U.S. ARMY CORPS
OF ENGINEERS

Office of the Chief of Engineers
Value Engineering Study Team

VALUE ENGINEERING STUDY

SOUTHEAST LOUISIANA FLOOD CONTROL, ORLEANS PARISH, LA

(OLEANDER AND DUBLIN PUMP STATION AND CANALS)

DRAFT REPORT

Sponsored By:
U.S. Army Engineering District, New Orleans

June 1997

VALUE ENGINEERING TEAM STUDY
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VALUE ENGINEERING TEAM STUDY

PROJECT DESCRIPTION AND BACKGROUND

PROJECT TITLE:	Southeast Louisiana Project, Oleander – Dublin Pump Station and Canals
PROJECT LOCATION:	Orleans Parish, Louisiana

The Oleander - Dublin Drainage Area is in Orleans Parish and designated as Subbasin OE10. The Oleander Canal drains by gravity into Seventeenth Street Canal; and Dublin Canal, which is interconnected with Oleander Canal, drains by gravity into Washington/Palmetto Canal.

The current plan is designed to convey runoff generated by a rainfall with an intensity of 1 inch per hour. The proposed improvements will redirect all flow from the Oleander Canal into the suction basin of the Oleander Pumping Station. In order to accommodate redirected flows, two additional vertical pumps with a total capacity of 250 cfs is proposed for Oleander Pumping Station. The three existing pumping units, with a total capacity of 100 cfs, will be reconfigured to provide the necessary pumping rate during periods of low water flow and during the entire storm period. The operation of the pumping station will remain completely automated.

Oleander and Dublin Canals will be improved to increase their capacity. Oleander Canal will be enlarged to a 20-foot wide X 10-foot deep CBC between Dublin Street and General Ogden Street and a 24-foot wide X 10-foot deep CBC between General Ogden Street and Oleander Pumping Station. Dublin Canal will be changed from a large diameter pipe to a 6-foot wide X 5-foot deep CBC between Belfast Street and Palmetto Street.

The budgeted amount for this portion of the Southeast Louisiana Project is $24,909,000.

VALUE ENGINEERING TEAM STUDY
EXECUTIVE SUMMARY

The Value Engineering Study was conducted at the New Orleans District during the week of 2-6 June 1996.

The project was studied using the standard VE methodology, consisting of six phases: Information, Speculation, Analysis, Development, Presentation, and Implementation.

During the Information Phase, the Team studied the drawings, figures, descriptions of project work, and cost estimates to fully understand the work to be performed and the functions to be achieved. Cost Models were prepared to determine areas of relative high cost to ensure that the Team focused on those parts of the project which offered the most potential for cost savings. (See Appendix C.)

The Team performed the Speculation Phase by conducting a brainstorming session to generate ideas for alternative designs (see Appendix B). All Team Members were encouraged to contribute ideas.

Following the Speculation Phase, the Team analyzed these ideas and ranked them by priority for development. Ideas which did not survive critical analysis were deleted.

The selected priority ideas were developed for further definition. In addition to proposals, VE Team Comments are included for items of special interest, which were not developed as technical proposals, but offer enhancements to the project. The reader is encouraged to review these comments which follow the VE Study Proposals.

The summary of the VE recommendations is given on the following page.

OVEST will be available, if requested, to assist during the Implementation Phase of this Study.

VALUE ENGINEERING TEAM STUDY
SUMMARY OF RECOMMENDATIONS

Thirty-seven ideas for ways to improve the project or reduce costs were generated during the Speculation Phase of this study. The Analysis Phase of the study reduced the number of ideas to the following:

PROPOSAL NO.	DESCRIPTION	POTENTIAL SAVINGS
C-1	New Alignment from Dublin Along Olive to Joliet, Along Railroad Right-of-Way to Monticello	$3,003,800
C-2	New Alignment from Dublin Along Olive to Joliet, Along Railroad Right-of-Way to Monticello; Install New Submersible pump Station near Colapissa Street	$4,029,600
C-3	Optimize Culvert Sizes Using CIP or Pre-Cast Culverts	
C-3A		$1,534,000
C-3B		$2,226,000
C-3C		$1,861,000
C-3D		$2,206,000
C-4	Use Steel Sheet pile Walls with Concrete Facing and Concrete Invert and Top	$62,709
C-5	Use Vinyl Sheet Pile Shoring	$791,317
C-6	Use Submersible Pumps	$86,881
C-7	Use a Free-Standing Building at Oleander Pump Station	$47,523
C-8	Add Flap Gates to the Oleander Culvert	($27,000)
Commentary 3	Avoid Buying Residence	$150,000
	TOTAL POTENTIAL CUMULATIVE SAVINGS	$7,256,198

Total includes C-2, C-3B, C-5, -6, C-8, and Commentary 3.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: C-1 PAGE NO: 1 OF 6

DESCRIPTION: New Alignment from Dublin Along Olive to Joliet, Along Railroad Right-of-Way to Monticello

ORIGINAL DESIGN:

(See Drawing No. 1.) The current design considers several proposed alignments from Dublin to Oleander Pump Station, along Forshey, Oleander or Colapissa. Construction involves excavating existing streets, relocating utilities, installing larger box culverts and adding two additional pumps at the existing Oleander Pump Station.

PROPOSED DESIGN:

(See Drawing No. 2.) Install a culvert system along Olive Street from Dublin to Joliet. At Joliet, continue along the abandoned railroad right-of-way to Monticello. Locate additional pump station for the two new pumps at Monticello (Prichard and Live Oak, on the end of the railroad right-of-way). Pressure outfall will extend under Monticello and over the floodwall into 17th Street Canal.

ADVANTAGES:

1. Eliminates majority of utility relocation items.
2. Degrades existing railroad berm which currently blocks drainage.
3. Provides recreational area/jogging trail, after construction completion.
4. Avoids disruption of neighborhood access, traffic, sewerage and utilities.
5. Eliminate tearing up and repaving streets.
6. No disruption to existing Oleander drainage system or pump facility.
7. Allows greater potential for future expansion.

DISADVANTAGES:

None known.

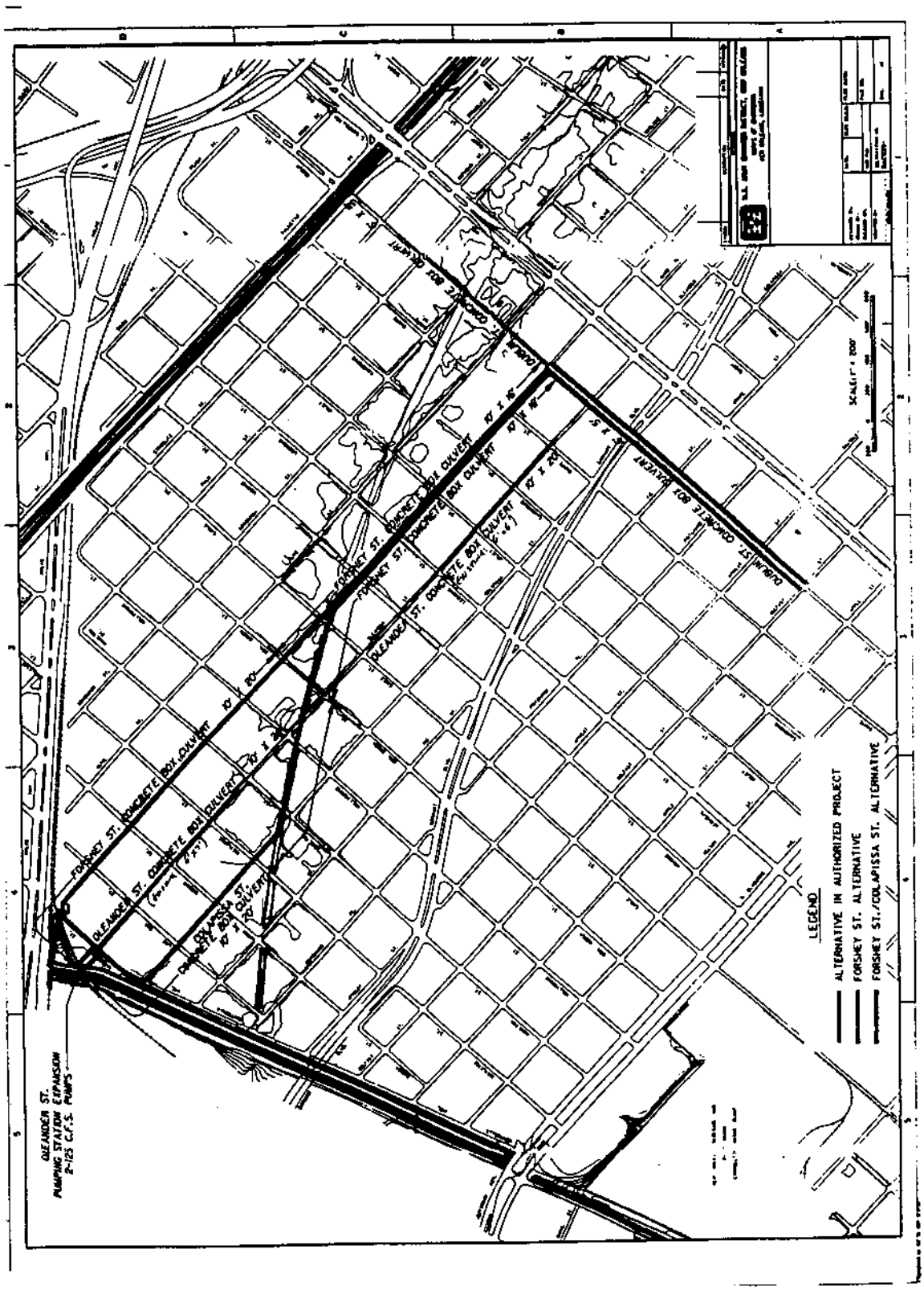
JUSTIFICATION:

Existing abandoned railroad right-of-way begs to be used for drainage improvement and upgrading of the neighborhood. Few utilities pass across the railroad right-of-way, so relocations costs will be eliminated. Although there will be an acquisition cost for the abandoned railroad right-of-way, that will be considerably less than the cost of deconstructing and reconstructuring any of the proposed street alignments. The railroad alignment traverses the area in such a way as to intercept flows crossing it from the south, providing additional advantage in drainage control. The existing Oleander Station will remain in place and functional without intervention during this entire project improvement. The completed project will provide a most needed greenbelt recreational area almost a mile long throughout this neighborhood.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: C-1 PAGE NO: 3 OF 6

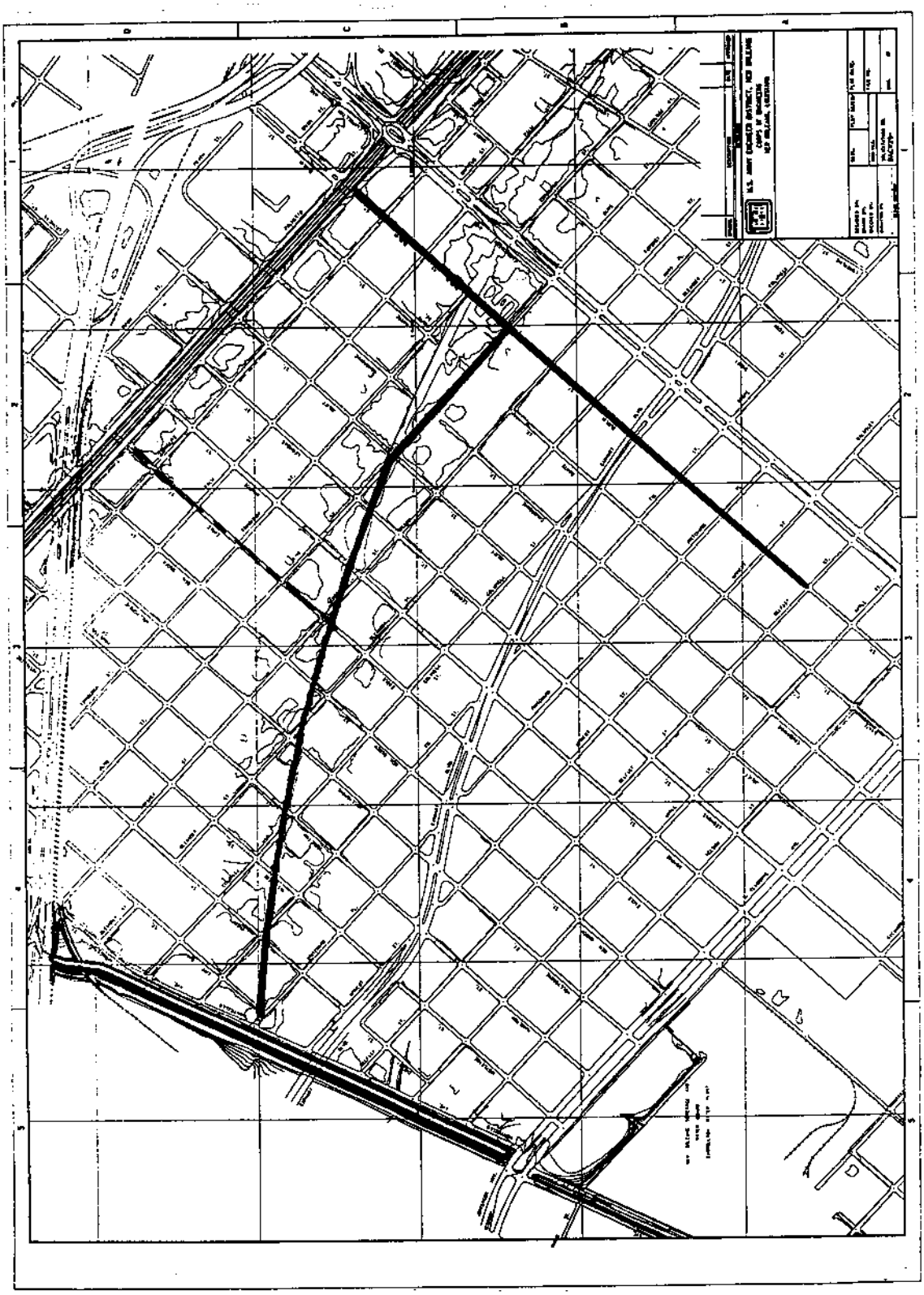
DRAWING NO. 1



VALUE ENGINEERING PROPOSAL

PROPOSAL NO: C-1 PAGE NO: 4 OF 6

DRAWING NO. 2



COST ESTIMATE WORKSHEET

PROPOSAL NO: C-1 PAGE NO: 5 OF 6

DELETIONS

ITEM	U/M	QTY	UNIT COST	TOTAL
Relocations (Roads)	LS	1	$1,100,000.00	$1,100,000
Relocations (Utilities)	LS	1	2,920,000.00	2,920,000
*Relocations (30/36" sewer main)	Blocks		--	--
TOTAL DELETIONS				$4,020,000

ADDITIONS

ITEM	U/M	QTY	UNIT COST	TOTAL
Real Estate Acquisitions	LS	1	$900,000.00	$900,000
Relocations (Roads)	LS	1	100,000.00	100,000
Relocations (Utilities)	LS	1	80,000.00	80,000
Dispose RR Fill	CY	40,000	5.00	200,000
**Relocations (50" water main)	LS	2	64,000.00	128,000
Relocations (30" sewermain)	Block	3	--	--
TOTAL ADDITIONS				$1,408,000

Net Savings (Deletes - Adds)	$2,612,000
Markups 15%	391,800
TOTAL SAVINGS	$3,003,800

Markups include E&D and S&A where applicable.

*These relocations along Oleander Street between Mistletoe and Livingston were not identified in the original project estimate. This cancels added cost of comparable relocation along Olive Street.
**From SELA estimate for Oleander relocations.

Note: This proposal does not include savings which will be realized by optimizing culverts to smaller sizes. Also, note the original estimate did not include cost of a building extension for housing pumps at Oleander Station. Therefore, no additional cost is added for a stand alone building and pump infrastructure.

THE FOLLOWING UTILITIES EXIST ALONG OLIVE STREET OR RAILROAD RIGHT-OF-WAY ALONG THE PROPOSED REALIGNMENT:

*	30" Sewer Main Along Olive Street
$64,000	50" Water Main Along Joliet Crossing Railroad Right-of-Way
$10,000	4" Water Line Along Forshey Crossing Railroad Right-of-Way
$30,000	20" Sewer Line along eagle Crossing Railroad Right-of-Way
$64,000	50" Water Main Along Gen. Ogden Crossing Railroad Right-of-Way
$13,000	12" Water Line Along Oleander Crossing Railroad Right-of-Way
$11,000	10" Sewer Line Along Mistletoe Crossing Railroad Right-of-Way
$13,000	12" Water Line Along Cherry Crossing Railroad Right-of-Way

COMMENT:

Proposal s Nos. C-1 and C-2 are compared to cost of Oleander Plan. Note that pipe sizes for this revised alignment can be smaller since the existing Oleander Channel will be left in place (as in the Forshey and Colapissa alignments). Note that no reduction of pipe sizes was considered in this proposal, so additional savings will be realized. No attempt was made to estimate the optimized pipe sizes, since this is currently being analyzed by Hydraulics.

*Cost was not identified in SELA estimate for 30/36" sewer main shown along Oleander from Mistletoe to Livingston.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: C-2 PAGE NO: 1 OF 6

DESCRIPTION: New Alignment from Dublin Along Olive to Joliet, Along Railroad Right-of-Way to Monticello; Install New Pump Station Near Street

ORIGINAL DESIGN:

(See Drawing No. 1.) The current design considers several proposed alignments from Dublin to Oleander Pump Station, along Forshey, Oleander or Colapissa. Construction involves excavating existing streets, relocating utilities, installing larger box culverts and adding two additional pumps at the existing Oleander Pump Station

PROPOSED DESIGN:

(See Drawing No. 2.) Install a culvert system along Olive Street from Dublin to Joliet. At Joliet, continue along the abandoned railroad right-of-way to Monticello. Locate additional pump station for the two new pumps near Colapissa Street (in the railroad right-of-way). This would allow a single 60" diameter outfall pipe to the Monticello Canal.

ADVANTAGES:

1. Eliminates majority of utility relocation items.
2. Degrades existing railroad berm which currently blocks drainage.
3. Provides recreational area/jogging trail, after construction completion.
4. Avoids disruption of neighborhood access, traffic, sewerage and utilities.
5. Eliminate tearing up and repaving streets.
6. No disruption to existing Oleander drainage system or pump facility.
7. Allows greater potential for future expansion.
8. No residential disturbance with submersible station.
9. Use of smaller pressure line versus gravity culvert for approximately 900'.

DISADVANTAGES:

Owner experience with submersible pump O&M has been negative.

