

# **Restoration of the Salton Sea**

**Volume 2:      Embankment Designs and Optimization Study**

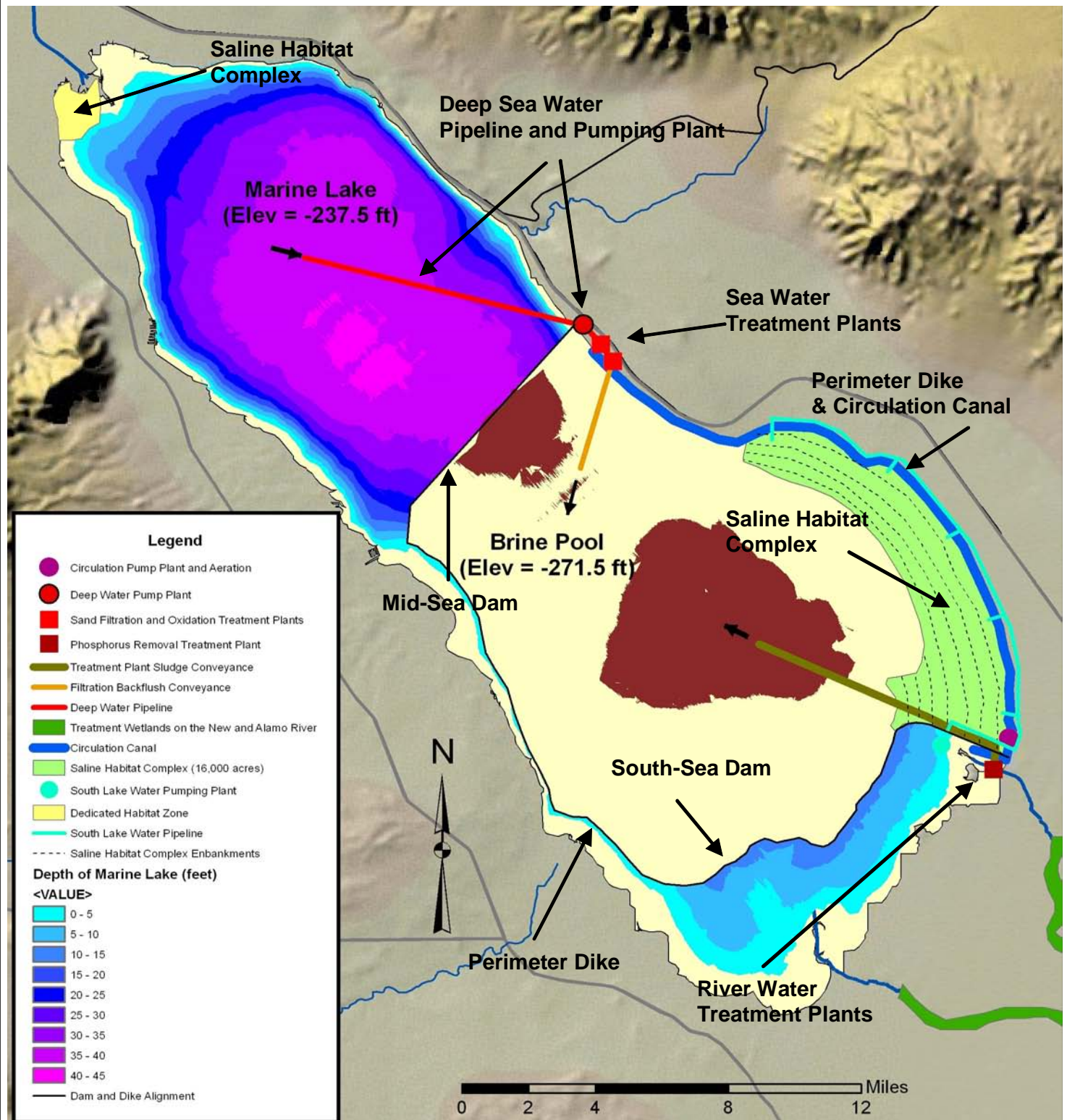
**Appendix 2D: Risk Analysis**

**Attachment A: Project Drawings**

**Prepared for:  
U.S. Department of the Interior  
Bureau of Reclamation  
Lower Colorado Region  
Boulder City, Nevada**

**Prepared by:  
Kleinfelder, Inc.  
Golden, CO 80401  
Project No. 71100**

**May 2007**



United States  
Department of the Interior  
Bureau of Reclamation

**SALTON SEA RESTORATION PROJECT**  
Embankment Designs and Optimization Study  
Appendix 2D - Risk Analysis

**Alternative No. 1**  
Mid-Sea-Dam / North Marine  
Lake (Salton Sea Authority  
Alternative)

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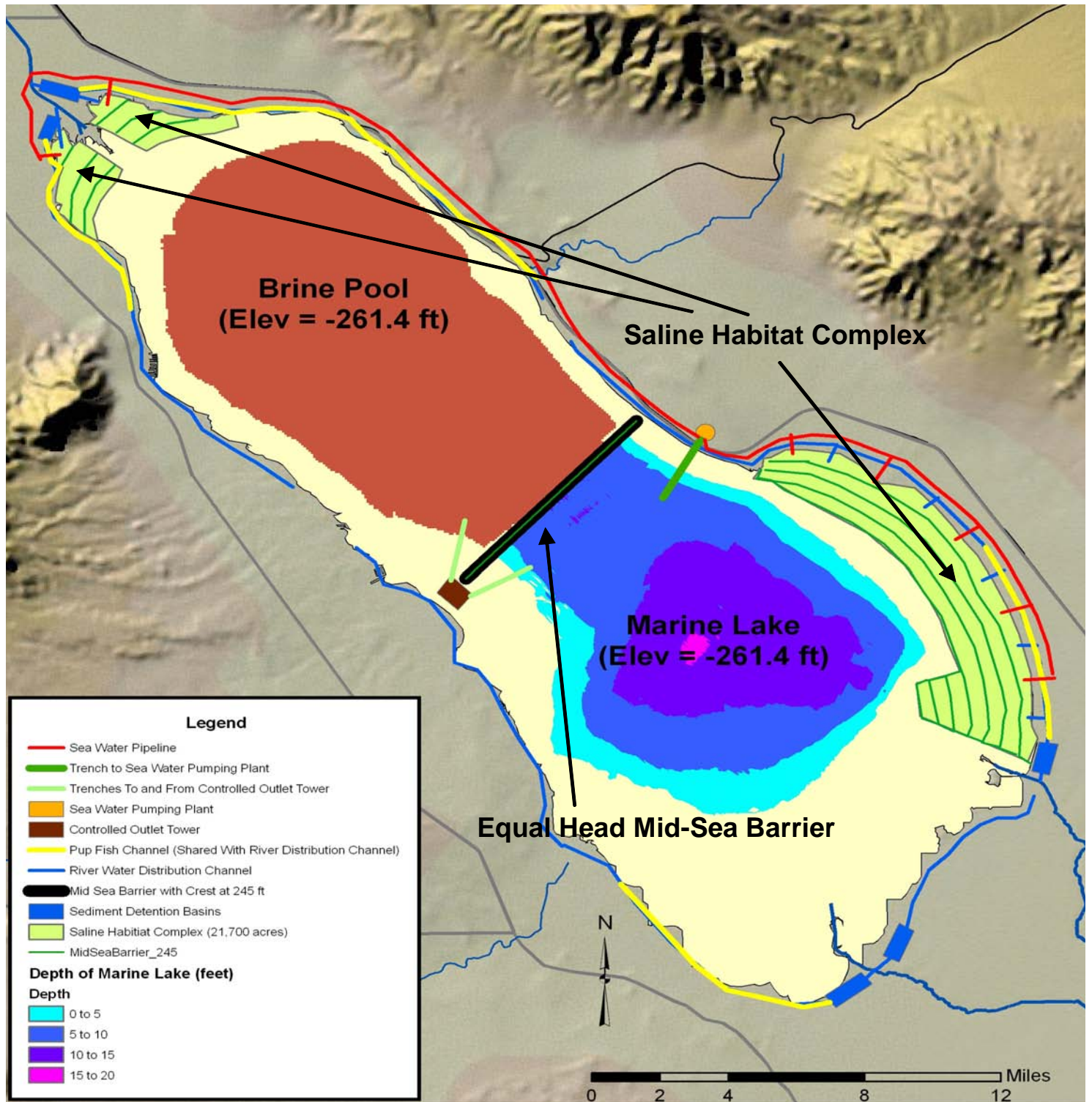
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Date: April 2007

