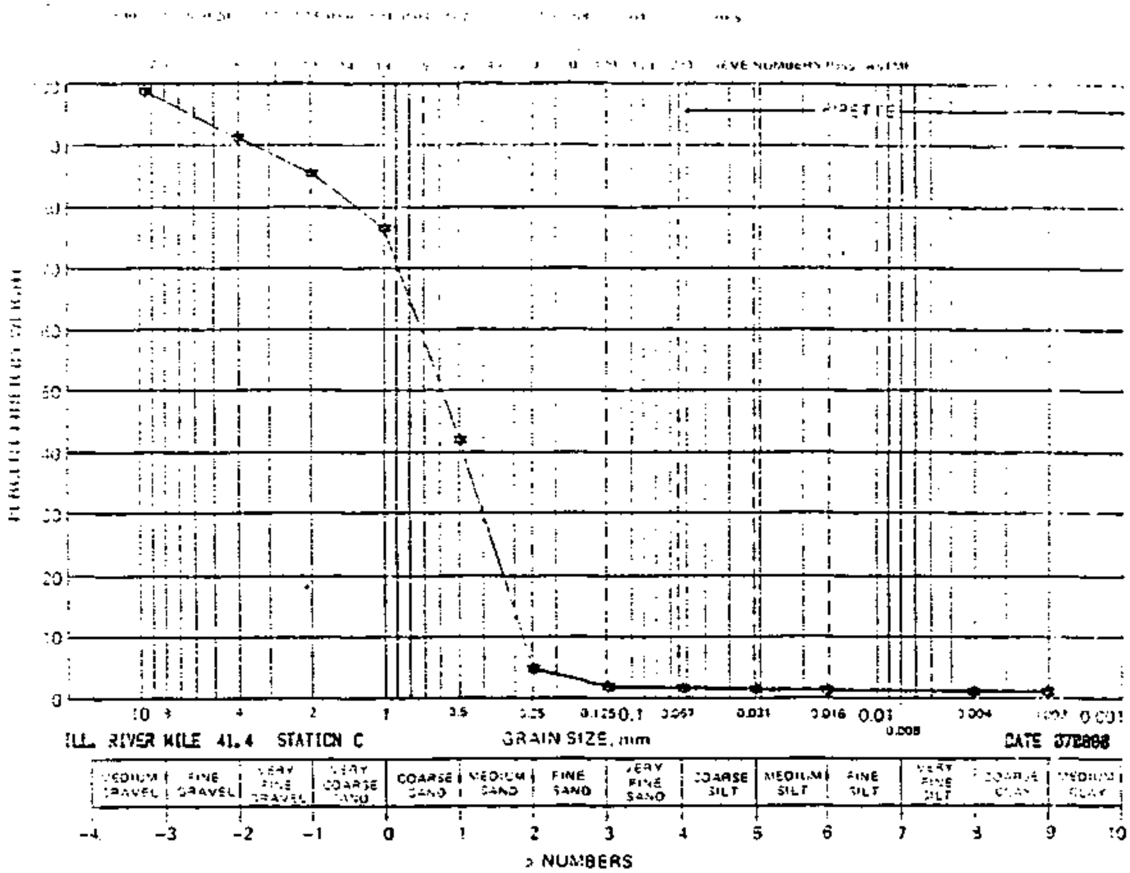


ILLINOIS STATE WATER SURVEY

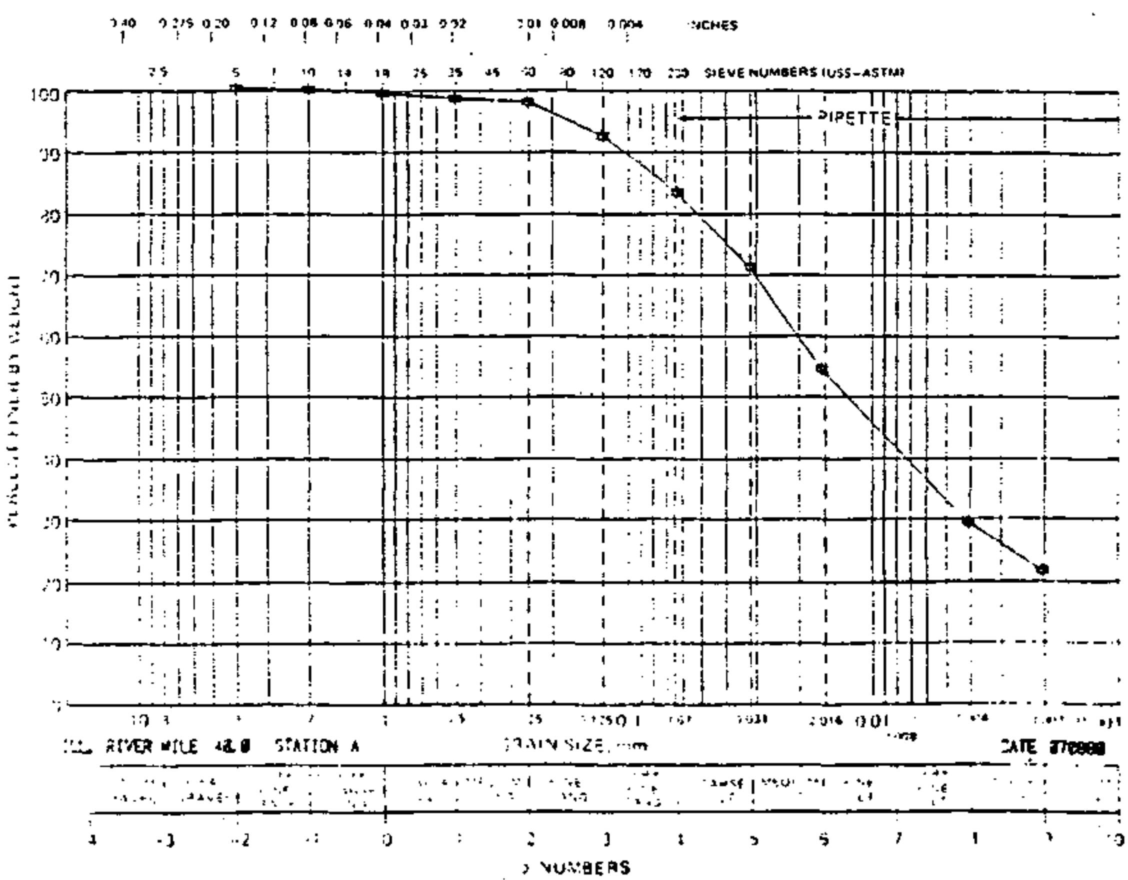
SEDIMENT LABORATORY



ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY

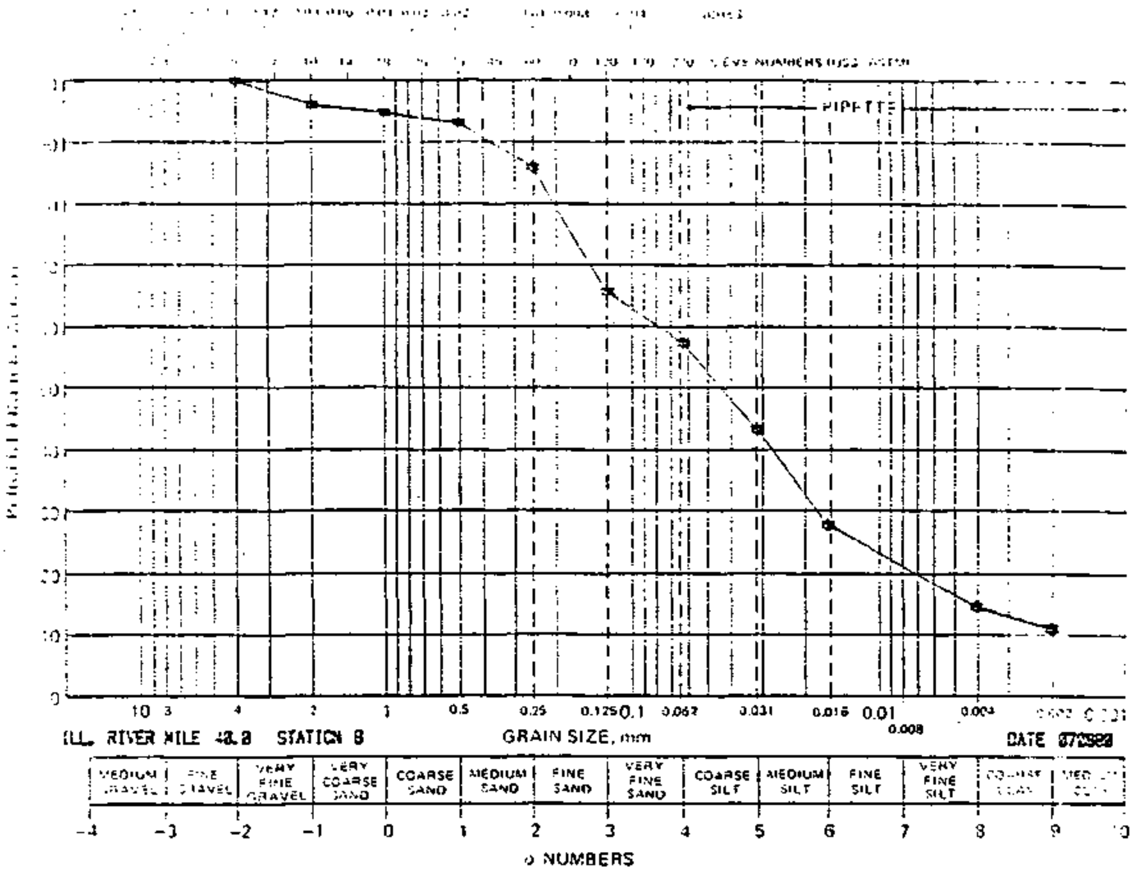


ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



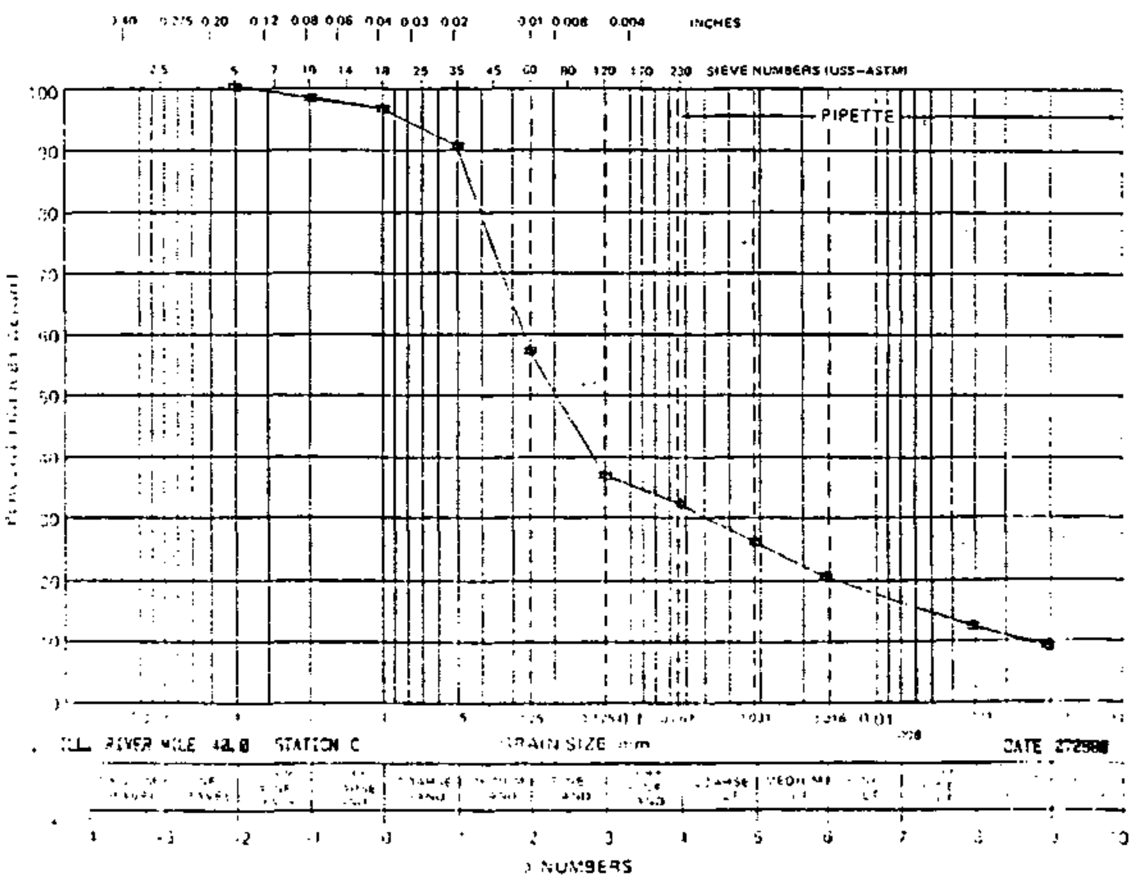
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY



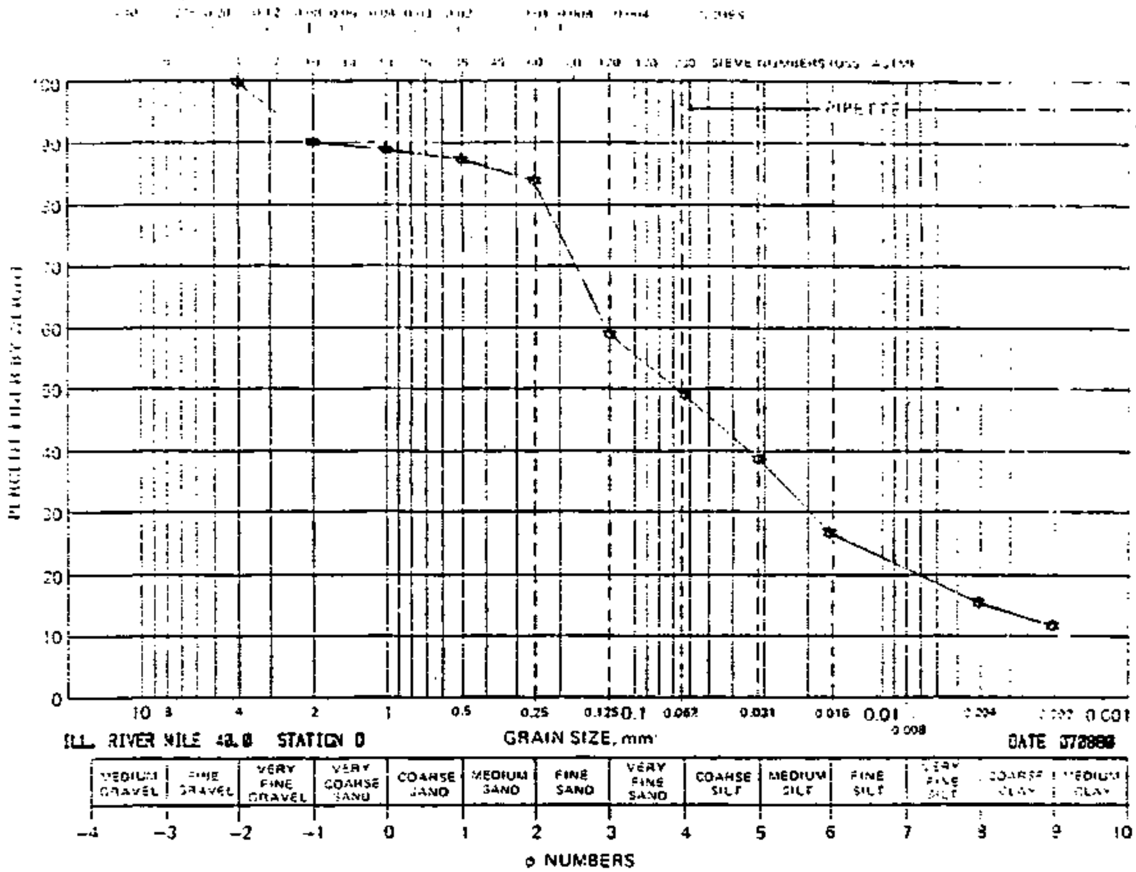
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY



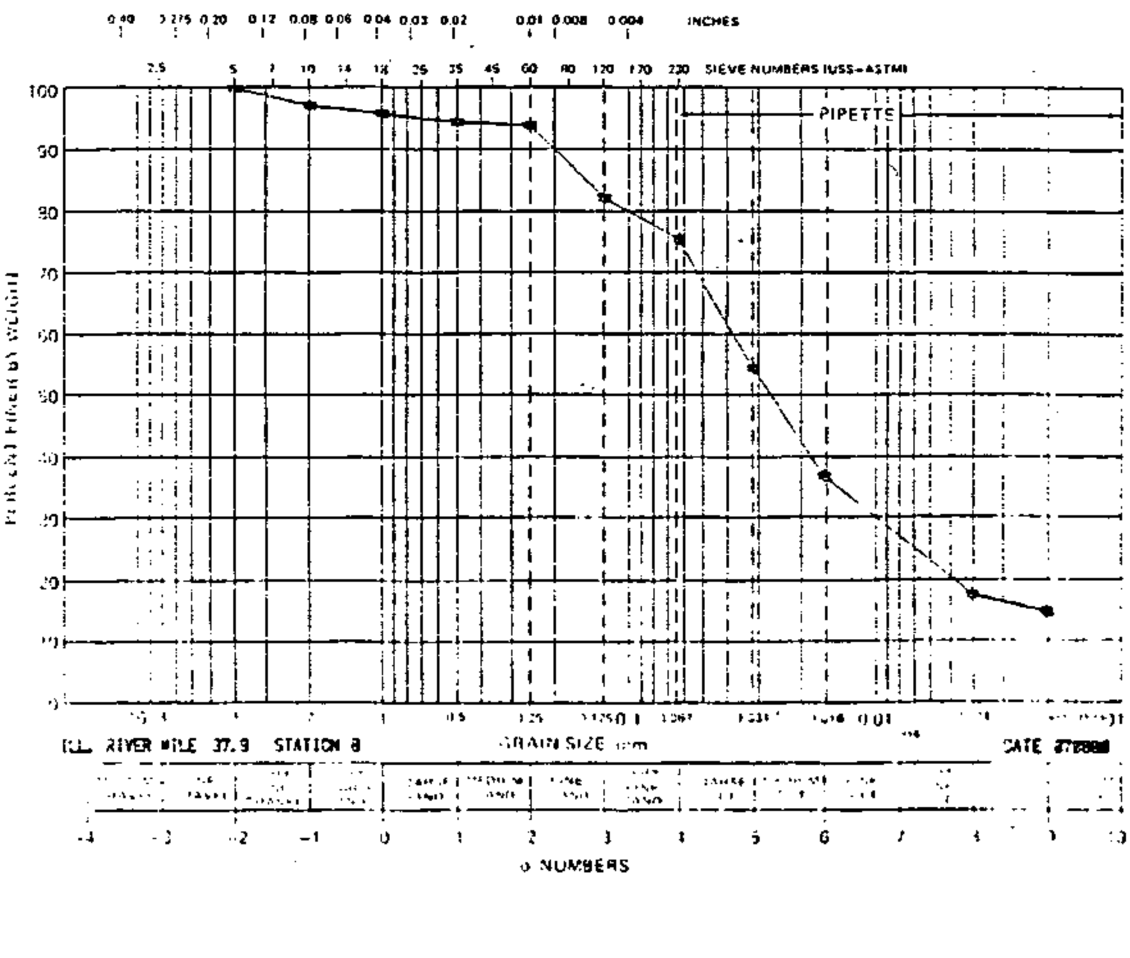
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY



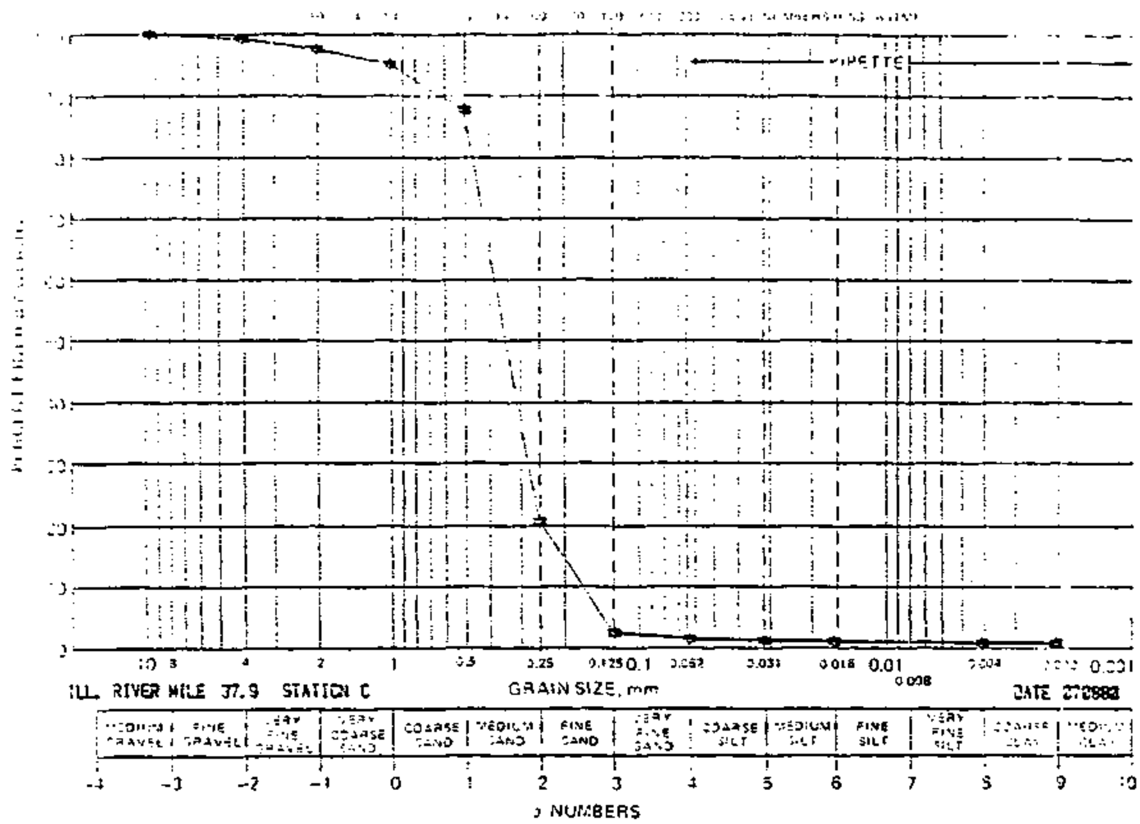
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY



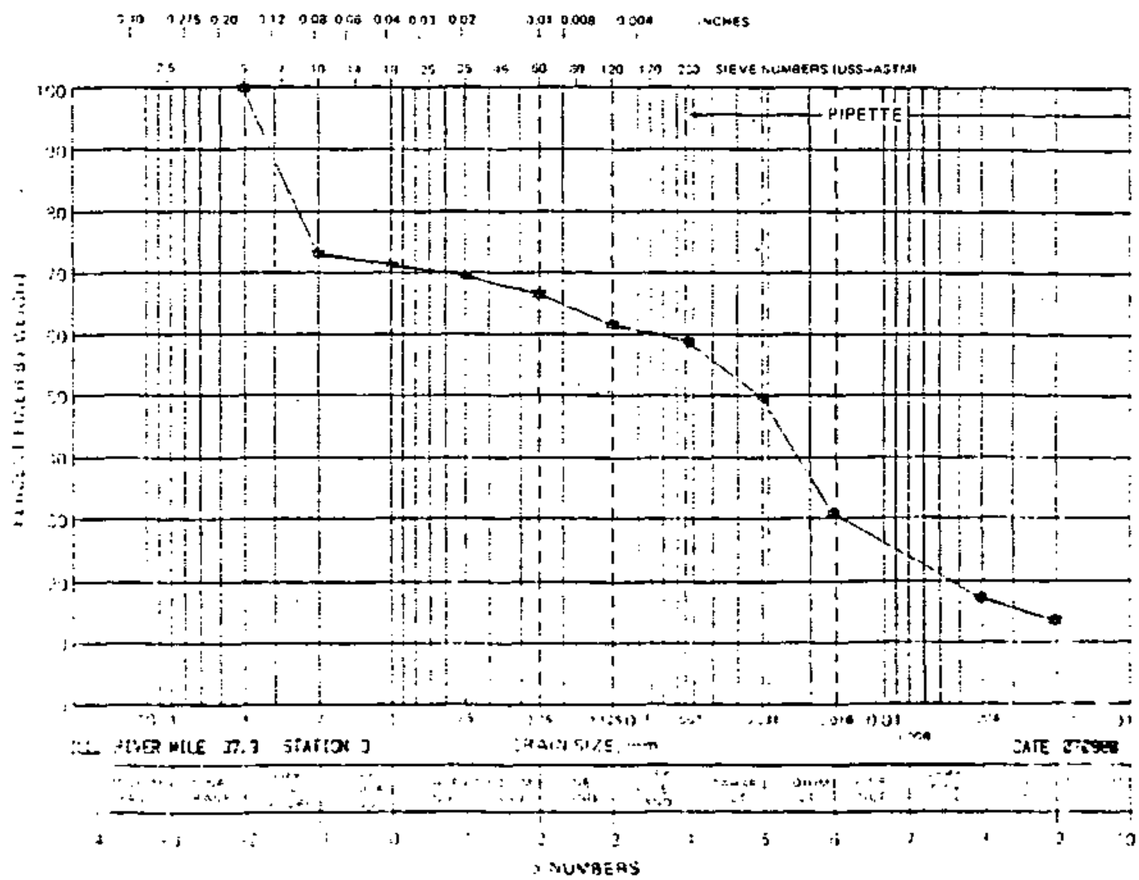
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY

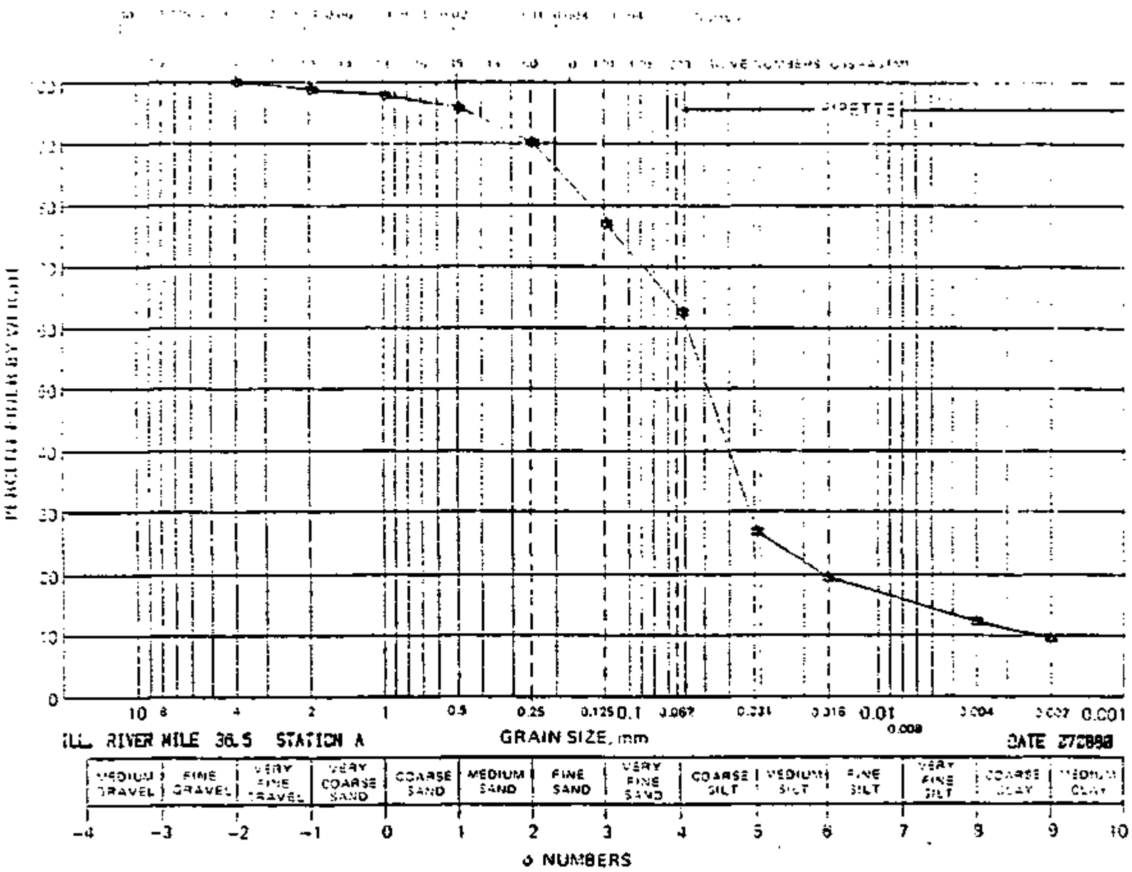


ILLINOIS STATE WATER SURVEY

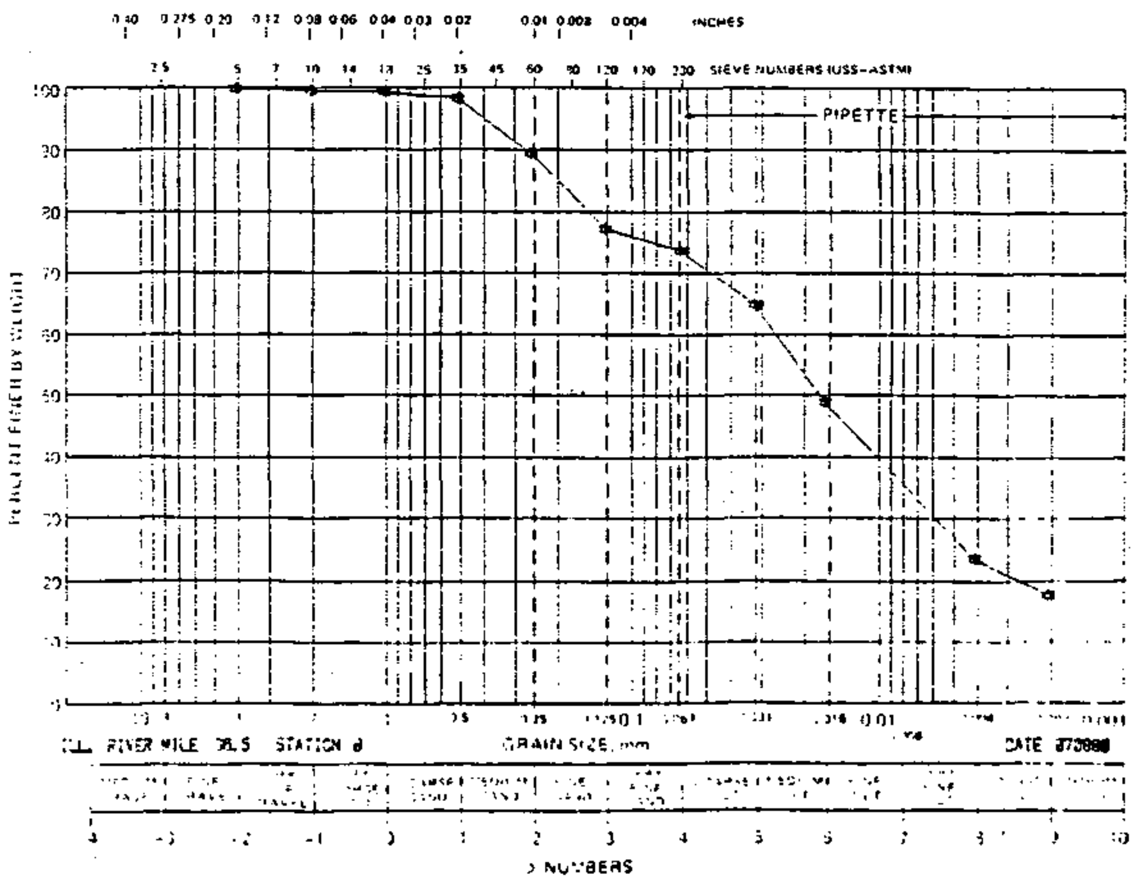
SEDIMENT LABORATORY



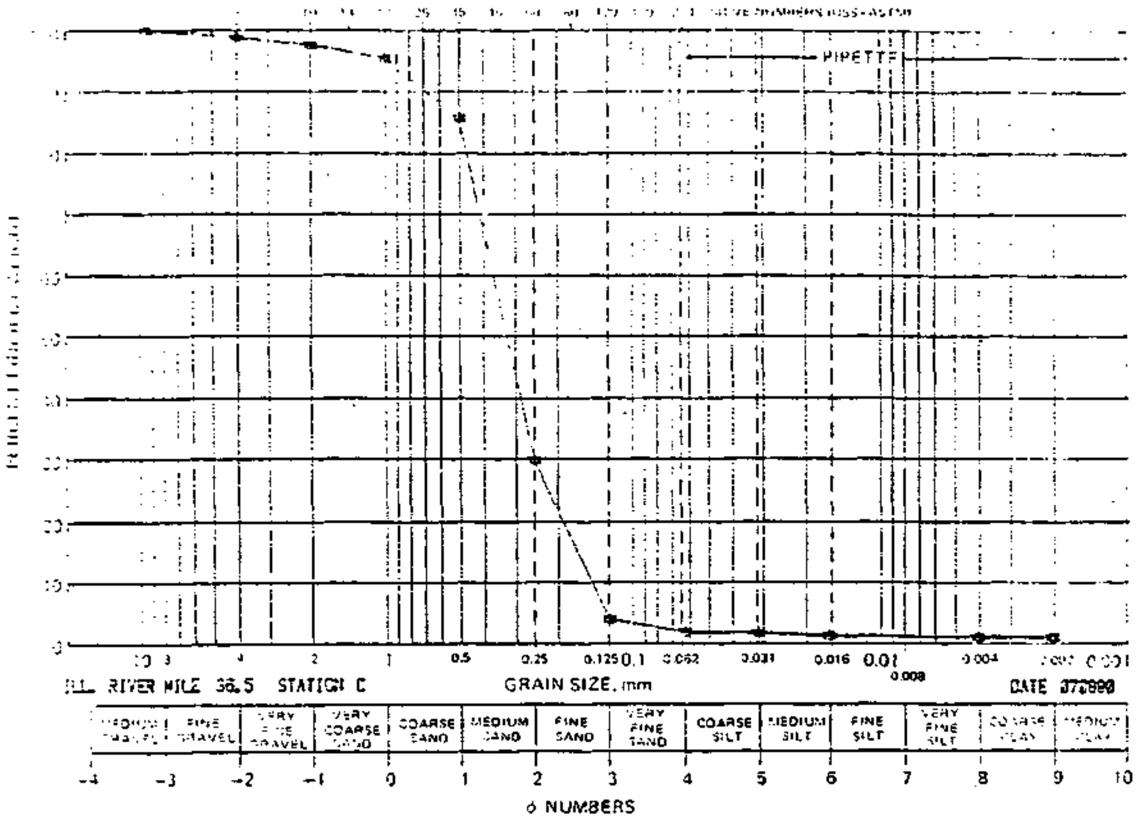
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



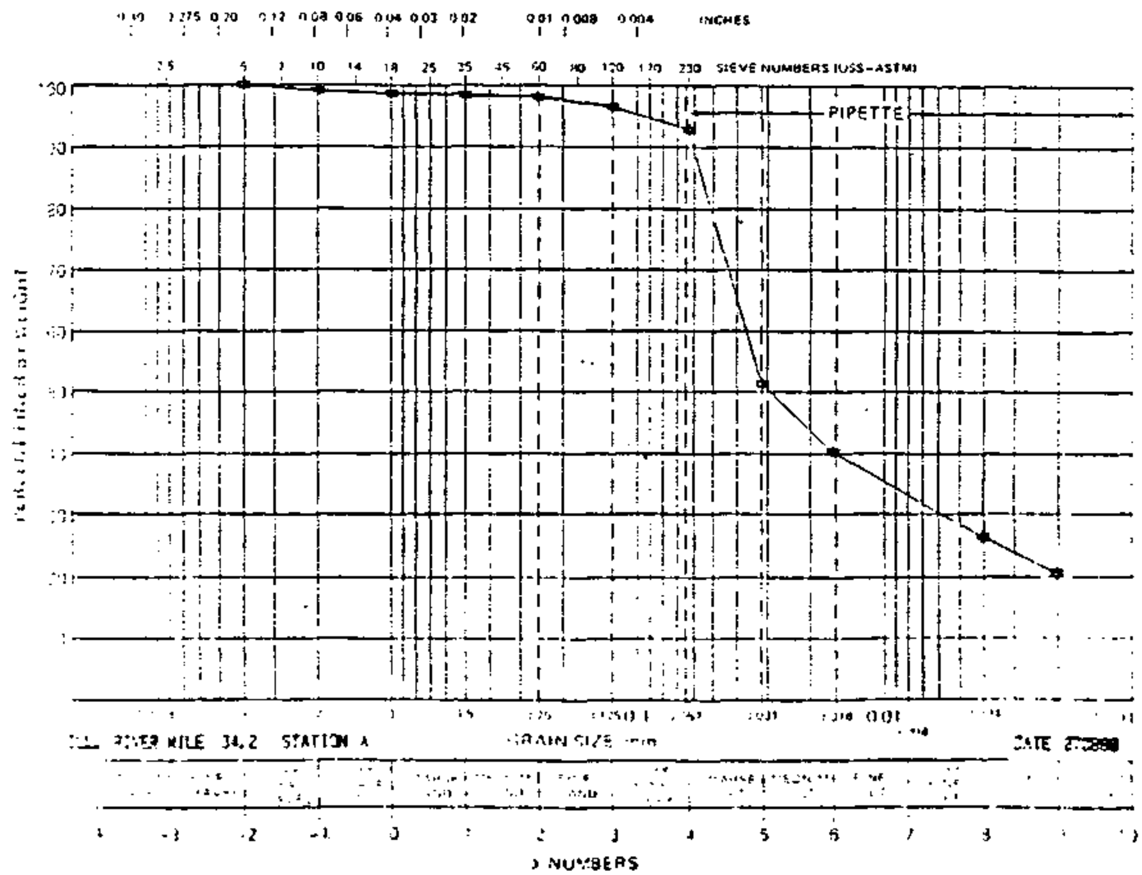
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



