

Restoration of the Salton Sea

Volume 2: Embankment Designs and Optimization Study

Appendix 2C: Deformation Analyses

Tables

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Original Scope Cases

Model Number /Alternative	Condition	Ground Motions	Maximum Displacement Vector (ft)	Average Crest Settlement (ft)	Minimum Crest Settlement (ft)	Figure Numbers
1 – Mid-Sea Dam	Non_Liquefied	Horizontal	7.18	-1.29	-0.18	D.5.4.1.1 to D.5.4.1.6
2 – Mid-Sea Dam	Liquified/Softened	Horizontal	27.3	-3.46	-2.41	D.5.4.2.1 to D.5.4.2.8
2 – Mid-Sea Dam	Liquified/Softened	Horizontal and Vertical	27.7	-2.80	-1.72	D.5.4.3.1 to D.5.4.3.12
3 – Perimeter Dike	Non_Liquefied	Horizontal	2.39	-0.47	-0.11	D.5.4.4.1 to D.5.4.4.12
3 – Perimeter Dike	Non_Liquefied	Horizontal and Vertical	2.87	-0.39	-0.03	
4 – Perimeter Dike	Liquified/Softened	Horizontal	4.51	-1.08	-0.56	
4 – Perimeter Dike	Liquified/Softened	Horizontal and Vertical	4.43	-0.98	-0.53	

Material No.	Soil Description	Elevation (feet, MSL)	Unit Weight (lb/ft ³)	Density (slug/ft ³)	Cohesion (lb/ft ²)	Friction Angle (°)	V _s (ft/s)	K ₀	Poisson's Ratio	Shear Modulus (lb/ft ²)	Bulk Modulus (lb/ft ²)
M1	Shell	-280 to -223	120	3.73	100	32	800	0.4	0.3	2.39E+06	5.17E+06
M2	Stone Columns	-305 to -223	120	3.73	0	38	1000	0.4	0.3	3.73E+06	8.07E+06
M3	Soft Lacustrine	-305 to -280	115	3.57	500	17	600	0.5	0.3	1.29E+06	2.79E+06
M4	Stiff Lacustrine	-318 to -305	118	3.66	200	33	800	1.5	0.3	2.35E+06	5.08E+06
M5	Stiff Lacustrine	-338 to -318	118	3.66	200	33	900	1.0	0.3	2.97E+06	6.43E+06
M6	Stiff Lacustrine	-418 to -338	118	3.66	200	33	1000	0.5	0.3	3.66E+06	7.94E+06

 United States Department of the Interior Bureau of Reclamation	SALTON SEA RESTORATION PROJECT EMBANKMENT DESIGNS AND OPTIMIZATION STUDY Appendix 2C – Deformation Analyses			Mid-Sea Dam Non- Liquefied Material Properties Model 1
KLEINFELDER	Project 71100	By S. Anderson	August 2006	TABLE 2C.4.2

Material No.	Soil Description	Elevation (feet, MSL)	Unit Weight (lb/ft ³)	Density (slug/ft ³)	Cohesion (lb/ft ²)	Friction Angle (°)	V _s (ft/s)	K ₀	Poisson's Ratio	Shear Modulus (lb/ft ²)	Bulk Modulus (lb/ft ²)
M1	Shell	-280 to -223	120	3.73	500	0	800	0.4	0.3	2.39E+06	5.17E+06
M2	Stone Columns	-305 to -223	120	3.73	1000	0	1000	0.4	0.3	3.73E+06	8.07E+06
M3	Soft Lacustrine	-305 to -280	115	3.57	250	17	600	0.5	0.3	1.29E+06	2.79E+06
M4	Stiff Lacustrine	-318 to -305	118	3.66	200	33	800	1.5	0.3	2.35E+06	5.08E+06
M5	Stiff Lacustrine	-338 to -318	118	3.66	200	33	900	1.0	0.3	2.97E+06	6.43E+06
M6	Stiff Lacustrine	-418 to -338	118	3.66	200	33	1000	0.5	0.3	3.66E+06	7.94E+06

 United States Department of the Interior Bureau of Reclamation	SALTON SEA RESTORATION PROJECT EMBANKMENT DESIGNS AND OPTIMIZATION STUDY Appendix 2C – Deformation Analyses			Mid-Sea Dam Liquefied or Softened Material Properties Model 2
KLEINFELDER	Project 71100	By S. Anderson	August 2006	TABLE 2C.4.3

Material No.	Soil Description	Elevation (feet, MSL)	Unit Weight (lb/ft ³)	Density (slug/ft ³)	Cohesion (lb/ft ²)	Friction Angle (°)	V _s (ft/s)	K ₀	Poisson's Ratio	Shear Modulus (lb/ft ²)	Bulk Modulus (lb/ft ²)
M1	Rockfill	-264 to -239	115	3.57	200	45	1200	0.4	0.3	5.14E+06	1.11E+07
M2	Fine Rockfill	-264 to -239	118	3.66	0	42	1200	0.4	0.3	5.28E+06	1.14E+07
M3	Core (clean sand and gravel)	-264 to -239	120	3.73	0	30	900	0.4	0.3	3.02E+06	6.54E+06
M4	Untreated alluvium	-276 to -264	128	3.98	0	32	600	0.5	0.3	1.43E+06	3.10E+06
M5	Jet Grouted Alluvium	-276 to -264	130	4.04	9360	0	1000	1.0	0.3	4.04E+06	8.75E+06
M6	Stiff Lacustrine	-298 to -276	118	3.66	200	33	800	1.5	0.3	2.35E+06	5.08E+06
M7	Stiff Lacustrine	-323 to -298	118	3.66	200	33	900	1.0	0.3	2.97E+06	6.43E+06
M8	Stiff Lacustrine	-418 to -323	118	3.66	200	33	1000	0.5	0.3	3.66E+06	7.94E+06

