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Demonstration of The Separation and Disposal of Concentrated Sediments

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DEMONSTRATION OF THE SEPARATION AND DISPOSAL OF CONCENTRATED SEDIMENTS

By

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ABSTRACT

A demonstration was conducted of a system for removing and processing sediments from pond bottoms. The removal system consisted of a MUD CAT dredge, which is specifically designed to dredge without imparting substantial turbidity to the water column. The 500 gpm processing system consisted of, in order of flow, a pair of elevated clarifier bins arranged in series, a bank of hydrocyclones, a cartridge filter unit, and a Uni-Flow bag-type fabric filter consisting of 720 one-inch diameter polypropylene hoses.

The MUD CAT dredge proved efficient in removing the pond sediments and did not produce a substantial amount of resuspension of the sediments. An average final effluent quality of 445 mg/l of suspended solids was achieved by the processing system, with a reported range of from 47 to 1770 mg/l. The most effective components of the system in removing suspended sediment were the clarifier bins and the Uni-Flow filter.

After the field demonstration, further experiments were conducted on larger, five-inch diameter Uni-Flow hoses. Different materials, methods of screening, and lengths were tested in order to optimize the operating parameters of the hoses. It was determined that eight-foot long, polypropylene hoses with wire caging on both the inside and outside of the hose were more suited for further development than the other configurations tested. This hose yielded comparable effluent qualities and throughflow rates and required less hardware than the other hoses.

This report was submitted in fulfillment of Contract Number 68-01-0743 by Hittman Associates, Inc. under the sponsorship of the Environmental Protection Agency. Work was completed as of November 30, 1973.

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ACKNOWLEDGMENTS

The support and technical guidance received from Mr. John J. Mulhern, serving as Project Officer for the Environmental Protection Agency, is greatly appreciated. His guidance, timely suggestions, and technical expertise in the area of filter bag technology were especially helpful.

The field demonstration of the dredging and processing of the dredge spoil was done in cooperation with the Prince George's County, Maryland, Department of Public Works. They allowed unrestricted use of their sediment pond for dredging operations, and the surrounding land for the processing. They also provided access roads and grading at the processing site, constructed the necessary disposal basins, and provided dump trucks for hauling of the separated solids.

SECTION I
CONCLUSIONS

The MUD CAT dredge proved very efficient in removing the deposited sediments from the pond bottom and in preventing the resuspension of the sediments during the dredging operations. Overall, it lived up to its design criteria of being an efficient means of removing sediment from ponds and lakes up to 10.5 feet in depth.

Overall, the portable sediment processing system, consisting of two elevated clarifier bins, hydrocyclones, a cartridge filter unit, and a Uni-Flow bag-type fabric filter, proved efficient in removing suspended sediment from a dredged slurry.

The most efficient components of the system for sediment removal were the elevated bins (initial solids removal phase) and the Uni-Flow filter. They were both very effective in removing suspended solids from the dredged slurry during the field demonstration.

The hydrocyclones were not as efficient in removing suspended solids from the dredged slurry as originally anticipated. Use of a closed underflow header with silt collection pots and automatic solids unloading on the hydrocyclones is probably not justified in a portable sediment processing system. In addition, the use of hydrocyclones for dredged spoil processing should be limited to removing sand-size, i.e., 74 microns, or larger particles.

The usefulness of the cartridge filter unit in the processing system was marginal. Operating and maintenance restrictions would probably preclude the widespread utilization of such units for processing dredged slurry unless the suspended solids concentration of the slurry could first be reduced to near the design level of the units.

Overall, the removal system utilized proved to be a labor-intensive operation.

This program demonstrated that sediment basins can be cleaned without the availability of adjacent sediment deposition sites and that a high quality return water can be produced through use of a portable sediment processing system.

Five-inch diameter polypropylene hoses tested on a prototype test stand performed better than the one-inch hoses utilized on the Uni-Flow filter during the field demonstration.

SECTION II

RECOMMENDATIONS

It is recommended that the MUD CAT dredge or its equivalent be utilized for dredging of unconsolidated sediments from water bodies within its operational capabilities, since it produces a minimum of resuspension of the sediments into the water column.

Systems similar to the portable sediment processing system demonstrated should be considered for areas where dredging is required and adequate space is not available for conventional settling basins. The sizing and selection of the individual components should be done on a site by site basis. The clarifier bins, hydrocyclones, and Uni-Flow filter are all applicable to the processing of dredged sediments but must be sized with the physical characteristics of the dredged sediment and the solids loading rate expected in mind. Utilization of a cartridge-type water filter for processing of dredged slurry is not recommended due to the operational difficulties encountered while using it on influents with high suspended solids contents.

It is recommended that five-inch diameter hoses be utilized in any future Uni-Flow filter applications. It is also recommended that the Uni-Flow filter, in the form of an adapted air bag house, be utilized for processing wastes where the removal of suspended solids is a primary consideration. Further, it is recommended that further tests be performed on the five-inch diamater Uni-Flow hoses for their applicability to the filtering of other types of wastes and pollutants.

SECTION III
INTRODUCTION

In recent years, more and more developments are being built around natural and man-made lakes. These lakes serve as recreational and aesthetic focal points for the surrounding communities. Unfortunately, these lakes often become choked with sediment rather early in their lifetime due to soil erosion resulting from construction activity in the watershed. In order to restore these lakes to their original condition, some type of cleaning operation is necessary. In many cases, however, little premium land is available near the lake to conduct the necessary conventional dredging operations or for the standard settling ponds or diked disposal areas.

In numerous other cases, the disposal of dredged spoil and the return of the effluent to the water body has had severe restrictions placed upon it. The disposal of dredged material from small boat harbors onto the surrounding wetlands is no longer allowed in most cases; the disposal of dredge spoil on floodplains is being severely limited; and the effluents from dredging operations are receiving increased attention as water pollutants. Another problem associated with most conventional dredging operations is the turbidity imparted to the water body by the dredging operations themselves.

Consequently, Hittman Associates, Inc., under contract to the Environmental Protection Agency, conducted a demonstration of the separation and disposal of concentrated sediments from the dredging operations on a small lake. The purpose of the demonstration project was twofold. One, was to demonstrate a technique for relatively small maintenance dredging operations which would have minimal adverse effects on the surrounding water body. The second purpose of the program was to demonstrate a portable sediment processing system which could be set up to process the dredge effluent in a relatively small area, remove the majority of the solids, return clean water to the pond, and then be dismantled and moved after the dredging operation is complete.

The dredge used was a MUD CAT dredge manufactured by National Car Rental Systems, Inc. It is specially designed for use on small lakes, and to impart minimum turbidity to the water while dredging. It can discharge approximately 1500 gallons per minute (gpm) of slurry with a solids concentration of 10 to 30 percent.

The portable sediment processing system consisted of a pair of elevated settling bins, a bank of hydrocyclones, a standard cartridge-type water filter unit, and a bag-type filter known as a Uni-Flow. Basically, the Uni-Flow filter consists of a number of hanging hoses. The dirty water is pumped into the inside of the hoses and is allowed to filter through them. Periodically, the collected sludge is flushed from the inside of the hoses. The design of the Uni-Flow filter was based on experiments performed on a full-scale test stand. The total processing system was tested in a number of different arrangements during the course of dredging operations.

Additional experiments were also performed on the Uni-Flow bag-type filter. These tests were done on full-scale test stand after experiments with the total processing system in the field were complete. The purpose of these additional experiments was to refine the technology of the Uni-Flow filter to a point where additional prototype units could be built for other water and waste filtering applications.

This report constitutes the final report on the entire project. It includes the system design, the results of the field trials of the dredged slurry processing system, and the results of the additional testing of the Uni-Flow filter hoses on the test stand.

SECTION IV

REMOVAL AND PROCESSING SYSTEMS

REMOVAL SYSTEM

The system utilized for removing sediment from the demonstration pond bottom consisted of a 30-foot 2-inch long MUD CAT dredge manufactured by National Car Rental System, Inc., MUD CAT Division. The dredge moves in straight-line directions by winching itself along a taut, fixed cable. Figure 1 is an overall view of the MUD CAT dredge.

Bottom sediment removal equipment on the dredge consists of an eight-foot long, horizontally-opposed, adjustable depth, power-driven auger and a pump which is rated at approximately 1500 gallons per minute with a 10-30 percent

FIGURE 1. MUD CAT Dredge

solids concentration of the slurry. A retractable mud shield over the auger minimizes mixing of the disturbed bottom deposits with the lake water. Figure 2 is a close-up view of the auger on the MUD CAT dredge. The dredge also comes equipped with a rock box into which objects greater than eight inches in diameter (the diameter of the discharge line) are automatically discarded before the dredge spoil is pumped into the discharge line.

PROCESSING SYSTEM UNITS

The development of a portable sediment separation system centered around the use of a hydrocyclone initial stage followed by the Uni-Flow filter. Other alternative or additional devices were also evaluated for possible inclusion in the processing system based on the equipment's degree of portability, cost, expected performance, and the physical characteristics of the dredge spoil.

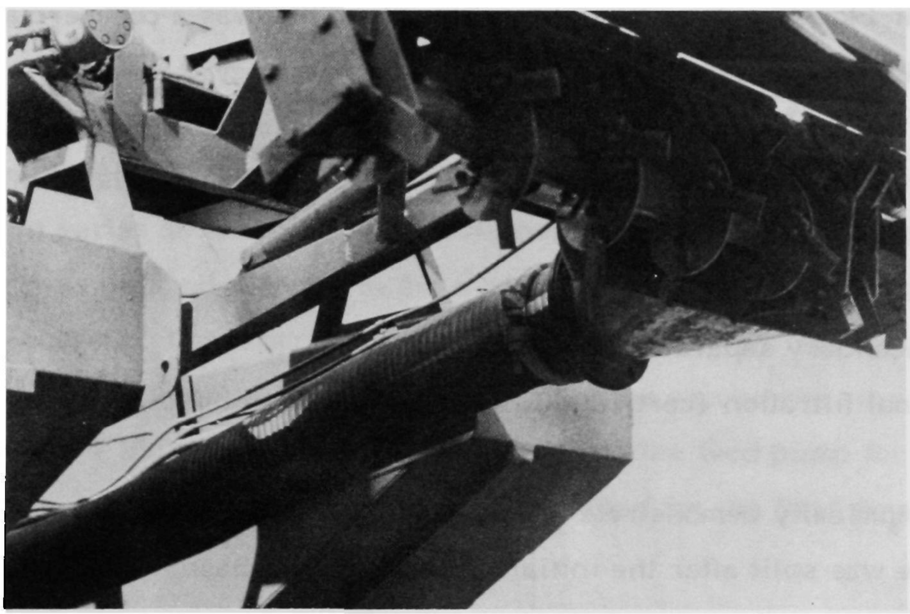

FIGURE 2. Close-up of MUD CAT Auger

Under normal conditions, the discharge from the MUD CAT dredge can be expected to contain between 10 and 30 percent solids by weight. This relatively high concentration of solids is an advantage in that less dredge spoil needs to be processed to remove a given amount of sediment. However, at the expected flow rates, such solids loadings exceed the design capacity of standard hydrocyclone units. In addition, some larger diameter gravel and rock can be expected to be pumped by the MUD CAT. The larger particles would be too large to be processed by the hydrocyclones. Consequently, an initial solids removal phase was deemed to be required in order to remove the larger particles and to generally reduce the overall suspended solids loading of the dredged slurry before processing by the hydrocyclones.

In order to achieve as clean a return water to the pond as possible, a final filtration step was added to the portable sediment processing system. Two different filters were installed and tested as part of this final filtration step. One was the Uni-Flow bag-type filter concept. The other was a commercially available cartridge-type water filter.

Basically, therefore, the portable sediment separation system consisted of three general steps:

1. Initial solids removal
2. Secondary separation (hydrocyclones)
3. Final filtration (cartridge filter unit and/or Uni-Flow filter)

In order to economically demonstrate a fully portable system, the total flow from the dredge was split after the initial solids removal phase. Thus, the fully portable system was designed to process a nominal 500 gpm. The remaining flow of approximately 1000 gpm was sent to a temporary earthen holding/settling basin.

Initial Solids Removal

The alternatives considered for the initial solids removal phase were narrowed down to either provide a type of portable settling tank or utilize one of the various coarse screening techniques available. The first alternative, that is, the settling tank, in the form of elevated bins of the type used for concrete batch plants, was found to be the most attractive alternative. Advantages of the elevated bins over the various screening techniques include:

(1) Settled solids can be loaded directly onto trucks by gravity flow.
(2) The bins are self-cleaning with steep-sloped sides.
(3) The elevated bins provide head for the pump which feeds the secondary separation phase (hydrocyclones).
(4) Ease of incorporation of a flow splitter device which would enable gravity flow to the holding basin.
(5) Elevated bins are not subject to clogging as some screens are.
(6) Elevated bins are less costly and remove a greater portion of the suspended solids at the given flow rate of approximately 1500 gpm.

Two elevated bins, each with an initial capacity of 36 cubic yards were installed in series as the initial solids removal phase. The discharge from the dredge was pumped directly to the first bin where settling of suspended solids occured. The slurry was then allowed to overflow into the second bin, where additional settling occured. From the second bin, the flow was split to either the temporary holding basin or to the feed pump for the hydrocyclones. Figure 3 shows the elevated bins used for the field demonstration.

