MONITORING PLAN

PROJECT NO. TV-18 (XTV-30) FOUR-MILE CANAL TERRACING AND SEDIMENT TRAPPING

July 19, 2004

Project Description

The Four Mile Canal Terracing and Sediment Trapping (TV-18) project is from the 9th priority list of the Coastal Wetlands Planning, Protection, and Restoration Act. The project is located approximately 4 miles (6.44 km) south of Intracoastal City in Vermilion Parish, Louisiana, and includes Little White Lake and the portion of Little Vermilion Bay immediately west of Four-Mile Canal also known as the Vermilion River Cutoff (figure 1). The total project area comprises approximately 2,269 acres (918.56 ha) of intermediate marsh and open water. There are approximately 160 acres (64.93 ha) of land and 2,109 acres (853.63 ha) of open water from the1993 land loss data. The 1988/90 habitat data classifies the area as having 62 acres (25.09 ha) of intermediate marsh, 53 acres (21.45 ha) of brackish marsh, 5 acres (2.02 ha) of unavailable data and 1,823 acres (737.34 ha) of open water (United States Geological Survey/National Wetlands Research Center [USGS/NWRC] 1988/90).

Soils around the project area are Clovelly and Lafitte muck with two patches of Udifluvents. Clovelly and Lafitte series are poorly drained organic soils that formed in herbaceous plant material over clayey alluvium. Udifluvents are sandy to clayey soils that were hydraulically excavated during the construction and maintenance of navigable waterways. Udifluvents are of medium fertility with water and air moving at a very slow to moderate rate. Many areas are very intermittently submerged and occur as small to large lakes (United States Department of Agriculture [USDA 1996]). Soil boring samples collected and analyzed by HNTB of Baton Rouge in one to four feet of water encountered two to five feet of very soft clay over two to eight feet of organic clay. This area was entirely a brackish marsh from 1949 through 1968 (O'Neil 1949, Chabreck et al. 1968). By 1978 through 1988 the marsh around the northern shore of Little White Lake and Four-Mile Canal was classified as an intermediate marsh (Chabreck and Linscombe 1978, 1988). The most recent classification in 1997 finds the project area surrounded by intermediate marsh (Chabreck and Linscombe 1997).

Emergent vegetation observed on the shore around Little White Lake consists of *Phragmites australis* (common reed), *Zizaniopsis mileacea* (giant cutgrass), *Spartina alterniflora* (smooth cordgrass), *Hymenocallis caroliniana* (Carolina spiderlily), *Triadica sebifera* (tallowtree), and *Sesbania drummondii* (poisonbean). In 1998, Foret found the vegetation community to include *Spartina patens* (saltmeadow cordgrass), *Cladium mariscus ssp. jamaicense* (Jamaica sawgrass), and *Schoenoplectus robustus* (sturdy bulrush). Vegetation in the open water portion of the project area were scattered stands of *Myriophyllum spicatum* (spike watermilfoil), *Ceratophyllum demersum* (coon's tail) and *Najas guadalupensis* (southern waternymph) (United States Department of Commerce/National Oceanic and Atmospheric Administration/National Marine Fisheries Service 2000).

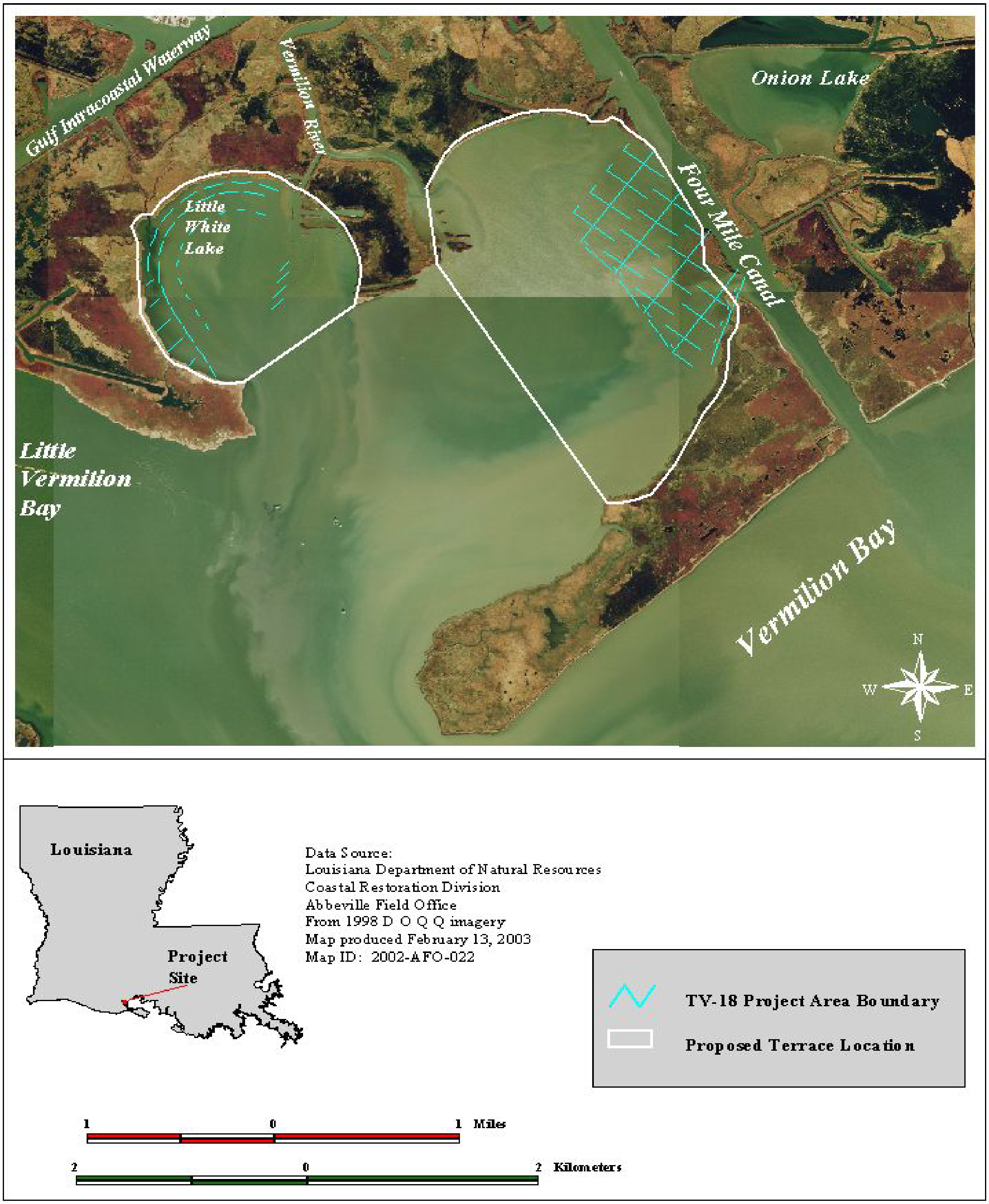

Figure 1. Four-Mile Canal Terracing and Sediment Trapping (T/V-18) project area showing boundary and proposed terrace locations.