 <i>United States Department of the Interior Bureau of Reclamation</i>	SALTON SEA RESTORATION PROJECT EMBANKMENT DESIGNS AND OPTIMIZATION STUDY Appendix 2C – Deformation Analyses			Perimeter Dike Non-Liquefied Material Properties Model 3
	KLEINFELDER	Project 71100	By S. Anderson	August 2006
				TABLE 2C.4.4

Material No.	Soil Description	Elevation (feet, MSL)	Unit Weight (lb/ft ³)	Density (slug/ft ³)	Cohesion (lb/ft ²)	Friction Angle (°)	V _s (ft/s)	K ₀	Poisson's Ratio	Shear Modulus (lb/ft ²)	Bulk Modulus (lb/ft ²)
M1	Rockfill	-264 to -239	115	3.57	200	45	1200	0.4	0.3	5.14E+06	1.11E+07
M2	Fine Rockfill	-264 to -239	118	3.66	0	42	1200	0.4	0.3	5.28E+06	1.14E+07
M3	Core (clean sand and gravel)	-264 to -239	120	3.73	500	0	900	0.4	0.3	3.02E+06	6.54E+06
M4	Untreated alluvium	-276 to -264	128	3.98	400	0	600	0.5	0.3	1.43E+06	3.10E+06
M5	Jet Grouted Alluvium	-276 to -264	130	4.04	9360	0	1000	1.0	0.3	4.04E+06	8.75E+06
M6	Stiff Lacustrine	-298 to -276	118	3.66	200	33	800	1.5	0.3	2.35E+06	5.08E+06
M7	Stiff Lacustrine	-323 to -298	118	3.66	200	33	900	1.0	0.3	2.97E+06	6.43E+06
M8	Stiff Lacustrine	-418 to -323	118	3.66	200	33	1000	0.5	0.3	3.66E+06	7.94E+06

 United States Department of the Interior Bureau of Reclamation	SALTON SEA RESTORATION PROJECT EMBANKMENT DESIGNS AND OPTIMIZATION STUDY Appendix 2C – Deformation Analyses			Perimeter Dike Liquefied or Softened Material Properties Model 4
KLEINFELDER	Project 71100	By S. Anderson	August 2006	TABLE 2C.4.5

Mid Sea Dam Parametric

Change to Model 2	Condition	Maximum Displacement Vector (ft)	Average Crest Settlement (ft)	Minimum Crest Settlement (ft)	Figure Numbers
Core – Cohesion Only 800 psf	Liquified/Softened	28.0	-5.27	-3.21	D.6.1 to D.6.6
Core – Cohesion Only 1,200 psf	Liquified/Softened	26.9	-2.18	-1.45	D.6.7 to D.6.12
Core – Cohesion Only 1,400 psf	Liquified/Softened	26.9	-1.36	-1.03	D.6.13 to D.6.18
Core – Cohesion Only 1,600 psf	Liquified/Softened	27.1	-0.86	-0.70	D.6.19 to D.6.24
Core – Friction Only 26 degrees	Liquified/Softened	27.4	-3.30	-0.87	D.6.25 to D.6.30
Core – Friction Only 28 degrees	Liquified/Softened	27.4	-2.95	-0.72	D.6.31 to D.6.36
Core – Friction Only 30 degrees	Liquified/Softened	27.4	-2.73	-0.59	D.6.37 to D.6.42
Core – Friction Only 32 degrees	Liquified/Softened	27.4	-2.36	-0.45	D.6.43 to D.6.48
Core – Friction Only 34 degrees	Liquified/Softened	27.3	-2.11	-0.33	D.6.49 to D.6.54
Core – Friction Only 36 degrees	Liquified/Softened	27.3	-1.88	-0.24	D.6.55 to D.6.60
Shell – Reduced Cohesion 200 psf	Liquified/Softened	34.3	-3.02	-2.11	D.6.61 to D.6.66
Shell – Reduced Cohesion 300 psf	Liquified/Softened	31.3	-3.23	-2.12	D.6.67 to D.6.72
Shell – Reduced Cohesion 400 psf	Liquified/Softened	29.0	-3.37	-2.12	D.6.72 to D.6.78

 United States Department of the Interior Bureau of Reclamation	SALTON SEA RESTORATION PROJECT EMBANKMENT DESIGNS AND OPTIMIZATION STUDY Appendix 2C – Deformation Analyses			Parametric Analysis Table of Analysis Cases, Summary of Results and Guide to Figure Numbers
KLEINFELDER	Project 71100	By S. Anderson	August 2006	TABLE 2C.6.4