**FIGURE D.A.1**





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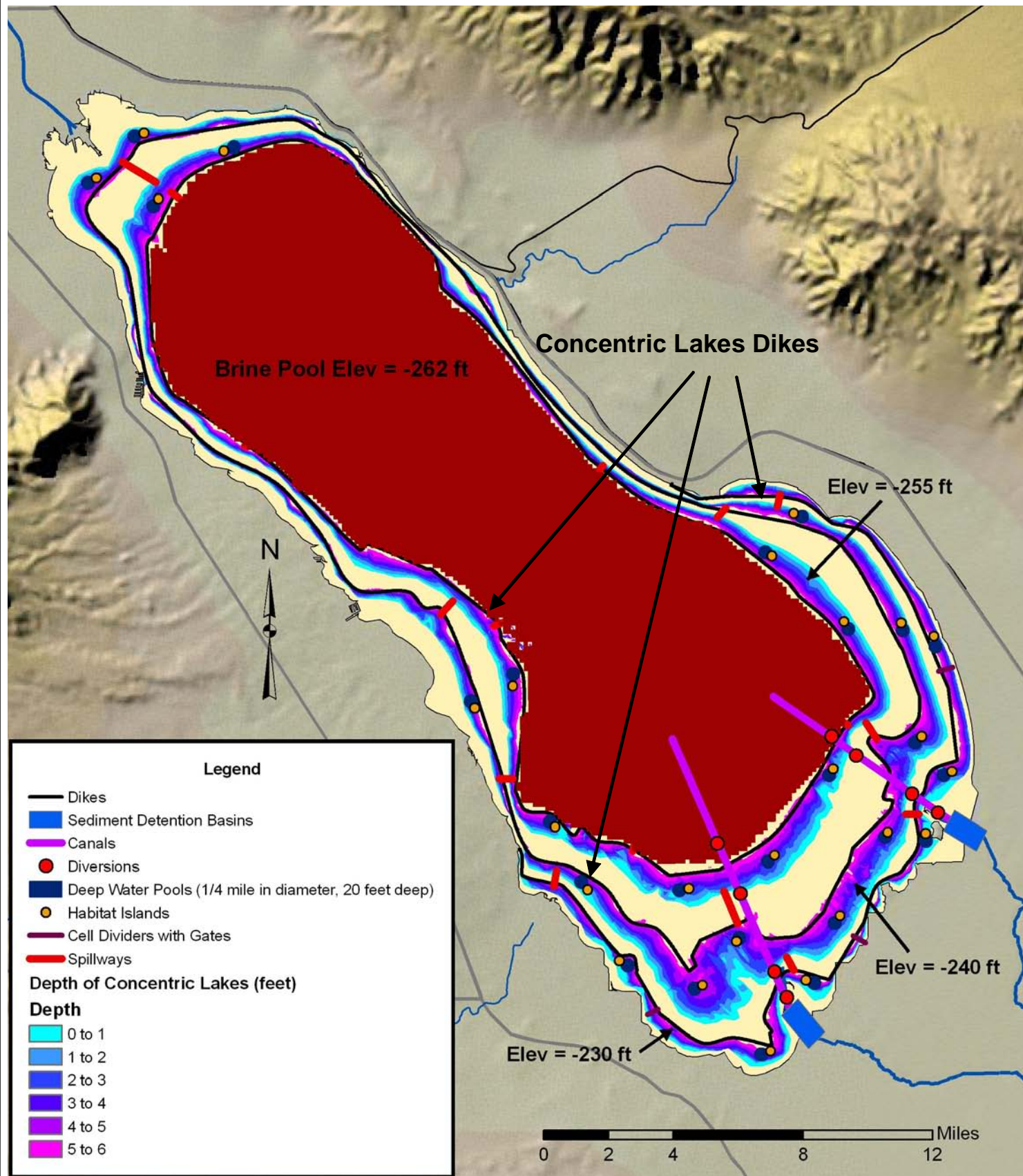
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**Alternative No. 2**

Mid-Sea-Barrier / South  
Marine Lake

**FIGURE D.A.2**





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**Alternative No. 3**  
Concentric Lakes Dikes

