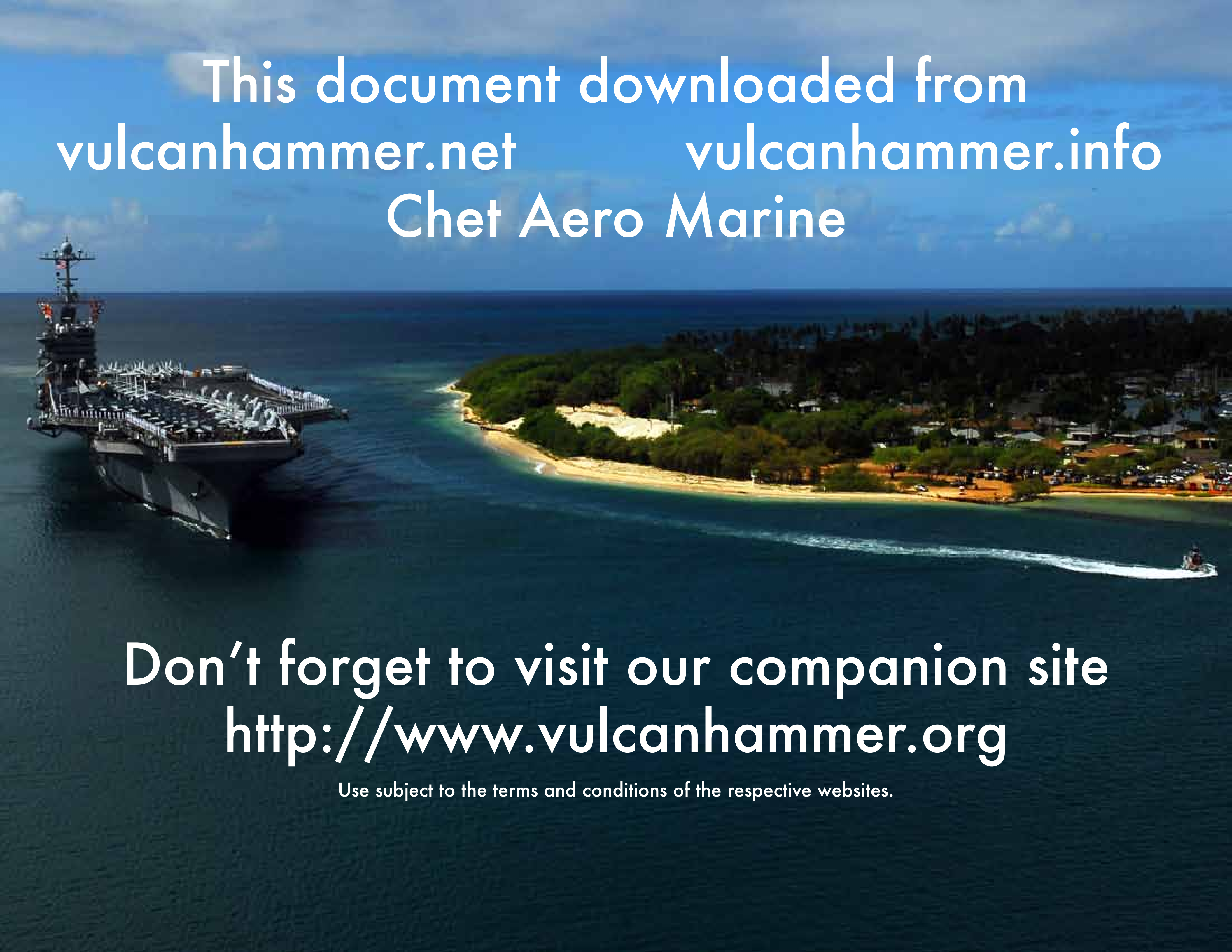

CECW-ED Regulation No. 1110-2-8152	Department of the Army U.S. Army Corps of Engineers Washington, DC 20314-1000	ER 1110-2-8152 31 August 1994
	Engineering and Design PLANNING AND DESIGN OF TEMPORARY COFFERDAMS AND BRACED EXCAVATIONS	
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CECW-ED

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

Regulation
No. 1110-2-8152

31 August 1994

Engineering and Design
PLANNING AND DESIGN OF TEMPORARY COFFERDAMS AND BRACED EXCAVATIONS

1. Purpose

This regulation provides directives for procedures to be followed while planning and designing temporary construction for cofferdams and unwatered excavations on major civil works projects. The objective is to provide criteria and guidance for providing safe working conditions and life protection, optimizing cost versus risk of damage, maintaining navigation, and securing the integrity of permanent structures during the use of temporary unwatered cofferdams and excavations on major civil works projects.