The Flood Control Act of 18 August 1941 enacted by the United States Congress provided for improvements in the Vermilion River. Vermilion River Cutoff, an 8 ft by 80 ft (2.44 m by 24.38 m) channel from the -8 foot contour in the Vermilion Bay to the Gulf Intracoastal Waterway (GIWW) was constructed for improving navigation from Lafayette, LA to the -8 foot (-2.44 m) contour in Vermilion Bay and to improve flood control from Port Barre, LA to the Vermilion Bay via Bayou Teche, Bayou Fusilier and Vermilion River. The materials excavated to build the canal were deposited in spoil banks along the canal. This prevented the river waters from nourishing the adjacent marsh (USACE 1993; HNTB 2002). The main cause of marsh loss in this area is believed to be shoreline erosion. From the 1978 Louisiana Department of Transportation and Development (LDOTD) inventory and assessment of shoreline erosion in coastal Louisiana, the Abbeville 15 Quadrangle, which is Vermilion Bay near Onion Bayou, documents an erosion rate of 1.6 ft/yr (0.5 m/yr) and just adjacent to that in the Cheniere Au Tigre & Abbeville 15 quadrangle, which is Vermilion Bay (Mud Point to Lake Cleodis) is an erosion rate of 2.6 ft/yr [0.8 m/yr] (Adams et al. 1978). Shoreline change, specifically in the project area, calculated by USGS was 2.86 ft/yr (0.87 m/yr) and island area change was 0.64 acres/yr (0.26 ha/yr [2003]). A combination of wave and wake erosion continues to deteriorate this area, which is relatively unprotected and affected by storm events emerging from Vermilion Bay. This erosion prevents sub-aerial marsh development from sediments introduced to the area by the GIWW through the Vermilion River and Four-Mile Canal (LDNR 1999).

The construction of terraces in Little White Lake and Vermilion Bay will buffer existing marsh against shoreline erosion by reducing wave and wake energy. Marsh will immediately be created by planting *S. alterniflora* along the crowns and slopes of the constructed terraces. Additionally, new marsh will be created as freshwater and suspended sediments introduced from Four Mile Canal and the Vermilion River are dispersed through the project area via conveyance channels, and trapped in the shallow open water adjacent to the terraces. In doing so, terraces may indirectly reduce water-column turbidity within the project area. This, in conjunction with decreased wave and wake energy, will create habitat suitable for the colonization by submerged aquatic vegetation (SAV). Fisheries habitat may be enhanced by the marsh edge created by the terraces and the propagation of SAV. Conveyance channels may also promote the exchange of organisms and organic material within and through the project area.

Project Goals and Strategies/Coast 2050 Strategies Addressed

CWPPRA projects are reviewed prior to authorization of construction funds for compatibility of project goals with those in Coast 2050 (Louisiana Coastal Wetlands Conservation and Restoration Task Force and Wetlands Conservation And Restoration Authority 1998), and for the probability that proposed restoration strategies will accomplish those goals. Project goals and strategies are provided to LDNR by the sponsoring federal agency through the Environmental Assessment (EA) and /or the Wetland Value Assessment (WVA) for the project. The following are the goals and strategies for the Four-Mile Canal Terracing and Sediment Trapping project.

Project Goals:

The goals of this project are to:

1) Create 70 acres (28.3 ha) of earthen terraces within the project area immediately after construction.
2) Reduce shoreline erosion rates by 50% (reduce from 8 ft/yr to 4 ft/yr) over the 20 year project life.
3) As a result of goals 1 and 2, achieve a 9% (approximately 17 acres [6.9 ha]) net increase in marsh habitat by the end of the 20 year project.
4) Increase submerged aquatic vegetation (SAV) coverage from 0% to 25% of the project area by the end of the 20 year project life.
5) Increase fisheries utilization of the project area.

Project Strategies:

The project goals will be achieved using the following design features:

1) Dredge conveyance channels and use dredged material to construct earthen terraces, either in a linear or "fish-net" orientation, in the open water areas of Little Vermilion Bay and Little White Lake.
2) Plant *Spartina alterniflora* (smooth cordgrass) along the slopes of the terraces.

Project Features

Project components include constructing approximately 40,300 linear ft (12,283.4 m) of terraces in the eastern portion of Little Vermilion Bay area adjacent to Four Mile Canal (figure 2) and 28,150 linear ft (8,580.12 m) in the Little White Lake area (figure 3). Data obtained from a USGS gauge at Cypremort Point from 1990 to 1999 indicate the average annual high water elevation in Little Vermilion Bay is +4.24 ft (+1.29 m) NAVD88 and average annual low water elevation is -1.63 ft (-0.50 m) NAVD88. Approximate marsh elevation in the area is 1.5 ft (0.46 m) NAVD88. Terraces in the Little Vermilion Bay area will be built to + 5.0 ft (+1.52 m) NAVD88 with a 20 ft crown and 4:1 ft (1.21:0.31 m) side slopes. Terraces in the Little White Lake area will also be built to + 5.0 ft (+1.52 m) NAVD88, but will have a 15 ft (4.57 m) crown with 4:1 ft (1.21:0.31 m) side slopes (figure 4). Post consolidation elevation of all terraces is expected to be between 2 and 3 ft NAVD88 (0.61 and 0.91 m) The borrow or floatation channel will be located on the land side of all terraces and will be at a maximum depth of 10 ft below the current water bottom. In order to minimize erosive energies, the terrace slopes and crowns will be planted with *Spartina alterniflora* (smooth cordgrass).

