DREDGING AEROBIC DIGESTED BIOSOLIDS INTO GEOTEXTILE TUBES FOR DEWATERING, NEW ORLEANS EAST MUNICIPAL SEWAGE TREATMENT PLANT, NEW ORLEANS, LA

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ABSTRACT

An innovative and economical method for dewatering digested biosolids, dredged material sediments, and industrial solid wastes, fly ash, coal slurry, has been developed using permeable high strength woven geotextile fabrics sewn to form large Geotextile Tubes for gravity dewatering and consolidation of fine grained solids. This technology has been successfully demonstrated at the Waste Water Treatment Plant and Culkin Water Treatment Plant at Vicksburg, MS dewatering sewage and alum sludge and further demonstrated with paper mill waste at Champion Paper, Decatur, AL, and dairy and hog waste at Clemson University, SC and the University of Georgia, GA. This technology has reduced the amount of pore water in the solids thus reducing weight, hauling cost and tipping fee costs at landfills. This method also reduces the storage capacity volume of proposed landfills and/or incineration cost. This paper describes the dredging methods and use of polymers to improve the sedimentation and consolidation time, cost effectiveness and improved storage capacity of the Geotextile Tubes at the New Orleans East Sewage Treatment Plant for period of about three years. The use of Geotextile Tubes and polymers has been successfully demonstrated to be competitive with other forms of dewatering techniques such as centrifuges, belt and plate presses. The dredging, containment and dewatering process was successful in removing accumulated sediments from thirty two aerobic digester chambers, therefore increasing the treatment plant efficiency.

Keywords: Industrial solids, sewage sludge, dredged material containment, dredge sediments, permeable fabrics

INTRODUCTION

The United States Environmental Protection Agency and the Louisiana Department of Natural Resources have restricted the use of many types of waste lagoons, disposal areas disposal alternatives such as those operated by municipal drinking water and sewage waste water treatment facilities. They have issued orders to restrict the use of these facilities, but have failed to provide economical solutions for future waste disposal of fine grained high moisture content materials. After the 2003 city elections the New Orleans East Municipal Sewage Treatment Plant discontinued the use of geotextile tubes for dewatering digester sludge in 2004 because of administration staff changes and philosophical reasons concerning economics. They are currently belt pressing the sludge from the clarifiers and incinerating these wastes on site. The ash is disposed of at local landfills. They have elected to replace the geotextile dewatering operation with belt presses and the dewatered sludge sediments and accumulated solids from the primary aerobic digesters are also being disposed of at local land fills.

Since the early 1990's, several thousand geotextile bags, tubes and containers have been successfully filled with a variety of fill materials throughout the world. This work was originally pioneered by the author and some of the projects are shown in the references. Dewatering applications for fine soil sediments from dredged material maintenance projects and sludge lagoons are unlimited. Table 1 shows a list of some of these applications where this new and innovative technology has been used.

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Table 1. Dewatering applications for fine grained sediments.

Fine grained dredged material	Fly Ash
Clean material	Coal power plants (Wet and dry)
Contaminated material	Municipal waste (Wet and dry)
Municipal sewage sludge	Paper and Lumber mills
Sewage sludge lagoon	Waste water lagoon
Digester sludge	Water Filtration
Water treatment plants	Potash lagoons
Lime waste	Phosphate lagoons
Aluminum sulfate waste	Radon contaminated
Sheetrock waste	Drilling mud and cuttings
Animal waste lagoons	Oil and gas wells on and offshore
Pork farms	Mine tailings
Dairy farms	Iron ore
Chicken farms	Oil shale
Cattle farms	Copper, Silver and Gold

Purpose

The purpose of this paper was to evaluate the dewatering and consolidation capabilities of large geotextile tubes for aerobically digested biosolids from a municipal sewage sludge plant and the water quality of the effluent passing through the geotextile filter fabric. The primary purpose of this project was to dredge accumulated solids from the primary aerobic digester. The purpose of the paper is also to evaluate the technical and economical feasibility of using geotextile tubes for dewatering aerobically digested biosolids.

Scope

The scope of this report is to present the results of the laboratory and field tests, to evaluate the dredging and filling methods and techniques, and to evaluate the consolidation and dewatering behavior of geotextile tubes filled with aerobically digested biosolids at the New Orleans East Municipal Sewage Treatment Plant.

BACKGROUND AND HISTORY

Sewage collection, treatment, and disposal systems were non-existent as late as 1950. Human waste was disposed of in the open pit privy, while household wastes found their way into open gutters and local streams and rivers. Such unsanitary conditions gave rise to typhoid fever, yellow fever, cholera, and other diseases, which decimated the population at regular intervals.

The unusual New Orleans topography, which made area drainage so serious a problem, also made a similar plan necessary for sewage disposal. The sanitary sewer system of the city is a gravity collection system, consisting of 2334 km (1,450 miles) of lateral and trunk sewers, ranging in size from 20 centimeters to 2 meters (8 inches to 7 feet) in diameter. Lifting and conveying the sewage by trunk sewers and sewer force mains requires 82 electrically operated pumping and lift stations. These transfer the total collected sewage from the entire city to the treatment plants.

Sewage Treatment

Recognizing the need, as well as the national effort being made to reduce the pollution of our country's waterways, the Sewerage and Water Board proceeded with a phased program for the treatment of all municipal sewage, both on the east and west banks of the Mississippi River.

West Bank Sewage Treatment Plant

In 1973, the 10 million gallon-per-day West Bank Sewerage Treatment Plant came on-line. This facility serves the entire west bank community of New Orleans and is currently undergoing an expansion to double its capacity.

East Bank Sewage Treatment Plant

In 1970, the Board began the design for conversion and expansion of its East Bank Plant from 23 million gallons per day to complete treatment of 122 million gallons per day of the city's wastewater. State-of-the-art technology was selected for the treatment process, employing the high-purity oxygen modification of the activated sludge process.

