

Water Preserve Areas Feasibility Study
Selected Plan
C9 design region (C-9 Impoundment)

Levee, Canals, Earth and Sitework
Submission to EN-C

Original Submission: 2 February 2001

1. Cost estimates are needed for design features associated with the C-9 impoundment within the Water Preserve Areas (WPA) Feasibility Study. This cost estimate will be used as the Selected Plan in the study.
2. The point of contact for this request is Mr. Keith Jones, at extension 1127. Let me know if I can be of more assistance.

Attachments Provided:

1. Spreadsheet Analysis Report (revised) - 3 pages
2. Geotechnical Data and Assumptions (revised) - 3 pages
3. 11" x 17" Layout Drawings - 2 pages
 - Site Layout (levee.dgn) - shows design and cross section location
 - Alignments/Locations (levee.dgn)(revised) - shows levee and canal centerlines, distances and areas used for calculation
4. 8½" x 11" Drawing - 1 page of C-9 Embankment Design
5. Cross Section Profiles - 5 pages
6. C-9 Design Region Scope - 3 pages
 - Contains a comprehensive list of design and cost feature

**Water Preserve Areas Feasibility Study
Levees and Canals Summary of Material Quantities
C-9 Impoundment and Design Region**

		Gross Volume cu-yds	Rock Volume cu-yds	Overburden Volume cu-yds	InRoads Volume cu-yds	Using full excavation borrow and fish refuge area shown on site layout cu-yds
Excavated Materials						
	Conveyance or Seepage Canals	615374	538373	77001		615374
	F&W Littoral Shelves	38144	34178	3966	699609	38144
	Intake and Discharge Basins (See Note 1)	56789	54853	1936		462318
	Totals	710307	627404	82903	699609	1115836
	Amount reusable= 70%	497215	439183	58032		781085
	Amount spoil= 30%	213092	188221	24871		334751
Quality Construction Material Required						
	Fill Material Requirements	830863			738629	830863
	Revetment - 12" Bedding Stone	3067				
	Revetment - 18" Rip Rap	6455				
Spoil Material Disposal Areas						
	Wind Breaks	77425				77425
	Borrow Pits/Mined Lakes	0				0
	Fill Areas	81467				81467
	Totals	158892				158892
Spoil Material Generated						
	Excavated Materials	213092				284973 See Note 2
	Totals	213092				284973

Notes:

Note 1: The area used for the S-509 Discharge and S-510 Intake can be viewed as a minimum requirement to be used for cost estimating. A larger area "excavation borrow and fish refuge area" is shown on the site layout drawing. That area is quantified below in the event such a large area is excavated.

Note 2: Number represents Total Excavated Material minus the Quality Construction Material Required. Calculation shows larger "excavation borrow and fish refuge area" can be optimized in size to provide the necessary material required to build the impoundment levees.

Intake and Discharge Basins	Area sqft	Area Acres	Average Ground ft-NGVD	Invert ft-NGVD	Cut Depth feet	Gross Volume cu-yds	Rock Volume cu-yds	Overburden Volume cu-yds
Excavation Borrow and Fish Refuge Area	2257180	51.8	3.7	-2.0	5.7	476516	476516	0

Note: Due to the close proximity of US-27, earthwork will include 18000' in length of stormwater runoff design from US-27. The design will require earthwork grading to create a dry storage swale approximately 1' deep. Assume 20-30' width along the 18000' length. Assume one 10' long concrete weir every 500' (35 required).

**Water Preserve Areas Feasibility Study
Levees and Canals Summary of Material Quantities
C-9 Impoundment and Design Region**

Excavation Requirements

Rock at Elevation = **4.0** ft-NGVD and below

Conveyance or Seepage Canals	Length feet	Inside Slope 1V on ?H	Outside Slope 1V on ?H	Bottom Width feet	Average Ground ft-NGVD	Canal Invert ft-NGVD	Canal Cut Depth feet	Cross Section Area sqft	Gross Volume cu-yds	Rock Volume cu-yds	Overburden Volume cu-yds	InRoads Length cu-yds	InRoads Volume cu-yds
Northern Boundary (chimney)	2270	3.0	3.0	10.0	5.2	-2.0	7.2	228	19129	14124	5004		
Eastern Boundary (chimney)													
North of Pembroke Road	5065	3.0	3.0	10.0	5.4	-2.0	7.4	238	44700	31516	13184		
South of Pembroke Road	2605	3.0	3.0	10.0	5.0	-2.0	7	217	20936	16209	4728	10074	91592
Northern Boundary (Impoundment)	4935	3.0	3.0	20.0	4.3	-4.5	8.8	408	74632	70689	3943		
Eastern Boundary (Impoundment)	10445	3.0	3.0	20.0	4.2	-4.5	8.7	401	155155	149615	5540	15387	293464
Western Boundary (south of Pembroke)	13030	3.0	3.0	10.0	5.0	-1.0	6	168	81076	60324	20751		
Western Boundary (north of Pembroke)	5025	3.0	3.0	10.0	5.9	-1.0	6.9	212	39424	23264	16160	18195	147753
Totals	43375								435051	365741	69309	43656	532809
C-9 Improvement	5065	1.0	1.0	50.0	5.0	-16.5	21.5	1537	288377	271118	17259	5362	274853
Existing C-9 Canal	5065	1.0	1.0	20.0	5.0	-11.0	16	576	108053	98486	9567		108053
Total from C-9 Improvement	5065								180323	172632	7691	5362	166800
Totals	48440								615374	538373	77001	49018	699609