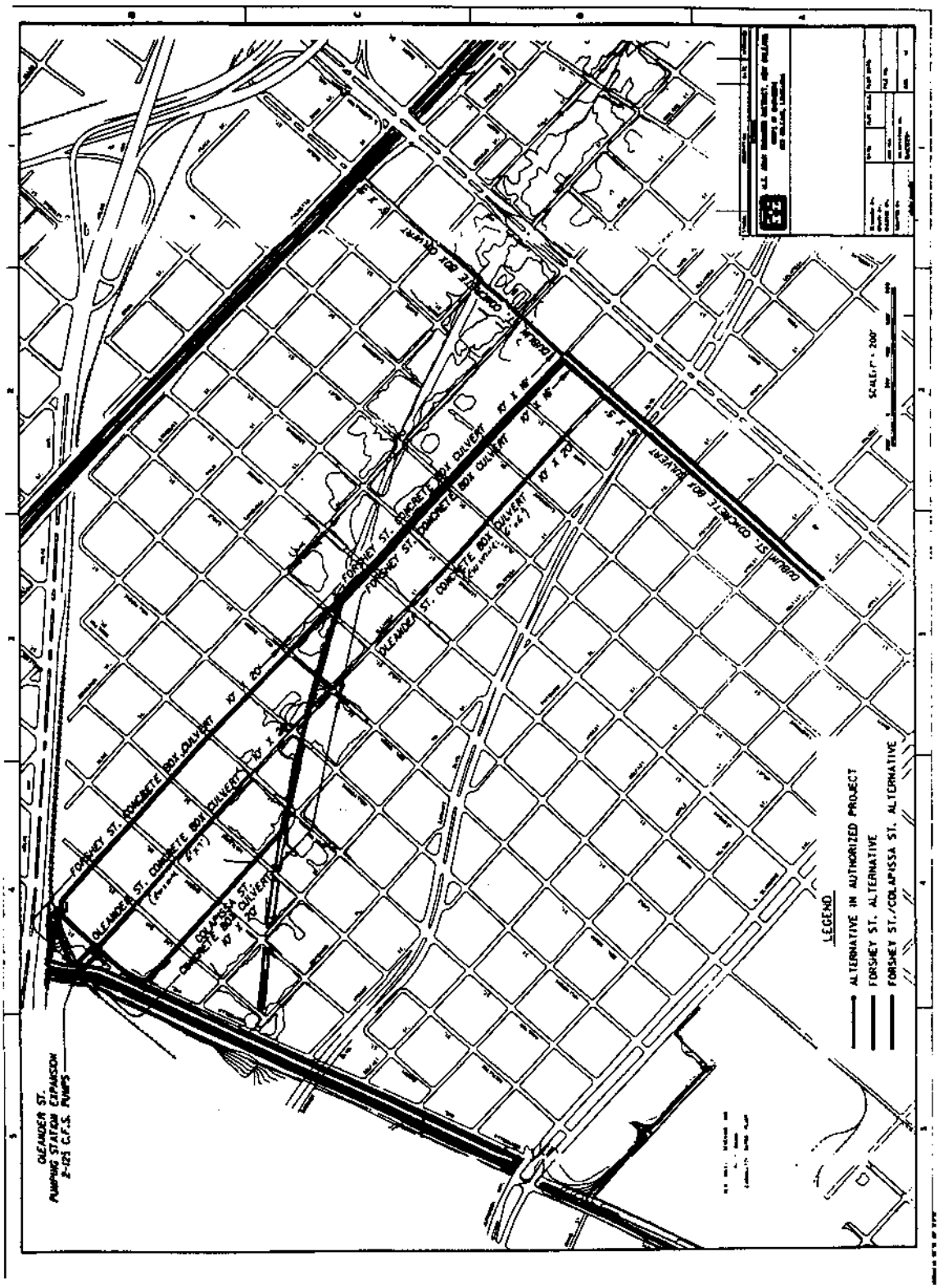
JUSTIFICATION:

Existing abandoned railroad right-of-way begs to be used for drainage improvement and upgrading of the neighborhood. Few utilities pass across the railroad right-of-way, so relocations costs will be eliminated. Although there will be an acquisition cost for the abandoned railroad right-of-way, that will be considerably less than the cost of deconstructing and reconstructuring any of the proposed street alignments. The railroad alignment traverses the area in such a way as to intercept flows crossing it from the south, providing additional advantage in drainage control. The existing Oleander Station will remain in place and functional without intervention during this entire project improvement. The completed project will provide a most needed greenbelt recreational area almost a mile long throughout this neighborhood.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: C-2

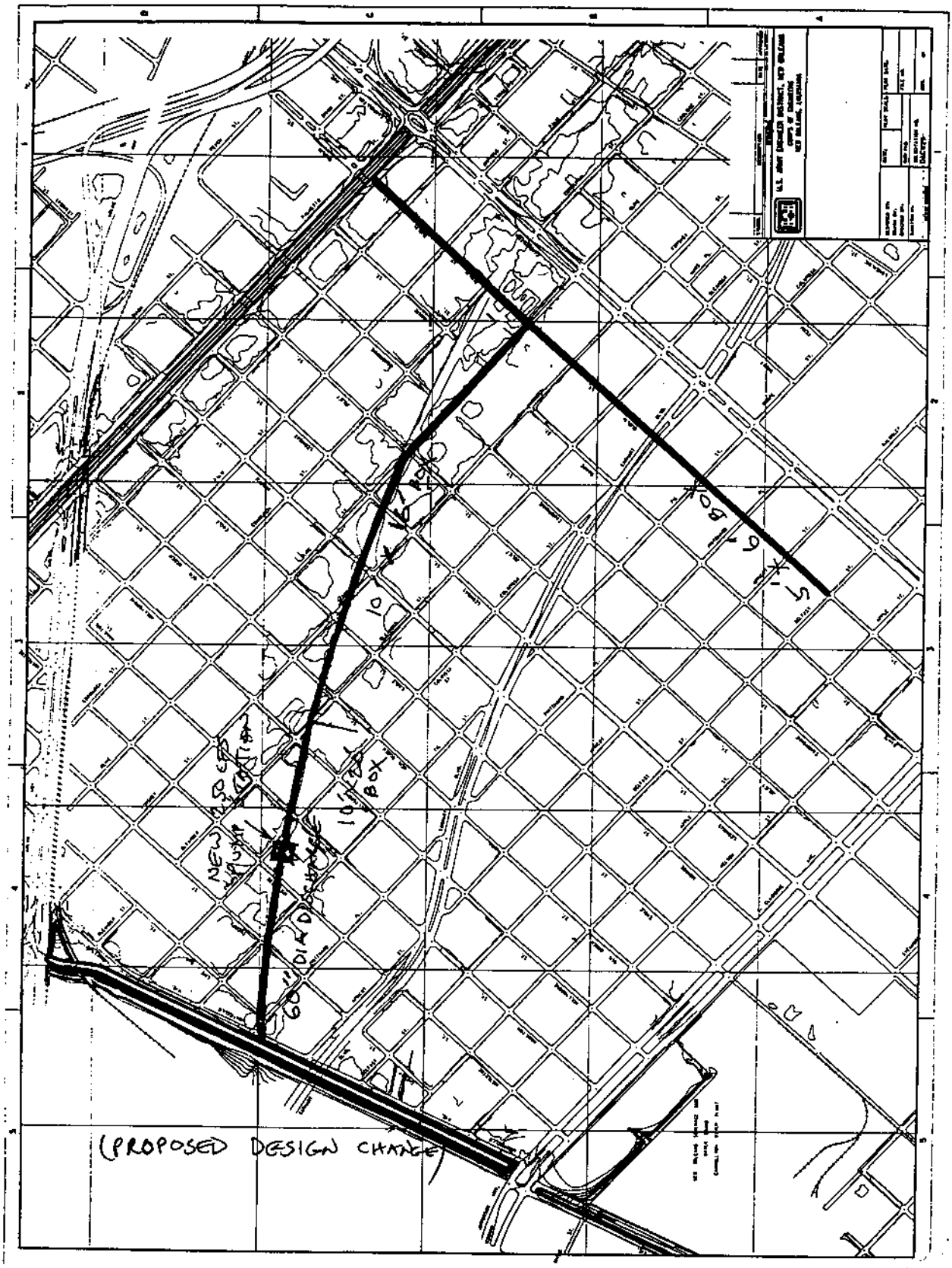
DRAWING NO. 1



VALUE ENGINEERING PROPOSAL

PROPOSAL NO: C-2

DRAWING NO. 2



COST ESTIMATE WORKSHEET

PROPOSAL NO: C-2

DELETIONS

ITEM	U/M	QTY	UNIT COST	TOTAL
Relocations (Roads)	LS	1	$1,100,000.00	$1,100,000
Relocations (Utilities)	LS	1	2,920,000.00	2,920,000
*Relocations (30/36" sewer main)	Blocks	3	--	--
10 X 20 Box Culvert				
(Slab Concrete)	CY	1,222	200.00	244,000
(Wall & Roof Concrete)	CY	1,963	330.00	648,000
TOTAL DELETIONS				$4,912,000

ADDITIONS

ITEM	U/M	QTY	UNIT COST	TOTAL
Real Estate Acquisitions	LS	1	$900,000.00	$900,000
Relocations				
30/36" Sewer Line	Blocks	3	--	--
(Roads)	LS	1	100,000.00	100,000
Relocations (Utilities)	LS	1	80,000.00	80,000
(50" Water Main)	EA	2	64,000.00	128,000
Real Estate Excavation				
and Disposal	CY	40,000	5.00	200,000
60" Diameter Discharge	LF	900	350.00	315,000
Outfall Structure	LS	1	100,000.00	100,000
TOTAL ADDITIONS				$1,408,000

Net Savings (Deletes - Adds)	$3,504,000
Markups 15%	525,600
TOTAL SAVINGS	$4,029,600

Markups include E&D and S&A where applicable.

*These relocations along Oleander Streetbetween Mistletoe and Livingston were not identified in the original project estimate. This cancels the added cost of comparable relocation along Olive Street.
**From SELA estimate for Oleander relocations.

Note: This proposal does not include savings which will be realized by optimizing culverts to smaller sizes. Also, note the original estimate did not include cost of a building extension for housing pumps at Oleander Station. Therefore, no additional cost is added for a stand alone building and pump infrastructure.

THE FOLLOWING UTILITIES EXIST ALONG OLIVE STREET OR RAILROAD RIGHT-OF-WAY ALONG THE PROPOSED REALIGNMENT:

*	30" Sewer Main Along Olive Street
$64,000	50" Water Main Along Joliet Crossing Railroad Right-of-Way
$10,000	4" Water Line Along Forshey Crossing Railroad Right-of-Way
$30,000	20" Sewer Line along eagle Crossing Railroad Right-of-Way
$64,000	50" Water Main Along Gen. Ogden Crossing Railroad Right-of-Way
$13,000	12" Water Line Along Oleander Crossing Railroad Right-of-Way
$11,000	10" Sewer Line Along Mistletoe Crossing Railroad Right-of-Way
$13,000	12" Water Line Along Cherry Crossing Railroad Right-of-Way

COMMENT:

Proposal s Nos. C-1 and C-2 are compared to cost of Oleander Plan. Note that pipe sizes for this revised alignment can be smaller since the existing Oleander Channel will be left in place (as in the Forshey and Colapissa alignments). Note that no reduction of pipe sizes was considered in this proposal, so additional savings will be realized. No attempt was made to estimate the optimized pipe sizes, since this is currently being analyzed by Hydraulics.

*Cost was not identified in SELA estimate for a comparable length of 30/36" sewer main shown along Oleander from Mistletoe to Livingston.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: C-3 PAGE NO: 1 OF 9

DESCRIPTION: Optimize Culvert Sizes Using CIP on Pre-Cast Culverts

ORIGINAL DESIGN:

(See Drawings Nos. 1 and 2.) The current design depicts three alternative alignments for this project -- the Oleander Street alignment, the Forshey Street alignment, and the Forshey/Colapissa Street alignment. Drawing No. 2 depicts about an 50% culvert fill. The series of proposals that follows (3A through 3D) optimizes the culvert sizes to flow full under the 10-year event considering cast-in-place or pre-cast culverts applied to the Oleander and Forshey Street alignments. The Forshey Street/Colapissa Street alignment was considered and proven unfeasible.

PROPOSED DESIGN:

(See Drawing No. 3.) This drawing, along with the table below, depicts the proposed culvert optimization:

PROPOSAL	ALIGNMENT	REPLACES CIP BOX CULVERT	WITH (CIP = Cast-in-Place; PC = Pre-Cast)
3A	Oleander	10 X 20 & 10 X 24	9 X 14 & 9 x 12 CIP
3B	Forshey	10 X 20 & 10 X 16	9 X 11 CIP & 9 X 9 PC
3C	Oleander	10 X 20 & 10 X 24	Two 9 X 9 & 8 X 8 PC
3D	Forshey	10 X 20 & 10 X 16	Two 8 X 8 PC & One 9 X 9 PC

ADVANTAGES:

Smaller culvert size reduces cost.

DISADVANTAGES:

1. Reduces project benefits above 1-year event.
2. May be under-designed if Pump Station No. 1 is significantly upgraded.

B/C Ratio is SELA plan

S&WB opposed to downsizing

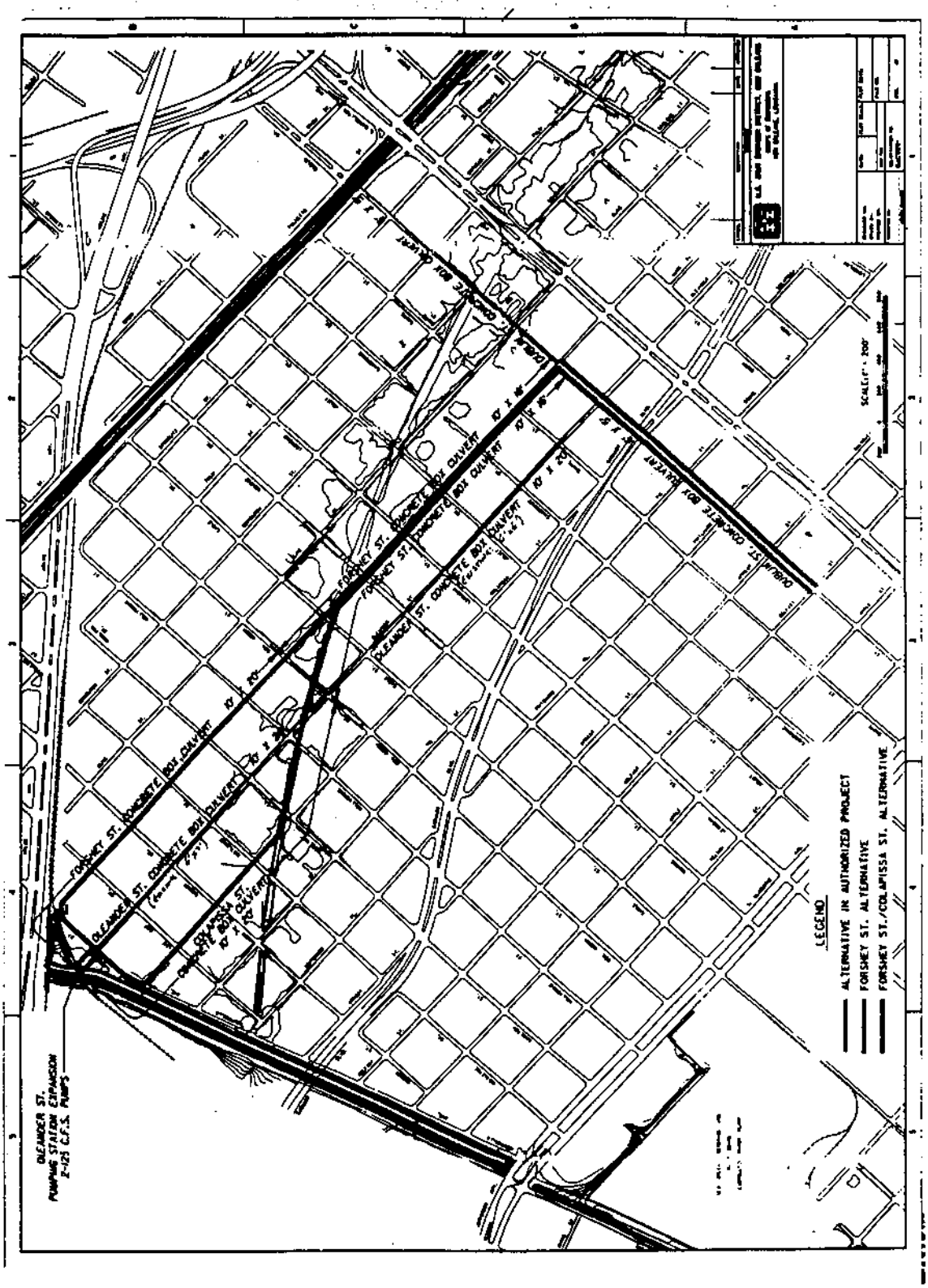
JUSTIFICATION:

Current hydraulic modeling indicates that the existing design of the Oleander (or Forshey) culvert will convey far in excess of a 10-year event (see Appendix E). The project could be optimized to convey a 10-year flow and reduce stages of larger events.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: C-3 PAGE NO: 3 OF 9

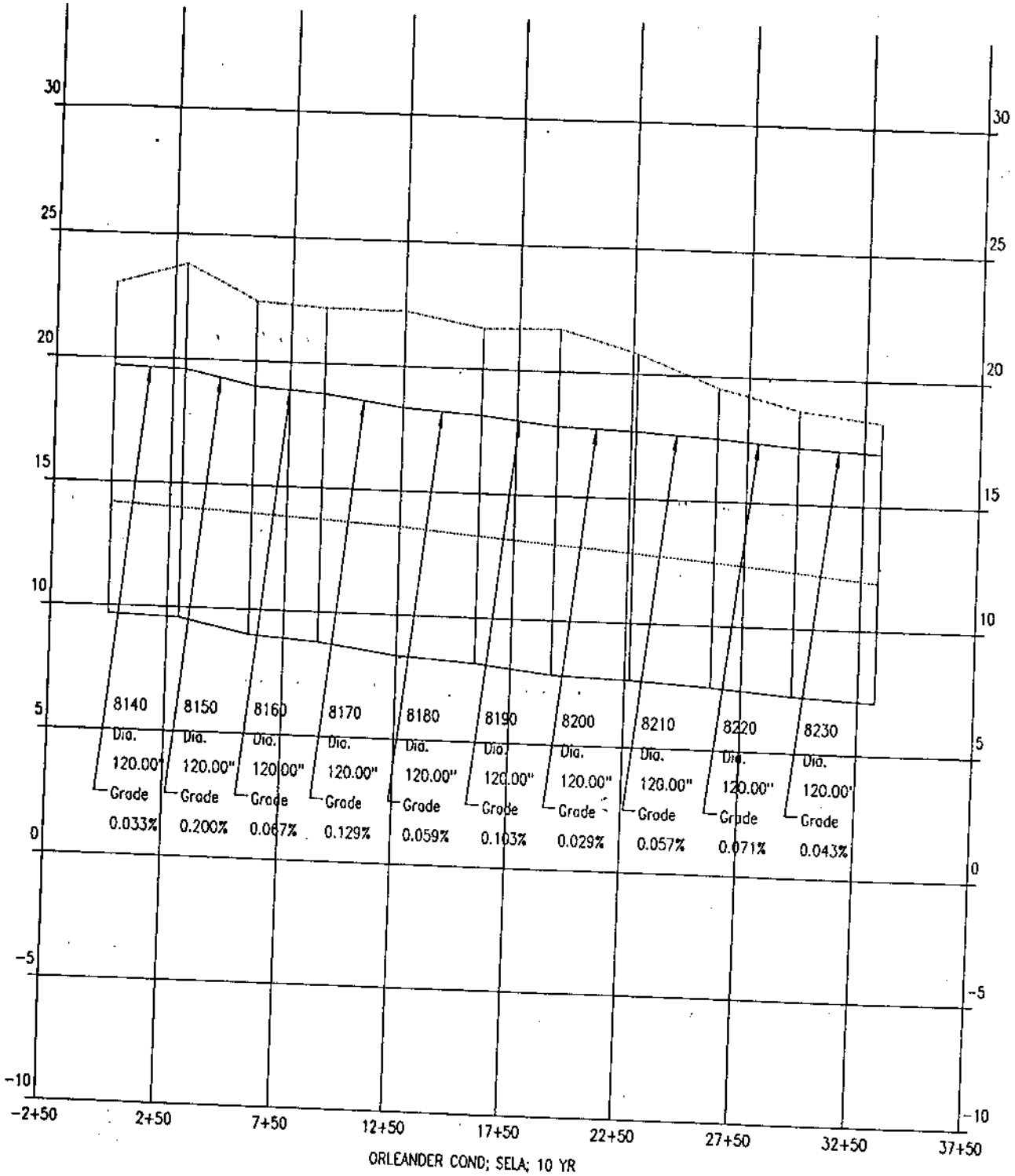
DRAWING NO. 1



VALUE ENGINEERING PROPOSAL

PROPOSAL NO: C-3

DRAWING NO. 2

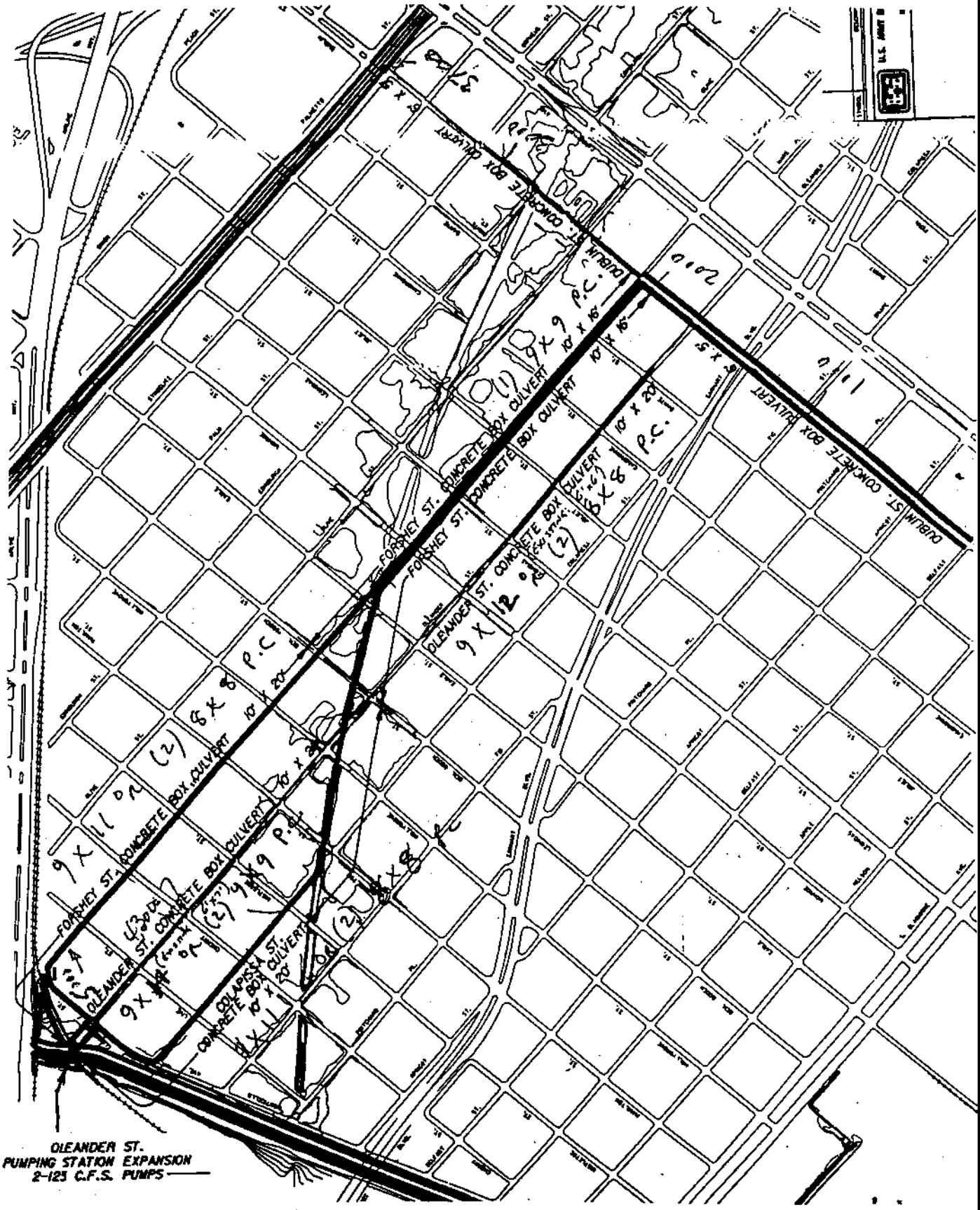


Orleander D.P.S. is pumping 350 cfs (PEAK)

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: C-3 PAGE NO: 5 OF 9

DRAWING NO. 3



COST ESTIMATE WORKSHEET

PROPOSAL NO: C-3A

DELETIONS

ITEM (Oleander)	U/M	QTY	UNIT COST	TOTAL
Wall and Roof Concrete	CY	9,714	$330.00	$3,206
Slab Concrete	CY	6,234	200.00	1,247,000
TOTAL DELETIONS				$4,453,000

ADDITIONS

ITEM	U/M	QTY	UNIT COST	TOTAL
Wall and Roof Concrete	CY	7,067	$330.00	$2,332,000
Slab Concrete	CY	3,933	200.00	787,000
TOTAL ADDITIONS				$3,119,000

Net Savings (Deletes - Adds)	$1,334,000
Markups 15%	200,000
TOTAL SAVINGS	$1,534,000

Markups include E&D and S&A where applicable.