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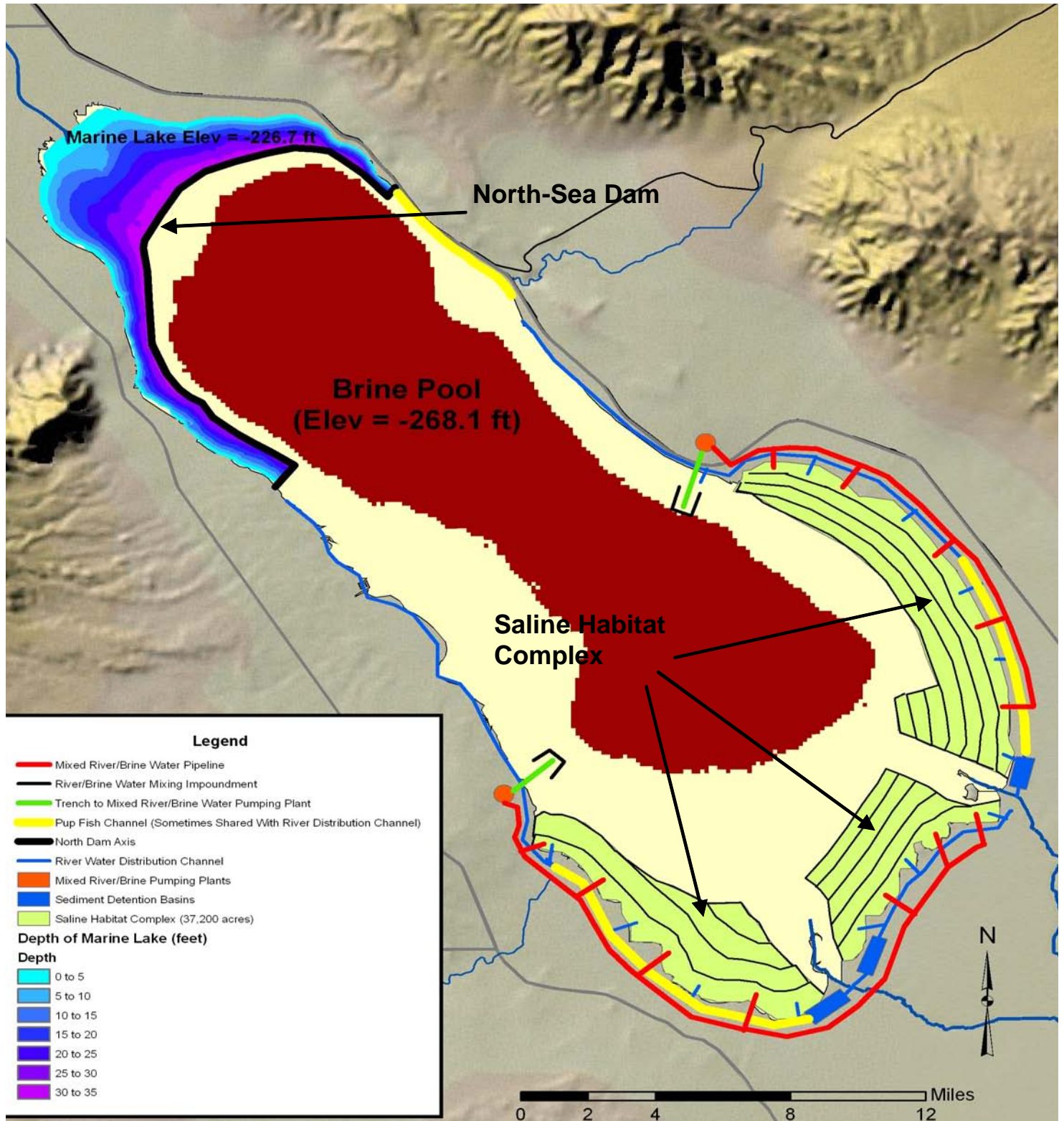
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**FIGURE D.A.3**





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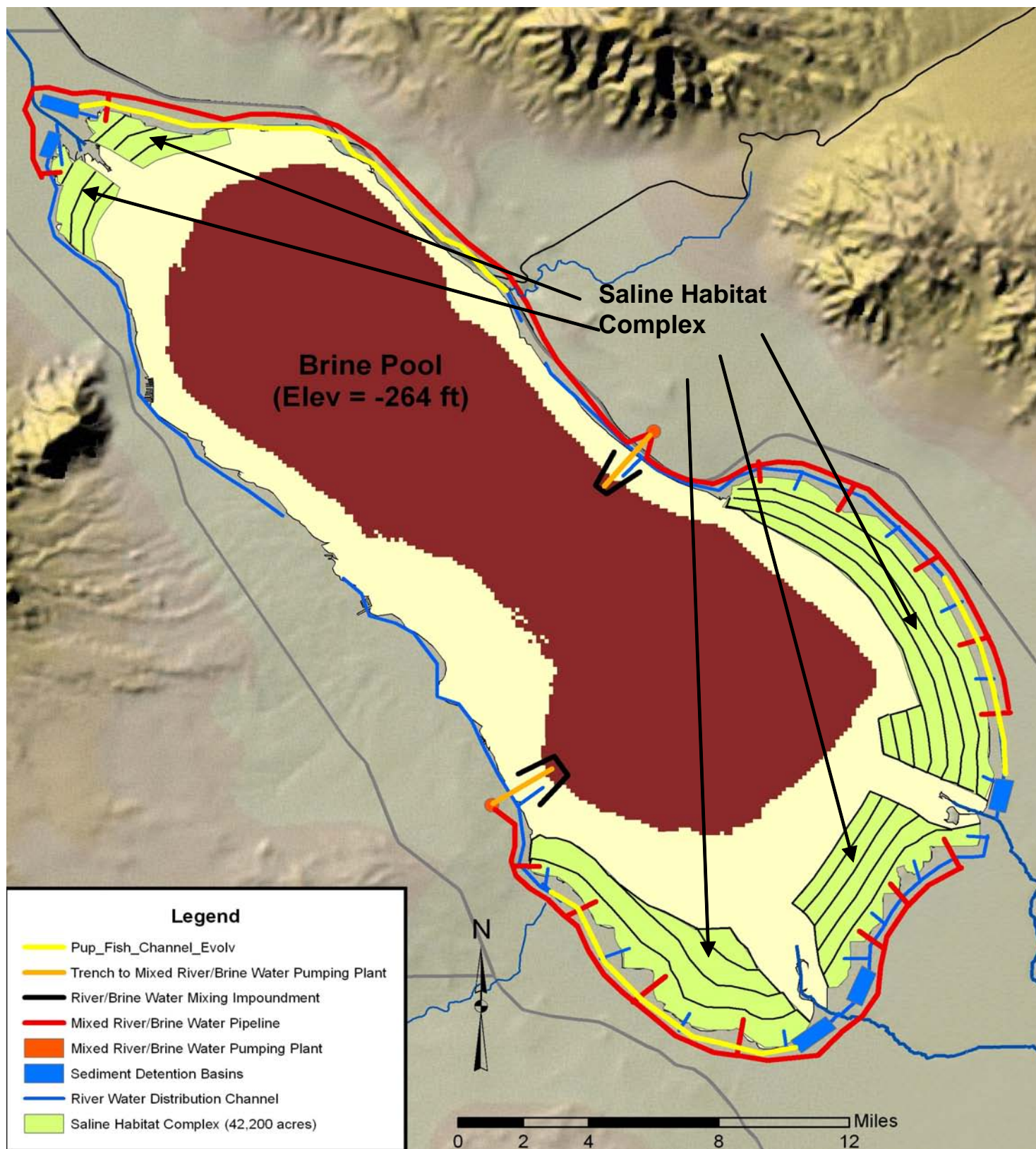
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**Alternative No. 4**