F&W Littoral Shelves	Length feet	Width feet	Area Acres	Average Ground ft-NGVD	Invert ft-NGVD	Cut Depth feet	Cross Section Area sqft	Gross Volume cu-yds	Rock Volume cu-yds	Overburden Volume cu-yds
Northern Boundary (Impoundment)	4935	30.0	3.4	4.3	2.0	2.3	69	12612	10967	1645
Eastern Boundary (Impoundment)	10445	30.0	7.2	4.2	2.0	2.2	66	25532	23211	2321
Totals	15380		10.6					38144	34178	3966

Intake and Discharge Basins	Area sqft	Area Acres	Average Ground ft-NGVD	Invert ft-NGVD	Cut Depth feet	Gross Volume cu-yds	Rock Volume cu-yds	Overburden Volume cu-yds
S-509 Discharge	87120	2.0	3.5	-2.0	5.5	17747	17747	0
S-510 Intake	87120	2.0	3.5	-2.0	5.5	17747	17747	0
S-512A Discharge	87120	2.0	4.6	-2.0	6.6	21296	19360	1936
Totals		6.0				56789	54853	1936

**Water Preserve Areas Feasibility Study
Levees and Canals Summary of Material Quantities
C-9 Impoundment and Design Region**

Fill Material Requirements

Levees	Length feet	Inside Slope 1V on ?H	Outside Slope 1V on ?H	Top Width feet	Average Ground ft-NGVD	Top of Levee ft-NGVD	Levee Height feet	Cross Section Area sqft	Gross Volume cu-yds	InRoads Length cu-yds	InRoads Volume cu-yds
Northern Boundary (chimney)	2125	3.0	3.0	12	5.2	9.5	4.3	107	8427		
Eastern Boundary (chimney)											
North of Pembroke Road	5025	3.0	3.0	12	5.4	9.5	4.1	100	18542		
South of Pembroke Road	2620	3.0	3.0	12	5.0	9.5	4.5	115	11135	17610	64077
Northern Boundary (Impoundment)	7085	3.0	3.0	12	4.4	16.5	12.1	584	153359		
Northern Boundary (ASR and Maintenance Berm)	2060	0.0	0.0	22	4.8	7.5	2.7	59	4532		
Eastern Boundary (Impoundment)	10315	3.0	3.0	12	4.2	16.5	12.3	601	229784		
Southern Boundary (Impoundment)	6905	3.0	3.0	12	4.2	16.5	12.3	601	153820		
Western Boundary											
Impoundment	10535	3.0	3.0	12	4.5	16.5	12	576	224747	34990	674552
Chimney south of Pembroke	2605	3.0	3.0	12	5.3	9.5	4.2	103	9968		
Chimney north of Pembroke	5025	3.0	3.0	12	5.7	9.5	3.8	89	16549		
Totals	52240								830863	52600	738629

Revetment	12" Bedding Stone					Rip Rap				
	Length feet	Width feet	Area acres	Depth feet	Gross Volume cu-yds	Length feet	Width feet	Area acres	Depth feet	Gross Volume cu-yds
Northwest Corner	1000	19.6	0.4	1.0	726	1000	27.5	0.6	1.5	1528
Northeast Corner	1000	19.6	0.4	1.0	726	1000	27.5	0.6	1.5	1528
Southeastern Corner	1000	19.6	0.4	1.0	726	1000	27.5	0.6	1.5	1528
Southwestern Corner	1225	19.6	0.6	1.0	889	1225	27.5	0.8	1.5	1872
Totals	4225		1.9		3067	4225		2.7		6455

Wind Breaks	Length feet	Inside Slope 1V on ?H	Outside Slope 1V on ?H	Top Width feet	Average Ground ft-NGVD	Top of Levee ft-NGVD	Levee Height feet	Cross Section Area sqft	Gross Volume cu-yds
Wind Break (west)	2385	3.0	3.0	12	4.4	14.5	10.1	427	37739
Wind Break (east)	2385	3.0	3.0	12	4.1	14.5	10.4	449	39686
Totals	4770								77425

Borrow Pits/Mined Lakes	Area sqft	Area acres	Bottom Depth ft-NGVD	Finished Depth ft-NGVD	Fill Depth feet	Gross Volume cu-yds
Totals		0.0			0.0	0