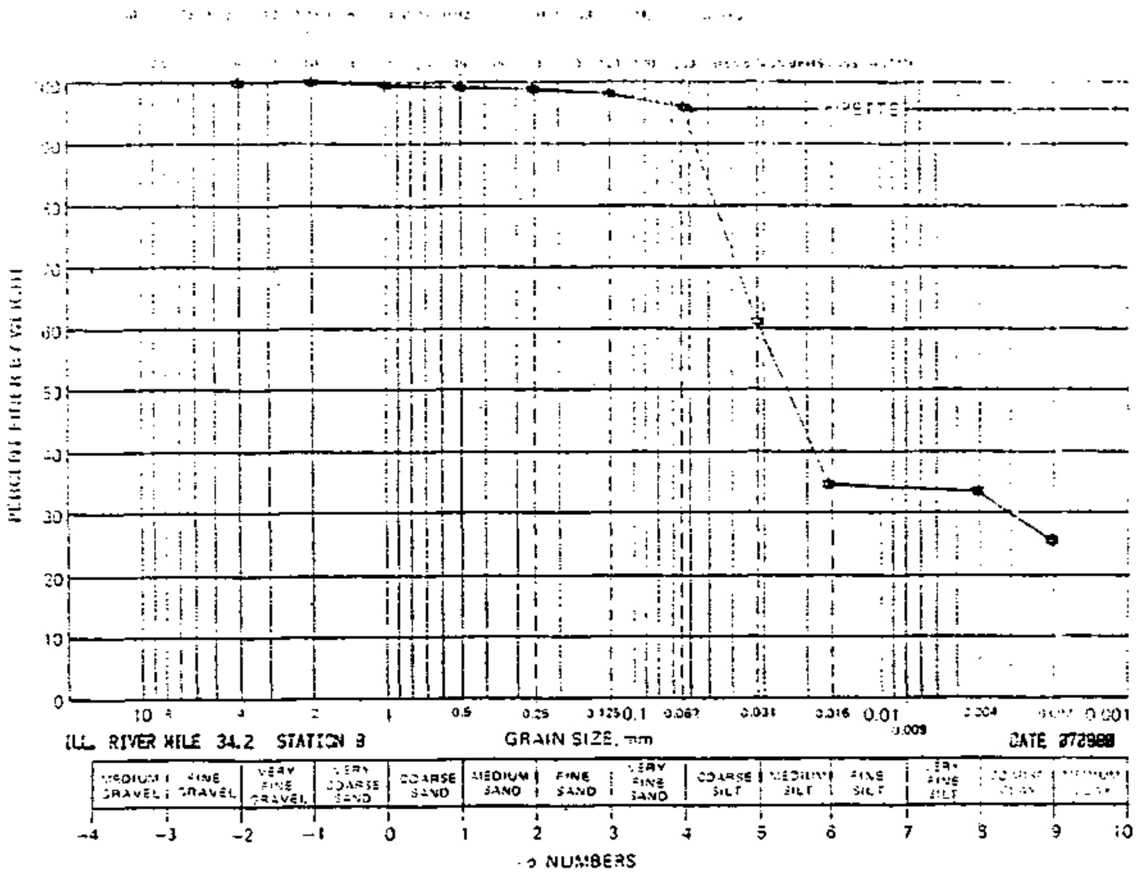
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



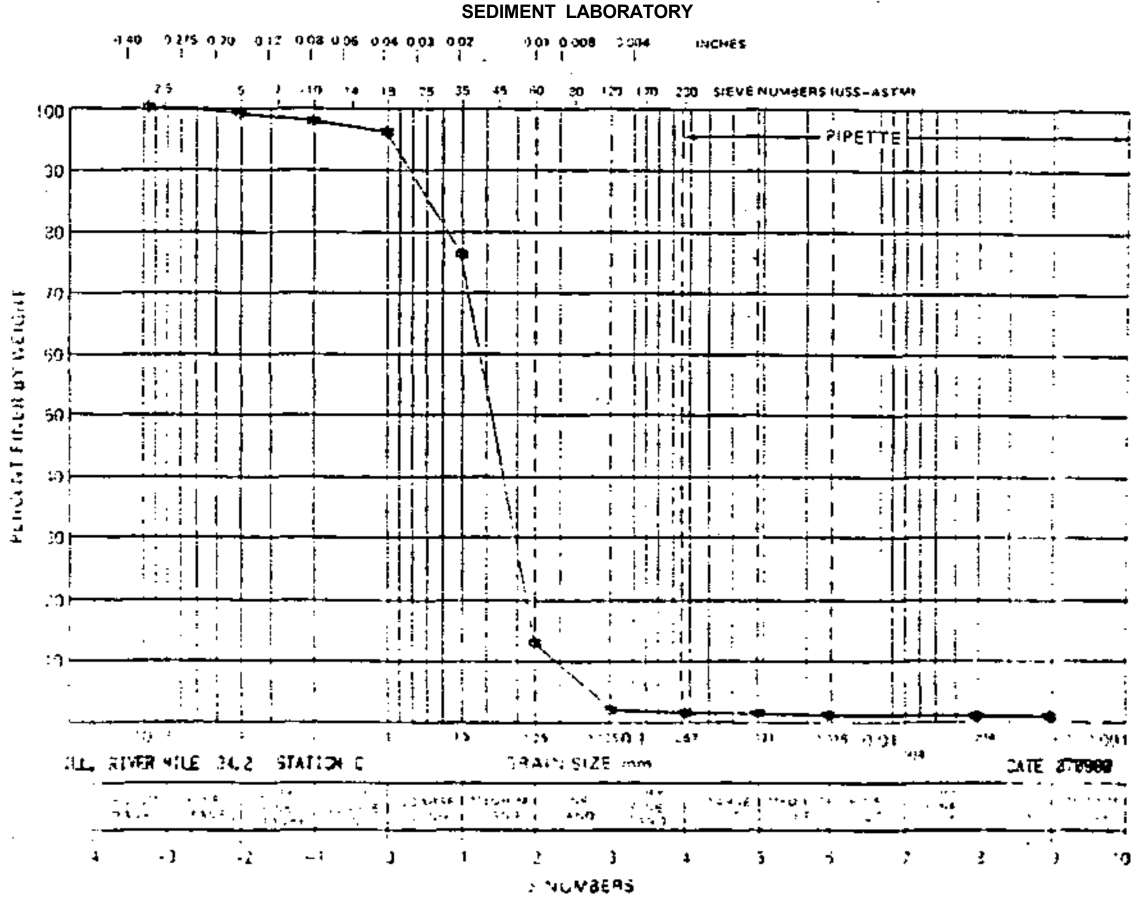
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



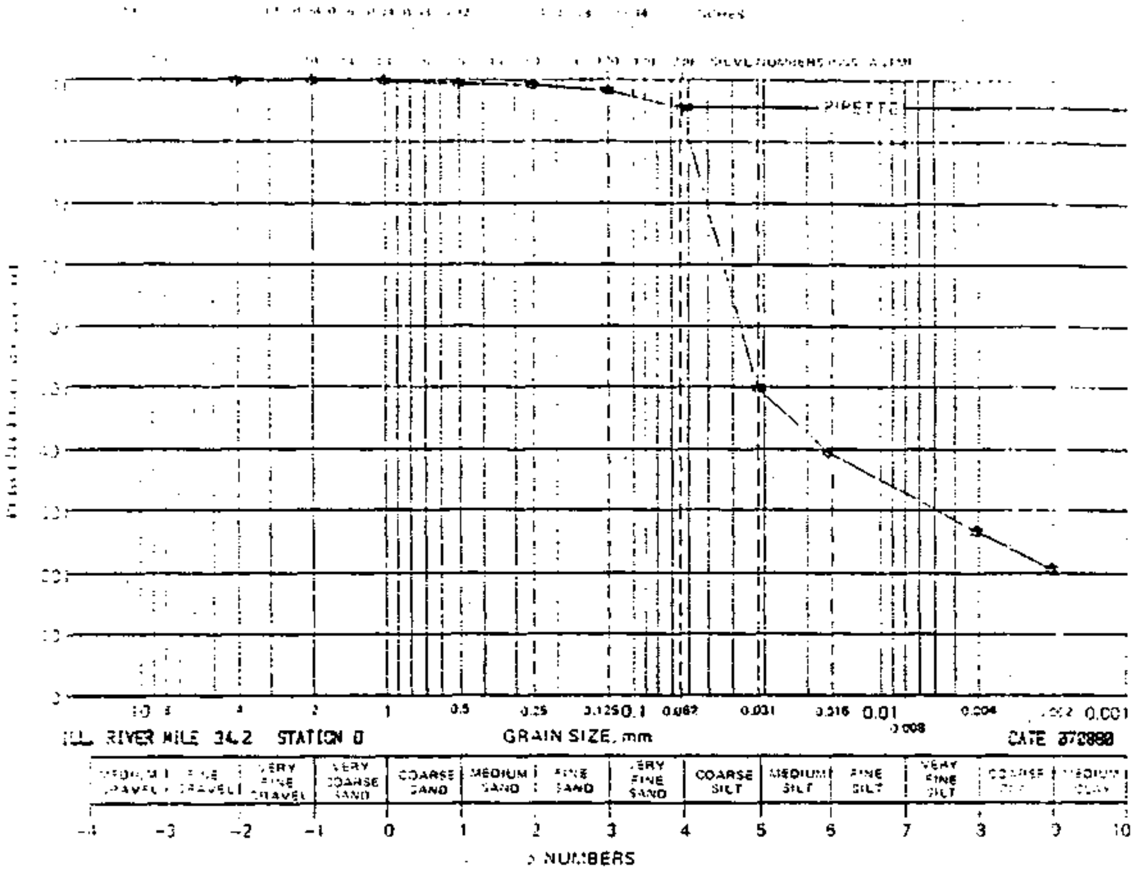
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



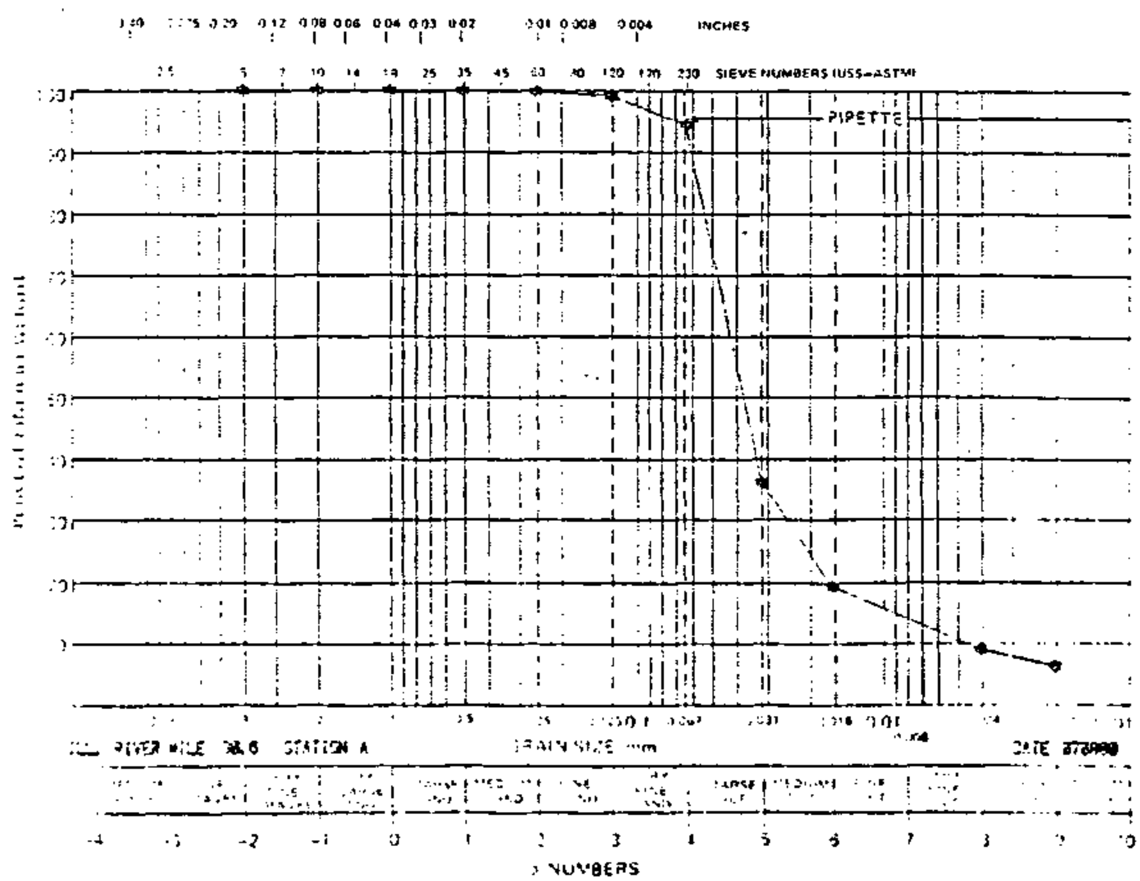
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY

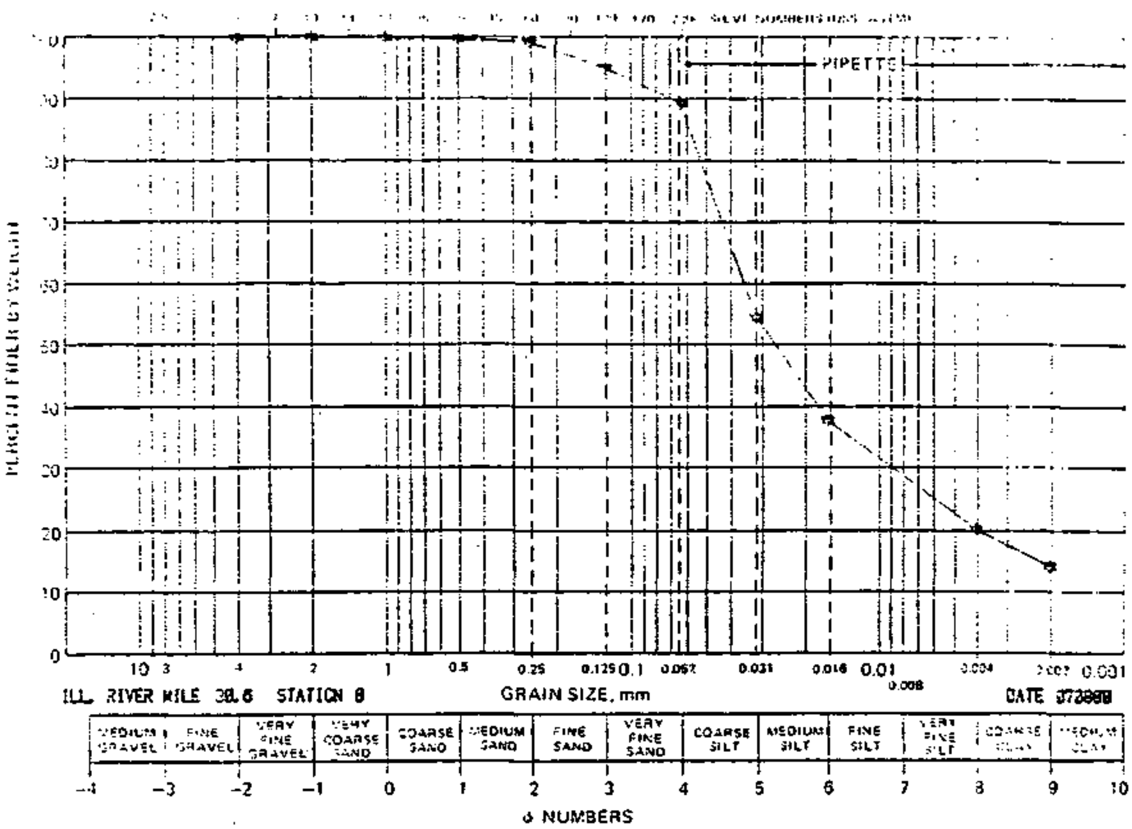


ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



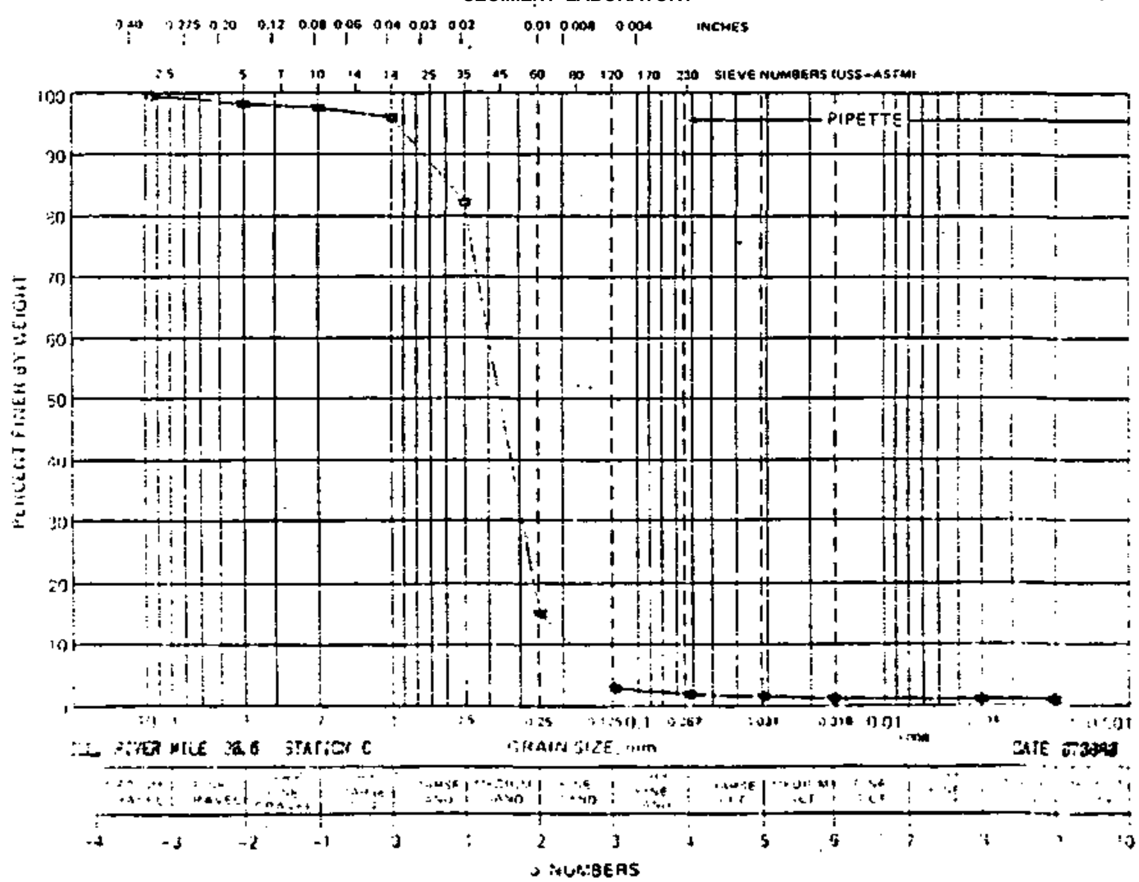
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY

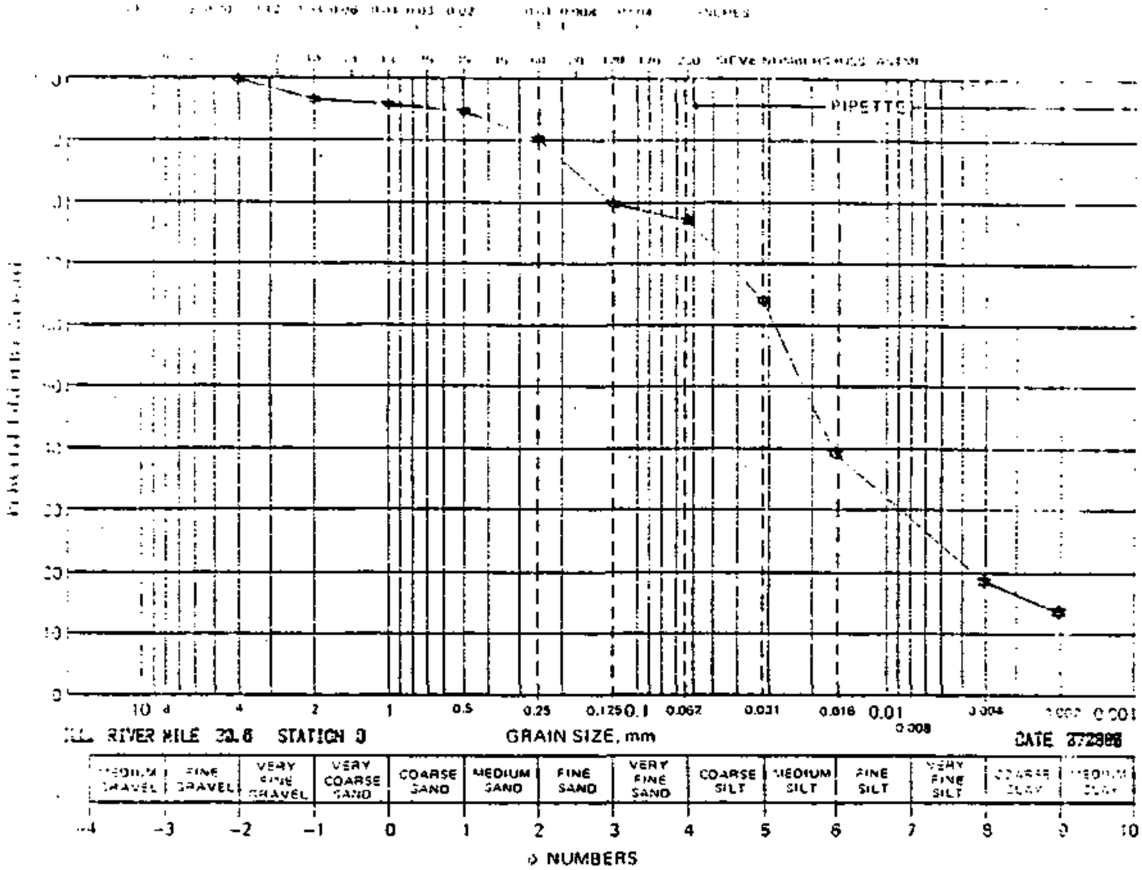


ILLINOIS STATE WATER SURVEY

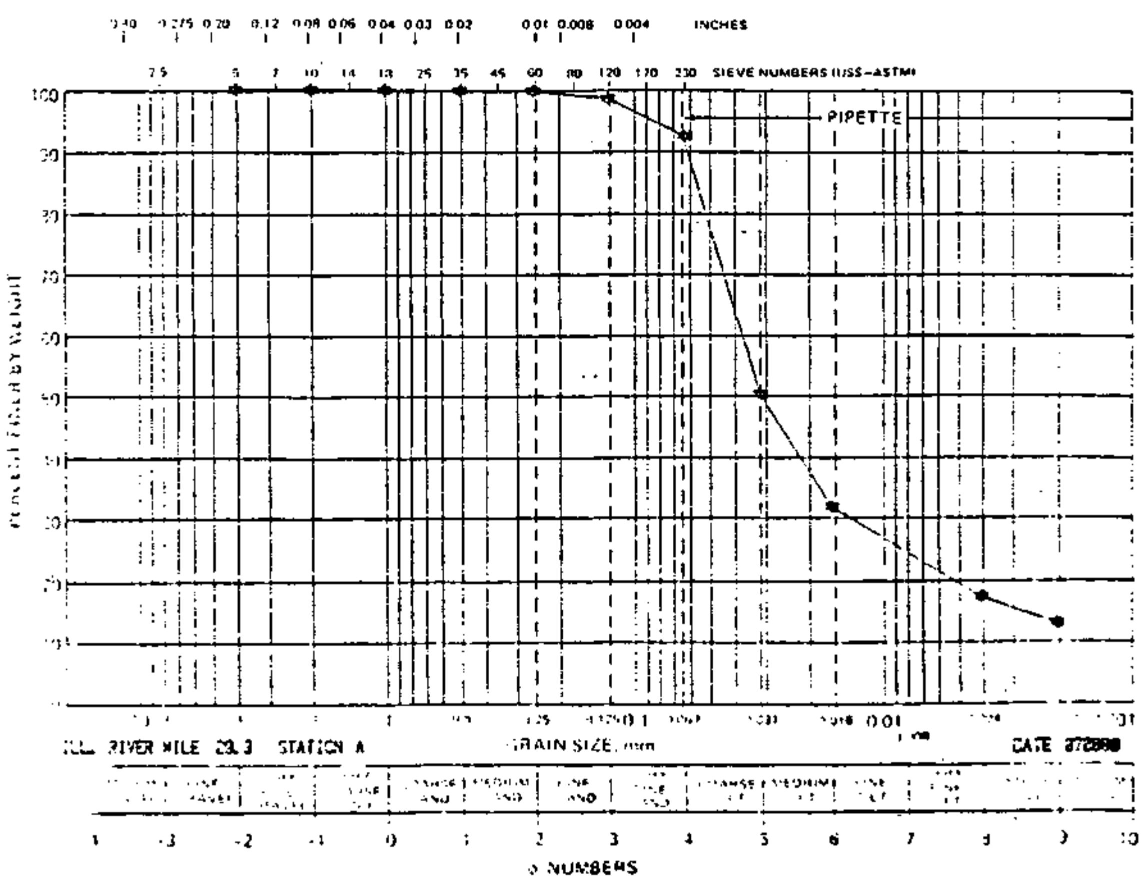
SEDIMENT LABORATORY



ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY

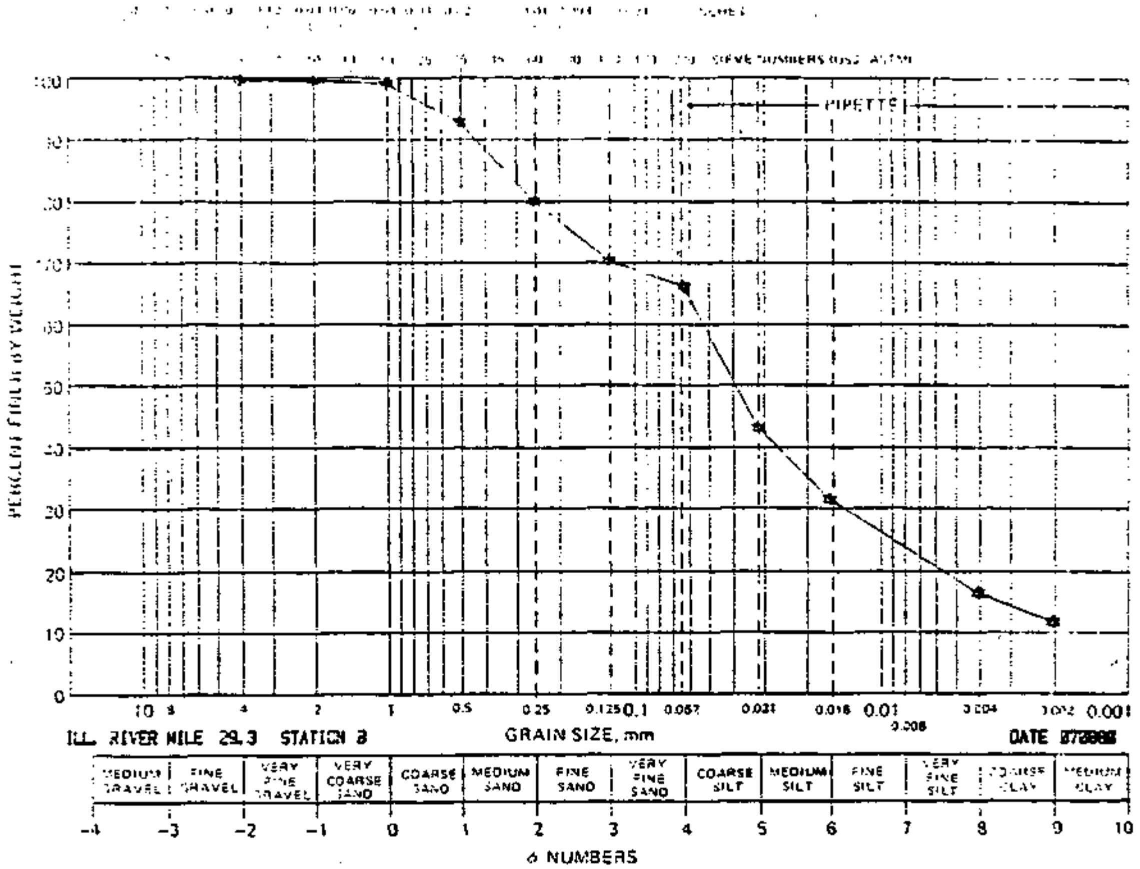


ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



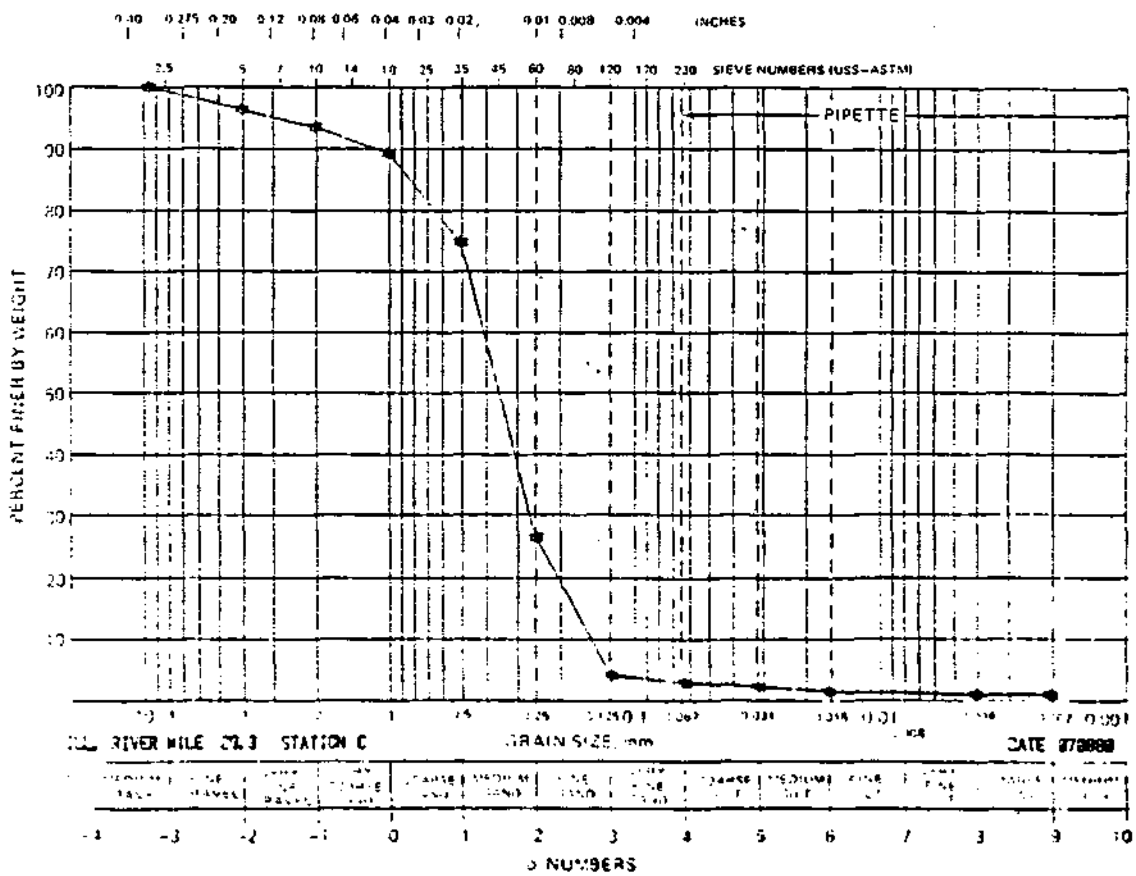
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY

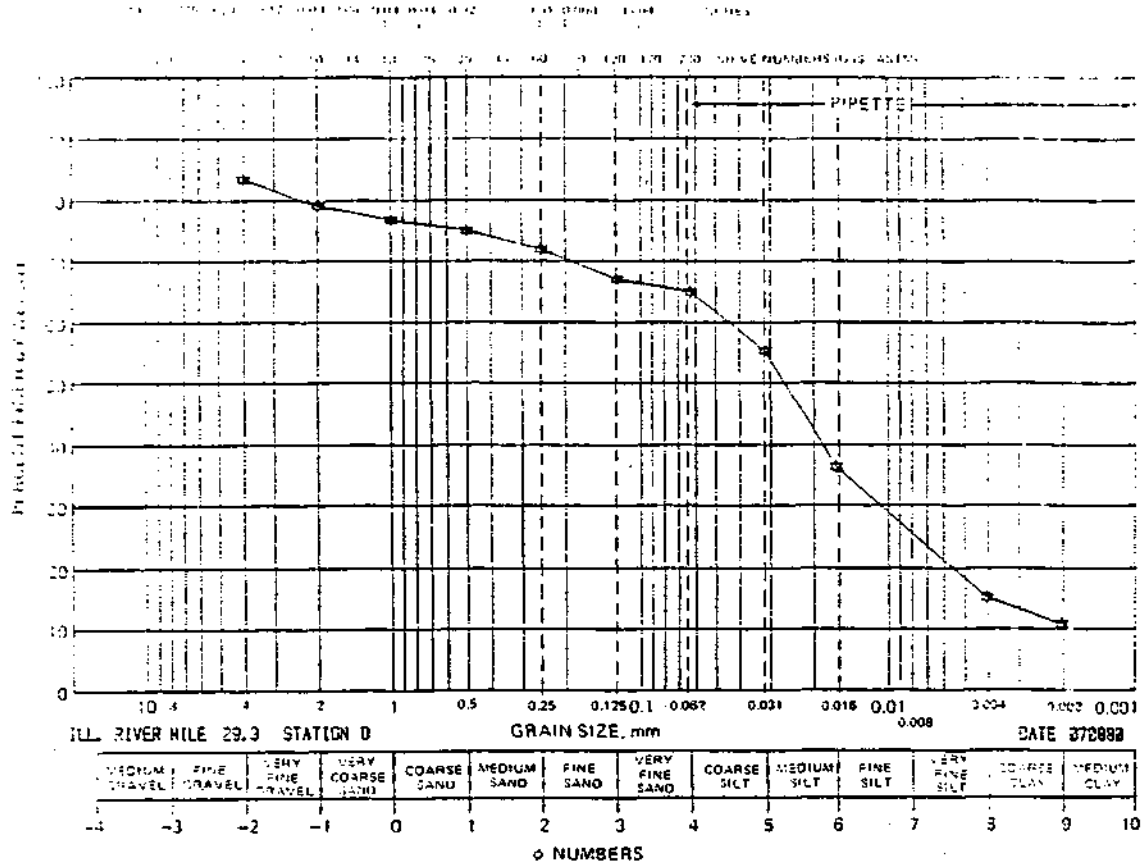


ILLINOIS STATE WATER SURVEY

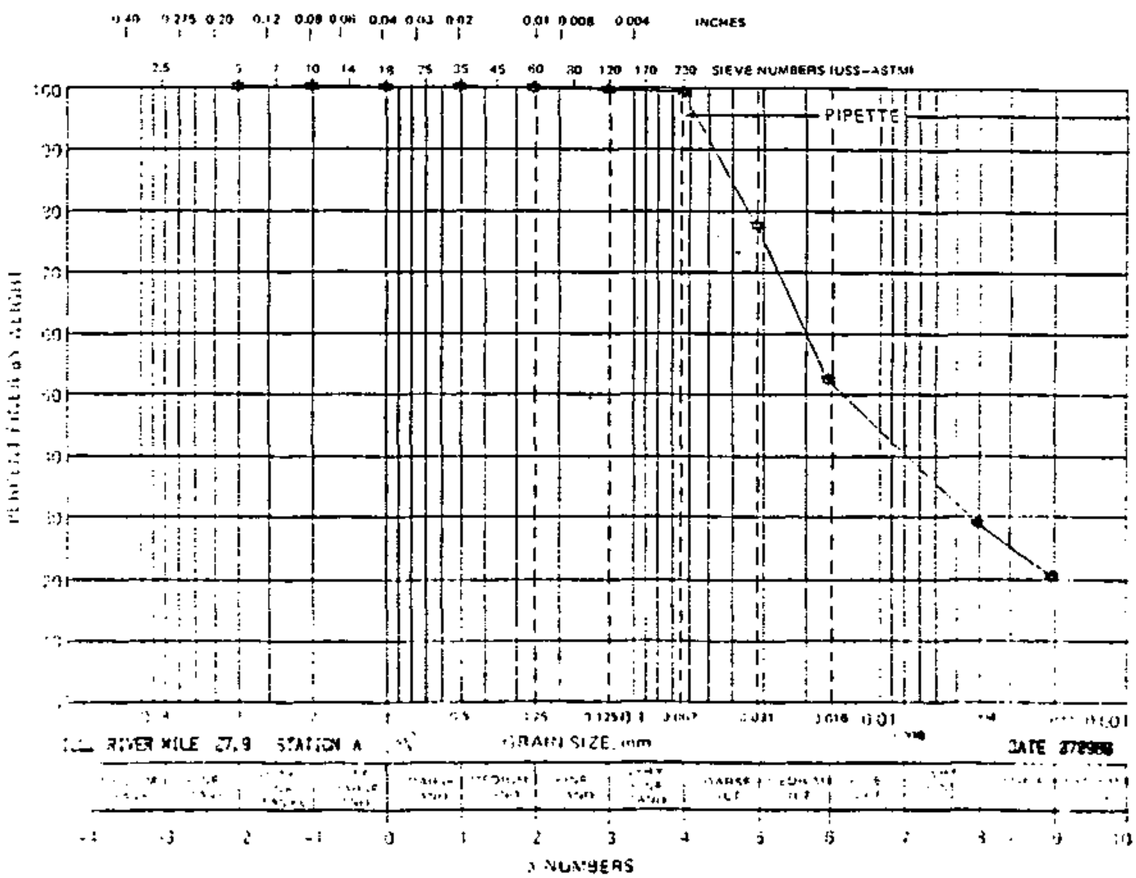
SEDIMENT LABORATORY



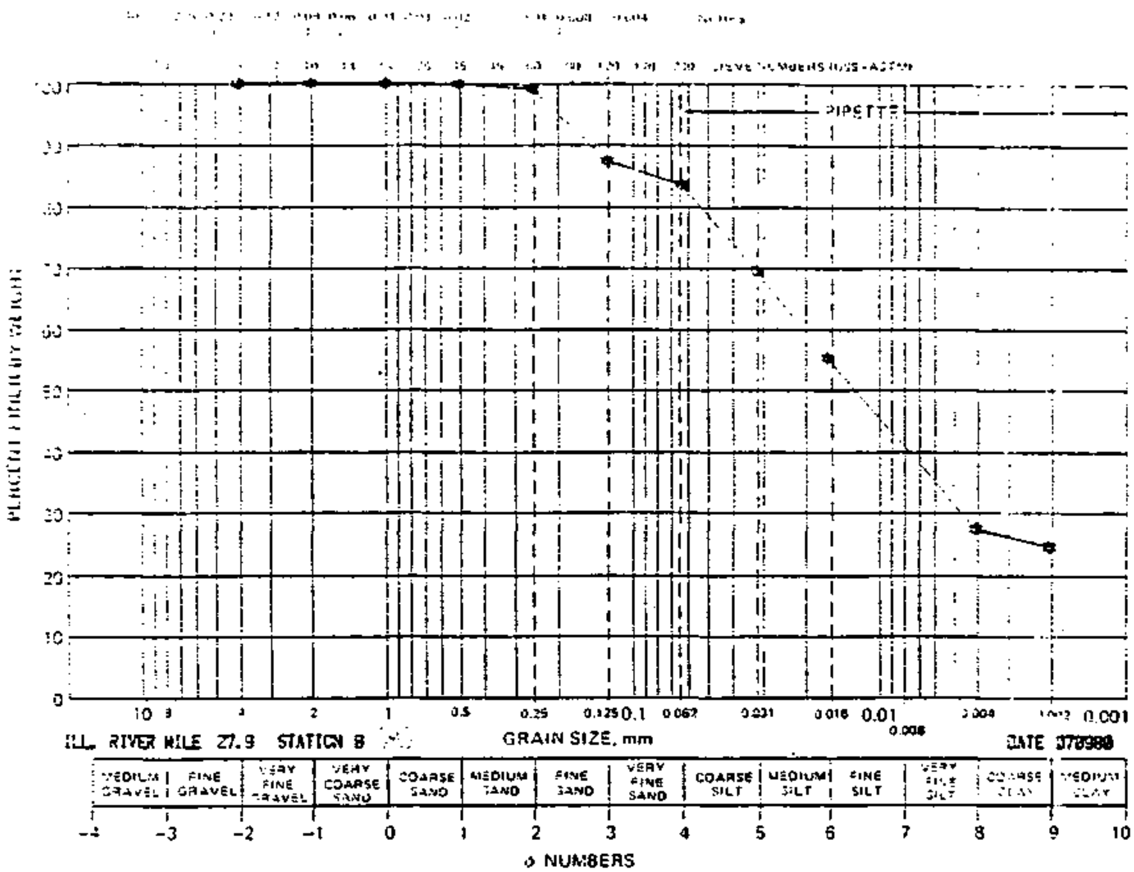
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