North-Sea Dam / Marine  
Lake

**FIGURE D.A.4**





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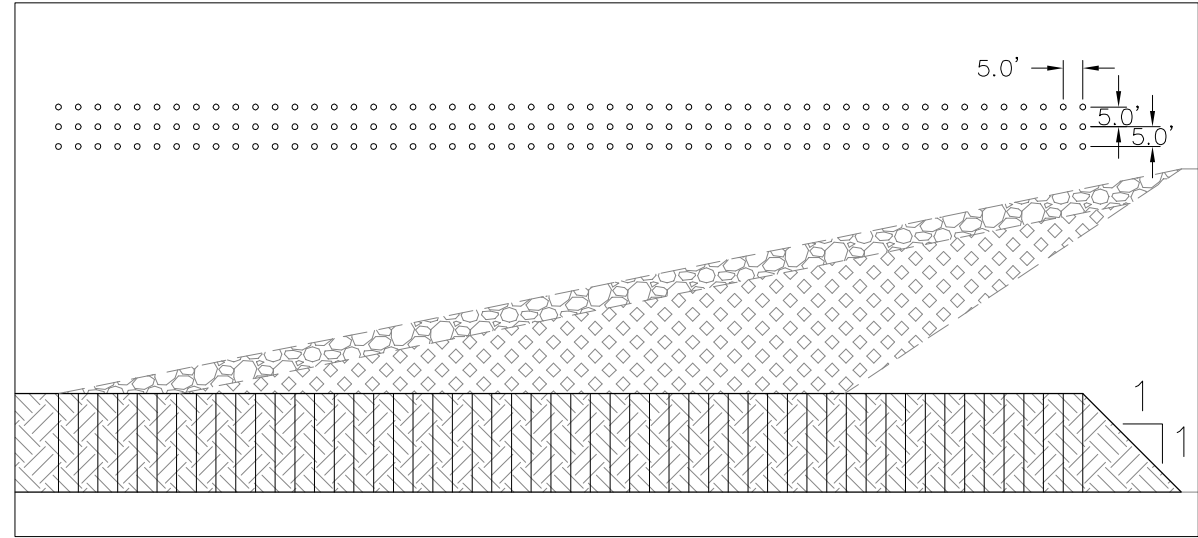
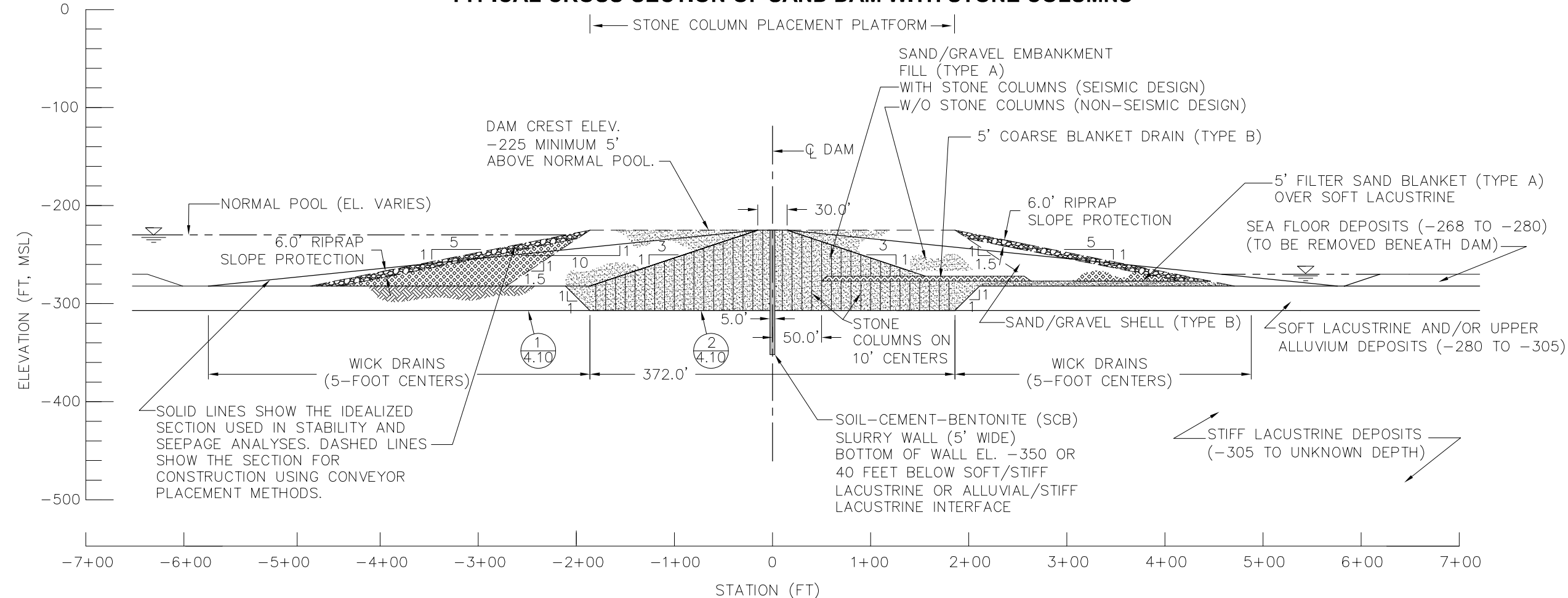
Date: April 2007