Monitoring Goals

Priorities:

The Four-Mile Canal Terracing and Sediment Trapping Project is classified as a terracing and sediment trapping project. The project is not proposing any hydrologic structures, however, the conveyance channels are expected to increase freshwater and sediment flow from Four-Mile

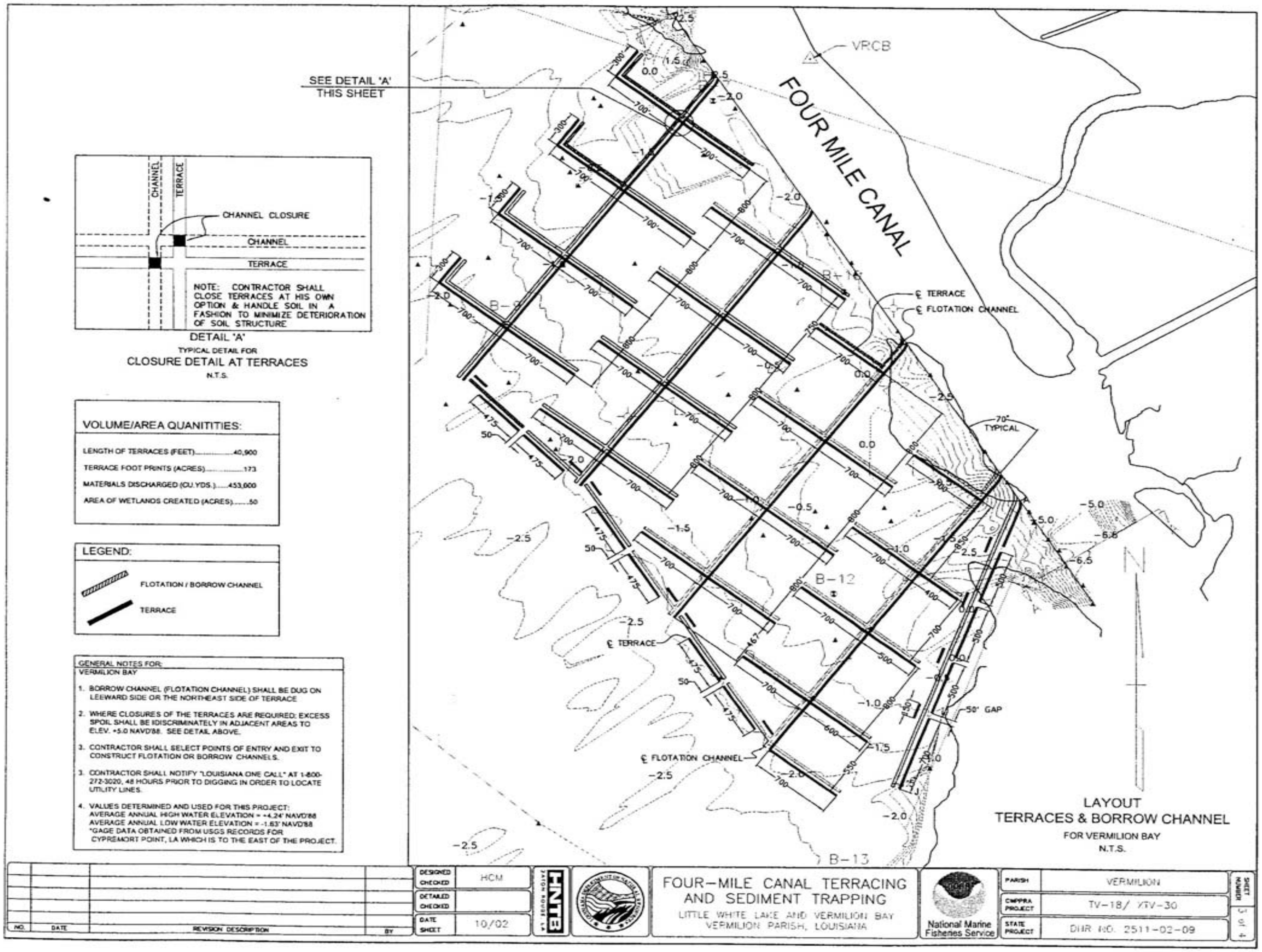

Figure 2. Proposed schematic for Four-Mile Canal Terracing and Sediment Trapping (T/V-18) for terraces in the eastern section of Little Vermilion Bay (HNTB 2002).