T ESTIMATE WORKSHEET

PROPOSAL NO: C-3B

DELETIONS

ITEM (Forshey)	M	QTY	UNIT COST	TOTAL
Wall and Roof Concrete	:Y	9,444	$330.00	$3,206,000
Slab Concrete	:Y	5,778	200.00	1,156,000
House Acquisition	.S	1	150,000.00	150,000
TOTAL DELETIONS				$4,423,000

ADDITIONS

ITEM	M	QTY	UNIT COST	TOTAL
Wall and Roof Concrete	:Y	3,472	$330.00	$1,146,000
Slab Concrete	:Y	1,806	200.00	361,000
9 X 9 Pre-Cast Concrete Box Culvert	.F	2,450	400.00	980,000
TOTAL ADDITIONS				$2,487,000

Net Savings (Delete:	ds)	$1,936,000
Markups 15%		290,000
TOTAL SAVINGS		$2,226,000

Markups include E&D and where applicable.

COST ESTIMATE WORKSHEET

PROPOSAL NO: C-3C

DELETIONS

ITEM (Oleander)	U/M	QTY	UNIT COST	TOTAL
Wall and Roof Concrete	CY	9,714	$330.00	$3,206
Slab Concrete	CY	6,234	200.00	1,247,000
TOTAL DELETIONS				$4,453,000

ADDITIONS

ITEM	U/M	QTY	UNIT COST	TOTAL
(2) 9 X 9 Pre-Cast Concrete Box Culvert	LF	2,500	650.00	1,625,000
(2) 8 X 8 pre-Cast Concrete Box Culvert	LF	2,220	550.00	1,210,000
TOTAL ADDITIONS				$2,835,000

Net Savings (Deletes - Adds)	$1,618,000
Markups 15%	243,000
TOTAL SAVINGS	$1,861,000

Markups include E&D and S&A where applicable.

COST ESTIMATE WORKSHEET

PROPOSAL NO: C-3D

DELETIONS

ITEM (Forshey)	U/M	QTY	UNIT COST	TOTAL
Wall and Roof Concrete	CY	9,444	$330.00	$3,117,000
Slab Concrete	CY	5,778	200.00	1,156,000
TOTAL DELETIONS				$4,273,000

ADDITIONS

ITEM	U/M	QTY	UNIT COST	TOTAL
(2) 8 X 8 Pre-Cast Concrete Box Culvert	LF	2,500	$550.00	$1,375,000
(1) 9 X 9 Pre-Cast Concrete Box Culvert	LF	2,450	400.00	980,000
TOTAL ADDITIONS				$2,355,000

Net Savings (Deletes - Adds)	$1,918,000
Markups 15%	288,000
TOTAL SAVINGS	$2,206,000

Markups include E&D and S&A where applicable.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: C-4 PAGE NO: 1 OF 5

DESCRIPTION: Use Steel Sheet Pile Walls with Concrete Facing and Concrete Invert and Top

ORIGINAL DESIGN:

The current plan provides piled founded concrete box culverts for approximately 4,650 LF along Oleander Street (10' X 20' or 10' X 24' CBC). Shoring for excavation will include steel sheet pile off-set approximately 4' behind culvert walls to facilitate forming and casting of reinforced concrete walls. Two alternative alignments are being considered using Forshey Street to Livingston/Monticello Alternative 2 (4,950 LF) or Forshey to Eagle Street, then along the former railroad right-of-way to Colapissa Street Alternative 3 (5,100 LF). The two later alternatives are smaller as Oleander's existing box culvert remains in place. (See Drawing No. 1.)

PROPOSED DESIGN:

It is recommended that an alternative box culvert design be developed using steel sheet pile walls with concrete facing and a concrete slab invert along with a reinforced concrete top. Box culvert size will match the selected alignment alternatives 1, 2, or 3 (see Drawing No. 2).

ADVANTAGES:

1. Construction sequencing is not limited to available sheet pile shoring.
2. Faster construction staging will generate a more favorable bid climate.
3. Excavation and dewatering is limited to actual box culvert sized (cost for both are reduced).
4. A similar design has been proposed for Napoleon Reach 1 with alternatives for Claibrone Avenue.
5. Contractors may develop further cost avoidance using a mix of shorter drive and pull shoring techniques.

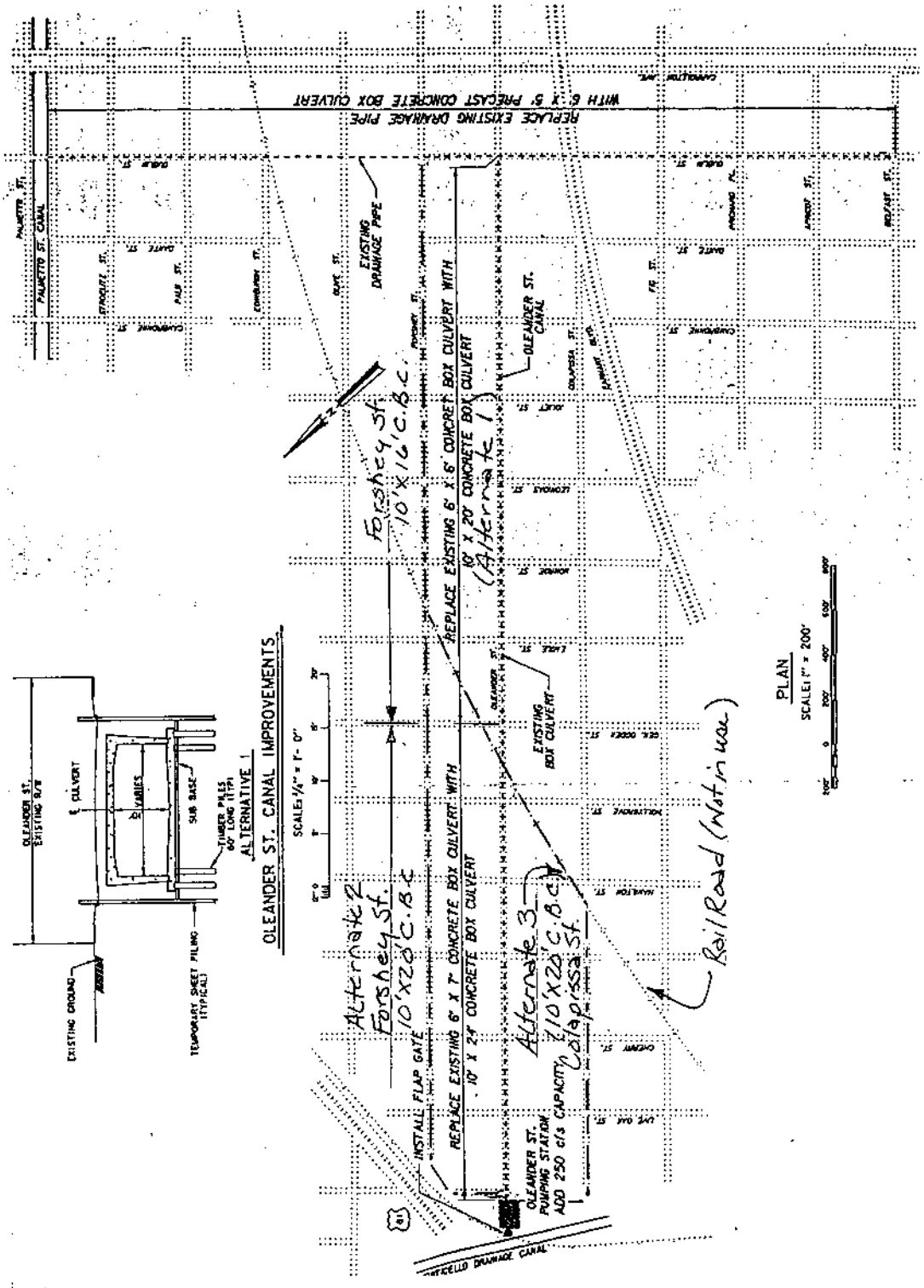
DISADVANTAGES:

None known.

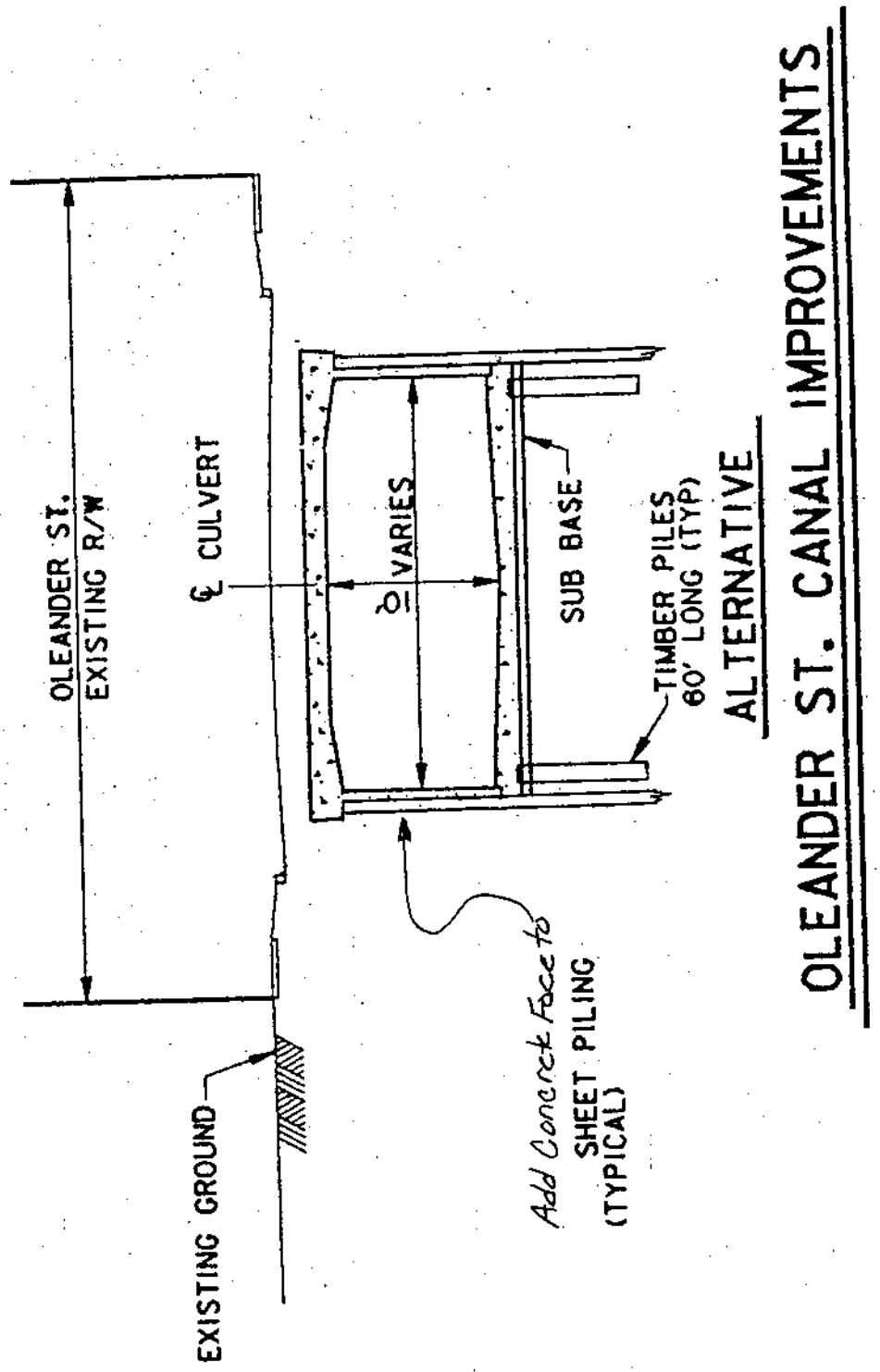
JUSTIFICATION:

This scheme will reduce construction steps, simplify construction, and accelerate culvert placement and project completion. Estimated savings based solely on unit price comparison do not reflect favorable bidding which recognizes time and effort savings. It is strongly recommended that a design option be provided to capture potential savings due to increased construction efficiency. Potential savings may range from $62,709 to $324,586.

DRAWING NO. 1


REPLACE EXISTING DRAINAGE PIPE WITH 6' X 5' PRECAST CONCRETE BOX CULVERT
EXISTING DRAINAGE PIPE
REPLACE EXISTING 6' X 6' CONCRETE BOX CULVERT WITH 10' X 20' CONCRETE BOX CULVERT (Alternate 1)
Foreshey St. 10'X16'C.B.C.
REPLACE EXISTING 6' X 7' CONCRETE BOX CULVERT WITH 10' X 24' CONCRETE BOX CULVERT
Alternate 2 Foreshey St. 10'X28'C.B.C.
Alternate 3 2-10'X22'C.B.C. Calpirsa St.
INSTALL FLAP GATE
OLEANDER ST. PUMPING STATION ADD 250 cfs CAPACITY
Rail Road (Not in use)
OLEANDER ST. CANAL
PALMETTO ST. CANAL
EXISTING BOX CULVERT
PLAN
SCALE: 1" = 200'
OLEANDER ST. CANAL IMPROVEMENTS
ALTERNATIVE 1
SCALE: 1/4" = 1'-0"
OLEANDER ST. EXISTING R/W
℄ CULVERT
VARIES
SUB BASE
TIMBER PILES 60' LONG (TYP)
EXISTING GROUND
TEMPORARY SHEET PILING (TYPICAL)

DRAWING NO. 2



OLEANDER ST. CANAL IMPROVEMENTS

ALTERNATIVE

COST ESTIMATE WORKSHEET

PROPOSAL NO: C-4

DELETIONS

ITEM (Oleander Street)	U/M	QTY	UNIT COST	TOTAL
PZ-22	SF	45,956	$12.50	$574,450
Steel Sheet Pile (Dr/Pull)	SF	321,694	5.00	1,608,470
Excavation	CY	16,175	5.00	80,875
Backfill	CY	16,175	11.00	177,925
12" Cement/Stone	CY	522	30.00	15,660
6" Sand	CY	261	15.00	3,915
Concrete Base	CY	1,565	200.00	313,000
Treat Timber Piles	LF	71,550	10.00	715,500
Concrete Wall Forms (1 Side)	SF	93,920	7.50	740,400
Concrete Wall (½ thickness)	SY	1,740	330.00	640,200
TOTAL DELETIONS				$4,870,395

ADDITIONS

ITEM	U/M	QTY	UNIT COST	TOTAL
PZ-22 (Drive - Leave-In-Place)	SF	321,694	$15.00	$4,825,410
*Alternative:				
PZ-22 (35' - 5' Below Grade)		241,270	15.00	3,619,050
PZ-22 (2nd Shoring)		111,600	5.00	558,000
System 15' Long		36,840	12.50	460,500
Drive & Pull				
TOTAL ADDITIONS				$4,825,410

Net Savings (Deletes - Adds)	$44,985
Markups 39.4%	17,724
TOTAL SAVINGS	$62,709

Markups include contingencies E&D and S&A where applicable.

*Alternative: Savings = $4,870,395 - $4,637,550 = $232,845 + Markups (39.4%) = $324,586

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: C-5 PAGE NO: 1 OF 3

DESCRIPTION: Use Vinyl Sheet Pile Shoring

ORIGINAL DESIGN:

The current construction plan for excavation and construction of concrete box culverts and provides shoring of excavations using PZ-22 steel sheet pile. The current plan identified a 6' X 5' pre-cast box culvert for Dublin Street (3,700 LF). (See Drawing No. 1.)

PROPOSED DESIGN:

It is recommended that vinyl sheet pile be used for excavation shoring in lieu of PZ-22 steel sheet pile. The vinyl sheet pile option serve as shoring and support dewatering during construction. Vinyl sheet pile can be driven and remain in place (no pulling for re-use).

ADVANTAGES:

1. Eliminated use of costly steel sheet pile.
2. Simplified transportation and handling of lightweight vinyl sheet pile.
3. Flexibility in excavated reaches (not limited to available steel sheet pile).

DISADVANTAGES:

Bracing is required for exposed excavation.

