DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
Washington, DC 20314-1000

ER 1110-1-1901

CECW-CE

Regulation
No. 1110-1-1901

28 February 2017

Engineering and Design, Construction
PROJECT GEOTECHNICAL AND MATERIALS COMPLETION REPORT
FOR MAJOR USACE PROJECTS

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1. Purpose.

a. Engineer Regulation ER-1110-1-1901 establishes the requirement for documenting all as-constructed geotechnical and materials aspects of major, complex, and uniquely engineered projects constructed by USACE. This regulation outlines a framework for compilation of relevant geotechnical and materials data, instrument and sensor data, graphics, imagery, plots, and tables to be assembled and summarized as part of the permanent project record. Also included in this framework is guidance for a detailed narrative that describes geotechnical aspects of the construction process. The narrative will describe processes and procedures that were conducted during foundation and abutment treatment, excavation procedures, embankment and backfill activities, and results of monitoring studies.

b. This regulation focuses on major construction projects defined by the following criteria: (1) new multi-million dollar, multi-purpose projects including all embankment and concrete dams and their appurtenant structures, all lock-and-dams, and all levees; (2) rehabilitation of all levees, all dams, and all lock projects; (3) rehabilitation of risk-assessed projects with high probability of failure where failure could result in loss of life; (4) any structure for civil works projects involving more than 25,000 cubic yards of concrete; and (5) unique and complex civil works construction projects. Unique and complex projects, regardless of size or cost are defined by the following criteria: (1) unusual or very stringent design requirements or performance criteria; (2) encounter difficult or unusual foundation, materials, or other geotechnical challenges; (3) involve unique or innovative design features, construction procedures, or materials utilized or (4) projects in environmentally sensitive areas.

c. The information and data presented in the Geotechnical and Materials Completion Report should capture all geotechnical and materials processes and procedures that occur during construction of the project.

d. Major design modifications that are executed during construction are summarized in this document, but the primary repository for design modifications (data, assumptions, computations and specifications) will be archived as updates to the Design Documentation Report (DDR).

This regulation supersedes ER 1110-1-1901, dated 22 Feb 1999; ER 1110-1-1801, dated 15 Dec 1981; ER 1110-2-402, dated 6 Aug 1990; ER 1110-1-1803, dated 19 Oct 1973; and ER 1110-2-1901, dated 15 Jun 1994.

e. The Geotechnical and Materials Completion Report will provide basic information for incorporation into appropriate sections of reports required for operation of the project. Additionally, this information can be used as a resource for subsequent design, construction, evaluation, or modification of similar projects.

f. Note that, in accordance with USACE Environmental Operating Principles (EOPs), digital copies of final completion reports are the preferred method for distribution. The user of this ER, as a member of a project PDT, is responsible for seeking opportunities to incorporate the Environmental Operating Principles (EOPs) wherever possible. A listing of the EOPs is available at: http://www.usace.army.mil/Missions/Environmental/EnvironmentalOperatingPrinciples.

2. Applicability. This regulation applies to all HQUSACE elements, major subordinate commands (MSC), districts, laboratories, and field operating activities having responsibilities for planning, design, and construction of civil works and/or Military construction projects.

3. References. See Appendix A.

4. Distribution Statement. Approved for public release, distribution is unlimited.

5. Background and Scope.

a. The Geotechnical and Materials Completion Report will serve as the permanent documentary record of all project work following completion of the DDR, and prior to initiation of activities under the Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRRR) report, and the Periodic Inspection Reports for the project. The report components are important for use when evaluating construction claims, planning additional foundation treatments, evaluating the causes of foundation or structural feature distress, and planning remedial action to prevent failure of a structure. Further, this document will support planning and design of major rehabilitation or modifications to the project, and anticipating foundation problems in other similar planned projects in similar geologic settings. The report will provide, in a single document, the significant information needed by the sponsor, USACE technical staff, and other team members to become familiar with the project as it was constructed. This document should closely connect to the DDR.

b. The scope of the Geotechnical and Materials Completion Report consists of sections that are defined by the nature of the project. The report need not include all sections listed below. Section headings may not have the same level hierarchy. A typical report consists of some or all of the following sections:

(1) Introduction. Section defines the purpose, scope, authority, location, and summary description and history of the project. Also identified in this section are the principal contractors, contract supervisors, key resident and technical support staff, designers on

record and/or external consultants responsible for design of features, and quality control organization.

(2) Field Excavations and/or Foundation Explorations. Section briefly summarizes subsurface investigation activities (test pits, borings, cores, cone penetration tests (CPTs), sonic sampling, etc.) and laboratory testing program conducted prior to and during construction. Investigations performed prior to construction in the form of the geotechnical data report (GDR) or geotechnical baseline report (GBR) may be summarized within the report with an electronic copy inserted on a digital versatile disk (DVD) or equivalent electronic format.

(3) Regional and Site Geologic Setting. Section defines the geomorphic, stratigraphic, and structural setting of the project. Typically, the regional geologic setting serves as introduction to the site geology. Subsections describe significant geologic features such as seismicity, landslides, karst, weathered materials, economic geology, surface and groundwater hydrogeology, and engineering characteristics of rock, unconsolidated soils, and weathered material are included.

(4) Special Design Considerations. Section describes factors that affected the construction process. Examples of design considerations are including, but not limited to swelling pressures from clay, soil stability, permafrost, unusual uplift forces, heave pressures, liquefaction potential, bedrock weathering and alteration, slide potential in rock, jointing, blasting and rock reinforcing requirements. These issues may also be described in the Engineering Considerations and Instructions to Field Personnel document.

