PROPOSED ALTERNATIVE FOR RAISING MISSISSIPPI LEVEES
USING GEOTUBE™ TECHNOLOGY DEVELOPED
UNDER THE CORPS OF ENGINEERS’
CONSTRUCTION PRODUCTIVITY RESEARCH PROGRAM (CPAR)

Proposal Submitted by

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to

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Mississippi Valley Division
P.O. Box 80
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and

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P.O. Box 60
Vicksburg, Mississippi 39181-0060

November 1, 1996
RAISING MISSISSIPPI LEVEES USING GEOTUBE™ TECHNOLOGY

1. Introduction

This proposal is submitted in response to the need for alternative methods for raising Mississippi levees more expeditiously and economically and with less impact on the environment as opposed to other alternatives proposed by the U. S. Army, Corps of Engineers, Mississippi Valley Division. It is suggested that more expeditious and economic methods of levee construction developed under the U. S. Army, Corps of Engineers, Construction Productivity Advancement Research (CPAR) program be utilized in raising levees on the Mississippi River.

2. Purpose

The purpose of this proposal is to explore the concept and use of Geotube™ technology developed by the U.S. Army, Corps of Engineers. This concept minimizes environmental damage and reduces cost and time needed to construct Mississippi River flood protection levees.

3. Objective

The objective of this proposal is to suggest a more expeditious, economical, and environmentally sensitive alternative that will not destroy sensitive forested wetlands on the riverside of the levee and will prevent borrowing fill material from expensive farmlands on the land side of the levee.

4. Scope

The scope of this proposed work consists of hydraulically filling geotubes parallel to the toe of the existing levee to form 5 to 8 ft high retention dikes for subsequent hydraulic placement of suitable dredged material for stability berms on both the land and river sides of the levee. Stockpiling dredged materials at the toe of the levee will provide a borrow source of materials to subsequently raise the levee crest height. The use of geotubes filled on top of the levee will be evaluated to supplement fill material required to raise the levee crest height.

5. Background

Over the past 23 years, the Corps of Engineers has developed plans to raise 220 miles of levee in a three state area, Arkansas, Mississippi and Louisiana. Between now and the year 2029 the levees are to be raised from 2 to 9 feet. Since 1973, about 83 miles have been raised. The Corps of Engineers’ 1973 Environmental Impact Study indicated that 11,400 acres of borrow areas would be required to raise the next 220 miles of levees.

The Fifth Louisiana Levee Board, has indicated that if the levee were overtopped near Lake Providence, the worst spot where the levee is 9 feet low, more than 1.8 million acres and 1,105 miles of major public roads would be flooded, impacting 25,000 homes and about 75,000 people.
A levee failure at Lake Providence would not only flood Winnsboro, Tallulah, and Monroe, Louisiana, but would cause problems all the way to the Gulf of Mexico as flood waters moved through the Delta. Total potential damage was estimated at $1.3 billion just in northeast Louisiana down to the Tensas-Concordia Parish line. Flooding south of this potential failure could double these estimates.

Most of the substandard levees are north of the Old River Control Structure and come under the jurisdiction of the U. S. Army, Corps of Engineers, Vicksburg District at Vicksburg, Mississippi. The Vicksburg District needs to raise 220 miles of levees, including 20 miles in Arkansas, 69 miles in Mississippi, and 131 miles in Louisiana. The 1973 flood emphasized these deficiencies; and since this time, the Vicksburg District has raised 83 miles of levee to the proper height.

In the past 20 years the District has spent $226 million on upgrading 83 miles of levees or about $2.8 million per mile. Additional project cost for the remaining 220 miles of levee are expected to be $698 million or $3.2 million per mile.

A major obstacle to raising the levees is economics with the local levee boards trying to budget money for their cost shared amount. The major cost involves obtaining real estate for borrow areas for levee fill material.

Meetings have been held to discuss new construction techniques aimed at reducing environmental concerns related to the levee and berm projects, but these meetings have not produced a consensus among a coalition of local, state, and national environmental groups.

Other major concerns is that the Sierra Club Legal Defense Fund, New Orleans, Louisiana, views the Mississippi River as an important part of the ecosystem of the United States. The Sierra Club is representing conservation groups such as the Mississippi Wildlife Federation, its national parent and affiliates in Louisiana and Arkansas, the Washington based American Rivers, and the Sierra Club’s Mississippi chapters.

These groups indicate that they are not challenging the plan to raise the levees but are challenging the Corps’ reluctance to revisit the 20-year-old environmental impact study (EIS). The basic issue is where the Corps will get several million cubic yards of fill for levee construction from the protected landside farmlands, from the riverside wetlands, or from the Mississippi River.