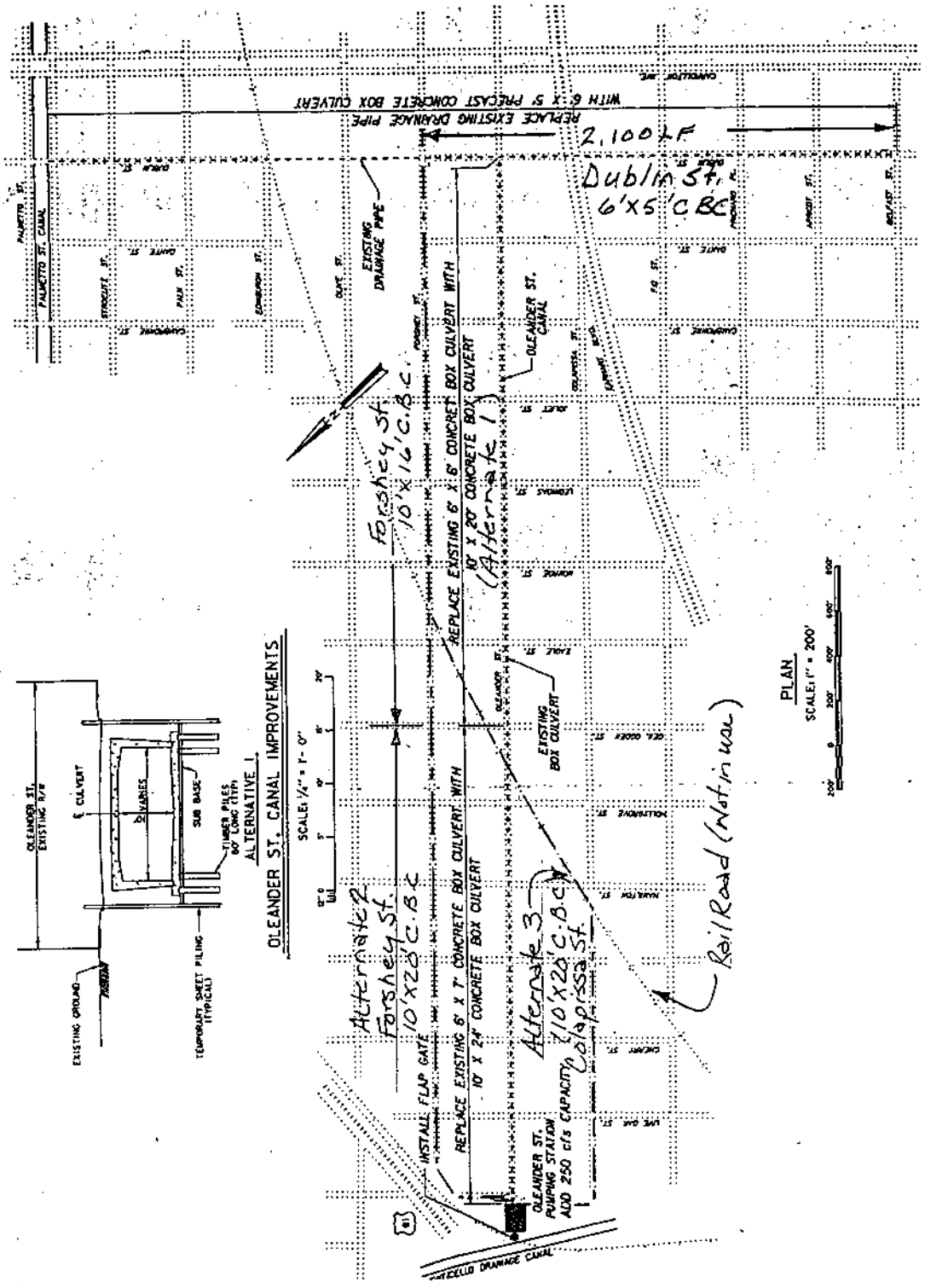
JUSTIFICATION:

Vinyl sheet pile capabilities can be analyzed for trench shoring for these project reaches. Vinyl sheet pile will enhance construction using lighter weight materials for transportation and handling. Lower cost vinyl can be left in place eliminating pulling for re-use (by PZ-22). See Appendix E for technical information on vinyl sheet pile.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: C-5 PAGE NO: 2 OF 4

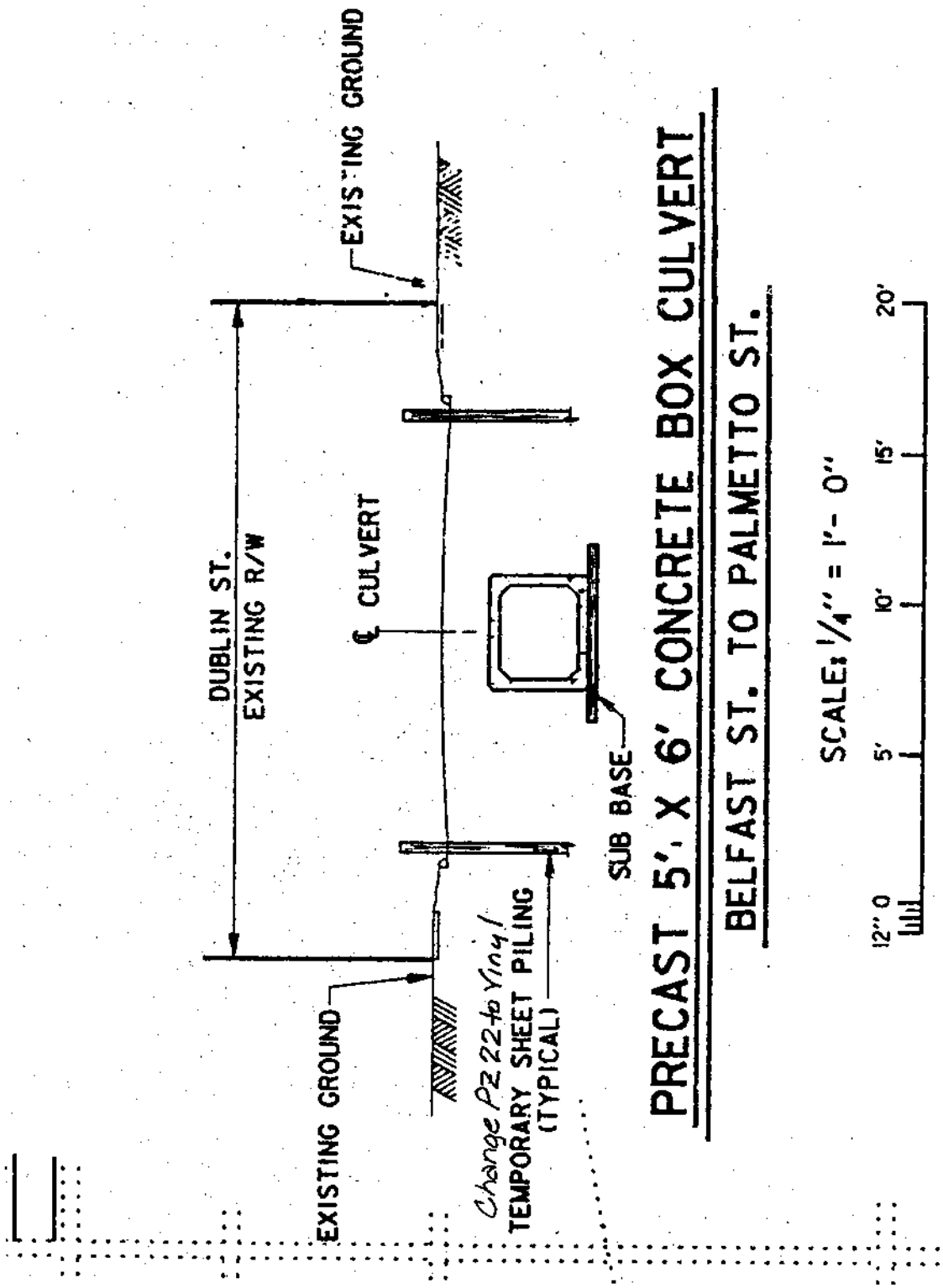
DRAWING NO. 1



VALUE ENGINEERING PROPOSAL

PROPOSAL NO: C-5 PAGE NO: 3 OF 4

DRAWING NO. 2



COST ESTIMATE WORKSHEET

PROPOSAL NO: C-5 PAGE NO: 4 OF 4

DELETIONS

ITEM	U/M	QTY	UNIT COST	TOTAL
Steel Sheet Pile				
Dublin PZ-22	SF	25,467	$12.50	$318,338
Dublin Dr/Pull		SF	152,800	5. 0 0
764,000				
TOTAL DELETIONS				$1,082,338

ADDITIONS

ITEM	U/M	QTY	UNIT COST	TOTAL
Vinyl Sheet Pile				
Dublin -- VSP	SF	25,467	$5.00	$127,335
Dublin Dr Only	SF	152,800	2.50	382,000
TOTAL ADDITIONS				$509,335

Net Savings (Deletes - Adds)	$573,003
Markups 38.1%	218,314
TOTAL SAVINGS	$791,317

Markups include Contractor's markup for Contingencies (20%), E&D (15%) and S&A where applicable.

Using Forshey Street:
Alternate 2 and Alternate 3: [2,100 LF = $56.8% X $791,317 = $449,468 / 3,700 LF]

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: C-6 PAGE NO: 1 OF 4

DESCRIPTION: Use Submersible Pumps

ORIGINAL DESIGN:

The current design concept calls for the addition of two 125 CFS vertical lift pumps to the existing Oleander Pump Station. Drawing No. 1 depicts the existing pump station plan. The placement of the two proposed additional pumps is not shown. These additional pumps increase the Oleander pump capacity to 350 CFS.

PROPOSED DESIGN:

(See Drawing No. 2.) This proposal suggests employing submersible pumps. This proposal not only applies to the existing design adjacent to the existing pump station but also to Proposals C-1, C-2, and C-3.

ADVANTAGES:

1. Reduced first cost.
2. Presents a better aesthetic appearance (low profile).

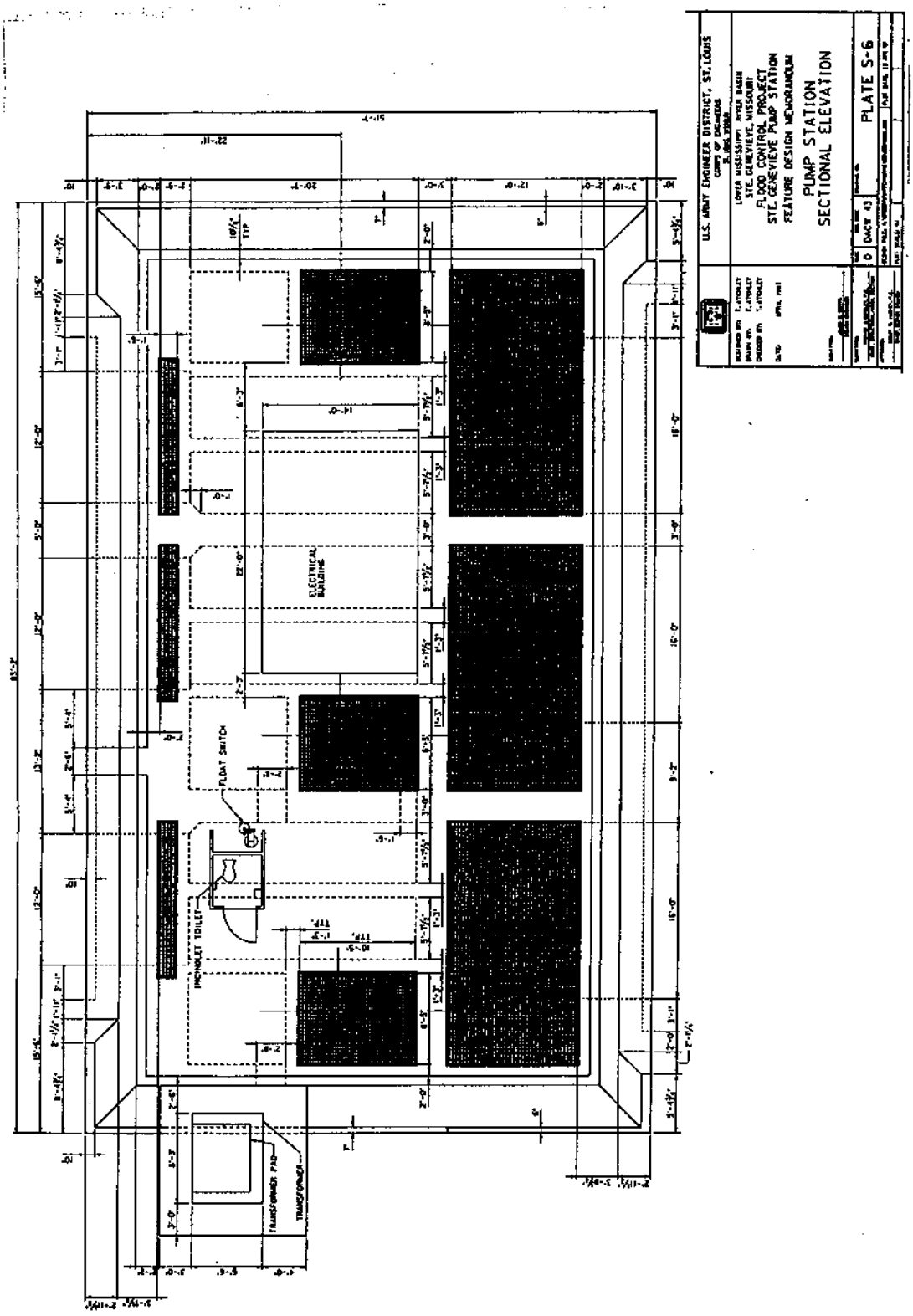
DISADVANTAGES:

None known.

JUSTIFICATION:

A reduced first cost as well as an aesthetic appearance (low profile) offers a better project.

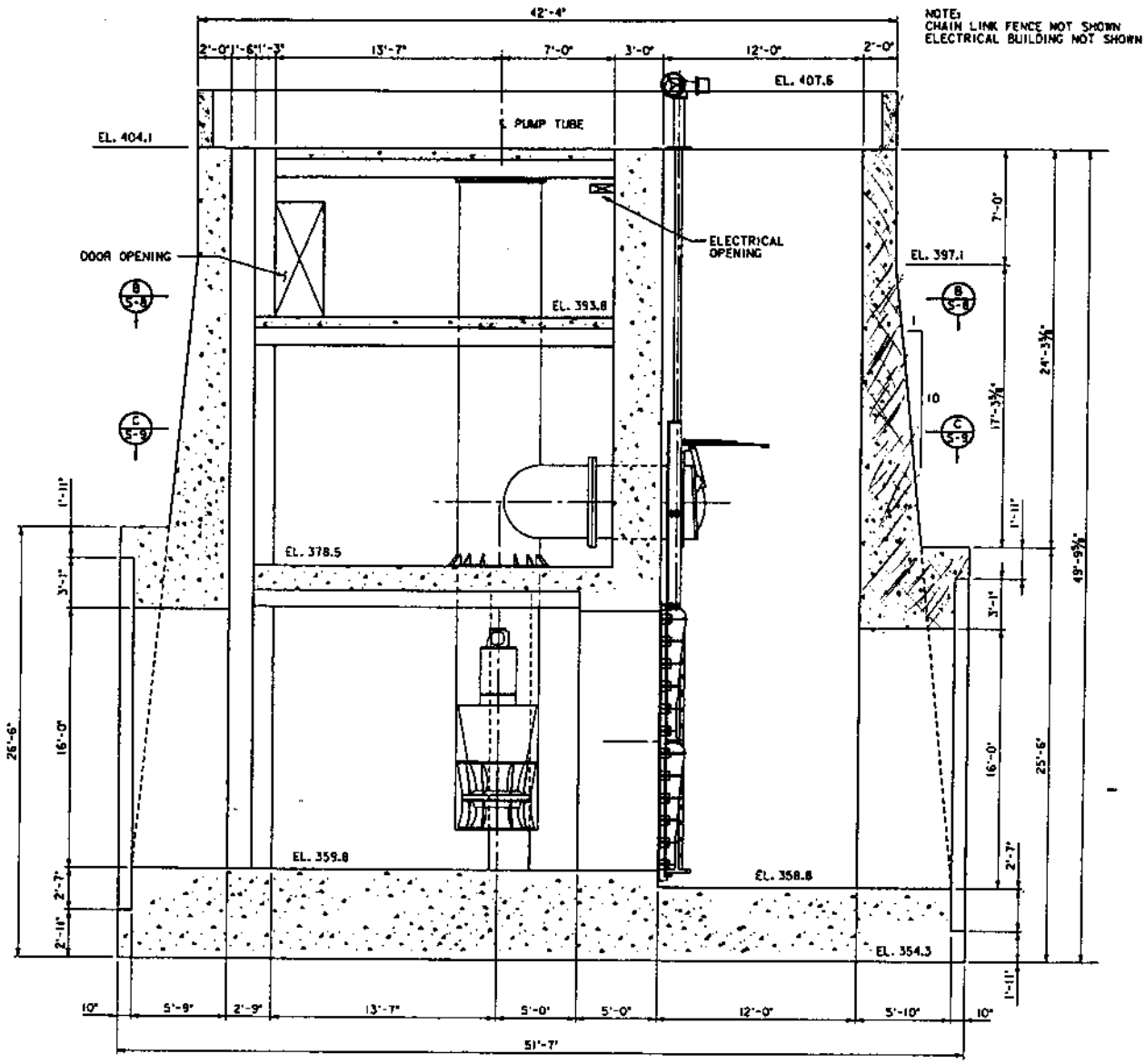
DRAWING NO. 1


U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
LOWER MISSISSIPPI RIVER BASIN
STE. GENEVIEVE, MISSOURI
FLOOD CONTROL PROJECT
STE. GENEVIEVE PUMP STATION
FEATURE DESIGN MEMORANDUM
PUMP STATION
SECTIONAL ELEVATION
PLATE S-6
ELECTRICAL BUILDING
FLOAT SWITCH
INCINOLET TOILET
TRANSFORMER PAD
TRANSFORMER

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: C-6 PAGE NO: 3 OF 4

DRAWING NO. 2



A SECTIONAL ELEVATION S-9

SCALE: 1/4" = 1'-0"

DRAWING IS TYPICAL (AS ARE DIMENSIONS) AND IS FOR ILLUSTRATIVE PURPOSES ONLY

COST ESTIMATE WORKSHEET

PROPOSAL NO: C-6 PAGE NO: 4 OF 4

DELETIONS

ITEM	U/M	QTY	UNIT COST	TOTAL
Demolition of Portion of Existing Building	LS	1	$15,000.00	$15,000
Masonry Building	SF	680	80.00	54,400
Crane Extension	LS	1	5,725.0	$5,725
TOTAL DELETIONS				$75,125

ADDITIONS

ITEM	U/M	QTY	UNIT COST	TOTAL
TOTAL ADDITIONS				$0

Net Savings (Deletes - Adds)	$75,125
Markups 15%	11,756
TOTAL SAVINGS	$86,881

Markups include S&I.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: C-7 PAGE NO: 1 OF 2

DESCRIPTION: Use a Free-Standing Building at Oleander Pumping Station

ORIGINAL DESIGN:

The current design intent is to expand the existing plant. The existing building is an elevated, masonry building housing three electrically driven pumps. This building also includes an overhead electric crane.

PROPOSED DESIGN:

This proposal recommends using a free-standing pre-engineered building to house the two new 125 CFS pumps. A 5-ton overhead electric crane will also be included. This proposal will eliminate demolition of a portion of the existing pump station and construct a more cost effective building. The location of this free-standing pump station has not been defined in this proposal.

ADVANTAGES:

1. First cost savings.
2. Simplify construction.
3. Leaves the existing pumping plant intact and available for flood protection.

DISADVANTAGES:

The pre-engineered building will not offer the same architectural appearance as the existing building.

JUSTIFICATION:

This proposal meets the project requirements at a reduced cost and the use of a pre-engineered building is consistent with the pump stations being designed for Peoples Triangle Pumping Station and Dwyer Road Pumping Station.

COST ESTIMATE WORKSHEET

PROPOSAL NO: C-7 PAGE NO: 2 OF 2

DELETIONS

ITEM	U/M	QTY	UNIT COST	TOTAL
Demolition of Portion of Existing Building	LS	1	$15,000.00	$15,000
Masonry Building	SF	680	80.00	54,400
Crane Extension	LS	1	5,725.00	5,725
TOTAL DELETIONS				$75,125

ADDITIONS

ITEM	U/M	QTY	UNIT COST	TOTAL
Pre-Engineered Building	SF	680	$35.00	23,800
5-Ton Overhead Elec Crane	LS	1	10,000.00	10,000
TOTAL ADDITIONS				$33,800

Net Savings (Deletes - Adds)	$41,325
Markups 15%	6,198
TOTAL SAVINGS	$47,523

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: C-8 PAGE NO: 1 OF 3

DESCRIPTION: Add Flap Gates to the Oleander Culvert

ORIGINAL DESIGN:

The current design maintains the use of the existing Oleander culvert. This culvert is 6' X 7' and opens into the Monticello Canal below the railroad bridge. The Oleander culvert currently is not protected by any black flow elements such as flap gates or sluice gates. Hence, any high water in Monticello Canal backs up into the Oleander culvert. The current design intent is to add a valve box and a manually operated sluice gate to the Oleander culvert.

PROPOSED DESIGN:

This proposal recommends the addition of flap gates to the sluice gate valve box which is already planned for the Oleander culvert. These flap gates will be similar to those in the existing wet well (see Drawing no. 1). The flap valves will make for automatic closure during high water conditions and will eliminate the need to manually close the sluice gate (except during emergency conditions; i.e., hurricane).

ADVANTAGES:

Provides automatic closure of Oleander culvert during high water conditions.