(5) Quarry and Materials Sources. Section documents each phase of aggregate production and placement. Descriptions of the location, composition, shape, and gradation of foundation materials are included. If blasting is employed, the most commonly used blasting pattern should include blast-hole burden, spacing and depth, powder types, powder factor, timing (delay) sequence for rock fragmentation and flyrock control. Other quarry activities are described as needed, including modes of materials transport and storage. Other materials used for filters, drain, riprap and fill are described similarly. If test data are available in TM 6-370 (CEWES), the volume, area, and index numbers should be included as an Appendix. Provide information on quarry certifications (if any) as a supplier of aggregate for roadway construction (e.g., base, asphalt) and the validation status as an Appendix.

(6) Excavation Procedures. Section defines the means and methods of excavation for each feature of the project. Blasting methods and excavation of overburden, rock, and soil using equipment are described here. Include in this section equipment type used and details on what worked and didn't work. Draining and dewatering of project features, surface water diversion, and slope stabilization processes to ensure safe and stable construction conditions are defined. Anchors, rock bolts, driven piles, and other subsurface structures for stabilization also are described.

(7) Foundation and Abutment Section. The foundation and abutments section has three focus areas: (a) foundation mapping to document pre- and post-treatment surface conditions; (b) means and methods of foundation treatment; and (c) criteria for acceptance. Foundation mapping establishes a permanent record of the geologic features and conditions in the foundation which may include geologic profiles and plan view maps. Foundation maps should include irregularities identified for treatment along with finished treatment of the irregular features. Surface preparations for subsequent treatment also are documented. Foundation treatments can include a variety of grouting methods such as grout curtain construction, and dental treatment of joints, cavities, and depressions. Application of protective coatings after treatment, and foundation clean-up also are documented. This section should be documented in detail using photos, drawings, maps and images.

(8) The Embankment Criteria and Performance Evaluation Section. The embankment criteria and performance evaluation section has four focus areas: (a) a summary of embankment design features; (b) documentation of embankment materials used during construction; (c) slope stabilization during construction; (d) means and methods for seepage control and drainage management. This section should be documented in detail using photos, drawings, and images, and supplemented by geotechnical data and results obtained during construction including a summary of material sources and how these source materials were utilized in the embankment construction.

(9) Instrumentation Section. Instruments and sensors are installed to monitor parameters including, but not limited to, seepage, pressure, deformation, and/or movement of structures, foundations, and embankments. The objectives of a data acquisition program are to provide data for an analytical assessment of project design and performance, prediction of future performance, legal evaluation, and development and verification for future designs. Pre-installation acceptance tests, and installation documentation including piezometer construction diagrams are appropriate for inclusion within this report. Plans for data management, processing, and presentation are summarized, with major conclusions and trends described in the narrative, figures, and plots. Threshold values for each instrument are defined in this section, as are responses to threshold exceedances. A schedule for data collection and instrument inspection should be proposed.

(10) Concrete, Grout and/or Cementitious Materials Section. This section documents each phase of materials production and placement during construction including, but not limited to, foundation and tunnel grouting. Problems encountered during materials emplacement, and their solutions are described. If a separate stand-alone grouting report is prepared for the project, this report should be included within the appendix section of the geotechnical completion report. There may be some overlap between this section and Section (5) Quarry and Materials Sources.

(11) Improvements during Construction. Modifications during construction to the original project design should be summarized including the reason and justification for the

design modification. However, the detailed analysis supporting the design modifications to the original project design and supporting documents are captured in updates to the DDR.

(12) Summary. This section should be structured to summarize major project conclusions drawn from evaluations in all preceding sections. For foundations, abutments and embankments, potential problem areas should be identified for future inspections. Project stability should be defined, based on instrumental data analysis and compared to design analysis. Any project modifications that were performed should be identified in earlier sections, and then summarized here. "Lessons Learned" often are presented in the summary section.

(13) References include as-built drawings, technical reports, and texts used for data analysis.

(14) Appendices. Appendices are compilations of all data obtained during construction. Appendices generally are separated into subsections that consist of maps, photographs, geotechnical data, verification borings data, laboratory analyses, materials analyses, quality control data and instrumentation records.

c. The task of document preparation is a critical part of the project record. As such, document preparation and review will be included in the Project Management Plan (PMP). Projects requiring a completion report will be subject to District Quality Control (DQC) procedures. For budgetary planning, the appropriate level of document review should be identified and a schedule prepared. Additionally, information contained in this report can be used as a resource for design, construction, evaluation, or modification of similar projects. Reports on similar projects should be sought out as guides.

6. Detailed Description of Critical Report Sections. The following sections are most important to document the project construction process. Additional detail is provided below to compose these sections.

a. Excavation Procedures. Details on excavation means and methods are described in this section. The schedule, sequence, and major equipment used during major phases of excavation will be defined. If blasting is integrated with excavation, the blasting system description should include information on the kinds and the quantities of explosives used, the sizes of charges, the depths and the spacing of holes, delays used, descriptions of any over breakage, special procedures such as smooth wall blasting or pre- splitting, and other pertinent data.

(1) For permanent and temporary piles, describe the type, depths, and driving of piles, including equipment used. Where structures are founded on piles, include pile driving and re-striking records, load tests, and documented condition after the piles are driven.

(2) For drilled piers and footings, describe the excavation and placement of drilled piers, large or unusual footings, or high performance foundations.