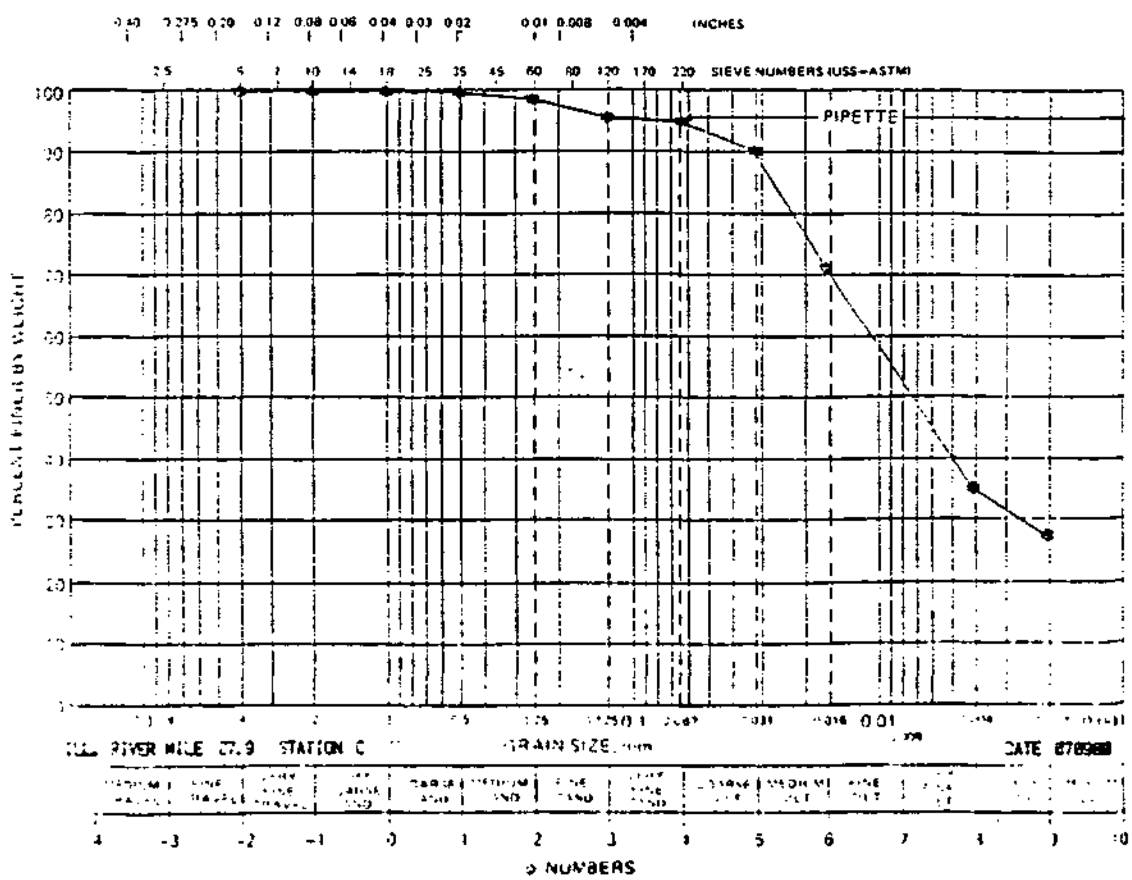
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



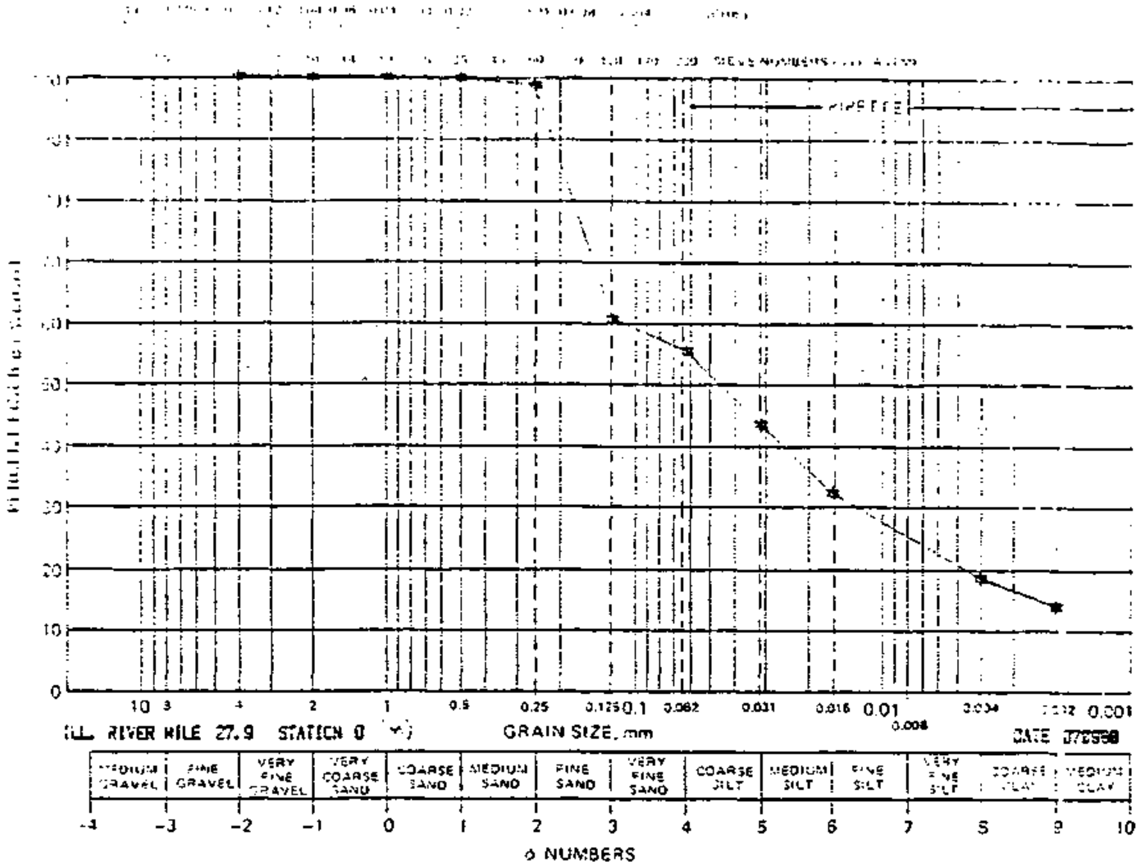
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



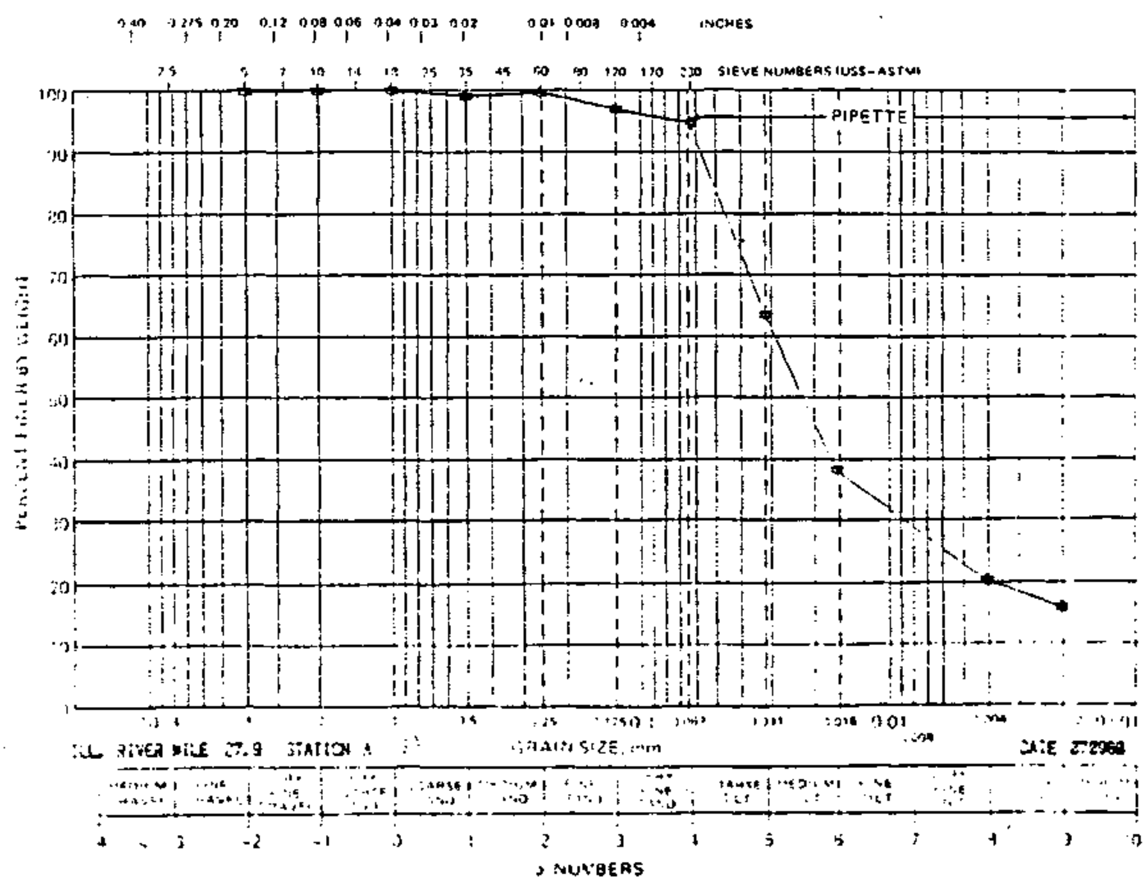
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



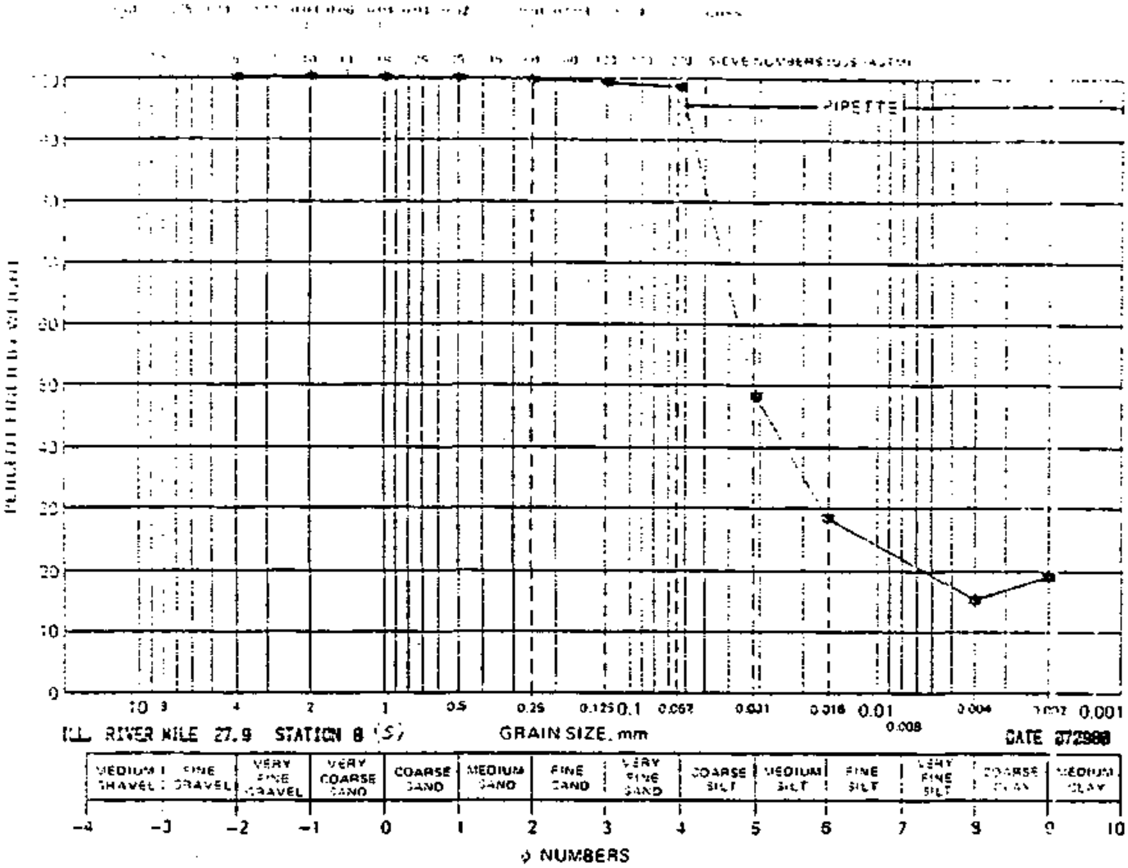
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



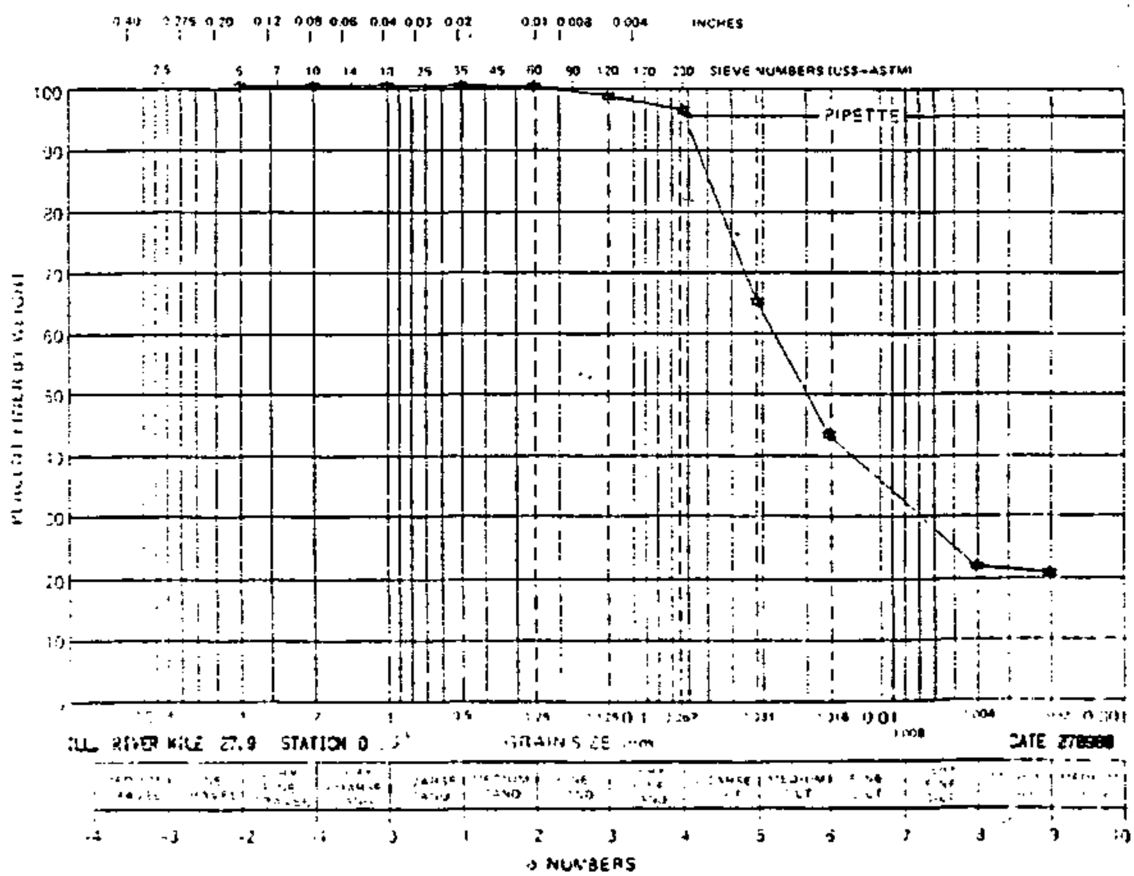
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



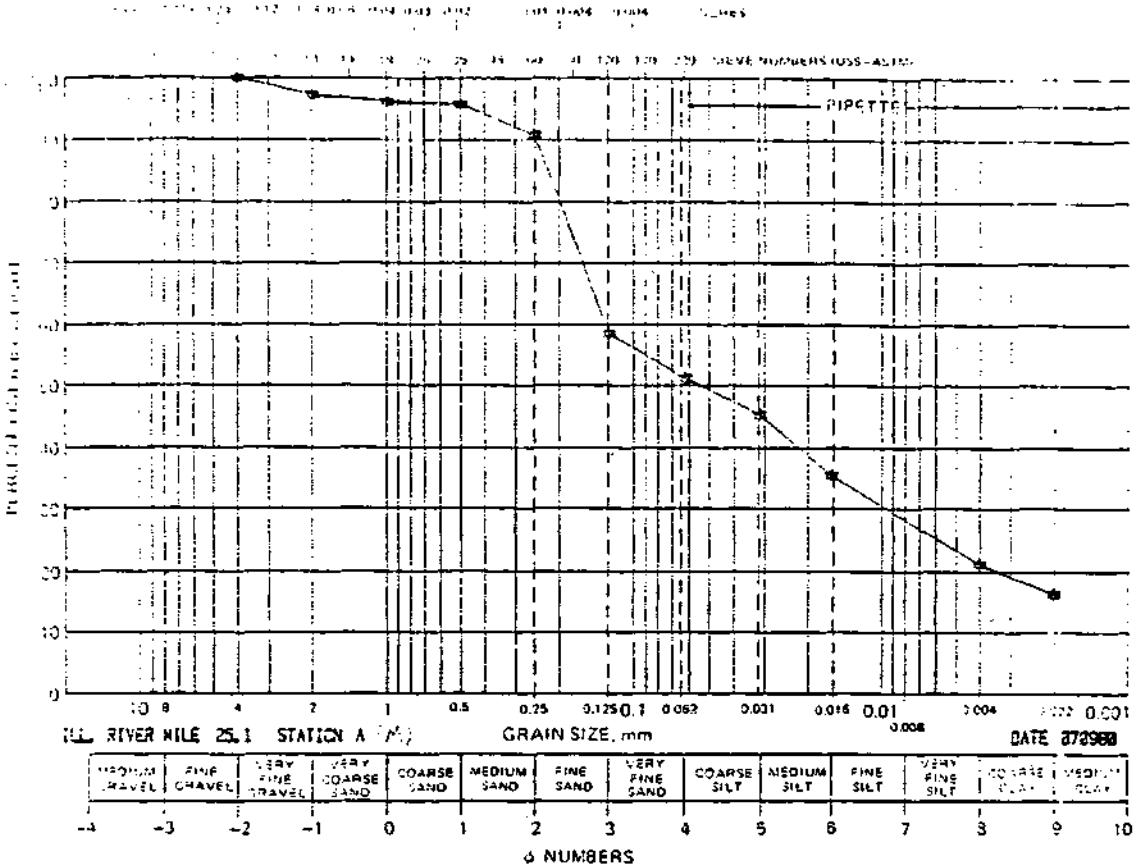
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



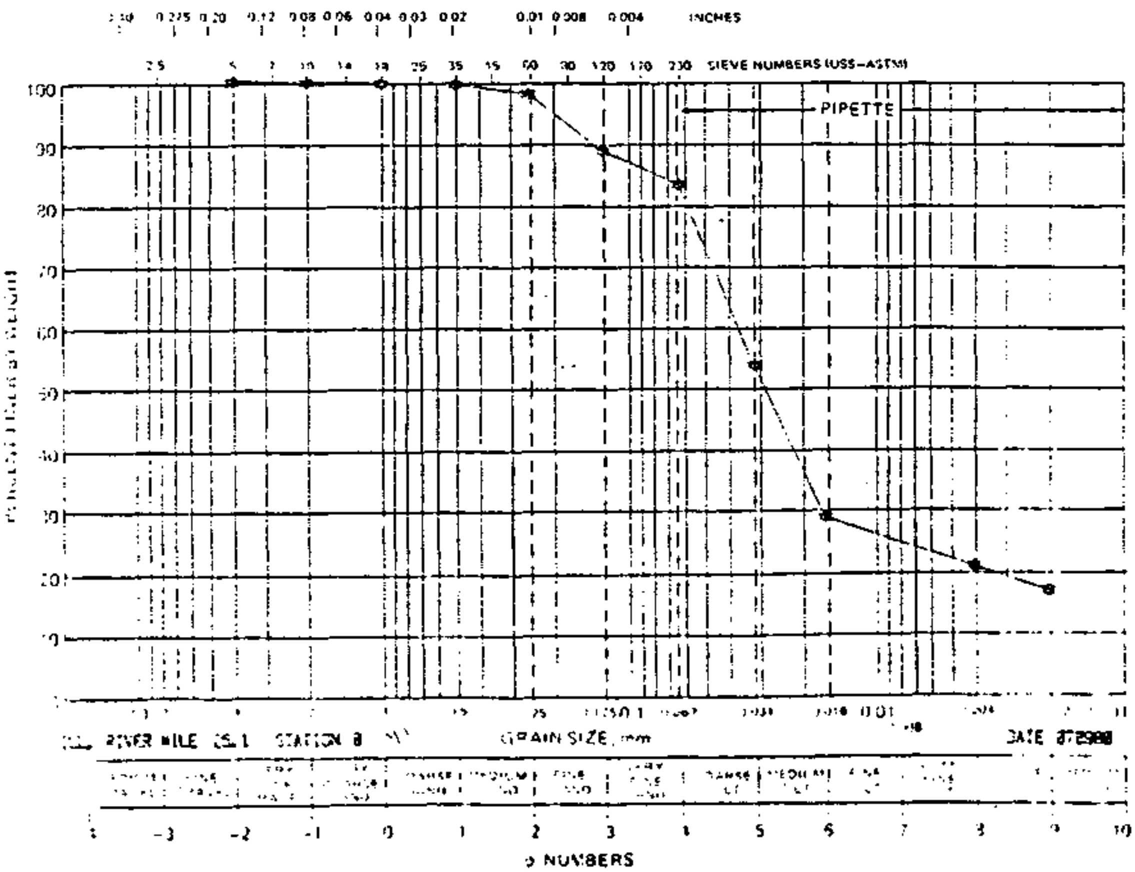
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



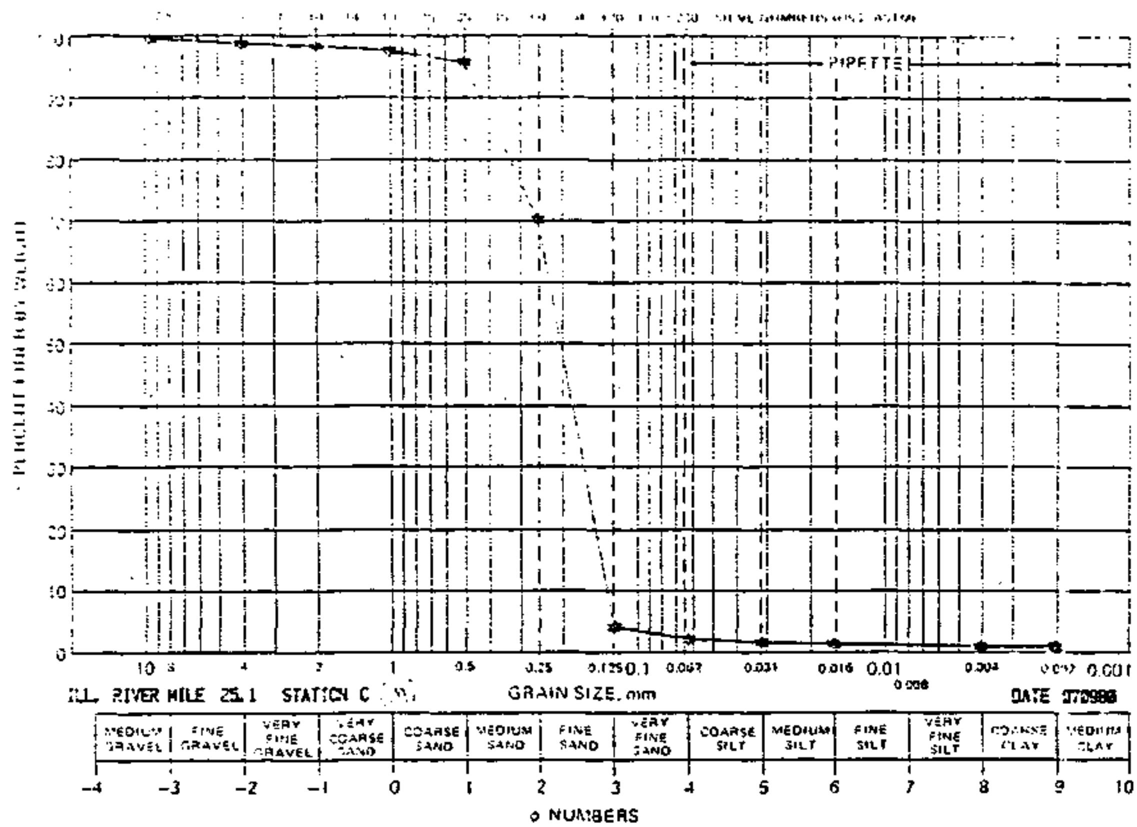
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



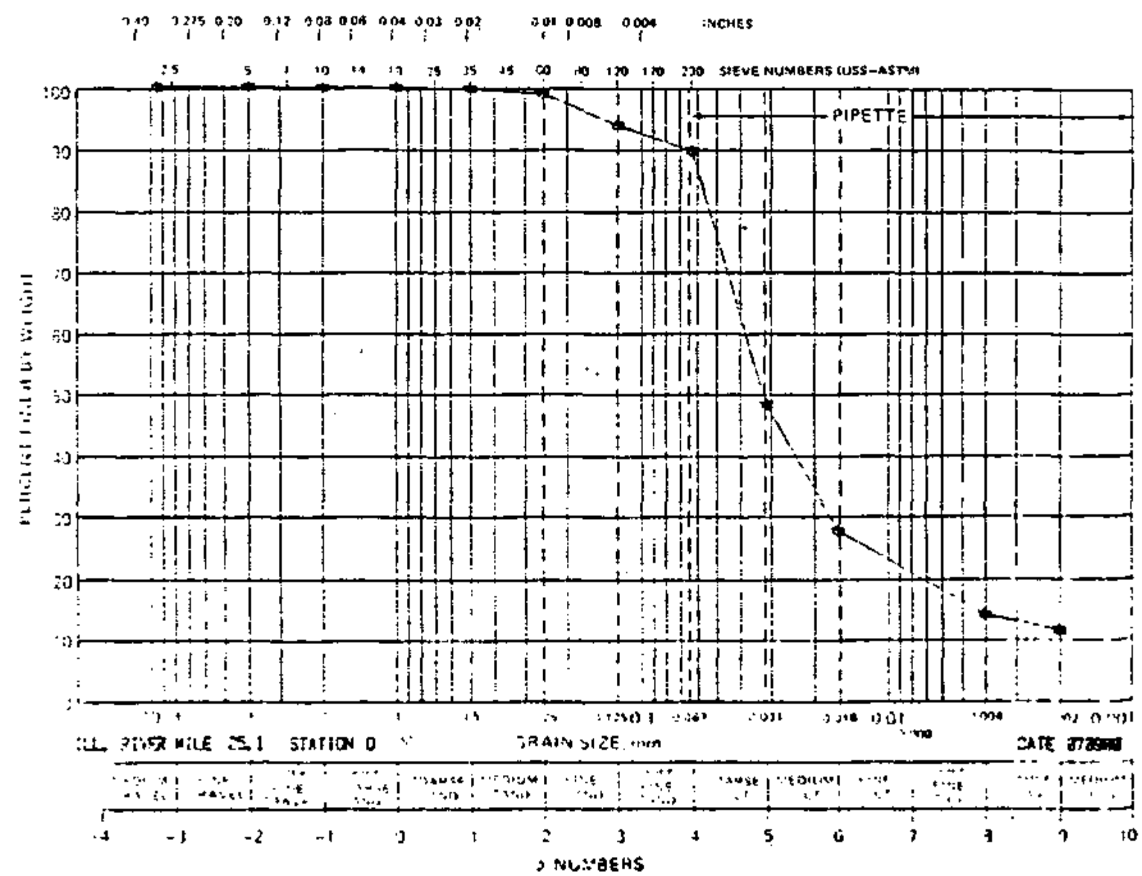
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



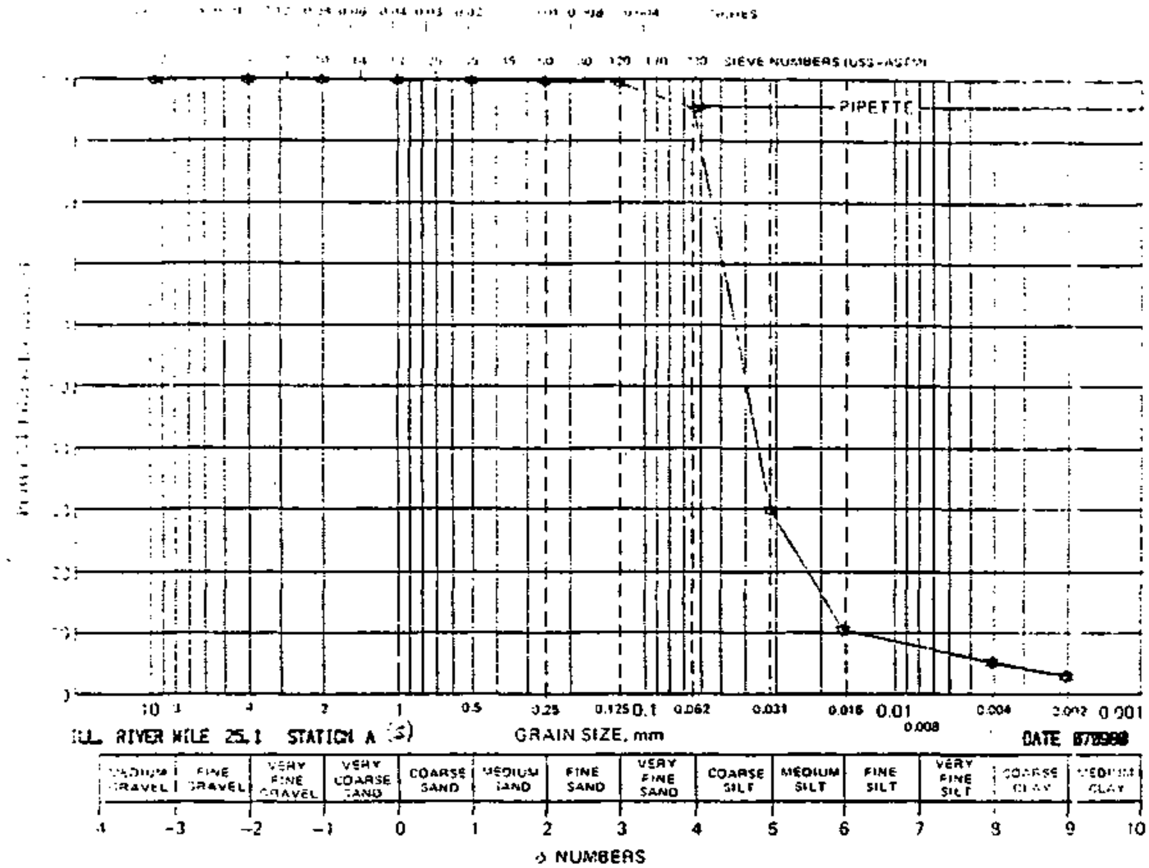
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



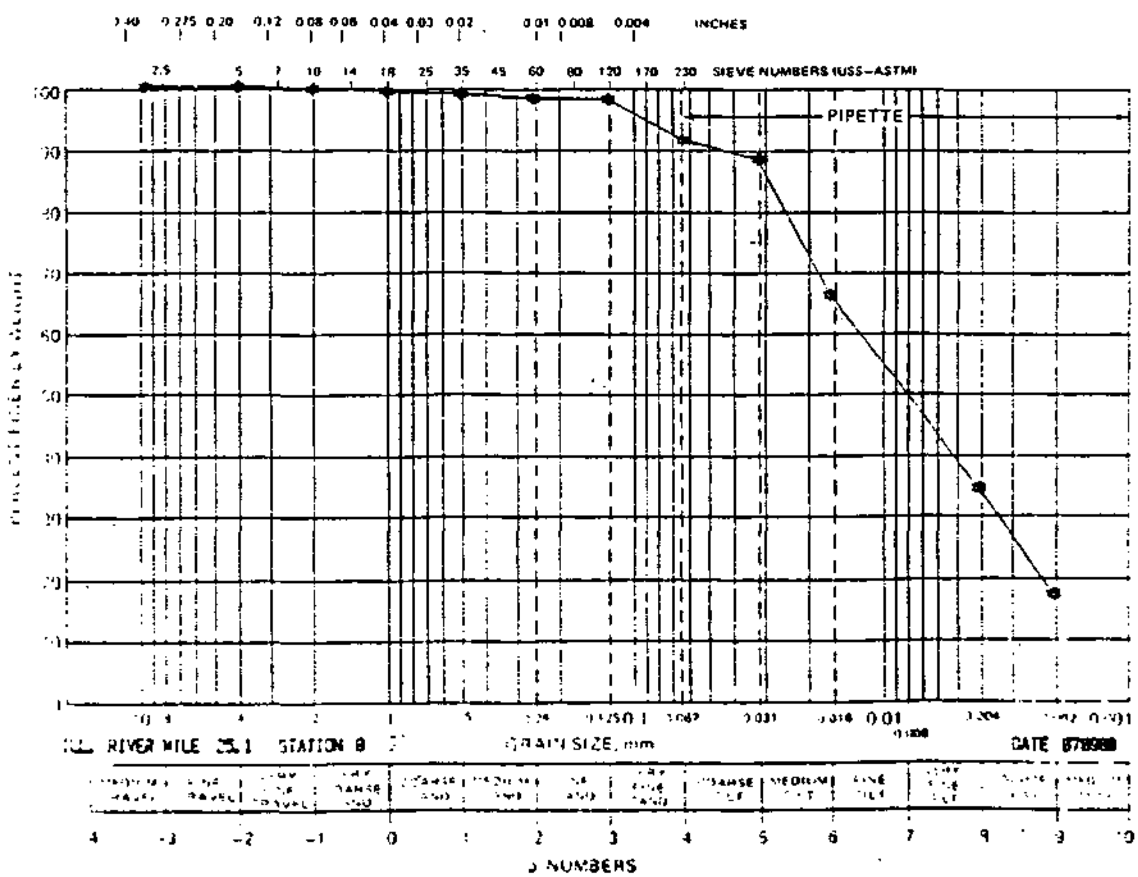
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



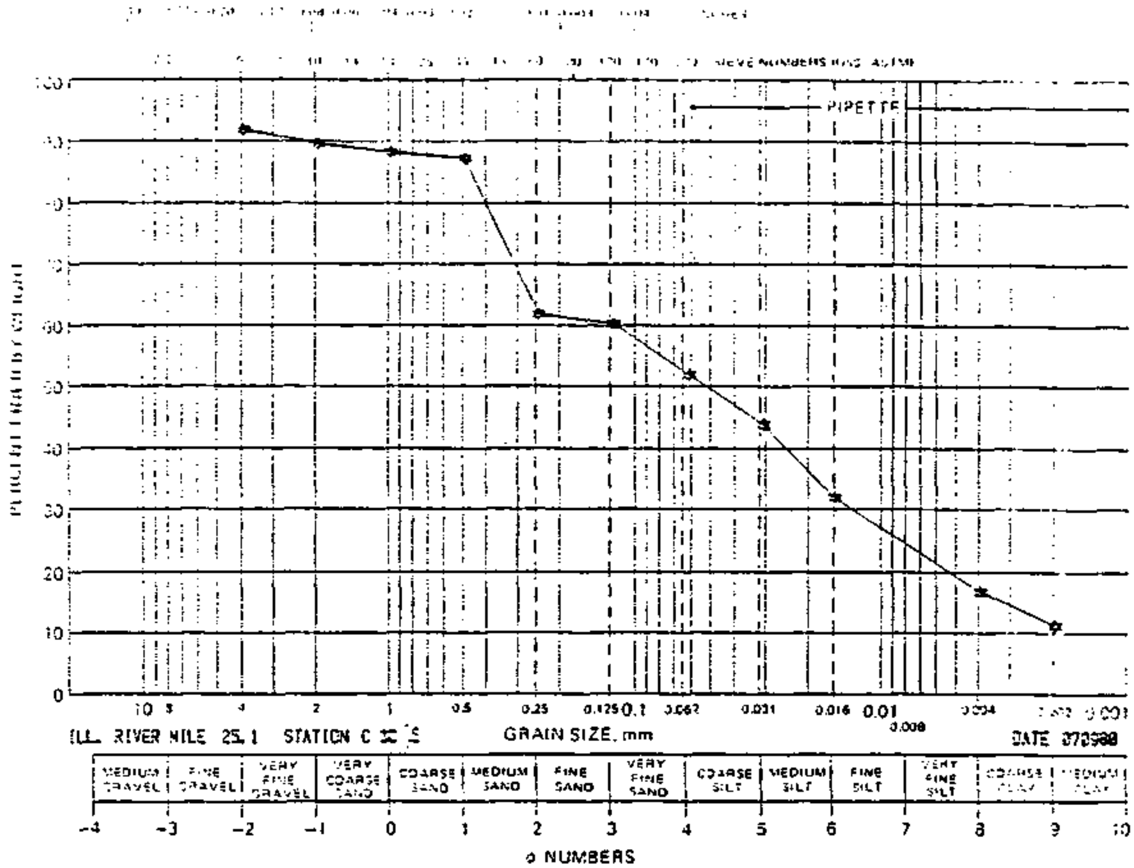
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