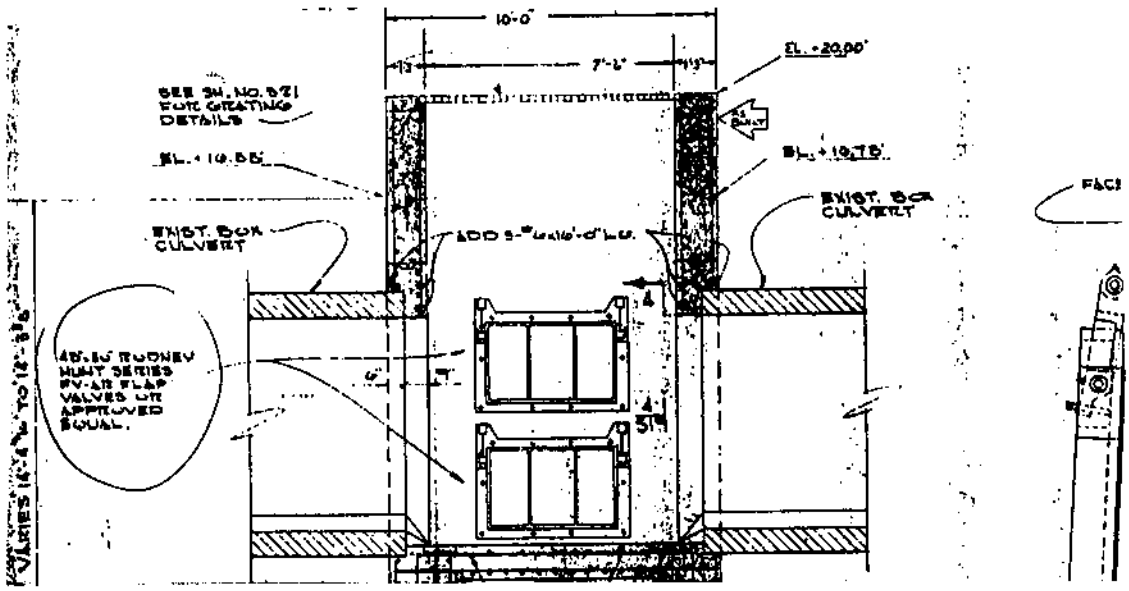
DISADVANTAGES:

1. Increases the project first cost.
2. Adds more valves to be maintained.

JUSTIFICATION:

This proposal improves the reliability of the New Orleans Flood Protection System.

DRAWING NO. 1



EXISTING WET WELL

COST ESTIMATE WORKSHEET

PROPOSAL NO: C-8 PAGE NO: 3 OF 3

DELETIONS

ITEM	U/M	QTY	UNIT COST	TOTAL
TOTAL DELETIONS				$0

ADDITIONS

ITEM	U/M	QTY	UNIT COST	TOTAL
Concrete work to Valve Box	LS	1	$5,000.00	$5,000
Flap Gates	EA	2	10,000.00	20,000
TOTAL ADDITIONS				($25,000)

Net Savings (Deletes - Adds)	($25,000)
Markups 8%	(2,000)
TOTAL SAVINGS	($27,000)

VALUE ENGINEERING COMMENTS

1. **Add Storm Sewer Connections East of Forshey to Capture Drainage** -- (See Drawing No. 1.) Comments were made that the Forshey alignment allows additional capture of storm drainage north of Forshey to the Palmetto Canal was not realized under the Oleander Plan. These connections can easily be made to the new railroad alignment at Dublin, Joliet, Leonidas and Monroe One block extensions will allow connection at Dante, Eagle and Holey Grove. Hookups can be made with one block extensions to the existing Oleander project at Hamilton (connections already exist at Dublin, Monroe, Holley Grove, and Cherry). The revised railroad alignment provides more versatility for capture of drainage north to Palmetto Canal.

2. **Recognize Recreational Benefits of the Railroad Alignment** -- The proposal to realign this project along the abandoned railroad right-of-way will leave a strip of land approximately 50' wide X 3,000' long through this neighborhood from Monticello to Joliet Street. The finished project should be graded to level of surrounding properties and planted as a recreational greenbelt for jogging, bicycling, grass-lot ball games, etc. These benefits are a value-added feature which should be recognized as a by-produce of this use of the abandoned railroad right-of-way.

3. **Avoid buying House at Alternate No. 2 Plan at Forshey Street** -- (See Drawing No. 2.) Drawing No. 2 routes the 10' X 20' culvert westward along Forshey Street where it passes between the railroad and an existing residence. This commentary suggests that, if the proposal to optimize the culvert size results in a significantly smaller culvert/pipe, that an effort be made to fit the culvert such that it avoids the purchasing of the residence.

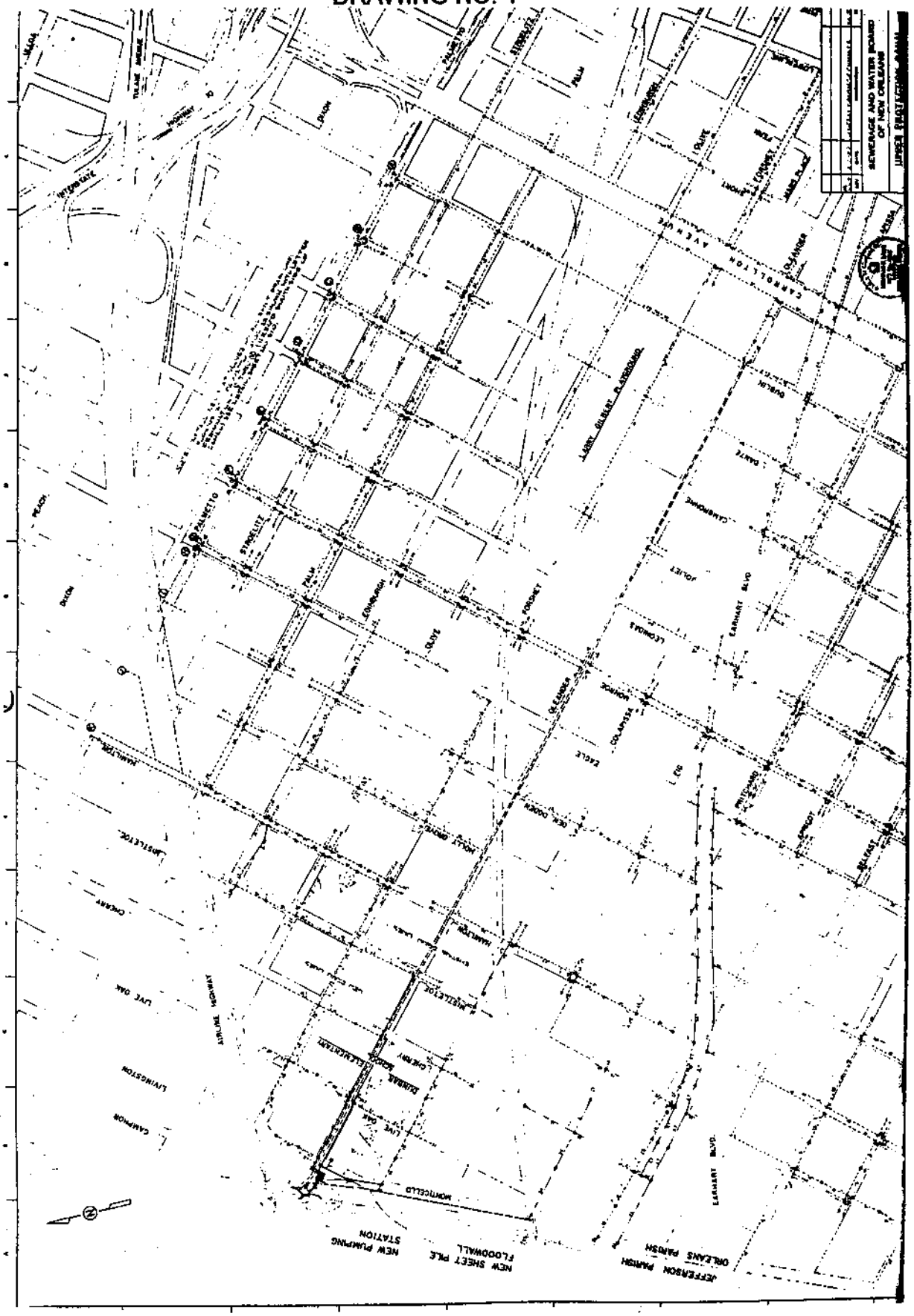
   Potential Savings: $150,000

4. **Develop a Performance Pre-Cast Concrete Culvert Specification to Include the Pre-Fab Arch Culvert** – Different pre-cast systems offer maximum competition in bidding which will reflect lowest bid for a system that will serve the project well. A pre-fab arch culvert is available in the project area and may well be used in other SELA project reaches. Constructibility issues make the pre-cast arch culvert alternative viable even though unit price analysis can not define a set dollar savings.

VALUE ENGINEERING COMMENTS

COMMENT NO: 1

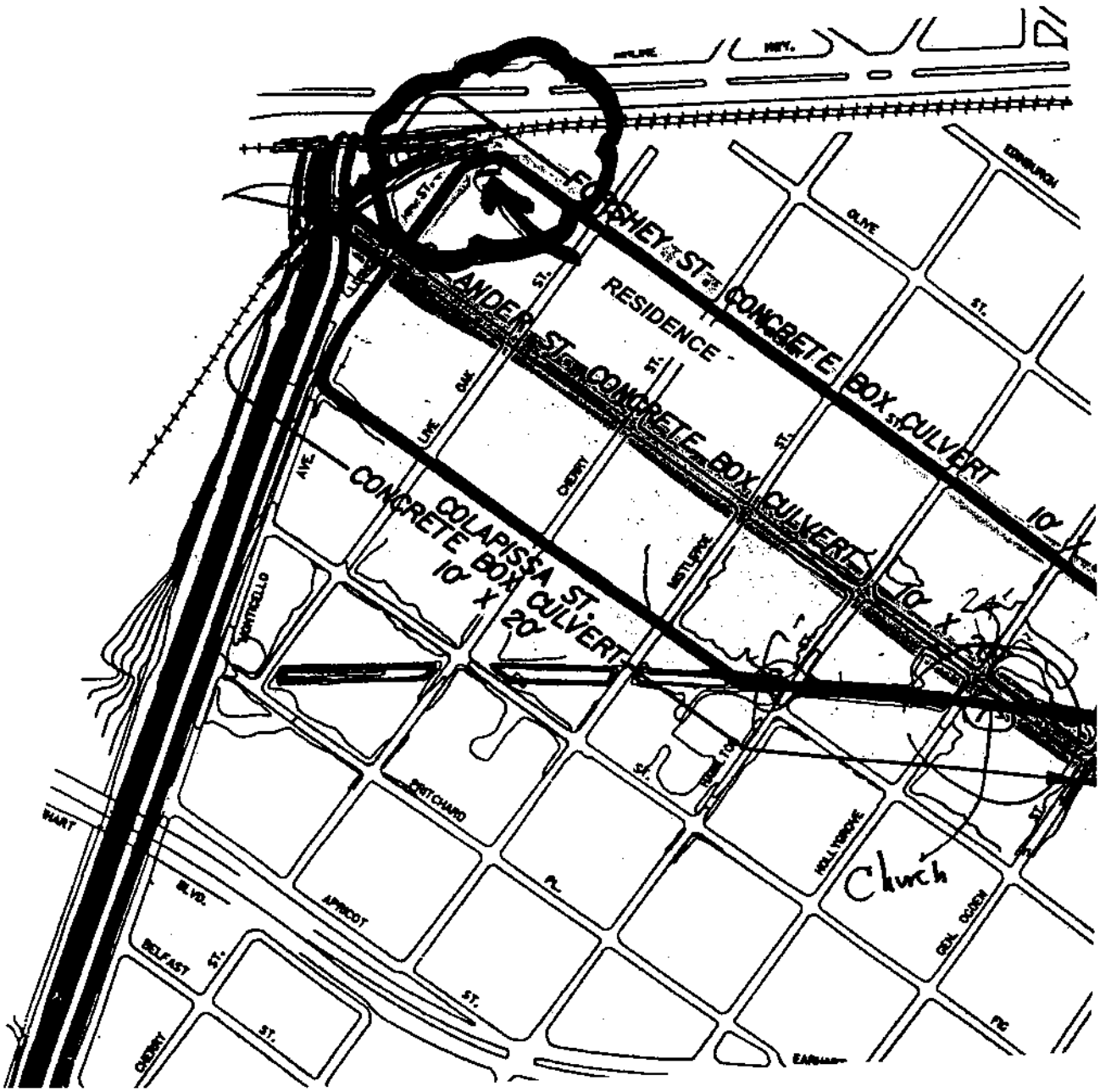
DRAWING NO. 1



VALUE ENGINEERING COMMENTS

COMMENT NO: 3

DRAWING NO. 2



CONTACT DIRECTORY

APPENDIX A: CONTACT DIRECTORY

NAME	ORGANIZATION	TEL/FAX NUMBERS
Frank Vicidomina	CELMN-VE	504-862-1251
Carl Anderson	CELMN	504-862-2610
Frank Vojkovich	CELMN	504-862-1034
Dan Marialone	BCG	504-454-3866
Gerry Preau	S&WB	504-865-0671
Ann Springston	BCG	504-454-3866
Jim Parker	S&WB	504-865-0660
Carl Canicatti	OVEST, CEMP-EV-T	912-652-5172/5956
Eara Merritt	OVEST, CEMP-EV-T	912-652-5171
Charlie Fore	OVEST, CEMP-EV-T	912-652-5174
Fred McAuley	OVEST, CEMP-EV-T	912-652-5715

SPECULATION LIST

VALUE ENGINEERING TEAM STUDY

APPENDIX B: SPECULATION LIST

✓=Develop Idea ?=Investigation X=Deleted CMT=Comment

✓	1.	Use submersible pumps for add-ons.
✓	2.	Make Pump Stations stand alone (i.e., separate from existing).
✓	3.	Make additional new stations with submersibles on railroad right-of-way and Colapissa Street. Add a pressure line from there to Monticello.
✓	4.	Make new alignment from railroad right-of-way (Oliver -- Jollietto -- Monticello) to Monticello.
✓	5.	Provide a new outfall from wet well to automatic closure vice manual operation of sluice gates.
✓	6.	Optimize culvert size to 10-year capacity.
CMT	7.	Add storm sewer to recapture benefits lost by railroad right-of-way alignment proposal (add extension arms).
X	8.	Replace three existing pumps with larger pumps.
X	9.	Pump Dublin into Palmetto.
X	10.	Leave Oleander as is, additional capacity to be done by Forshey (being done).
✓	11.	Re-route Forshey -- Railroad -- Oleander.
✓	12.	Forshey -- Railroad -- new pump (compare with Speculation Item No. 3).
X	13.	Extend discharge pipes for siphon effect.
✓	14.	Use pre-cast box culverts.
X	15.	If downsize to 10-year, use pipe vice rectangular culverts.
✓	16.	Use flap gates vice sluice gates.
X	17.	Reduce timber piling.
X	18.	Add three new pumps and new culverts (only if can use 30" intake, 24" discharge).
X	19.	Add a smaller (10 x 10) culvert next to existing 6' x 7'.
X	20.	Buy all houses in 10-year flood plain.
X	21.	Railroad right-of-way proposal – open canal ("U" frame/sloped earth).
X	22.	Use Forshey open flume.
✓	23.	Use Conspan arch pipe.
✓	24.	Use vinyl sheet pile, leave in place (temporary sheet pile).
✓	25.	Use in-place sheet pile and gunnite.
X	26.	Use CMP for culvert.
X	27.	Use top of culvert as road.
X	28.	Use tower site as Pump Station.
CMT	29.	Avoid buying house on Alternate No. 2.
X	30.	Buy two blocks at Larry Gilbert Park, insert detention basin and pump.
X	31.	Add pumps at 17th Street to keep Monticello dry (eliminates pumps).
✓	32.	Recognize recreational benefits of railroad right-of-way.
X	33.	Revisit pipe diameter (120" or 80 ft^2) versus culvert area (10' x 20' = 200 ft^2) model.

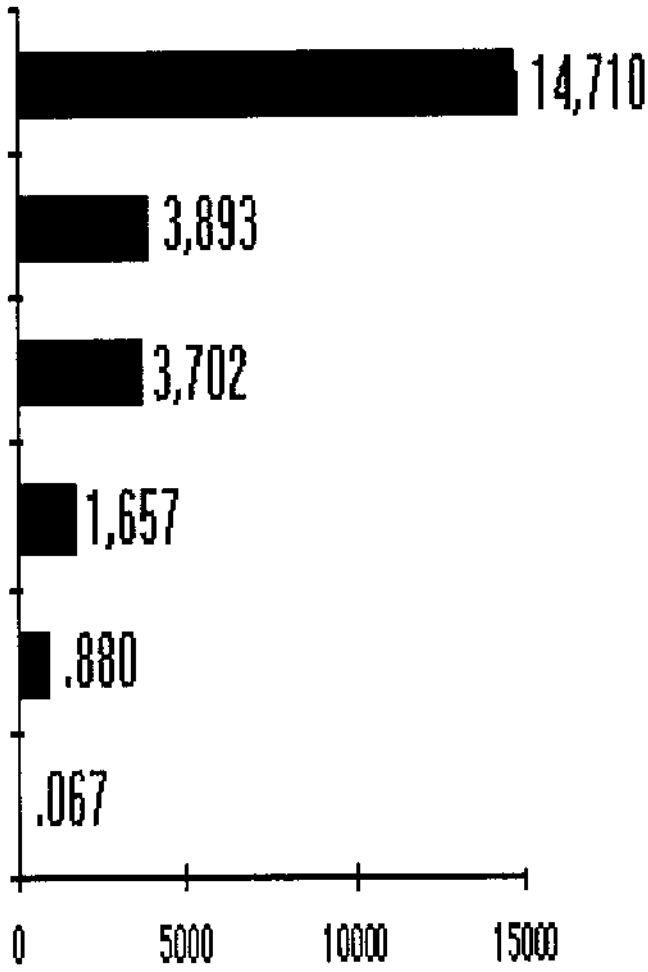
✓=Develop Idea ?=Investigation X=Deleted CMT=Comment

X	34.	Manifold siphon under existing 6' x 7' (railroad crossing) at crossing.
✓	35.	Use a yellow metal enclosure for new pump house or add-on.
X	36.	Have outdoor pump with wall.
✓	37.	Same as Speculation Item No. 4, except use submersible pumps in railroad right-of-way.