There are similar concerns about other projects, such as the $62 million plan to dredge and clear more than 130 miles of waterways in the Mississippi Delta’s Big Sunflower River Basin. The Corps has scaled back more than 50 percent in wetland destruction and has reforested 8,000 acres of wetlands near Sartartia, Mississippi.

The Corps indicated that their goal is to have no net loss to the environment, but funding for levee construction has slowed until more viable solutions for levee construction are discovered. Since 1991, the Waterways Experiment Station, Corps of Engineers at Vicksburg, Mississippi,
along with its industrial partner, TC Mirafi, Pendergrass, Georgia, have conducted research under the Construction Productivity Advancement Research (CPAR) Program and have spent over $1,000,000 in developing Geotube™ technology that could solve some of the major problems in raising levees on the Mississippi River.

The New Orleans District successfully designed and constructed 7000 ft of bendway weirs on the Mississippi River at Red Eye Crossing near Baton Rouge, Louisiana. Over 550 geocontainers, containing 150 to 550 cy each, and 38,000 geobags, containing 3 cy each, were placed in 4 to 5 ft/sec currents at water depths up to 70 ft deep. Over 300,000 ft of Geobags™ and 500,000 ft of Geocontainers™ were successfully placed in the submerged dike system, and all fill material was dredged from Mississippi River sand bars.

Since 1988, the parent company of TC Mirafi, TC Nicolon, in The Netherlands, has developed and used Geotube™ technology in successfully constructing and raising several miles of levees and dike systems in the North Sea. TC Nicolon is presently working on several projects in Japan, Malaysia, and the Philippines.

6. Proposal

It is proposed that a one to five mile lengths of levee be selected to evaluate the proposed Geotube™ alternative for raising Mississippi River levees. It is proposed that suitable borrow materials be located in the river for dredging and filling the geotubes and between the geotubes and levee. It is proposed that these retention areas be compartmentalize based on a design that allows for clear decant water to drain from these confined disposal areas over properly designed weir structures. It is proposed that both sandy and fine-grained materials such as soft maintenance clays and stiff clay ball materials be evaluated for levee construction. It is proposed that fine grain slurry materials be dewatered and conditioned where impermeable clay fill sections are required to raise the levee crest. It is proposed that a Geotube™ be located on top of the levee and incorporated within the required filled cross-section and evaluated as to how effective and economical this construction procedure would be compared to conventional construction methods. It is proposed that all decant water from the geotubes and disposal areas be monitored and returned to approved areas.

7. Required Dredged Material Properties

It is recommended that a range of dredged material properties from both silty, sandy materials, fine grained maintenance materials and stiff clays be obtained, tested, and evaluated for suitability for filling geotubes and for filling between the Geotube™ and levee for stability berms and subsequent use in raising the levee crest height. It is recommended that all geotubes used for perimeter retention dikes be filled with non-plastic sandy materials to minimize consolidation and loss in Geotube™ height and potential reduction in storage capacity for berm material. It has been shown at several Corps Districts during the CPAR program that a wide range of fill materials are suitable for filling geotubes for retention dikes for maintenance dredged material disposal areas. It has also been shown during the Dredge Material Research Program that when
fine-grained dredged materials are pumped into confined disposal areas they can be successfully
dewatered and conditioned for suitable levee fill material in a relatively short period of time. The
majority of dredged materials required for stability berms or sand boil protection berms may
consist of sandy materials because the height and weight of the berm is of primary importance.

Gradation tests should be performed to determine the angle of repose of the fill material pumped
into the Geotube™ and whether the fill material will be retained by the very open and permeable
geotextile fabric. The angle of repose is used to determine the proper spacing of fill openings.
Atterberg limits, in situ moisture content, density and specific gravity tests should be used to
predict volume relationships such as permeability, drainage, consolidation, bulking and shrinkage
ratios, and the required strength and maximum Geotube™ height.

8. Filtration Tests

It has been shown that filtration tests may not be necessary if the gradation tests indicate that the
particle size is greater than the Apparent Opening Size of the geotextile. Where the fine grain
material is less than a 74 microns (200 sieve) then filtration tests may be required using a non-
woven liner on the inside of the Geotube™ to prevent loss of fines.

9. Geotube™ Specifications

The geotextile tubes are designed with inner and outer tubes. The inner tube if required will
consist of a non-woven, 10 oz per square yard, polypropylene fabric that acts as a filter to retain
the fine grained, dredged material. An outer liner of high strength, woven, polyester fabric is
designed to contain the weight of dredged material and pumping pressures required to fill the
tube to the required height. The geotextile specifications are shown in Tables 1 and 2 for both
the non-woven and woven fabrics. Double butterfly type seams will be utilized for both the
inner and outer tubes. All seams will be sewn with a double needle, Union Special, Model
#80200, sewing machine. The sewing machine is capable of sewing two parallel seams about
one quarter inch apart. The thread will be 12 ply, 1000 denier passing through the needles and 9
ply, 1000 denier passing through the looper. Seam strengths for both the warp and weft
directions will exceed 500 pound per inch for the outer liner.