**Alternative No. 5**

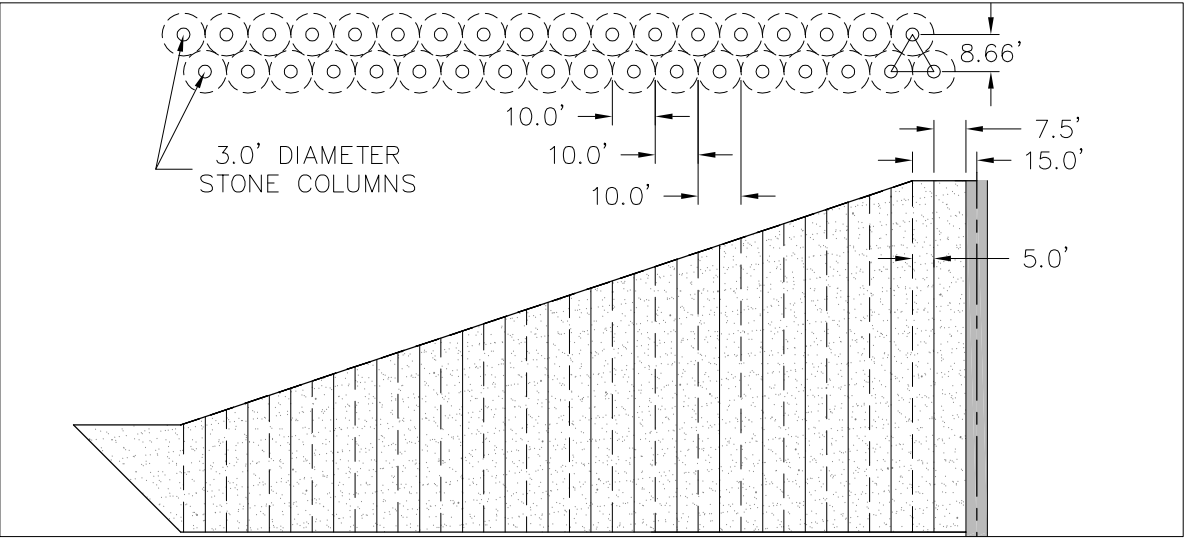
Habitat Enhancement  
without Marine Lake

**FIGURE D.A.5**

TYPICAL CROSS-SECTION OF SAND DAM WITH STONE COLUMNS



WICK DRAIN LAYOUT SCHEMATIC



TYPICAL STONE COLUMNS LAYOUT SCHEMATIC

LEGEND

- SAND/GRAVEL EMBANKMENT FILL (TYPE A): FINE TO COARSE SAND AND GRAVEL, MIX WITH MAXIMUM 3/4-INCH GRAVEL SIZE AND MAXIMUM 10% FINES SUITABLE FOR COMPACTION WITH STONE COLUMNS
- SAND/GRAVEL SHELL (TYPE B): FINE TO COARSE SAND AND GRAVEL WITH VARIABLE FINES NOT INTENDED FOR COMPACTION WITH STONE COLUMNS
- TYPE A WITH STONE COLUMNS: 3' DIA. STONE COLUMNS, 10' ON CENTERS, INSTALLED IN TYPE A SAND/GRAVEL (TRIANGULAR PATTERN).
- RIP RAP SLOPE PROTECTION: 1'-4' DIAMETER SOUND AND DURABLE QUARRY ROCK DUMPED UNDER WATER