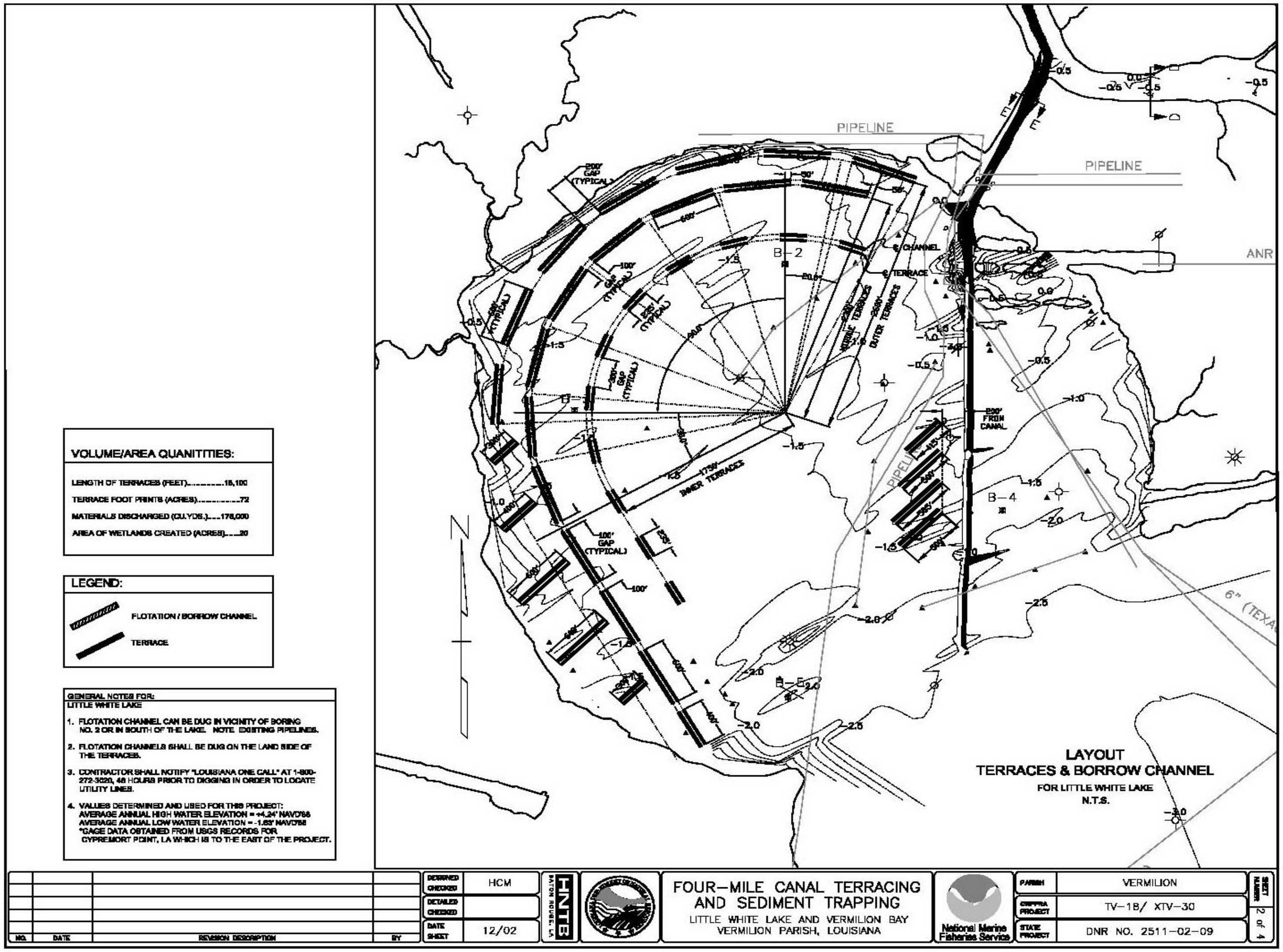

Figure 3. Proposed schematic for Four-Mile Canal Terracing and Sediment Trapping (T/V-18) for terraces in the western section of Little White Lake (HNTB 2002).

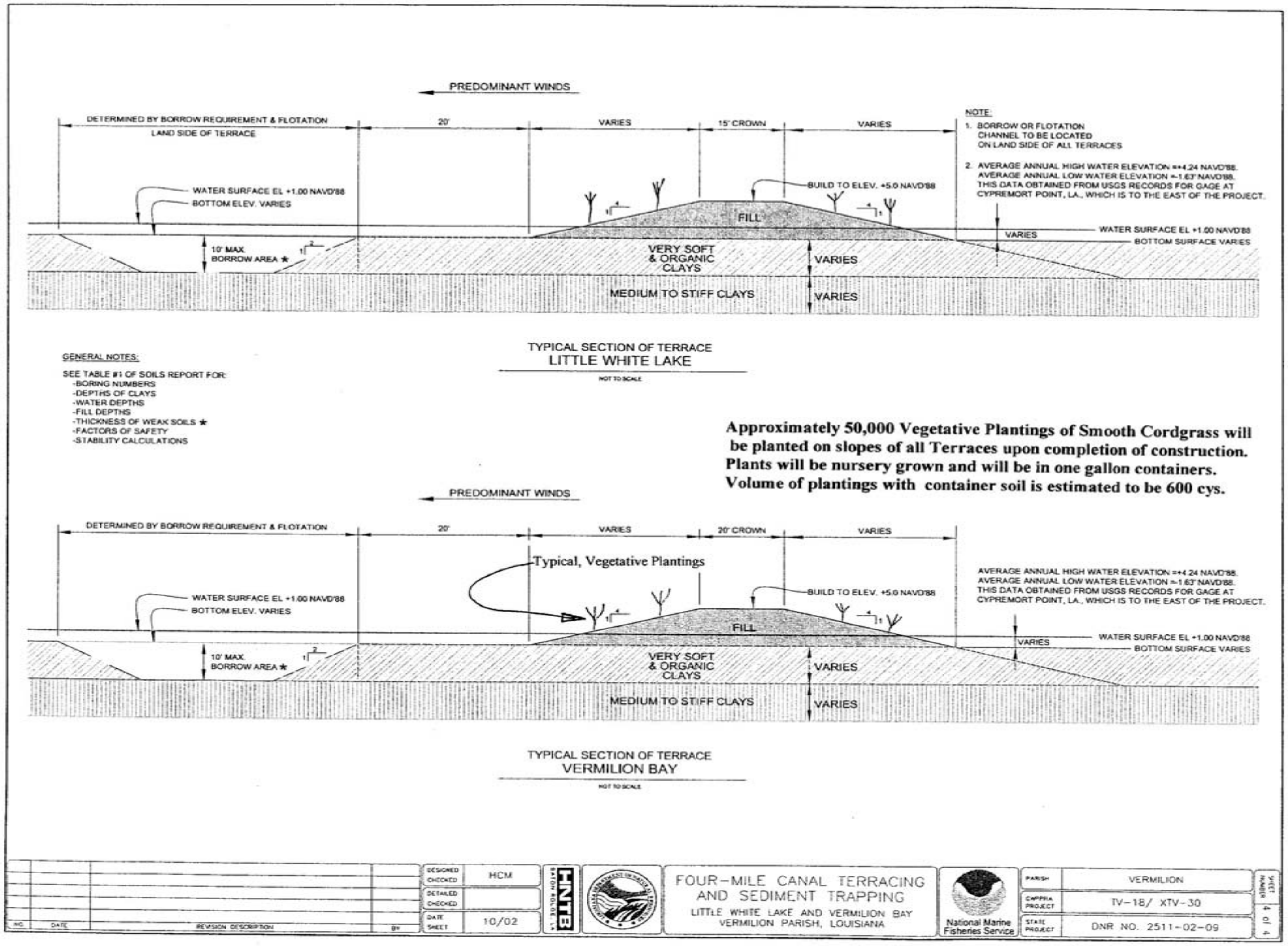

Figure 4. Typical layout and cross section of proposed terraces to be constructed in Little Vermilion Bay and Little White Lake for the Four-Mile Canal Terracing and Sediment Trapping (TV-18) project (HNTB 2002).

Canal into the project area. In addition, construction of the earthen terraces via channel dredging will facilitate water and sediment flow into the areas adjacent to terraces. Construction of terraces may also reduce turbidity within the project area by causing suspended sediments to fall out of the water column. The project also proposes to reduce shoreline erosion rates and increase marsh habitat, SAV and fisheries utilization. Insufficient resources and land rights acquisition prevent an evaluation of SAV, fisheries utilization, and other anticipated project benefits. Monitoring efforts will focus on evaluating project effects on shoreline change, land/water ratios, bathymetry/topography and vegetation planting. Any variation from expected results will be documented and evaluated. One study has indicated that terrace marsh supported densities of fisheries similar to those of a natural marsh however, land rights access for a suitable reference area and budget limitations prohibit the monitoring of fisheries utilization (Rozas and Minello 2001).

Specific Monitoring Goals:

1) Evaluate the rate of erosion along the shoreline of the project area (Little White Lake and adjacent Little Vermilion Bay).
2) Evaluate establishment of emergent vegetation on planted terraces.
3) Evaluate sediment deposition within the project area.
4) Evaluate land/water ratios with respect to initial and secondary land gains.