COST MODELS

COST MODEL
OLEANDER & DUBLIN

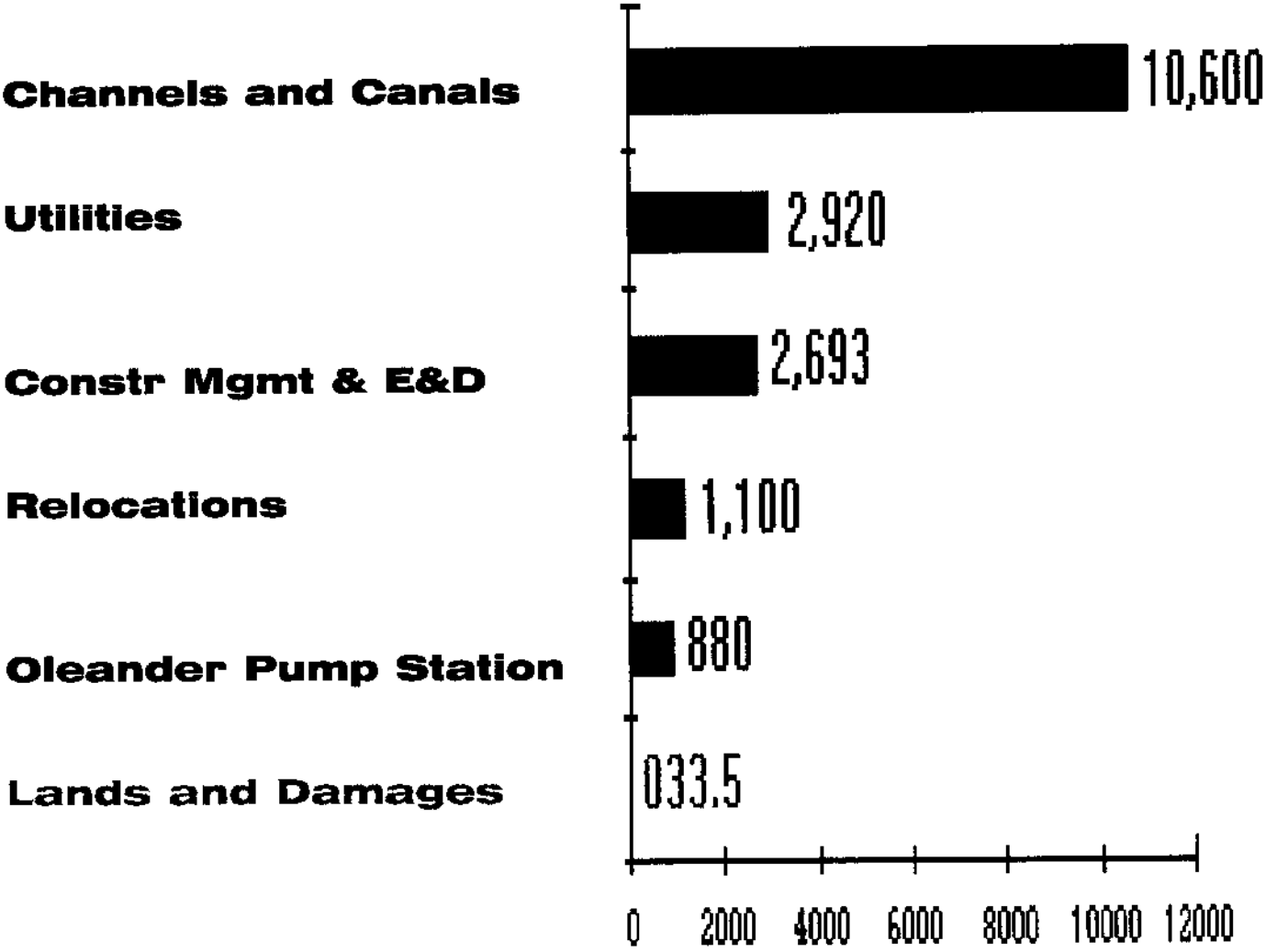
MAJOR COST ITEMS



TOTAL PROJECT COST: $24,909,000

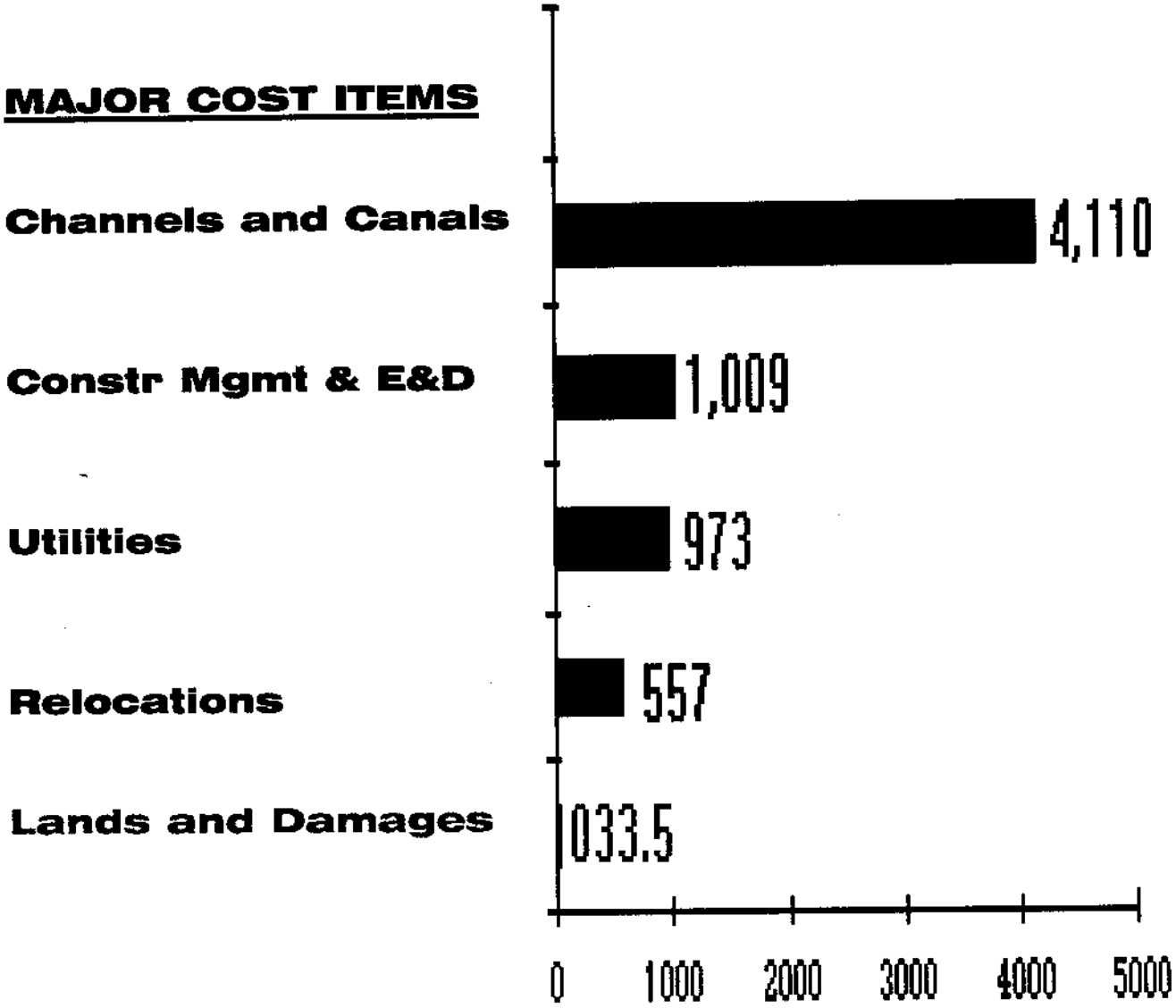
COST MODEL
OLEANDER

MAJOR COST ITEMS



OLEANDER TOTAL: $18,226,500

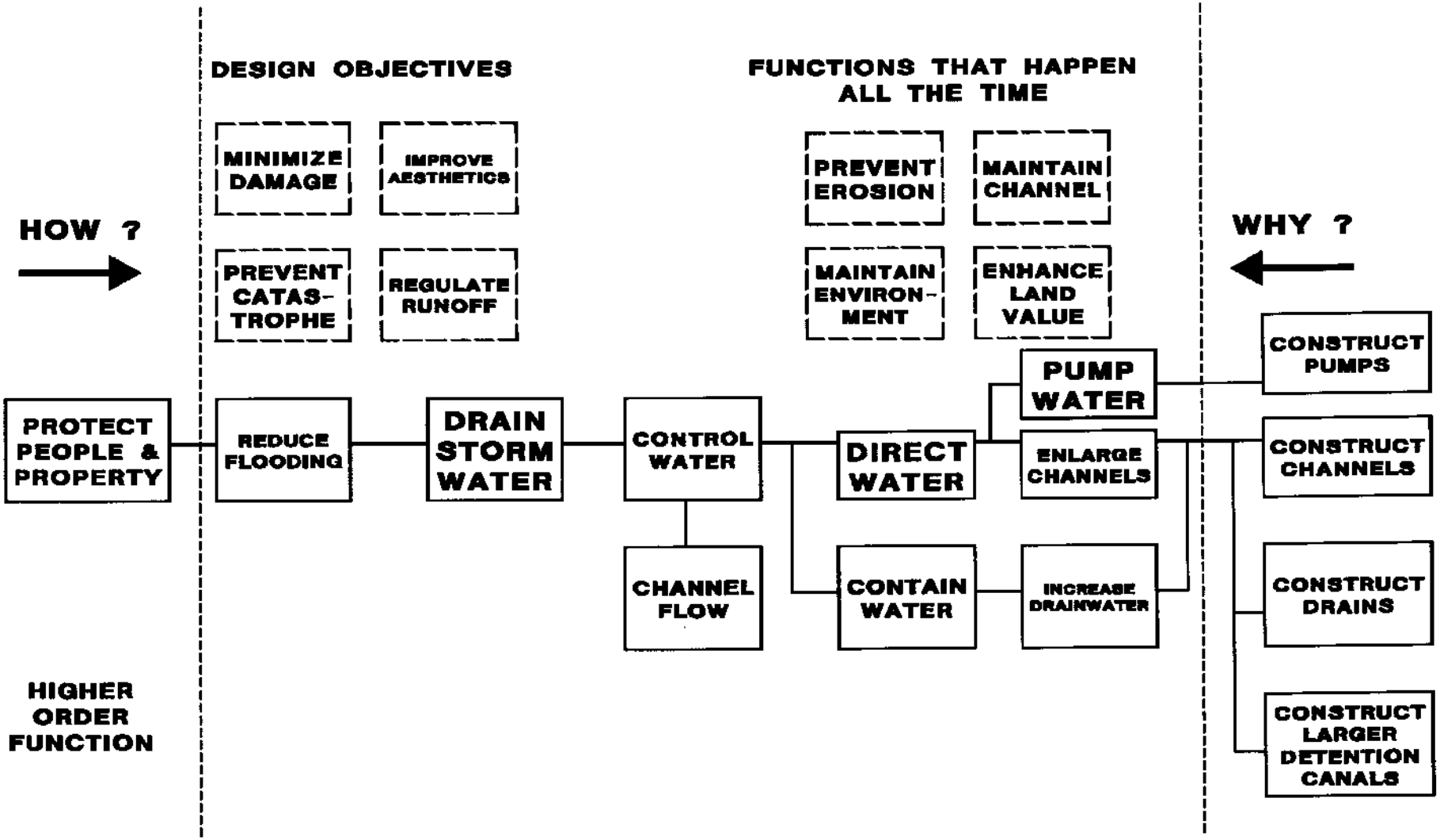
COST MODEL
DUBLIN



DUBLIN TOTAL: $6,682,500

FAST DIAGRAM

SOUTHEAST LOUISIANA PROJECT
OLEANDER -- DUBLIN PUMP STATION AND CANALS
ORLEANS PARISH, LOUISIANA



FUNCTION ANALYSIS SYSTEM TECHNIQUE
(FAST) DIAGRAM

SUPPORTING DOCUMENTS

SUPPORTING DOCUMENTS FOR PROPOSAL NO. C-3

DESIGN 3 SUB. INLETS

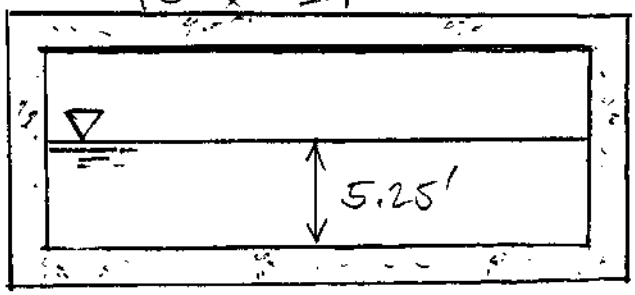
COMPUTATION SHEET

PROJECT SELA - OLEANDER/DUBLIN	PAGE 1 OF 6	COMPUTED BY	DATE 6/4/97
SUBJECT PROPOSAL - DOWNSIZE CULVERTS		CHECKED BY	DATE

(REF. SELA HYDRAULIC MODEL GRAPHS - SEE ATTACHED COPIES)

- UNDER 10-YR EVENT "WORST REACH" CONDUIT IS @ 5.24 FT DEPTH. REACH IS CLOSE TO GEN. OGDEN ∴ MAY APPLY TO BOTH 10 X 24 AND 10 X 20 CULVERTS AS SHOWN BELOW:

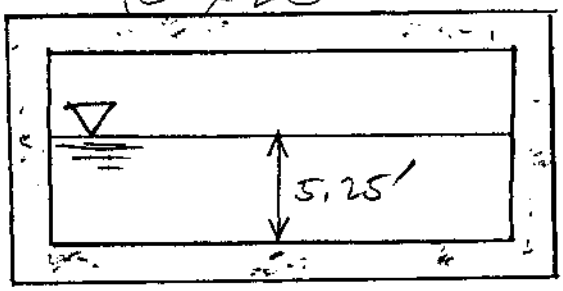
OLEANDER ST. ORIGINAL DESIGN (P.S. TO GEN. OGDEN)



"WET" AREA = 5.25 x 24 = 126

P_W = 34.5

(GEN. OGDEN TO DUBLIN)



A_W = 105

P_W = 30.5

COMPUTATION SHEET

PROJECT	PAGE 2 OF 6	COMPUTED BY	DATE 6/4/97
SUBJECT PROP.		CHECKED BY	DATE

COMPUTE EQUIVALENT HYD. SECTION

$$Q = \frac{1}{N} A \left(\frac{A}{P_W}\right)^{.67} S^{.5}$$

$$A_1 \left(\frac{A_1}{P_{W_1}}\right)^{.67} \leq A_2 \left(\frac{A_2}{P_{W_2}}\right)^{.67}$$

FOR ORIGINAL DESIGN - OLEANDER, P.S. TO GEN. OGD.

"TRY $9_D \times 14_W$"

$$126 \left(\frac{126}{34.5}\right)^{.67} \leq 126 \left(\frac{126}{32}\right)^{.67}$$

$$299 \qquad \text{OK}$$

"TRY (2) $9 \times 9'_5$"

$$299 \leq (2)\, 81 \left(\frac{81}{27}\right)^{.67}$$

$$299 \leq 337 \qquad \text{OK}$$

COMPUTATION SHEET

PROJECT	PAGE 3 OF 6	COMPUTED BY	DATE 6/4/9
SUBJECT PROP.		CHECKED BY	DATE

ORIGINAL DESIGN - OLEANDER, GEN. OGD. TO DUBLIN

" TRY $9_D \times 12_W$ "

$$105\left(\frac{105}{30.5}\right)^{.67} \leq 108\left(\frac{108}{30}\right)^{.67}$$

$$239 \overset{OK}{\leq}$$

" TRY (2) 8 x 8's."

$$239 \leq (2)64\left(\frac{64}{24}\right)^{.67}$$

$$239 \leq 246$$

$$\overset{OK}{\leq}$$

COMPUTATION SHEET

PROJECT	PAGE 4 OF 6	COMPUTED BY	DATE 6/4/97
SUBJECT PROP.		CHECKED BY	DATE

ALTERNATE DESIGN – FONSHEY (OR COLAPISSA)
P.S. TO GEN. OGDEN

"TRY 9"D × 11"W

$$126\left(\frac{126}{34.5}\right)^{.67} \leq 42\left(\frac{42}{19}\right)^{.667} + 99\left(\frac{99}{29}\right)^{.667}$$

(EXISTING 6×7)

$$299 \leq 71 + 224 = 295 \quad \text{CLOSE}$$

OK 2

"TRY (2) 8 × 8

$$299 \leq 71 + (2)(64)\left(\frac{64}{24}\right)^{.667}$$

$$299 \leq 317$$

OK 3

COMPUTATION SHEET

PROJECT	PAGE 5 OF 6	COMPUTED BY	DATE 6/4/97
SUBJECT Prop.		CHECKED BY	DATE

ALTERNATE DESIGN – FORSHEY ST., GEN. OGD. TO DUBLIN

"TRY 9 x 9"

$$105\left(\frac{105}{30.5}\right)^{.67} \leq 36\left(\frac{36}{18}\right)^{.67} + 61\left(\frac{81}{27}\right)^{.67}$$

(EXISTING 6X6)

$$234 \leq 57 + 168 = 225 \quad \text{CLOSE}$$

OK

COMPUTATION SHEET

PROJECT SELA - OLEANDER/DUBLIN	PAGE 6 OF 6	COMPUTED BY	DATE 6/4/9
SUBJECT PROPOSAL		CHECKED BY	DATE

SUMMARY :

(ORIGINAL PLAN)

OLEANDER → P.S. TO GEN. OGDEN

- USE $9_D \times 14_W$ CAST IN PLACE
- OR (2) 9 x 9 PRE-CAST

→ GEN. OGDEN TO DUBLIN

- USE $9_D \times 12_W$ CAST IN PLACE
- OR (2) 8 X 8 PRE-CAST

(ALTERNATIVES)

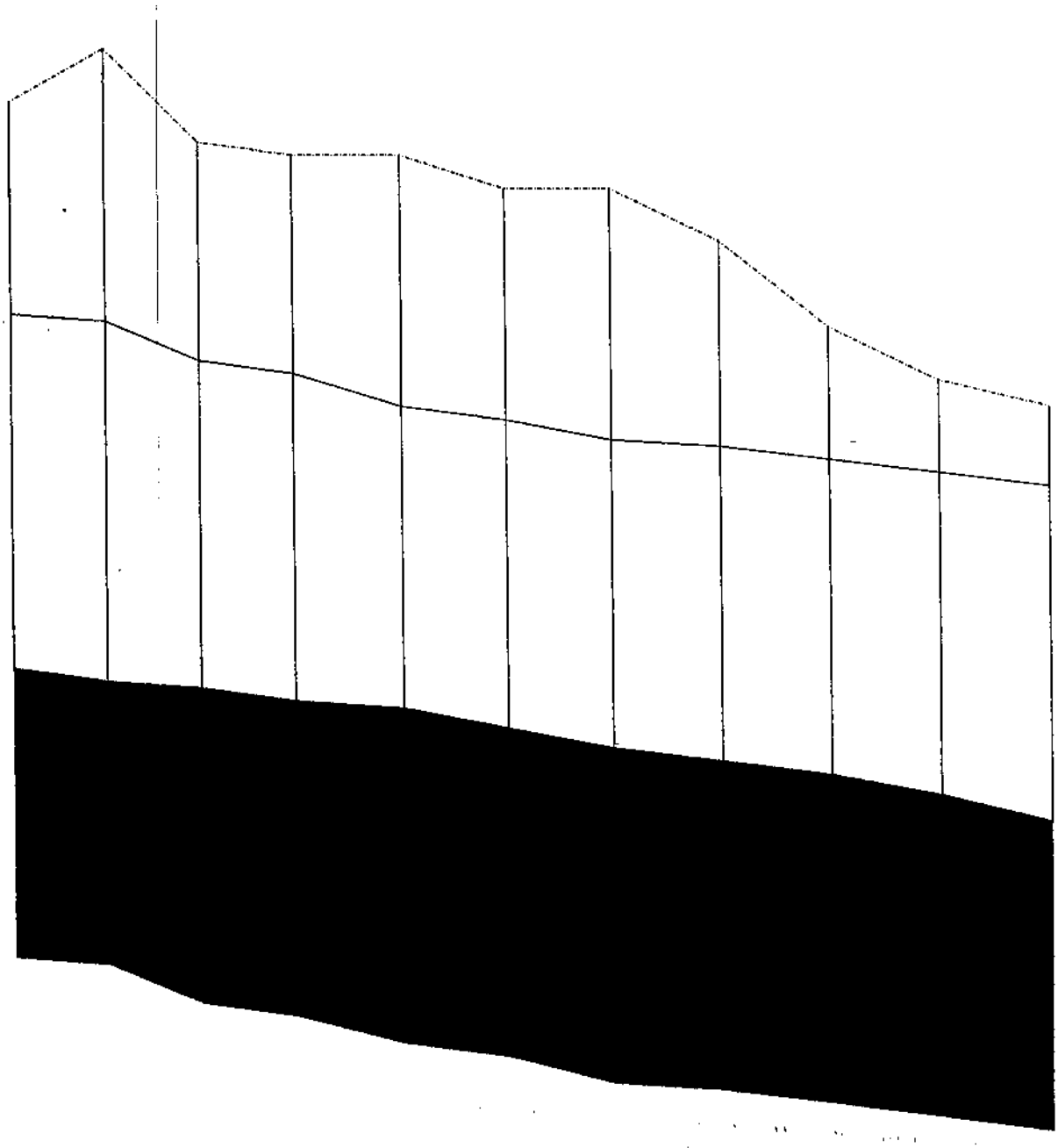
FORSHEY ST. + COLAPISSA → P.S. TO GEN. OGDEN