Openings for filling the Geotube™ shown in Figure 1 will be spaced as a function of the angle of
repose of the fill material. Geotube™ lengths of 500 ft to 1000 ft are available, but Geotube™
length may be determined based on available space for placement. A 30 ft circumference
Geotube™ is capable of containing about 2 cy per foot or about 1000 cy per 500 ft long
Geotube™. A 45 ft circumference Geotube™ is capable of containing 4 cy per foot or about
2000 cy per 500 ft long Geotube™.

Heights of 5 to 6 ft can be obtained with a 30 ft circumference Geotube™ whereas a 45 ft
circumference Geotube™ can be pumped to a height of 6 to 8 ft. Multiple stacked geotubes can
be used to raise the fill by placing another Geotube™ on the berm fill material retained between
the levee and the first Geotube™.
Figure 1. Standard Detail for Geotube™ 30 ft Circumference

10. Construction Procedure

Dredged material would be dredged from the Mississippi River from predetermined locations in the river where suitable or select materials could be defined for subsequent levee construction. Sandy materials are preferred inside the Geotube™. Dredge pipe sizes of not greater than 20 inches in diameter should be specified to fill the geotubes and the berm area between the Geotube™ and levee. The dredge pipe size should be specified based on the optimum size of the disposal area to prevent channelization and to prevent an excess discharge of water across the weir and subsequent loss of fines. Figure 1 shows the standard details and construction procedure for filling a 30 ft circumference Geotube™ to a height of 5 ft. Figures 2 and 3 show photographs of a Geotube™ filled with sandy material and dredged sand being retained behind a Geotube™ for build up of land on the North Sea in The Netherlands.

Figure 4 is a schematic view that shows a profile view of the Mississippi River, existing borrow pits and forested wetlands, the proposed Geotube™ dikes, dredged material disposal area for berm construction and the existing levee. Figure 4 also shows a more detailed profile view of the Geotube™ and berm area and a Geotube™ on the levee crest.
Figure 2. Photograph of Geotube™ Dike on the North Sea in the Netherlands

Figure 3. Photograph of Geotube™ Dike with Dredged Fill behind Geotube™ in the Netherlands
11. Geotube™, Erosion Blanket and Dredging Cost

The cost of a geotextile Geotube™ will be about $25.00 per foot or about $12.50 per cy for tubes containing about 2 cy per ft. Dredging cost to place dredged material in the geotubes and in the area between the Geotube™ and the levee will be about $5.00 per cy. After the materials have consolidated and dewatered, the dredged material will be excavated and used to build up the levee crest the required height. Depending on the grain size and permeability of the dredged material, it will require about 2 to 4 months for consolidation and desiccation drying of the fine-grained material, but the sandy materials should dewater immediately. If the geotubes do not reach the desired height during the first filling, they can be pumped a second or third time to assure a height that would reduce cost and increase storage capacity in the berm areas.

The cost of a filling Geotube™ for retention dikes and disposal of dredged material behind these dikes is estimated to be about $5.00 per cy. The cost of an erosion blanket beneath the Geotube™ will cost about $5.00 per foot. An estimated cost breakdown is shown below for each
activity.

Cost Estimate for Raising Mississippi Levees

Cost of 30 ft circumference Geotube™ $25.00 per linear ft
Cost of a Geotextile Erosion Blanket 5.00 per linear ft
Cost of Dredging Material into the Geotube™
   based on 2 cy per linear ft $5.00 per cy 10.00 per linear ft
Cost of dredged material placement between the geotubes and levee
   for the stability berms is $5.00 per cy which is based on an
   estimated fill volume of 40 cy per linear ft 200.00 per linear ft
Cost of Removal of Consolidated and Desiccated Material to the
   Levee Crest is Estimated at 10 cy per linear ft at $5.00 per cy 50.00 per linear ft
Mobilization and Demobilization Costs 2.00 per linear ft
Total Cost Estimate $292.00 per linear ft
Total Cost per one mile or 5280 ft $1.5 million per mile

The cost of using geotubes for retaining river dredged materials for levee construction is estimated at $1.5 million per mile for 220 miles or $330 million for the total cost.

