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- Page 15 – Example of stress-strain compatibility
- Pages 52, 301-305 – Correlations of shear strength with plasticity characteristics
- Pages 669-702 – Chapter on landfill stability including recommended interface strengths and examples of critical sections

B **BOUTWELL, Gordon P., "Slides Happen – Landfill Stability Analyses", 2002 Aleksandar Vesic Memorial Lecture, October 2002. entire document, related to stability analyses**

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B **BUREAU of RECLAMATION**

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- pages 95-97 – Contains updated database of USBR testing results on compacted soils as a function of Unified Soil Classification

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U.S.Army Corps of Engineers, *Engineer Manual, Engineering and Design – Design and Construction of Levees*, EM 1110-2-1913, 2000 excerpt only, related to stability analyses

- page 3-4 (Figure 3-2a, 3-2b, 3-2c) – Relation of c/p data versus plasticity index and c/p [s_u/σ} versus overconsolidation ratio ("OCR") for several regional clays
- page 3-5 (Figure 3-3a) – Correlation of compression index data along the Mississippi River versus liquid limit
- page 3-7 – Requirements for unconsolidated-undrained ("Q") tests for general foundation design and consolidated-undrained ("R") and consolidated-drained ("S") laboratory tests for major levees and/or when important structures are located within the levee system.

- pages 6-4 – 6-5 – Minimum acceptable factors of safety for Corps levees using Corps design procedures and shear strength selection

U.S. Army Corps of Engineers, *Engineer Manual, Engineering and Design – Slope Stability*, EM 1110-2-1902, 2003. excerpt only, related to stability analyses

- pages 2-1 – 2-7 – Specified procedures for assigning shear strength values
- pages 3-1 – 3-2 – Minimum acceptable factors of safety for Corps dams using Corps design procedures and shear strength selection
- pages 4-1 – 4-2 – verification of computer analyses and results
- Appendix D – Shear strength characterization

D **DUNCAN, J. Michael, Stephen G. Wright, *Soil Strength and Slope Stability*, John Wiley & Sons, 2005. excerpt only, related to stability analyses**

- page 27 – Range of c_v, for clay given as 10 to 1,000 ft^2/year; value of T_{99} = 4 for 99% consolidation
- pages 35- 53 – Shear strengths of soil and municipal solid waste
- pages 103-111 – methods of analyzing slope stability
- pages 199-211 – Factors of safety and recommendations (note pages 200-201 – Corps of Engineers analysis considered a special subset, page 203 – reliability & coefficient of variance for common geotechnical properties, page 204-205 – graphical three-sigma analysis)
- page 232 – verification of stability calculations

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E U.S. EPA, *Evaluation of Subsurface Engineered Barriers at Waste Sites*, Volumes I and II, EPA 542-R-98-005, August 1998. excerpt only, related to subsurface barriers to control leachate, contaminated groundwater, and landfill gas migration

- pages vii-viii – Executive summary including state of practice
- page 12 – Commentary on design, CQA/CQC, and monitoring
- pages 19-20 – Hydrogeologic investigation
- page 20 (Table 3-2) – Acceptable industry practices for barrier design
- pages 21-22 – Geotechnical investigation
- pages 22-23 – Key into the "aquitard"
- page 24 – Analysis trench stability
- pages 27-33 – Summary of the evaluated sites' design
- pages 36-38 – Confirmation of key and "aquitard,", prevention of "windows"
- page 31 (Table 3-6) – Industry baseline standard of practice for performance monitoring
- pages 94-96 – Recommendations for design, CQA/CQC, monitoring, and long-term maintenance
- pages 97-98 – References

- pages 99-102 – Glossary

E U.S. EPA, *Guide to Technical Resources for the Design of Land Disposal Facilities*, EPA/625/6-88/018, RREL-Cincinatti, December 1988. excerpt only, related to stability analyses and final cover design

- pages 1-2 – Introduction
- page 3 – Regulation and performance standard
- pages 3-10 – Foundations, field investigation, settlement
- pages 11-20 – Slope stability and recommended factors of safety (pages 11-15 – Discussion of slope stability including recommended factors of safety, pages 15-16 – Discussion of settlement)
- Pages 49-50 – Discussion of settlement and sliding instability of final covers

Sep Folder U.S. EPA, *Interim Final RCRA Facility Investigation (RFI) Guidance*, EPA 530/SW-89-031, Volumes I-IV, May 1989. excerpt only, related to RCRA facility monitoring and corrective action, specifically referenced in 56 FR 50978