Fill Areas	Length feet	Width feet	Area sqft	Area acres	Average Ground ft-NGVD	Finished Height ft-NGVD	Fill Depth feet	Gross Volume cu-yds
Parking and Scenic Overlook Area			16450	0.4	4.4	7.5	3.1	1889
Miramar Parkway	2400	120.0	288000	6.6	7.0	11.5	4.5	48000
C-9 North Bank Raised	6745	22.0	148390	3.4	5.2	7.5	2.3	12641
C-9 South Bank Raised	7575	25.0	189375	4.3	4.8	7.5	2.7	18938
Totals	16720			14.7				81467

***Geotechnical Data and Assumptions to Use for
Feasibility Level Cost Estimates (Amended 1/28/01)

Design Region: C-9

Compaction Factor for Sandy Overburden:
Answer: 0.85

Swell Factor for Sandy Overburden:
Answer: 1.10

Compaction Factor for Rock:
Answer: 0.85

Swell Factor for Rock:
Answer: 1.30

Material Makeup of Levee Embankment:

Answer: Crushed rock from Canals/Fish refugia. This material must be crushed to a maximum particle size of 3 inches or less in order to utilize for levee construction. The rock will also need to be processed to produce a well-graded material for dam construction. Material may also be utilized from the sand and gravel overburden excavated for the seepage canals/Fish refugia. A majority of the rock will be excavated from the adjacent C-502B Canal (Seep 3B Design Region). **It is estimated that overburden exists from ground surface to elevation +4. From +4 to elevation -13.5 feet NGVD limestone bedrock will be encountered with intermittent Sand lenses. At elevation -13.5 and deeper, mostly hard limestone is in place.**

Special Levee Construction Design Criteria:

Foundation Treatment:

Answer: Remove top 18 inches of overburden for levee width. In addition, assume 1% of levee length requires removal of 36 inches of overburden.

Seepage Control

Answer: None

Slope Protection:

Answer: Protect 19.6 feet of upstream levee slope for approx. 4300 feet of levee perimeter (See Cross-Section

*** Assumptions based upon limited subsurface information and prior projects, as of 1/28/01

hand carried to EN-H which includes 12 inches bedding stone plus 18 inches of rip rap from toe to elevation 10.7 ft NGVD +/-). Rip Rap to be placed in strategic locations including sharp corners, bends, and areas of long wind fetch. Hand drawing showing approximate locations was delivered to EN-H on 1/29/01. Use excess limestone from onsite excavations if available. Otherwise import limestone. Remaining 75% of upstream embankment perimeter will be grassed for erosion protection. See hand delivered drawing for estimated locations of rip rap.

Where the material will come from?

Answer: Material for the C-9 Impoundment will be obtained from:

1. Usable excavated material from adjacent seepage canals
2. Limited excavation within the impoundment
3. Usable excavated material from construction of C-502A and C-502B (seep3a and seep3b area will be next priority)
4. Usable excavated material from construction of other WPA features in a 10 mile proximity of C-9

Notes:

1. Material balance will be developed showing how much will come from each location
2. When constructing the levee, the Contractor will be required to utilize 12 inch lifts which then will be compacted down to 10 to 11 inches. Compaction requirements will be to 98% maximum dry density based upon standard proctor compaction tests or a nuclear density meter. Also, control of excessive moisture shall be the responsibility of the Contractor.

Excavation Procedure/Technique and/or Blasting Requirements (at this location only):

Answer: Assume some blasting of rock will be required (Rios from EN-G will supply blasting patterns/plan). After initial rock blasting some additional ripping will be required with backhoe with ripper attachment. Following blasting and ripping, normal excavation equipment may be utilized.

Percentage of Usable Excavated Overburden Soil Material:

Answer: Assume 70% of the material can be reused. The remaining 30% should be disposed of onsite or at an approved disposal area. Using excess unsuitable material to build wind breaks, boat ramps or to flatten interior slopes is recommended also. The distribution of overburden soil versus rock is detailed above in red.

Percentage of Usable Excavated Rock Material:

Answer: Assume 70% of the material can be reused. The remaining 30% should be disposed of onsite or at an approved disposal area. Using excess unsuitable material to build wind breaks, boat ramps or to flatten interior slopes is recommended also. The distribution of overburden soil versus rock is detailed above in red.