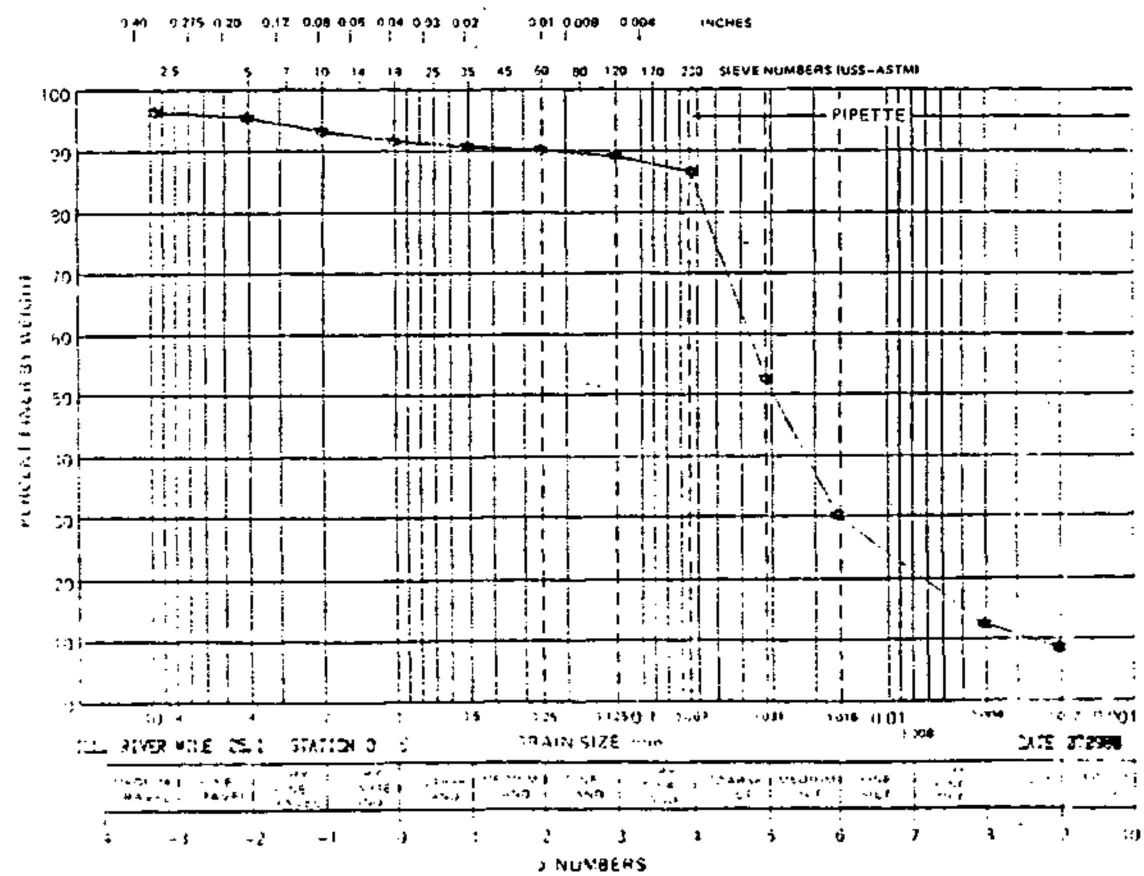
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



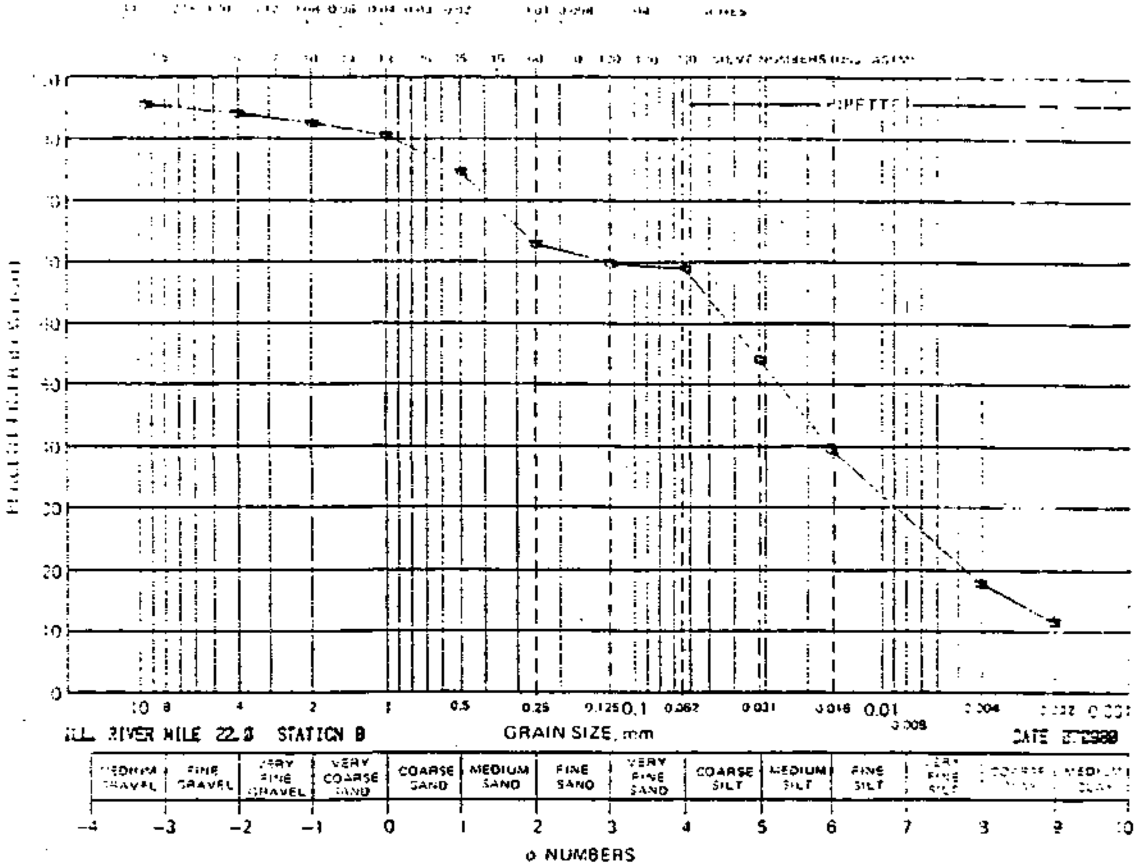
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



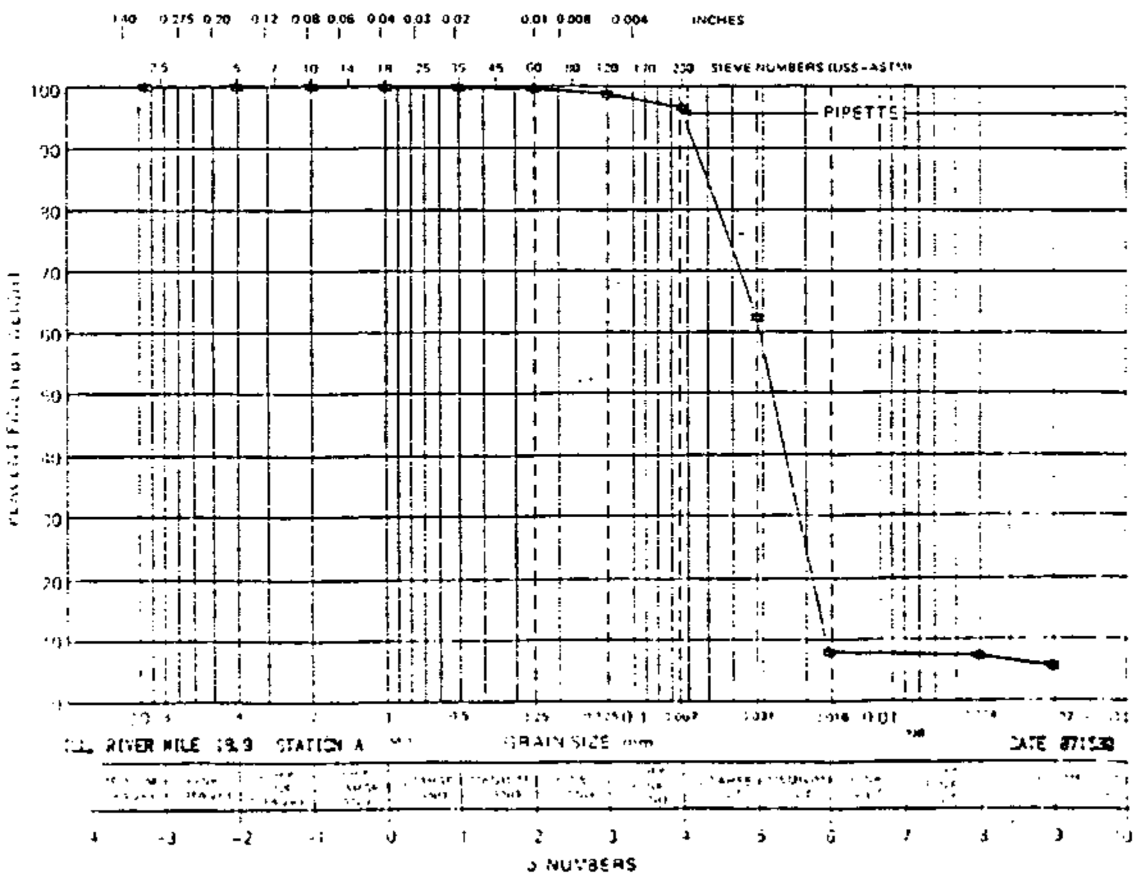
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



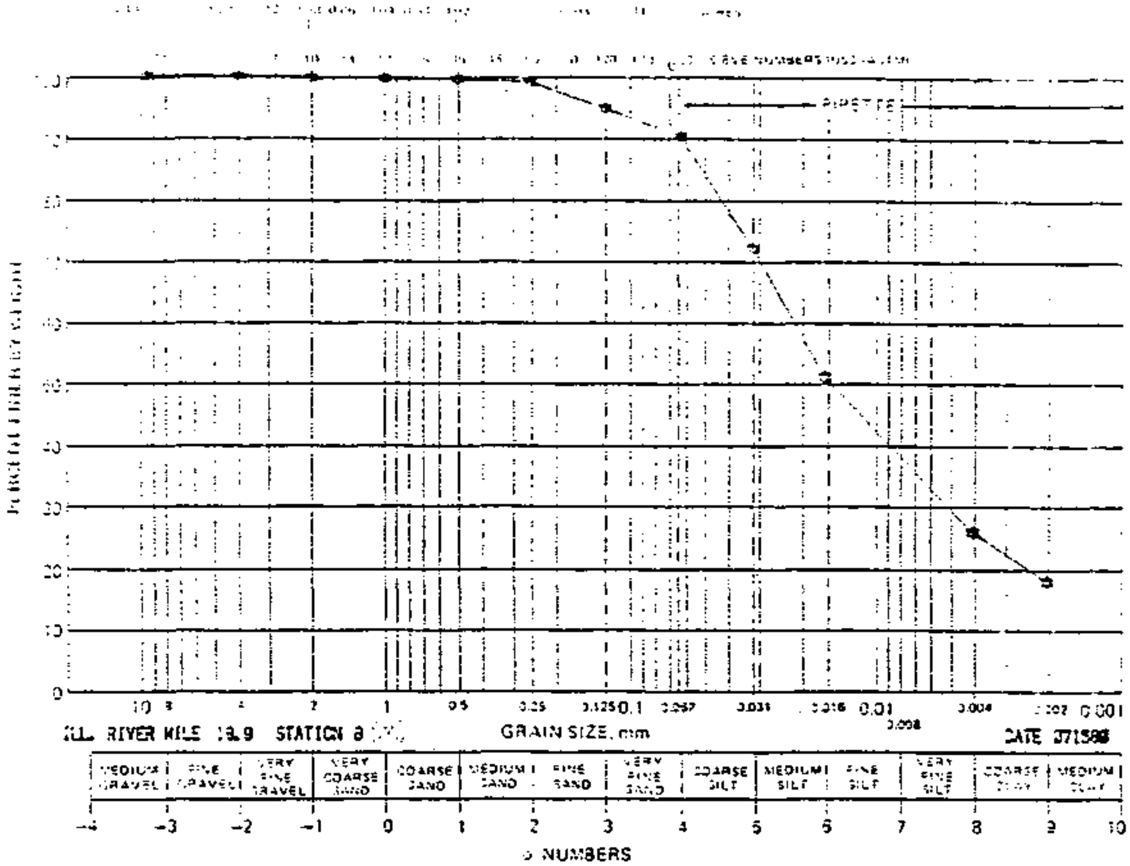
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



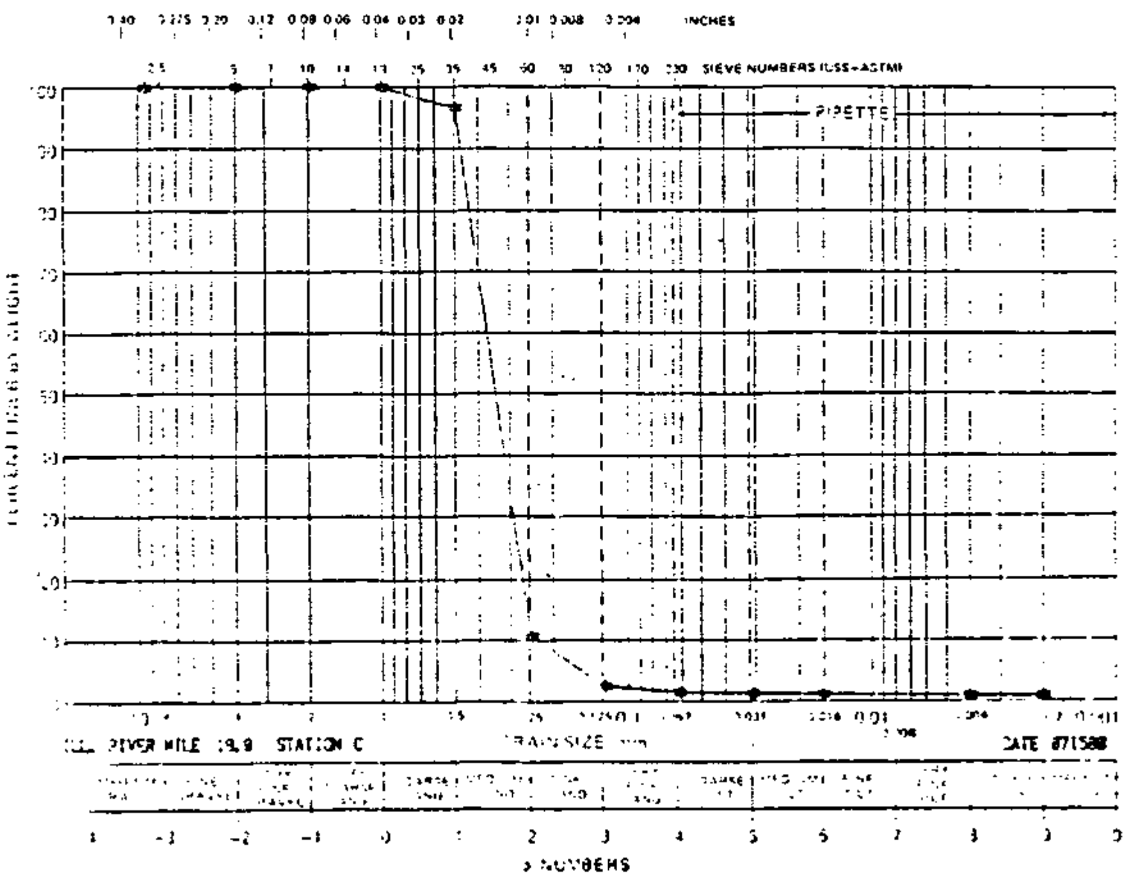
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



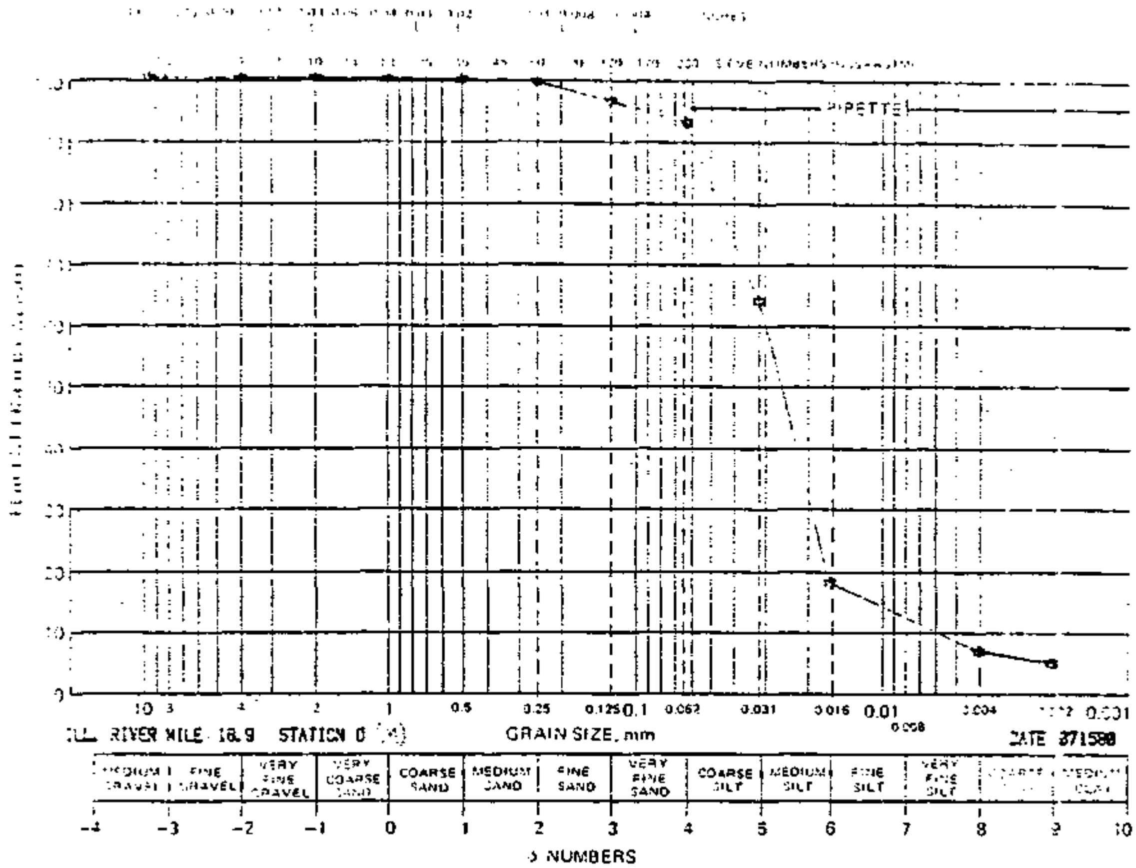
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



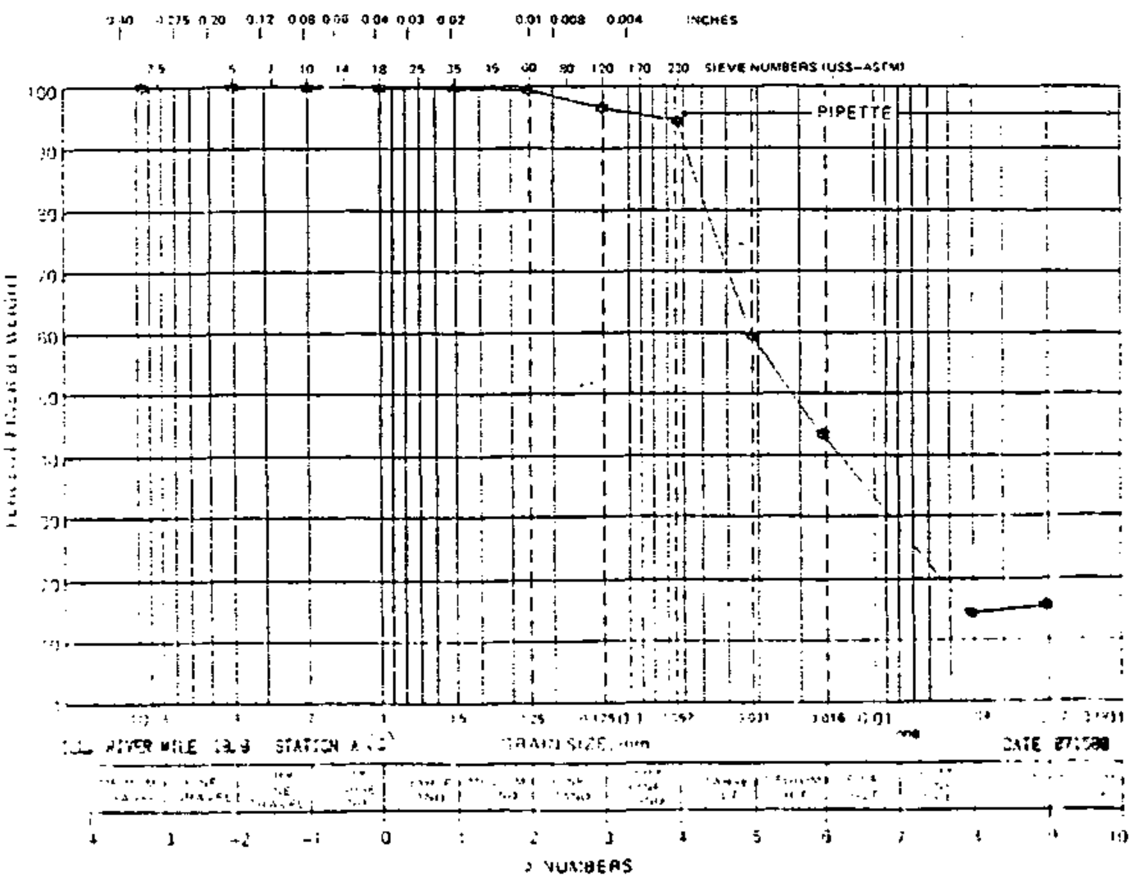
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY

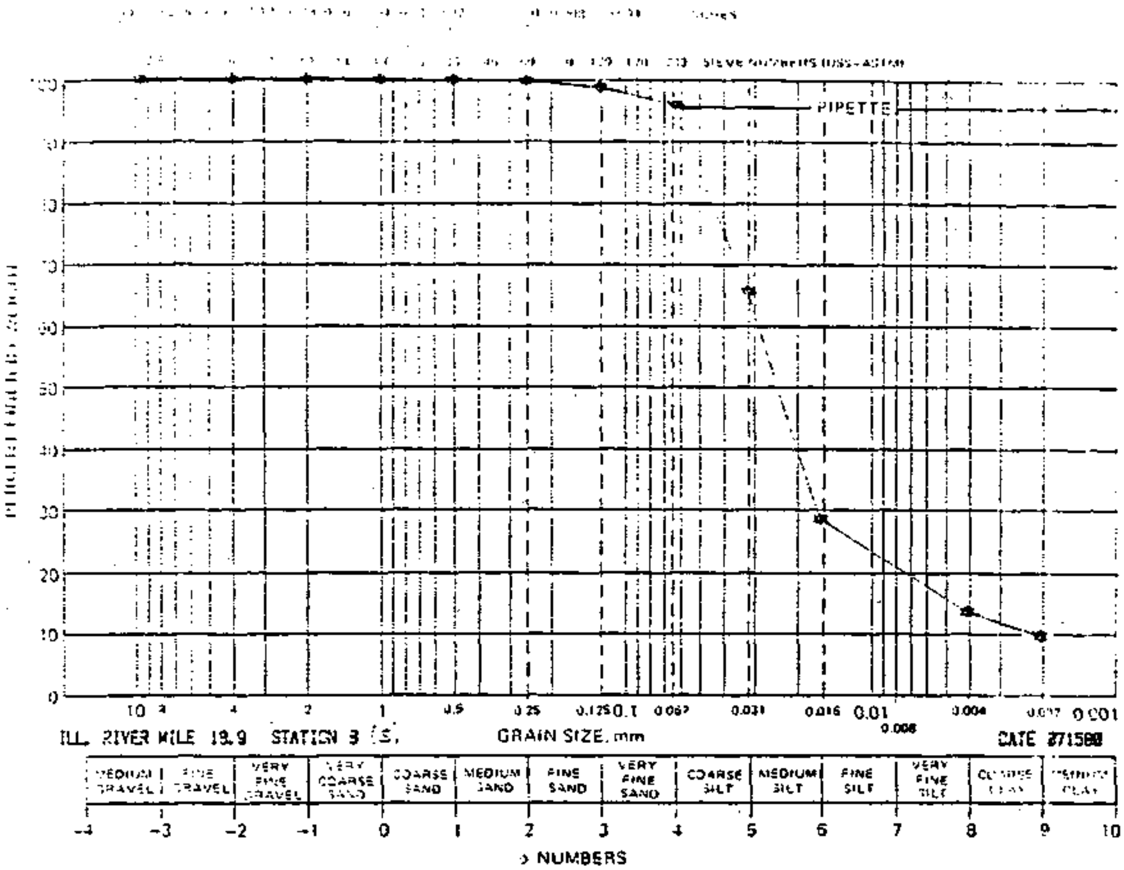


ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



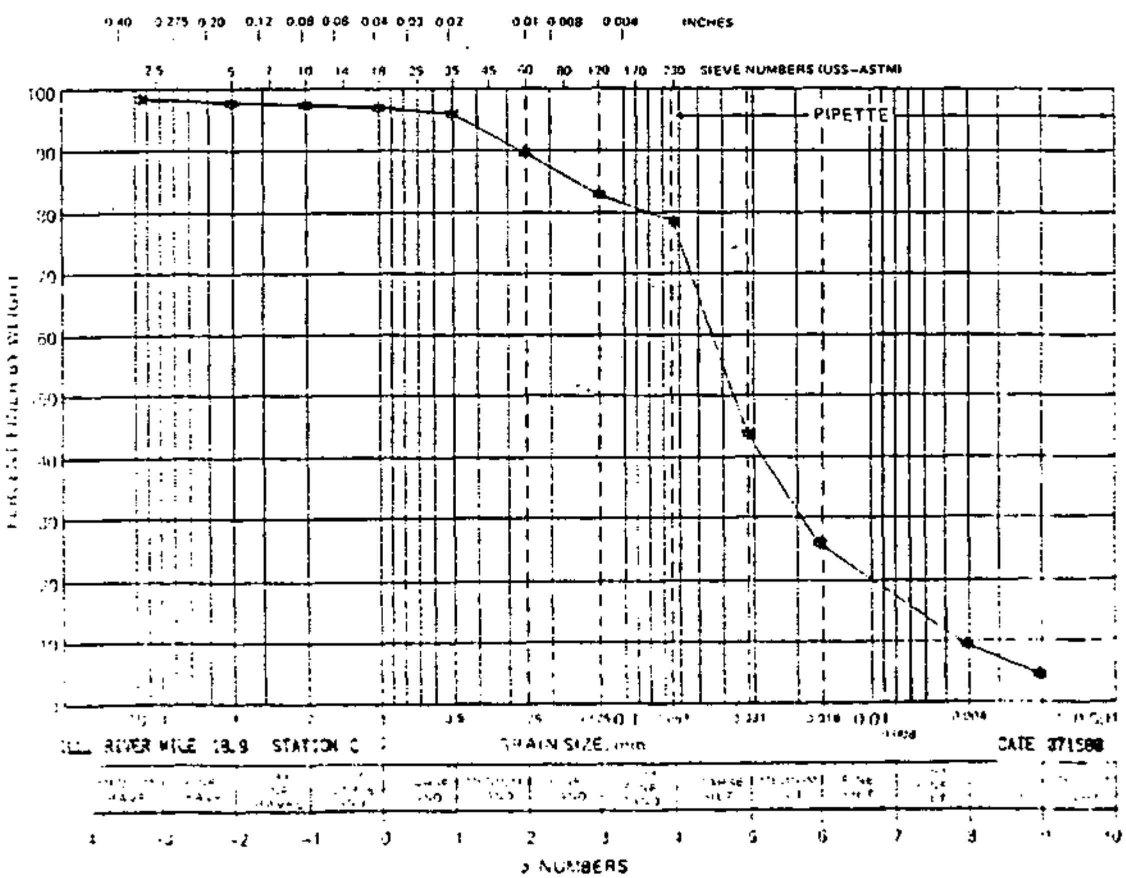
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY

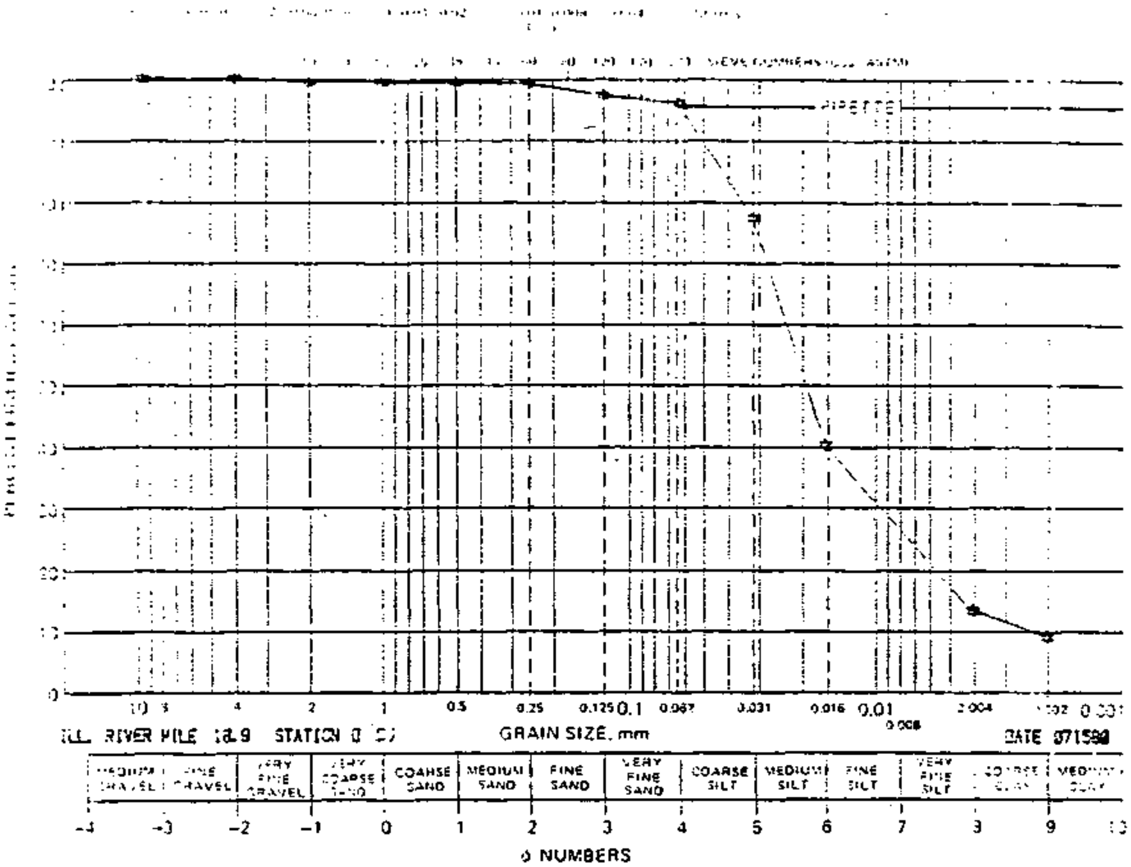


ILLINOIS STATE WATER SURVEY

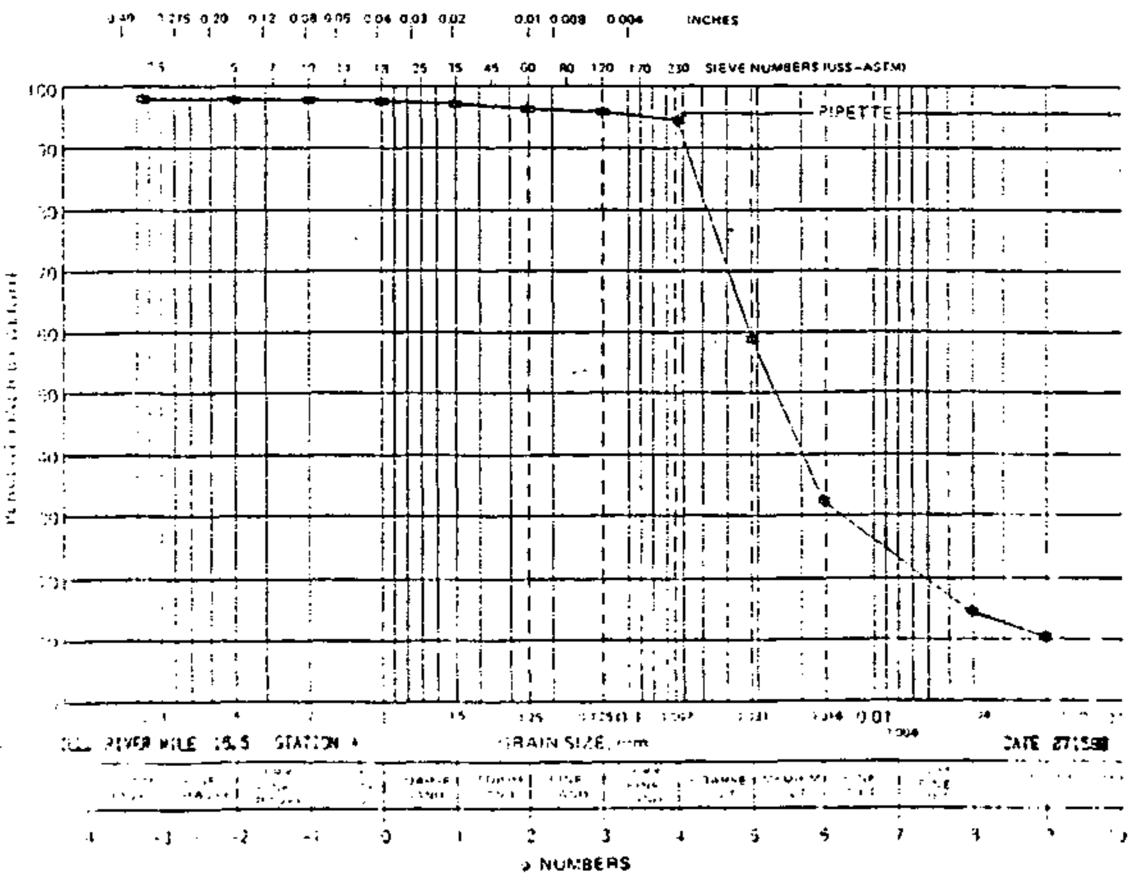
SEDIMENT LABORATORY



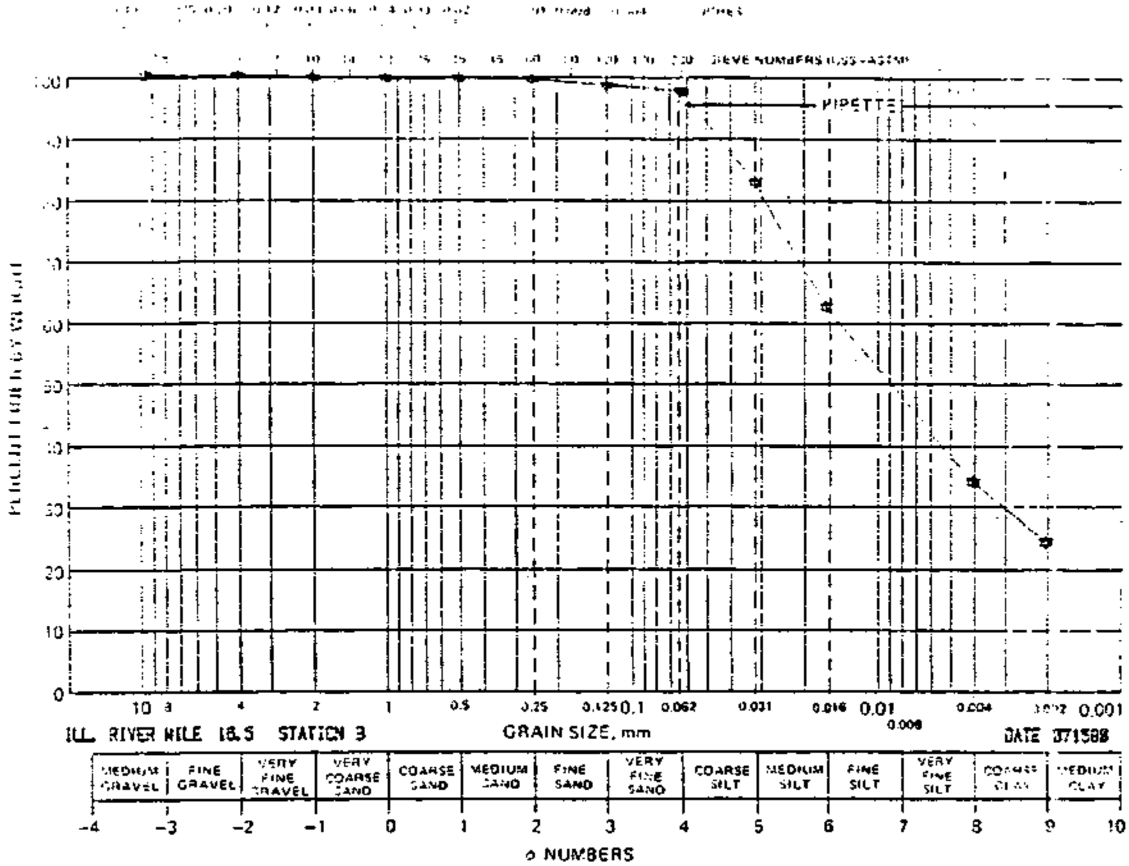
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



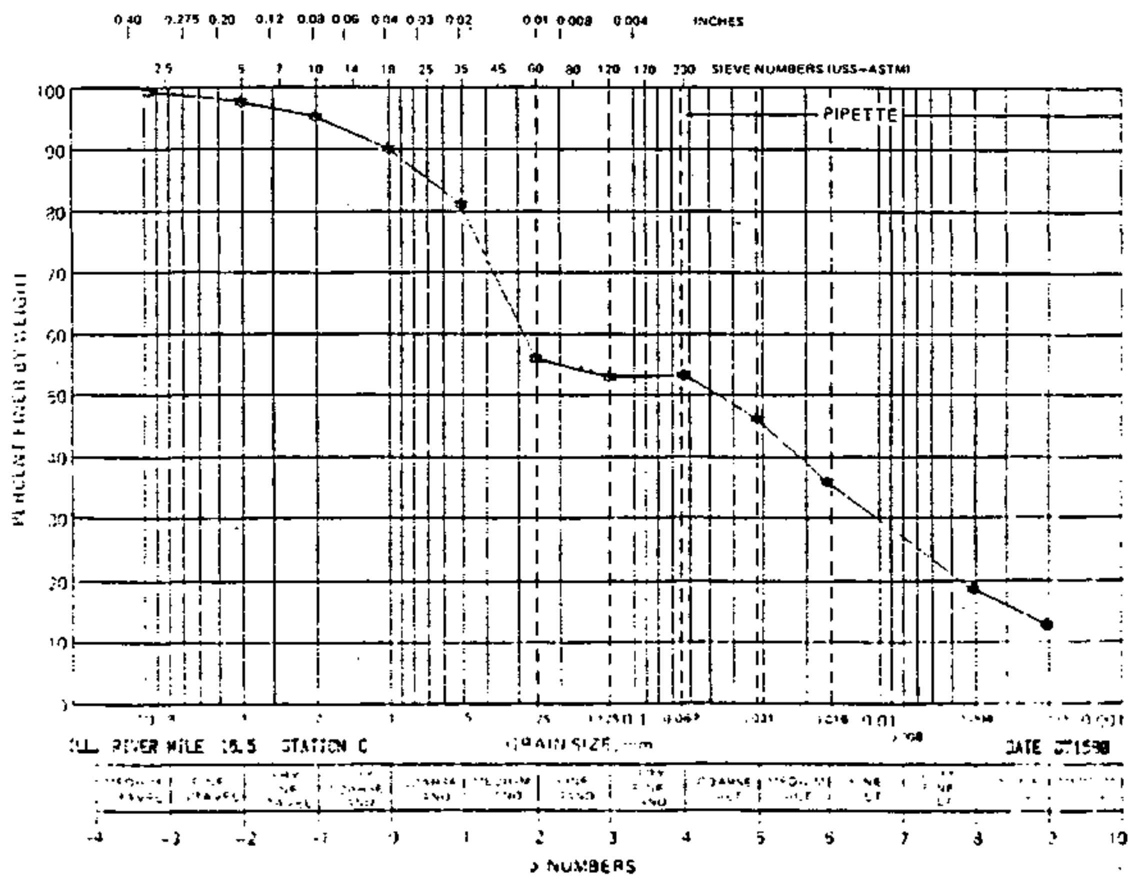
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY

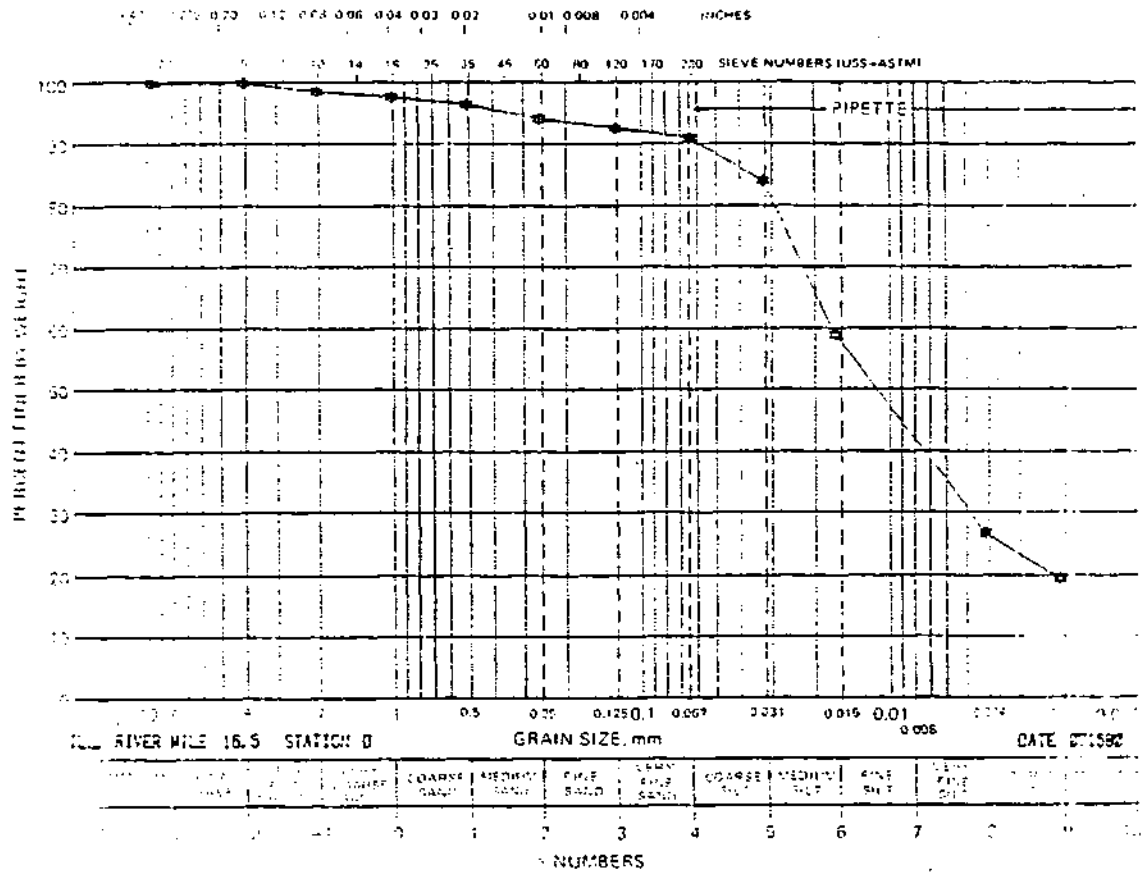


ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



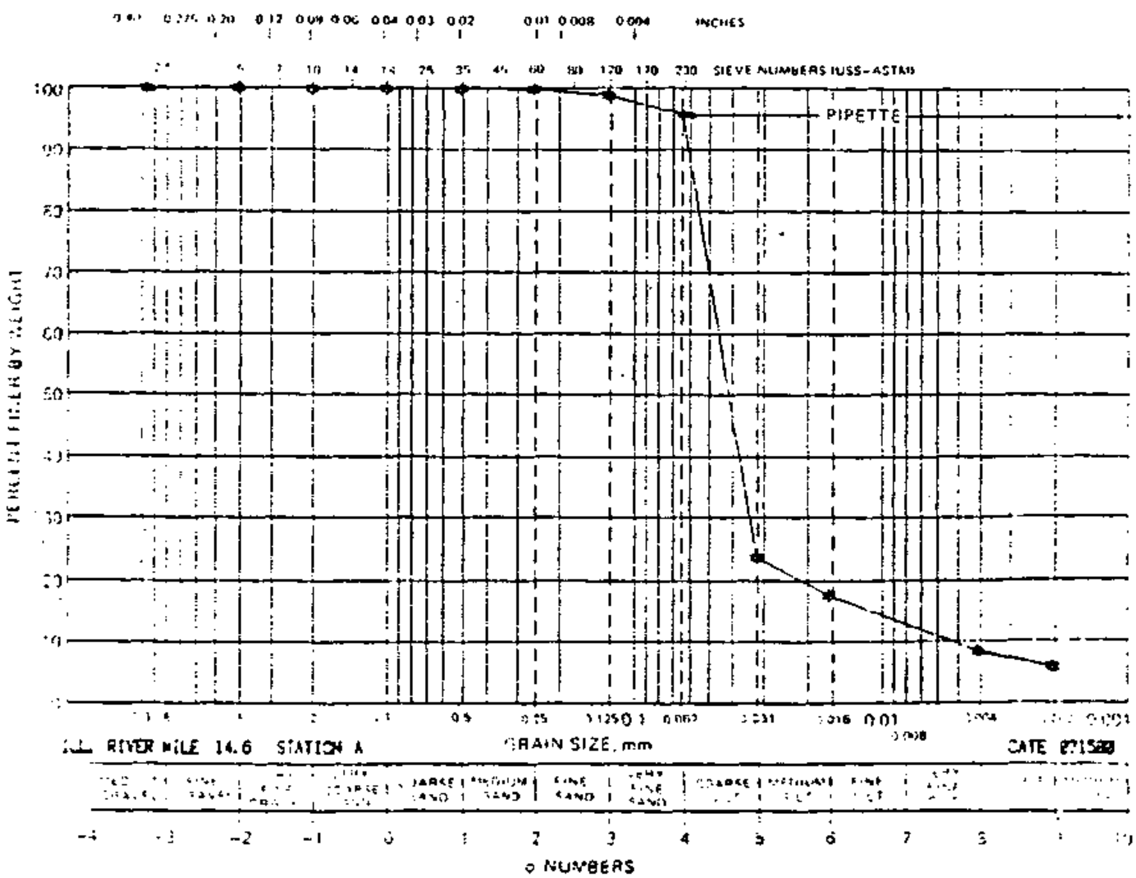
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY

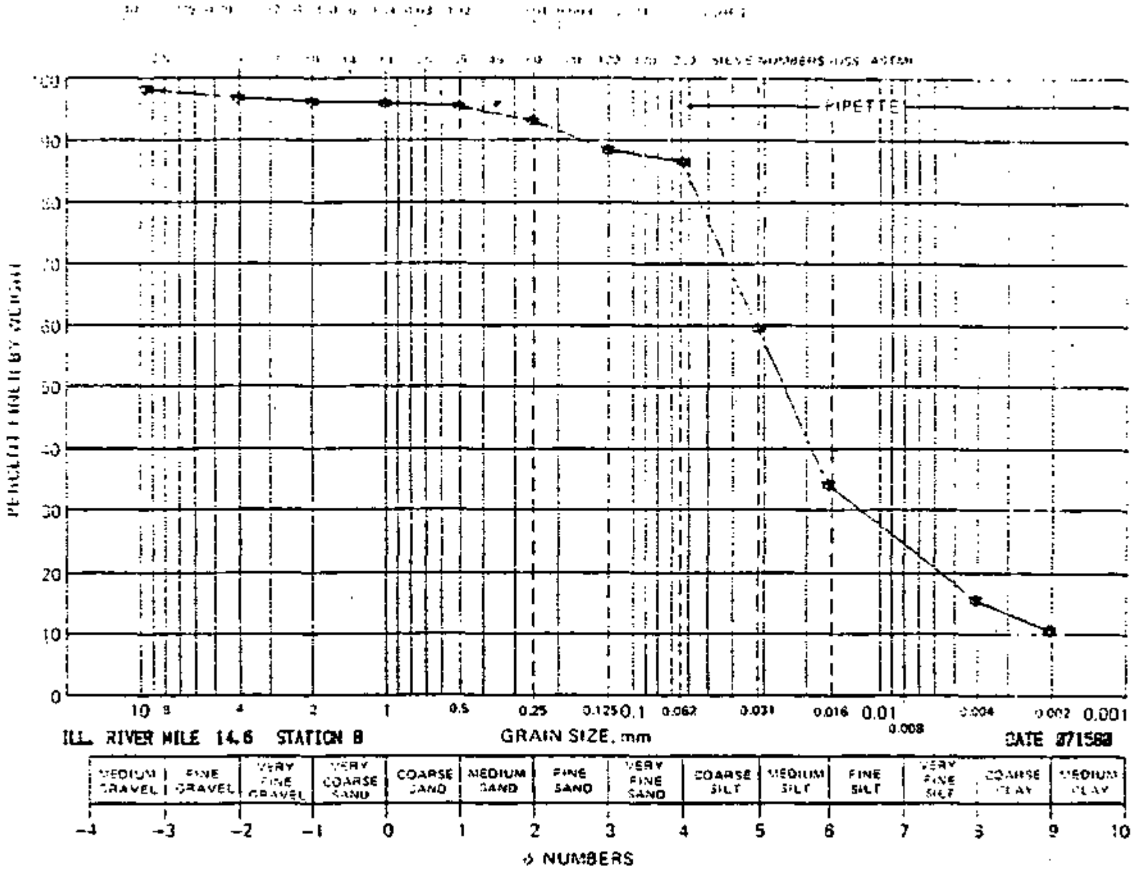


ILLINOIS STATE WATER SURVEY

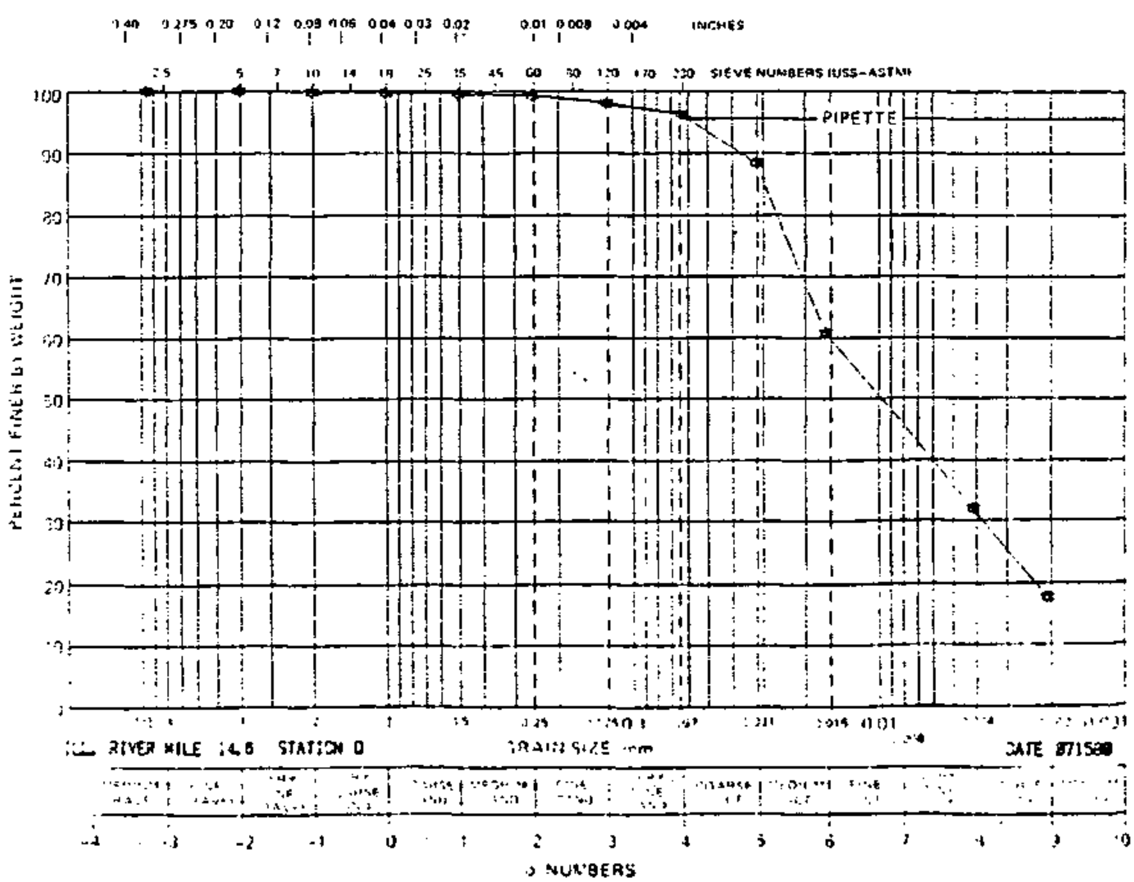
SEDIMENT LABORATORY



ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY

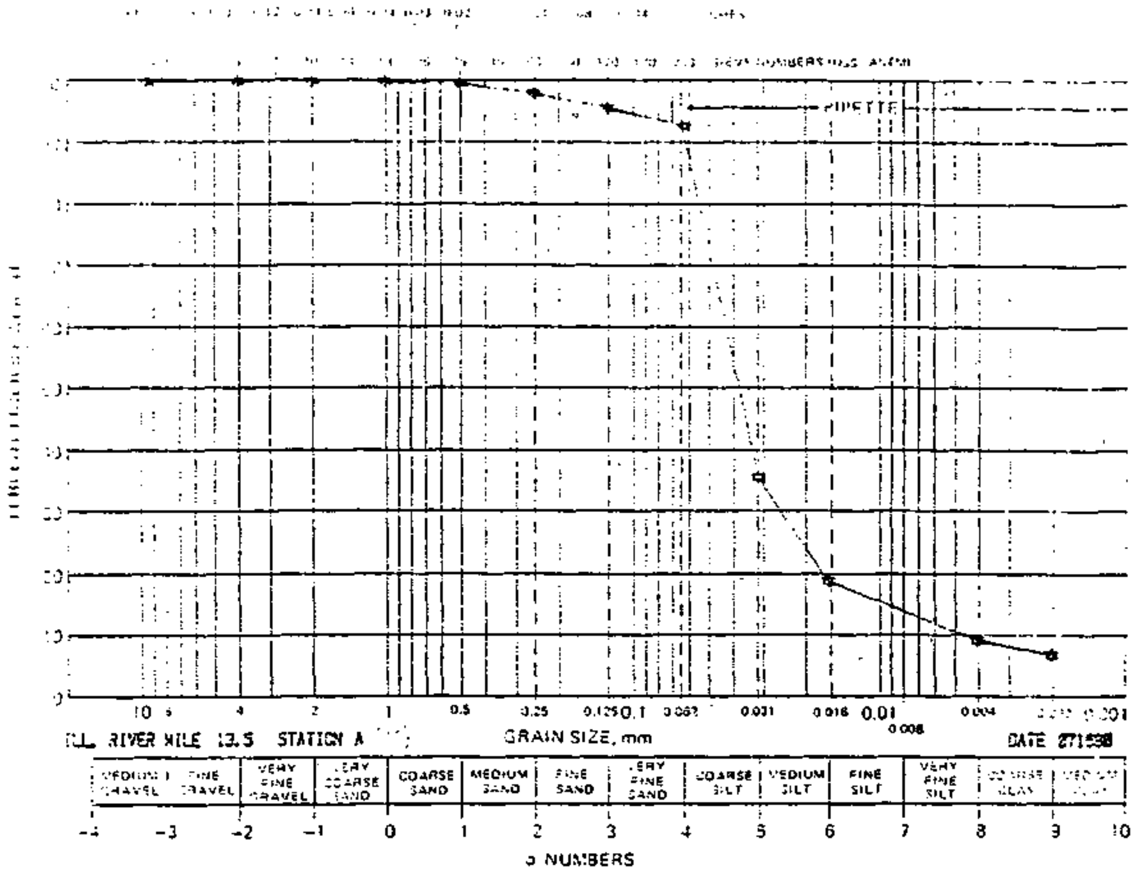


ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



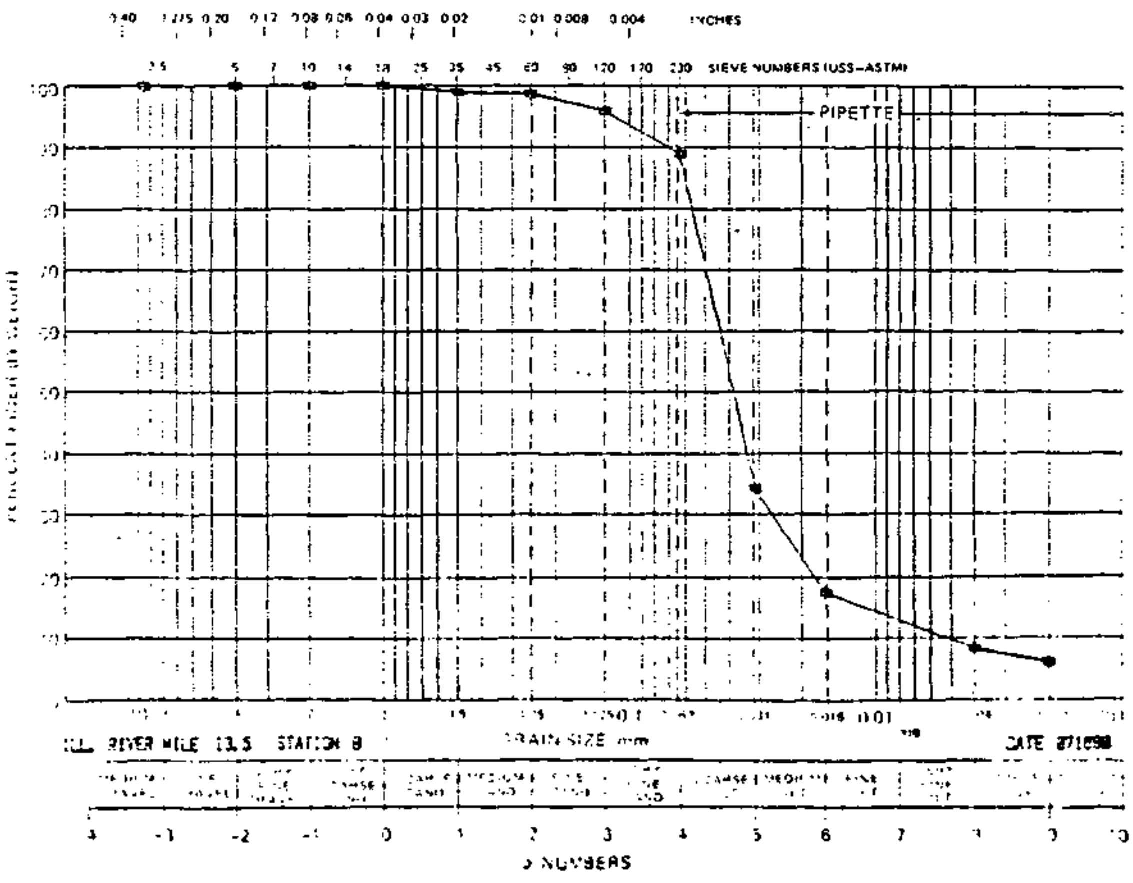
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY



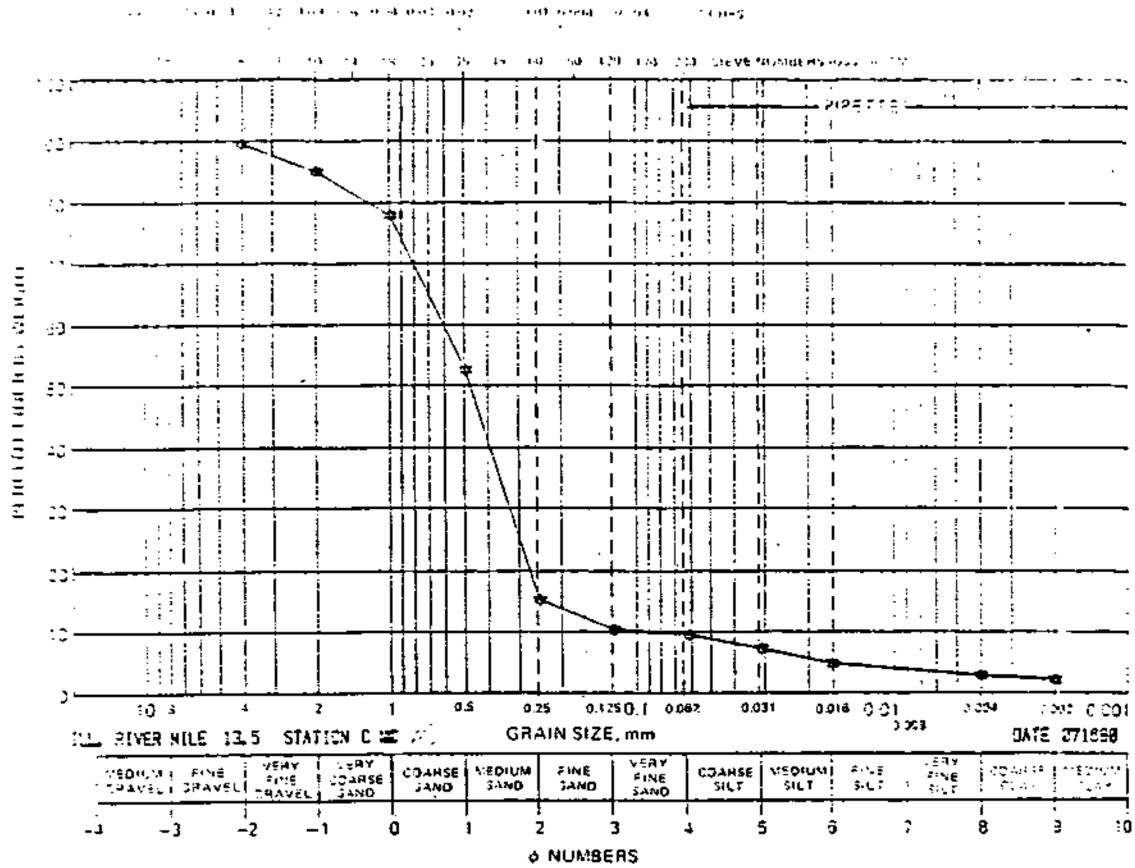
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY



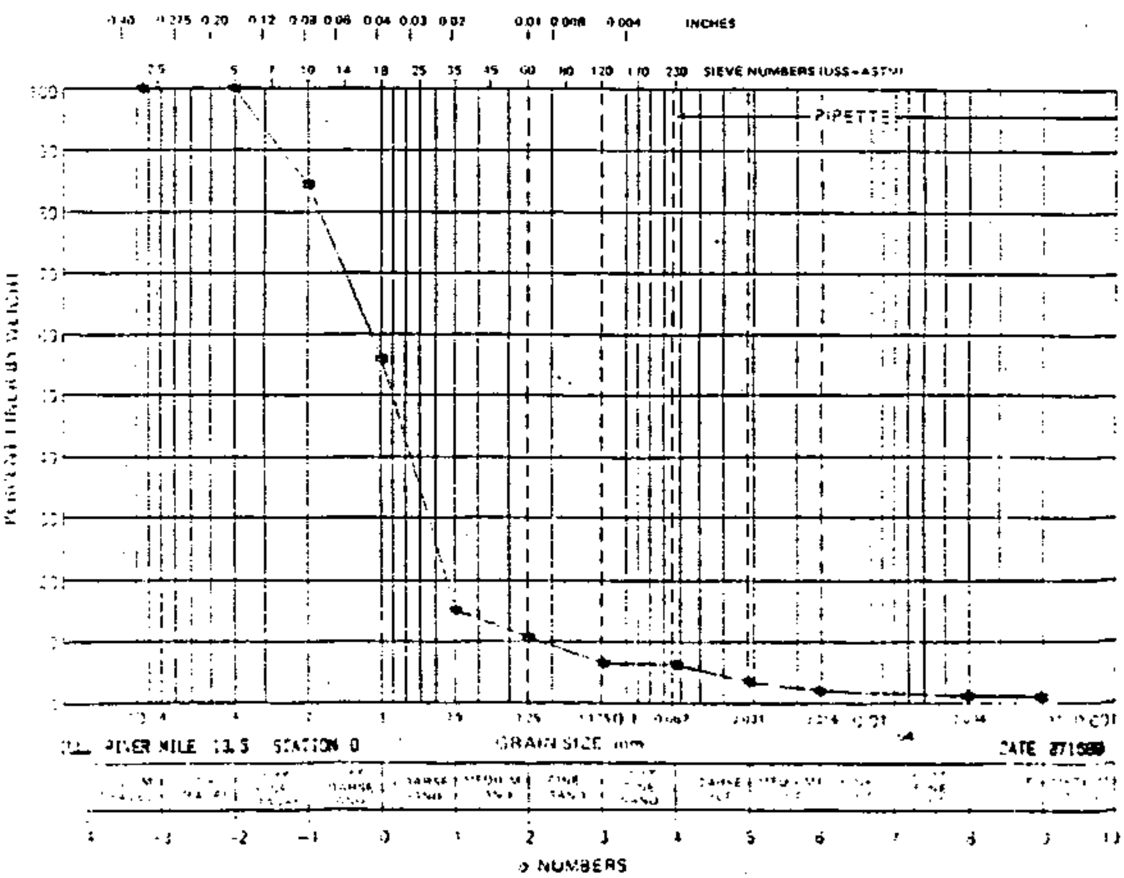
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY



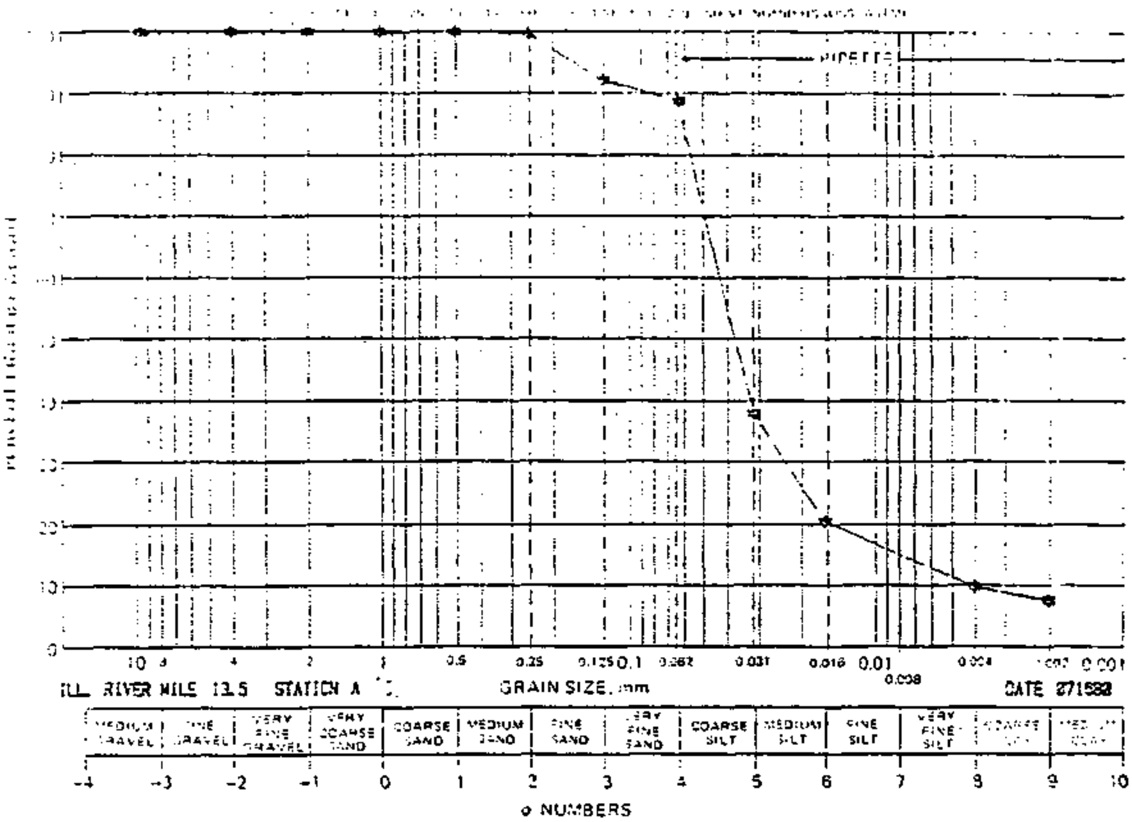
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY



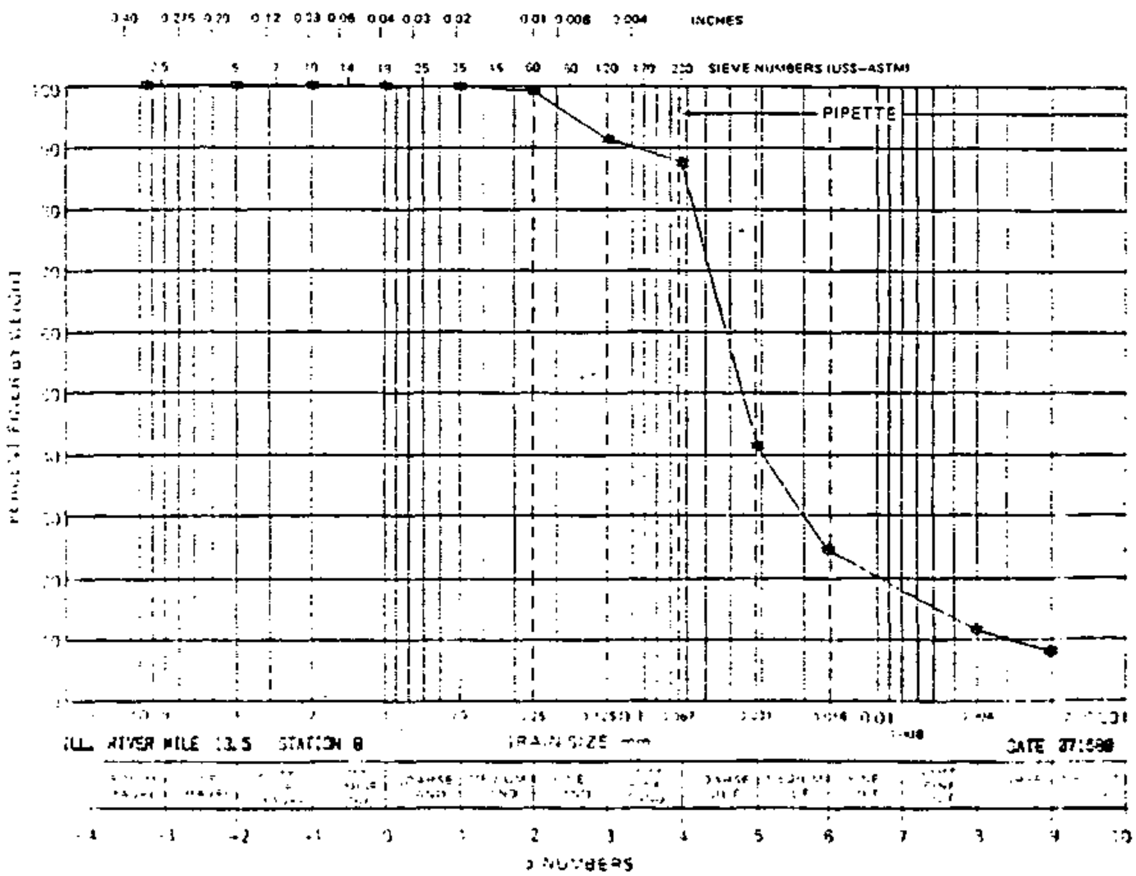
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY

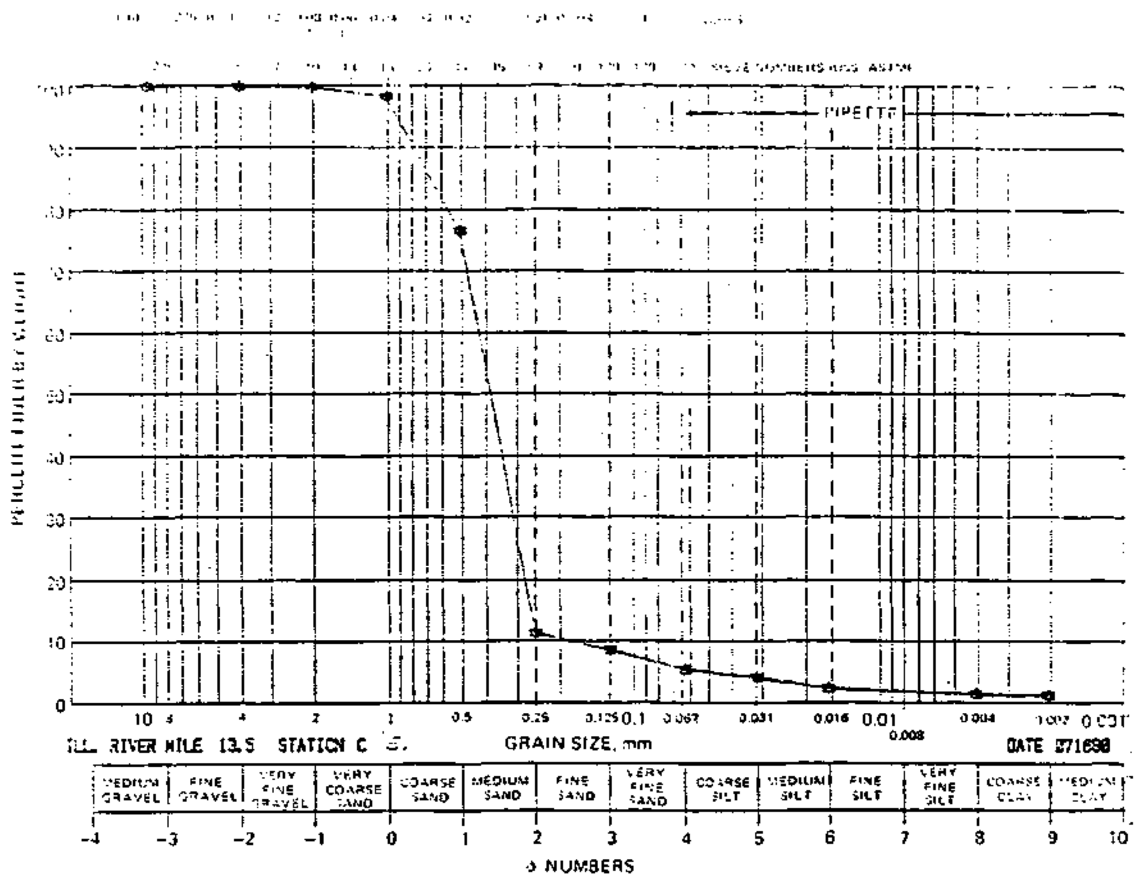


ILLINOIS STATE WATER SURVEY

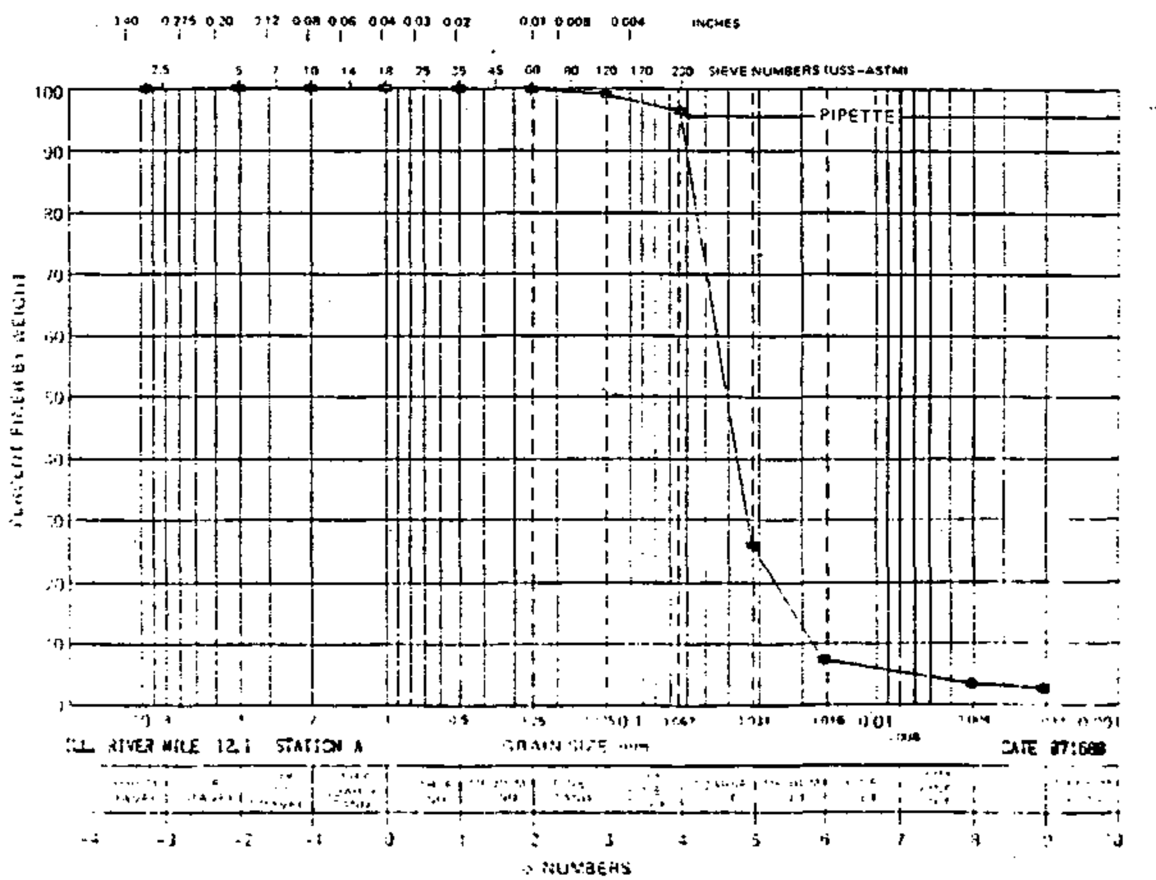
SEDIMENT LABORATORY



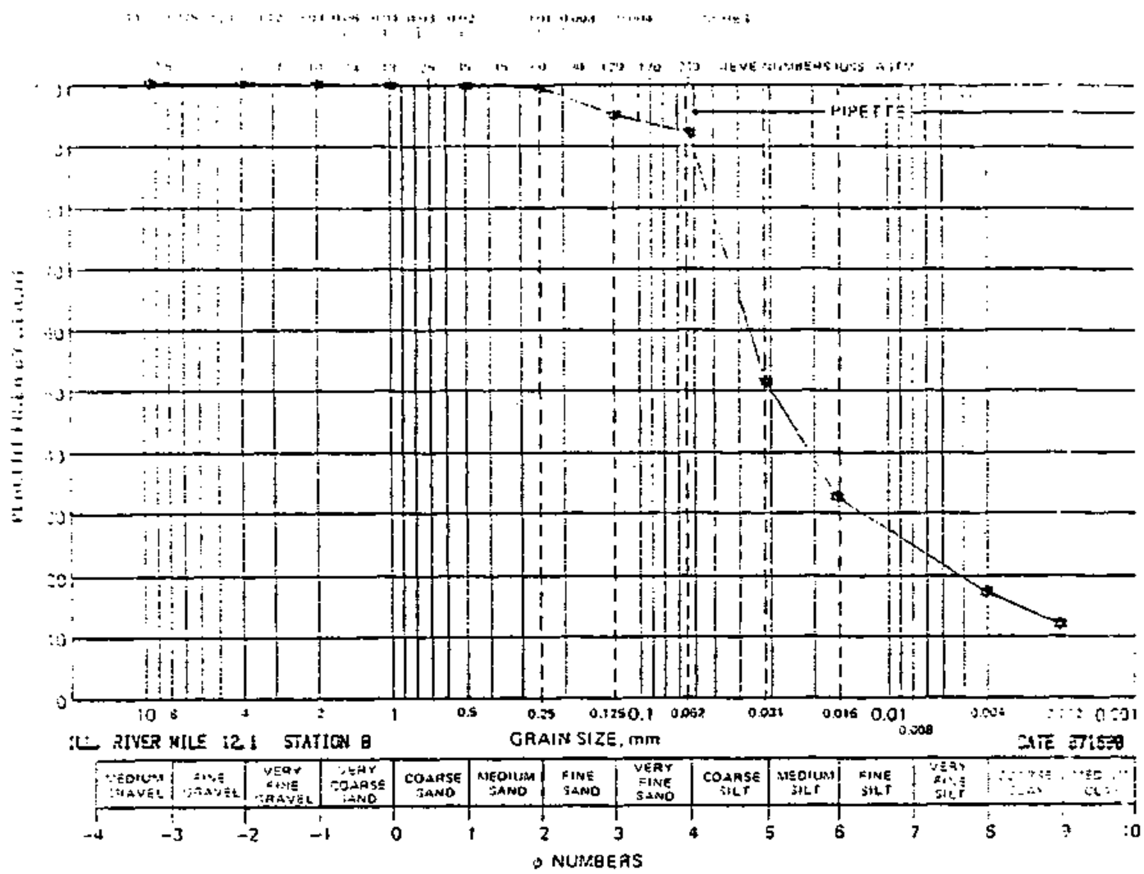
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