2. Applicability

This regulation applies to all HQUSACE elements, major subordinate commands (MSC), districts, laboratories, and field operating activities having civil works responsibilities.

3. References

a. Required references.

(1) Clean Water Act, Sections 402 and 404.

(2) TM 5-818-5, Dewatering and Groundwater Control for Deep Excavations.

(3) ER 1110-2-101, Reporting of Evidence of Distress of Civil Works Structures.

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

(5) EM 1110-2-1902, Stability of Earth and Rock-Fill Dams.

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

(7) EM 1110-2-2503, Design of Sheet Pile Cellular Structures, Cofferdams and Retaining Structures.

(8) CWGS 02411, Metal Sheet Piling.

b. Related references.

(1) ER 5-7-1(FR), Project Management.

(2) ER 1105-2-100, Guidance for Conducting Civil Works Planning Studies.

(3) ER 1110-2-1200, Plans and Specifications for Civil Works Projects.

(4) ER 1110-2-1461, Design of Navigation Channels Using Ship-Simulation Techniques.

(5) ER 1130-2-306, Navigation Lights, Aids to Navigation, Charts, and Related Data, Policy, Practices and Procedures.

(6) EM 385-1-1, Safety and Health Requirements Manual.

(7) EM 1110-2-1605, Hydraulic Design of Navigation Dams.

(8) EM 1110-2-1908, Instrumentation of Earth and Rock-Fill Dams.

(9) EM 1110-2-2504, Design of Sheet Pile Walls.

(10) EM 1110-2-2906, Design of Pile Foundations.

(11) ETL 1110-2-338, Barge Impact Analysis.

4. Scope

a. Construction cofferdams used in this context are temporary structures, in which collapse or inundation can result in a potential risk to life or that exceed 10 percent of the project cost for the permanent structures, used to facilitate construction of major civil works projects. Temporary construction cofferdams include sheet pile structures, cellular cofferdams, movable cofferdams, slurry walls, braced and unbraced excavations, tie-back walls, and embankments that can be unwatered for construction of permanent hydraulic structures inside the cofferdam area. Major civil works projects are those that involve construction of, or alterations to, navigation, hydropower, or multipurpose dam projects or other similar hydraulic structures.

b. Recognizing that the cost of cofferdams and the associated dewatering can be a large percentage of the final project's cost, innovative techniques such as reusable cofferdams, in the wet construction, and incorporation of the cofferdam into the permanent construction should be investigated.

5. Policy

Construction cofferdams on major civil works projects shall be planned, designed, reported, approved, specified, and inspected by the government in the same manner as for permanent project features. Construction cofferdams shall be designed or reviewed by engineers experienced in this area. Use of experienced consultants in this specialized field should be considered for important cofferdam structures. Performance specifications for contractor-furnished dewatering systems can be developed based on the government's design and associated criteria. For uniformity in bidding, contract plans and specifications will include the major features developed from the approved criteria and design. Alternate contractor-proposed designs will meet the approved government design criteria and will be reviewed and approved by the government. Deviation from this policy will be made only in consultation with and approval by CECW-E.

6. Planning

The results of the necessary investigations and studies made for the purpose of planning and designing construction cofferdams will be reported in the feasibility report and appropriate design memoranda in accordance with ER 1110-2-1150.

a. Feasibility phase. The feasibility report must include the results of the studies of the type and geometry of cofferdams, construction procedures, and diversion plans, including alternate schemes investigated. The general features of the construction cofferdam, including layout, materials construction sequence, number of stages, degree of protection, cofferdam height risk analysis, and economic studies, along with the recommended plan, must be reported. Coordination with navigation interests, local interests, and sponsoring agencies must be conducted and reported. Sufficient information on the hydrologic, stream flow, scour, and sedimentation characteristics, and the topographic, geologic, and soils features, including the effect on dewatering, must be presented to support the general features of the cofferdam.

b. Construction procedure and diversion plan - feasibility phase. The results of the following investigations and studies, proposed design criteria, and preliminary design of the construction cofferdams must be reported in the feasibility report on the construction procedure and diversion plan.