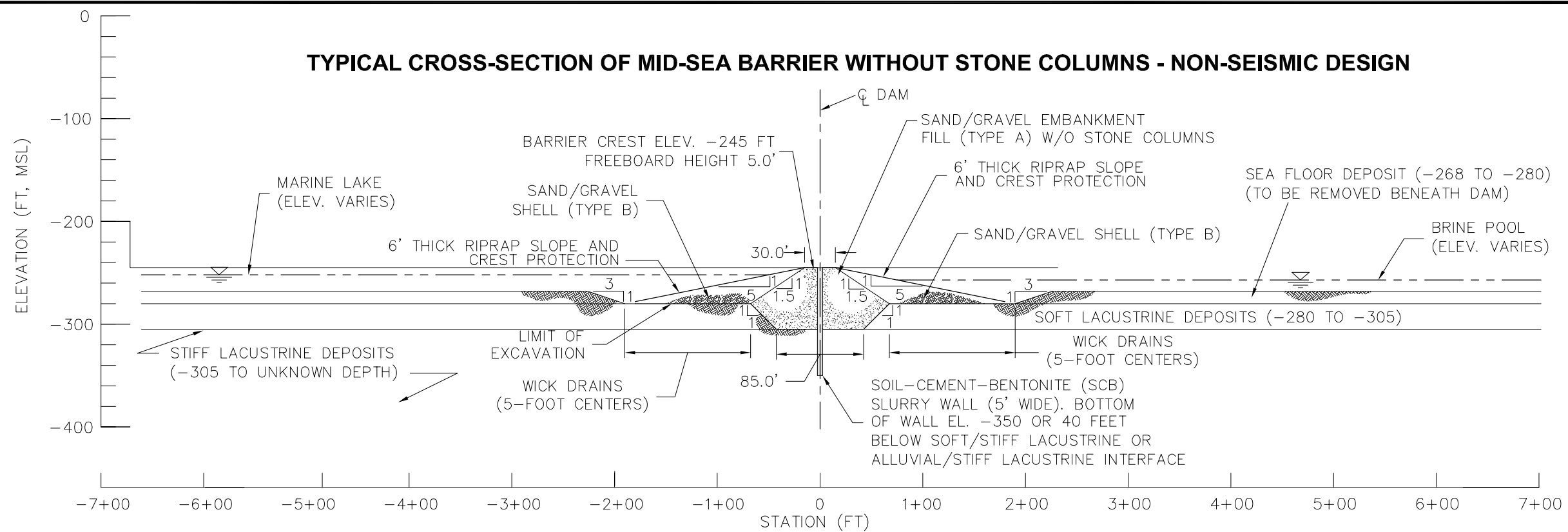


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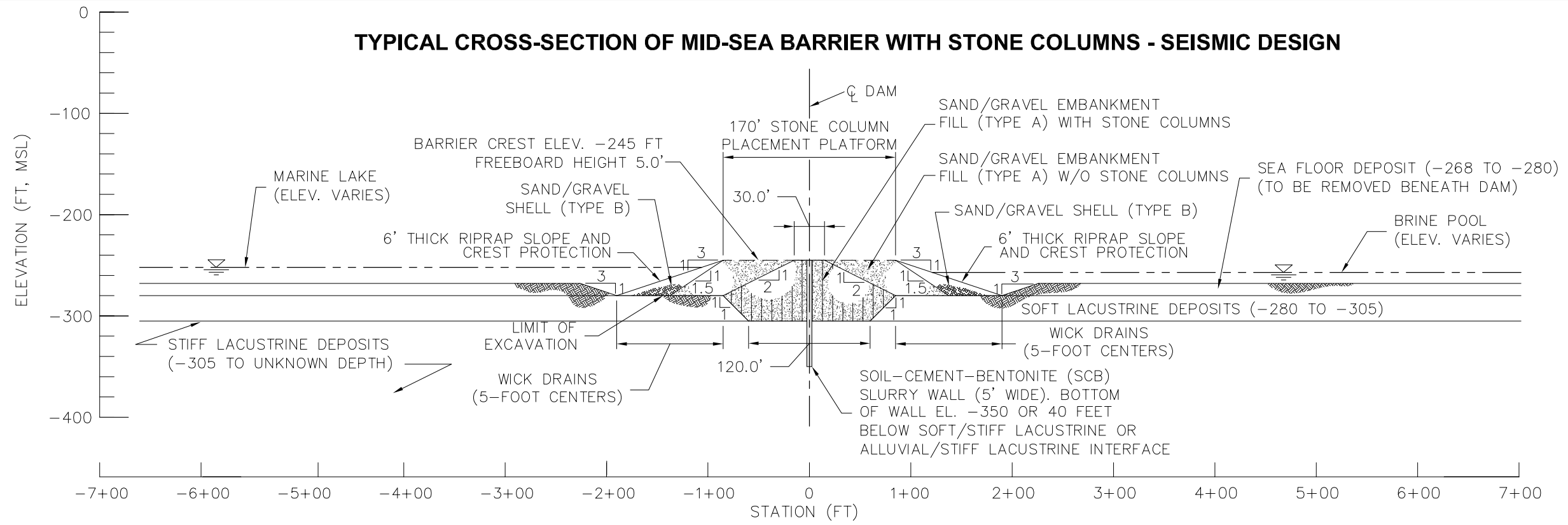




TYPICAL CROSS-SECTION OF MID-SEA BARRIER WITHOUT STONE COLUMNS - NON-SEISMIC DESIGN



TYPICAL CROSS-SECTION OF MID-SEA BARRIER WITH STONE COLUMNS - SEISMIC DESIGN

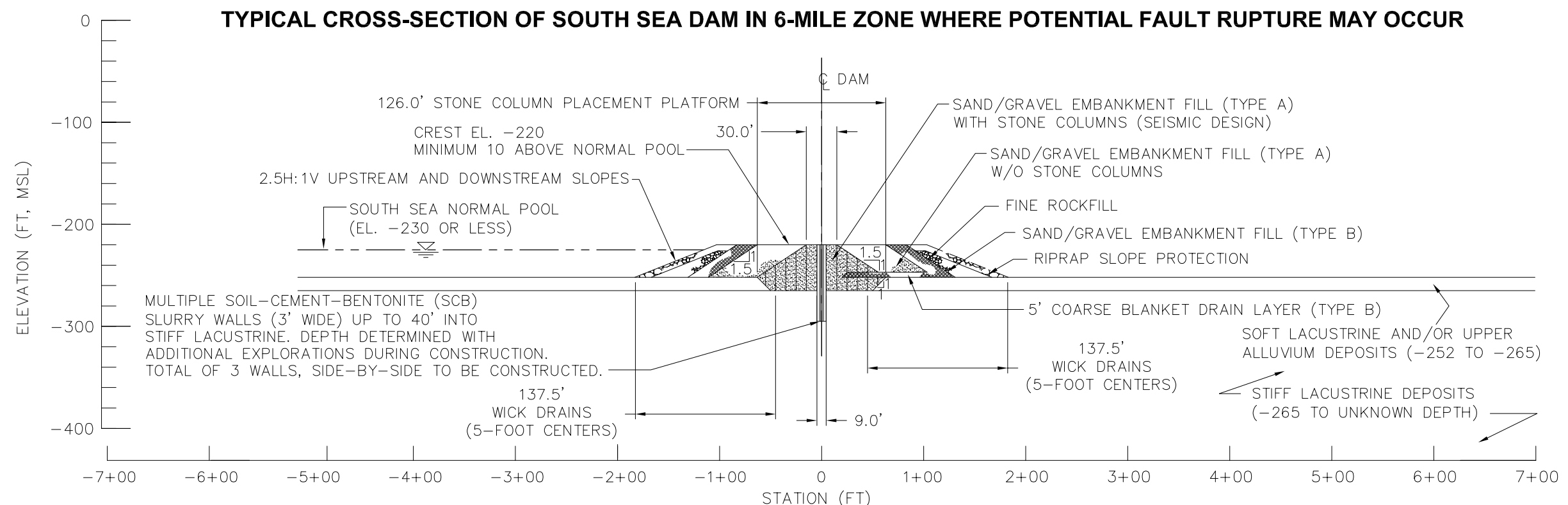
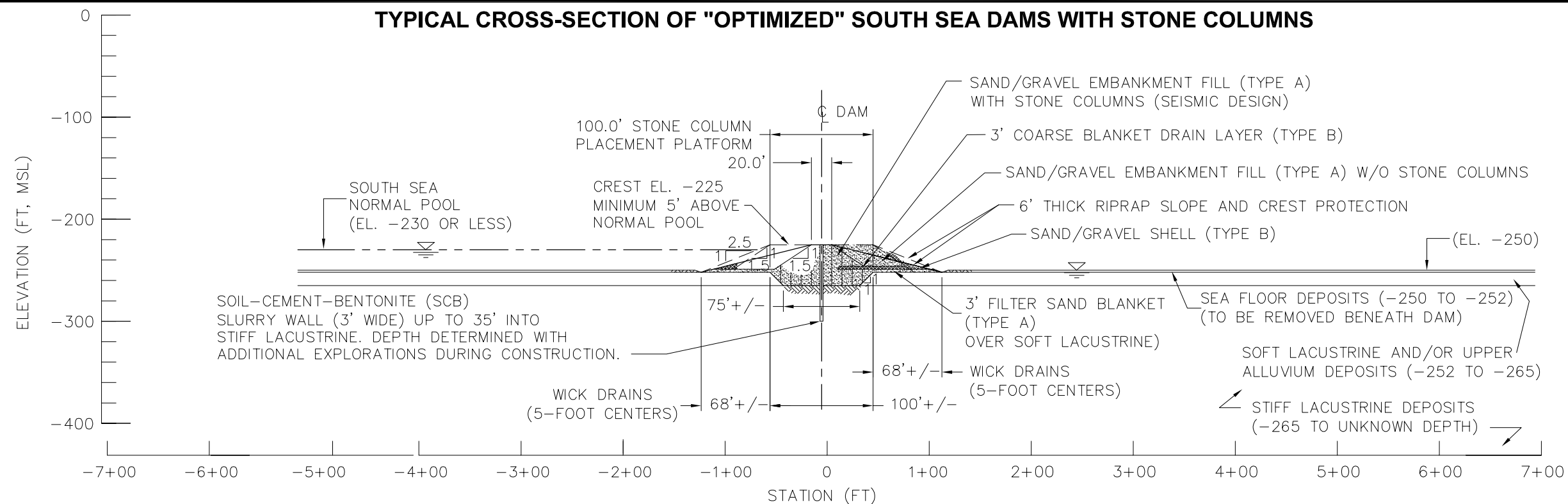