Reference Area:

The location, topography and hydrologic regime that exist for this project could not be matched to a suitable reference location for the shoreline, submerged aquatic vegetation or the bathymetric/topographic monitoring strategies therefore; a reference location was not selected for these monitoring elements.

<u>Monitoring Strategies</u>

The following monitoring elements will provide the information necessary to evaluate the specific goals listed above:

1. Shoreline Survey

    To document shoreline movement, differential GPS will be used to map the shoreline in Little Vermilion Bay and Little White Lake. Differential GPS will be used as described in Steyer et al. (1995). Differentially corrected GPS data sets will be obtained 2004 (as built terraces), and post-construction in years 2010, and 2017. GPS data will be taken during the spring of each monitoring year to minimize errors associated with taking data at different times of the year, not accounting for seasonal changes that might occur to the shoreline.

2. Terrace Vegetation

    The condition of the natural emergent and planted vegetation on the terraces over the life of the project will be monitored using a stratified sampling scheme on 16 of the total planted terraces using a modified Braun-Blanquet sampling method as outlined in Steyer et al. (1995). Transect lines and plots will be established across selected terraces to include both high and low energy environments. Three sampling plots will be established on randomly selected transect lines which will include a plot on both slopes and 1 plot on the crown. At each station, percent cover, dominant plant height, and species composition will be documented in a 4 m^2 sample area. Each plot will be marked with 2 corner poles to allow for revisiting the sites over time. Vegetation will be evaluated at the sampling sites in the spring of 2004 (as built), and in the spring of 2007, 2010, and 2016.

3. Bathymetry/Topography

Sediment deposition will be monitored along existing transects used in bathymetry map creation (for engineering purposes). Twenty eight (28) transects encompassing an array of terrace and channel formations will be selected for development of elevational profiles (figure 5). Elevation of the water bottom sediments will be determined along each transect in a similar fashion to that in the initial survey. Surveys will be conducted by a professional engineering firm in 2003 (immediately post-construction, funded by construction), and replicated in 2010, and 2017. Survey years may change to gather additional information earlier in the project life based on potential effectiveness of the project.

4. Digital Color Infrared Video Imagery

To document land to open-water ratios and marsh loss/gain rates in the project area, color infrared video imagery (1:12,000) will be obtained in the summer of 2004 (as built), 2007, and 2010. Imagery will be delineated to classify all land in the project area as either (1) preexisting wetlands, (2) vegetated and non-vegetated terraces, and (3) non-terrace, newly developed wetlands (i.e., those that develop in open water areas between the terraces or adjacent to the preexisting perimeter levees).

Anticipated Analyses and Hypotheses

The following describes comparisons, hypotheses, and statistical tests, if applicable, used to evaluate each of the Monitoring goals and thus effectiveness of the project.

1. Shoreline Survey: Shoreline position will be mapped and compared pre- and post-construction.

    Goal: 1) Evaluate the rate of erosion along the shoreline of the project area (Little White Lake and adjacent Little Vermilion Bay).

2. Terrace Vegetation: To evaluate marsh vegetation on terraces, we will use ANOVA to compare % occurrence and % cover of vegetation species as-built and at 3 periods post-construction. Data will be compared with the digital color infrared video imagery to verify vegetated to non-vegetated areas.

    Goal: 2) Evaluate establishment of emergent vegetation on planted terraces

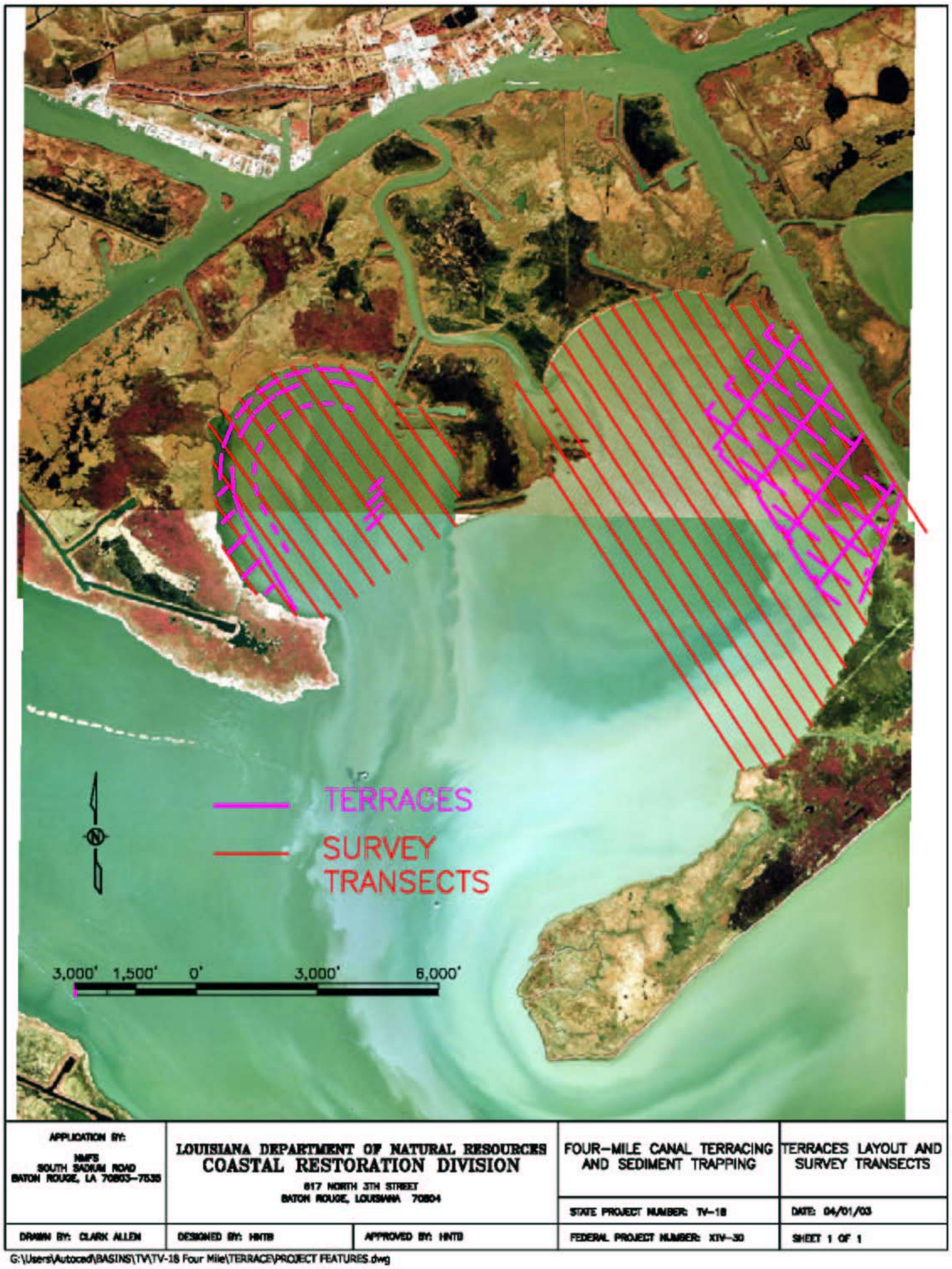

Figure 5. Layout for terraces and survey transects for Four-Mile Canal Terracing and Sediment Trapping (T/V-18).