(3) For tunnels and underground structures, a description of excavation methods and equipment used and support systems/anchors installed, and any problems encountered during construction.

(4) Cofferdams. Include installation procedures and materials used for temporary or permanent cofferdam structures including pile driving, earthwork, stream flow diversion and dewatering issues including a discussion of field performance versus design analysis.

b. Foundation and Abutment Construction. This section will document foundation conditions encountered during construction, and methods to adapt structures to these foundation conditions. Topics covered in this section should include the following aspects of a subsurface investigation.

(1) Geologic conditions at the project site as they pertain to foundation engineering. Document the foundation condition, including ground improvement and treatments to improve and stabilize the foundation. If foundation preparation includes removal of unsuitable materials, the location, type, and volume removed shall be defined, along with any supplemental subsurface investigations and results that were obtained during construction.

(2) Document the soil or rock conditions on which individual structural components were placed.

(3) Identify conditions that may require observation and treatment during operation of the project. For example, conditions that possibly could lead to development of leakage, development of uplift pressures, development of slides or settlement in the foundation materials, mechanical and chemical deterioration of riprap stone, or abnormal erosion of spillway and outlet channels.

(4) Define the criteria for foundation acceptance. Documentation should include an in-situ geologic map of the foundation with supporting digital images and survey data. The inspection period and process shall be defined, and should include concurrence by the sponsor. The final foundation acceptance memorandum should be included within the appendix section per ER 1110-2-1156, Safety of Dams Policy and Procedures, if the project is part of the USACE Dam and Levee Safety Program.

(5) Describe changes and contract modifications made to the original design during construction, and how these modifications improved the foundation condition. Methods employed to overcome those difficulties should be described.

(6) Retain selected geotechnical borings and soil samples for future reference. Rock cores, regardless of age, will be retained until the detailed logs, photographs, and test data have been made a matter of permanent record in the final Project Geotechnical and Materials Completion Report. If borehole camera images exist, only representative cores need to be retained. Otherwise all cores shall be retained at least until all release of claims

have been signed by the Contractor. If photographs of soil samples exist, then only representative samples shall be stored. Otherwise all soil samples shall be maintained until release of claims. Samples and cores related to future construction and a few representative cores of foundation and abutment conditions will be retained for a minimum of five years after final completion of the project provided no unforeseen foundation or abutment conditions have developed.

c. Embankment Criteria and Performance Evaluation Section. This section documents the embankment construction process, and how that embankment performed during operational testing. Text should be as brief as possible, with the main presentation consisting of photographs, drawings, tables, graphs, data summaries, and instrumentation plots. Topics covered in this section should include the following subsections.

(1) Describe the embankment design including alignment, sections, and major water control features associated with the embankment such as spillways, outlets, stilling basins, locks, gates, slides, weirs, drains.

(2) Describe the schedule and sequence of embankment construction. Embankment materials and the sequence of their emplacement and any interim stabilization measures should be described in this subsection. Also discuss problems that arise during material production and placement, and the method by which the problem is resolved.

(3) Embankment stability during construction. This section will include data acquired for typical construction work including, but not limited to, work platforms, crane pads, earthen cofferdams and access ramp stabilization performed during construction. Also include a description of the methods for seepage control if applicable.

d. Concrete, Grout and/or Cementitious Materials. The purpose of this section is to document each phase of materials production and placement. Aggregate production and placement can be described here, with “Quarry and Materials Source” section restricted to the characterization and source of aggregates. Where practical, authors should visit batching plants to document their mixing procedures, operations, and Contractor quality control. This section would be best authored by the Materials personnel who were involved with the design on the project, especially for projects where mix designs were specified. When completed, this section should serve as a resource for similar projects where problems are encountered during materials emplacement. Topics covered in this section should include the following subsections.

(1) Document aggregate production, gradation and stockpiling. The sequential processing of fine and coarse aggregate production shall be documented with a flow-chart and photographs. List major equipment used in aggregate production by make, model, and capacity. The number of stockpiles and gradation of coarse aggregate in each stockpile should be noted. The approximate size of the stockpile during normal aggregate

production and concrete placement should be noted. If a stockpile was reduced to a very low level during concrete placement, the time of this occurrence should be noted. Documentation of the stockpile conditions such as moisture control, cooling from adding chilled water, ice chips and/or shading, fine aggregate chilling, coarse aggregate wet belt, mixing of stockpiles and prevention of segregation. Details regarding quality assurance plans and other checks on the aggregate production should be included in this section.

(2) Characterize and document the use of cementitious materials. The sources of Portland cement, blended hydraulic cement (as applicable), pozzolan (including flyash), slag cement, and silica fume should be listed. The dates of cementitious materials used from each source and the approximate locations of their use should be recorded. The means and schedule of cementitious materials transportation to the project site should be noted, along with the transfer and storage facilities for cementitious material. Pozzolan sources, either commercial or natural, should be identified by supplier and location. If silica fume or slag cement were used only in certain locations on the project, those locations, dates placed, and mixture proportions should be documented. Properties and test results on the cementitious materials should be documented, to monitor any potential changes in concrete strength and performance.

(3) Chemical admixtures. The brand names, sources, application rates, and test data for all chemical admixtures used on the project should be tabulated, including the structure feature in which admixtures are applied. Photographic documentation of the admixture storage containers and tier capacities should be recorded.