12. Cost Estimate by WES for Monitor and Document this New and Innovative Construction Methodology

The Waterways Experiment Station (WES- John Palmerton and Roy Leach) is willing to monitor and document the work conducted using this new and innovative construction methodology in a formal report. The WES will also compare the affect on the environment of this technology against conventional construction methods. The WES (Bob Ballard) also has the capability to locate suitable dredged material using acoustical impedance techniques to determine the subsurface material types. Cost for WES to assist in the design, monitor the work, and prepare a formal report is estimated to cost $100,000.

13. Cost Estimate for the Demonstration Section

The cost estimated for the Vicksburg District Corps of Engineers to raise the levee to a height that equals to filling the levee 40 cy per linear ft during this demonstration section will be $1.5 million per mile.
14. Recommendations

It is recommended that one to five miles of geotubes be used to raise the levee as a demonstration project. TC Mirafi is willing to supply geotubes for this demonstration project.

15. Conclusions

It is concluded that there are no significant impacts to forested wetlands other than assembly and disassembly of a dredge pipe that would, at intervals, temporarily pass along the surface of the wetlands. A minimum amount of heavy construction equipment would be necessary to deploy and recover the dredge pipe after construction. There would be practically no impact on the environment as compared to excavation of levee fill material from existing or new borrow pits or land side farmland.

It is also concluded that the need to obtain levee fill material from expensive farmlands would not be required therefore eliminating impact on farming activities.

A major attribute is the reduction in cost and time normally expended by real estate acquisitions. Potential condemnations would be virtually eliminated and the cost and time are reduced by approximately 50 percent of the Corps of Engineers estimated cost.

Previous costs by the Corps of Engineer, Vicksburg District, per mile for raising 83 miles of levee over the past 23 years has been $2.8 million per mile. The estimated cost for future levee construction to the year 2029 (33 years) is estimated to be $3.2 million per mile for 220 miles of proposed levee or $698 million. This proposed construction method using geotubes is $1.5 million per mile for a savings of $368 million compared to conventional construction methods proposed by the Corps of Engineers.

16. For Further Information

If you have any further questions or requests for information regarding this proposal please contact one of the following:

Jack Fowler, Geotec Associates
Telephone 601-636-5475
FAX  601-630-9911

Ed Trainer, Sales Manager
TC Mirafi
Telephone 800-795-0808
FAX  706-693-4400
TABLE 1. WOVEN POLYESTER OUTER CONTAINER FABRIC PROPERTIES

Product Description

TC Mirafi MDR 1000 is a woven polyester fabric designed specifically for use in the fabrication of Geotubes™. TC Mirafi MDR 1000 conforms to the property values listed in the following table.

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<th>Property</th>
<th>Unit</th>
<th>Test Method</th>
<th>Minimum Average</th>
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</thead>
<tbody>
<tr>
<td>Wide Width Tensile Strength</td>
<td>lb/in</td>
<td>ASTM D4595</td>
<td>1000 X 1000</td>
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<tr>
<td>Wide Width Tensile Elongation</td>
<td>%</td>
<td>ASTM D4595</td>
<td>10 X 10</td>
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<td>A. O. S Sieve No.</td>
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<td>ASTM D4751</td>
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<tr>
<td>Seam Strength</td>
<td>lb/in</td>
<td>ASTM D4595</td>
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<tr>
<td>Puncture</td>
<td>lbs</td>
<td>ASTM D4833</td>
<td>400</td>
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<tr>
<td>Trapezoid Tear</td>
<td>lbs</td>
<td>ASTM D4533</td>
<td>900 X 800</td>
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</tbody>
</table>

TABLE 2. NON-WOVEN POLYPROPYLENE INNER CONTAINER FABRIC PROPERTIES

TC Mirafi S1000 is a 100% polypropylene non-woven needle-punched fabric. This staple geotextile is resistant to degradation due to ultraviolet exposure. The material is resistant to commonly encountered soil chemicals, insects, and mildew and is non-biodegradable. Polypropylene is stable within a ph range of 2 to 13. TC Mirafi S1000 conforms to the physical property values listed in the following table.

<table>
<thead>
<tr>
<th>FABRIC PROPERTY</th>
<th>TEST METHOD</th>
<th>UNIT</th>
<th>TYPICAL</th>
<th>MINIMUM AVERAGE ROLL VALUES</th>
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<td>Fabric Weight</td>
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<td>Thickness</td>
<td>ASTM D-5199</td>
<td>mils</td>
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<td>Grab Tensile Strength</td>
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<td>lbs</td>
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<tr>
<td>Grab Elongation</td>
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<td>%</td>
<td>60/80³</td>
<td>50</td>
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<tr>
<td>Trapezoid Tear Strength</td>
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<td>lbs</td>
<td>130/145³</td>
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<tr>
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<td>Mullen Burst Strength</td>
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(1) MD/CD = MD - MACHINE DIRECTION  
CD - CROSS DIRECTION