Descriptive statistics will be used to characterize species distribution of marsh vegetation.

Hypothesis:

H^1_o: Species distribution of marsh vegetation post-construction will not be significantly greater than species distribution as built.

H^1_o: Species distribution of marsh vegetation post-construction will be significantly greater than species distribution as built.

H^2_o: Mean % occurrence and mean % cover of marsh vegetation species on planted terraces at 2 time-periods post-construction will not be significantly greater than mean % occurrence and mean % cover of marsh vegetation species as built.

H^2_a: Mean % occurrence and mean % cover of marsh vegetation species on planted terraces at 2 time-periods post-construction will be significantly greater than mean % occurrence and mean % cover of marsh vegetation species as built.

3. Bathymetry/Topography: Appropriate parametric and/or nonparametric methods will be used to test the following hypothesis.

   Goal: 3) Evaluate sediment deposition within the terraced project area.

   Descriptive statistics will be used on the bathymetry/topography contours to characterize the change in elevation.

Hypothesis:

H_o: Mean elevation of sediment between terraces in the terraced project area after project implementation will not be significantly greater than mean elevation of sediment between terraces as-built.

H_a: Mean elevation of sediment between terraces in the terraced project area after project implementation will be significantly greater than mean elevation of sediment between terraces as-built.

4. Digital Color Infrared Video Imagery: Data from video imagery and GIS interpretation will be used to estimate land-water ratios pre- and post-construction to evaluate marsh gains.

   Goal: 4) Evaluate land/water ratios with respect to initial and secondary land gains.

Notes

1)	Proposed Implementation:	Start Construction:	March 2003
		End Construction:	April 2004
2)	NMFS Project Manager:	John Foret	(337) 291-2107
3)	DNR Project Manager:	Gregory Grandy	(225) 342-6412
	DNR Construction/O&M Manager:	Herb Juneau	(337) 482-0684
	DNR Biological Monitoring Manager:	Christine Thibodeaux	(337) 482-0655
	DNR Ecological Review Manager:	Kyle Balkum	(225) 342-9429

4) The twenty year monitoring plan development and implementation budget for this project is $179,280. Comprehensive reports will be coordinated with the Teche Vermilion Basin reports scheduled for every three years beginning in 2007, and continuing every three years for the life of the project, in 2010, 2013, 2016, 2019, 2021. These reports will describe the status and effectiveness of the project.

5) Available ecological data, including both descriptive and quantitative data, will be evaluated in concert with the statistical analysis to aid in determination of overall project success. This includes ancillary data collected in the monitoring project but not used directly in statistical analysis, as well as data available from other sources (NMFS, ULL, LSU, etc.).

6) Bathymetry/Topography surveys that are scheduled by the operation and maintenance portion of the project will be paid through the Operations and Maintenance budget. Extensions of transect lines to cover monitoring needs will be covered under the Monitoring budget.

7) References:

Adams, R. D., P. J. Banas, R. H. Baumann, J. H. Blackmon, and W. G. McIntire. 1978. Shoreline erosion in coastal Louisiana: inventory and assessment. Baton Rouge: Louisiana Department of Transportation and Development, Coastal Resources Program. 139 pp.

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——— 1988. Vegetation type map of the Louisiana coastal marshes. Louisiana Department of Wildlife and Fisheries, New Orleans. Scale: 1:62,500.

——— 1978. Vegetation type map of the Louisiana coastal marshes. Louisiana Department of Wildlife and Fisheries, New Orleans. Scale: 1:62,500.

Chabreck, R. H., T. Joanen, and A. W. Palmisano 1968. Vegetation type map of the Louisiana coastal marshes. Louisiana Department of Wildlife and Fisheries, New Orleans. Scale: 1:62,500.

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National Oceanic and Atmospheric Administration 1998. Environmental Assessment of Little Vermilion Sediment Trapping. U. S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. Silver Springs, Maryland. 34 pp.

Rozas, L. P. and T. J. Minello 2001. Marsh Terracing as a wetland restoration tool for creating fishery habitat. Wetlands 21:327-341.

U. S. Army Corps of Engineers 1993. Rivers And Harbors Flood Control Projects Flood Control M. R. & T. Project Maps. New Orleans District, New Orleans, LA.

U. S. Department of Agriculture, Soil Conservation Service 1996. Soil Survey of Vermilion Parish, Louisiana. Publication No. 1996-405-693/20014/SCS. Washington, D.C.: U.S. Government Printing Office. 183 pp, 98 maps. Scale 1:20,000.

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U. S. Geological Survey, National Wetlands Research Center, National Biological Survey 1988/90. ME-19 Grand-White Lake Land Bridge Protection Habitat Type map data. Map ID: 2003-04-109. USGS/NWRC, Coastal Restoration Field Station, Baton Rouge, La. Unpublished data.

U. S. Geological Survey, National Wetlands Research Center, National Biological Survey 2003. ME-19 Grand-White Lake Land Bridge Protection Shoreline Change Analysis map data. Map ID: 2003-11-1781. USGS/NWRC, Coastal Restoration Field Station, Baton Rouge, La. Unpublished data.