Construction, begun in 1973, was completed in 1980, giving the Sewerage and Water Board the capacity for secondary treatment of 100 percent of the city's sewage. The city needs to double the capacity of this plant.

East Bank Sewage Treatment Plant Description

The East Bank Plant treats the bulk of the city’s domestic, commercial, and some industrial wastewater. The New Orleans East Municipal Sewage Treatment Plant is located in east New Orleans, LA at the end of Florida Avenue adjacent to a city landfill that has been filled and capped. Figure 1 is a vicinity map showing the location of the Sewage Treatment Plant. An aerial view of the sewage treatment plant is shown Figure 2. Pretreatment consists of screening and grit removal. The facility does not have primary clarification. Pretreated wastewater flows (pumped) directly to a pure oxygen aeration basin. Pure oxygen is cryogenically generated on site and delivered to the aeration basin. The aeration basin consists of four trains of eight 15 by 15 meter (50 by 50 ft) chambers that are 6 meters (20 ft) deep. The chambers are oriented two wide and four long. Each chamber is interconnected by 3 meter (10 ft) wide and 4 ft high openings between the chambers. These openings are located at the floor level and about 1.2 m (4 ft) off the floor. Each chamber contains an electric motor turning a gear box that turns a 4.5 m (15 ft) long shaft with agitator blades located on the end of the shaft. The electric motor and gear box are attached to a 2.7 m by 2.7 m by 5 cm (9 ft by 9 ft by 2.0 inch) thick steel plate. Prior to filling the geotextile tubes the agitator pumps, gear box, steel shaft and agitator blades and steel cover plates were removed to allow access to each of the rooms. Figure 3 shows an aerial photograph of the aerobic digester chambers and clarifiers looking east. Figure 4 is a schematic drawing that shows a cross sectional view of four chambers in a train.

The wastewater-biomass slurry gravity flows to final clarifiers. Biosolids agglomerate, settle, and thicken in the final clarifiers. A portion of the thickened solids are returned to the aeration basin. The balance is pumped to aerobic digesters. The clarified wastewater is disinfected prior to discharge. Aerobically digested solids are dewatered by a series of belt presses. The original design incorporated incineration as the final sludge handling step prior to ash disposal.

Biomass Handling Background

The expanded East Bank plant experienced higher than anticipated flows. The high flows, combined with aeration basin mixer issues, caused excessive heavy solids carryover and deposition in the aerobic reactor chambers. The heavy solids deposition decreased system volume, created basin short circuiting and contributed to deteriorating effluent quality.

PRELIMINARY TESTS AND EQUIPMENT

Prior to design and use of geotextile tubes for dewatering the digester sludge a number of samples were obtained from the aerobic digester chambers. Percent solids, moisture content, wet bulk density and Specific Gravity tests were conducted on these samples. Wet bulk density tests indicated that the sewage sludge was consistently near 0.99 to 1.03 grams per milliliter or near the weight of salt water. Specific Gravity tests of the solids indicated values ranging from 1.40 to 1.60 which is typical for organic bio solids. The percent solids being dredged from the digesters ranged from 2 % to 10 % solids but generally were observed to be about 4 % during dredging.

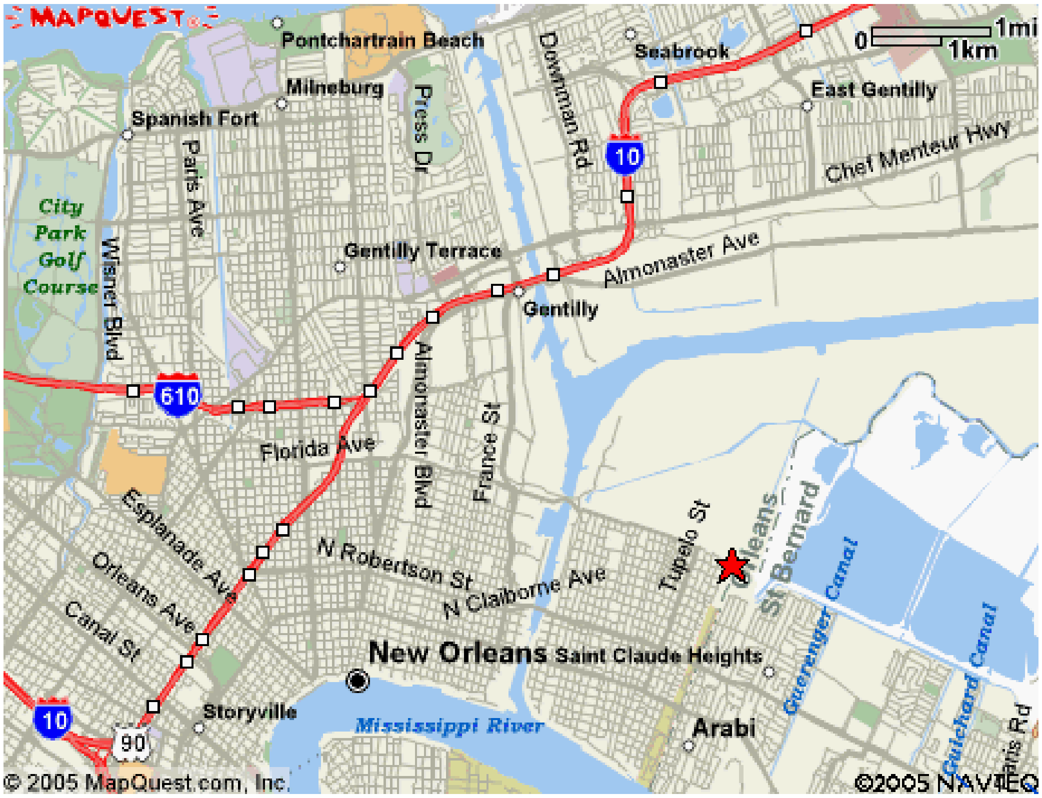

Figure 1. Vicinity map showing the location of the New Orleans East Sewage Treatment Plant