- USE $9_D \times 11_W$ CAST IN PLACE
- OR (2) 8 x 8 PRE-CAST

→ GEN. OGDEN TO DUBLIN

- USE (1) 9 x 9 PRE-CAST

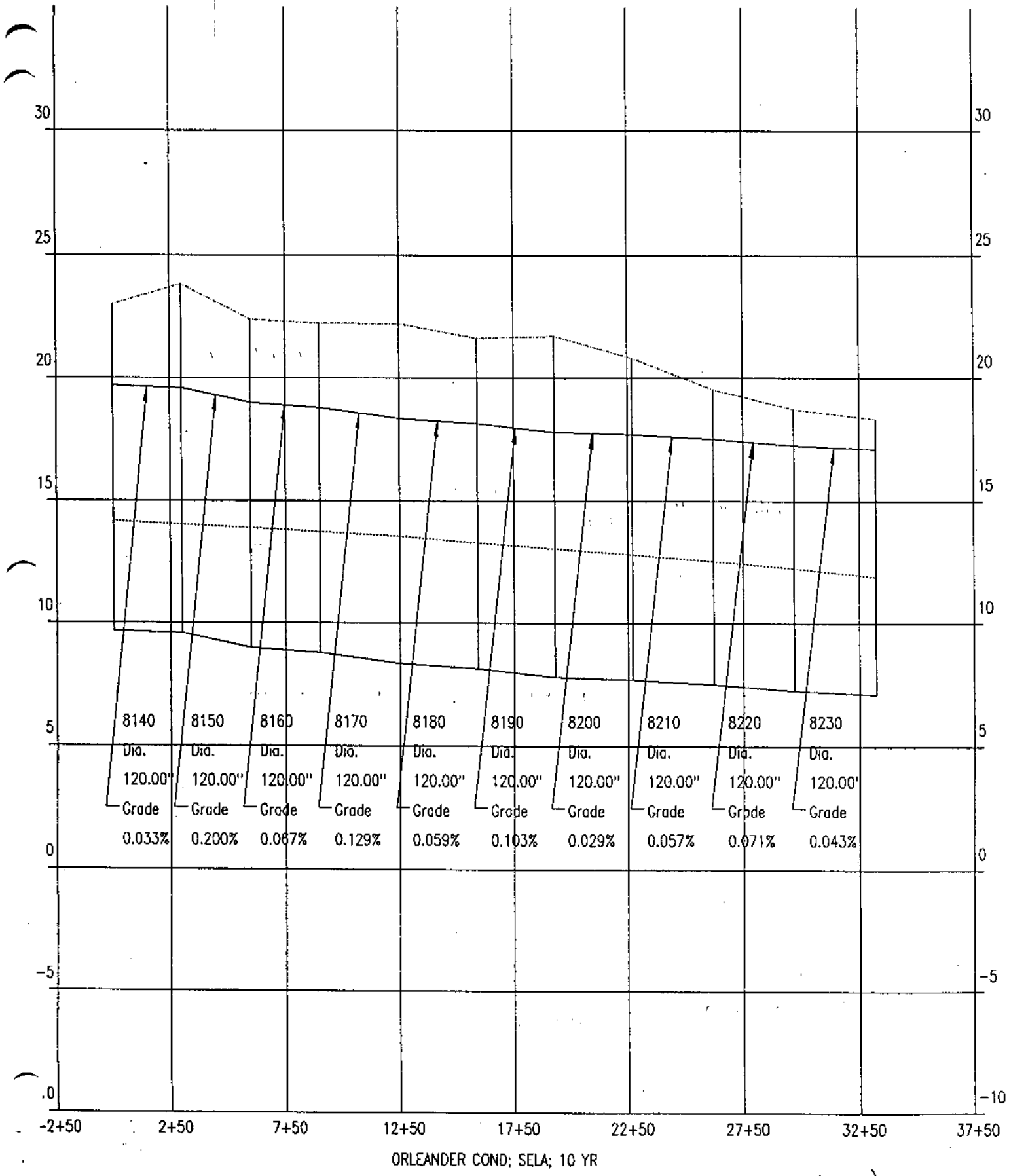
4.48 4.42 4.89 4.95 5.21 5.15 5.24 5.11 5.05 5.01 4.82



10 YRS

8129 8139 8149 8159 8169 8179 8189 8199 8209 8219 8229
196.80 200.69 212.87 223.09 263.56 278.05 294.25 308.93 323.15 334.48

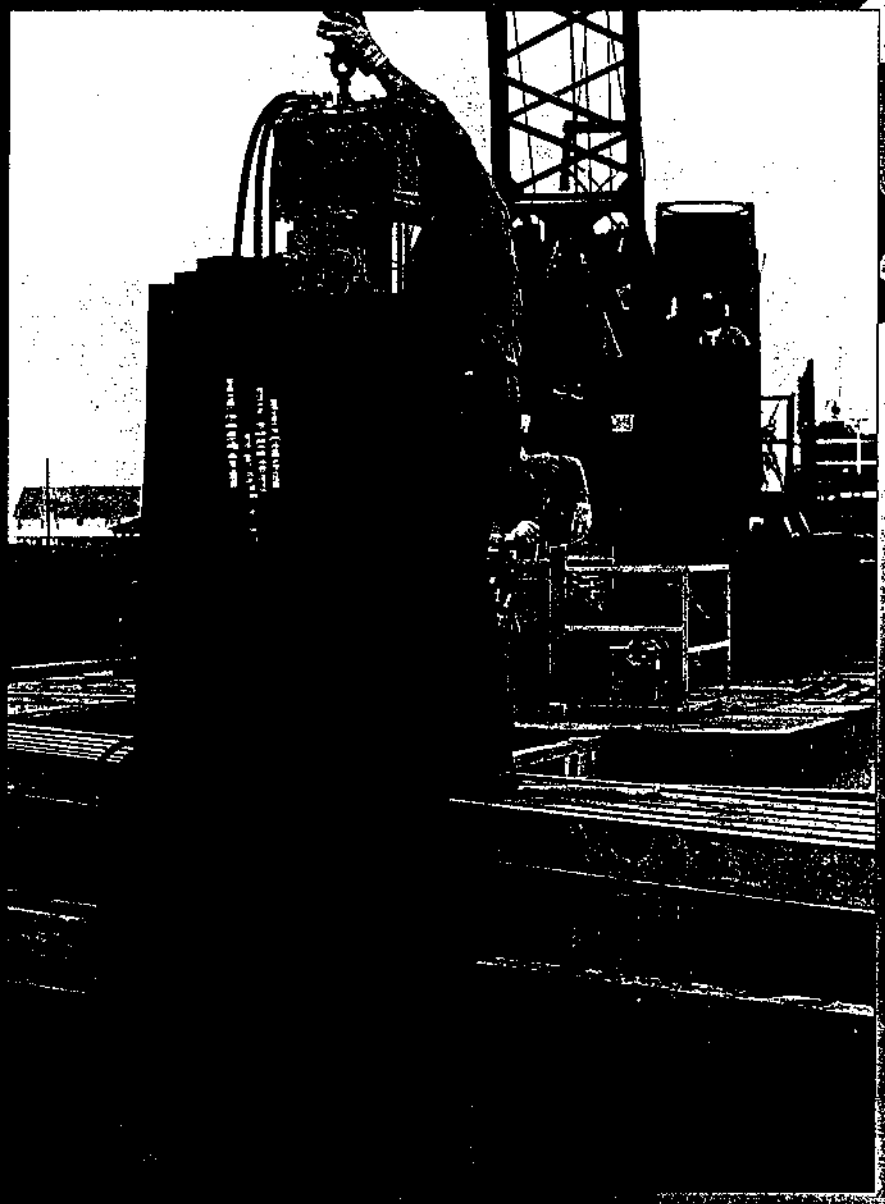
Envelope of Maximum manhole DEPTH / LEVEL



Orleander D.P.S. is pumping 350 cfs (peak)

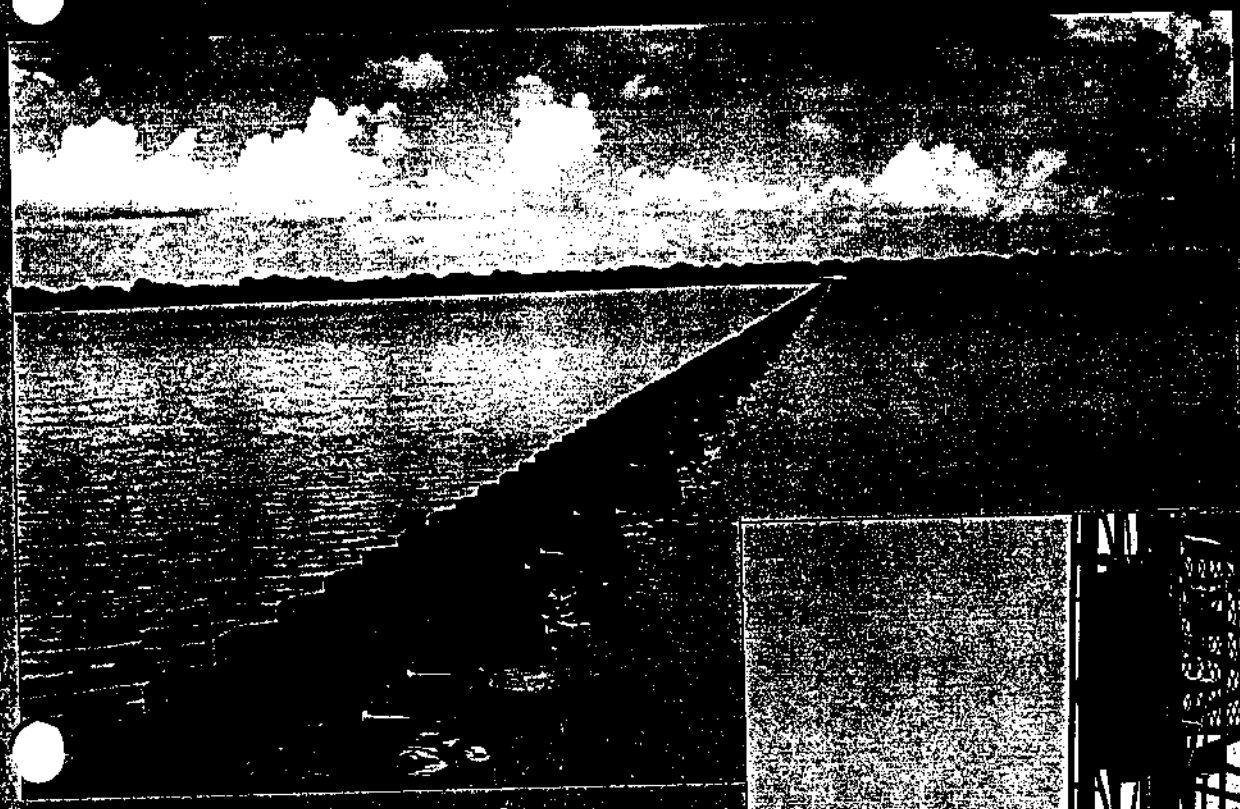
SUPPORTING DOCUMENTS FOR PROPOSAL NO. C-5

...The Superior Way to Cut Costs and Increase Service Life...

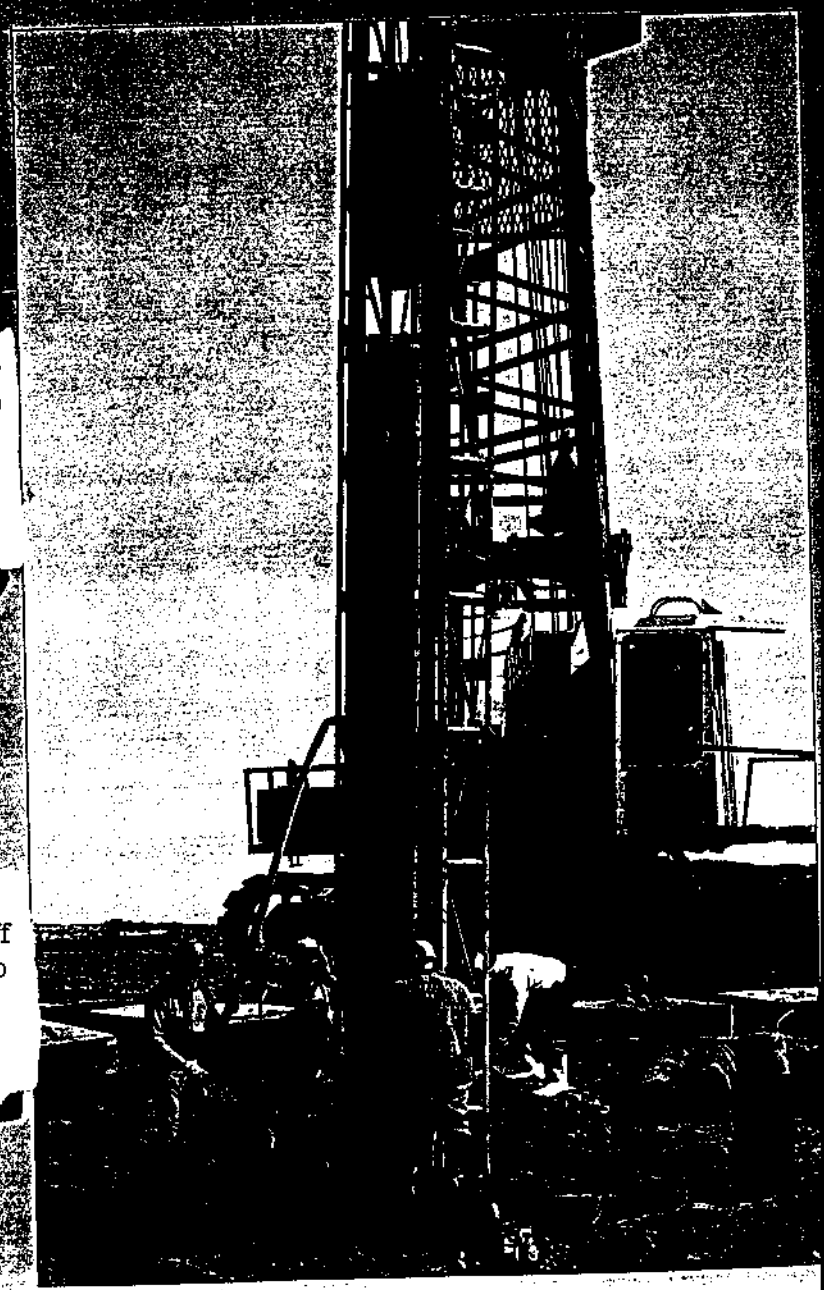


GeoGuard™
VINYL SHEET PILING

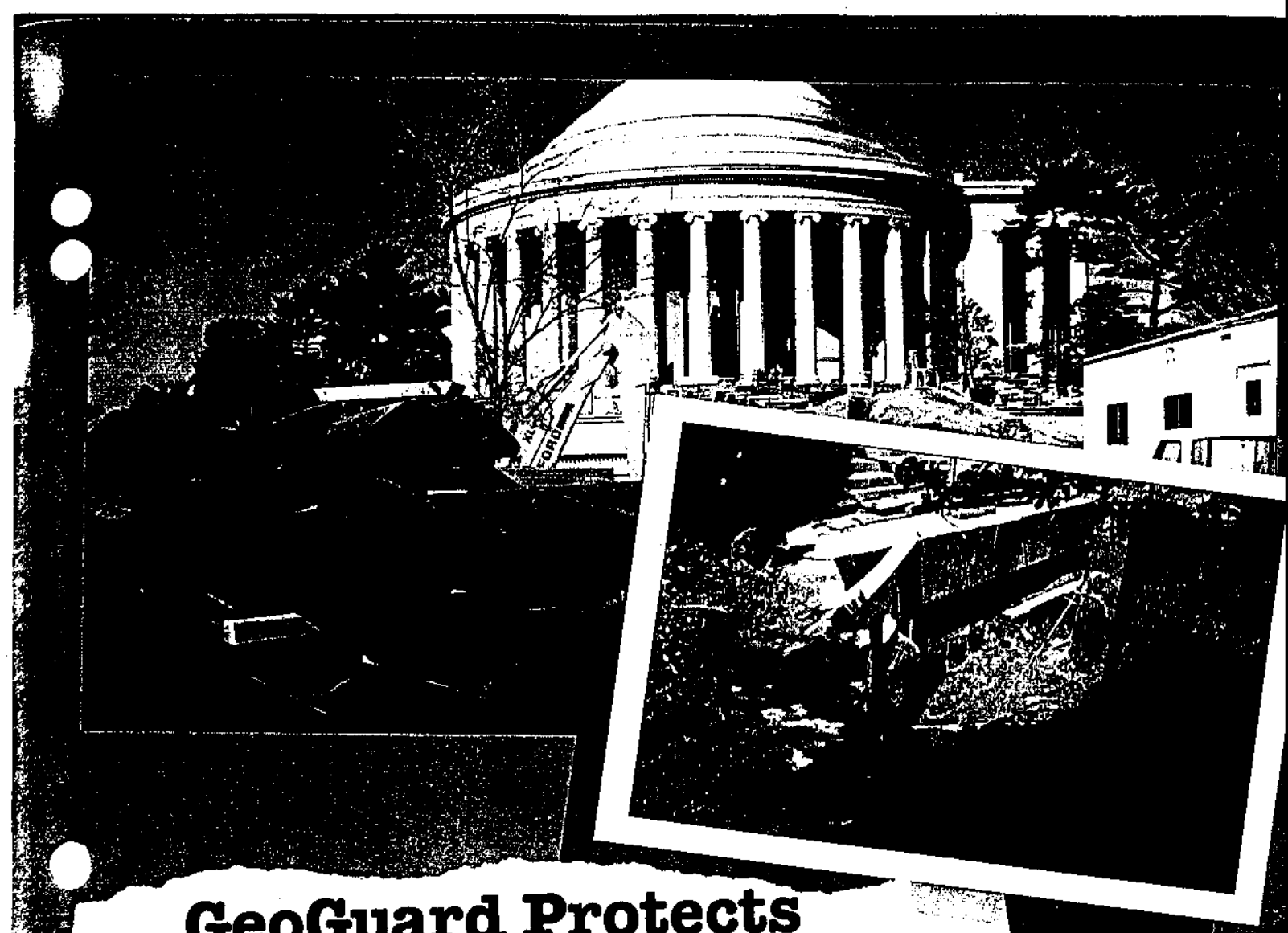
GeoGuard Saves Refinery $500,000



Star Enterprise's Number 7 Reservoir Polymer Sludge Lagoon was constructed for $500,000 less than originally estimated by using a GeoGuard™ Vinyl Sheet Piling wall in lieu of a random rubble levee. The project was completed 4 weeks ahead of schedule and disruptions to the facility and local traffic were minimized.



Toughness, no surprise. A GeoGuard cut-off wall was installed using a 3500 pound drop hammer in stiff clay on this Louisiana flood control project.



GeoGuard Protects Jefferson Memorial for the Next 100 Years

MEMORANDUM

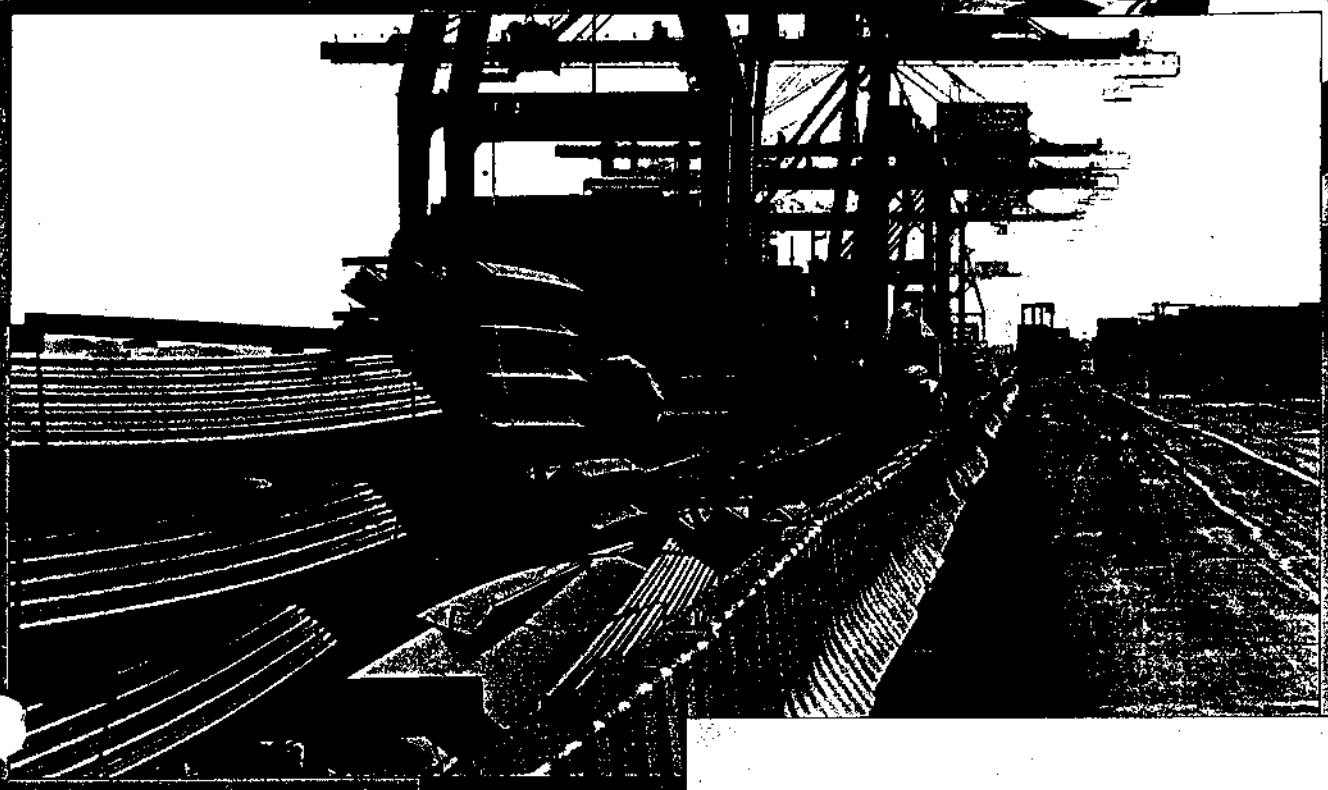
To: **Engineering**
From: **Sales**
Re: **Thomas Jefferson Memorial**
Washington, D.C.

The engineering firm in charge of designing the structural work for the Jefferson Memorial Rehabilitation Project chose GeoGuard Vinyl Sheet Piling to protect the foundation of the National Monument.