(4) Concrete production and placement. Concrete production and placement is a critical aspect of many civil works projects, so rigorous documentation is necessary. Describe the concrete batching and mixing plant including, but not limited to, make, model, and capacity of major bins, conveyor belts, hopper mixers, and controls. Mixture proportioning studies should be documented and proportions of the concrete mixtures used during the bulk of placement of each major class should be tabulated. Any adjustments or corrections made to cementitious materials, mixture quantity and quality and placement should be documented for all phases of the project. Aggregate batch weights should be reported as saturated surface dry weight. If significant field adjustments were made to the concrete mixtures, the extent of the adjustments should be noted and reasons for adjustments explained including any additional design or trial mix data from the field. Specify the equipment and technique used for joint preparation. Describe a typical concrete mixture placement including, but not limited to, the type and capacity of equipment used for concrete transport from the mixer to the placement site, the means of placement, and note the number and type of vibrators used. Also describe any non-typical concrete placements. Specify the normal and maximum rates of placement of each major class of concrete on the project. A brief description should describe the contractor’s selected means of curing and protecting the concrete, along with any factor that may have reduced the level of protection or truncated the curing process on major structures. Describe the temperature control measures used and temperature monitoring performed, including the

types of insulation used, the major components of any required pre- or post-cooling systems, the dates that various control measures were used during the construction period, and any mishaps which resulted in deviations from the specified control requirements as well as how the situation was corrected. For any project that utilizes concrete different than a cast-in-place mass or structural concrete, a section should be provided detailing the materials used, mix proportions, method of placement, problems encountered, and how these were solved. For pre-cast units, note the type, description, name and location of the manufacturer, materials and mix proportions.

(5) Concrete Quality Assurance and Quality Control. The procedure and the extent of Government Quality Assurance (GQA) program and the Contractor Quality Control (CQC) program should be described. Typically included in the QA/QC program are the types and the frequencies of tests and quality verifications performed by the Government for GQA purpose and by the contractor for CQC. Summarize all GQA and CQC test data using charts and tables where possible. Charts and tables should show average of the values presented as well as extremes, and compared to the specification limits. Raw data can be archived in an Appendix. Note any unusual problems encountered during the scheduled concrete construction, including stoppages, rejection of material due to non-compliance, etc. Describe the corrective actions taken to maintain construction schedule during concrete placement. For additional details on preparing the Concrete, Grout and/or Cementitious Materials section, consult EM 1110-2-2000, Standard Practice for Concrete for Civil Works Structures.

e. Instrumentation. This section defines the methods and results of a geotechnical data acquisition program designed to detect changes in pressure, stress, temperature, and deformation in project foundations, structures, and embankments. This section should identify the objectives for a data acquisition program, types, numbers and locations of instruments and sensors used, frequency of measurement, and methods used to automate data acquisition. Document locations and installation methods for each instrument and sensor at the project site using maps and tables as appropriate. The Instrumentation section should summarize the results obtained before, during, and after operational testing of the project. A detailed engineering analysis of all acquired data should appear in this section.

f. Appendix Sections. Example Appendices are included in Appendices B through G of this guidance document. In general, project location maps, geologic maps, sequential construction photographs, tables, plots and graphs, materials data summary sheets and where practical referenced documents such as as-builts, contract documents, geotechnical data or baseline reports, relevant submittals (for example, cofferdam installation procedures), and testing results should be included. Also include analyses supporting design changes that occurred during construction. Reference documents may be included as an insert on a DVD or equivalent electronic format.

7. Users. The report may be useful for OMRRR and Periodic Inspection Reports, emergency management planning, future design and construction and post risk analysis for USACE Dam and Levee Safety projects.

8. Lumping/Splitting of Reports. For new construction, the project should define a "system" to be documented in a single completion report, even if the system components were constructed under several contracts. For remediation projects, dissimilar contracts should appear as separate completion reports. A completion report could include multiple contracts if all focus on a system (e.g., a single test section with multiple contractors).

9. Authors. The utility of the project completion report depends upon completeness and accuracy of the information it contains. The authors of this report should have first-hand knowledge of the project construction. Where possible, the authors should be the Resident Geotechnical Engineer and/or Geologist, Structural Engineer, or Engineers specializing in construction methods and materials and who provide project oversight during construction. Additionally, the geotechnical engineer(s), the materials or concrete engineer(s) and engineering geologist(s) responsible for the original design and performance evaluation should collaborate in authoring the report. Where practical, and to the extents possible, the report should be written by USACE personnel involved in the day-to-day construction activities rather than written completely by contractors. Preparation of reports should be a joint responsibility between the Chief of Construction and Chief of Engineering for the specific MSC or District.

10. Review. Review of the Project Geotechnical and Materials Completion report will be consistent with guidance from EC 1165-2-214 (or successor document).

11. Distribution of Completed Reports. Information in the report, including text, graphs, tables, figures and appendices, may not be published, duplicated, scanned, photocopied, photographed, emailed, or otherwise distributed without written permission from the District's Chief, Engineering Division.