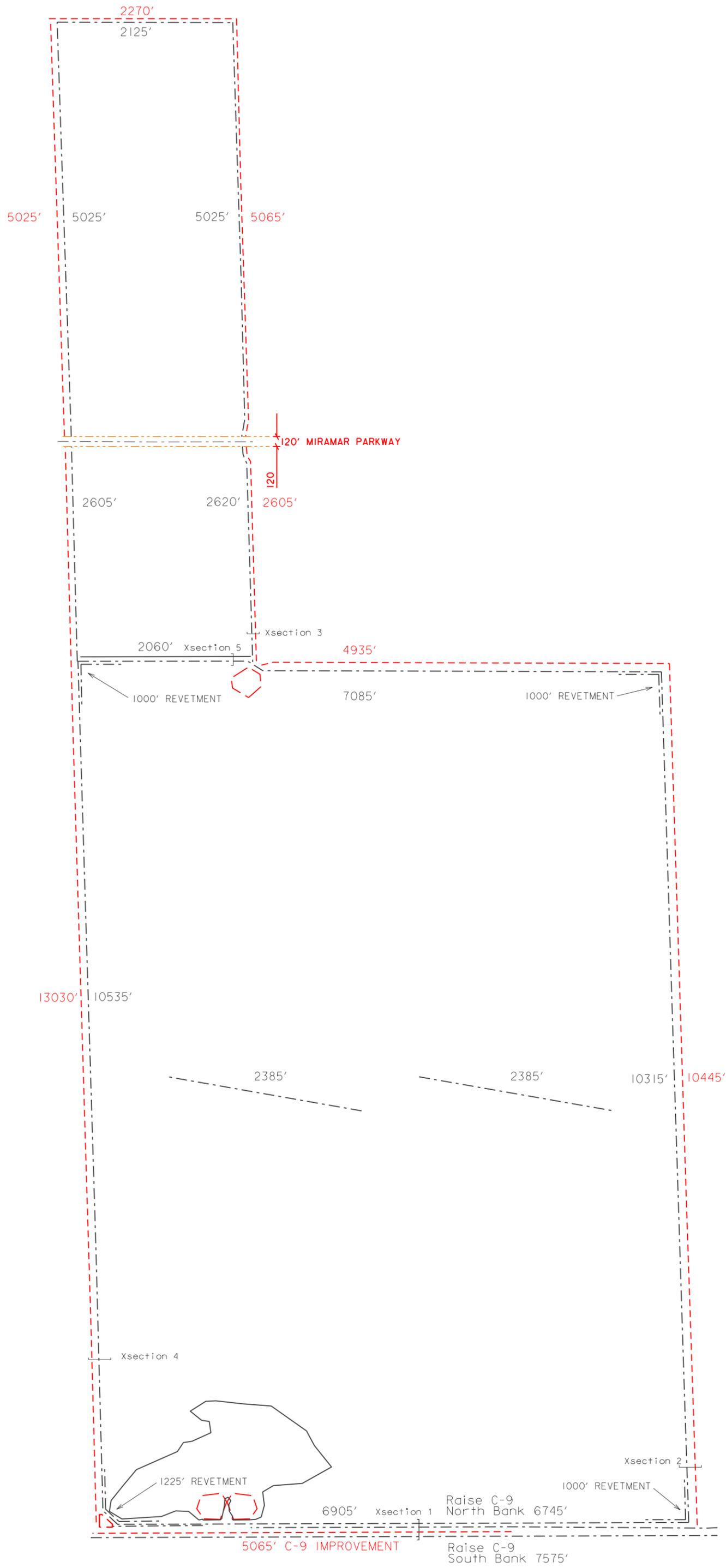
Other Considerations:

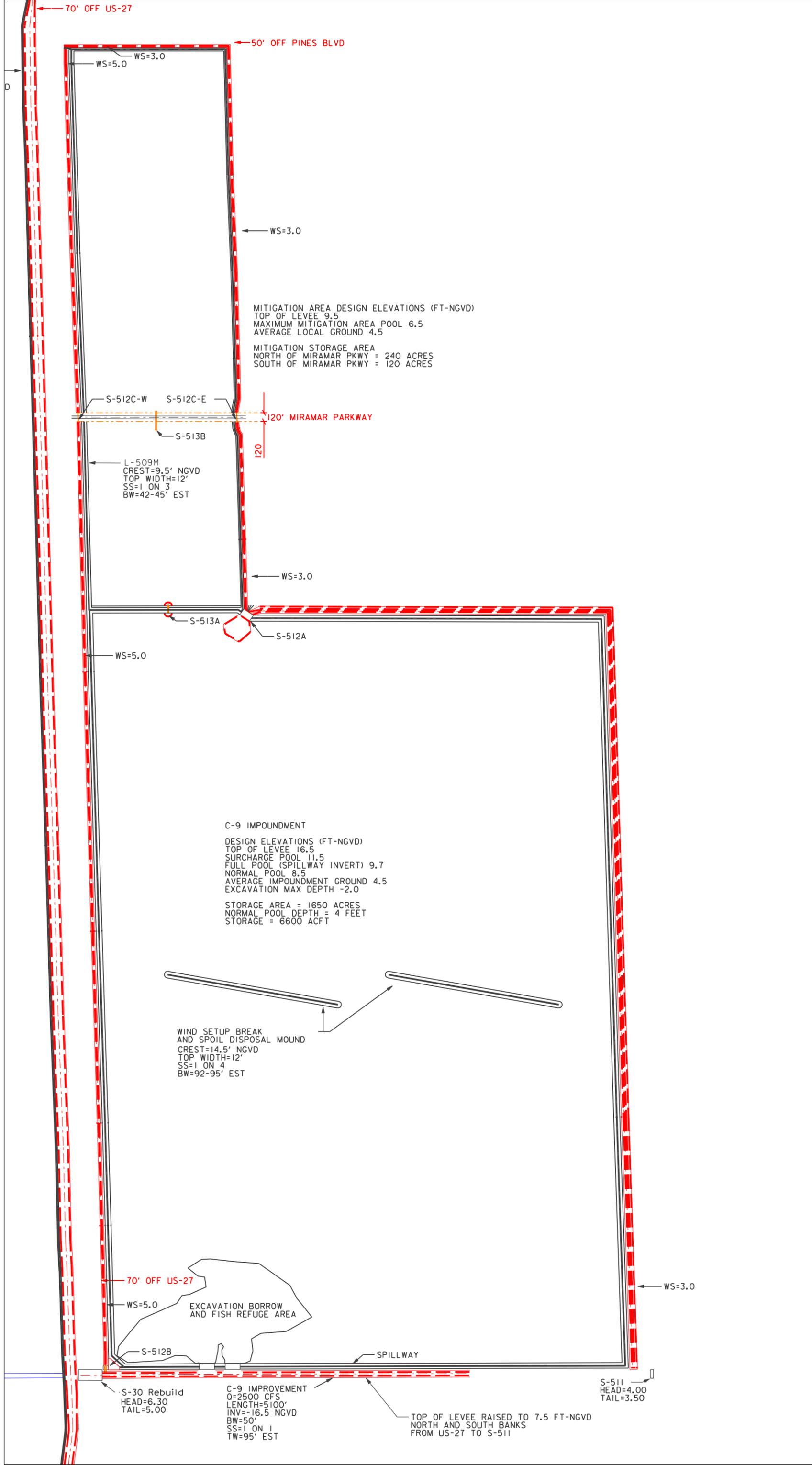
1. A rock crushing plant will be setup within the impoundment to process excavated material prior to placement.
2. Assume overburden soils have a unit weight of 115 pcf while limestone has unit weight of 145 pcf for hauling purposes.

Geotechnical Instrumentation:

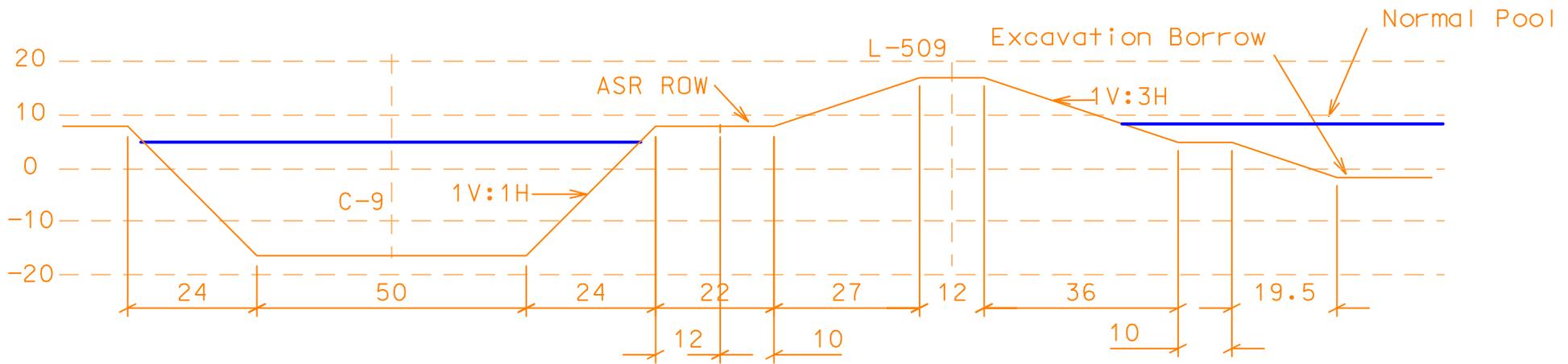
NOTE: This instrumentation is required for monitoring and operational safety of project features within the design region.

1. Shallow Depth Piezometers (\pm 5.0 feet from natural grade)
Answer: Assume 3 piezometers will be included.
2. Medium Depth Piezometers (greater than 5.0 and less than 50 feet from natural grade) - Assume 10 piezometers will be included.
3. Deep Depth Piezometers (greater than 50 feet from natural grade) - Assume 3 piezometers will be included.
4. Inclinometers - Assume 1 constructed through final embankment downstream slope down to hard limestone. Locate on east section adjacent to housing development.