Each of the elevated bins selected for testing in the portable sediment separation system provided about 144 square feet of surface area for settling. At the expected 1500 gpm flow rate, a theoretical upflow velocity of approximately

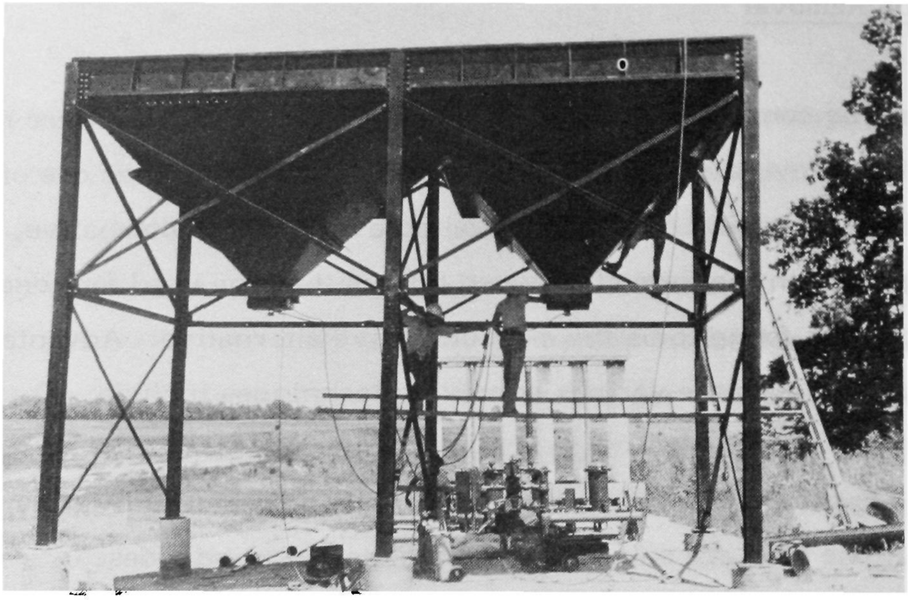

FIGURE 3. Initial Solids Removal Phase: Elevated Bins

0.023 ft/sec is produced. Based on the theoretical settling velocities for va
ious size particles presented in Table 1, all particles down to approximatel
100 microns in size could be expected to be settled-out in the initial solids removal step.

Table 1. THEORETICAL SETTLING VELOCITY OF PARTICLES IN WATER AT 50° F

Diameter of Particles (microns)	Settling Velocity (ft/sec)
1000	0.328
500	0.174
200	0.069
150	0.049
100	0.026
50	0.010

Secondary Separation

A bank of hydrocyclone cones comprised the secondary separation step of this portable sediment handling system. Hydrocyclones are excellent devices for use in portable sediment processing installations. Their advantages over conventional water treatment alternatives in these situations include:

(1) Compact units make them easily portable.

(2) Automatic operation.

(3) No backwash or filter cleaning cycle is required.

(4) Generally maintenance-free since there are no moving parts.

(5) Removal of particles in the desired size range can be simply accomplished through the selection of the proper cone size.

The hydrocyclones utilized for this demonstration project were manufactured by DEMCO Incorporated and consisted of six four-inch, style H cones with abrasion-resistant urethane liners, and equipped with three-gallon silt pots, a closed underflow header, and automatic solids unloading. Figure 4 shows the hydrocyclone unit as installed in the sediment processing system.

Final Filtration

Final filtration of the dredged slurry was required so that a high quality effluent could be returned to the pond. Two separate filtering schemes were utilized for this step:

(1) A commercially available polishing filter

(2) A prototype of the Uni-Flow wet bag-house type filter

The commercially-available filter selected for the field trials was of the cartridge filter type and was manufactured by Crall Products, Inc. and

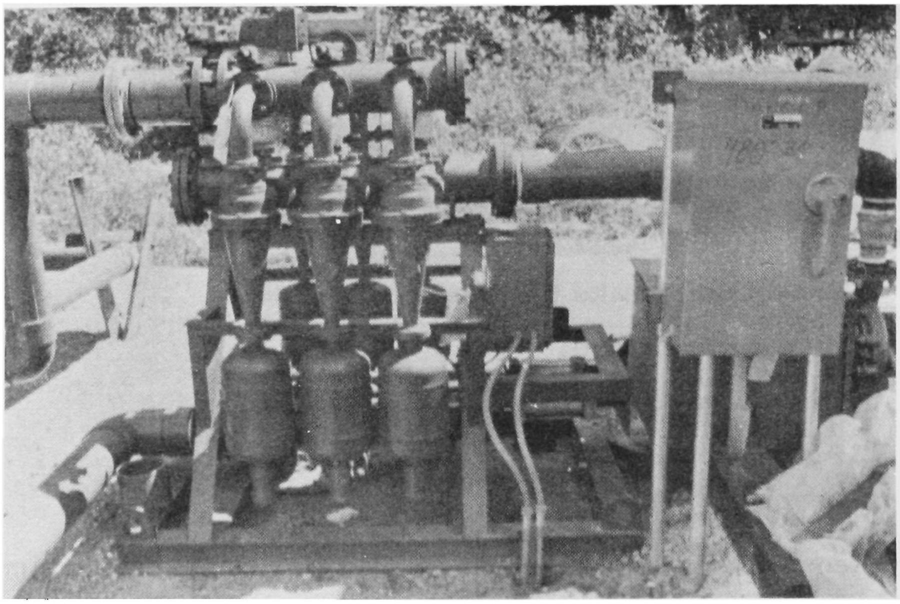

FIGURE 4. Secondary Separation: Hydrocyclones

assembled by DEMCO Incorporated. The unit consisted of four model 16-17-51 filters, each of which contained 51 permanent sand cartridges with filter openings rated at 25 microns. An on-line automatic backflush cycle was installed so that one filter unit could be backflushing while the other three remained on-line. Figure 5 shows this cartridge filter unit. Selection of this type of polishing filter was based on the following:

(1) Its compatibility with the hydrocyclone unit over its entire range of working pressures. Therefore, no booster pumps were required.

(2) Relative ease of maintenance and ability to change filter cartridges.

(3) Range of flow rates available for cartridge elements with various rated openings.

(4) Small size in that only 87.5 square feet were required for a fully automated unit which could handle the expected 500 gpm of flow.

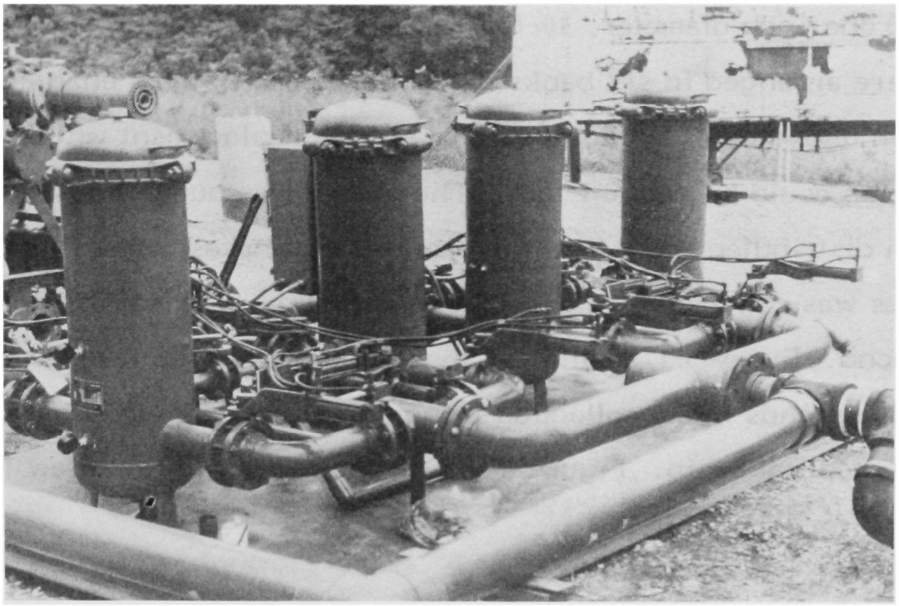

FIGURE 5. Final Filtration: Cartridge Filter Unit

Previous experiments with the Uni-Flow filter indicated that such filters showed promise for use as a final polishing filter for suspended sediment slurries, in that high quality effluent water could be expected. Basically, the Uni-Flow filter is a system of hollow fabric "soaker" hoses that present a more or less solid, impermeable barrier to suspended material. The dredged slurry is pumped into the center of the hoses, the suspending liquid permeates through the hoses and is collected in a filtrate collector and is piped away. The loose sludge within each hose is periodically discharged into a sludge collector and is removed from the filter unit.

Further experiments were conducted under this program in order to arrive at design criteria for a prototype unit which would be capable of processing the expected 500 gpm of flow. Relying on the previous basic data, one-inch diameter, 10 to 20-foot long hoses of both cotton and polypropylene fabrics was tested on a small, three-hose test stand.

The final design criteria arrived at through these tests produced a unit which contained 720 one-inch diameter, 10-foot long, woven polypropylene hoses. The hoses were arranged in six banks of 120 hoses each. This enabled the shutting-down of one bank for hose maintenance or replacement while the other five banks could be kept on-line. The slurry was pumped into a top header which distributed the influent to each bank of hoses. The filtrate from the hoses was collected in a bottom tray and allowed to flow by gravity back to the pond. Every 5 1/2 minutes, the sludge within the hoses was drained for 30 seconds into a collection trough and allowed to flow by gravity into a sludge disposal basin. Figure 6 shows this prototype Uni-Flow filter.

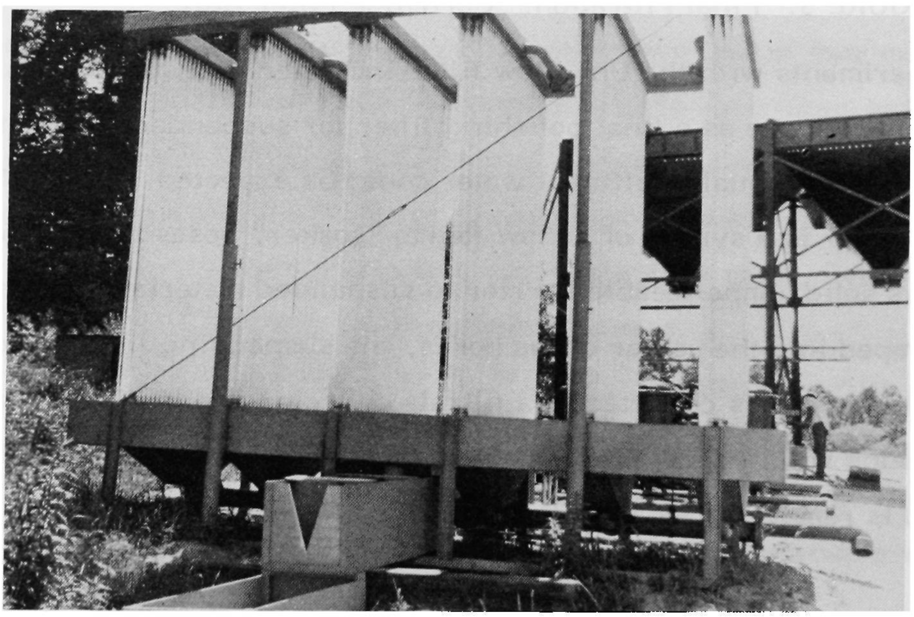

FIGURE 6. Final Filtration: Uni-Flow Filter

OVERALL SYSTEM DESCRIPTION

Figure 7 is a schematic diagram of the overall processing and sludge disposal system. Bypass lines were constructed within the system so that selected components of the system could be bypassed in order to test the operating aspects of the system with the different units on-line. During the field demonstration, a number of different system configurations were tested. These were:

(1) Entire system
(2) Bins, hydrocyclones, and cartridge filter unit
(3) Bins, hydrocyclones, and Uni-Flow filter
(4) Bins to Uni-Flow filter

Samples of the dredged slurry were taken periodically before and after each piece of equipment, and of the backflushes or sludges from each piece of equipment. With this sampling program, many other system configurations could be tested besides the four listed above. For example, samples from the process stream immediately after the elevated bins would define how efficiently a processing system consisting of only the bins would be in removing suspended sediment. Similar analyses could be made at each point in the processing stream.

The portability of the system was evidenced by its ability to be transported entirely on two standard, flat-bed, semitrailer trucks. Auxiliary equipment such as valves, air compressor, miscellaneous piping, etc. all fit on a standard pick-up truck.