(1) Geotechnical. Sufficient foundation and embankment investigations will be conducted to adequately determine the strengths, permeability, and other foundation and embankment characteristics affecting the integrity of the cofferdam. Weak or fault zones beneath the cofferdam that may cause sliding or overturning risks must be identified. Excavations for permanent structures must be planned to prevent the undermining of cofferdam foundations, particularly in weak rock formations or where weak seams underlying the cofferdam will be exposed by the excavation. Sources of cell fill and embankment material shall be identified and engineering properties evaluated for use in the cofferdam and embankments. Adequate space must be provided between the cofferdam and structural excavation to accommodate relief wells, piezometers, or strengthening devices such as toe buttresses and foundation anchors if they are necessary. Also, sufficient area should be provided to accommodate construction activities and access. Estimated amounts for cofferdam dewatering and care of water must be determined.

(2) Hydraulic/hydrology. Design studies and economic evaluations must be conducted for construction staging and diversion alternatives. Risk-based analysis

procedures must be used to determine the most economical diversion plan. This plan will minimize hazards to the construction activity, downstream development, and upstream swellhead effects on flood protection, land use, or infrastructure. Effects on river environment and navigation will be determined from studies to determine flow directions, velocity patterns, and tendencies for sedimentation and scour, including probabilistic analysis of discharges and river stage. Elevations for top of protection must be determined from risk-based analysis procedures. Guidelines for risk-based analysis procedures can be obtained from CECW-EH. Directives will be provided in a future engineer regulation. Hydraulic models can be used for the design to determine the sequence of individual cell construction, effects of scour and sedimentation during construction, and closure geometry and sequencing. The hydraulic model can also be used to assist in the design of scour protection for individual and partially completed cells and current deflector structures used during the installation of cells. Effects on navigation during intermediate cofferdam construction and closure can also be determined. The results of these studies and designs must be reported in the feasibility report or design memorandum.

(3) Coordination with navigation or sponsoring agencies. For cofferdams used to construct navigation projects, close coordination must be maintained with navigation interests. The views of navigation interests are a valuable asset while planning cofferdam staging that may affect navigation. Towboat pilots could give design input when shown the hydraulic navigation model with model towboats to demonstrate construction staging alternatives. Costs of interference factors to the navigation industry due to temporary construction should be fully evaluated and reported in the feasibility report. Requirements for temporary construction of local protection projects should be coordinated with the sponsoring agency to ensure that items such as necessary real estate are obtained.

(4) Structures. During cofferdam design and economic studies, the following factors should be considered: type and availability of cofferdam material (i.e., sheet pile, walers, anchors, and tie-backs), erosion protection, source of cell fill or embankment material, flooding provisions, rate of construction, construction techniques, and navigation requirements. Items to be considered are braced, anchored, or tied-back sheet pile walls, slurry trench walls, soldier pile and lagging, and single wall cofferdam. If applicable and feasible, cofferdam planning and design must include provisions for construction access, equipment storage, heavy cranes and machinery, and work areas around and on top of the cofferdam. The baseline design must be performed in sufficient detail to develop quantities and cost estimates required for feasibility reports.

(5) Hazardous, toxic, and radioactive waste (HTRW). During the reconnaissance phase, potential HTRW in the construction area must be thoroughly explored. Mitigation measures and costs must be reported in the feasibility report.

(6) Section 402 and Section 404, Clean Water Act. Construction of cofferdams generally requires removal or placement of fill materials in the river. Necessary 402 and 404 permits must be reported in the feasibility report. Necessary permits must be scheduled and obtained before construction.

7. Design

Design guidance for cellular cofferdams is contained in EM 1110-2-2503. The design of earth cofferdams will be in accordance with the applicable provisions of EM 1110-2-1902 and EM 1110-2-2300. Guidance for the design of unwatering and groundwater control systems for deep excavations is contained in TM 5-818-5. Limited guidance is available in official publications for design of braced excavations, soldier pile lagging, and concrete slurring trench walls. Industry standards and expert consultation should be used in these instances. In addition, the following items should be included:

a. Sheet piling tolerances.

(1) Interlocks. If the analysis indicates that the sheet piling cofferdam cells have significant hoop tension, the interlock tolerances may be critical to provide the needed tensile strength. Since there is no American Society for Testing and Materials (ASTM) specification for tolerances on interlock dimensions, it may be necessary to specify the interlock tolerances in the contract documents. The sheet piling should be gauged to ensure dimensional requirements at the mill, and government inspectors should also gauge a representative number of sheets at the jobsite.