8) Stratified Sampling Scheme:

Nabendu Pal
Department of Mathematics
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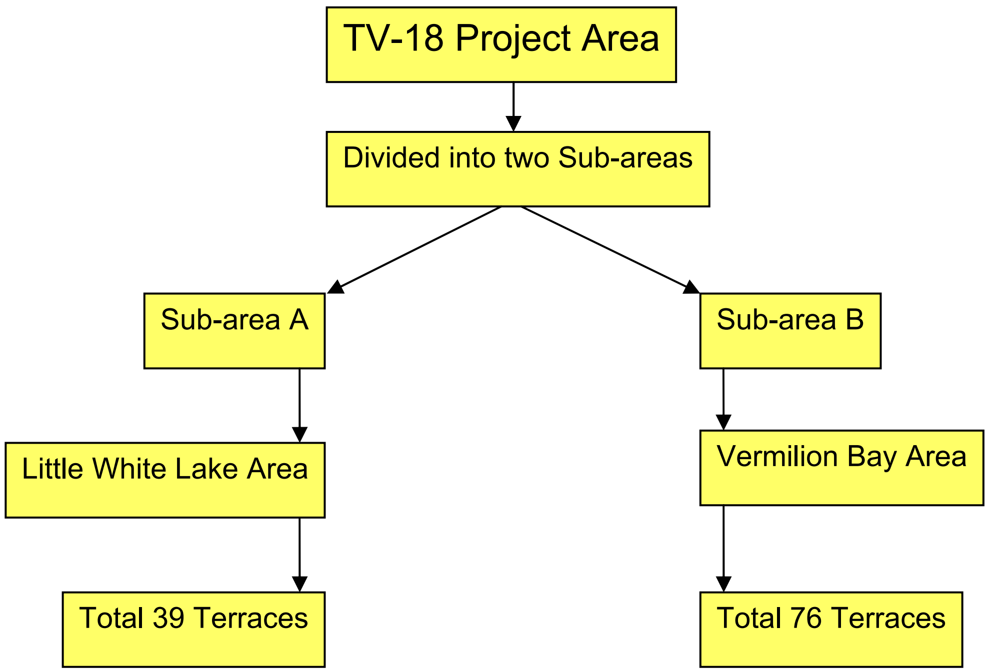
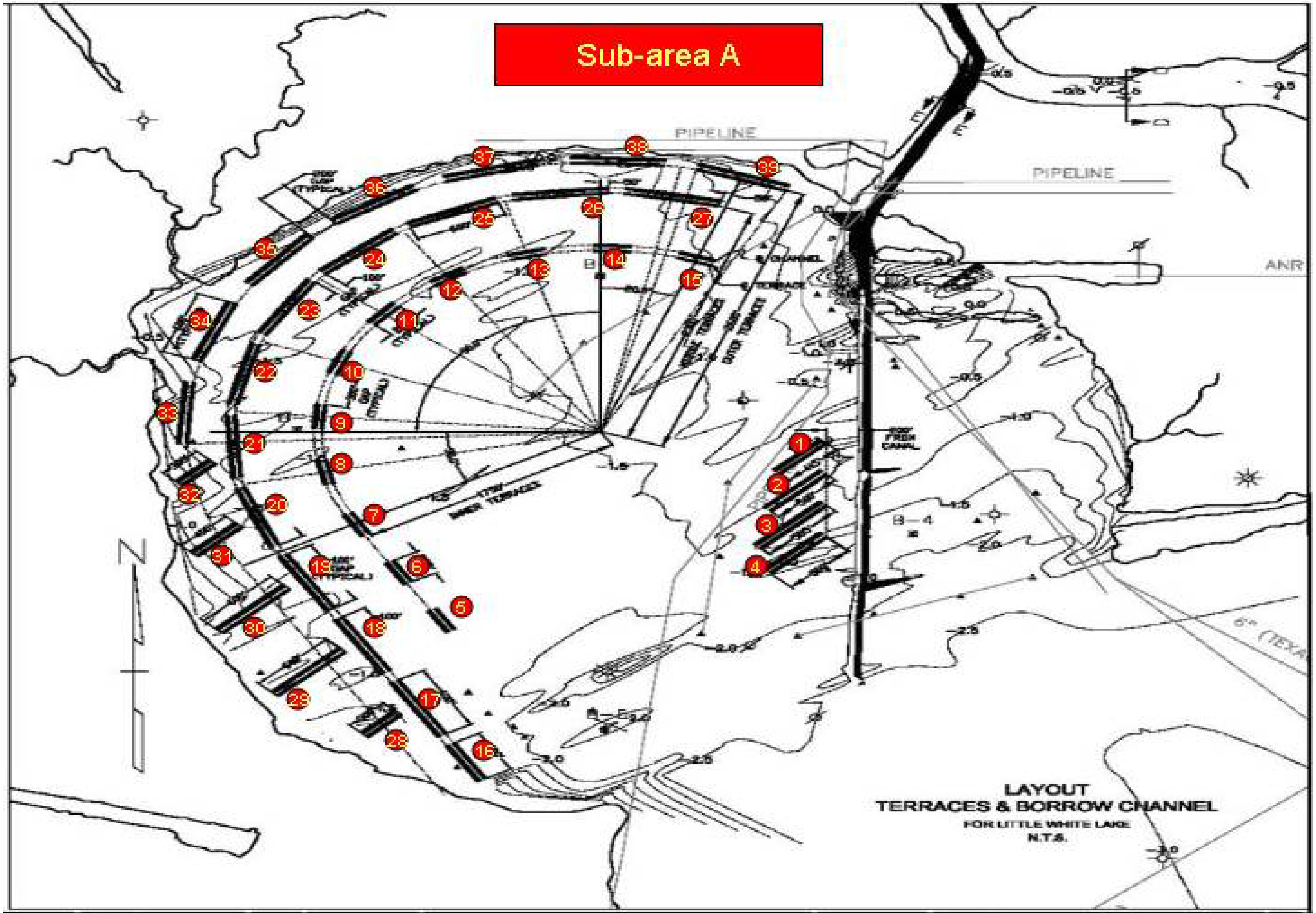
A Stratified Sampling Scheme for the Four-Mile Canal Terracing and Sediment Trapping Project (TV-18)



Approximate proportion of number terraces in A and B = 1:2.


Sub-area A
PIPELINE
PIPELINE
ANR
LAYOUT
TERRACES & BORROW CHANNEL
FOR LITTLE WHITE LAKE
N.T.S.

Sub-area A

Depending on the lay-out, divide the terraces into the following strata.

Stratum - 1: 1, 2, 3, 4 = subtotal 4

Stratum - 2: 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 = subtotal 11

Stratum - 3: 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27 = subtotal 12

Stratum - 4: 28, 29, 30, 31 = subtotal 4

Stratum - 5: 32, 33, 34, 35, 36, 37, 38, 39 = subtotal 8

Step – 1: Randomly select one terrace from each stratum. This yields a total of 5 terraces.