- pages 1-1 – 1-13 – Overview of RCRA corrective action program
- pages 2-2 – 2-26 – RFI work plan requirements
- pages 3-1 – 3-37 – General strategy for release investigation
- pages 7-1 – 7-23 – Waste and [waste] unit characterization
- pages 8-1 – 8-66 – Health and environmental assessment
- pages 9-1 – 9-68 – Soil [release to]
- pages 10-1 – 10-116 – Ground Water [release to]
- pages 11-1 – 11-44 – Subsurface gas [release to]
- pages D-1 – D-12 – Subsurface gas migration model
- pages E-1 – E-5 – Vapor intrusion into building
- pages 12-1 – 12-137 – Air [release to]
- pages 13-1 – 13-75 – Surface water [release to]
- pages 15-119 – 15-123 – Case study for two liquid phase contamination
- pages 15-137 – 15-143 – Case study for landfill gas migration
- pages 15-144 – 15-152 – Case study for gas migration model

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- page 1 – applicable to MSW landfills that codispose sewage sludge
- pages 84-85 – discussion of unstable areas including bearing capacity and settlement
- pages 96-98 – Field investigation and foundation design including bearing capacity and settlement
- pages 114-118 – slope stability and settlement including data requirements and recommended minimum factors of safety
- pages 154-155 – references

E U.S. EPA, *Quality Assurance and Quality Control for Waste Containment Facilities*, EPA/600/R-93/182, U.S. EPA, 1993, excerpt only, related to subsurface barriers to control leachate, contaminated groundwater, and landfill gas migration

- pages 235-252 – Chapter discussing vertical cutoff wall design, installation and problems (pages 235-236 – Graphic illustrations of "hanging" vertical barriers versus "keyed" vertical barriers, page 248 – Illustration of various problems in slurry wall installations)

IJ U.S. EPA, *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document (TEGD)*, OSWER-9950.1, U.S. EPA, 1986. excerpt only, related to RCRA facility monitoring and corrective action, specifically referenced in 56 FR 50978

- pages ii-iii – Overview
- pages 1-44 – Characterization of site hydrogeology
- pages 45-70 – Placement of detection monitoring wells
- pages 143-189 – Assessment monitoring

H U.S. EPA, *Seminar Publication – Design and Construction of RCRA/CERCLA Final Covers*, EPA 625/4-91/025, 1991. excerpt only, related to stability analyses and final cover design

- pages 1-7 – Overview of cover system design and potential problems – particularly Subtitle D issues including waste settlement
- pages 9-26 – Soil cover components including leakage rates, settlement-related tensile strains, and interfacial shear
- page 28 – Stresses in geomembrane cover components
- pages A-1-A-27 – Stability and tension considerations for composite covers including localized subsidence

H U.S. EPA, *Solid Waste Disposal Facility Criteria: Technical Manual*, EPA530-R-93-017, 1993 (revised April 1998). excerpts only, related to stability analyses, unstable area location restriction, groundwater monitoring, landfill gas monitoring

- 1998 update notice
- table of contents
- pages iv-viii – Purpose, "how to use manual", and manual limitations
- pages 45-65 – Unstable area location restriction (slope stability including factors of safety, settlement, poor foundation support) and closure requirement for MSWLF units that cannot make required demonstration
- pages 77-84 – Procedures for excluding the receipt of hazardous waste, etc.
- pages 87-101 – Explosive gases control
- pages 101-103 – Air criteria
- pages 149-181 – Composite liner and leachate collection systems
- pages 211-240 – Ground water monitoring
- pages 291-317 – Corrective action
- pages 333-337 – Final cover systems

F FEDERAL REGISTER

53 Federal Register 33314, "40 CFR Parts 257 and 258, Solid Waste Disposal Facility Criteria; Proposed Rule" Volume 53, Number 168, Tuesday, August 30, 1988. excerpts only, related to all aspects of Subtitle D

- pages 33314-33432 – Entire document
- page 33314 – Summary
- page 33316 – Authority and background
- pages 33317-33321 – Nature and scope of problem
- page 33325 – Specific reference to unstable area restrictions for existing MSWLF units
- pages 33333-33335 – Unstable areas
- page 33335 – Excluding regulated hazardous waste and PCB waste
- pages 33336-33337 – Explosive gases control
- pages 33361-33364 – Relationship between annual precipitation and leachate generation
- page 33367 – Benefits of siting in "good" locations
- pages 33369-33370 – Ground-water monitoring design similar to Subtitle C, discussion of complex flow systems, "mounding" impact
- page 33371 – TEGD recommended for ground-water sampling and analysis
- page 33376 – Remedies must control sources
- page 33405 – Proposed 258.1 – purpose, scope, and applicability
- page 33407 – Proposed 258.15 – unstable areas and proposed 258.20 – procedures for excluding the receipt of hazardous waste
- page 33415 – Proposed 258.57 – selection of remedy, source control