Figure 2. Aerial view of the New Orleans East Sewage Treatment Plant looking north adjacent to a landfill

Figure 3. Aerial photograph of the aeration basins and clarifiers looking east

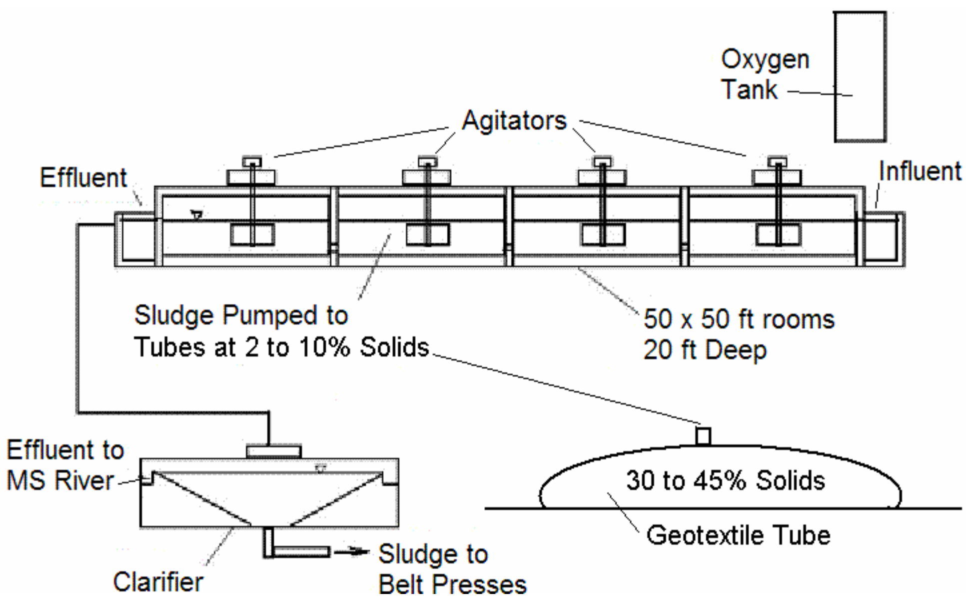

Figure 4. Schematic view of four out of eight aeration chambers, oxygen tank, clarifier and geotextile tube

Hanging Bag Tests

Hanging bag tests were conducted to determine the dewatering capabilities of the fabrics used to construct the geotextile tubes. The hanging bag test procedure developed by the author (ref.) consist of filling a 1.5 m (5 ft) long 1.2 m (4 ft) circumference bag with about 40 gallons of the sewage sludge sediment and measuring the percent solids before and after the water has drained from the bag. The test procedure for saturated dredged material is shown in Figure 1. This method of analysis does not consider air or gas entrainment in the dredged material therefore the required storage is slightly over estimated. Effluent water was normally collected and tested in the laboratory for percent solids and coliforms but the effluent from the large geotextile tubes drained into the clarifiers. Since the effluent was treated in the clarifier the coli-form tests were not conducted. Effluent percent solids from the hanging bag test were consistently below 15 milligrams per liter.

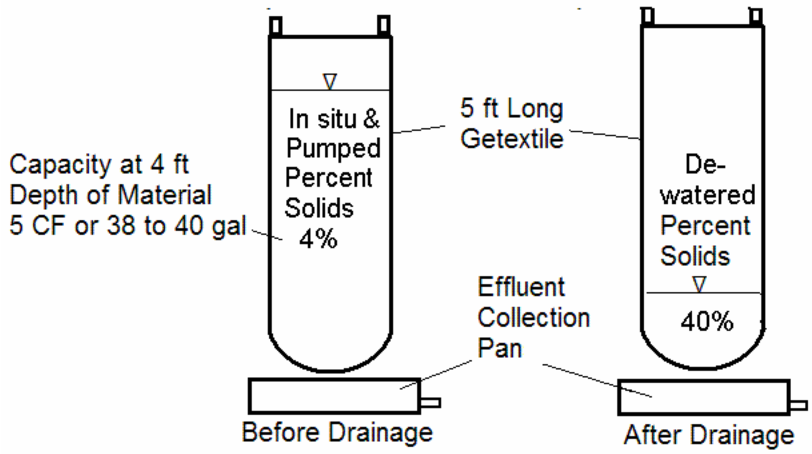

Figure 5. Schematic drawing of the hanging bag before and after drainage

Instructions for conducting the hanging bag test procedure using the percent solids method is as follows:

Determine the Specific Gravity of the Solids, G_s

Determine the in situ percent solids of the dredged material in the digester, $S_{in\ situ}$ %

Determine the initial percent solids of the slurry effluent from the dredge pipe before placing in the hanging bag, $D_{Dredge\ pipe}$ %

Determine the final percent solids of the sediment after dewatering in the bag or tube, $D_{Dewatered}$ %

Determine the quantity of material to be dredged, Q

Once the percent solids have been determined then the moisture content, w and void ratio, e and shrinkage factor is determined from the following excel spread sheet:

Table 2. Saturated soil properties in situ, during pumping and after dewatering in the tubes

Specific Gravity of Solids	Water Content Ww/Ws	Void Ratio e=Vv/Vs	Percent Solids S%= Ws/Wt	Wet Bulk Density (Gs+e)/(1+e) Wt/Vt	Dry Bulk Density Gs/(1+e) Ws/Vt	Dry Bulk Density Wt/Vt	Shrinkage or Bulking Factor (e+1)/(e+1)	Volume	Remarks
	%		%	gr/ml	gr/ml	pcf	SF	Wet cy	
1.6	2400	38.4	4	1.015	0.041	2.54		290,000	In Situ
1.6	2400	38.4	4	1.015	0.041	2.53	1.00	290,000	Pumped
Soil Properties After Dewatering in the Geotextile Tubes									
1.6	150	2.4	40	1.176	0.471	73.4	11.59	25,025	Tubes

The contractor transported about 19,000 cubic meters (25,000 CY) of saturated dewatered bio-sediments to the landfill. Using this number in the above spread sheet, then the total number of cubic yards pumped during the project was calculated to be about 222,000 cubic meters (290,000 CY).