Xsection 1 of L-509 and C-9 Improved
 Southern Level of C-9 Impoundment
 Looking West

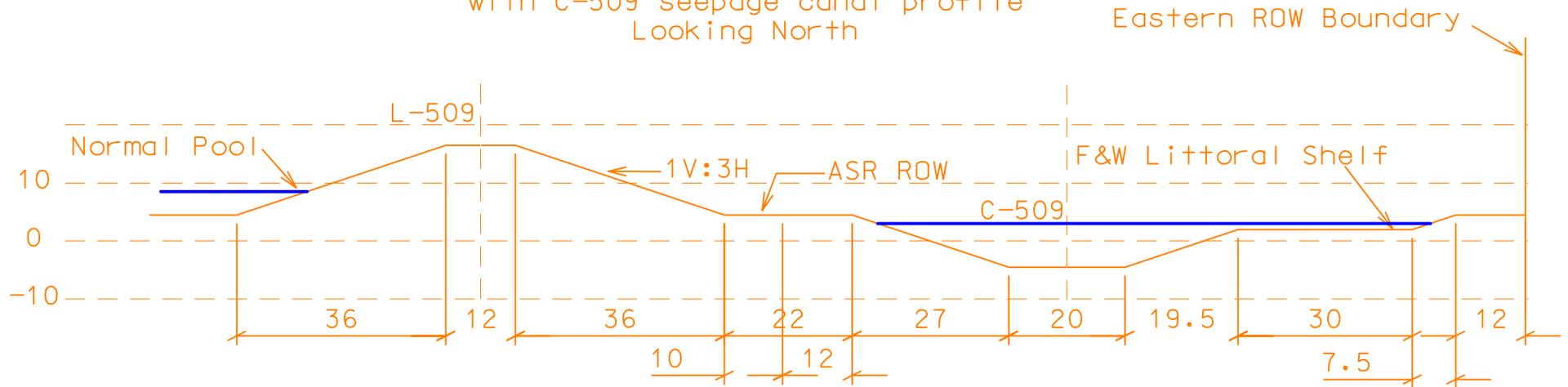


Design Elevations (ft-NGVD)
 Top of Levee 16.5
 Surcharge Pool 11.5
 Full Pool (Spillway Invert) 9.7
 Normal Pool 8.5
 C-9 North & South Levee 7.5
 Average Impoundment Ground 4.5
 Average Local Ground 4.0
 C-9 Optimum 4.0-5.5
 C-9 Bottom -16.5
 Excavation Max Depth -2.0

Preliminary Design Slopes
 Outside Levee Slope = 1V:3H
 Inside Levee Slope = 1V:3H
 Excavation Borrow Slope = 1V:3H
 C-9 Slope = 1V:1H

10' set aside for ASR ROW at
 outside toe of impoundment levee

Xsection 2 of L-509
 Eastern Levee of C-9 Impoundment
 with C-509 seepage canal profile
 Looking North



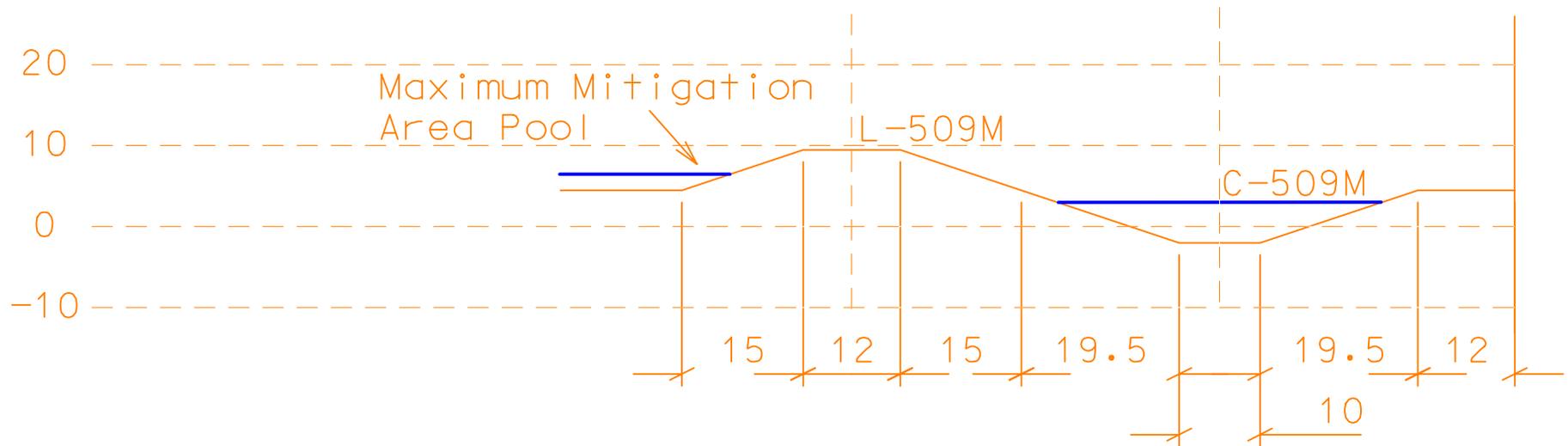
Design Elevations (ft-NGVD)
 Top of Levee 16.5
 Surcharge Pool 11.5
 Full Pool (Spillway Invert) 9.7
 Normal Pool 8.5
 Average Impoundment Ground 4.5
 Average Local Ground 4.0
 C-509 Optimum 3.0
 C-509 Bottom -4.5
 F&W Littoral Shelf 2.0