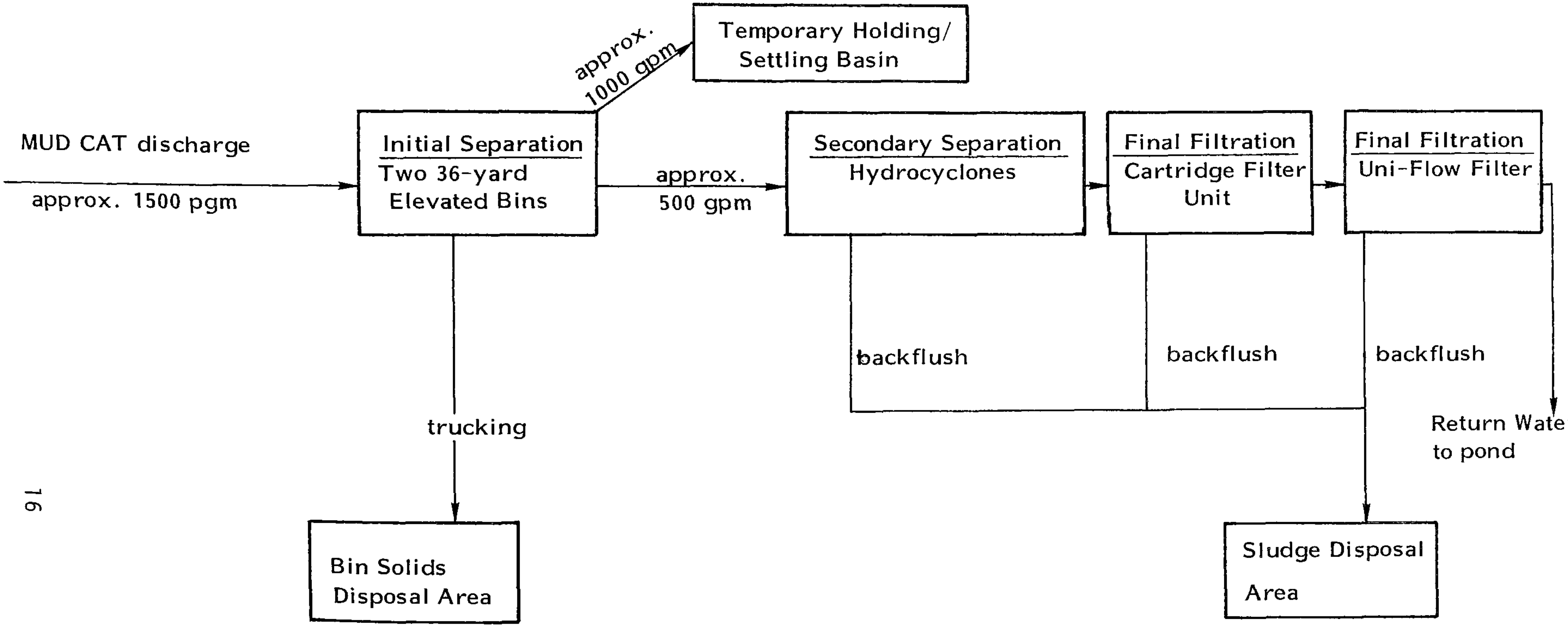

Figure 7. Schematic of Processing and Sludge Disposal System

SECTION V
FIELD DEMONSTRATION

TEST SITE

The site selected for the field demonstration of the removal and processing system was located in Prince George's County, Maryland, at what is known as the Bowie Airpark Site. This site contains a pond which was designed and built as a sediment retention basin to control sediment produced by airpark construction. Table 2 presents the pertinent characteristics of this pond.

Table 2. DEMONSTRATION POND CHARACTERISTICS

Surface Area	1.7 acres
Maximum depth	9.0 feet
Present Condition	99 percent filled with sediment
Age	2 years
Estimated Capacity	14,000 cubic yards

Since the maximum water depth of the pond before dredging began was less than the minimum depth required to float the MUD CAT dredge, that is, approximately 21 inches, it was necessary to raise both the normal and emergency spillway elevations in order to acquire enough freeboard to float the MUD CAT. A small spring fed the pond and helped to provide adequate water for dredging.

The processing system was set-up on a 50-foot high knoll, approximately 600 feet from the edge of the pond. From this site, the overflow (split flow) from the bins and the backwash sludges from the hydrocyclones, cartridge filter unit, and Uni-Flow filter could flow by gravity to, respectively, the temporary holding/settling basin and the sludge disposal basin. Both these basins were formed by earthern dikes. The clean water effluent from the processing system could also return to the pond by gravity flow. After decanting the excess water, the solids from the elevated bins were emptied directly into dump trucks and were trucked to a disposal area in another part of the Bowie Airpark Site.

BASELINE SURVEYS

Approximately two months before dredging and processing operations began, a number of water quality and sediment samples were taken in the demonstration pond in order to establish the natural pond conditions and to aid in the final design of the equipment for the sediment processing system. The pond water was sampled at a number of points throughout the pond. These samples were analyzed for a number of the standard water quality indicators. The results of these analyses are given in Table A-1 in Appendix A.

Six core samples, up to two feet in depth, of the undisturbed pond bottom were acquired. These sediment samples were analyzed for their grain size distribution and specific gravity. These analyses were useful in providing final specifications and design criteria for the hydrocyclone and cartridge filter units in the processing system, even though full-depth core samples of the pond sediments could not be obtained. Table 3 shows the composite grain size distribution of the undistrubed pond sediments. As can be seen from the table, the large majority of the sediment is finer than 100 microns. This affected the design of the equipment for the sediment processing system in the following ways:

Table 3. PHYSICAL CHARACTERISTICS OF COMPOSITE SEDIMENT IN POND BEFORE DREDGING

Grain Diameter (microns)	Percent Finer
250	99
150	95
100	91
40	12
8	7
3	6
1	2

Average Specific Gravity = 2.3

In-Place Moisture Content = 28.8 to 50.3 percent

(1) The automatic dump cycle on the hydrocyclones was shortened to provide the capability to unload accumulated solids at intervals less than 15 minutes apart.

(2) Automatic backflushing of the cartridge filters was similarly specified at less than 10 minute intervals between cycles.

During the initial dredging operations, a number of samples were taken of both the undisturbed pond water and of the MUD CAT discharge. These samples were composited and subjected to a more rigorous water quality analysis. A comparison between the water quality of the pond water and that of the dredged slurry could thus be obtained. This comparison gives an indication of constituents which might be present in the pond sediments but which are not present in significant quantities in the pond water itself. Tables A-2 and A-3 in Appendix A present the complete results of these baseline water quality tests.

RESUSPENSION OF BOTTOM SEDIMENT DURING DREDGING

A sampling and analysis program was initiated to determine the amount of sediment which was resuspended into the pond water as a result of the dredging operations. Samples were taken around the periphery of the dredge at various distances from the dredge and at various depths. These samples were analyzed for their suspended solids concentrations.

Generally, the MUD CAT dredges more efficiently during a backward cut than during a forward cut. This is true from both a solids removal and a resuspension of sediment aspect. During a backward cut, the mud shield is lowered over the auger (see Figure 2), and the bottom sediment is dragged into the auger. This allows a deeper cut along with less sediment being imparted to the water. During a forward cut, the dredge proceeds with the mud shield raised. The auger alone then acts to convey the solids into the pump intake line. This not only imparts a greater amount of turbidity to the surrounding water, but also is a less efficient method of picking-up the bottom sediment.

Consequently, the sampling and analysis program concentrated on determining the resuspension during the worst case, that is, during the forward cut mode of operation. Appendix B contains the detailed data from this sampling and analysis program.

In general, the suspended sediment plume imparted to the surrounding water during dredging is confined to within 20 feet of the dredge. The maximum suspended solids concentration reported within the plume was 1260 mg/l. Also, the major part of this plume is confined to the area directly in front of the dredge. In addition, some turbidity is occasionally imparted to the water behind the dredge. This is not a direct result of the dredging operations, but due to the fact that the fresh water system intake is located at the rear of the dredge. The system is used to flush the main pump bearings and the auger bearings. The fresh water intake will sometimes stir up the bottom sediments if the pond is relatively shallow, thus imparting a small plume of suspended sediment to the water behind the dredge.

PROCESSING SYSTEM EFFICIENCY

Suspended Solids Removal

Slurry from the dredging operations was pumped through the portable processing system described in Section IV for a total of seven weeks. During this time, the system was tested in a number of different configurations, including bypassing of the cartridge filter units, and processing directly from the elevated bins to the Uni-Flow filter.

Appendix C contains the detailed data on the water quality monitoring program for the processing system. Table 4 is a summary of the suspended solids concentrations in the effluents of the components of the processing system when the full system was in operation. Similarly, Table 5 is a summary of the concentrations of suspended solids in the sludges or backflushes of the system components. This table gives an indication of the solids concentration in the sludge which can be expected or achieved from the system during fully automatic operation. Basically, the sludge from the hydrocyclones ranged from 2 to 29 percent solids, with an average of 10 percent; the backflush from the cartridge filters ranged from 2 to 28 percent solids with an average of 8 percent; and the sludge from the Uni-Flow filter ranged from 5 to 19 percent solids, with an average of 11 percent.

Table 6 gives an indication of the average efficiency of the system as a whole, and of the individual components, in removing suspended solids from the dredged slurry. This table indicates that the largest amount of solids are removed by two components, the clarifier bins and the Uni-Flow fabric filter. This data confirms the field observations.

A solids balance for the entire processing system was computed utilizing the average suspended solids concentrations shown in Table 6, a MUD CAT pumping rate of 2000 gallons per minute, which was the average during the field demonstration, the reported average specific gravity of the pond sediments of 2.3, and the average total system flow rate during the field demonstration of 220 gallons per minute. This solids balance was computed in order to give an indication of the amount of solids generated and processed

Table 4. SUMMARY OF SYSTEM COMPONENT EFFLUENT CONCENTRATIONS (mg/l)

Component	Max. Run	Min. Run	Run Aver.
MUD CAT Discharge	261,000	107,000	170,300
Elevated Bins Effluent	254,000	55,800	131,200
Hydrocyclones Effluent	179,600	31,400	88,300
Cartridge Filters Effluent	105,400	22,700	57,200
Uni-Flow Filter Effluent (Return Water to Pond)	1,770	100	445

Table 5. SUMMARY OF SLUDGE (Backflush) CONCENTRATIONS (mg/l)

Component	Max. Run	Min. Run	Run Aver.
Hydrocyclones	293,000	22,000	103,500
Cartridge Filters	284,600	22,000	82,800
Uni-Flow Filter	191,600	51,000	114,300

Table 6. REMOVAL EFFICIENCIES OF SYSTEM UNITS
(All Units On Line)

Component	Aver. Suspended Solids Concentration (mg/l)	Percent of Inflow Solids Remaining	Percent Removed Through System	Percent Removed per Component
MUD CAT Discharge	170,300	100	-	-
Bins Effluent	131,200	77.0	33.0	33.0
Hydrocyclones Effluent	88,300	51.8	48.2	15.2
Cartridge Filters Effluent	57,200	33.6	66.4	18.2
Uni-Flow Effluent (Return Water to Pond)	445	0.3	97.7	31.3

by each component of the system when it is in a fully automatic mode of operation. Figure 8 presents this system solids balance.

The Uni-Flow filter was observed to have a very high efficiency in removing suspended solids from the dredged slurry, even when the cartridge filter unit as an initial final filtration step was bypassed. Consequently, an experiment was conducted during the field trials in which both the hydrocyclones and the cartridge filter units were bypassed, that is, the dredged slurry was pumped directly from the effluent of elevated clarifier bins to the Uni-Flow filter. Table 7 summarizes the results of this run.

The run began with clean bins and clean but used hoses on the Uni-Flow filter. Five of the six banks of hoses were in operation. The system was run at the maximum Uni-Flow pressure (and consequently the maximum flow rate) which it could be operated at without causing excessive bowing of the hoses and their consequent bursting. As can be seen from Table 7, the Uni-Flow filter still had a high efficiency of removal of suspended solids in this configuration. However, due to the high solids concentrations in the influent, the hoses soon became blocked with sediment, and the flow rate through the system decreased rapidly. The automatic backflush cycle of 5 1/2 minutes between flushes with a one-half minute duration flush was not sufficient to prevent the hoses from becoming blocked with accumulated sediment. Consequently, the run had to be terminated after 90 minutes when the hoses became completely blocked with sediment and the system throughflow decreased to near zero.