(2) Camber and sweep. Tolerances for camber and sweep can affect the ability to construct sheet pile cells. These tolerances should be studied and the requirements included in the contract documents.

b. Cold formed sheet piling. Cold formed sheet piling is not appropriate for use on cellular construction cofferdams. Difficulties in maintaining in-plane plumb tolerances and the propensity to drive the sheets out of the interlocks, coupled with the greater tendency of migration of water and materials through the loose fitting interlocks, render the use of cold formed sheet piling inappropriate for cofferdam applications.

c. Effective section modulus. In cases where the sheet piling is subjected to high bending stresses, the effect of transverse stresses and the width-to-thickness relationship shall be evaluated to ensure the desired capacity of the section in bending.

8. Construction

Construction cofferdams must be constructed by the contractor in accordance with the government-prepared plans and specifications. The contractor will, however, be afforded the opportunity to recommend changes by the value engineering incentive provisions of the contract. For any deviations from the plans and specifications, the value engineering proposal must be submitted for approval of the district's engineering division prior to acceptance of the proposal.

a. Plans and specifications. The project plans and specifications must include the results of the design in sufficient detail for the bidders to evaluate all construction techniques, scour protection provisions, deflector structures, cofferdam rewatering, and instrumentation and surveillance requirements. The contract documents must fully and clearly cover surveillance requirements, instrumentation, and construction conditions requiring special attention to protect permanent works and foundations. Additional provisions such as interlock size tolerances and camber and sweep tolerances are contained in CWGS 02411. Reference to design investigations such as pile driving tests, pump tests, and design memorandum will be listed in the plans and specifications, and these documents will be made available to the bidders prior to bidding. Environmental conditions, such as weather, river stage frequency, wind conditions, and temperature, should be considered in the design and stated in the specifications under the conditions under which the contract is to be performed.

b. Care and diversion of water. The cofferdam and diversion are site-specific. Each project usually has features which make it difficult to set forth a specific design that will be the most economical for a specific dewatering contractor. Thus, performance specifications for care and diversion of water are preferred. However, a government design for the unwatering system must be performed to determine the performance requirements to be included in the contract. If necessary, a plan for flooding, rewatering, and subsequent unwatering of the cofferdam will be developed in the plans and specifications.

c. Quality construction. The safety and integrity of the cofferdam depends, to a large extent, on quality construction fostered by active cooperation and communication between the design team, the quality assurance engineers, and the contractor's supervisory and quality control staff. To ensure conformity with the design intent and that safe, quality construction practices are achieved, the engineers of record from the design team will review the contractor submittals and be involved in engineering during construction. The engineers of record should conduct frequent field visits to monitor and discuss the construction with the quality assurance staff. In accordance with the contractor's quality control plan, the engineers of record should be involved in the preparatory and initial phase meetings. Engineering instructions to the field describing the design principles, design intent, assumptions, and construction procedures required to achieve the design must be prepared and furnished to the project office prior to start of construction. Partnering concepts are useful in fostering communication and resolving disputes that disrupt the successful quality construction of cofferdams. Members of the partnering team should consist of engineering, construction, and contractor representatives.

d. Cofferdam instrumentation and surveillance. Requirements for contractor surveillance and operation of the cofferdam must be clearly stated in the contract documents. Movement monitoring procedures, alarm systems, personnel escape facilities, flood warning and flooding criteria, foundation drainage provisions, scour surveys, and other essential aspects of surveillance and operation must be thoroughly stipulated and enforced. Tolerable redline criteria for such items as movement monitoring, water levels, and uplift pressures will be included in the instructions to the field. An emergency response team should be formed from the engineering, construction, and operations staff for decisionmaking actions in response to emergency situations. In addition, the contracting officer must maintain an effective, continuous monitoring and evaluation program to ensure safety and stability. A specific plan of action must be prepared should the cofferdam become endangered by overtopping or structural and foundation distress.

e. Report of distress. To maintain a file of lessons learned, cofferdam failures that result in flooding, loss of life, unresolved project delays, or significant economic loss must be reported to CECW-E according to ER 1110-2-101 with proposed or actual corrective actions.

9. Deviations

In general, deviation from the policy for planning, designing, constructing, and operating construction cofferdams will be approved only for local protection works, pumping plants, and relocation facilities. Authority may be granted for the design of a construction cofferdam by the construction contractor where there is no potential for major damage or significant delays in project benefits resulting from cofferdam failure. This authority may also be granted for a major project only upon assurances that the construction schedule will provide ample design and review time to ensure a competent, safe design. All requests for assigning cofferdam design responsibility to the construction contractor must be submitted in the feasibility report.

FOR THE COMMANDER:

R. L. VANANTWERP
Colonel, Corps of Engineers
Chief of Staff