LEGEND

- SAND/GRAVEL EMBANKMENT FILL (TYPE A): FINE TO COARSE SAND AND GRAVEL, MIX WITH MAXIMUM 3/4-INCH GRAVEL SIZE AND MAXIMUM 10% FINES SUITABLE FOR COMPACTION WITH STONE COLUMNS
- SAND/GRAVEL SHELL (TYPE B): FINE TO COARSE SAND AND GRAVEL WITH VARIABLE FINES NOT INTENDED FOR COMPACTION WITH STONE COLUMNS
- STONE COLUMNS: 3' DIA. STONE COLUMNS, 10' ON CENTERS, INSTALLED IN TYPE A SAND/GRAVEL (TRIANGULAR PATTERN).
- RIPRAP SLOPE PROTECTION: 1'-4' DIAMETER SOUND AND DURABLE QUARRY ROCK DUMPED UNDERWATER



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	<b>KLEINFELDER</b>	Project: 71100	By: KAF/CL/MB Date: August 2006	



#### LEGEND

- SAND/GRAVEL EMBANKMENT FILL (TYPE A): FINE TO COARSE SAND AND GRAVEL, MIX WITH MAXIMUM 3/4-INCH GRAVEL SIZE AND MAXIMUM 10% FINES SUITABLE FOR COMPACTION WITH STONE COLUMNS
- SAND/GRAVEL SHELL (TYPE B): FINE TO COARSE SAND AND GRAVEL WITH VARIABLE FINES NOT INTENDED FOR COMPACTION WITH STONE COLUMNS
- STONE COLUMNS: 3' DIA. STONE COLUMNS, 10' ON CENTERS, INSTALLED IN TYPE A SAND/GRAVEL (TRIANGULAR PATTERN).
- RIPRAP SLOPE PROTECTION: 1'-4' DIAMETER SOUND AND DURABLE QUARRY ROCK DUMPED UNDERWATER
- FINE ROCKFILL: 1"-6" SAND AND GRAVEL



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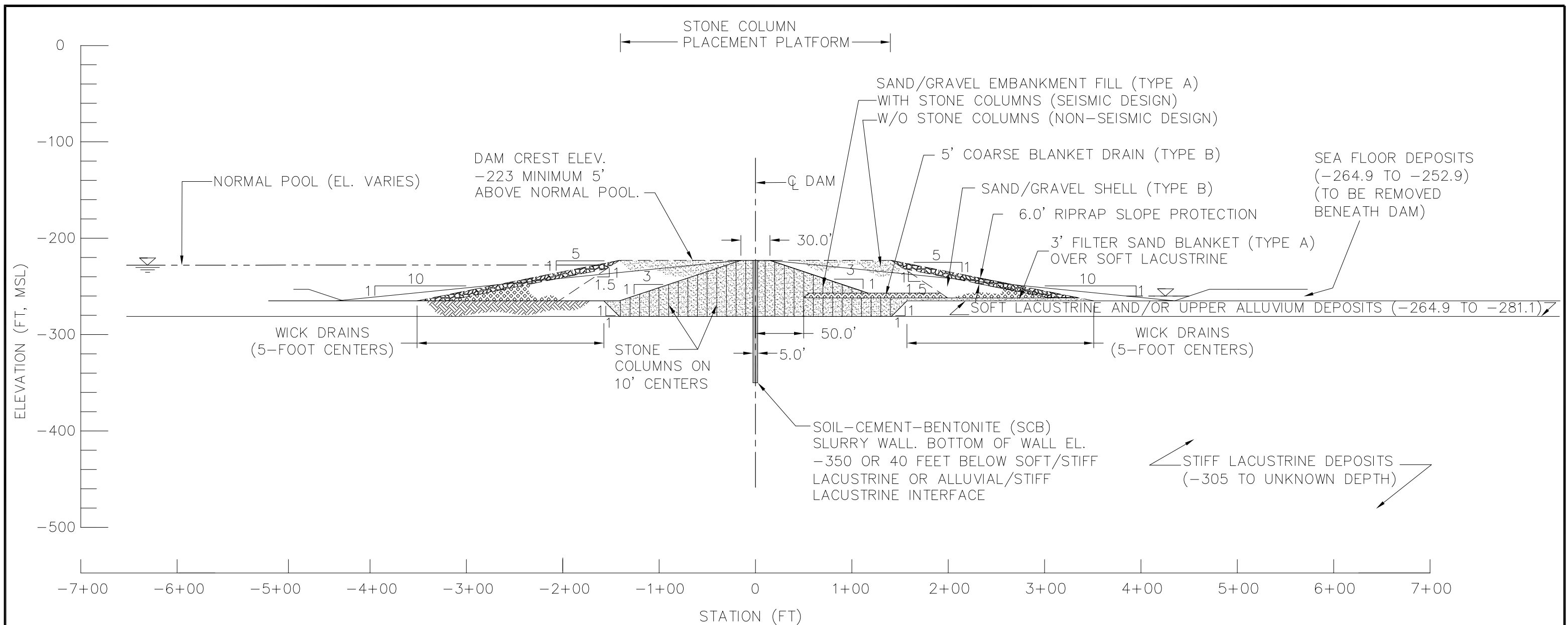
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"OPTIMIZED" SOUTH-SEA  
SAND DAM WITH STONE  
COLUMNS

**FIGURE D.A.9**





**TYPICAL CROSS-SECTION OF NORTH SEA SAND DAM WITH STONE COLUMNS**

**NOTES**

SOLID LINES SHOW THE IDEALIZED SECTION USED IN STABILITY AND SEEPAGE ANALYSES. DASHED LINES SHOW THE SECTION FOR CONSTRUCTION USING CONVEYOR PLACEMENT METHODS.