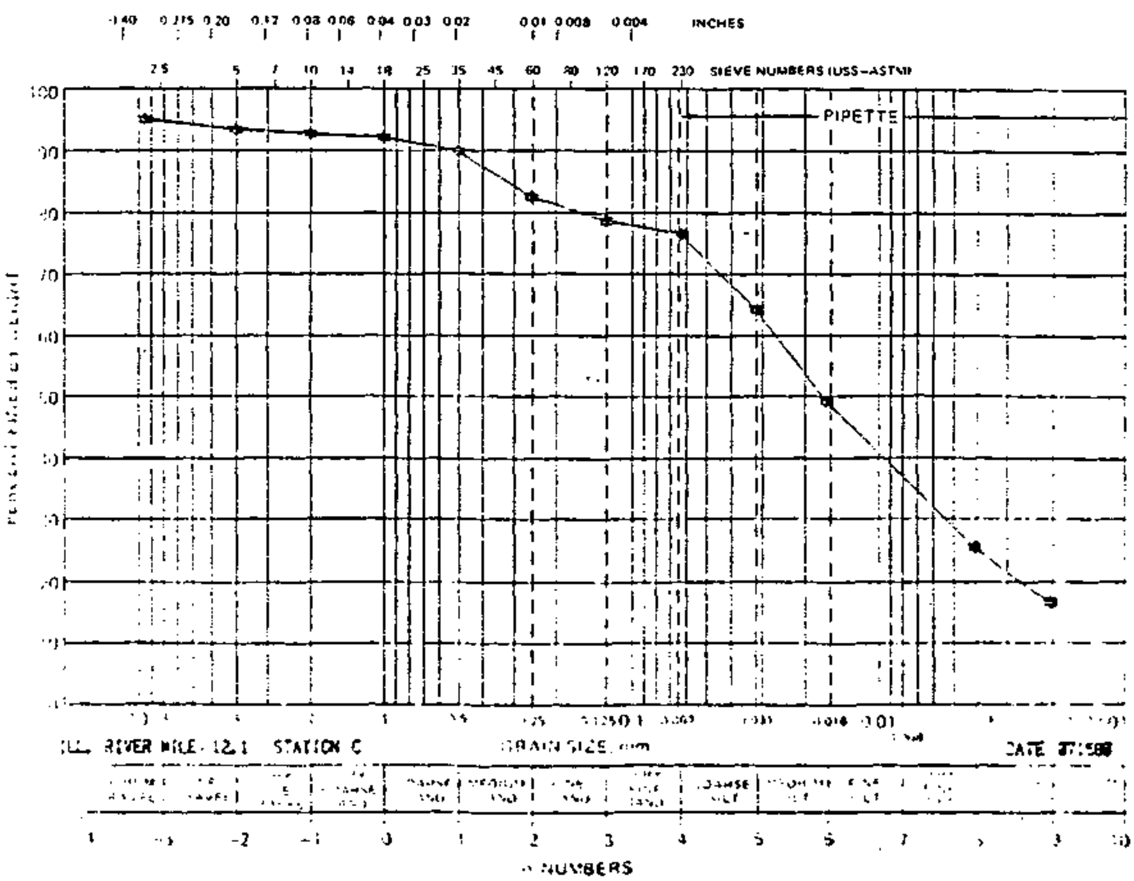
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY

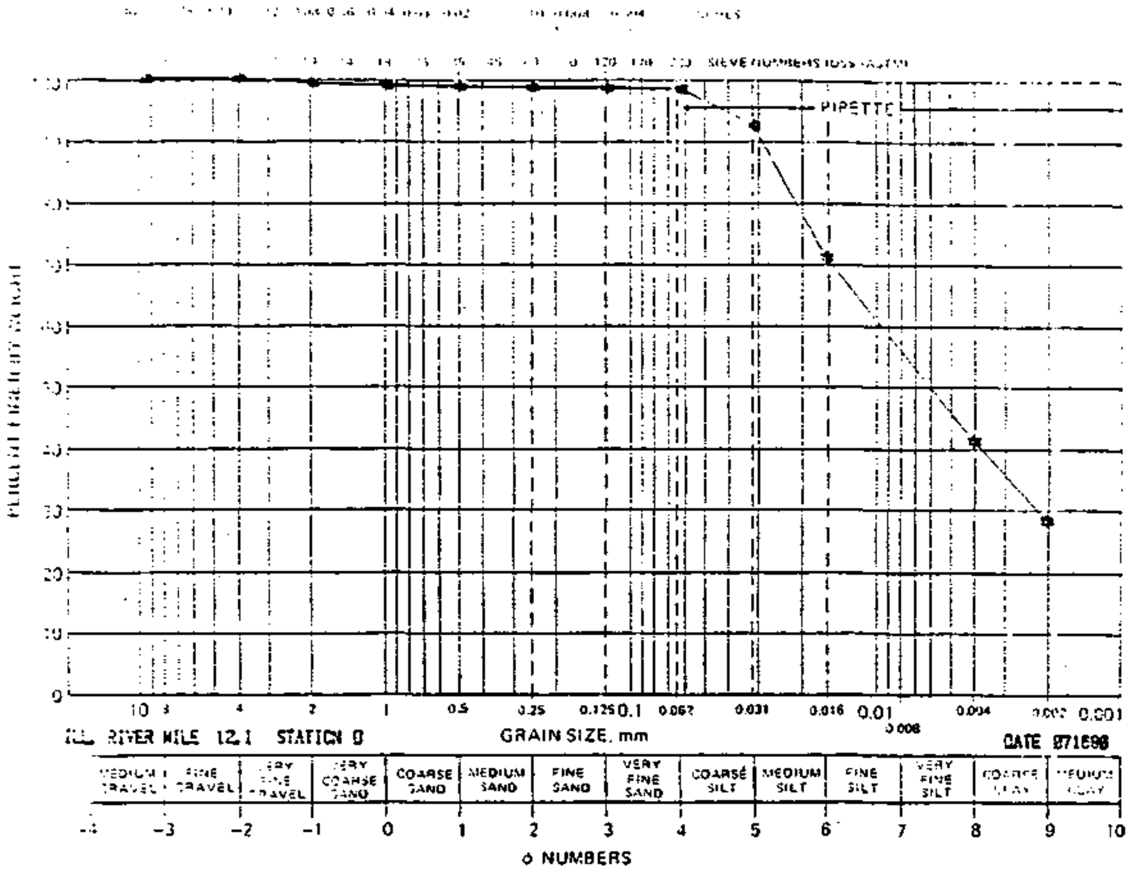


ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



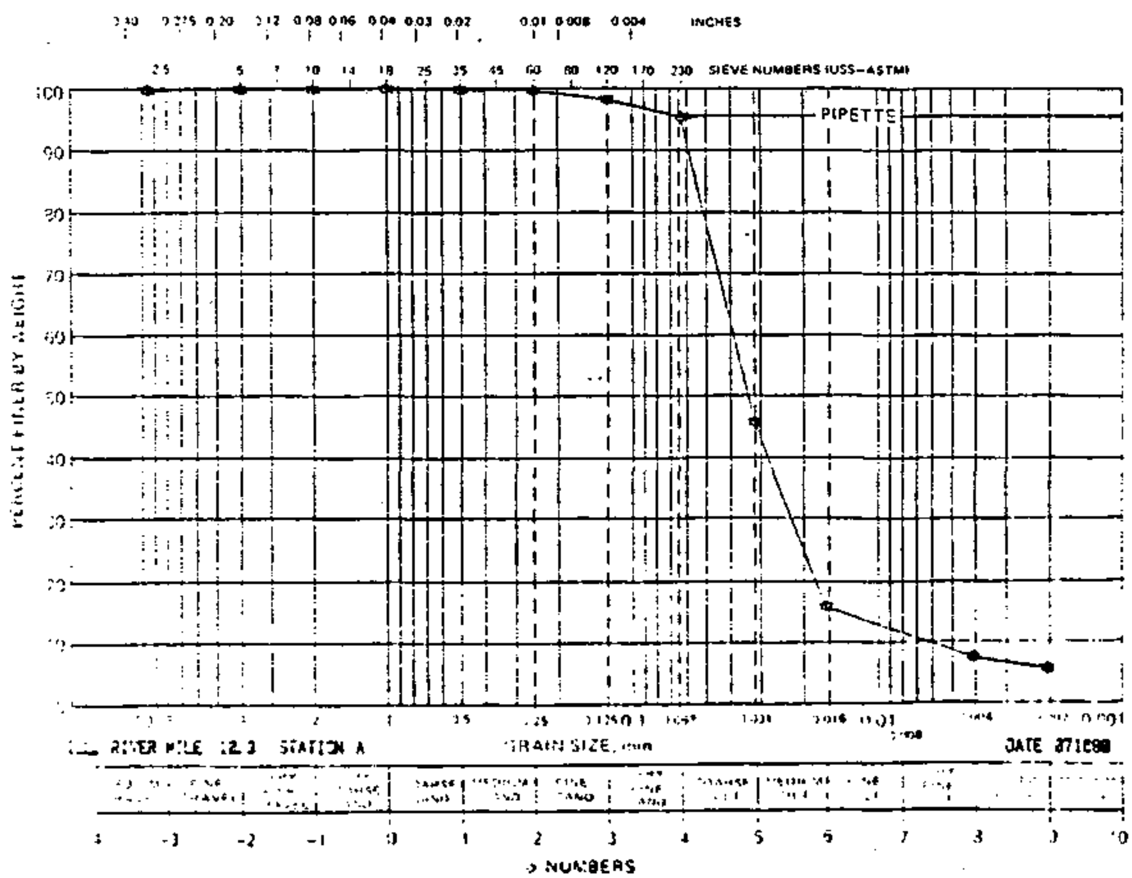
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY

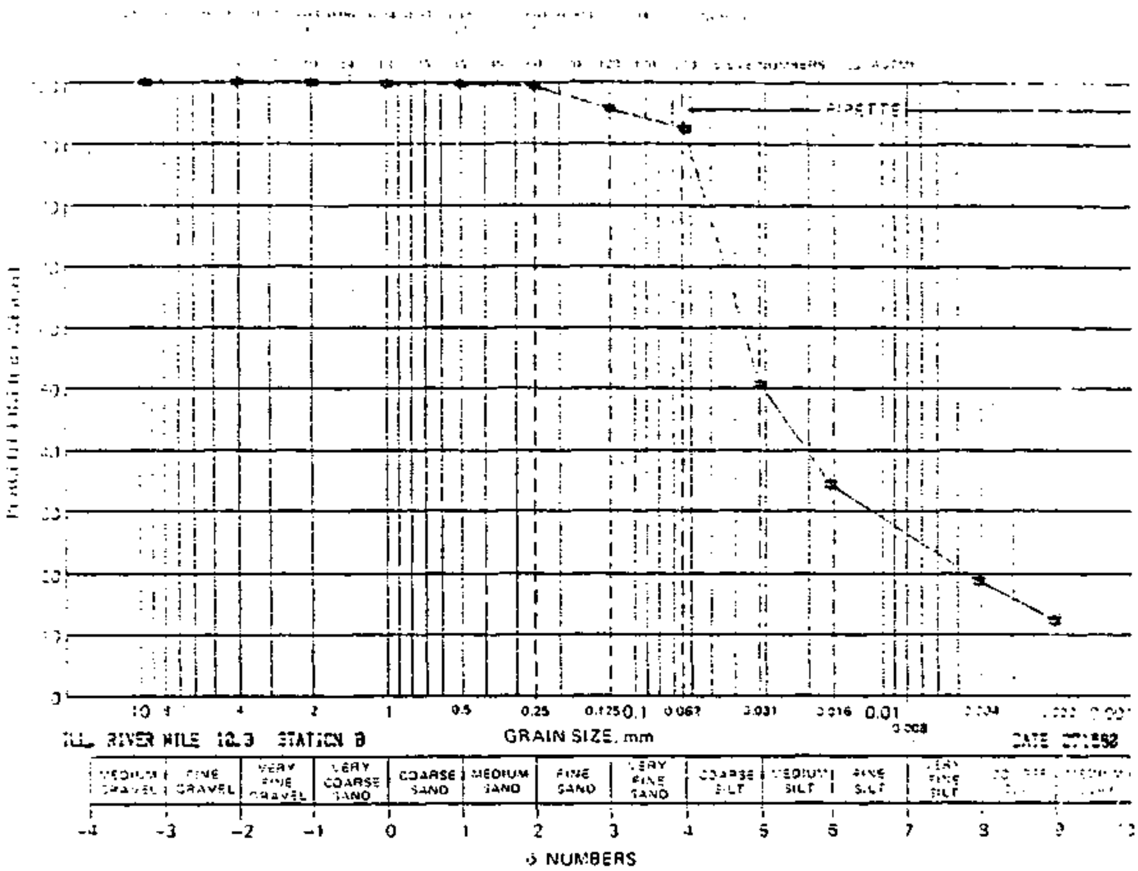


ILLINOIS STATE WATER SURVEY

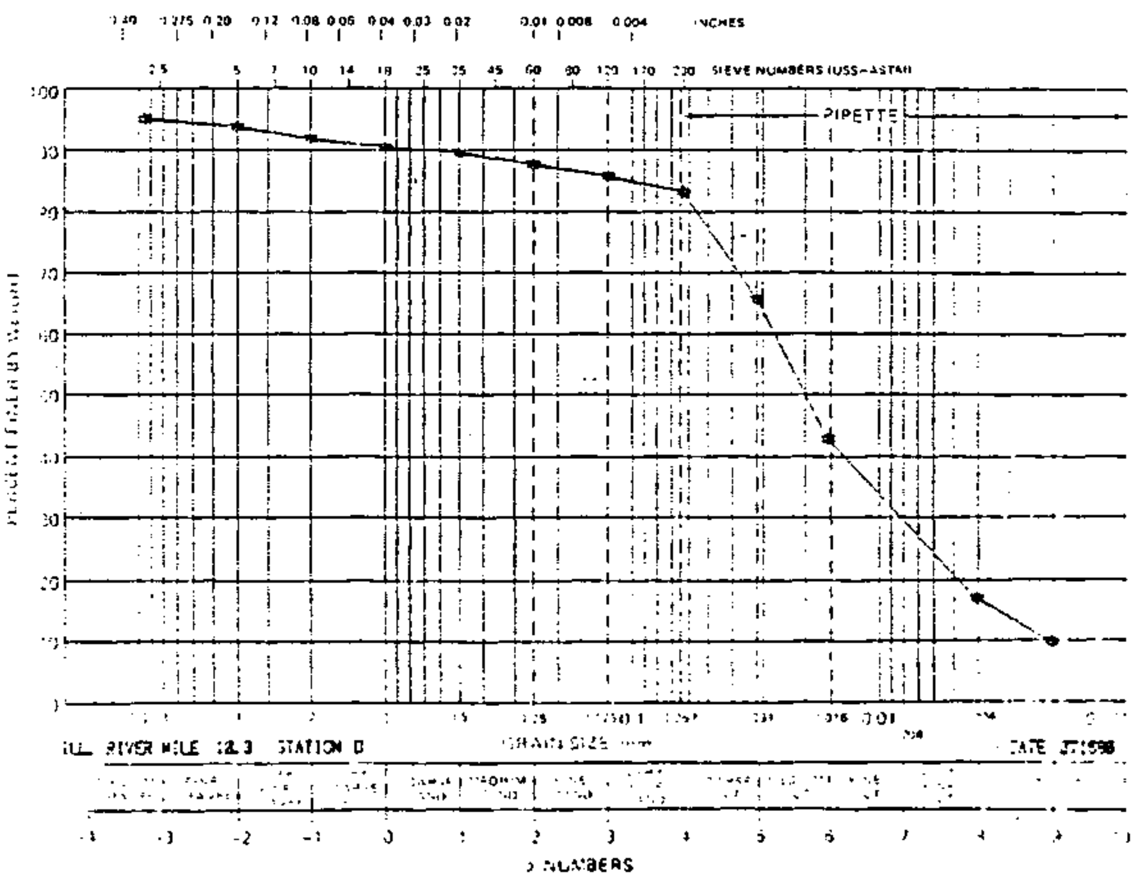
SEDIMENT LABORATORY



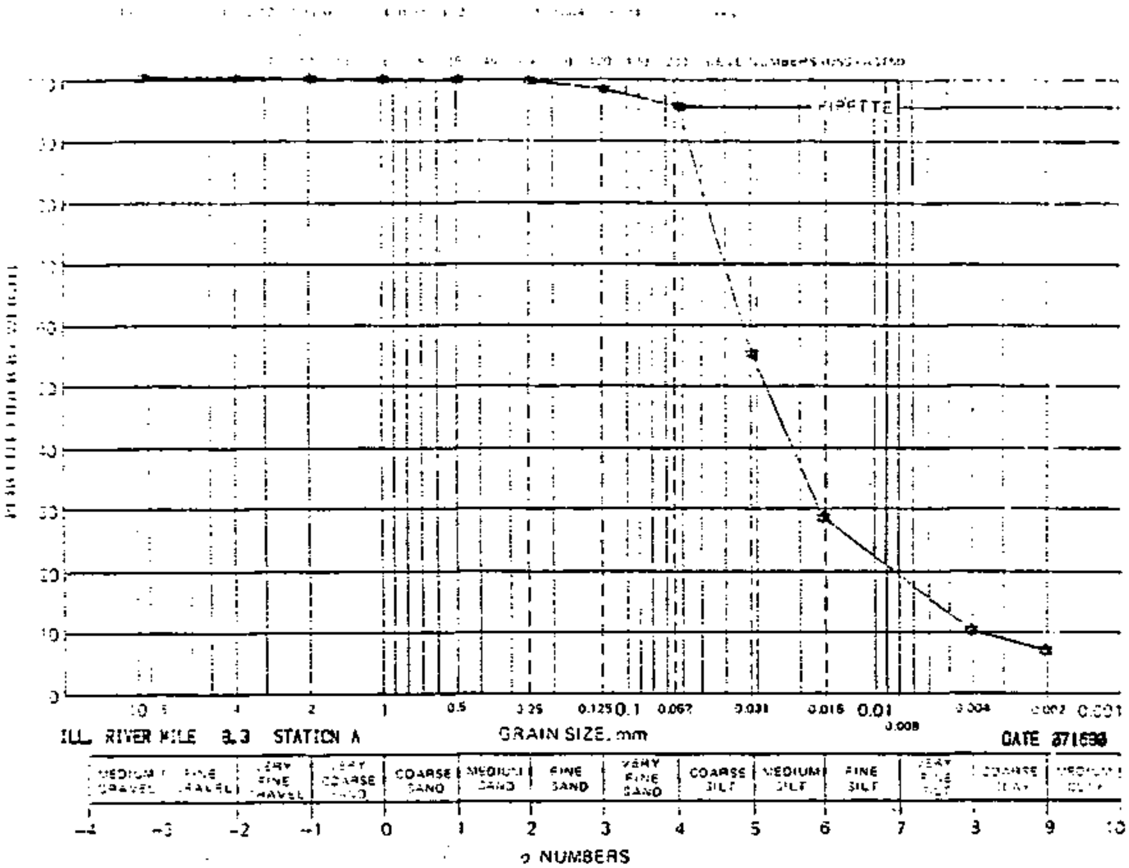
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



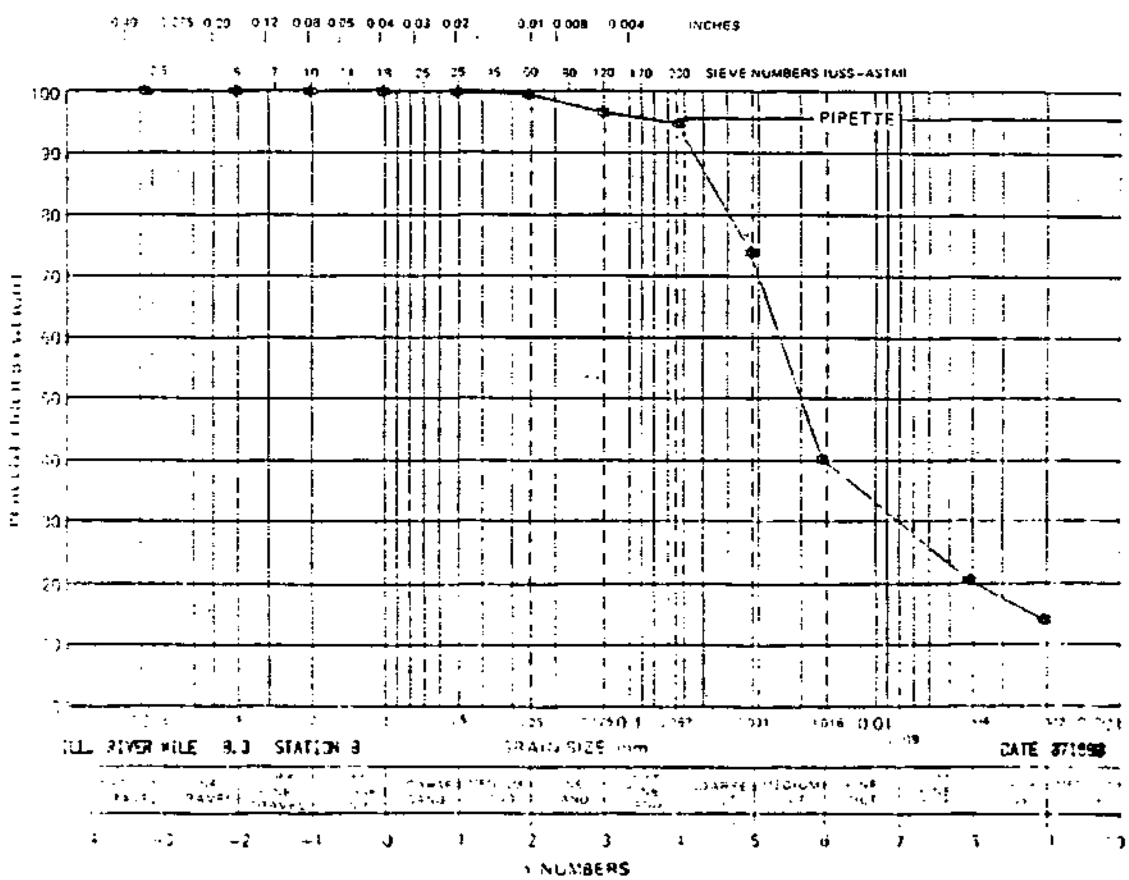
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



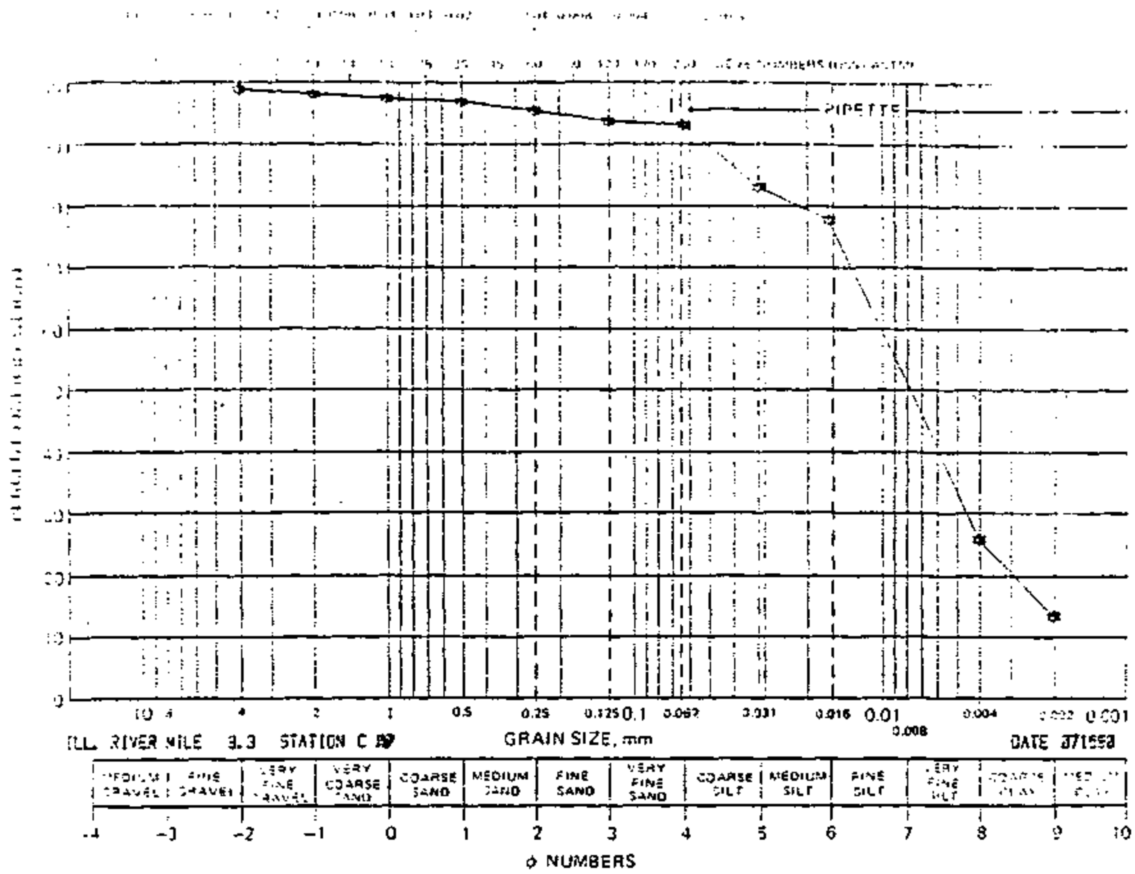
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



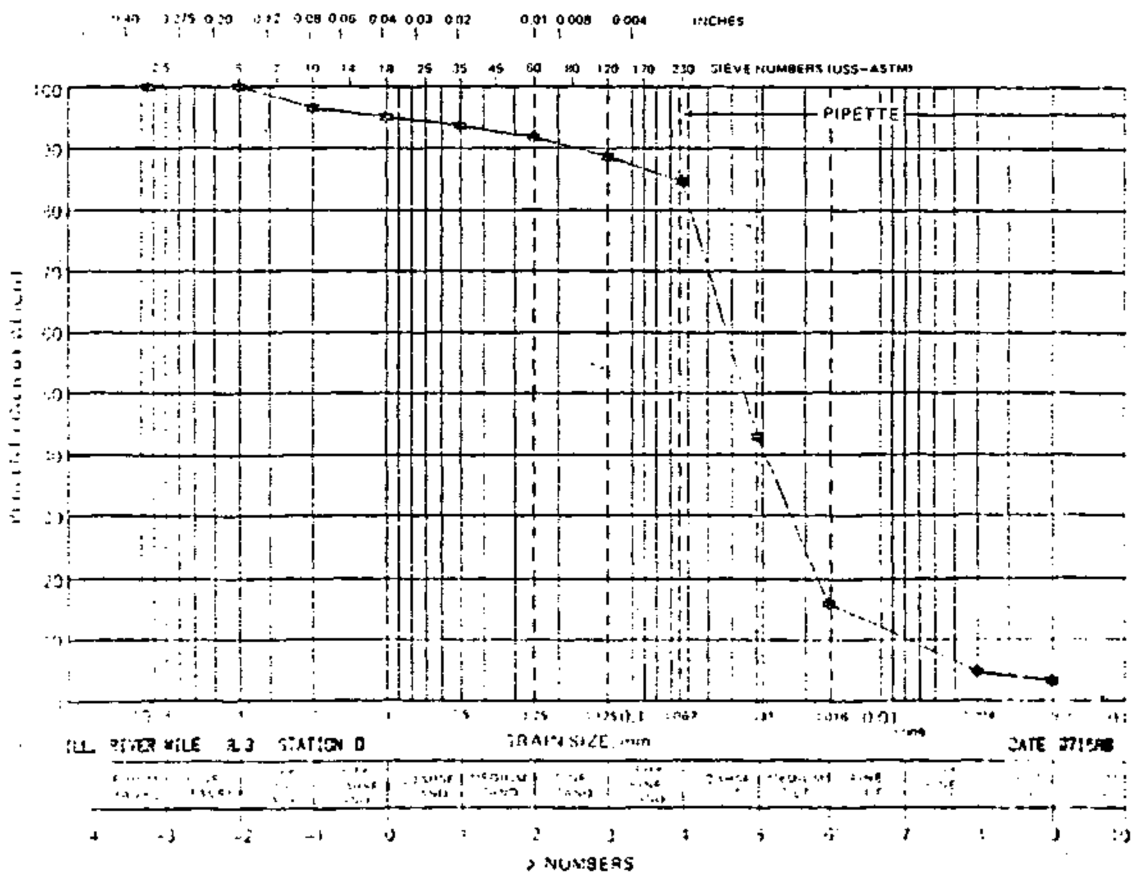
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



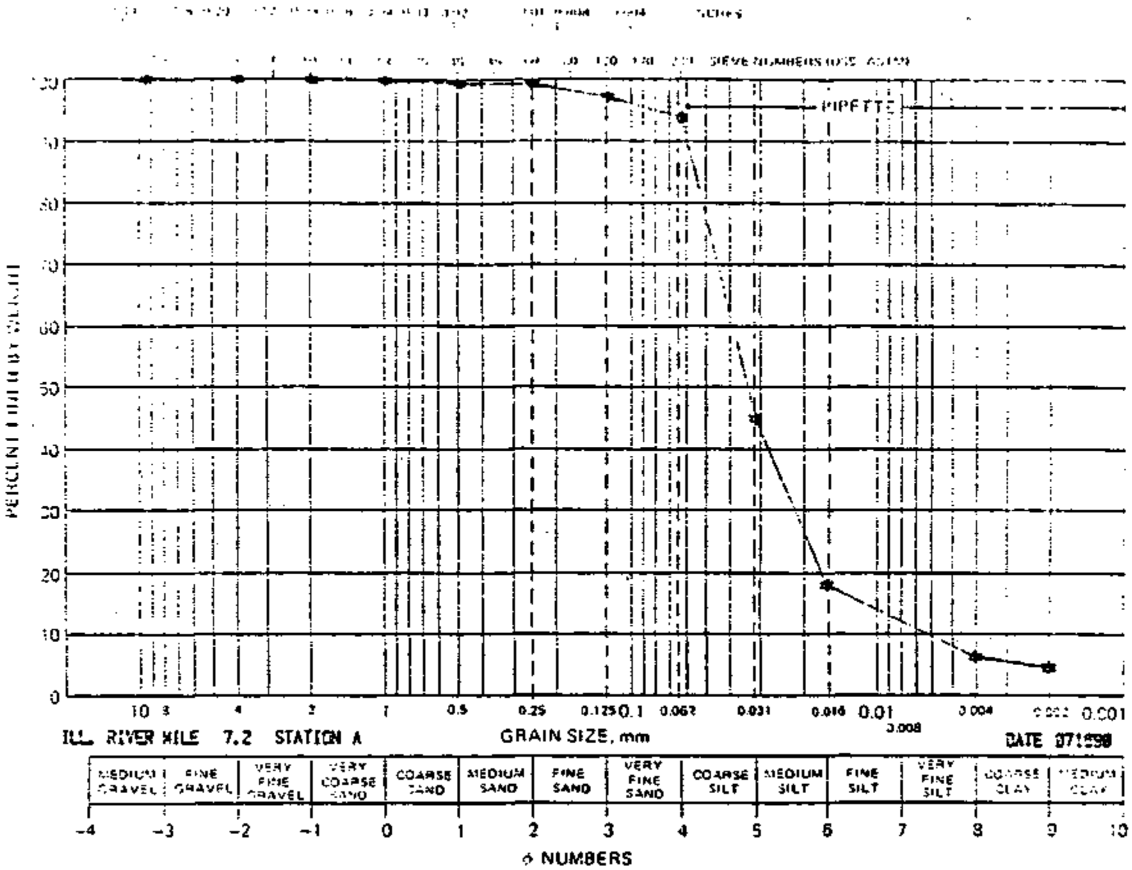
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



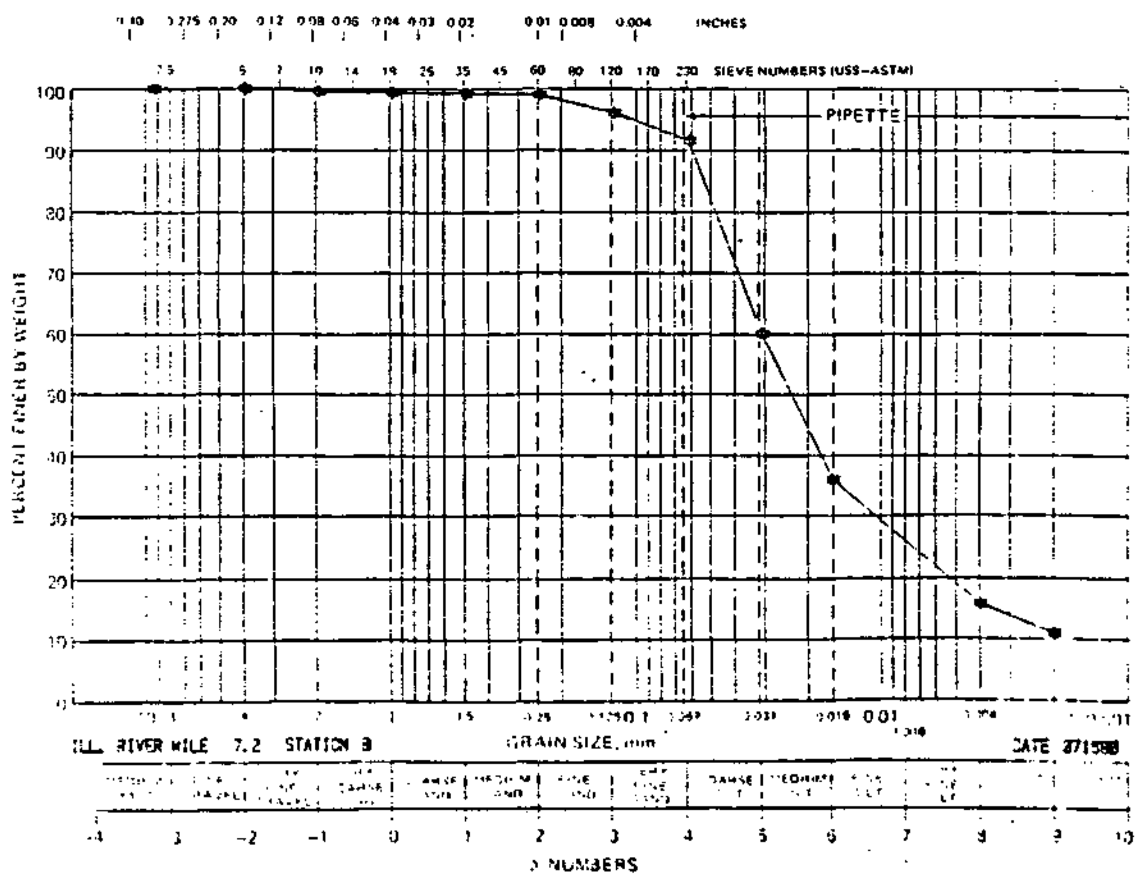
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY