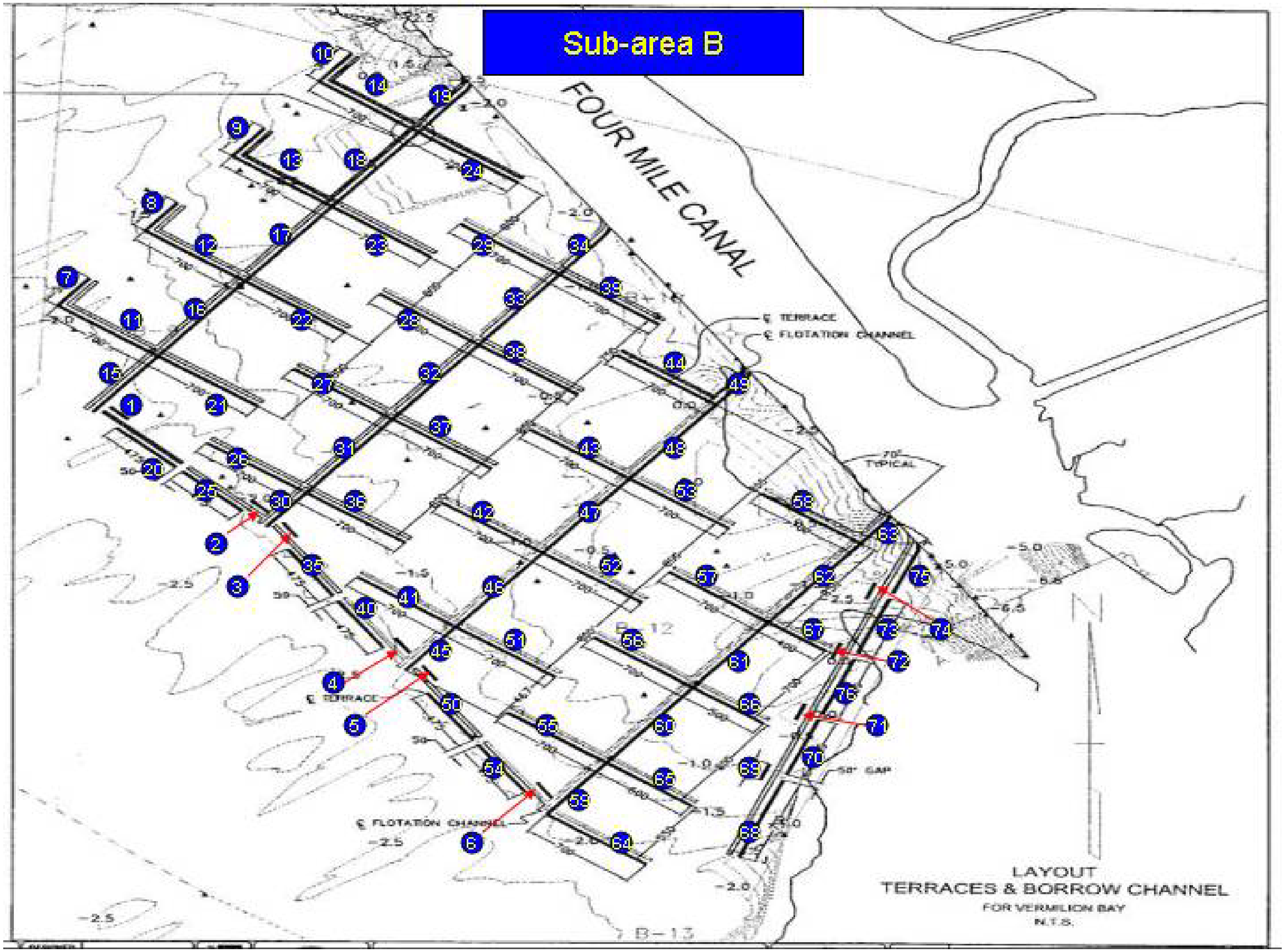
Step – 2: Number transect line(s): for a terrace in stratum - 1 = 2
for a terrace in stratum - 2 = 1
for a terrace in stratum - 3 = 2
for a terrace in stratum - 4 = 2
for a terrace in stratum - 5 = 2

The transect line(s) is/are to be selected randomly. If this is not possible, then locate the transect line(s) towards the middle (along the length) of the terrace.

Total number transect lines = 2 + 1 + 2 + 2 + 2 = 9.

Step – 3: Select total 3 plots across the terrace along a transect line. The plots are to represent inner slope, outer slope and the crown.

Total number sampling plots in Sub-area A = 9 x 3 = 27 plots.


Sub-area B
FOUR MILE CANAL
℄ TERRACE
℄ FLOTATION CHANNEL
70° TYPICAL
50' GAP
LAYOUT
TERRACES & BORROW CHANNEL
FOR VERMILION BAY
N.T.S.

Sub-area B

Divide the terraces into the following strata:

Stratum - 1: 1, 2, 3, 4, 5, 6 = subtotal 6

Stratum - 2: 7, 8, 9, 10 = subtotal 4

Stratum - 3: 11, 12, 13, 14, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 50, 51, 52, 53, 54, 55, 56, 57, 58, 64, 65, 66, 67 = subtotal 37

Stratum - 4: 15, 16, 17, 18, 19, 30, 31, 32, 33, 34, 45, 46, 47, 48, 49, 59, 60, 61, 62, 63, 68, 70, 73, 75, 76 = subtotal 25

Stratum - 5: 68, 70, 71, 73 = subtotal 4

<u>Step – 1:</u> Number terraces to be selected randomly: from stratum - 1 = 1

from stratum - 2 = 1

from stratum - 3 = 5

from stratum - 4 = 3

from stratum - 5 = 1

Total number terraces from Sub-area B = 11

Note: Stratum - 3 can further be stratified as

Stratum - 3a = 20, 25, 35, 40, 50, 54, 64

Stratum - 3b = 14, 24, 29, 39, 44, 58 = subtotal 6

Stratum - 3c = the rest of stratum - 3 = subtotal 25

Now select one terrace at random from Stratum - 3a, one terrace from Stratum - 3b, and three at random from stratum - 3c.

This sub-stratification of stratum - 3 is done because the terraces in stratum - 3a and 3b constitute a frontline and are expected to have higher damage than those in stratum - 3c.

<u>Step – 2:</u> Number transect line(s):

for a terrace in stratum - 1 = 1

for a terrace in stratum - 2 = 1

for a terrace in stratum - 3 = 2

for a terrace in stratum - 4 = 2

for a terrace in stratum - 5 = 1

So, total number transect lines = (1 x 1) + (1 x 1) + (5 x 2) + (3 x 2) + (1 x 1)

transect lines from stratum - 1

transect lines

transect lines from stratum - 3

transect lines

transect lines from stratum - 4

transect lines

= 1 + 1 + 10 + 6 + 1 = 19

<u>Step – 3:</u> Three plots from each transect lines, i.e., 19 x 3 = 57 plots.

NOTE: Proportion of plots from A & B = 27:57 which is approximately 1:2.