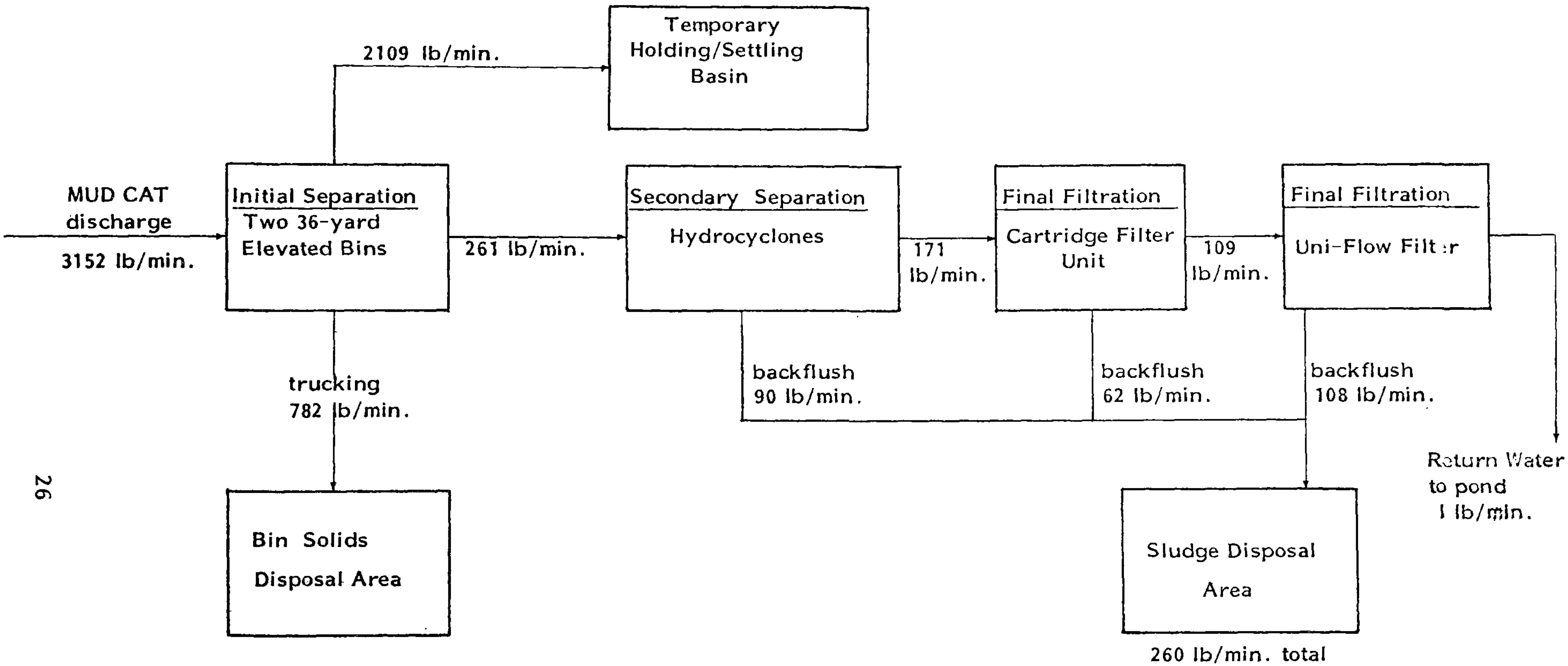

FIGURE 8. Solids Balance for Processing System

Table 7. RESULTS OF BINS TO UNI-FLOW FILTER RUN

<table>
<tr><th rowspan="2">Time (min.)</th><th colspan="3">Suspended Solids Concentration (mg/l)</th><th rowspan="2">System Flow (gpm)</th><th rowspan="2">Uni-Flow Pressure (psi)</th></tr>
<tr><th>MUD CAT Discharge</th><th>Bins Effluent</th><th>Uni-Flow Effluent</th></tr>
<tr><td>15</td><td rowspan="2">158,200</td><td rowspan="2">135,900</td><td rowspan="2">208</td><td>250</td><td>8</td></tr>
<tr><td>30</td><td>120</td><td>10</td></tr>
<tr><td>45</td><td rowspan="2">96,200</td><td rowspan="2">70,100</td><td rowspan="2">127</td><td>70</td><td>12</td></tr>
<tr><td>60</td><td>60</td><td>12</td></tr>
<tr><td>75</td><td rowspan="2">145,900</td><td rowspan="2">84,500</td><td rowspan="2">424</td><td>50</td><td>10</td></tr>
<tr><td>90</td><td>30</td><td>11</td></tr>
</table>

Other Water Quality Parameters

Seven additional water quality constituent parameters were intermittently measured during the testing program. The parameters measured were: orthophosphate ($PO_4^=$), nitrate and nitrite nitrogen ($NO_3^- + NO_2^-$) iron (Fe^{++}), sulfate ($SO_4^=$), hydrogen ion concentration (pH) and turbidity measured in Jackson Turbidity Units (JTU). The phosphate, nitrate, nitrite, iron, and sulfate chemical analyses were performed with a Hach Chemical Company portable water quality laboratory kit. Turbidity and pH measurements were performed with a Hach turbidimeter and a Fisher Accument pH meter respectively. Summary data results for five days of test operations are presented in Appendix C, Table C-2.

Because the parameters measured were, with the exception of turbidity, essentially completely dissolved upon entering the settling bins (sample point # 5), it was generally expected that the physical sediment separation unit processes being evaluated would have little or no effect on their concentration. Speculation was made that interactions between the various ions and suspended sediment particles might result in some ion removal, particularly with the Uni-Flow filter unit.

Inspection of the test data results indicates that no substantial ion removals occurred. The accuracy of the test results are such that the data are inconclusive as to whether minor amounts of ion removal were effected.

SECTION VI

DISCUSSION OF FIELD DEMONSTRATION

REMOVAL SYSTEM

During the field demonstration period, approximately 10,000 cubic yards of material was removed from the pond. Of this total, 3000 cubic yards was pumped into the bins for processing, and the remaining 7000 cubic yards was disposed of in a conventional settling basin. Table 8 shows the destinations of the various quantities of material from the total sediment removed from the pond.

Table 8. DESTINATION OF DREDGED SEDIMENT

Destination	Quantity (cu.yd.)
Settled in Bins	750
Processed Through Remainder of System	250
Total Removed by System	1,000
Bins Overflow to Holding Basin	2,000
Total Pumped to Head End of System	3,000
Pumped to Conventional Settling Basin	7,000
Total Removed from Pond	10,000

The MUD CAT dredge proved very efficient in removing the deposited sediments from the pond bottom and in preventing the resuspension of the sediments during the dredging operations. Minor perturbations to the smooth dredging operation were the result of:

(1) Clogging of the pump or fouling of the auger by large debris and objects such as tree stumps, logs, large rocks, or lengths of barbed wire.

No damage is done to the dredge due to this blockage or fouling, and dredging can be continued as soon as the pump and auger are shut down and the debris is removed.

(2) Bars of sediment which protrude above the water level. Dredging operations are slowed by cuts which must be made above water level. In this case, the auger and intake must be raised and the sediment must be dragged back into the pond by the mud shield. This operation must be repeated until adequate draft (approximately 18 inches) is available for passage of the MUD CAT. Naturally, this operation takes longer than a normal dredging operation, but is well within the capabilities of the MUD CAT.

(3) The need for quite a number of positioning moves of the dredge in order to dress-up the banks of the pond. Since movement of the MUD CAT is limited to a straight line along a taut, fixed cable, this cable must be moved a greater number of times per cubic yard of sediment dredged when short cuts are being made in order to dress-up the pond banks.

Overall, the MUD CAT dredge lived up to its design criteria of being an efficient means of removing sediment from ponds and lakes up to 10.5 feet in depth. It or an equivalent dredge's application to such lake cleaning operations is thus recommended. Some additional advantages of the MUD CAT in this connection include:

(1) The dredged slurry can be pumped to a remote site for disposal, thus eliminating the near shore mess that is usually associated with conventional dragline operations. The engine and pump on the MUD CAT permit the slurry to be moved up to 3000 feet from the lake without the use of a booster pump.

(2) Since the MUD CAT was not built for dredging through undisturbed ground, there is probably little danger of inadvertently puncturing the natural pond or lake bottom and causing leakage.

(3) The MUD CAT can usually be unloaded directly into the lake or pond from a standard-size, tilt-bed trailer.

PROCESSING SYSTEM

Overall, the processing system proved effective in removing the large majority of suspended sediment from the dredged slurry. The average return water quality to the pond contained 445 mg/l of suspended solids. Each component's individual contribution to the efficiency of the total system varied, however. The operational aspects of each component are discussed in the succeeding paragraphs.

Elevated Bins

The elevated clarifier bins performed very efficiently as an initial solids removal phase in the sediment processing system. Their actual efficiency, in fact, was discovered to be better than their expected efficiency as predicted by ideal settling theory. Tables C-3 through C-5 in Appendix C show the grain size distributions of composite samples taken of the sediments in both elevated bins and in the effluent from the bins (influent to the hydrocyclones).

According to ideal settling theory, the elevated bins could be expected to settle out all particles down to approximately 100 microns in size. The data in Tables C-3 and C-4 indicate that a substantial portion of the material below 75 microns in size was also settled out in the bins. In the first bin, approximately 26 percent of the trapped sediment was less than 75 microns in diameter. In the second bin, about 36 percent, on the average, of the trapped particles were below 75 microns in diameter. Table C-5 in Appendix C shows the grain size distribution of the solids in the effluent from the bins (influent to the hydrocyclones). It shows that almost all of the particles over 105 microns in diameter remained in the bins. Thus, as evidenced by these data, the elevated bins performed better than expected in that almost all of the particles down to the expected size (100 microns) were removed as well as an additional fraction of the particles below 100 microns in size.

The factors which produced this deviation from ideal settling theory during the field demonstration included:

(1) The effects of turbulence on the settling of particles produces perturbations from ideal settling theory. Some small fraction of material larger than the size expected to be settled (in this case, 100 microns) can be expected to be lost over the overflow due to turbulence. However, a larger fraction of particles below the critical size are deposited due to turbulence effects.[1] The distribution of particle sizes settled in the bins correspond roughly to those predicted by the theory of turbulence effects on settling.

(2) Some collision and/or agglomeration of small size particles with larger-sized particles may have occurred in the turbulent regions of the elevated clarifier bins. This action would either slow down particles or produce larger particles, both of which conditions would cause settling of the smaller than critical size particles to occur more readily than would normally be expected.

During the field demonstration, cleaning of the elevated bins was necessary after approximately two to three hours of continuous dredging. After this time, the bins were essentially full and no additional settling occurred.

When this happened, the entire solids loading from the dredge flowed through the bins directly to the hydrocyclones. Figure 9 shows the sediment accumulated in the first bin after approximately two hours of continuous dredging.

To empty the bins of sediment, the dredging operation was shut down and the water was decanted from the bins. This operation was usually scheduled for either directly before the midday break or before final shut down at the end of the day. The sediment was then allowed to dry during the break, and emptying of the bins through the bottom doors began immediately after lunch or the first thing the next morning. At this time, the sediment was never fluid enough to drop unaided into the dump trucks underneath the bins. Therefore, standard hand-held concrete vibrators were utilized to help fluidize and drain the sediment into the trucks. Normally, cleaning of both bins by this process, once the water was decanted, took two men about one hour. This assumes that an adequate number of trucks were available for continuous loading.

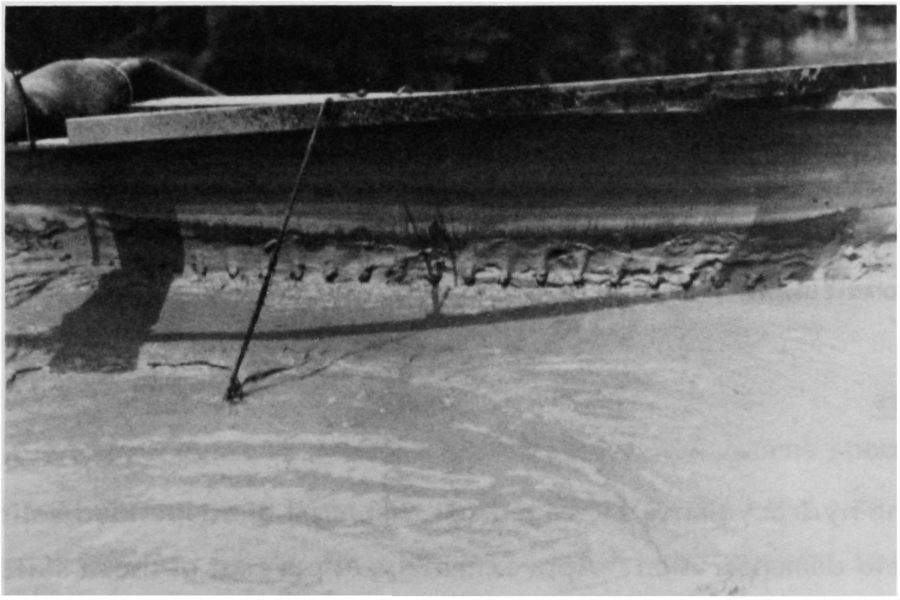

FIGURE 9. Sediment Accumulated in First Bin After Two Hours of Dredging

Two other methods for cleaning of the sediment from the bins were experimented with during the course of the field demonstration. One involved draining of the sediment into trucks without first decanting the water. Utilization of this method took less time to empty the bins than it took when the water was decanted first, since the sediment was more fluid. However, more sediment spills were created by this method since the excess sediment-laden water either drained away from under the bins during loading of trucks or was spilled from the trucks during hauling.

Another bins cleaning method tried involved the draining of the accumulated sediment from the bottom of the bins while the processing system was in full operation. This method often created an even greater amount of spilled, sediment-laden water. The accumulated sediment was solid enough to drain directly onto trucks during full system operation. However, precise control needed to be exercised on the dump gates since once the solids were drained, the dredged slurry in the bins began to rapidly drain out the open gate, creating a muddy environment below the bins if much was allowed to drain out.

These two alternate methods of bin cleaning, although faster than the one in which the bins were decanted of water, were judged to be more messy. Consequently. the "cleaner" but slower method of bin cleaning by first decanting the water was the one primarily utilized during the remainder of the field demonstration.

Hydrocyclones

The feed to the hydrocyclones averaged 131,200 mg/l of suspended solids during the field demonstration. Approximately 74 percent of these solids had a particle size less than 75 microns in diameter (Table C-5), that is, the large majority of the solids loading to the hydrocyclones was in the silt and clay range. The solids concentration in the underflow averaged about 10 percent over the course of the entire field demonstration.

Some observations on the efficiency of the hydrocyclones in processing the sediment at the field demonstration site are:

(1) The hydrocyclones were not as efficient in removing suspended solids as anticipated. This was thought to be due to two factors present during the demonstration: the high influent solids loadings and the small particle sizes in the influent. Both of these factors are thought to have reduced the efficiency of removal of the hydrocyclones.

(2) The use of a closed underflow header with silt collection pots and automatic solids unloading is probably not justified in a portable sediment processing system. The higher underflow solids loadings anticipated through use of this configuration did not materialize, probably due to the factors mentioned in (1) above.