12. As-Built Drawings.

a. Project Data Storage and Retention. Modern construction projects generate a large quantity of supporting as-built and QA/QC data that shall be preserved along with the completion report. While these data may be impractical to print on paper due to storage constraints, the electronic distribution of Completion reports makes it possible to include these project records in an appendix to the Completion report.

b. As-built drawings shall be included in this appendix. These drawings shall detail the final configuration and installation details of all project elements and shall be in an electronic form that can be used for paper printing of legible drawings per current as built and CAD standards. Where generated for the project, the appendix shall also include the 3D CAD, GIS or other electronic drawing files that show the as built

condition of the project, whether or not these drawings are easily rendered in 2D form on printed plans sheets. Supporting files for these drawings, such as geo-databases for GIS drawings shall be included. Where linked or embedded files are used, such as project records that can be accessed through these drawings, these files shall also be included. Files shall be stored in a documented logical file structure in an appendix. The appendix shall include a document that describes the files that are included, explains the file structure, includes metadata on the files, explains any file naming conventions and includes instructions on how to implement links where they are used.

c. Where a project database has been implemented, capturing data during construction of the project, a version of this database shall be included in the appendix. This database shall be documented, with metadata and structure of all tables and fields detailed. Units for any field containing quantities (cu-yds, ft, gallons, etc.) shall be clearly defined and documented. Given USACE needs for long-term access to the data, where possible, all electronic data included in this appendix shall be stored in as accessible a format as is available at the time the report is completed. Open standard data formats and databases are preferred to proprietary formats that may become unusable and inaccessible over time. Where USACE mandates the use of a particular software product, files shall be included in that format. However, if it is possible to reasonably include a copy of the drawings, files or databases in a more open format by using the USACE mandated software, copies of the data in this more open format shall be included.

13. Time of Completion. Data to be included in the report should be planned in advance of construction and the actual information and data will be assembled throughout the construction phase. Every effort should be made to collect and document data and lessons learned as timely as possible during construction. All completion reports should be completed within one-year of construction completion. Completion of reports should be a joint responsibility between the Chief of Construction and Chief of Engineering for the specific MSC or District.

14. Funding. Funding for report preparation should be in accordance with ER 37-1-30 for all civil works projects and in accordance with guidance for preparing as-built drawings for all other projects. The costs for report preparation, review, scanning of prior reports, and printing should be included in the Project Management Plan (PMP).

15. Disposition of Reports. An electronic copy of the main report, excluding appendices and referenced documents, but to include the report text and all figures, shall be combined in a single, searchable, digital file (e.g., Portable Document Format, PDF) for permanent reference. In addition, all appendices and referenced documents shall also be included on an appropriate media (e.g., DVD).

a. Civil Works Projects. Upon completion, review and approval by the District, a copy of the completed report should be retained by the District as part of the PMP, one

copy should be retained for Operations Division for Periodic Inspections and Evaluations of Completed Civil Works Structures and one copy should be made a part of the permanent project records stored at the project office. Additionally, the report should be distributed in electronic copy format, in accordance with USACE Environmental Operating Principles as follows:

(1) Sponsor/Owner - 1 copy (Electronic Only).

(2) Each MSC - 1 copy, each (Electronic Only).

(3) ERDC Technical Library CEERD-ITL-MS - 1 copy (Electronic Only).

(4) Requesting Districts - 1 copy (Electronic Only).

(5) Project Office – 1 copy (Hardcopy and Electronic).

b. Foundation Construction Reports for Military Construction Projects. Requirement Control Symbol (RCS) exempt per AR 335-15 Management Information and Control System, paragraph 5-2e. Additionally, the report should be distributed in electronic copy format, in accordance with USACE Environmental Operating Principles as follows:

(1) Defense Technical Information Center (DTIC). Submit documents to the DTIC online library at http://www.dtic.mil/dtic/. Unclassified reports submitted to DTIC will contain DD Form 1473 (Report Documentation Page) prepared in accordance with AR 70-31. Distribution limitation statements will be applied in accordance with AR 70-31.

(2) Additionally, the report should be distributed as follows:

(a) Each MSC - 1 copy, each (electronic only).

(b) Requesting MILCON districts - 1 copy (electronic only).

c. Release outside of USACE. Per AR 380-10 and AR 25-55, the release of a completion report outside of USACE shall be limited for civil works or military projects, because they reveal critical details of structures. There should be no release of completion reports on dams or lock-and-dams without written permission of the District Dam Safety Officer, and no release of levee completion reports without written permission of the District Levee Safety Officer. Completion reports should be treated as For-Official-Use-Only (FOUO) and labeled as such, both on the cover and as a page header or footer. Freedom-of-Information-Act (FOIA) requests for a completion report should be forwarded to both HQ Security Office and HQ Office of Counsel for review.

16. Deviations. Any deviations or waivers to the requirements of this engineer regulation shall be approved by HQUSACE CECW-CE.

FOR THE COMMANDER:

PAUL E. OWEN
COL, EN
Chief of Staff

7 Appendices
(See Table of Contents)

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Appendix A

Bibliography

A-1. Department fo the Army Documents.

AR-25-55, the Department of the Army Freedom of Information Act Program.

AR 70-31, Standards for Technical Reporting.

AR 335-15, Management Information Control System.

A-2. U.S. Army Corps of Engineers (USACE) Documents.

USACE Environmental Operating Principles Revised, http://www.usace.army.mil/Missions/Environmental/EnvironmentalOperatingPrinciples.

TM 6-370 (CEWES), Test Date, Concrete Aggregates and Riprap Stone in Continental United States and Alaska.

ER 5-1-11, Management, USACE Business Process.

ER 37-1-30, Financial Administration, Accounting and Reporting.

ER 1110-1-261, Quality Assurance for Laboratory Testing Procedures.

ER 1110-1-8100, Laboratory Investigations and Testing.

ER 1110-2-112, Required Visits to the Construction Sites by Design Personnel.