56 Federal Register 50978, "40 CFR Parts 257 and 258, Solid Waste Disposal Facility Criteria; Final Rule" Volume 56, Number 196, Wednesday, October 9, 1991. excerpts only, related to all aspects of Subtitle D

- pages 50978-51119 – Entire document
- page 50978 – Summary
- page 50979 – RCRA Subtitle D criteria
- pages 50981 – Improving MSWLFs
- pages 50982-50984 – Statutory basis for criteria
- page 51012 – State implementation of criteria
- pages 51047-51048 – Discussion of "unstable areas" with examples
- pages 51049-51052 – Excluding regulated hazardous waste and PCB waste
- pages 51051-51052 – Explosive gases control
- page 51059 – EPA rejection of "equivalent" liner systems
- pages 51065-51066 – Ground-water systems, reference to **TGED and RFIG**
- pages 51084-51085 – Contaminant plume characterization
- page 51089 – Selection of remedy and source control

64 Federal Register 19494, "Texas; Final Full Program Adequacy Determination of State Municipal Solid Waste Permit Program" Volume 64, Number 76, April 21, 1998.

entire document related to EPA approval of Texas' plan entire document, EPA acceptance of Texas Subtitle D plan

- pages 19494-19496 – Entire document

G **GILBERT, Bob, "*Shear Strength and Slope Stability*," presentation at Geosynthetic Clay Liner University, Houston, September 30, 2008. excerpts only, related to stability analyses, unstable area location**

- page 3-4 & 7-8 – comments on shear strength
- page 11 – RCRA Subtitle D
- page 15 – cover slope failures

K **KOERNER, Robert M., *Designing with Geosynthetics*, Fifth Edition, Prentice-Hall, 2005. excerpts only, related to stability analyses, vertical expansions, waste settlement**

- pages 374, 554-559 – Addresses requirements for "piggyback landfills", i.e., new landfill over an existing one
- page565 – Empirical data showing excessive settlement of waste mass over time

M **MITCHELL, James K., Raymond B. Seed, H. Bolton Seed, "Kettleman Hills Waste Landfill Slope Failure. I: Liner-System Properties", ASCE Journal of Geotechnical Engineering, Vol. 116, No. 4, April 1990. entire document, related to stability analyses**

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Naval Facilities Engineering Command, *Soil Dynamics, Deep Stabilization, and Special Geotechnical Construction, Design Manual 7.3*, NAVFAC DM-7.3, May 1983. excerpts only, related to waste settlement

- pages 7-3-77 – 7-3-80 – Empirical compression indices for both primary and secondary consolidation of waste

O **OHIO EPA**

Geotechnical Resource Group (GeoRG), *Geotechnical & Stability Analysis for Ohio Waste Containment Facilities*, Ohio EPA, May 2005. entire document, related to stability analyses, unstable areas, and vertical expansions

- entire publication dedicated to landfill stability; considered definitive work for standard of practice
- pages xi-xviii – Definitions
- pages 1-1 – 1-4 (Chapter 1) – Significance of stability failures relative to risk to human health and the environment and graphic example that stability failures are not always obvious
- pages 2-1 – 2-17 (Chapter 2) – General investigation of critical layers, compressible layers, and selection of appropriate shear strength conditions
- pages 3-1 – 3-10 (Chapter 3) – Subsurface investigation to obtain higher quality data for all critical layers and compressible layers. Note specific prohibition against averaging strength values and averaging characteristics of compressible layers (page 3-5)
- pages 4-1 – 4-28 (Chapter 4) – Appropriate geotechnical testing for settlement, bearing capacity, and stability. Note specific requirement to use empirical correlations producing weakest reasonable estimate of shear strength and prohibition against averaging (page 4-3). Further note assumption of saturated undrained shear strength for clay materials (page 4-4, 4-7). Residual shear strength required for slopes greater than 5% or that will be loadfed with more than 1,440 psf (page 4-16)
- pages 6-1 – 6-19 (Chapter 6) – Settlement and bearing capacity analysis
- Pages 7-1 – 7-9 (Chapter 7) – Hydrostatic uplift analysis
- pages 8-1 – 8-38 (Chapter 8) – Deep-seated failure analyses (*note photograph of City of Irving, Texas MSWLF failure at page 8-5*) with required factors of safety. Note shear strength specifications and strain incompatibility (page 8-7)
- pages 9-1 – 9-34 (Chapter 9) – Shallow failure analysis with required factors of safety