The design specification calling for a non-corrosive product with a 100 year design life was right up our alley. GeoGuard was selected as the value engineered solution because it met the 100 year design life, while saving taxpayer dollars!

The firm was pleased and comfortable with the decision they made and the engineering support provided by Materials International.

New York Port Authority Demands Permanent Solution

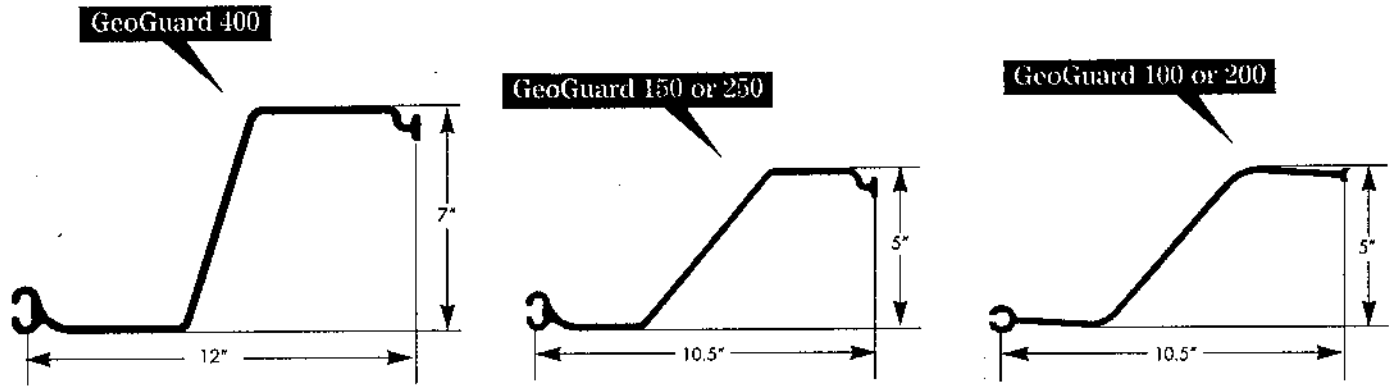


Low cost, long life, and ease of installation made GeoGuard the best choice for the New York Port Authority. The vinyl sheet piling cut-off wall provided a permanent structural support for this concrete relieving platform.

The Solution is GeoGuard

City officials, engineers, and contractors selected GeoGuard as the best solution for this flood control structure in Brigantine, New Jersey. Why? GeoGuard is environmentally friendly, inexpensive, and outlasts traditional materials.

Specifications



Physical Property	GeoGuard 400	GeoGuard 250	GeoGuard 150	GeoGuard 200	GeoGuard 100
Color	Grey, Brown or Green	Grey, Brown or Green	*Grey or Brown	Grey or Green	*Grey or Brown
Vinyl Composition	100% Virgin	100% Virgin	100% Recycled	100% Virgin	100% Recycled
Linear Coverage per Sheet Pile	12 inches	10.5 inches	10.5 inches	10.5 inches	10.5 inches
Depth of Z-Section	7 inches	5 inches	5 inches	5 inches	5 inches
Weight per Foot of Sheet Pile	3.2 Pounds	1.9 Pounds	1.9 Pounds	1.9 Pounds	1.9 Pounds
Nominal Sheet Pile Thickness	0.25 inches	0.20 inches	0.20 inches	0.20 inches	0.20 inches
Minimum Tensile Strength	6,300 psi	6,300 psi	6,300 psi	6,300 psi	6,300 psi
Impact Strength	13,750 in-lb/sq in	11,000 in-lb/sq in	11,000 in-lb/sq in	11,000 in-lb/sq in	11,000 in-lb/sq in
Long Term Allowable Moment	2,400 ft-lb	1,200 ft-lb	1,100 ft-lb	1,100 ft-lb	1,000 ft-lb

Physical properties are defined by ASTM Test Standards for Plastic Building Products. The values shown are typical and may vary slightly.
**Color of recycled product may vary.*

MATERIALS INTERNATIONAL
Materials International, Inc.
Engineered Structures Division
4501 Circle 75 Parkway, Suite E-5370
Atlanta, Georgia 30339 USA
(800) 256-8857 • (770) 933-8166 • Fax (770) 933-8363

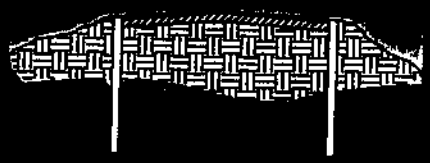
GeoGuard™ VINYL SHEET PILING

Applications

GeoGuard cut-off walls, divider walls, dike cores, retaining structures, mechanically stabilized earth walls, foundation protection, slope stabilization, and noise walls are low cost, long life, and environmentally friendly.

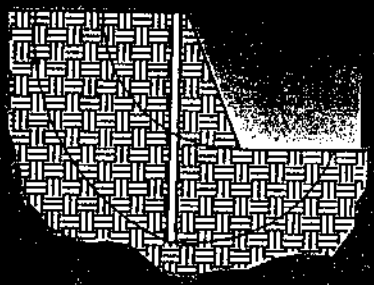
Cut Type Retaining Wall

Subgrade Stabilization of Roadways

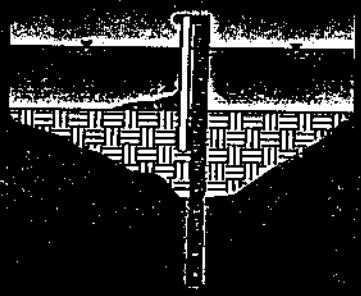


Cooling Pond Capacity Upgrade

Slope Stability

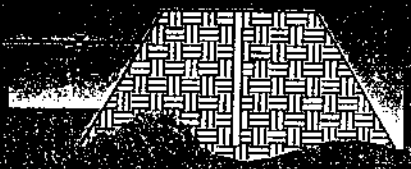


Reservoir Management Silt Fence

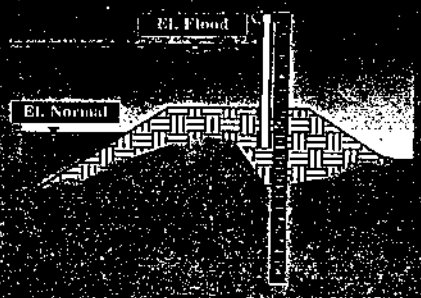


Channel Lining

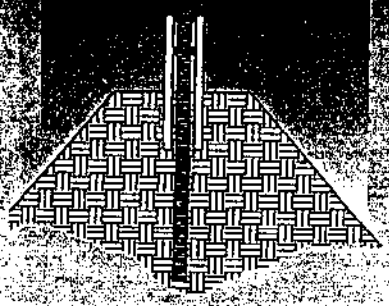
Dike Core



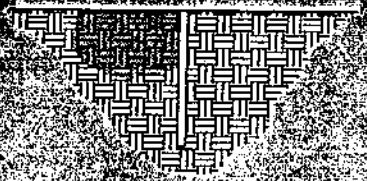
Flood Control



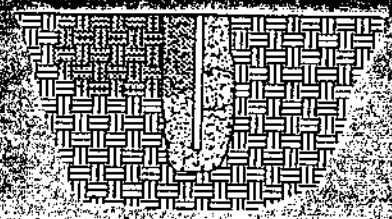
Containment Dike Vertical Extension



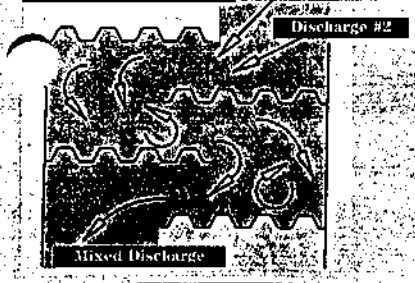
Cut-Off Wall



Seismic Stability of Bentonite Slurry Cutoff Wall

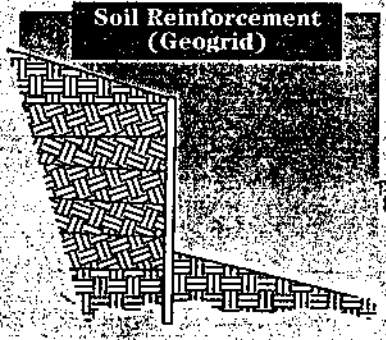


Baffle System Mixes Effluent Streams

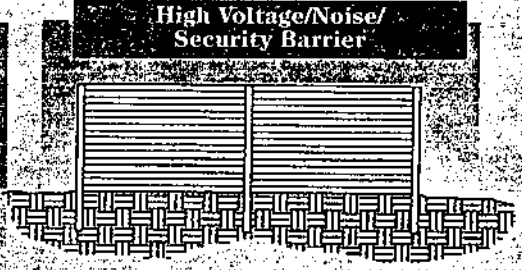


Plan View

Soil Reinforcement (Geogrid)



High Voltage/Noise/ Security Barrier



TECHNICAL BULLETIN

GG 10 - GeoGuard Product Profile by C. Hazenberg, P.E.
Engineered Structures Division
Materials International
4501 Circle 75 Parkway, Suite E-5370
Atlanta, Georgia 30339
(770) 933-8166

Over 2 million square feet of rigid weatherable PVC Sheet Piling has been used for a variety of civil engineering applications. However, these projects have been designed by a limited number of engineers. The vast majority of civil engineers have limited working knowledge of how to design PVC sheet piling. Thus, an understanding of the common issues - strength, creep, UV, impact strength, and chemical durability is warranted.
durability is warranted.

INTRODUCTION

GeoGuard™ is a line of corrosion resistant sheet piling made of a special formulation of polyvinyl chloride. During the development, careful consideration was given to choose the best raw material and geometry that would provide excellent corrosion resistance while being inexpensive, strong, ductile, weatherable, tough and attractive.

Rigid, impact modified, weatherable polyvinyl chloride (PVC) was chosen due to it's excellent strength, creep performance, chemical inertness, weatherability (UV resistance), stiffness, impact properties, and environmental friendliness.

DID YOU KNOW?

In commercial production since the 1920's, PVC is one of the world's oldest and most thoroughly tested plastics. In 1994, over 6 billion pounds of PVC water pipe, house siding, and window frames were utilized by the construction industry. PVC's low cost, long service life, durability in aggressive environments, environmental friendliness, and aesthetically pleasing colors are the primary reasons for its extensive use.

CONSISTENT PERFORMANCE

Each formulation of PVC is defined by the American Society of Testing Materials by ASTM D4216. This 12 digit cell classification describes the polymer type, impact strength, tensile strength, modulus of elasticity, deflection temperature, coefficient of linear expansion, and weatherablity.

The specific material properties of GeoGuard are dictated by the raw materials cell classification and are proven consistent from bench testing of GeoGuard, and numerous other construction products manufactured from the same type of PVC.

An exceptionally high reliability level of performance is enjoyed by GeoGuard due to the manner in which it is manufactured. GeoGuard is manufactured by continuous extrusion from a raw plastic called PVC compound. This method of production, combined with stringent quality control procedures maintain the proper molecular structure and consistent product performance.

STRENGTH

Structural members made from conventional materials such as steel typically utilize the flexural stress (12,000 psi for GeoGuard) of the material and the shape or section modulus of the member to define it's strength. If the same method were used in the design of a PVC structural member such as GeoGuard, the products expected performance would be overstated.

The appropriate method to define the bending strength performance of synthetic structural members is to limit the amount of tensile stress developed in the product. The maximum bending strength of GeoGuard is defined when 5% of the outer fibers of the sheet piling are subjected to the maximum tensile yield (T_{max}) strength of 6300 pounds per square inch. Note that the tensile yield strength of PVC is approximately half of it's flexural yield strength. Here, the maximum moment (M_{max}) of GeoGuard with a section modulus(S) of 6.1in ^{3}/ft and 10.9in ^{3}/ft, respectively is:

$$M_{max} = T_{max} * S$$

$$M_{max} = (6300\ psi) * (6.1\ in.^3/ft) * (1\ ft/12in) = 3200\ ft\text{-}lbs/ft$$

$$M_{max} = (6300\ psi) * (10.9\ in^3/ft) * (1\ ft/\ 12\ in) = 5720 ft\text{-}lbs/ft$$

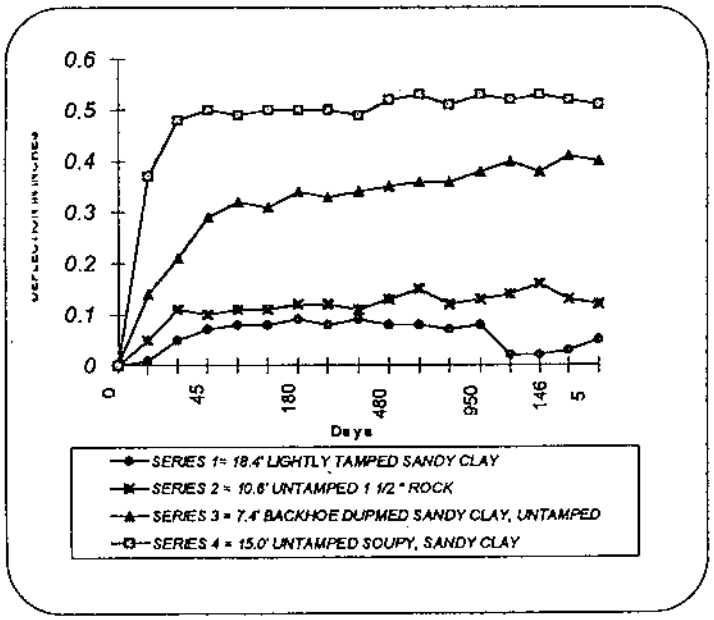
While this method may seem overly conservative, it ensures expected product performance and allows the engineer or architect to use conventional beam equations in structural designs.

AVOIDING THE EFFECTS OF CREEP

Unfortunately, many designers have a misunderstanding of how creep affects thermoplastics, and the relationship of creep to product performance. Creep is not a destructive force in plastic that undermines the structural system, but, is defined as the continuing deformation of a material subjected to a constant load over a period of time. Fortunately, PVC has far superior creep performance than most thermoplastics. In fact, the creep rate of PVC decreases quite rapidly with time. This results in allowable stress of 2 to 3 times greater then most thermoplastics.

*Field testing of GeoGuard and other products such as PVC pipe have demonstrated that rather than creep, **proper backfill and compaction plays the critical role** in deformation of the structure.*

From Unibell:
Deflection vs. Time for Buried PVC Pipe



Deformation will generally occur within the first three 3 months. It is also worth noting that as PVC creeps, and equilibrium is reached, stress relaxation occurs, allowing the internal stresses to decrease.

While short term tensile yield strengths are 6,000-8,000 psi, the conservative long term tensile, compression, and flexural strength of PVC based on creep is 4,000 psi. Applied loads below this stress level will preclude creep failure. For additional conservatism, the applied or allowable stresses (Tall) are held under 2365 psi to provide a long-term factor of safety of 1.7 at a creep limit strain far below 2%.

Therefore, the long term or allowable bending strength (M_{all}) determined for vinyl sheet piling with a section modulus (S) of 6.1in^3/ft, and 10.9in^3/ft, respectively is:

$M_{all} = T_{all} * S$

M_{all} = (2365 psi) * (6.1 in^3/ft) * (1 ft/12 in) = 1200 ft-lbs/ft

M_{all} = (2365psi) * (10.9 in^3/ft) * (1 ft/12 in) = 2150 ft-lbs/ft

Based on 16 years of creep data, Findley and Tracy demonstrated that strain of PVC can be described as

$$\epsilon = \epsilon^{o} + \epsilon^{+} t^{n}$$

where:

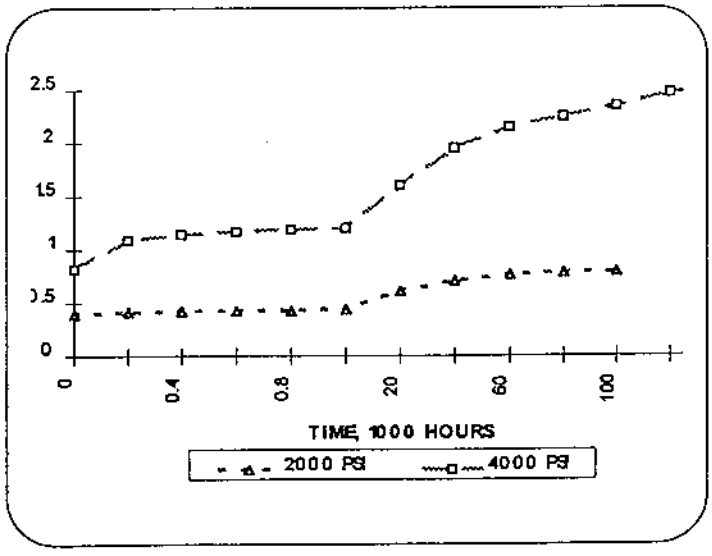
- ϵ = total strain
- ϵ^{o} = constants for constant stress
- ϵ^{+} = constants for constant stress
- n = constant independent of stress
- t = time

Constants for Creep

Material	Stress	ϵ^{o}	ϵ^{+}	n
PE	225psi	1.07	.236	.154
PE	450psi	2.30	.710	.154
PVC	2000psi	.37	.0124	.305
PVC	4000psi	.81	.046	.305

Hence, a 75 year tensile strain of less than 2% is predicted for an allowable load of 2365psi.

CREEP CURVES FOR PVC AT 75 °F



CHEMICAL DURABILITY IN THE FIELD

GeoGuard has proven it's resilience in harsh marine and industrial applications. Industrial baffles, sludge lagoons, cut-off walls, containment walls, and marine bulkheads are applications where GeoGuard has proven its longevity over conventional materials. Also, PVC is well known for being one of the most chemically durable polymers available today. Immersion and sink trap testing of the compound in extreme conditions has demonstrated a resilience to over 75% of 605 concentrated chemicals.

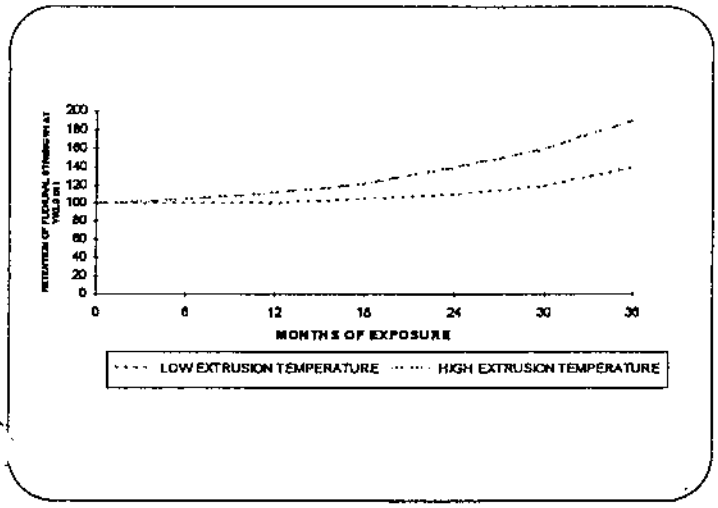
UV PERFORMANCE

GeoGuard does not degrade in sunlight because it is made from a weatherable PVC that resists UV degradation. Because of the quality of today's PVC formulations, even if GeoGuard were manufactured from high quality untreated PVC, it would exhibit an exceptional level of weatherability because of the thickness of the sheet. UV degradation is limited to depths of 0.001" - 0.003" of the exposed surface of the material.

Weatherability of GeoGuard is achieved by a combination of ultraviolet inhibitors. The primary actor is Titanium Dioxide which is used in numerous products as a UV inhibitor. Other industries which have utilized billions of pounds of the same technology includes fencing, gutters, siding, utility boxes, windows, roofing, and automotive components.

Summers and Rabinovitch of BF Goodrich describe how UV absorption, oxidation and HCL unzipping by conjugated double bonds is negated since the plasticizer screens and absorbs the sun's harmful energy. Thin coupons of weatherable vinyl illustrate the following strength characteristics:

RETENTION OF FLEXURAL STRENGTH FOR RIGID PVC



IMPACT DURABILITY

GeoGuard is subjected to rigorous quality control testing such as ASTM D4226 Impact Test. This test of minimum impact strength of 11,000 inch pounds per square inch is the equivalent of the energy of a .22 caliber bullet. GeoGuard must have this high level of impact resistance because of the immense impacts required during installation. Many of GeoGuard installations are driven into the ground using vibratory hammers and drop hammers weighing up to 3500 pounds.

APPLICATIONS

Applications for GeoGuard are only limited by the designers imagination. Retaining structures, containment barriers, dike cores, erosion protection, slope stabilization, and noise walls are some of the examples of GeoGuard structures. Structures requiring low cost, low maintenance durability, and extended service life warrants serious consideration of GeoGuard by owners and their engineers.

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Materials International
Atlanta, Georgia
wesd.sam 6/13/95