The 13.5 m (45ft) circumference geotextile tube shown in Figure 6 dewatered the sediment more efficiently than the 18 m to 27 m (60 ft to 90 ft) circumference tubes because of the higher pore pressure exhibited by smaller circumference tubes. When 13.5 m (45 ft) circumference tubes were filled to a height of 2 m (7.0 ft) with sediments that had a wet bulk density of 1.2, the tube has a storage capacity of about 10.5 cubic meters per linear meter (4.2 CY per linear foot).

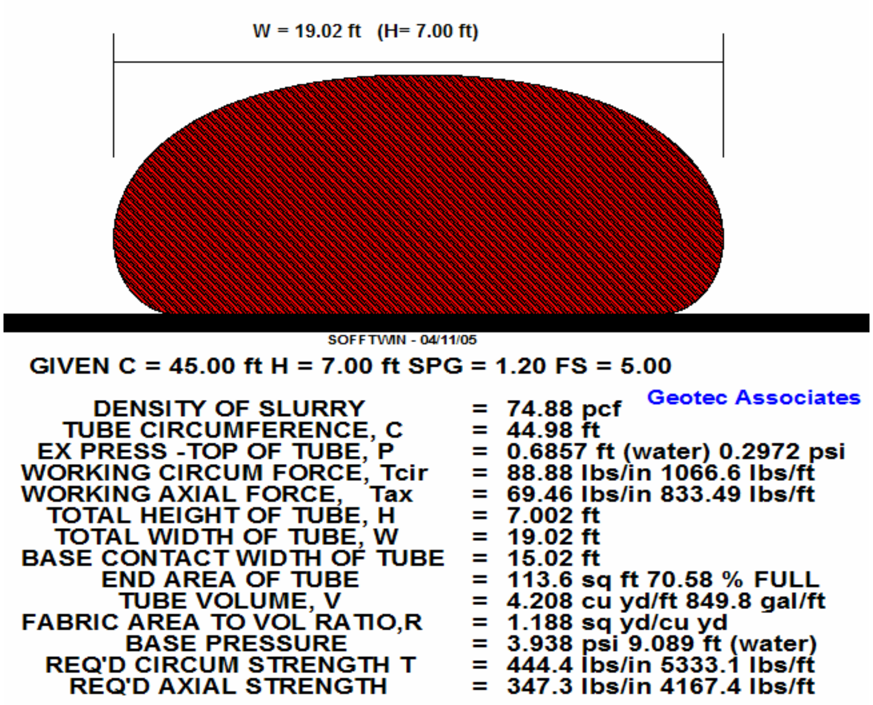

Figure 6. Cross section of a 13.5 m (45 ft) circumference geotextile tube used to dewater biosolid sediments

A number of preliminary bench tests with polyacrylamide emulsion polymers were conducted prior to conducting the hanging bag tests. These tests consisted of sediment with and without cationic polymers to determine the appropriate ratios for improved water quality, settling time and consolidation of the sediments. Hanging bag tests conducted to estimate shrinkage factors and to determine water effluent quality are shown in Figure 7. Effluent water collected in the collection pan was reasonably clear indicating percent solids of less than 15 ppm. The dewatered biosolids in the hanging bags ranged from 30 to 45 percent solids by dry weight after draining for a period of about 24 hours. The percent solids achieved in the small hanging bag for a period of 24 hrs will be much greater than those achieved in the large geotextile tubes during the same period of time because the longer drainage paths. The large tubes may require a few days to two weeks depending on the amount of grit, polymers and sediment characteristics.

Figure 7. Includes the bag hanging in a wooden frame and clear effluent collecting in the pan and bucket

Description of the Hydraulic Dredges

Several dredge types were used to dredge the biosolid sediment within the 50 by 50 ft 20 ft deep aerobic digester rooms. Once the electric drive motor, gear box, 3 by 3 m (10 by 10 ft) steel plate and agitator were removed from the top of each room, it only left an opening of 2.7 by 2.7 m (9 by 9 ft) in the ceiling to insert dredging equipment. A remote controlled submergible hydraulic actuated track dredge was lowered through this opening into the digester rooms. Figure 8 shows example of a typical remote control submergible hydraulic type dredge that was used to dredge sediment from these rooms. The sediments were agitated and sucked into an onboard dredge pump that pumped the sediment pass the polymer feed system to the geotextile tubes. The dredged sediments pumped through the 6 inch diameter HDPE pipeline to the tubes ranged from about 2 to 10 % solids. The track dredge was abandon because it was not productive and too difficult to operate.