Preliminary Design Slopes
 Outside Levee Slope = 1V:3H
 Inside Levee Slope = 1V:3H
 C-509 Slope = 1V:3H

10' set aside for ASR ROW at
 outside toe of impoundment levee

Xsection 3 of L-509
 Eastern Levee of C-9 Impoundment
 mitigation area to the north
 with seepage canal profile
 Looking North

Eastern
 ROW Boundary

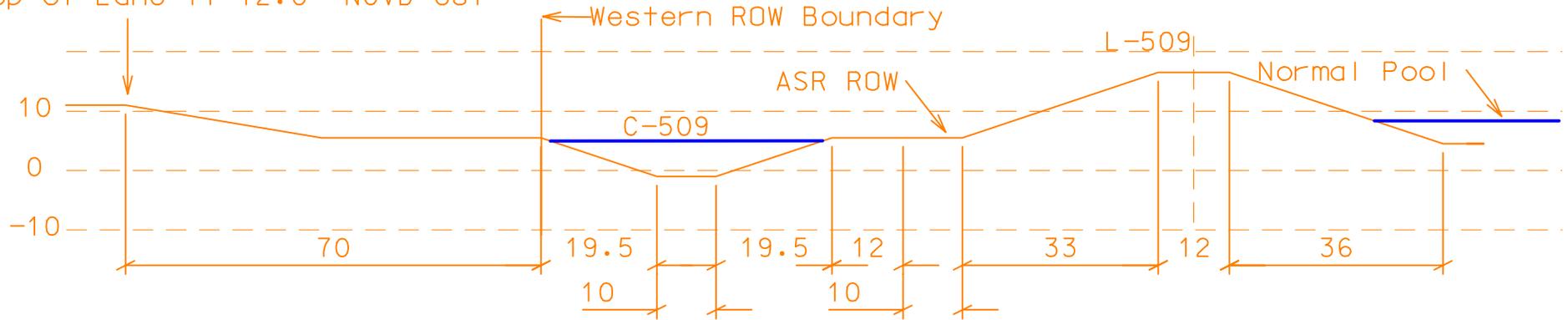


Design Elevations (ft-NGVD)
 Top of Levee 9.5
 Maximum Mitigation Area Pool 6.5
 Average Local Ground 4.5
 Seepage Canal Optimum 3.0
 Seepage Canal Bottom -2.0

Preliminary Design Slopes
 Outside Levee Slope = 1V:3H
 Inside Levee Slope = 1V:3H
 Seepage Canal Slope = 1V:3H

Xsection 4 of L-509
 Western Levee of C-9 Impoundment
 with seepage canal profile
 Looking North