A recently completed study on the use of hydrocyclones for the processing of dredged slurry also arrived at conclusions similar to the observations in (1) above. The study concluded that the hydrocyclone is not applicable to dredged spoils with high solids contents and high viscosity at low shear rates. Sand spoils with low organic content were applicable for separation by a hydrocyclone. It was also recommended that the influent have a suspended solids concentration of less than 10,000 mg/l.[2]

The use of hydrocyclones in dredged spoil processing systems should thus be limited to the separation of particles down through the sand size range, that is, 74 microns or greater in size. Within these constraints, hydrocyclones should prove even more efficient in removing suspended solids than was demonstrated during the field trials under this program.

Cartridge Filter Unit

Cartridge filters are generally designed and utilized as polishing filters. In such applications, they are usually used to produce effluent water of drinking water quality from influents which contain at most a few thousand mg/l of suspended solids. Thus, the operating conditions to which the cartridge filter unit was subjected during the field demonstration, when it was subjected to an average influent of 88,300 mg/l, far exceeded its design capacity. As a result, frequent backflushing of the filters was necessary. This was done at six-minute intervals for the majority of the demonstration program. Even at this frequent rate, the cartridge filters frequently blocked-up with sediment prematurely, causing excessive backpressure to build up in the system and the total system flow rate to consequently decrease.

Midway through the field trials, the internals of each filter unit were thoroughly inspected. This inspection revealed a buildup of sediment in the "dead water" areas of each filter unit as well as a number of broken filter cartridges. Of the 204 total cartridges which were in the four subunits, 20, or approximately 10 percent were found to be broken. It was speculated that excessive backpressure during backflushing caused the cartridges to rupture. The broken cartridges were replaced and the cartridge filter unit was placed back in operation.

Broken cartridges were speculated to be the cause of the relatively dirty effluent from the unit. Frequent spot inspections revealed continuing breaking of cartridges while trying to maintain adequate system flows. Therefore, the usefulness of the cartridge filter unit in such a processing system was marginal. Operating and maintenance restrictions would probably preclude the widespread utilization of such units unless the suspended solids concentration in the dredged slurry could be reduced to near the design level of the units. Such a situation might arise if the dredged material consisted of mainly sand-sized and larger particles and these particles were effectively removed before being fed to the cartridge filters by clarifier tanks and/or hydrocyclones. In such a situation, the cartridge filters would be performing the polishing function for which they were designed.

Uni-Flow Filter

The Uni-Flow filter, a fabric hose type filter, proved to be very effective in removing suspended solids from a dredged slurry during the field demonstration. The Uni-Flow delivered a very good effluent: as low as 47 mg/l of suspended solids, with a normal average of a few hundred mg/l unless a hose burst or a puncture developed in a hose and the effluent water quality deteriorated corresponding.

It was observed during the field demonstration that the average effluent quality could have been even better if an inexpensive, easily installed, completely watertight method of fastening the ends of the hoses to the pipe nipples could be found. Minor but numerous leaks were observed to occur around the hose clamp and gasket seals which fastened the hoses to the nipples in the six Uni-Flow filter headers.

After three weeks of operation, the hoses became so blocked with sediment that the installation of a completely new set of hoses became necessary. Previous to this, simple shaking of the hoses by hand after the sediment had dried was tried as a simple maintenance cleaning procedure. Although this method produced acceptable results in that the sediment was loosened from the sides of the hoses and fell into the sludge collection hopper, it proved to be very time consuming. Blockage of a large number of the hoses occurred daily, but daily maintenance cleaning of the hoses in this manner proved too costly and time consuming.

The small diameter hoses appear to have caused bridging of the sediment. Figure C-1 in Appendix C shows the amount of hoses which were found to be completely bridged by sediment when the hoses were changed after three weeks of operation. Out of the 720 total hoses, 484 or 67.2 percent were completely blocked with sediment. No significant pattern of bridging was found to exist.

The average flow through the system over the entire field demonstration of the system was approximately 220 gallons per minute. This is only about one-half of what was originally expected. The two limiting factors for the flow rate were the blockage of the Uni-Flow filter hoses and the build up of backpressure in the cartridge filter unit. Only when completely new hoses were installed on the Uni-Flow filter and the cartridge filter unit was thoroughly flushed with clean water did the flow rate of the system during the processing of dredged slurry approach 500 gallons per minute.

The high efficiency of suspended solids removal of the Uni-Flow filter yet the accompanying quick blockage of its hoses when fed a concentrated slurry was illustrated in Table 7. This table presented the summarized results of the processing of the dredged slurry utilizing only the elevated bins and the Uni-Flow filter. When this test was stopped, essentially all of the hoses were blocked with sediment and would have had to be changed if further utilization of the Uni-Flow was desired.

The promise which the Uni-Flow filter demonstrated during the field trials prompted further investigations into its use as a filter for suspended solids. Additional experiments were performed on a small prototype test stand after the field demonstration was completed. These tests concentrated on larger diameter hoses in order to prevent the blockage problem with the small, one-inch diameter hoses which was experienced during the demonstration of the portable sediment processing system in the field. The results of these larger diameter hose tests are presented in Section VII.

COSTS

Table 9 shows the capital costs of the major components of portable sediment processing system and the various pieces of required auxiliary equipment which were used in the field demonstration. Similarly, Table 10 is a compilation of the operating and maintenance costs incurred during the six-week field demonstration of the system, excluding the costs of trucking the sediment from the elevated bins.

As is seen from Table 10, the operating and maintenance costs of the overall system were $4.23 per cubic yard of sediment removed. This relatively high cost was due to a number of factors, all of which were directly related to the amount of labor required. The factors which required a labor-intensive effort were:

(1) Changing of the Uni-Flow filter hoses
(2) Removal of sediment from the bins
(3) Cleaning and replacing filter cartridges

Since the system demonstrated in the field was a prototype system, it is probable that the operating and maintenance costs could be reduced by approximately 30 percent through the judicious streamlining of the system. Suggestions for streamlining of the system include:

(1) Elimination of the cartridge filter unit

Table 9. CAPITAL COSTS OF THE PORTABLE SEDIMENT PROCESSING SYSTEM

Item		Cost ($)
Elevated Bins: ganged together with common central columns and air operated gates		7,300
Hydrocyclones: assembly including six 4-inch cones with replaceable urethane liners, 3 gal. silt pots, a closed underflow header, and automatic, air-actuated solids unloading		4,987
Cartridge Filter Unit: assembly including four units with 51 cartridges each and automatic, air-actuated backflushing in sequence		7,875
Uni-Flow Filter:		
basic assembly	$10,450	
header valves	55	
sludge dump valve and actuator	319	
cycle timer and box	33	
720 10' polypropylene hoses @30¢/yd	720	
1440 hose clamps & tape gaskets	203	
pressure gages and protectors	63	
Subtotal	$11,843	11,843
Pumps:		
1-500 gpm @ 200 ft. of head	858	
1-500 gpm @ 25 ft. of head	579	
1-gasoline for bin decanting	101	
Subtotal	$ 1,538	1,538
Air compressor: including hoses, regulator, couplings, and filter		637
Miscellaneous Equipment: including connecting and bypass piping, flanges, valves, overflow pipe, railroad ties, sludge culvert, etc.		2,045
TOTAL		$ 36,225

Table 10. SIX-WEEK OPERATING & MAINTENANCE COSTS OF THE PORTABLE SEDIMENT PROCESSING SYSTEM (Excluding Trucking)

Item	Cost ($)
Elevated Bins: rental of concrete vibrators	180
Hydrocyclones:	0
Cartridge Filter Unit: 20 replacement cartridges @ $3.50 ea.	70
Uni-Flow Filter: 730, 10' replacement hoses @ 30¢/yd	730
1460 tape gaskets	8
Labor: 600 man-hours @ $5.35/hr. av.	3,210
Miscellaneous: electricity, gasoline for air compressor, etc.	30
TOTAL	4,228

Cost per cubic yard removed by system = 4228/1000 = $4.23 per cubic yard

Cost per cubic yard removed, excluding labor = 1018/1000 = $1.02 per cubic yard

(2) Utilization of a Uni-Flow filter with larger diameter hoses to eliminate the hose blocking problem

(3) Investigation of applicable available equipment or alteration of equipment to permit automatic solids unloading at an acceptable moisture content from the initial solids removal stage clarifier tanks.

SECTION VII

ADDITIONAL TESTS - LARGE DIAMETER FABRIC FILTER HOSES

BACKGROUND

Fabric filter hoses of greater than one inch in diameter were tested and evaluated on a separate system after the field demonstration of the portable sediment processing system was completed. The project was undertaken for the purpose of determining whether larger diameter fabric filters exhibit performance characteristics superior to those of one-inch diameter fabric filters. The investigation centered on the use of the fabric filters for the clarification of suspended sediment slurries and the concentration of the sediment sludge. In particular, larger diameter filters were investigated for their ability to resist bridging with sediment, the cheif problem with the smaller diameter fabric filters. In addition, the larger diameter filters were tested for:

(1) Filtration rate, expressed as the ratio of gallons per minute of effluent to square feet of filter surface area.

(2) Pressure handling ability (psi)

(3) Tendency of the filter tubes to bow with increased pressures (deflection in inches)

(4) Quality of the effluent (milligrams per liter of suspended solids)

(5) Total effluent flow (gallons per minute)

(6) Filtration cycle time (time between backflushes)

(7) Ease of cleaning during a normal backflush (sludge draining) cycle.

The sediment used in the influent slurry was made from a mixture of sand and the finer silts and clays. These materials were taken from dredged spoil disposal areas and mixed to simulate typical dredged slurries. Appendix D contains the measured particle size distributions of the influent solids for various large diameter hose tests.

Five-inch nominal diameter hoses were selected for testing. This size was selected because it is one of the standard diameter bags which are used in air bag houses for stack gas filtering. The underlying consideration during the large diameter hose test program was to investigate the adaptability of standard air bag technology to the water filtration field, and in particular, to the processing of slurries with high suspended solids concentrations. If larger diameter hoses proved feasible for water filtration, available, off-the-shelf equipment might then be adapted to solve a current problem.

Four different fabrics were initially identified as being potentially applicable to water filtration and were subsequently tested. These were:

(1) Multifilament polypropylene
(2) Nylon
(3) Nylon with a sateen weave
(4) Homopolymer acrylic

The apparatus for testing of the nominal five-inch diameter fabric filter hoses is shown in Figure 10. Basically it consisted of:

(1) Fabric filter hose column test stand.
(2) Elevated bin for influent slurry.
(3) Influent pump.
(4) Effluent bin.
(5) Hose internal pressure gauge.
(6) Effluent flow meter.
(7) Influent sampling valve

Testing was performed in two phases. In the first phase, the four fabric filter materials were subjected to tests of about 1 hour in length, and the results of the tests were compared to determine the fabric material which exhibited the best performance characteristics in terms of the seven handling characteristics described above.

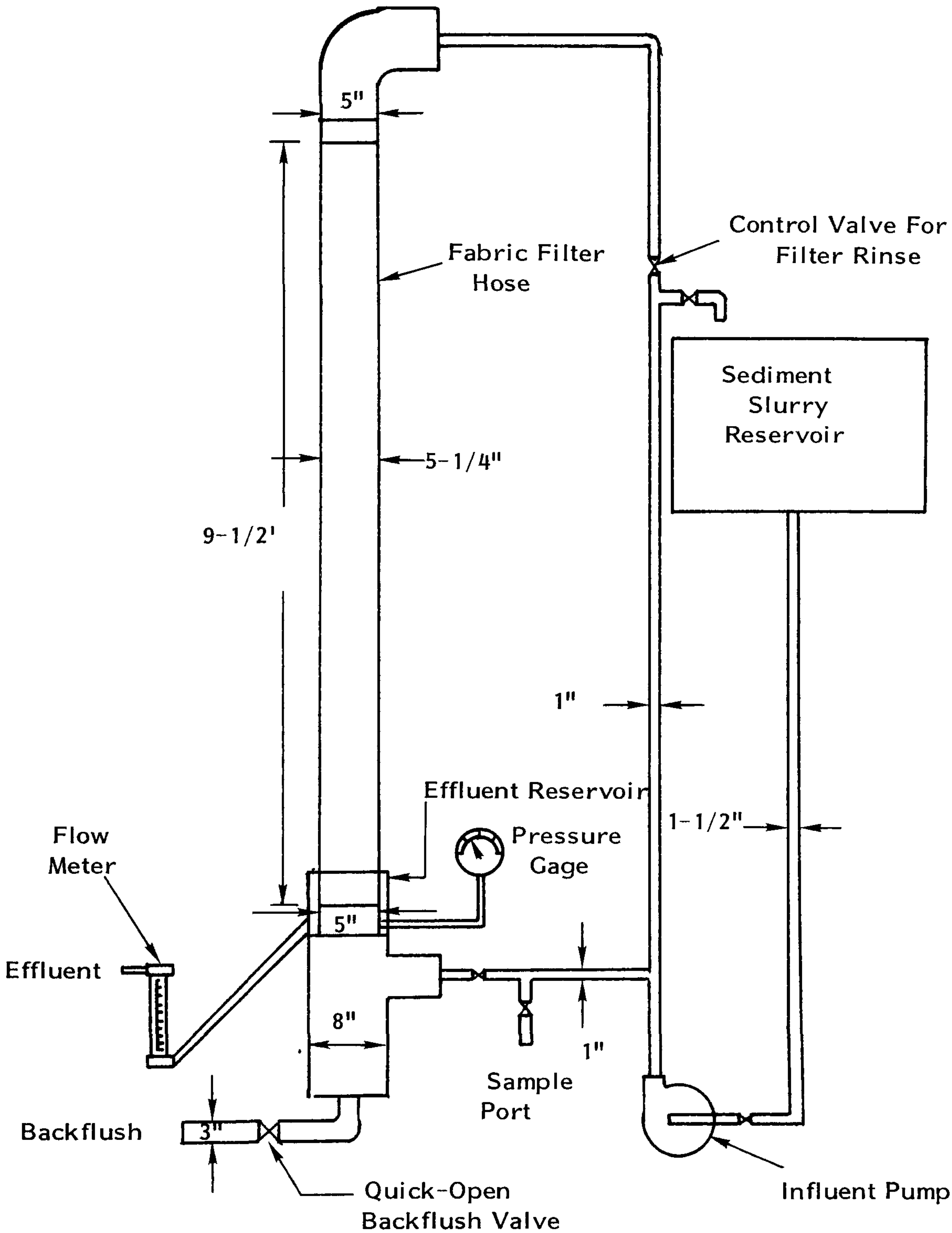

FIGURE 10. Large Diameter Fabric Filter Hose Test Apparatus

During this phase of the testing, three different backflushing, that is, sludge drainage and filter washing methods were also experimented with:

(1) A simple one-time draining of the hose.