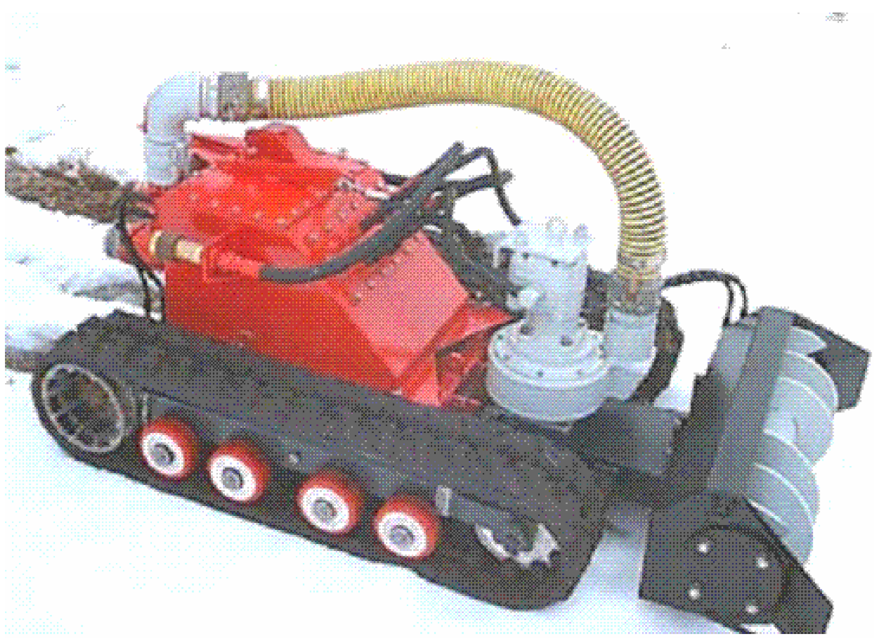

Figure 8. Typical submergible hydraulic track dredge and suction cutterhead (ref. Liquid Waste Technology)

Another type of dredged that was successful in pumping biosolid sediment from these rooms, was a submergible hydraulic dredge pump that was lowered through this 9 by 9 ft opening. The pump was mounted on a floating platform so it could be moved around in the rooms to maximize sediment removal. Figure 9 shows a typical submergible hydraulic dredge pump and hydraulic power supply system that is commonly used. This dredge was able to dislodge sediment from the floor by high pressure water jets attached the bottom of the pump. Once these materials were agitated they were sucked into the pump and pumped pass the polymer feed system through the 6 inch diameter HDPE pipeline into the geotextile tubes.

Polymer feed system

The polymer feed system was an inline dilution system that applied a polyacrylamide emulsion. This emulsion was a medium charged and medium molecular weight cationic polymer. After a number of preliminary bench tests conducted in the field it was decided to use an emulsion because of the ease of application. The dosage rate that provided the most rapid settling and consolidation properties varied from 100 to 500 parts per million. The initial supplier and polymer feed system designer was Hank Santicola who is an independent polymer consultant (ref). The chemical supply tanks and automatic emulsion feed system are shown in Figure 10. A bypass pipe was installed around a series of values, short pipes and elbows assembled to promote mixing of the polymer emulsion. The system was design to intercept biosolids that were being dredged from the aerobic digester chambers. The system was designed with sampling ports and values so that sediment samples could be acquired before, during and after application of the polymer. Sediment samples ranged from 2 to 10% solids in the dredge pipe and the resulting settling and consolidation in the tubes ranged from 30 to 45 % solids. The filtrate effluent passing through the geotextile tube fabric was clear.

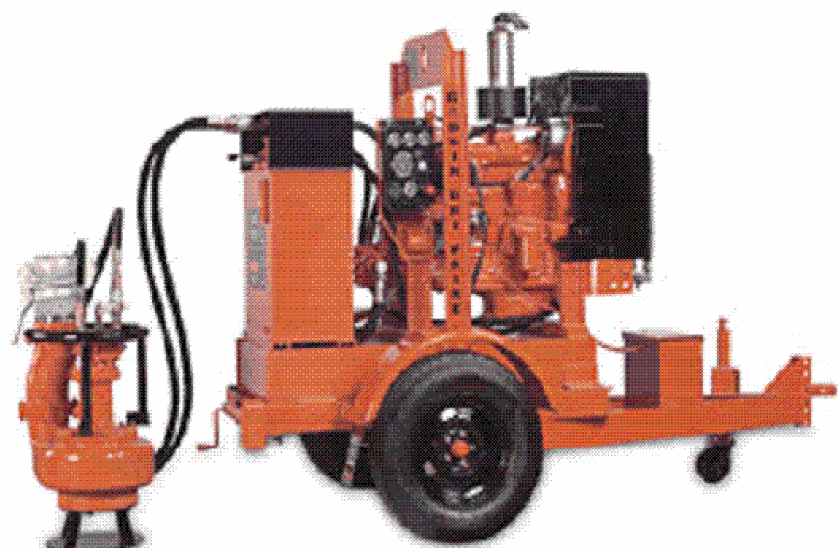

Figure 9. Hydraulic submergible dredge and power supply (ref. Godwin Pumps of America)

At various times during pumping the biosolids, the sediment had a lot of grit present which aided in rapid settling and consolidation. The grit removal system which had recently been modified and repaired was not working very efficiently. The key to successful operation of a polymer feed system is monitoring through frequent sampling and evaluation of these samples to prevent under and over treatment of polymer. Over dosage will cause blinding off the geotextile filter fabric inhibiting proper drainage. Under dosage will also cause blinding of the geotextile filter fabric and also inhibiting proper filtration and drainage. The use of a large mix tank ahead of the polymer feed system would have improved the treatment process by providing a more even flow of solids and lowering the use and cost of polymers.

Figure 10. Polymer feed system including values and polymer tanks

GEOTEXTILE TUBES

Small Geotextile Tube Tests

Four geotextile tubes 4.5 m (15 ft) circumference, 6 m (20 ft) long were filled with sewage sludge sediments to determine their dewatering and containment capabilities and to evaluate the effluent water quality coming out of the tubes. Figure 11 shows a photograph of these tubes and manifold pipes and cutoff values. One of the tubes was filled with sewage sludge without polymer treatment and three tubes were filled with sludge that was treated with different polymer emulsion concentrations. An automatic polymer feed system was setup to provide a given polymer emulsion percentage that ranged from 100 to 500 ppm dosage rate that was mixed with the biosolids prior to entry into the geotextile tubes. The dosage rate was regulated based on the percent solids being pumped. The geotextile tube that was filled with sediment that did not receive any polymer did not drain or consolidate and change in volume or height.