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- magazine article that introduced GeoRG's publication to the nationwide MSW practice
- author is a senior project manager with Weaver Boos Consultants in Columbus Ohio

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- pages 93-94 – Relation between c/p ratio and plasticity index

PQ QIAN, Xuede, et al, *Geotechnical Aspects of Landfill Design and Construction*, Prentice-Hall, 2001. excerpts only, related to stability analyses, vertical expansions, waste settlement

- pages 48-49 – Testing for foundation settlement design
- pages 199-204 – Compressibility of municipal solid waste
- pages 440-442 – Empirical data showing excessive settlement of waste mass over time

- pages 451 – Settlement of existing waste due to vertical expansion
- pages 469-473 – Landfill foundation settlement
- pages 477-543 Chapter 13) – Entire chapter devoted to landfill stability analyses including numerous case histories of failures (page 481 – Specific reference to slope and height, pages 485-486 – Discussion of consolidation timeframe (including time equation) for selection of strength parameters, i.e., undrained versus drained, pages 513-520 – Importance of assessing soil properties and examples of stability failures due to poor foundation conditions)
- pages 544-559 – General considerations for vertical landfill expansions including expansions over unlined landfills(page 557)
- pages 572-573 – Stability analyses of vertical expansions
- page 573 – Reiteration of waste settlement and effect on stability

R **ROWE, R. Kerry, et al, *Barrier Systems for Waste Disposal Facilities*, Second Edition, Spon Press, 2004. excerpts only, related to vertical expansions, waste settlement, subsurface containment**

- pages 8-9 – Common use of slurry wall is to limit contaminant migration from existing sites with inadequate design
- pages 39-40 – Geotechnical failures
- pages 454-455 – Impact of settlement on landfills. Additional design requirements for vertical expansions due to highly variable waste settlements, etc.
- pages 455-462 – Discussion of stability including examples of notable landfill slope failures, critical sections

S **SEED, Raymond B., James K. Mitchell, H. Bolton Seed, "Kettleman Hills Waste Landfill Slope Failure. II: Stability Analyses", ASCE Journal of Geotechnical Engineering, Vol. 116, No. 4, April 1990. entire document related to stability analyses**

- entire document
- August 30, 1980 Engineering News Record Magazine article on Kettleman Hills litigation is appended.

T **TAYLOR, Taylor, Donald W., *Fundamentals of Soil Mechanics*, 1948.**

- pages 613-617 – Pressure distributions and settlements for both rigid and flexible footings **excerpts only, related to stability analyses, vertical expansions, waste settlement**

T **TERZAGHI, Karl, & Ralph B. Peck, *Soil Mechanics in Engineering Practice*, Second Edition, John Wiley & Sons, 1967. excerpts only, related to stability analyses, vertical expansions, waste settlement**

- page 73 – Typical empirical relationship between compression index and liquid limit
- page 87 – Relation between liquid limit and coefficient of consolidation, c_v, for clay (e.g., for liquid limits of 40 to 80%, $c_v = 10^{-4}$ to 10^{-3} cm^2/sec or 3.4 to 34 ft^2/year)
- pages 112-117 – Procedures for estimating c/p [undrained shear strength to effective vertical stress] ratio for normally-consolidated soil as a function of PI [plasticity index] and evaluating degree of consolidation from actual c/p ratio
- pages 118-121 – Discussion of characteristics of overconsolidated clays
- Pages 179-182 – values for dimensionless time factor, T_i
- pages 346-347 – Relation of clay consistency with unconfined compressive strength [q_u]; note stiff clay has $q_u \geq 1$ tsf or undrained shear strength, $s_u \geq 0.5$ tsf
- pages 422-425 – Properties of stiff clays

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Texas Natural Resource Conservation Commission, *Liner Construction and Testing Handb*ook, July 1, 1994. entire document related to liner construction QA/QC

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- pages 3-1 – 3-17 – General guidance on slope stability using geosynthetic components
- pages 5-19 – 5-20 – Discussion of strength selection and recommendations for factor of safety

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- pages 7-8 – Determination of "critical slip plane"
- pages 9-10 – Selection of shear strength
- pages 14-16 – Strain incompatibility
- pages 26-27 – Recommendations for practice

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- pages 1-2 – importance of slope stability in Texas relative to soils of high plasticity

- pages 47-49 – effects of anisotropy on soil shear strength
- pages 52-57 – Procedures for estimating c/p [undrained shear strength to effective vertical stress] ratio for normally-consolidated soil as a function of PI [plasticity index] and evaluating degree of consolidation from actual c/p ratio
- page 76 – Taylor clay residual shear strength
- pages 79-81 – summary and recommendations

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- pages 770-775 – Slurry walls for pollution control