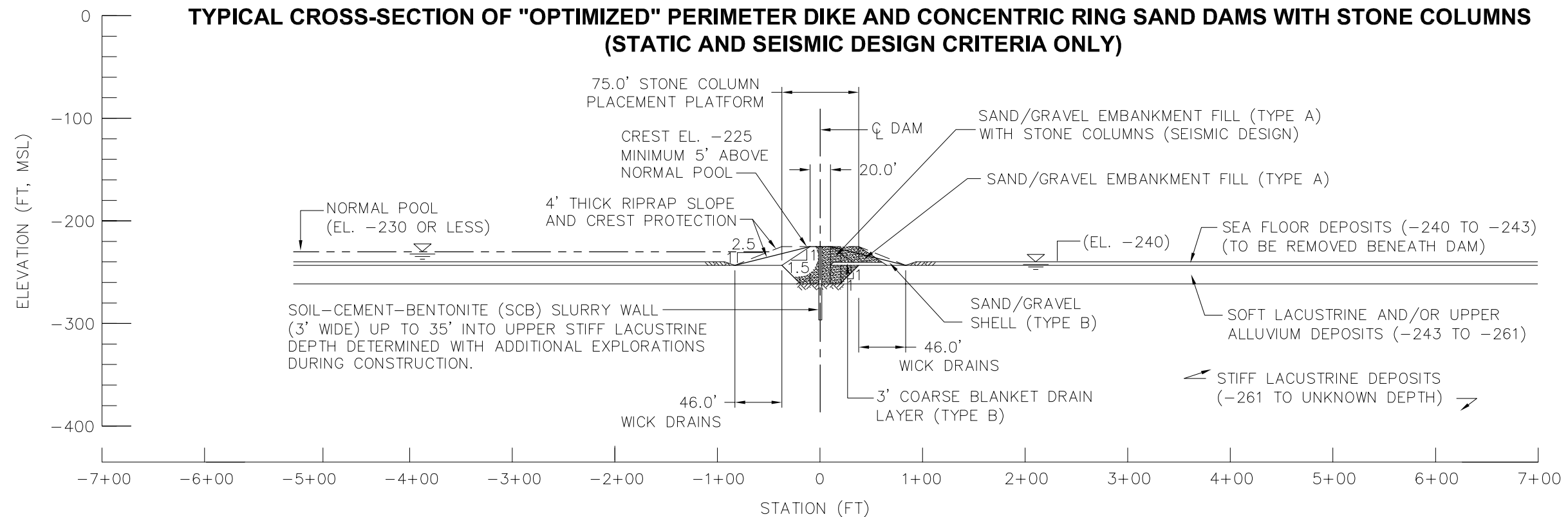


**LEGEND**

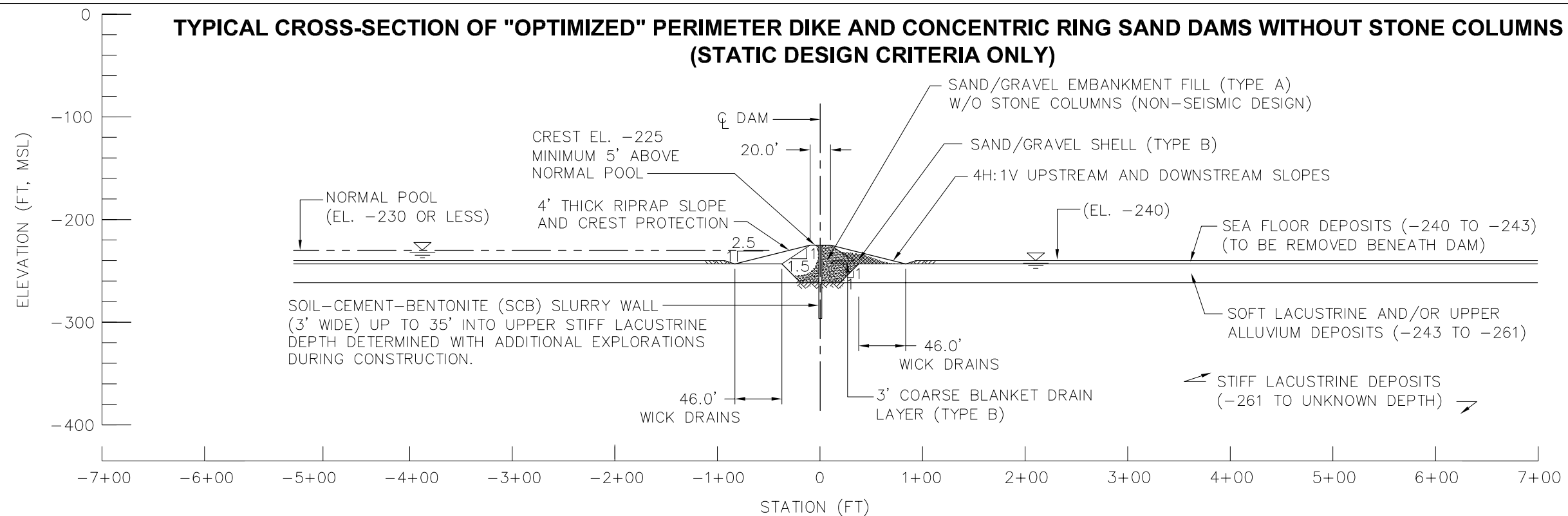
- SAND/GRAVEL EMBANKMENT FILL (TYPE A): FINE TO COARSE SAND AND GRAVEL, MIX WITH MAXIMUM 3/4-INCH GRAVEL SIZE AND MAXIMUM 10% FINES SUITABLE FOR COMPACTION WITH STONE COLUMNS
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- RIP RAP SLOPE PROTECTION: 1'-4' DIAMETER SOUND AND DURABLE QUARRY ROCK DUMPED UNDERWATER

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# **TYPICAL CROSS-SECTION OF "OPTIMIZED" PERIMETER DIKE AND CONCENTRIC RING SAND DAMS WITH STONE COLUMNS (STATIC AND SEISMIC DESIGN CRITERIA ONLY)**



# **TYPICAL CROSS-SECTION OF "OPTIMIZED" PERIMETER DIKE AND CONCENTRIC RING SAND DAMS WITHOUT STONE COLUMNS (STATIC DESIGN CRITERIA ONLY)**



## **LEGEND**

- SAND/GRAVEL EMBANKMENT FILL (TYPE A): FINE TO COARSE SAND AND GRAVEL, MIX WITH MAXIMUM 3/4-INCH GRAVEL SIZE AND MAXIMUM 10% FINES SUITABLE FOR COMPACTION WITH STONE COLUMNS
- SAND/GRAVEL SHELL (TYPE B): FINE TO COARSE SAND AND GRAVEL WITH VARIABLE FINES NOT INTENDED FOR COMPACTION WITH STONE COLUMNS
- STONE COLUMNS: 3' DIA. STONE COLUMNS, 10' ON CENTERS, INSTALLED IN TYPE A SAND/GRAVEL (TRIANGULAR PATTERN).
- RIPRAP SLOPE PROTECTION: 1'-4' DIAMETER SOUND AND DURABLE QUARRY ROCK DUMPED UNDERWATER



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"OPTIMIZED" PERIMETER AND  
CONCENTRIC LAKES SAND  
DAMS (DIKES) WITH AND  
WITHOUT STONE COLUMNS

**FIGURE D.A.11**