When polymers were applied to the sediments, water would flow very rapidly from the geotextile tube during filling but without polymer the flow was negligible. With polymer the water effluent flowing out of the tube was very clear. After 3 days of drainage and consolidation the top of tubes were removed and Figure 12 shows a photograph of the consistency of the sediments where polymers were applied. Figure 13 shows wider and deeper desiccation cracks only one day after the tops was removed. Consolidated samples collected from the tubes indicated percent solids ranging from 30 to 45 % solid.

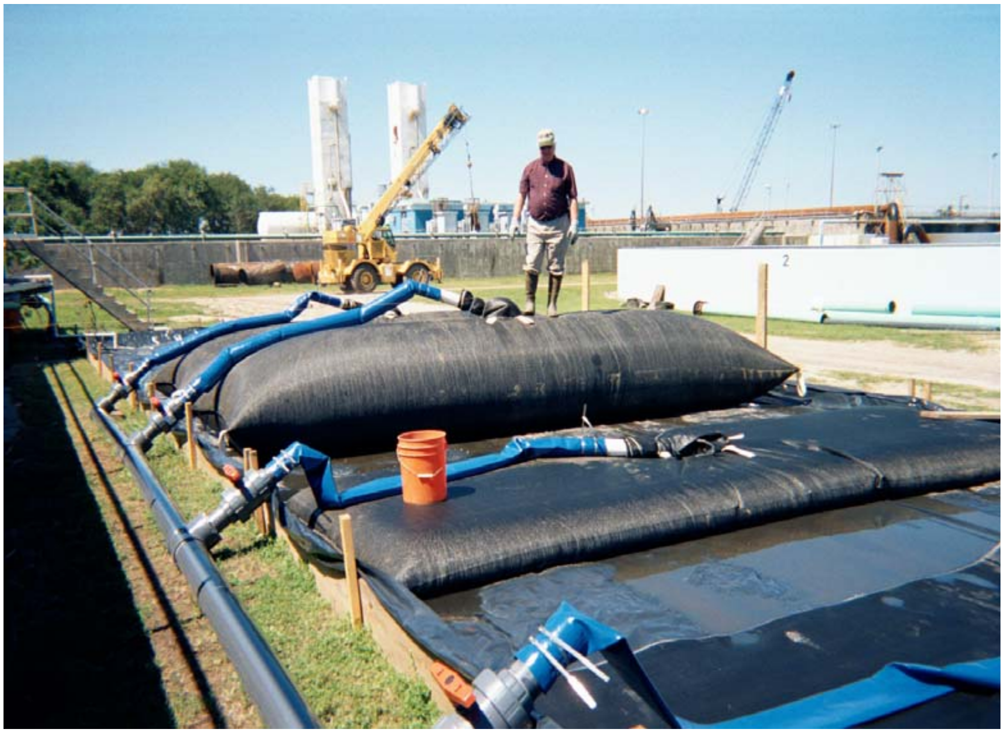

Figure 11. Filling 15 ft circumference diameter tubes to evaluate dewatering capabilities

Large Geotextile Tubes

The large geotextile tubes used for dewatering the biosolids during this project ranged from 3.5 m to 27 m (45ft to 90ft) in circumference. They were manufactured in lengths of 26 to 82 m (85 to 270 ft) and placed on a concrete drainage apron that was designed to slope to a metal grate and 45 centimeter (18 inch) diameter storm drain located every 18 m (60 ft) along the center of the apron. The concrete drainage apron or pad was about 107 m (350 ft) long and 21 m (70 ft) wide. The geotextile filter fabric used to construct the tubes was a woven polypropylene that had a working tensile strength of 70 kN per linear meter (400 pounds per linear inch) in the longitudinal direction of the tube and 106 kN per linear meter (600 pounds per inch) in the circumferential direction of the tube. The woven fabric had an Area Opening Size of 40 which is equivalent to a U.S. Sieve size 40. The woven polypropylene fabric used in the large tubes was the same as the fabric used in the hanging bags and smaller size geotextile tubes. Fill ports were sewn into the top of the tubes were spaced about every 12 to 15 m (40 to 50 ft). The fill port spacing is shown in an aerial photo of a 27 m (90 ft) circumference 82 m (270 ft) long tube in Figure 14.