ER 1110-2 1150, Engineering and Design for Civil Works Projects.

ER 1110-2-1156, Safety of Dams, Policy and Procedures.

EM 1110-2-1100, Coastal Engineering Manual.

EM 1110-2-1204, Environmental Engineering for Coastal Shore Protection.

EM-1110-1-1804, Geotechnical Investigations.

EM 1110-2-1901, Seepage Analysis and Control for Dams.

EM 1110-2-1902, Slope Stability.

EM 1110-2-1908, Instrumentation of Embankment Dams and Levees.

EM 1110-2-1911, Construction Control for Earth & Rock-Fill Dams.

EM 1110-2-1913, Design and Construction of Levees.

EM 1110-2 2000, Standard Practice for Concrete for Civil Works Structures.

EM 1110-2-2006, Roller Compacted Concrete.

EM 1110-2-2300, General Design and Construction Considerations for Earth and Rock-Fill Dams.

EM 1110-2-2901, Tunnels and Shafts in Rock.

EM 1110-2-3506 Grouting Technology.

A-3. Industry Document.

ASTM C33/33M Standard Specification for Concrete Aggregates.

Appendix B

Outline for Project Geotechnical and Materials Completion Report for Major USACE Projects

B-1. Outline. Figure B-1 shows an outline for a Project Geotechnical and Materials Completion Report for Major USACE Projects. Where practical, completion reports should use sections of the outline shown in Figure B-1 that are appropriate for the project.

I. Organizational Material.
   A. Title Page(S):.
   B. Executive Summary (<1 Page, <2 Pages for Complex Projects).
   C. Table of Contents.
   D. List of Photos.
   E. List of Figures.
   F. List of Tables (Tables Should Be Included in the Main Text).
   G. List of Drawings.
   H. List of Acronyms.

II. Introduction.
   A. Purpose.
   B. Construction Authority.
   C. Project Location.
      1. Maps and Figures.
   D. Project Description and Major Features (Including Project Pertinent Data).
   E. Project History and Background.
   F. Key Personnel.
      1. Contractor and Major Subcontractors.
      2. Contract Supervision.
      3. Resident Engineer.
      4. Contractor Quality Control and Government Quality Assurance Personnel.
      5. Board of Consultants (Note: If a Board of Consultants Is Used They Should Be Identified by Name and Discipline).

Figure B-1. Outline for Project Geotechnical and Materials Completion Report for Major USACE Projects.

III. Regional and Site Geology.
  A. Regional Geologic Setting.
    1. Physiography.
    2. Structural Geology.
    3. Overburden and Weathered Surficial Material.
    4. Geological Formations and Lithostratigraphy.
    5. Regional Hydrogeologic Framework.
    6. Seismicity.
  B. Site Geologic Setting.
    1. Foundation Structure.
    2. Weathered Material.
    3. Site Hydrogeology.
    4. Bedrock Characteristics.
  C. Summary of Geologic Investigations for Foundation Design.
IV. Quarry and Materials Sources.
  A. Vendors and Locations.
  B. Mineralogy and Materials Composition.
  C. Blasting and Excavation.
  D. Gradation.
  E. Aggregate Production Process.
  F. Quarry Certifications and Test Reports.

Figure B-1. Continued.

V. Foundation Excavations.
  A. Excavation Requirements.
    1. Excavation Grades.
    2. Heavy Equipment.
    3. Dewatering Provisions.
    4. Excavation of Overburden and Rock.
    5. Line Drilling, Pre-Splitting, Production and Contour Blasting.
    6. Foundation Compaction, Consolidation, and Backfilling.
    7. Surface Preparation.
    8. Stabilization with Anchors, Bolts, Shotcrete, Wire Fabric and Geotextiles.
    9. Pile Driving.
    10. Tunnels, Shafts, and Underground Structures.
  B. Foundation Exploration during Construction.
  C. Unusual or Unanticipated Conditions Encountered during Excavation.
VI. Character of the Foundation.
  A. Engineering Characteristics of Foundation Materials.
  B. Hydrogeologic Considerations.
  C. Initial Foundation Surface Condition.
    1. Foundation Surface Map.
  D. Foundation Surface Treatments.
    1. Grouting Procedures.
      a. Dental Treatment Procedure.
      b. Curtain Grouting.
    2. Shotcrete or Other Surface Treatment.
    3. Methods of Ground Improvement.
  E. Foundation Treatment Mapping.
    1. Separate Subsection Documenting Each Acceptance Section.
  F. Decommissioning Dewatering Features.
  G. Possible Future Problems.

Figure B-1. Continued.

VII. Embankment Criteria and Performance Evaluation.

A. Embankment Dimensions and Features.

1. Modifications to Original Design.

B. Construction Sequence.

C. Embankment Materials.

1. Impervious Fill.
2. Random Fill.
3. Drainage Fill, Toe Drain.
4. Filter Material.
5. Riprap.
6. Contractor Quality Control.
7. Record Samples.

D. Embankment Materials Placement Quantities.

E. Slope Stability.

F. Seepage Control.

G. Closure and Diversion.

H. Construction Notes.

I. Operations Notes.

Figure B-1. Continued.

VIII. Concrete, Grout, and Cementitious Materials.

A. Concrete Mix Design.
   1. Aggregate Proportioning per Specification.
   2. Compressive Strength.
   3. Concrete Quantities.
   4. Water-Cementitious Materials Ratio.
   5. Air Content.