(2) A simple one-time draining of the hose followed by an internal washing of the hose by allowing approximately five to six gallons of influent water to wash down the inside of the hose.

(3) Multiple draining and refilling of the hose during the backflush cycle.

In the second phase, the best-performing fabric was subjected to a series of tests in which the operating and physical parameters of the hose were varied to provide more detailed information on the performance of the filter. The parameters that were varied were:

(1) Type of backflushing operations
(2) Presence of wire mesh cylinder inside filter column
(3) Presence of wire mesh cylinder outside filter column
(4) Presence of wire mesh cylinder outside and inside filter column
(5) Length of the fabric filter column
(6) Time duration of the test
(7) Suspended solids concentration of the influent

The wire mesh cylinders were added so that their effects on the performance of the filter as indicated by effluent quality, backflushing time, and filtration rate as well as pressure handling ability could be investigated. The basic function of the wire mesh cylinder was, in the case of the external cage, to impart increased rigidity to the filter column to enable it to withstand higher pressures and thus, hopefully, produce a greater effluent flow with the same quality; and to prevent the fabric filter from collapsing during backflushing, thus helping the sediment deposited on the hose to be washed off, when the wire cage was placed inside the filter hose.

The length of the fabric filter column was shortened from a nominal ten feet to eight feet towards the end of the testing program. Wire mesh cylinders were placed both inside and outside the shortened fabric filter column and remained in place for all tests of the eight foot long filter. The eight-foot filter was always tested with wire mesh on both the inside and outside of the tube.

Three tests of the eight-foot long filters were conducted. The first was a short duration test of approximately one hour, and the second and third together were a long duration test of about five hours.

TEST PROCEDURE

The procedure for testing the nominal five-inch diameter fabric filter hoses is described in the following steps:

(1) An influent slurry was mixed in the sediment reservoir to the approximate desired concentration of suspended solids.

(2) The influent pump was started.

(3) When the influent water reached the top of the fabric filter column, the time was recorded, samples of the influent and effluent were taken simultaneously, and readings of the pressure gauge and flow meter were taken simultaneously and recorded.

(4) The pressure was recorded at two minute intervals for short duration tests and ten minute intervals for the long duration test. Flow readings were taken continuously.

(5) Backflushing was performed when the flow rate fell to below one gallon per minute.

(6) After backflushing, the procedure began at step three (3) again.

After all samples were taken, laboratory analyses were performed to determine the concentrations of suspended solids in the influent and effluent samples, using the procedure in part 224C, Total Suspended Matter, in Standard Methods For the Examination of Water and Wastewater.[3]

TEST RESULTS

First Phase

A summary of the results of the first phase of the five-inch diameter hose testing in which the four different fabrics were tested is given in Table 11. At the conclusion of the first phase tests it was evident that the multifilament polypropylene fabric performed the best, both in terms of the effluent quality and the average flow rate through the hose. All of the first phase tests summarized in Table 11 were performed utilizing the filter wash from the top of the hose during the backflush cycle. The average pressure, and consequently, the average flow rate at which the polypropylene hose was tested was higher than the other three fabrics could be tested at. This was because the polypropylene did not bow out as much under pressure. This bowing of the hose

Table 11. SUMMARY OF FIRST PHASE FIVE-INCH UNI-FLOW HOSE TESTS

Fabric Filter Type	Effluent Quality (mg/l susp. solids)			Influent Quality (mg/l susp. solids)			Aver. Pressure	Aver. Flow	Aver. Filtration Rate
	Max.	Min.	Avg.	Max.	Min.	Avg.	(psi)	(gpm)	(gpm/ft^2)
Polypropylene	740	0	95	19,950	1940	5065	11.2	3.2	0.23
Nylon	1260	205	525	3,555	540	1445	6.7	0.8	0.06
Homopolymer Acrylic	3870	0	400	26,065	1095	5230	10.8	2.6	0.19
Nylon Sateen	3340	17	1500	8,080	4030	5985	9.7	2.8	0.20

was especially evident in the nylon hose, which had to be run at a very low pressure (flow) in order to prevent its breaking away from its seals at the ends of the test column.

Second Phase

After the polypropylene fabric was determined to be the most suitable for the filtration of suspended solids of the fabrics tested, experiments were conducted in order to better define the operating parameters and to try to optimize the performance of five-inch polypropylene hoses. The goal of this second phase of five-inch hose testing was to maximize the flow rate through the hose yet maintain a high overall effluent water quality. An additional consideration was to reduce the operational hardware requirements of any full scale prototype as much as possible.

In order to reduce the hardware requirements, washing of the filter from the top was eliminated during the second phase tests, and a simple draining of the hose during backflushing was substituted instead. This simple draining of the tube did not produce as clean a hose as with a wash from the top, and consequently the average flow rates of the nonrinsed hose were correspondingly lower. Filling and draining the hose a number of times during the backflush cycle was also tried and produced a somewhat cleaner hose, but the amount of backflush water required was more than the hose throughput. The sequence of testing during the second phase involved first the testing of the wire cages on the inside, outside, and both inside and outside of the hose, and the reducing the length of the hose to eight feet. In all tests during the second phase, the hoses were run until their flow dropped below 0.9 gpm, at which time they were backflushed and the tests continued. The reduction in length was designed to see if a somewhat shorter hose would produce the approximate same flow rate as a 10-foot long hose. A shorter hose would require less supporting superstructure in a full-scale filter. The wire cages used were built of galvanized, 16-gage welded wire fencing with openings of 2" x 2 5/8".

Table 12 presents a summary of the results for the entire second phase of testing. In order to compare the performance of the hoses under approximately the same test conditions, the tests in which the concentration of suspended solids in the influent was approximately 10,000 mg/l were analyzed. A summary of these tests is presented in Table 13. As can be seen from this table, the addition of wire cages to the polypropylene hose did not produce a substantial increase in flow at the 10,000 mg/l influent level. However, reducing the length of the hose to eight feet did not substantially reduce the flow rate at this influent concentration. The average effluent quality for all tests summzaized in Table 13 (influent concentrations of approximately 10,000 mg/l) were comparable.

Figures 11 and 12 are plots of the flow and effluent concentrations respectively, on the last long duration test on the eight-foot long hose with cages on both the inside and outside. These figures show the typical flow and effluent quality patterns evident during the test program. As seen on Figure 11, immediately after backflushing the flow increases to some higher point, and then decreases as sediment builds up on the inside of the hose. As the sediment builds up on the inside of the hose the flow rate drops. Backflushing washes the accumulated sediment from the hose and the flow rate again increases. During the test shown in Figure 11, the hose was backflushed when the flow rate fell below approximately 0.9 gpm.

The effluent quality is usually low after a backflush and becomes better as the sediment forms a coating on the inside of the hose. However, as seen from Figure 12, the effluent quality did not follow as regular a pattern as the flow rate curve. This may be due to a number of factors, such as variance in the cleansing action of the backflushes, amount of soil particles trapped within the fabric, soil particle agglomeration, etc.

Table 12. SUMMARY OF RESULTS OF SECOND PHASE POLYPROPYLENE TESTING

	Test Parameters	Average Influent Concen. (mg/l)	Average Effluent Concen. (mg/l)	Average Flow Rate (gpm)	Average Test Pressure (psi)
10' Filter Column	No Cages	7,765	1020	1.4	16.0
	Cage Outside	7,840	605	1.3	18.5
	Cage Inside	25,480	980	1.5	18.5
	Cages Outside & Inside	11,685	1580	1.2	17.5
8' Filter Column	Cages Outside & Inside Test 1	18,200	1220	1.1	19
	Cages Outside & Inside Test 2	8,990	520	1.2	19
	Cages Outside & Inside Test 3	11,640	330	1.2	20

Table 13. SUMMARY OF RESULTS OF SECOND PHASE POLYPROPYLENE TESTING FOR INFLUENT CONCENTRATIONS NEAR 10,000 mg/l

	Test Type	Average Influent Concen. (mg/l)	Average Effluent Concen. (mg/l)	Average Flow Rate (gpm)	Average Test Pressure (psi)
10' Filter Column	No Cages	9995	665	1.5	16.0
	Cage Outside	8310	275	1.2	18.5
	Cage Inside	9330	240	1.8	18.5
	Cages Outside & Inside	9090	1030	1.3	17.5
8' Filter Column	Cages Outside & Inside Test 1	7830	1420	1.2	20.0
	Cages Outside & Inside Test 2	9575	750	1.3	19.0
	Cages Outside & Inside Test 3	9885	160	1.3	20.0

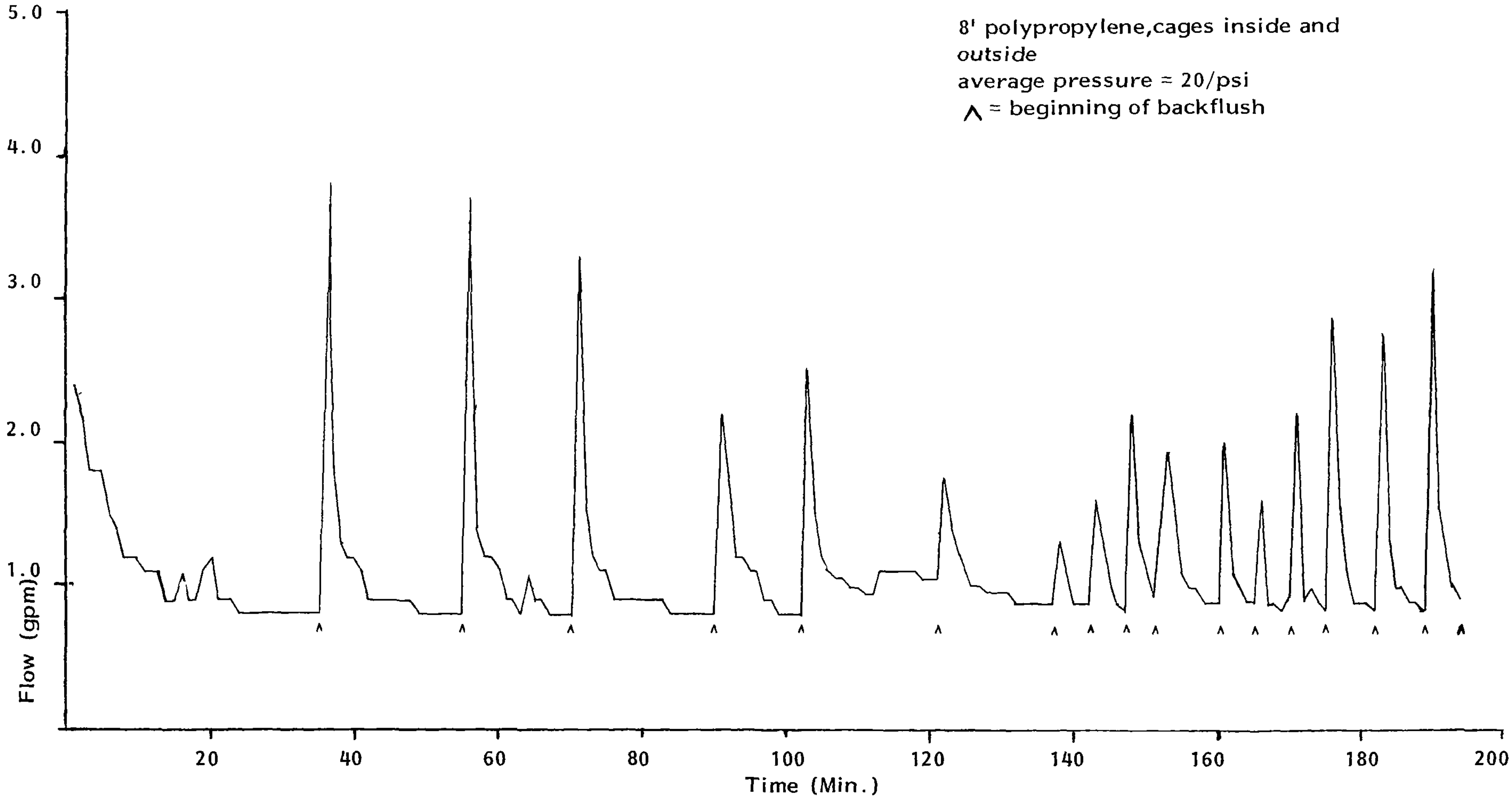

FIGURE 11. Flow vs. Time (Eight-Foot Hose)