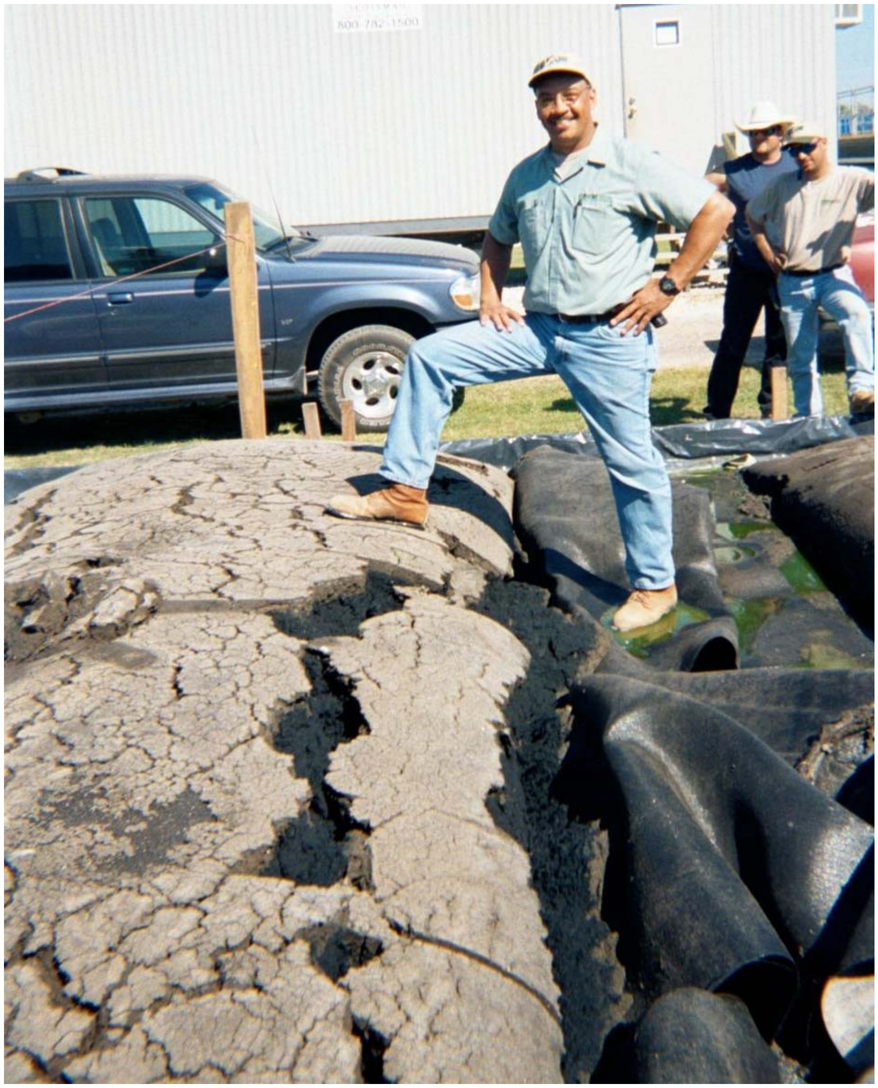

Figure 12. Consistency of the sludge after dewatering and removal of the geotextile fabric top

In the beginning of the project large 27 m (90 ft) circumference 82 m (270 ft) long tubes were used but it was discovered later on into the project that the ideal size tube for optimum dewatering were 13.5 m (45 ft) circumference tubes. Figure 15 show and end view of a 27 m (90 ft) circumference 82 m (270 ft) long 2 m (7 ft) high tube after it was fill with sediment. During filling of the very large27 m (90 ft) circumference tubes the fabric along the center and very top of the tubes did not exhibit a lot of excess pressure for release of water until one would walk on the surface. The top of the tube would feel very soft and the fabric would not be very tight or in tension. During walking on the tube surface, the pressure from walking would cause excess pressure and release of water through the tube fabric.

It was decided to use three small 13.5 m (45 ft) circumference 26 m (85 ft) long tubes during each dredging and dewatering cycle because smaller circumference tubes exhibited higher pore water pressure and the sediments drained in a shorter period of time. Three 26 m (85 ft) long tubes or 78 m (255 ft) of tube would contain 10.5 cubic meters per linear meter (4.2 CY per linear ft) at a height of about 2 m (7.0 ft). The total volume for 78 m (255 ft) of tube at 10.5 cubic meters per linear meter (4.2 CY per linear ft) was about 1070 of dewatered sediment. It generally required about 3 to 4 days to fill the tubes and then they would be immediately open up for sediment removal. They would drain to about 30 to 45 percent solids in less than three to four days during filling. The smaller circumference tubes dewater quicker because they have higher pore water pressure and shorter drainage paths for water to exit the sidewalls of the tubes.

Figure 13. Consistency of the sludge after one day of desiccation drying in the 4.5 m (15 ft) circumference tubes

Figure 14. Aerial view of clarifiers and 27 m (90 ft) circumference 82 m (270 ft) long geotextile tube filled to a height of 2 m (7 ft)

Figure 15. Ninety foot circumference 270 ft long geotextile tube pumped with sludge to a height 7 ft

Various methods were tried to promote under drainage such as placement of three dimensional plastic grid systems, perforated plastic pipes, and wooden mats under the tubes. A polypropylene Tensar type grid and a Mirafi grid were tried but these drainage systems clogged up because of excessive and rapid growth of biosolids in the drainage medium. Perforated pipes were placed under the tubes but they also did not appear to improve under drainage. Wooden pallets and wooden mats constructed by the contractor were used and it appeared that this technique provided improved drainage and were less of problem than the three dimensional plastic grid systems. Disposal of these bulky plastic grid systems was always a problem hauling them off to the landfill in dump trucks. The wooden pallets and mats were reusable and were not carried to the landfill unless they were severely damaged.

Sediment Sampling

Quantifying the amount of biosolid sediment accumulation before dredging in the aeration basins (or rooms) was indeterminate because sewage was constantly entering the plant. It was almost impossible to survey the rooms through the 2.7 m by 2.7 m (9 ft by 9 ft) openings that were previously occupied by the mechanical agitators. The agitators in only eight cells or one train at a time could be removed so that the dredging equipment could be lowered into the chambers. Removal of more than one train of agitators from operation would adversely affect the wastewater treatment of the plant efficiency. Each aeration basin was 15 by 15 m (50 by 50 ft) and 6 m (20 ft) deep and contained about 3 to 3.7 m (10 to 12 ft) of grit and biosolids that was interfering with the plant's efficient digestion. Each of the eight basins or rooms were interconnected by 1.2 m by 3 m (4 ft by 10 ft) openings in the 0.6 m (2 ft) thick concrete partitioning walls between each cell and the incoming effluent flowed through the train during dredging. There was not way to disrupt this flow.

Sampling and surveying of the accumulated sediments on the floor of the cells was accomplished with the use of a 6 m (20 ft) long two inch diameter PVC pipe with a plastic ball valve. This technique was somewhat successful but it was very difficult to obtain representative samples. Samples from the sediment accumulation in these cells revealed percent solids ranging from about 2 to 10 percent. Once the dredges were operational, samples were taken at sampling values located before and after the polymer feed station. These samples also revealed that sediments also ranged from about 2 to 10 percent solids.