B. Aggregate Production.
   1. Pit or Quarry Operation.
   2. Fine Aggregate Production.
   3. Coarse Aggregate Production.
   4. Stockpiling and Handling.

C. Cementitious Materials.
   1. Portland Cement Sources.
   2. Blended Hydraulic Cement Sources.
   3. Pozzolan Sources.
   4. Slag Cement Sources.
   5. Silica Fume Sources.

D. Chemical Admixtures.
   1. Air-Entraining Admixtures.
   2. Water-Reducing Admixtures.
   3. Retarding Admixtures.
   4. Accelerating Admixtures.
   5. Viscosity Modifying Admixtures.
   6. Underwater or Anti-Washout Admixtures.
   7. Admixture Compatibility.
   8. Additives for Aggressive Aggregates.
   9. Others.

E. Concrete Batching and Mixing Plants.

Figure B-1. Continued.

F. Concrete, Grout and/or Cementitious Mixtures.
   1. Mass Concrete.
   2. Structural Concrete.
   3. Special Concrete (Roller Compacted Concrete, Self-Consolidating Concrete, Tremied, Underwater, Chloride Ion Penetration Resistant, Fiber Reinforced, Etc.).
   4. Shotcrete.
   5. Pre-Cast Concrete.
   6. Soil-Cement Bentonite (Scb).
   7. Grout.

G. Construction Joints: Preparation, Type, and Material.

H. Expansion Joints: Joint Filler, Waterstops, and Joint Sealant.

I. Concrete Transportation, Placement, and Consolidation/Compaction.
   1. Concrete Transportation.
   2. Concrete Placement.
   3. Shotcrete Placement.
   4. Rcc Placement.
   5. Concrete Placing Schedule.
   6. Concrete Consolidation.
   7. Rcc Compaction Methods.

J. Curing and Protection.

K. Temperature Control.
   1. Insulation.
   2. Aggregate Cooling.
   3. Other Methods Utilized (E.G., Liquid Nitrogen Injections).
   4. Pre-Cooling.
   5. Post-Cooling.
   6. Heating.
   7. Temperature Monitoring.

L. Precast Concrete.

Figure B-1. Continued.

M. Cement Grouts.`
1. Viscosity.
2. Density.
3. Bleed .
4. Filtrate Loss/Pressure Filtration Coefficient.
5. Initial/Final Gel Time.
6. Initial/Final Set Time.
7. Compressive Strength.

IX. Quality Assurance and Testing.

A. Government Quality Assurance.
1. Identify All Corps-Validated Laboratories Used.

B. Summary and Discussion of Test Data.
1. Concrete Mix Design.
2. Aggregate Quality Tests.
3. Aggregate Grading Tests.
4. Aggregate Moisture Monitoring/Control.
5. Tests for Cementitious Materials and History of Mill Reports.
6. Tests for Admixtures.
7. Concrete Strength Tests.
8. Concrete Freeze/Thaw.
9. History of Performance for the Same Mixture Design If Available.
10. Air Content Tests.
11. Slump of Flow Tests.
12. Vebe Tests (Rcc).
13. Placing Temperature.
14. Resistance Thermometer Data.
15. Washout Tests of Underwater Concrete.

C. Other Specialty Testing Requirements.

D. Special Problems and Corrective Actions.

Figure B-1. Continued.

X. Rock Mass, Soils and/or Structural Instrumentation.
   A. Data Collection Objectives.
   B. Types of Sensors and Instruments.
   C. Surface Control Monuments.
   D. Inspection Schedule.
   E. Data Summary.
      1. Reservoir Levels.
      2. Movements and Deformations.
      3. Inclinometer Data.
      4. Piezometer Data.
      5. Pore Pressure.
      6. Seepage Gradients.
   F. Potential Future Problems.
      1. Conditions That Could Produce Problems.
      2. Potential Failure Modes to Monitor.
      3. Recommended Observations for Continued Monitoring.
   G. Lessons Learned.

Figure B-1. Continued.

Appendix C

Example Outline for Appendix B, “Drawings”

C-1. Outline. Figure C-1 shows an example outline for Appendix B, “Drawings.”

I.	Project location and vicinity map
II.	General plan
III.	Site plan
IV.	Geologic map (regional and/or site specific)
V.	As-built drawings including as-builts for instrumentation or ancillary structures
VI.	Plan of explorations made prior to and during construction
VII.	Post construction investigations (if warranted due to construction issues)
VIII.	Logs of core borings
IX.	Foundation map (in-situ foundation map prior to disturbance or improvements).
X.	Final foundation acceptance report (if foundation acceptance is required for the project, for example on a dam project)
XI.	Geologic profiles and cross sections for embankment foundation, intake structures, control structures, tunnels, abutments and spillway axis
XII.	Drilling and grouting records, plans and profiles (showing areas of major takes, connections, surface leaks, etc.).
XIII.	Foundation dewatering plan
XIV.	Embankment/structure plan with boring and instrumentation locations shown
XV.	Embankment/structure cross sections with instrumentation shown
XVI.	Embankment/structure design, construction and phasing details
XVII.	Embankment slope stability cross sections with design assumptions, critical failure surfaces and/or planes, and factors of safety shown
XVIII.	Embankment slope stability reevaluation, if necessary
XIX.	Embankment/structure seepage control design with assumptions, section, and selected design shown
XX.	Distribution of field control test locations. For each zone tested, plot a profile parallel to the axis with field control test data plotted at the locations sampled.
XXI.	Instrumentation installation details

Figure C-1. Example Outline for Appendix B, “Drawings.”