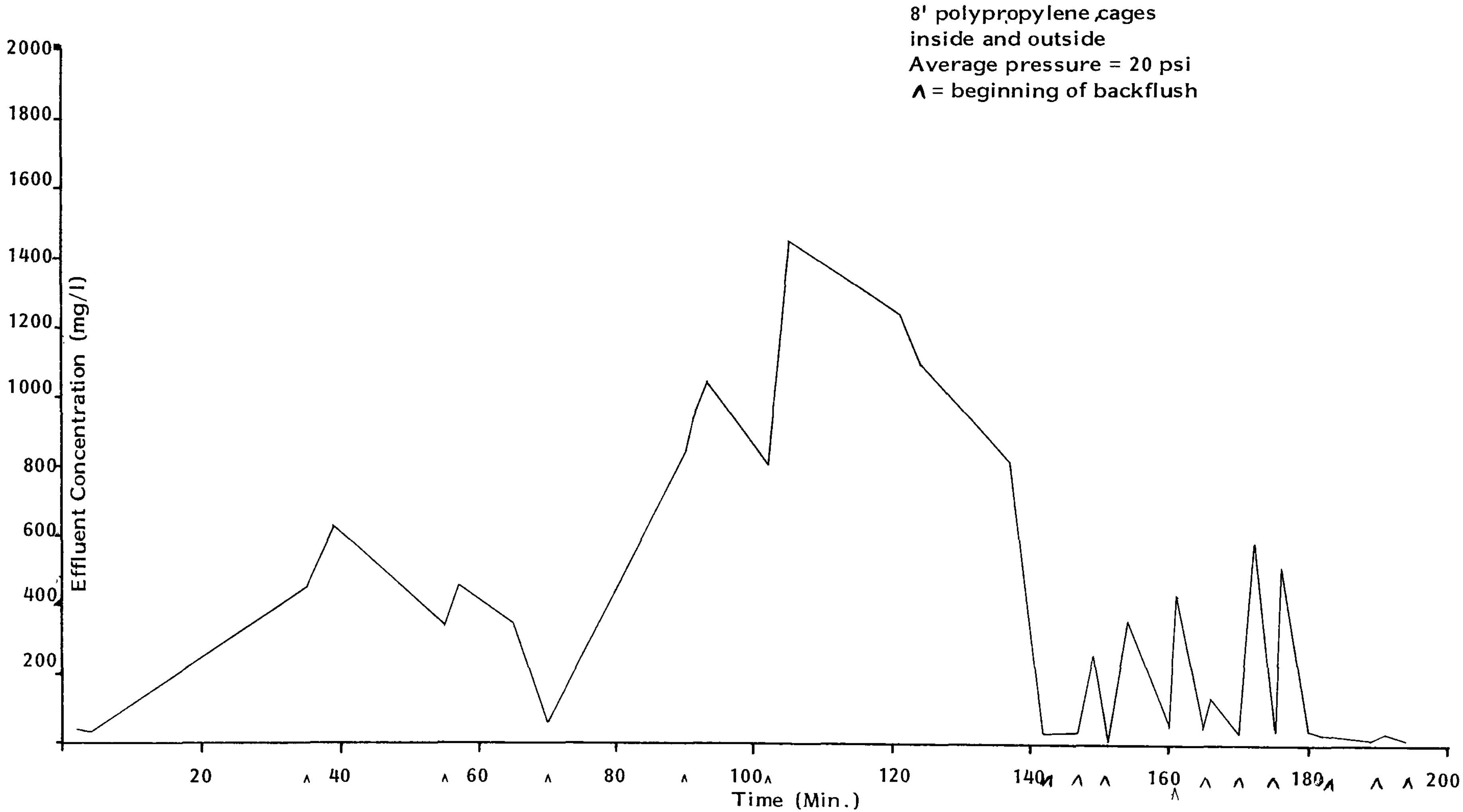

FIGURE 12. Effluent Concentration vs. Time (Eight-Foot Hose)

OBSERVATIONS AND ANALYSES

Blockage by Sediment

The nominal five-inch diameter fabric filters tested all developed a build-up of sediment of less than one-quarter of an inch at the point where the effluent flow had decreased to just less than 0.9 gpm. Consequently, there was no blockage of the fabric filter columns with sediment.

Shedding of Sediment During Backflushing

All fabric filters tested shed most of the built-up sediment during simple-draining backflushing (no rinsing from the top). However, backflushing with rinsing from the top produced a cleaner filter and consequently a greater average flow rate than when rinsing from the top was not used. The installation of a wire cage on the inside of the hose helped the hose to shed sediment during the simple-draining backflush used during the second phase. The cage prevented the collapse of the hose during draining. Collapse of the hose prevented the sediment from sliding off the side of the hose.

Filtration Rate

The filtration rates for the fabric filters tested ranged from 0.07 gpm/ft^2 for the second phase tests to a maximum of 0.44 gpm/ft^2 for the first phase tests. Filtration rates for the large diameter fabric filters are compared to the filtration rates of previously tested one-inch diameter fabric filters in Table 14.

Table 14. PERFORMANCE HISTORY OF UNI-FLOW FABRIC FILTERS

Test	Fabric Type-Influent	Operating Pressure Range psi	Filtration Rate Range gpm/ft^2	Average Operating Pressure psi	Average Filtration Rate gpm/ft^2
Aqua-Ion Corp. 1" dia. testing model (EPA Contract No. 68-01-0043)	Cotton-Acid Mine Drainage Waste	12-20	0.13	12-20	0.13
Hittman Assoc. 1" dia. testing model	Cotton-Sediment Slurry	5-33	0.05-0.13	11	0.06
Hittman Assoc. 1" dia. full scale prototype field tests	Polypropylene-Sediment Slurry	5-12	0.06-0.19	10	0.13
Hittman Assoc. 5 1/4" dia. testing model	Polypropylene-Sediment Slurry	10-23	0.07-0.44	12	0.24* 0.11** 0.13***

* 10' long, rinsed from top

** 10' long, not rinsed from top (simple draining)

*** 8' long, not rinsed from top

The ten foot long polypropylene filters which were rinsed from the top during backflushing had the highest average filtration rates. The filters which were not rinsed during backflushing exhibited filtration rates of about one-third to one-half the filtration rates of the filters which were rinsed during backflushing. Filters tested in the first and second phases are ranked in order of decreasing filtration rates in Table 15.

Operating Pressure

The 10-foot long polypropylene fabric filter columns were tested at a maximum pressure of 15 psi. The 10-foot polypropylene fabric filters which incorporated wire mesh columns on the inside and outside were tested at an average pressure of 18.5 psi. The eight-foot long fabric filter columns incorporating wire mesh columns both inside and outside the filter column were tested at an average pressure of 20 psi and withstood a maximum operating pressure of 24 psi.

With increased pressure, the fabric filter columns bow outwards such that deflection from the centerline of the filter columns increased with increased pressures. Deflections of up to 12 inches were measured in the polypropylene fabric hoses at high pressure, and similar deflections were measured at much lower pressures for the other fabric hoses. Cages on the outside of the hoses prevented this bowing.

Effluent Quality

The effluent quality of the various configurations of polypropylene hoses tested followed comparable cycles during the tests. The quality was usually lowest immediately following a backflush and improved as the hose became coated with sediment. A decrease in the average effluent quality was evident

Table 15. FILTRATION RATE RANKING OF POLYPROPYLENE FABRIC FILTERS

Polypropylene Filter Parameters	Filtration Rate (gpm/ft^2)	Average Effluent Quality (mg/l)	Average Time Between Backflushes (min.)
10' long, no cages, rinsed from top	0.24	95-140	10-16
10' long, cage inside	0.13	240	5
8' long, cages inside and outside	0.13	750	8
10' long, no cages	0.11	665	10
10' long, cages inside and outside	0.10	1030	2
10' long, cage outside	0.09	275	4

when cages were added to the outside of the fabric filter column.

Filtration Cycle Time (Time Between Backflushes)

Filtration time between backflushes was greatest for the tests of ten-foot long polypropylene fabric filters which were rinsed from the top. It should be noted that the times between backflushes reported for these tests are from the time when the influent slurry reached the top of the filter to the time when the effluent flow was two and one-half gallons per minute as opposed to the one gallon per minute criteria for backflushing in the other tests. Therefore, the time between backflushes for the ten foot long polypropylene filters which were rinsed from the top would have actually been much greater than the values reported if backflushing had been initiated when the effluent flow fell to below one gallon per minute.

The filtration times between backflushes for the ten-foot long filters in the second phase of testing were very much lower than the filtration time between backflushes for the ten-foot long polypropylene filters of the first phase. During this second phase, as seen from Table 15, the tests of ten-foot long filters with both no cages and a cage only on the inside produced a higher average filtration time between backflushes than the two configurations of filters with wire mesh outside the column. As discussed previously, wire mesh inside the filter column increases the filtration time between required backflushes.

A comparison can be made between the tests of ten and eight-foot long filters with wire mesh both inside and outside the filter column. The shorter filter exhibited average backflush times of one and one-half times those for the longer filter when considering the results of the entire tests. However, the second test on eight foot long fabric filters was performed on a thoroughly cleaned filter. The average backflush time for the rinsed filter increased by about five times over the backflush time for the previous test of the unrinsed filter, considering results for the entire tests.

A third test on the eight-foot filter was started after the rinsed filter of the second test had operated for two hours. At thirty minutes into the third test, the backflush time had decreased to the range of backflush times found for the first test. Therefore, in two and one-half hours, the performance of the rinsed filter deteriorated to the performance level of one used extensively without rinsing.

The backflushing method was varied at certain times during the long term test of the eight-foot filter so that immediately after the concentrated sediment slurry had been discharged from the filter, influent water was pumped into the filter from the bottom and the quick-open backflush valve was opened when the water level reached the top of the filter column. This procedure is evidenced by the relatively short times between backflushes shown toward the end of Figures 11 and 12.

SECTION VIII

REFERENCES

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APPENDIX A

This Appendix contains the detailed background data on the quality of the pond water before dredging began and basic data on the water quality parameters of the dredged slurry. These data were collected as part of the baseline survey.

Table A-1. POND WATER QUALITY BEFORE DREDGING OPERATIONS

Constituent	Concentration (mg/l unless stated otherwise)				
	Location*				
	1	2	3	4	5
Sulphate	10	-	23	50	28
Phosphate	0.9	-	0.7	1.4	0.2
Iron	0.45	-	0.3	0.7	0.25
Copper	0.35	-	0.3	0.5	0.15
Zinc	0.00	-	0.01	3.25	0.00
NH_3	0.8	-	0.7	1.6	0.4
COD	-	-	3.4	7.6	1.6
Total Nitrogen	12.0	-	9.0	13.0	14.0
Coliform (Presumptive)	-	Positive 5/5	-	-	-
pH	6.0	-	6.75	6.1	6.1
Suspended Solids	-	-	381	745	37
Volatile Solids	531	-	67	68	42
Total Dissolved Solids	-	-	57	21	48
Total Solids	2980	-	505	834	137
Turbidity (JTU)	-	-	130	135	13
Oxidation-Reduction Potential (mv)	50	-	60	75	20

* Location Description:

1 - Pond inflow from watershed
2,3 - Near the inflow end of the pond

4 - Near the discharge end of the pond

5 - Pond discharge

Table A-2. ANALYSIS OF COMPOSITE POND WATER SAMPLE

Constituent	Concentration (ppm unless stated otherwise)
Zinc, as Zn	0.0
Chlorinated Hydrocarbons	0.000
Oil and Grease	24
Total Organic Carbon	12
Mercury, as Hg	0.0
Lead, as Pb	0.0
Oxidation-Reduction Potential	-4 mv
Total Dissolved Solids, @ 105° C.	148
Phenolphthalein Alkalinity, as $CaCO_3$	0
Total Alkalinity, as $CaCO_3$	36
Carbonate Alkalinity, as $CaCO_3$	0
Bicarbonate Alkalinity, as $CaCO_3$	36
Carbonates, as CO_3	0
Bicarbonates, as HCO_3	43.9
Hydroxides, as OH	0
Carbon Dioxide, as CO_2	6
Chloride, as Cl	42
Sulfate, as SO_4	52
Fluoride, as F	0.0
Phosphate, as PO_4	0.3
pH (Laboratory)	7.1
pHs	8.8
Stability Index	10.5
Saturation Index	-1.7
Total Hardness, as $CaCO_3$	39
Calcium Hardness, as $CaCO_3$	18
Magnesium Hardness, as $CaCO_3$	21
Calcium, as Ca	7.2
Magnesium, as Mg	5.1
Sodium, as Na	9.6
Iron, as Fe	5.6
Manganese, as Mn	0
Copper, as Cu	0.02
Silica, as SiO_2	6
Color, Standard Platinum Cobalt Scale	65
Odor Threshold	0
Turbidity, Jackson Units	20

Table A-3. ANALYSIS OF COMPOSITE DREDGED SLURRY SAMPLE

Constituent	Concentration (ppm unless stated otherwise)
Zinc, as Zn	0.0
Chlorinated Hydrocarbons	0.000
Oil and Grease	7.5
Total Organic Carbon	68
Mercury, as Hg	0.0
Lead, as Pb	0.0
Oxidation - Reduction Potential	+14 mv
Total Dissolved Solids, @ 105° C.	77
Phenolphthalein Alkalinity. as $CaCO_3$	0
Total Alkalinity, as $CaCO_3$	15
Carbonate Alkalinity, as $CaCO_3$	0
Bicarbonate Alkalinity. as $CaCO_3$	15
Carbonates, as CO_3	0
Bicarbonates, as HCO_3	18.3
Hydroxides, as OH	0
Carbon Dioxide, as CO_2	200
Chloride, as Cl	30
Sulfate, as SO_4	39
Fluoride, as F	0.0
Phosphate, as PO_4	0.55
pH (Laboratory)	5.1
pHs	9.3
Stability Index	13.5
Saturation Index	-4.2
Total Hardness, as $CaCO_3$	15
Calcium Hardness, as $CaCO_3$	12
Magnesium Hardness, as $CaCO_3$	3
Calcium, as Ca	4.8
Magnesium, as Mg	0.7
Sodium, as Na	8.1
Iron, as Fe	9
Manganese, as Mn	3.7
Copper, as Cu	0.0
Silica, as SiO_2	11
Color, Standard Platinum Cobalt Scale	80
Odor Threshold	6
Turbidity, Jackson Units	100+

APPENDIX B

Contained herein are the data collected during the investigation of the resuspension of bottom sediments by the MUD CAT dredge during normal dredging operations.