Stabilization of Dewatered Sediments

It took about 3 to 4 days to fill the tubes to their maximum capacity and height of about 2 m (7.0 ft). Once the tubes were filled they were allowed to drain over night and opened up the next day. The far end of the tubes was opened up by cutting large panels of geotextile fabric with a sharp box blade knife. These fabric panels were loaded onto dump trucks and disposed of at the landfill along with the dewatered sediments. Once the tubes were opened the dewatered sediments were removed with a front loader and mixed on the concrete apron with variety of drying agents to improve odor and consistency, and to pass paint filter tests at the sewage plant and landfill. A paint filter test was performed by randomly collecting 100 grams of material, placing it in a common cone shaped paint filter, and suspending it a couple of inches above a clean dry sheet or sample pad. To pass the test the material had to sit at ambient temperature in the paint filter for a period of five minutes and not release a single drop of liquid onto the dry sheet below. These tests were conducted onsite by Rotag and by the landfill mangers on a random basis when the dump trucks arrived at the landfill.

Quick lime was initially used to control moisture, e-coli and vector attractants but the ammonia odor during dumping at the landfill was too offensive to the dozer operators. This treatment was not able to control the vector attractants. This technique was replaced with fly ash. The contractor experimented with a couple of trailer loads of fly ash but had to mix it nearly half and half to get the consistency that was needed. This method was too expensive because cost outweighed the benefits. Cement was used for a couple of tubes but it was also too expensive. Fly ash from cement was used for a couple applications but storage of the fly ash became a problem because of wind, rain and lack of available storage space. Both the cement and fly ash did an excellent job in stabilizing the dewatered sludge and passing the paint filter test at the landfill.

It was discovered that a product called “bagasse,” which is a sugar cane fiber by product from sugar mill refineries in south Louisiana, proved to be an excellent product for stabilizing the dewatered sludge. The “bagasse” mixed at a ratio of 1 to 50 made a significant difference in not only reducing the odor but it also stabilized the sludge. The “bagasse” increased sludge consistency and reduced the water content, allowing it to pass the paint filter test at the landfill. The “bagasse” virtually eliminated odor and reduced vector attraction to the point where there were no visible signs any insects, flies, or even knats.

Site and Landfill Disposal Odors

Once the tubes were opened and the stabilization process had begun with the “bagasse” it required about two days to mix and haul the material to the landfill. The visqueen lined dump truck had no problems with leakage during transportation and/or placing the stabilized sediments at the landfill. The landfill had received a couple complaints about odor, so parish officials hired an odor consultant to investigate the waste streams to determine where the odors were originating. The odor consultant was specifically instructed to investigate Rotag Industrial Service’s geotextile dewatering operation and he made several site visits during the contract. Rotag also invited the parish’s odor consultant to visit the project on several other occasions but they could not identify any odor or vector attractant problems associated with the geotextile tube dewatering operation. There were no odor or spillage problems during transportation or dumping the dewatered sediments at the landfill. It generally required about one day to cleanup and wash down the area and layout another geotextile tube and hookup the fill pipes and hoses.

Landfill Disposal Quantities

The dozer operators also had no problems spreading and using these materials as suitable landfill cover of municipal waste. Approximately 25,000 tons of moist stabilized sediments were transported to the landfill at about 40 percent solids. The weight of “bagasse” and other stabilizers was considered to be negligible when compared to the total weight and volume of materials dredged and dewatered. To achieve 25,000 tons at the landfill it was determined that the contractor was responsible for dredging over 222,000 cubic meters (290,000 CY) of sediment from the aeration basins at 4% solids. The shrinkage factor was determined to be 11.59%.

CONCLUSIONS

It was concluded that accumulated biosolids in aerobic digester cells can be successfully and economically dredged and dewatered using geotextile fabric tubes. It was also concluded that 13.5 m (45 ft) circumference tubes dewater more efficiently than large circumference tubes because of the higher pore pressure exhibited by this size tube. Wooden under drain pallets were able to provide drainage under the tubes where three dimensional plastic drains clogged with biosolid growth. In situ sediments were dredged at an averaged of 4 percent solids and consolidated to

40 percent solids in the geotextile tubes. A shrinkage factor of 11.59 % was calculated for the total volume pumped into the tubes. It was concluded that the inline dilution feed system successfully applied the cationic polyacrylamide emulsion for efficient flocculation and dewatering of the sludge. It was also concluded that these sediments could be successfully dredged and pumped into tubes but would require careful monitoring of the cationic polymers to release water bonded to the biosolids. It was also concluded that the effluent that flowed from the tubes during dewatering was less than 15 ppm and appeared to be clear.

It was also concluded that to achieve 25,000 tons of wet material weighed at the landfill the contractor had to dredge about 222,000 cubic meters (290,000 CY) at 4 % solids from the digesters. It generally required a period of about 3 to 4 days to dredge into the tubes and about one day to stabilize and haul these materials to the landfill. Dewatering and consolidation occurred simultaneously during pumping into the geotextile tubes. It was also determined that a by product called "bagasse" from sugar cane processing mills in south Louisiana was successful in reducing odor, stabilizing the biosolids during transportation and enabling the contractor to pass the paint filter test at the landfill. There were no odor or spillage problems during transportation or dumping the dewatered sediments at the landfill.

Recommendations

It is recommended that an inline dilution feed systems be used and carefully monitored when applying polyacrylamide cationic emulsion polymers during dewatering biosolids in geotextile tubes. It is recommended that 13.5 m (45 ft) circumference geotextile tubes be used in lieu of larger tubes because the smaller tubes are more efficient in dewatering the sediments. It is also recommended that until some other suitable under drain method is found that a series of wooden pallets be used under the tubes in lieu of plastic under drains. It is also recommended that "bagasse" be used for odor control and stability where it is readily available.

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