XXII. Interpretations of instrumentation data

A. Settlement profile or contour plan

B. Alignment profiles of measured movements

C. Embankment section with embankment and foundation pore pressure distribution or contours. It may be necessary to plot contour diagrams at various dates or fill stages

D. Embankment/structure sections showing phreatic surface through foundation

E. Profile in relief well line showing well and piezometer locations, and measured and design heads.

XXIII. Rock slope stability including stabilization features.

XXIV. Slope Drainage Features

XXV. Critical or key foundation sliding blocks.

XXVI. Deformation moduli axis profile and plan

XXVII. Curtain grouting zone map

XXVIII. Dental concrete treatment plan and cross sections

XXIX. Ground improvement profiles and plan

XXX. Excavation and embankment quantities

Figure C-1. Continued.

Appendix D

Example Outline for Appendix C, “Photographs”

D-1. Outline. Figure D-1 shows an example outline for Appendix C, “Photographs.”

D-2. Photograph Identifiers. Note that photograph locations, view direction, main subject and date should be identified on photo titles.

I. Overall views of construction site and sequential work being performed.

II. Structural foundation photographs. Foundation stripping, excavation, treatment, and sequential foundation construction including photo of completed structure.

III. Foundation photographs capturing critical information. For example, construction equipment used for compaction, areas to receive dental treatment (before and after treatment), unusual geology or features and in-situ condition prior to disturbance or improvements.

IV. Embankment construction. Sequential photos from foundation preparation thru top out including placement of slope protection such as geotextile and riprap.

V. Instrumentation devices being installed.

VI. Any issues that occurred during construction such as leaking, seepage, slope failure, potential differing site condition claims and/or unusual findings.

VII. Rock or concrete core photographs

VIII. Borehole video photograph logs and/or down-hole camera photograph logs

IX. Geologic Mapping by Digital Photogrammetry Methods (if applicable)

X. Concrete and rock processing (grizzly) plant photographs.

XI. Concrete placement photographs.

XII. Photographs of testing laboratory facilities and equipment use.

XIII. Any special items.

Figure D-1. Example Outline for Appendix C, “Photographs.”

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Appendix E

Example Outline for Appendix D, “Tables, Plots and Graphs”

E-1. Outline. Figure E-1 shows an example outline for Appendix D, “Tables, Plots and Graphs,” including examples of information to include if applicable to the project.

I. Embankment zone placement quantities.

II. Embankment zone design placement requirements compared with summary of field control test data results.

III. Graphic summaries of embankment and foundation design shear strength test data with selected design values shown.

IV. Summary of record control shear strength test results compared against embankment shear strength design assumptions.

V. Plot of pool versus time.

VI. Plot of pool or fill elevation versus surface settlement point, settlement plate, (if settlement is being monitored as part of construction.

VII. Plot of pool elevation versus piezometer levels.

VIII. Plot of settlement versus time.

IX. Plot of pool or fill elevation versus piezometer levels.

X. Plot of piezometer levels during construction versus time. For a dam, this information should also be plotted headwater/tailwater versus time on the x-axis. For a levee, this information should be plotted with river stage versus time on the x-axis.

XI. Plot of pool or fill elevation versus inclinometer/extensometer displacement.

XII. Plot of inclinometer/extensometer displacement versus time for constant loading.

XIII. Plot of pool elevation versus total relief well discharge quantities.

XIV. Plot of pool elevation versus seepage weir discharge.

XV. Other significant performance parameters versus load and/or time.

XVI. Discharge of toe and slope drains versus pool elevation.

Figure E-1. Example Outline for Appendix D, “Tables, Plots and Graphs.”

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Appendix F

Example Outline for Appendix E, “Data Summary Sheets for Concrete, Grout and/or Cementitious Materials”

F-1. Outline. Figure F-1 shows an example outline for Appendix E, “Data Summary Sheets for Concrete, Grout and/or Cementitious Materials.”

I. Quality Control and Quality Assurance testing results for concrete, grout or cementitious materials.
II. Aggregate quality tests
III. Aggregate gradation tests
IV. Tests for cementitious materials
V. Tests for admixtures
VI. Concrete strength tests
VII. Concrete freeze/thaw tests
VIII. Abrasion tests
IX. Soundness tests
X. Air content tests
XI. Slump tests
XII. RCC tests
XIII. Placement temperature and temperature controls
XIV. Resistance thermometer data

Figure F-1. Example Outline for Appendix E, “Data Summary Sheets for Concrete, Grout and/or Cementitious Materials.”

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Appendix G

Example Outline for Appendix F, "Data Summary Sheets for Soil and Foundation Materials"

G-1. Outline. Figure G-1 shows an example outline for Appendix F, "Data Summary Sheets for Soil and Foundation Materials."

I. Quality Control and Quality Assurance testing results for fill material and/or foundation materials to include gradation and compaction test results.

II. Record Control Samples for Foundation and Embankment materials

III. Riprap quality tests

IV. Riprap gradation tests

V. Erosion Protection

VI. Geotextile product information

VII. Nuclear density and/or sand cone testing

VIII. Atterberg and moisture content testing

IX. Permeability testing

X. Geophysical/Structural testing (e.g., ground penetrating radar, pile integrity testing (PIT) or pile driving analysis (PDA)).

XI. Seepage cutoff wall verification boring results.

Figure G-1. Example Outline for Appendix F, "Data Summary Sheets for Soil and Foundation Materials."

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