US-27 North Bound Lane
 Top of Lane 11-12.0' NGVD est

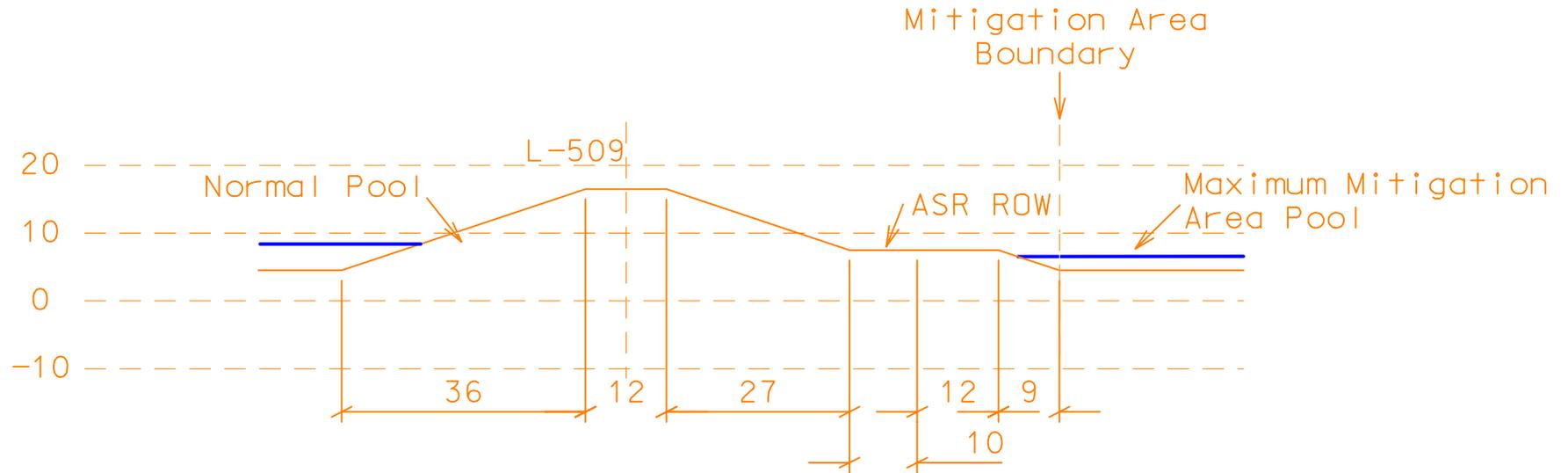


Design Elevations (ft-NGVD)
 Top of Levee 16.5
 Surcharge Pool 11.5
 Full Pool (Spillway Invert) 9.7
 Normal Pool 8.5
 Average Impoundment Ground 4.5
 Average Local Ground 5.5
 Seepage Canal Optimum 5.0
 Seepage Canal Bottom -1.0

Preliminary Design Slopes
 Outside Levee Slope = 1V:3H
 Inside Levee Slope = 1V:3H
 Seepage Canal Slope = 1V:3H

10' set aside for ASR ROW at
 outside toe of impoundment levee

Xsection 5 of L-509
 Northern Levee separating C-9 Impoundment
 from mitigation area to the north
 Looking West



Design Elevations (ft-NGVD)
 Top of Levee 16.5
 Surcharge Pool 11.5
 Full Pool (Spillway Invert) 9.7
 Normal Pool 8.5
 Top of 10' Maintenance and 12' ASR ROW 7.5
 Maximum Mitigation Area Pool 6.5
 Average Impoundment Ground 4.5
 Average Local Ground 4.5

Preliminary Design Slopes
 Outside Levee Slope = 1V:3H
 Inside Levee Slope = 1V:3H
 10' set aside for ASR ROW at
 outside toe of impoundment levee

Design Region: c9 (C-9 Impoundment)

Design:

- a) Design levees and seepage canals for 4' deep impoundment. Consider future ASR systems retrofit in design. Provide revetment for inside slope protection where sharp corners occur.
- b) Design gated spillway and a pump station for a 6' deep impoundment.
- c) Design gated culvert structures for seepage control.
- d) Miramar Parkway future route is along Pembroke Road alignment through the 2' impoundment (mitigated wetland). Design for 120' width. Allow for flow between north and south areas. Possibly raise Miramar Parkway 120' ROW with fill to elevation 11.5-12.0 ft-NGVD to allow for future improvement.
- e) Clear and grub within impoundment.
- f) Provide parking and scenic overlook in southwest area off of US-27.

Impoundment Design Elevations (ft-NGVD)

Top of Levee 16.5
Surcharge Pool 11.5
Full Pool (Spillway Invert) 9.7
Normal Pool 8.5
Average Impoundment Ground 4.5
Excavation Max Depth -2.0

Impoundment Storage Area = 1660 Acres

Mitigation Area Design Elevations (ft-NGVD)

Top of Levee 9.5
Maximum Mitigation Area Pool 6.5
Average Local Ground 4.5

Mitigation Storage Area

North of Miramar Pkwy = 240 acres
South of Miramar Pkwy = 115 acres

Pumps:

1. S-509 Impoundment inflow
2. S-512A Seepage control of eastern boundary

Spillways:

1. S-510 Impoundment discharge

Gated Culverts:

1. S-511 C-9 water level control east of impoundment

2. S-512B Seepage control on western boundary
3. S-513A Control discharge from impoundment into mitigation area

Un-Gated Culverts:

1. S-512C-E Seepage control of eastern boundary of mitigation area between north and south areas separated by Miramar Parkway
2. S-512C-W Seepage control of western boundary of mitigation area between north and south areas separated by Miramar Parkway
3. S-513B Allow water level equalization between mitigation areas north and south of Miramar Parkway alignment

Levees:

1. L-509 4' deep impoundment levee
2. L-509M 2' deep impoundment area around mitigation

Canals:

1. C-509 Seepage canals around perimeter of impoundment - Due to the close proximity of US-27, earthwork will include 18000' in length of stormwater runoff design from US-27. The design will require earthwork grading to create a dry storage swale approximately 1' deep. Assume 20-30' width along the 18000' length. Assume one 10' long concrete weir every 500' (35 required).
2. C-9 Canal improvement to 2500 cfs for 5100' east of US-27
HW at S-30 = 4.00 ft-NGVD
TW at S-509 (PS) = 3.70 ft-NGVD
Mean channel velocity = 1.80 fps (OK)

Depth = 20 ft
Bottom Elevation = -16.15 ft-NGVD
Bottom Width = 50 feet
Top Width = 98 feet
Side Slopes are 1 on 1

Utilities:

1. Phone and electric

Notes:

1. ROW - Western boundary limits begins approximately 70' from US-27 northbound lane.

Issues:

1. ASR system is beneficial in controlling seepage by drawing down impoundment. Seepage cannot be controlled if impoundment is kept full.