Table B-1. RESUSPENSION OF POND SEDIMENTS DURING DREDGING - 7/5/73

Operating Condition	Distance from Front of Dredge (ft.)	Depth below Surface (ft.)	Suspended Solids Concen. (mg/l)
Before Dredging	5	1	39
	5	3	50
	5	5	64
	5	7 (bottom)	523
Dredging (forward cut)	5	1	88
	5	5	179
	5	7 (bottom)	1260
	10	1	54
	10	5	86
	20	1	39

Table B-2. RESUSPENSION OF POND SEDIMENTS DURING DREDGING 7/6/73

Operating Condition	Distance from Front of Dredge (ft.)	Depth below Surface (ft.)	Suspended Solids Concen. (mg/l)
Before Dredging	5	Depth Integrated Composite - 0 ft. to bottom	89
Dredging (forward cut)	4	1	900
Dredging (forward cut)	10	1	649
	10	5	175
Dredging (forward cut)	20	1	226

Table B-3. RESUSPENSION OF POND SEDIMENTS DURING DREDGING - 7/11/73

Operating Condition	Distance from Dredge (ft.)	Depth below Surface (ft.)	Suspended Solids Concen. (mg/l)
Before Dredging	5 ft. from front	1	18
		4	75
		7 (bottom)	1000
Dredging (forward cut)	5 ft. from front	1	72
		7 (bottom)	1257
Dredging (forward cut)	5 ft. from side	1	89
Dredging (forward cut)	1 ft. behind	1	1262

Table B-4. RESUSPENSION OF POND SEDIMENTS DURING DREDGING - 7/18/73

Operating Condition	Distance From Front of Dredge (ft.)	Depth below Surface	Suspended Solids Concen. (mg/l)
Before Dredging	5	1	34
Dredging (forward cut)	5	1	83
	10	1	19

APPENDIX C

This Appendix contains additional detailed data collected during the water quality sampling and analysis program conducted on the portable sediment processing system, and other operational data on the field demonstration.

Table C-1. SUSPENDED SOLIDS CONCENTRATIONS IN PROCESSING SYSTEM

Date	Suspended Solids at Sampling Point (mg/l) # 5	# 1	# 2	# 3	#4	Average System Flow (gpm)	Remarks
6/25/73	158,000		29,500	*	190	300	3 hr. composite samples; 2 Uni-Flow hoses with holes
				*	1440	300	sample after 1 Uni-Flow hose burst
6/26/73					150	250	2 hr. composite sample
					136	250	" " "
					340	250	" " "
7/2/73	261,000	231,700	149,500	105,400	240	300	4 hr. composite samples
7/11/73				*	47	250	2 hr. composite sample
				*	491	250	" " "
				*	1127	250	" " "
7/12/73	195,200	151,200	108,000	97,200	100	200	3 hr. composite sample
7/13/73		76,400	52,400	*	184	200	2 hr. composite sample; cartridge filters bypassed
	254,000	254,000	179,600	50,400	227	200	2 hr. composite sample; bins completely full of sediment
7/14/73					392	250	2 hr. composite sample; bins completely full of sediment
7/23/73	129,200	61,300	40,400	26,200	230	100	composite sample of run
7/26/73	107,600	87,600	31,400	22,700	570	100	Composite sample of run
7/27/73	107,000	67,400	44,700	26,200	660	300	Composite sample of run
7/30/73	138,000	55,800	49,500	34,700	520	250	Composite sample of run
8/1/73		140,500	103,000	94,400	1770	200	Composite sample of run
8/6/73			+	*		250	15 min. av. flow; Uni-Flow pressure = 8 psi
	158,200	135,900	+	*	208	120	15 min. av. flow; Uni-Flow pressure 10 psi; 1/2 hr. composite samples
			+	*		70	15 min. av. flow; Uni-Flow pressure 12 psi
	96,200	70,100	+	*	127	60	15 min. av. flow; Uni-Flow pressure 12 psi; 1/2 hr. composite samples
			+	*		50	15 min. av. flow; Uni-Flow pressure = 10 psi
	145,900	84,500	+	*	424	30	15 min. av. flow; Uni-Flow pressure = 11 psi; 1/2 hr. composite samples

\+ hydrocyclones bypassed
* cartridge filters bypassed

Sampling Point Key

5 = MUD CAT discharge into elevated bins
1 = Bin effluent Influent to hydrocyclones
2 = Hydrocyclone effluent - Influent to cartridge filters
3 Cartridge filter effluent - Influent to Uni-Flow filter
4 Uni-Flow effluent (return water to pond)

Table C-2. OTHER WATER QUALITY CONSTITUENTS IN PROCESSING SYSTEM

Date	Sampling Point	$PO_4^{=}$	$NO_3^- + NO_2^-$	Fe^{++}	$SO_4^{=}$	Total Dis. Solids	pH	Turbidity (JTU)
		Constituent Concentration (mg/l)						
6/25/73	# 1						5.9	
	# 2						6.0	
	# 3						6.0	
	# 4					16	5.8	153
	# 6						6.0	
	# 7						6.0	
	# 8						6.0	
6/26/73	# 1	1.8	9.0	0.35				
	# 2	1.6	12.0	0.15				
	# 3	1.8	14.0	0.35				
	# 4	1.8	11.0	0.27		120		140
7/2/73	# 1	1.5	13.0	0.15				
	# 2	2.8	12.0	0.10				
	# 3	1.5	11.0	0.05				
	# 6	1.8	14.0	0.10				
	# 8	1.7	15.0	0.10				
7/6/73	# 5	5.2	13.0	0.75				
	# 1	8.0	11.0	1.50				
7/12/73	# 5	2.3	13.0		17.0			
	# 2	0.6	8.0		25.0			
	# 3	0.7	13.0		22.0			

Sampling Point Key:

5 = MUD CAT discharge into bins
1 = Bin effluent - Influent to hydrocyclones
2 = Hydrocyclone effluent - Influent to cartridge filters
3 = Cartridge filter effluent - Influent to Uni-Flow filter
4 = Uni-Flow effluent (return water to pond)
6 = Hydrocyclones sludge
7 = Cartridge filters sludge
8 = Uni-Flow sludge

Table C-3. GRAIN SIZE DISTRIBUTION OF SEDIMENT IN FIRST BIN

Particle Size (microns)	Percent Finer (7/2/73)
4760	99.8
2000	99.7
420	99.1
250	98.0
105	41.9
75	24.4

Moisture Content = 26%

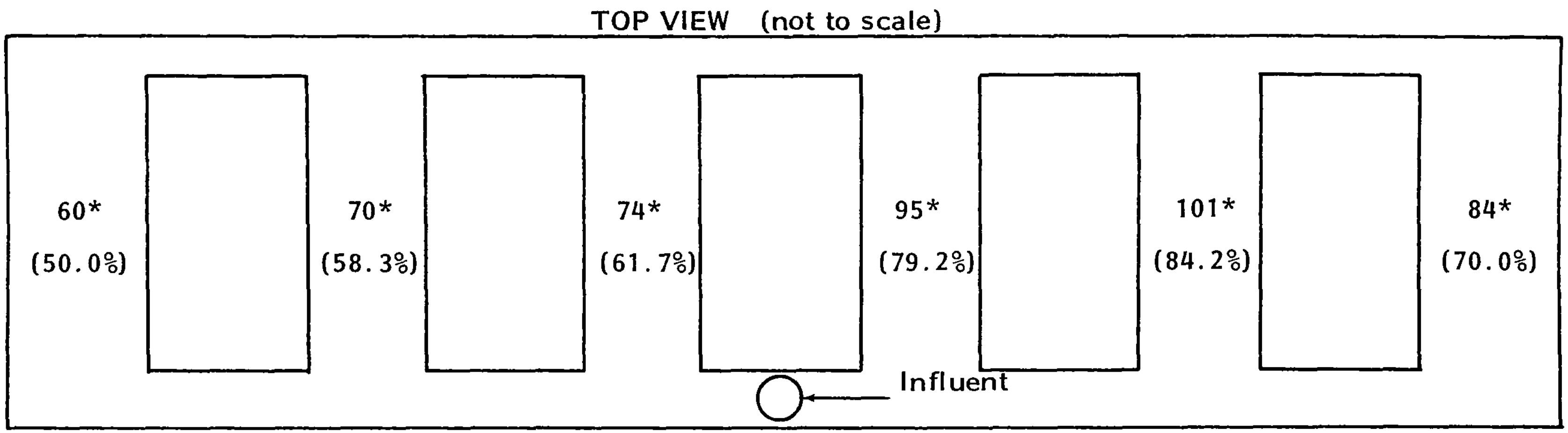
Table C-4. GRAIN SIZE DISTRIBUTION OF SEDIMENT IN SECOND BIN

	Percent Finer		
Particle Size (microns) Date:	7/2/73	7/10/73	7/13/73
4760	100		
2000	99.3		100
420	98.4	100	99.9
250	97.4	99.9	99.8
105	59.9	82.8	85.0
75	27.3	36.5	45.0

Moisture Content = 26%

Table C-5. GRAIN SIZE DISTRIBUTION OF SOLIDS IN EFFLUENT FROM BINS

Particle Size (microns)	Percent Finer (7/13/73)
420	100
250	99.9
105	92.9
75	73.6



Overall percentage of hoses completely blocked = 67.2%

* number of completely blocked hoses out of 120 total hoses in header

( ) = percentage of completely blocked hoses in header

FIGURE C-1. Pattern of Blockage of Uni-Flow Hoses

APPENDIX D

This Appendix contains the particle size distributions of the solids in the influent for the large diameter fabric filter hose tests. Periodic samples of the influent were taken and analyzed in order to ensure that the particle distribution of the soil approximated a dredged slurry that would be obtained from actual dredging operations.

TABLE D-1. INFLUENT GRAIN SIZE DISTRIBUTIONS - LARGE DIAMETER HOSE TESTS

Test Parameters:	10'-No Wire	10'-Wire Outside	10'-Wire Inside	10'-Wire Inside and Outside	8'-Wire Inside and Outside	8'-Wire Inside and Outside	8'-Wire Inside and Outside
Particle Size (microns)	Percent Finer						
420	100	100	67	100	97	99	98
250	99	89	53	96	92	95	88
105	84	66	33	74	63	79	74
75	58	46	18	56	32	67	67
54		31	12	49	23	55	41
39		28	9	48	18	51	
28		25	8	46	16	45	
13		18	5			29	23
10		14	3	22	5	22	16
7		10	2	16	4	15	11
5		7	1	10	2	9	8
4		3		2	1	3	

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7. *Author(s)* Nawrocki, Michael A.	10. Project No. PE 1B2042
9. *Organization* Hittman Associates, Inc. Columbia, Maryland 21045	11. Contract/Grant No. 68-01-0743
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15. *Supplementary Notes*

Environmental Protection Agency report No. EPA-660/2-74-072, June 1974

16. *Abstract*

A demonstration was conducted of a system for removing and processing sediment from impoundment bodies. A MUD CAT dredge was used to remove the sediment from a pond. The dredged slurry was then pumped through a processing system consisting of a pair of elevated clarifier bins in series, a bank of hydrocyclones, a cartridge filter unit, and a Uni-Flow bag-type fabric filter consisting of 720 one-inch diameter hoses.

The MUD CAT proved efficient in removing sediment from the pond bottom without imparting a substantial amount of turbidity to the pond water. The processing system was effective in removing suspended sediment from the dredged slurry. Its effluent averaged 445 mg/l with an average influent suspended solids of 170,300 mg/l.

Experiments were also conducted on the use of five-inch diameter hoses on the Uni-Flow filter. These produced better results than the one-inch hoses in that they were not prone to blockage by sediment.

17a. *Descriptors*

*Dredging, *Sediment Deposition, *Filtering Systems, *Separation techniques, Impoundments, Water Quality Control, Desilting

17b. *Identifiers*

*Suspended solids separation, Pond dredging

17c. *COWRR Field & Group* 05G

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