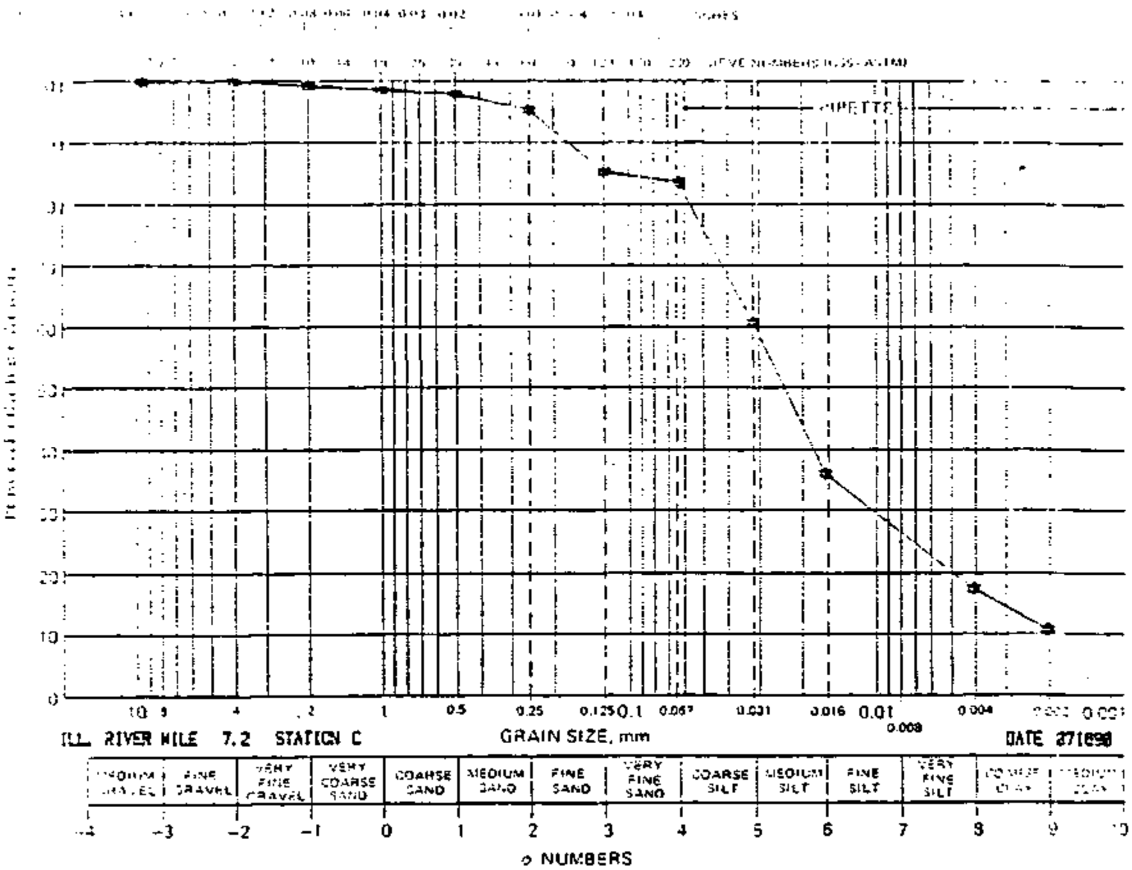


ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



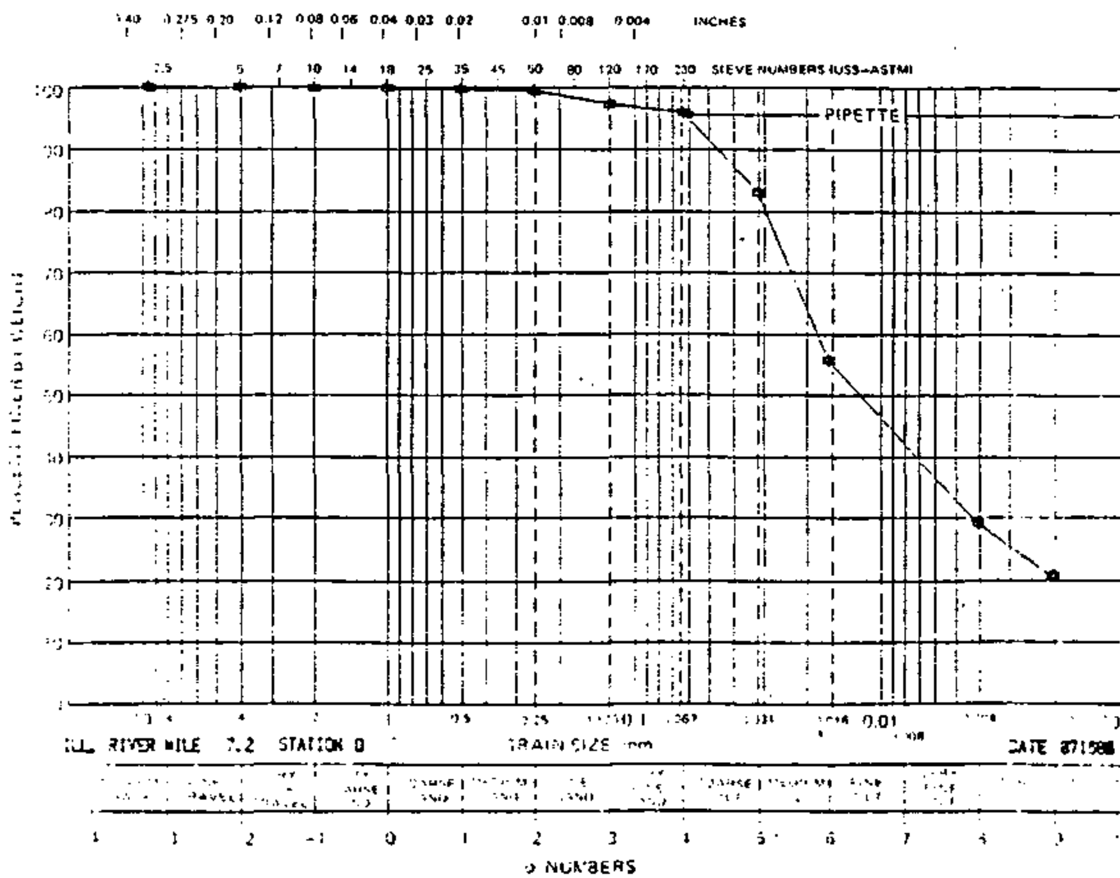
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY

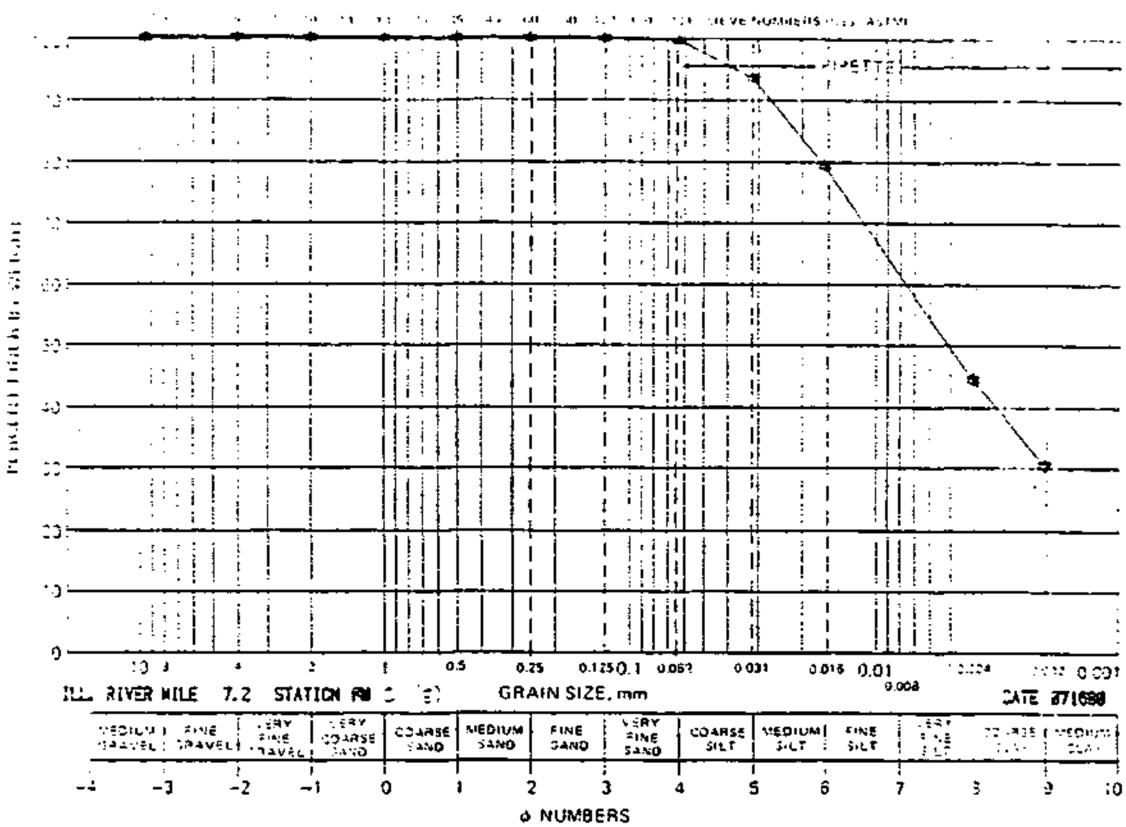


ILLINOIS STATE WATER SURVEY

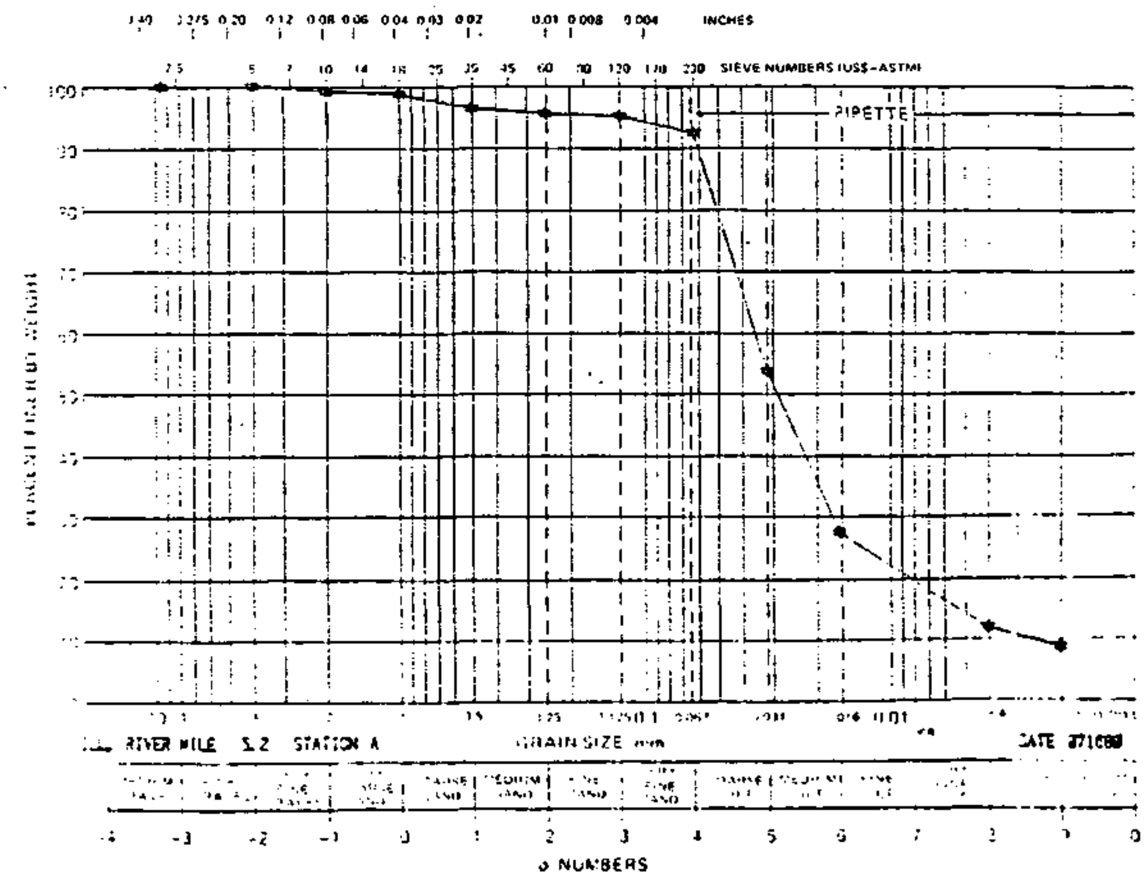
SEDIMENT LABORATORY



ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY

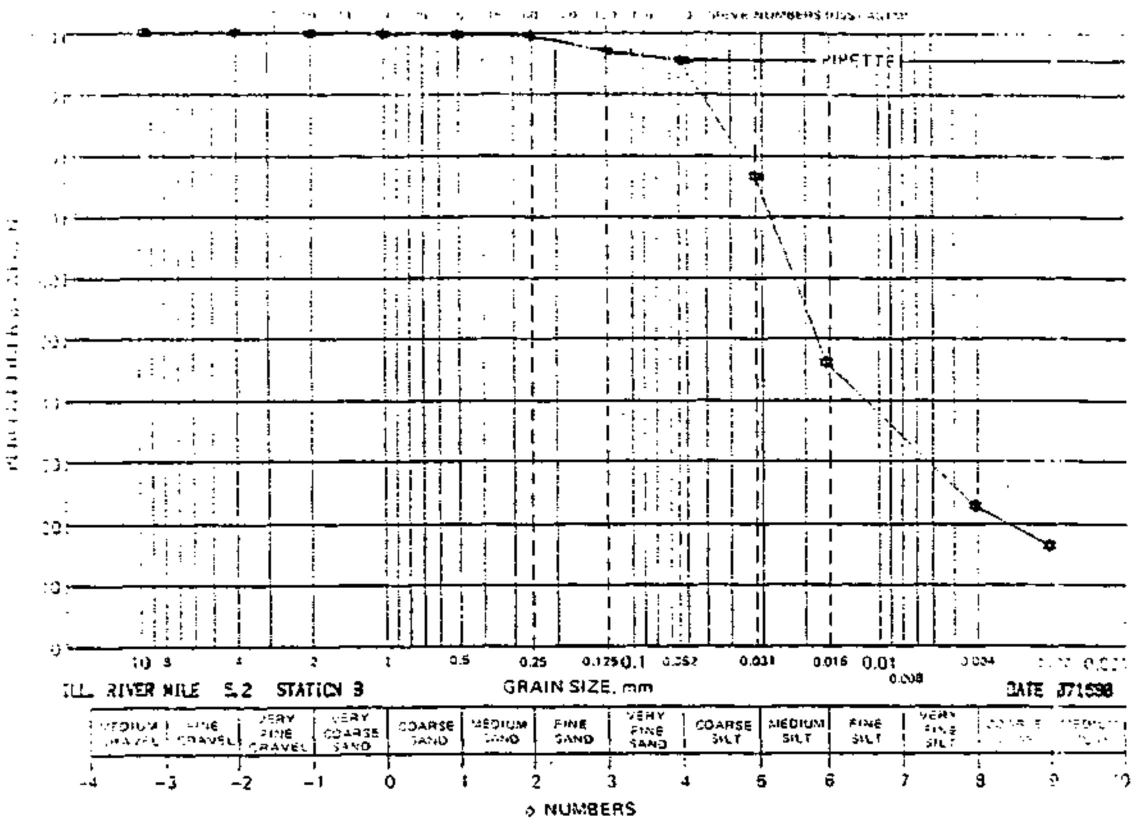


ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



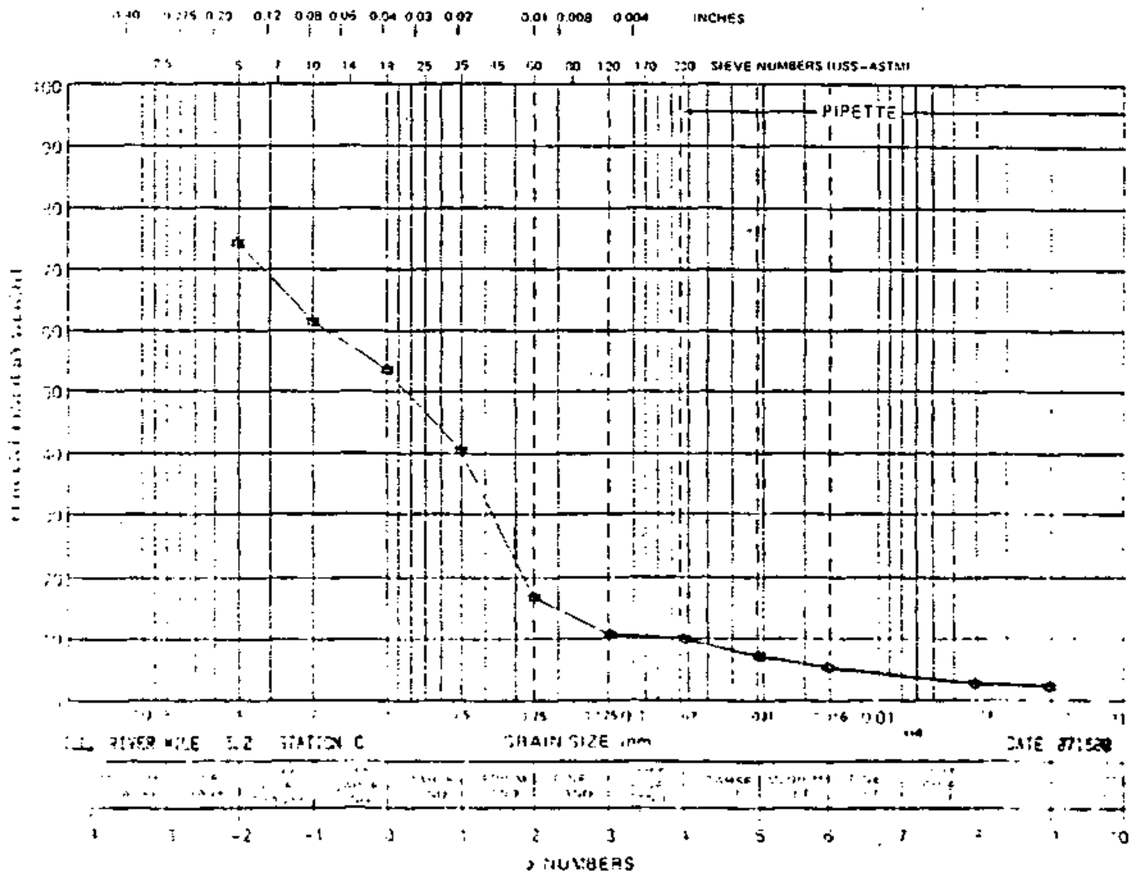
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY

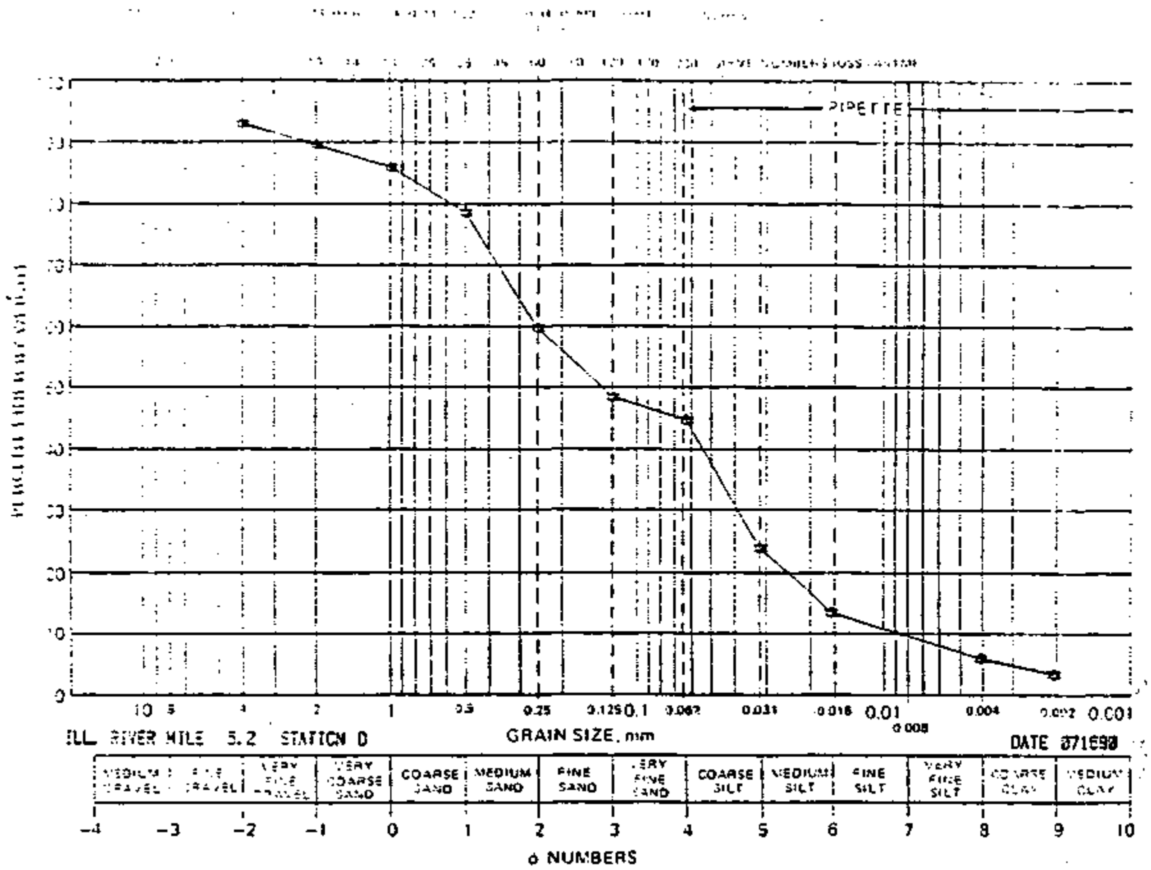


ILLINOIS STATE WATER SURVEY

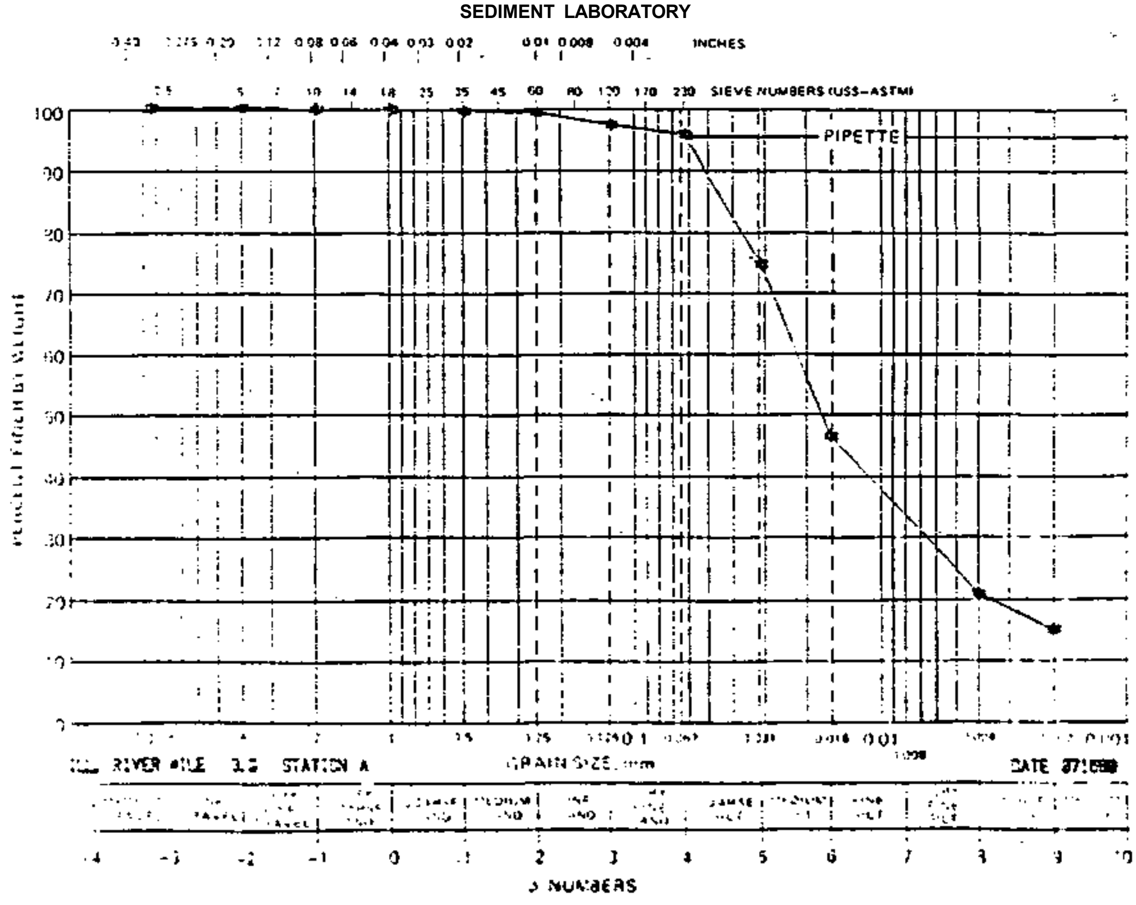
SEDIMENT LABORATORY



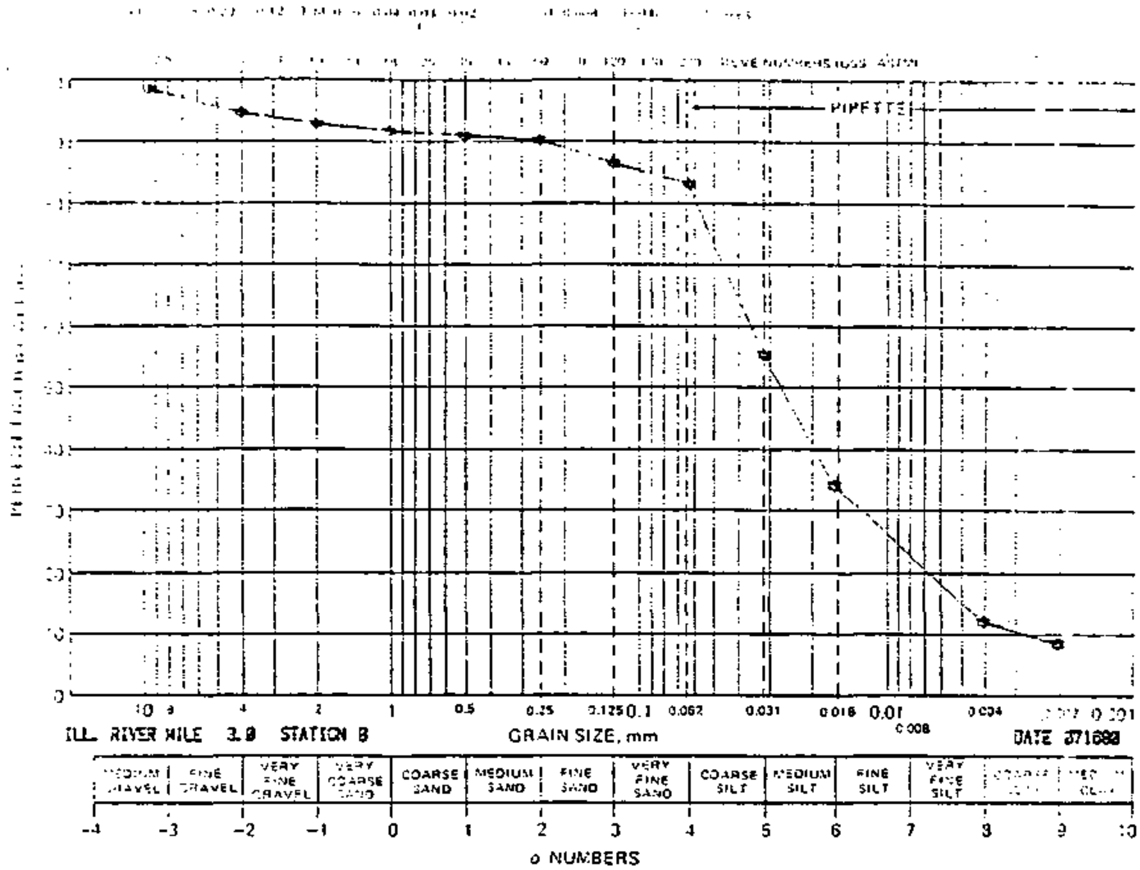
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



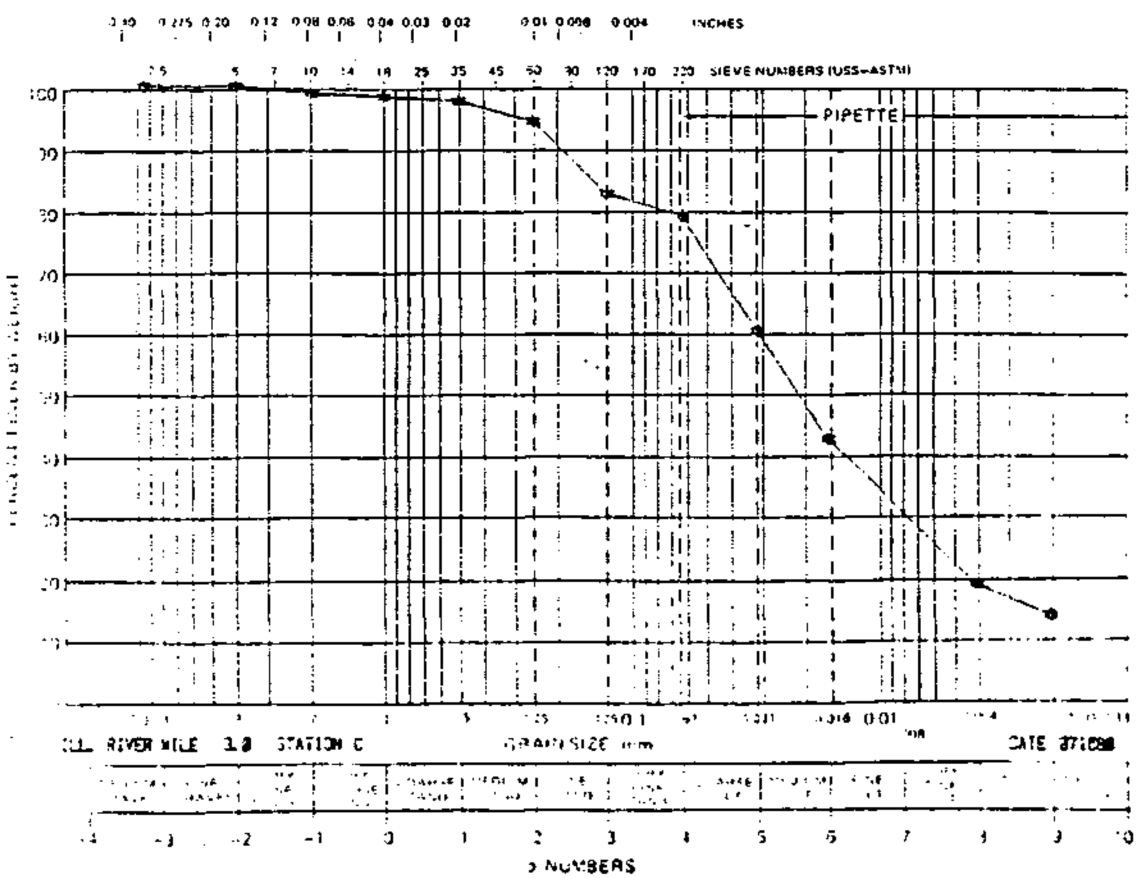
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



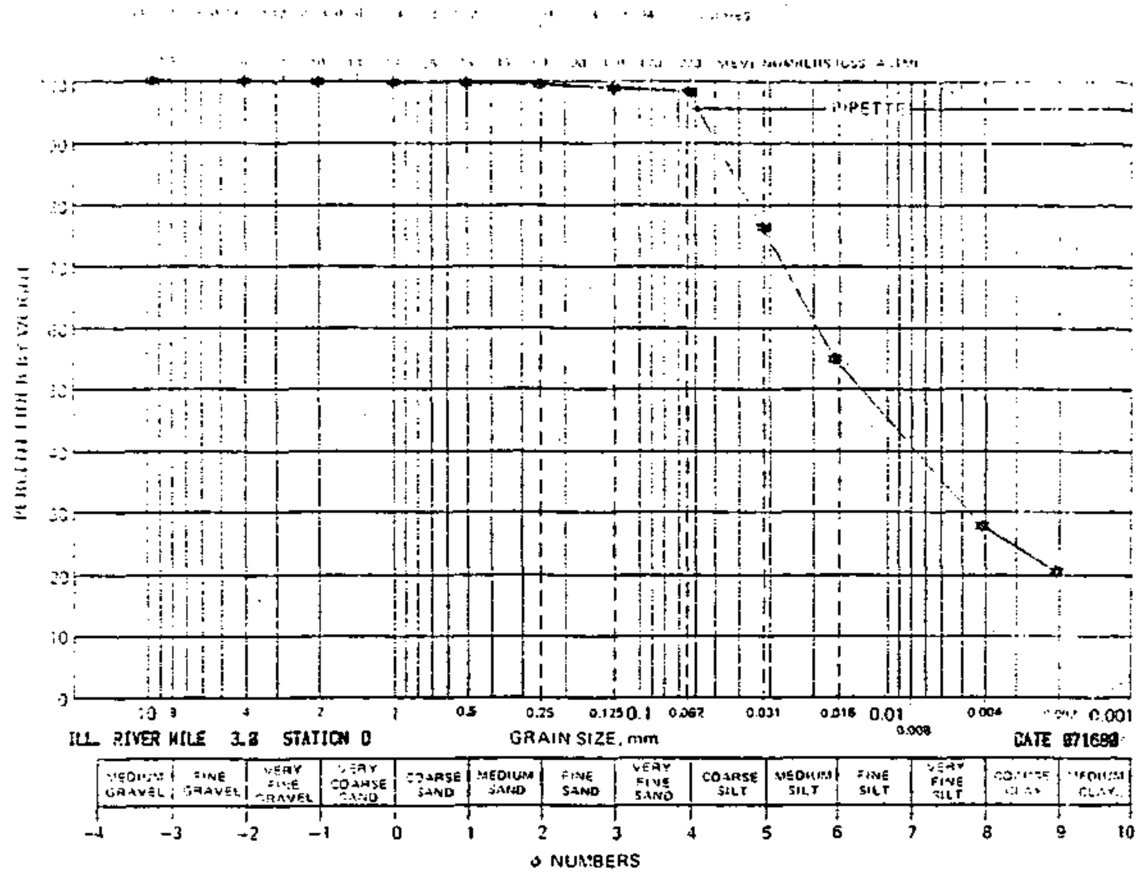
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



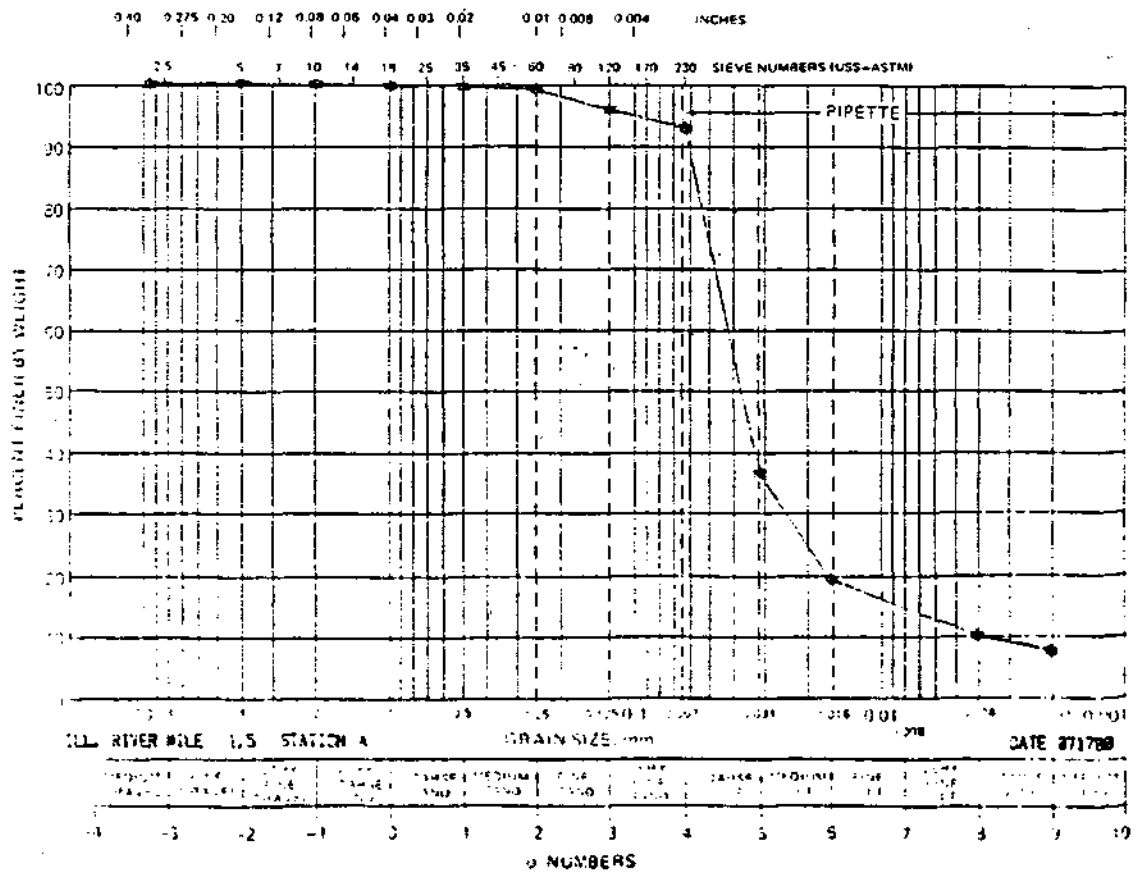
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY

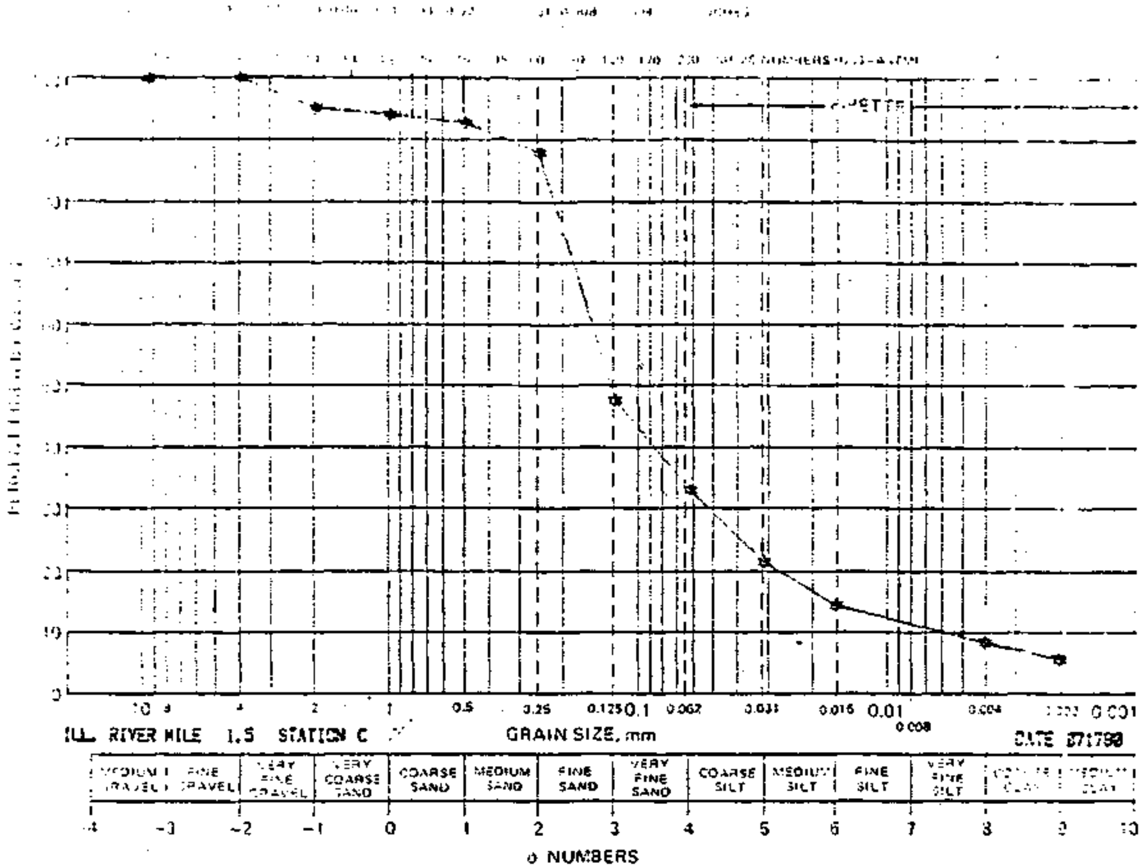


ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



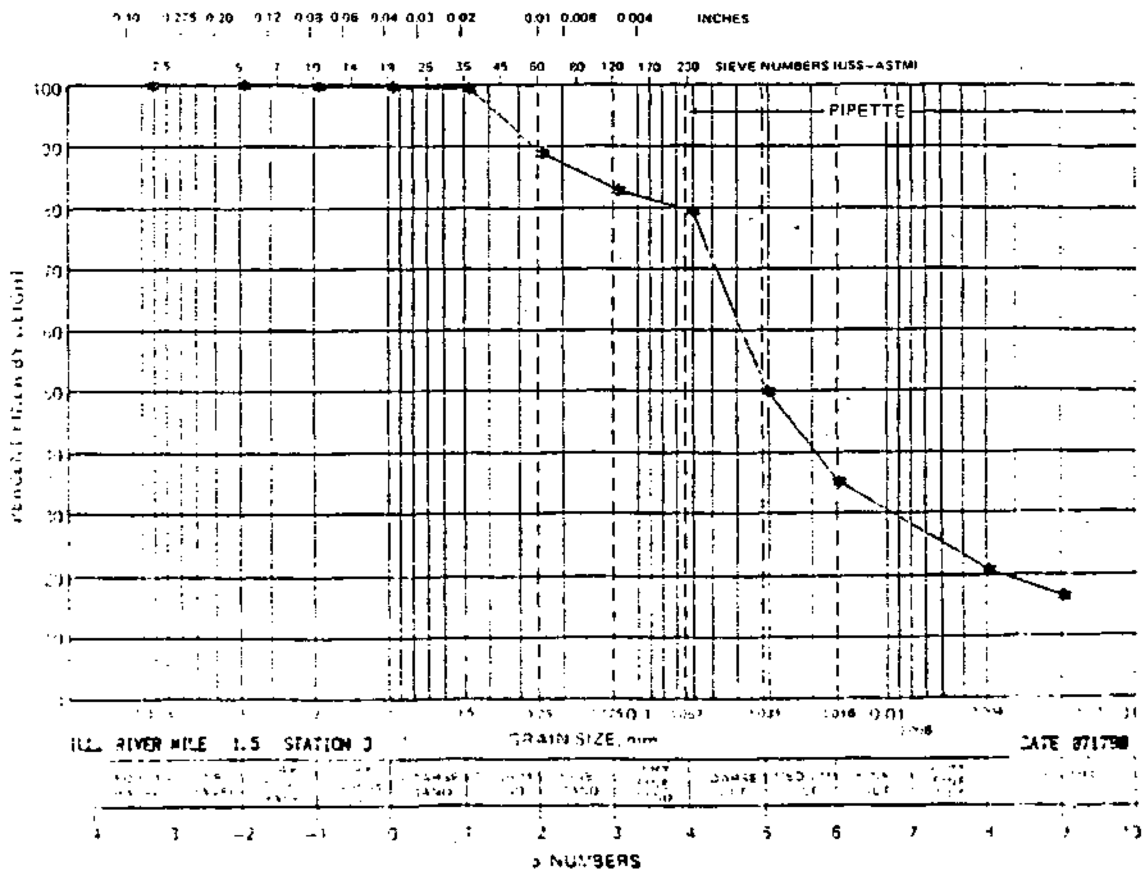
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY



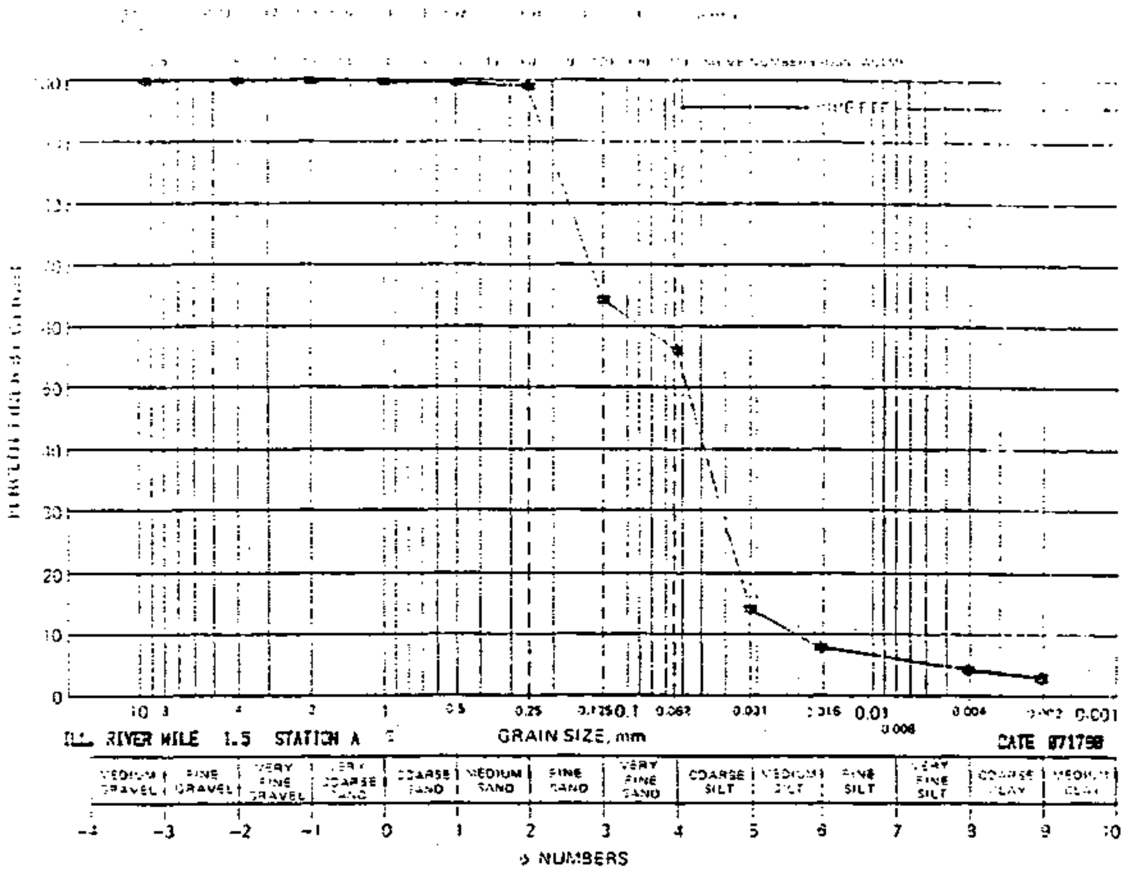
ILLINOIS STATE WATER SURVEY

SEDIMENT LABORATORY



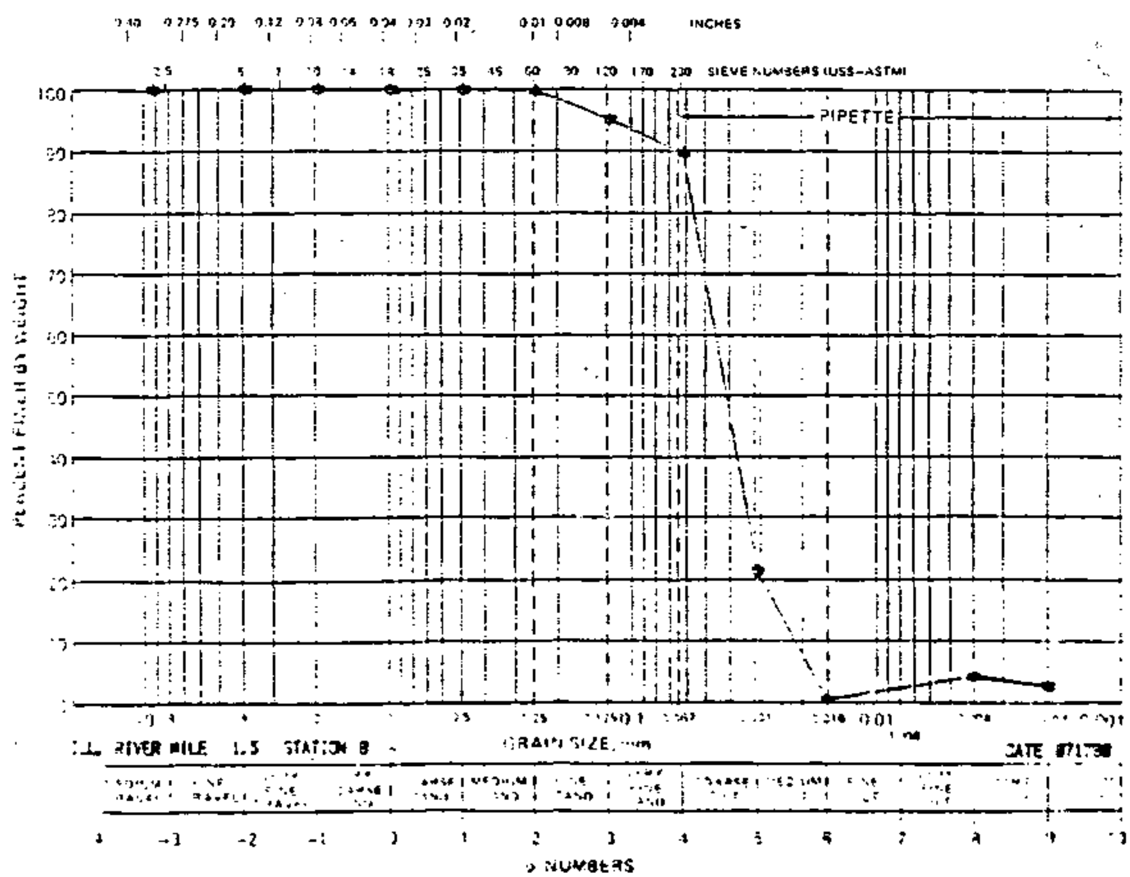
…LINOIS STATE WATER SURVEY

SEDIMENT LABORATORY

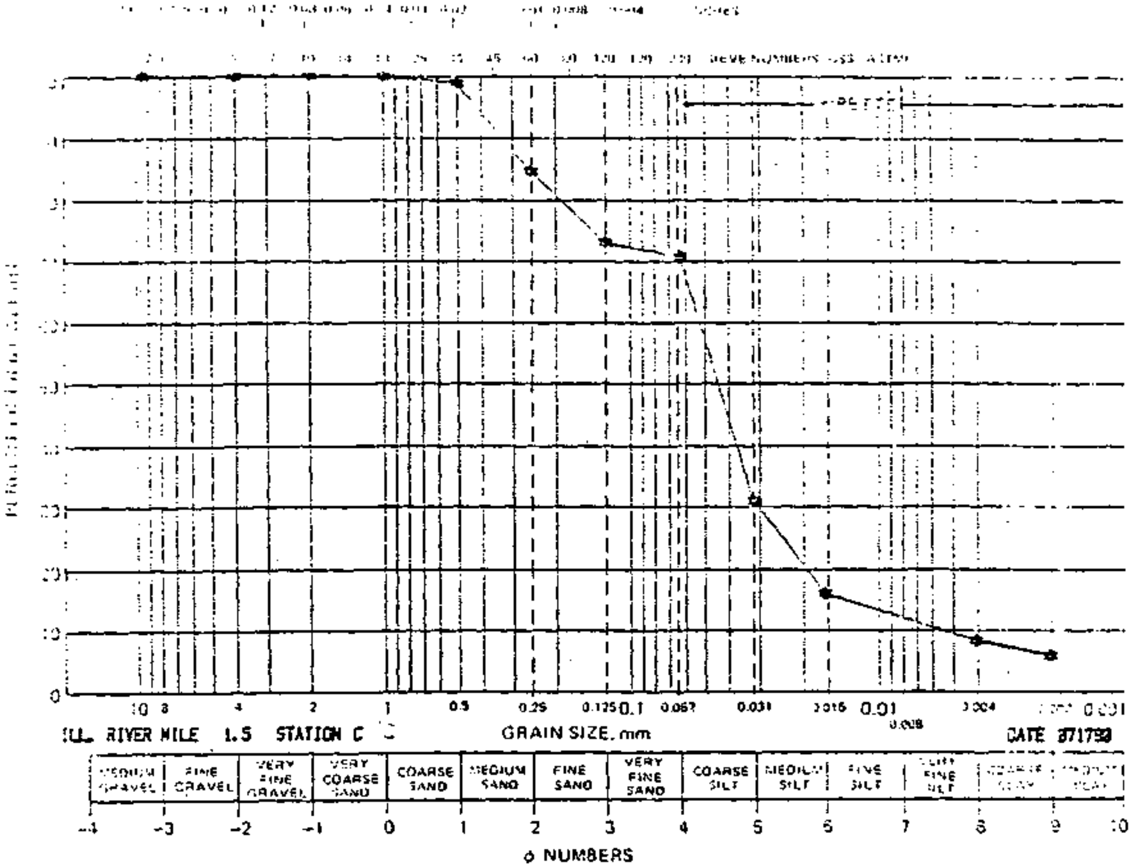


ILLIMOIS STATE WATER SURVEY

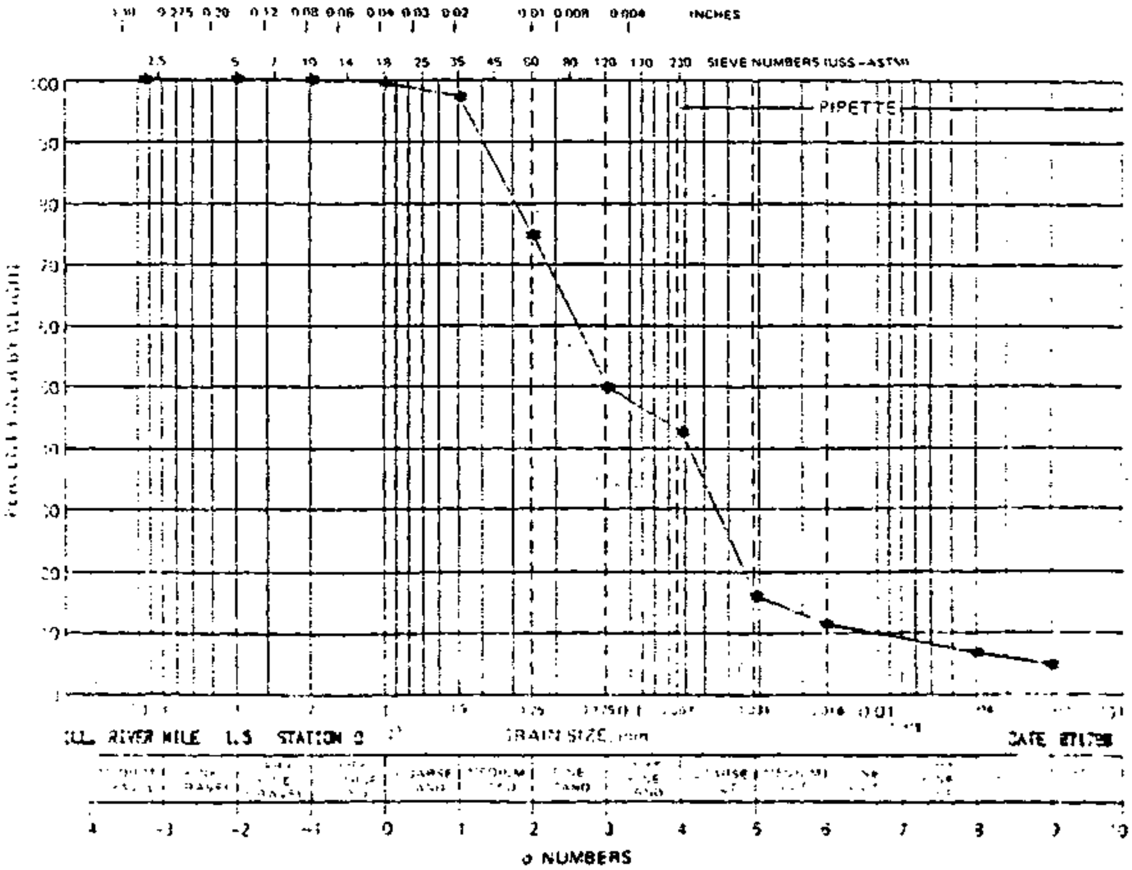
SEDIMENT LABORATORY



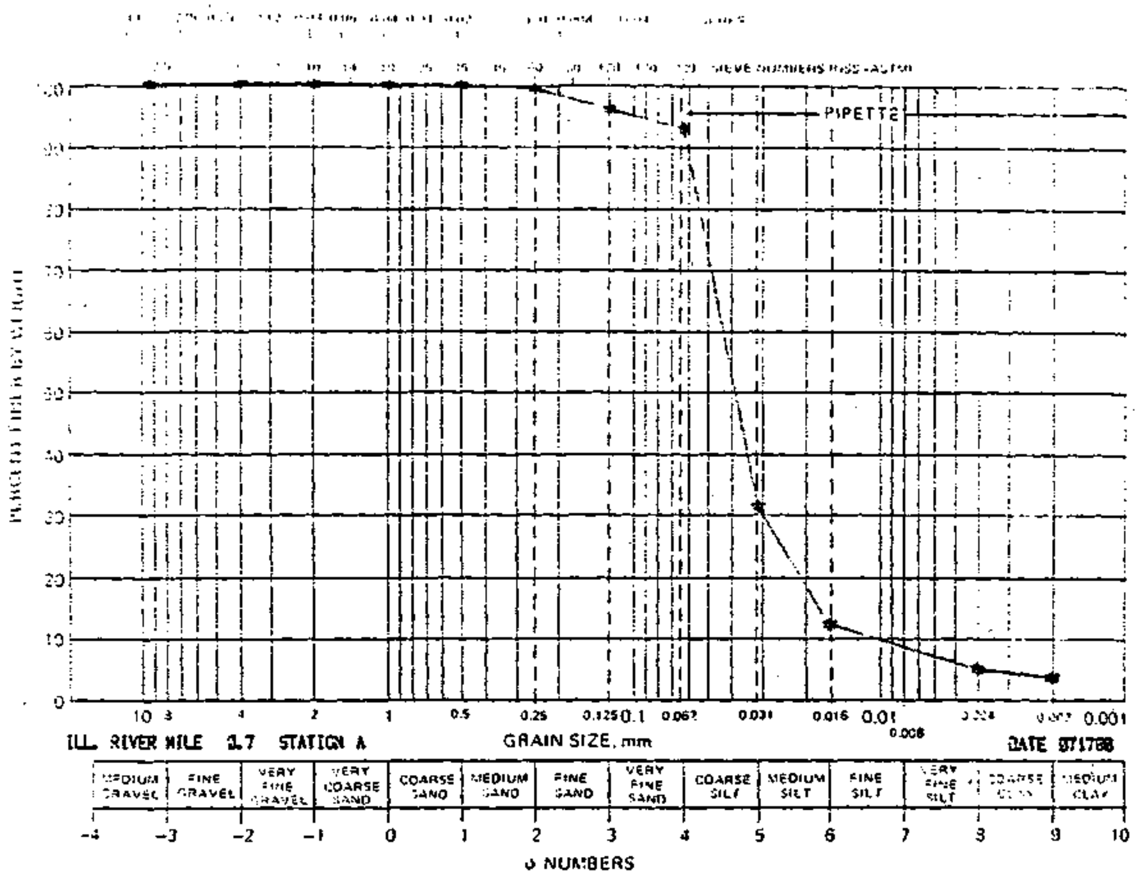
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



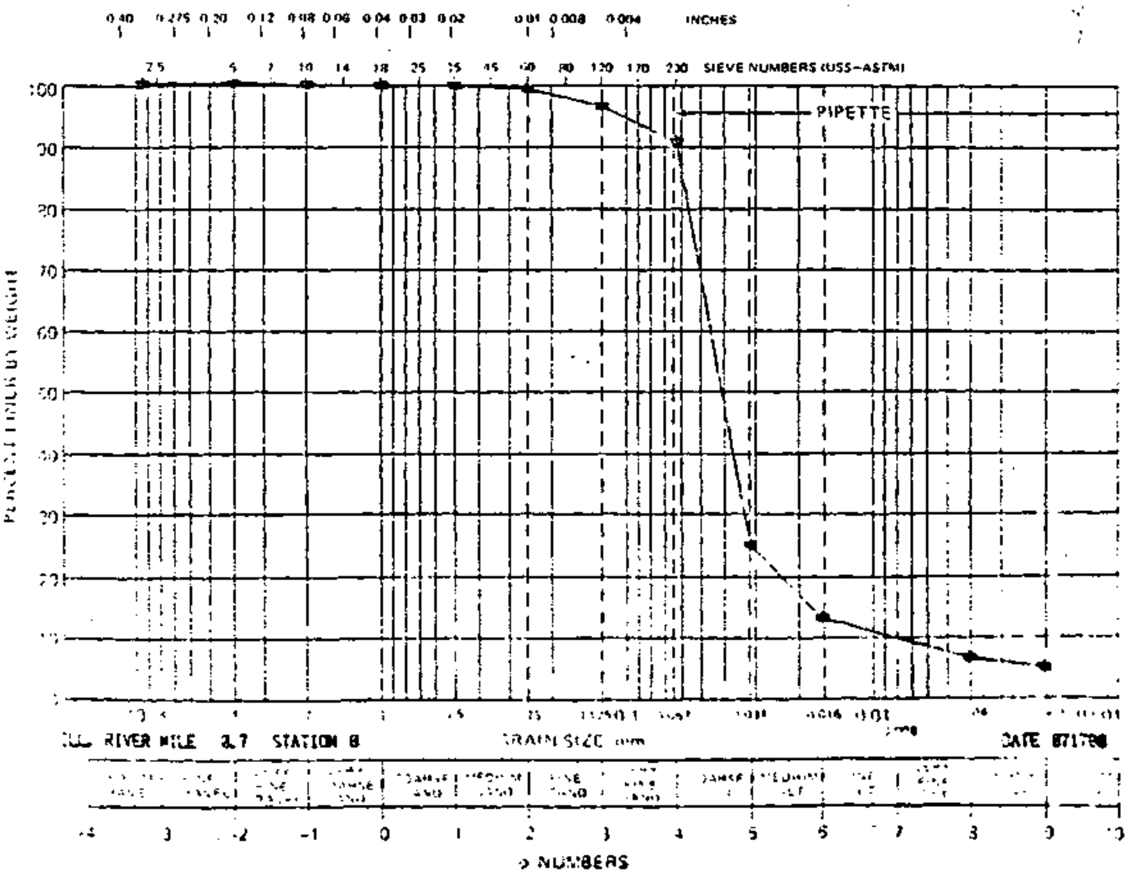
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



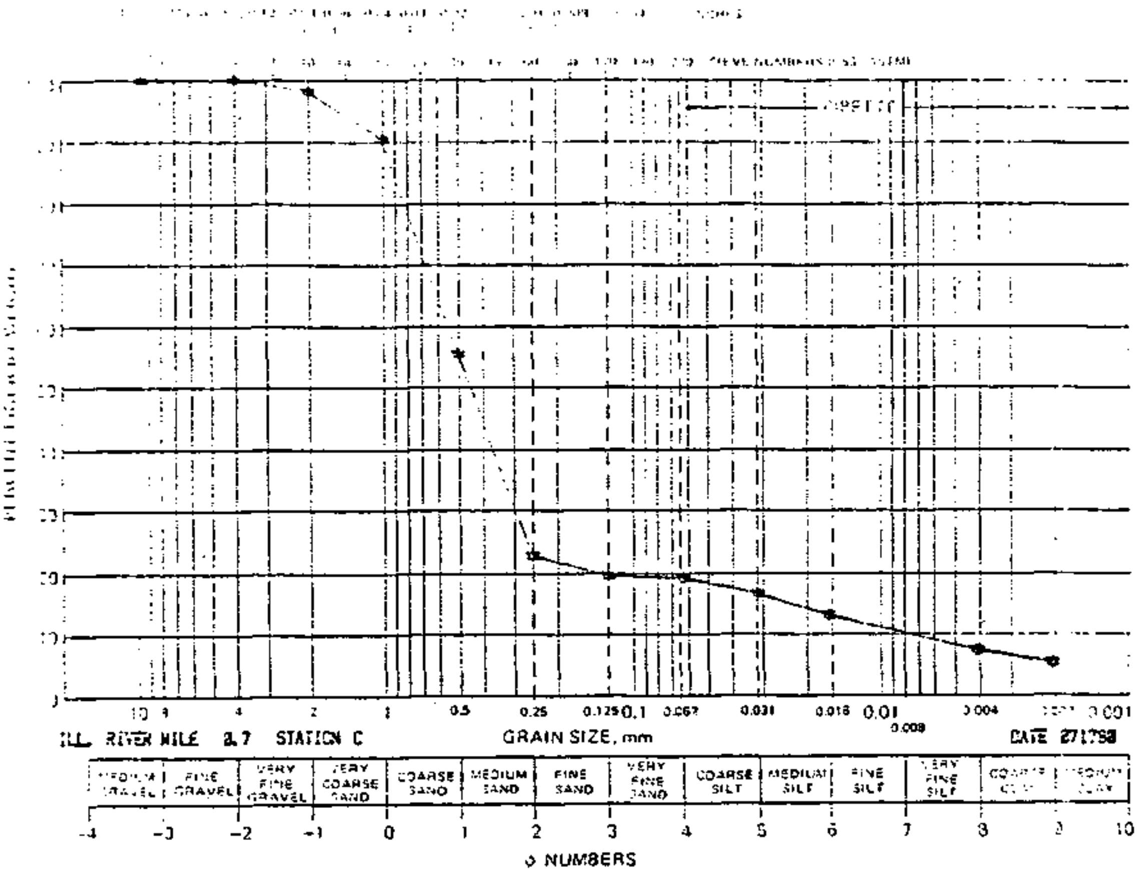
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



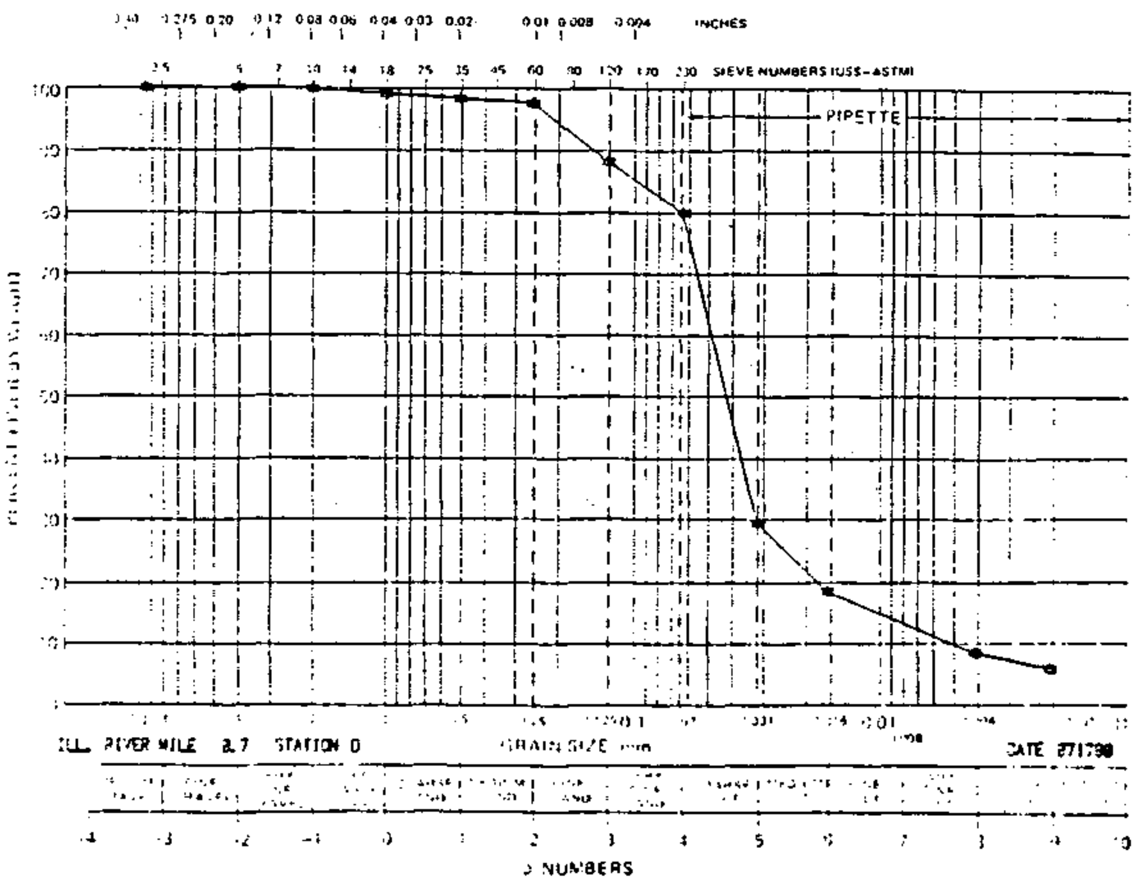
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



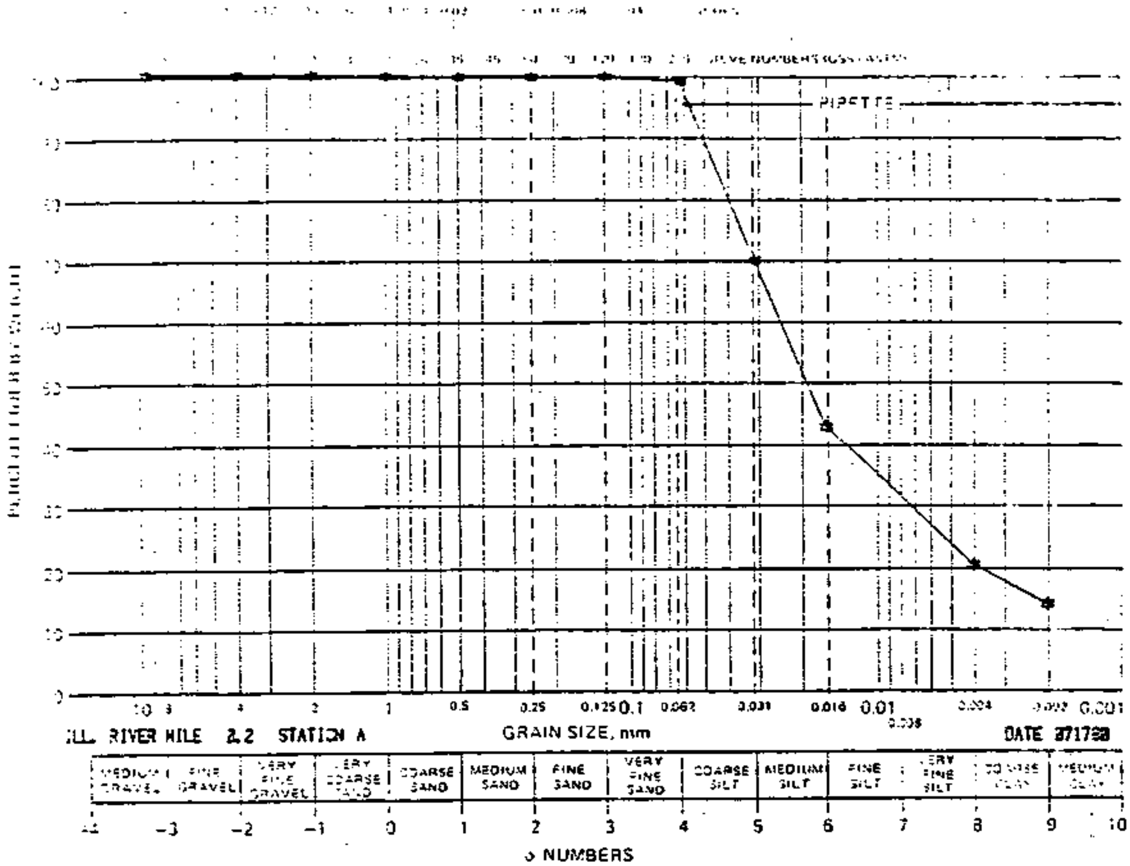
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



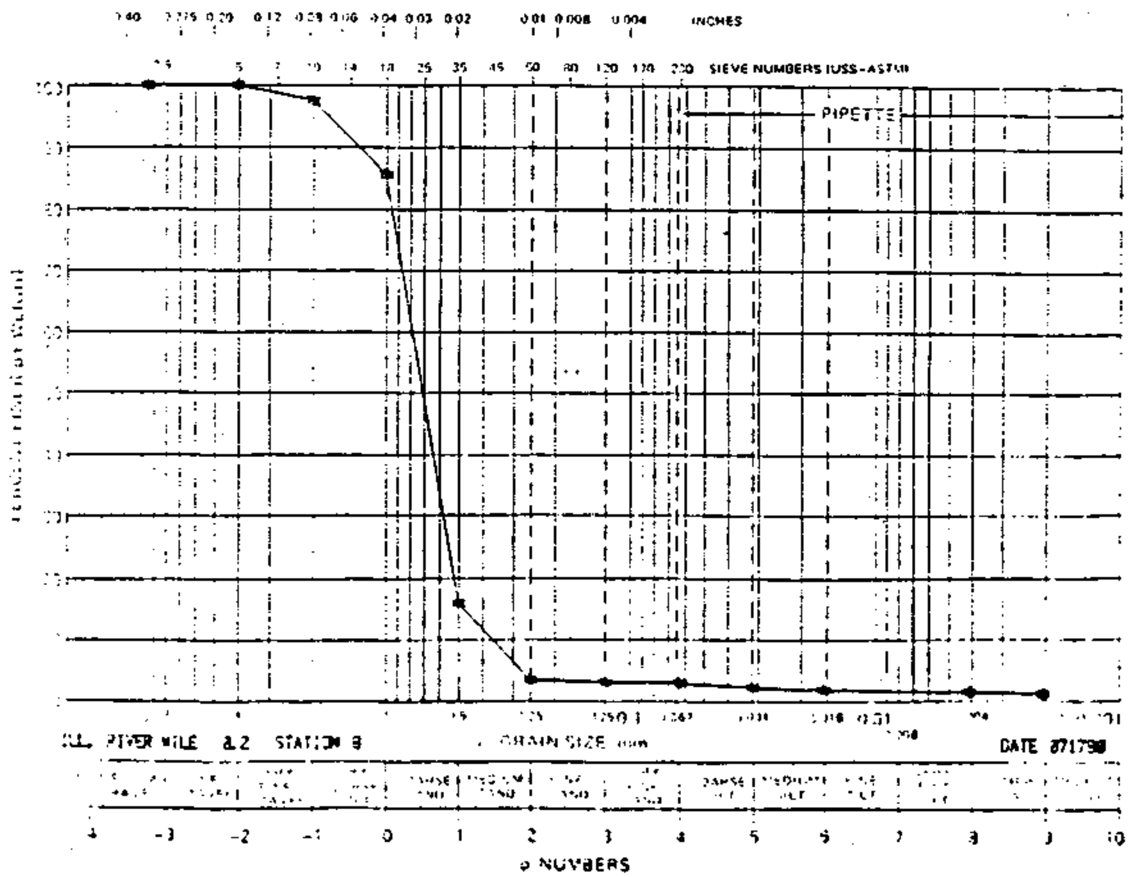
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



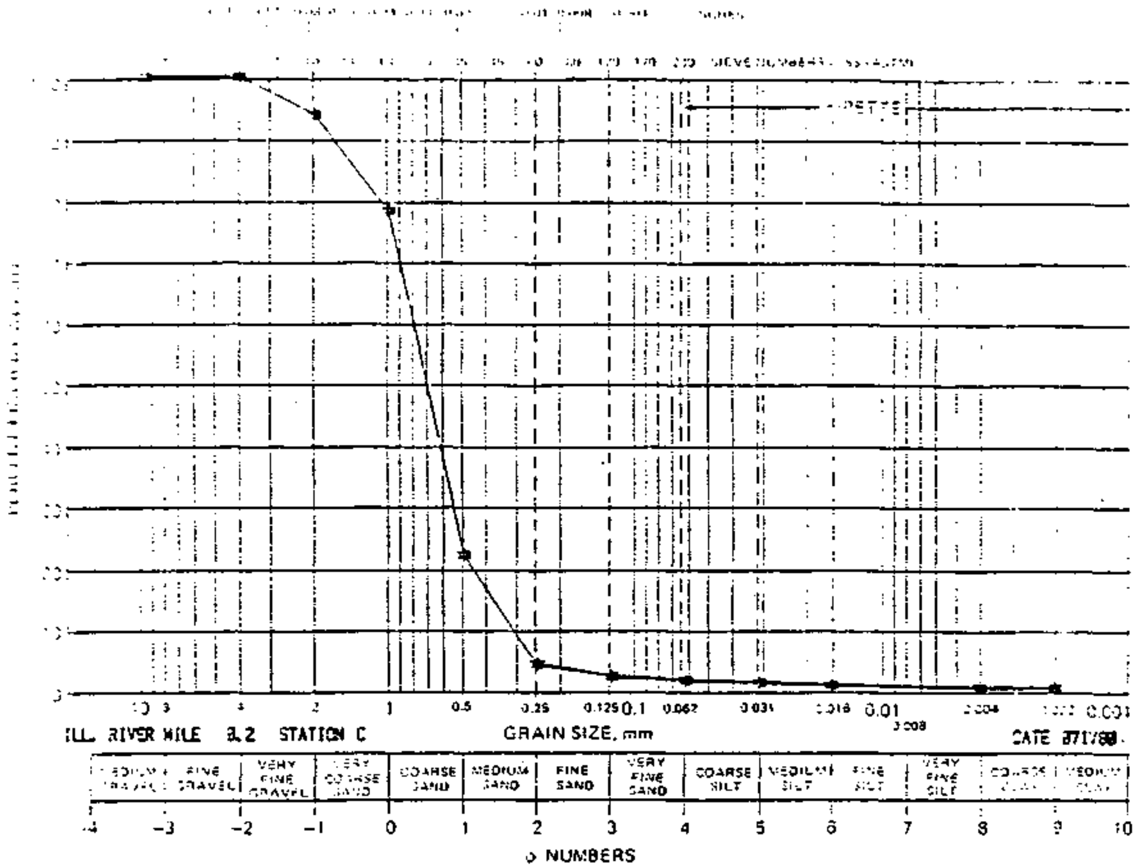
ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY



ILLINOIS STATE WATER SURVEY
SEDIMENT LABORATORY