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MEMORANDUM FOR MAJOR SUBORDINATE COMMANDS AND DISTRICT COMMANDS

SUBJECT: Policy Guidance Letter No. 26, Benefit Determination Involving Existing Levees

1. Purpose: This Policy Guidance Letter provides guidance on policy and procedure for determining without project conditions and with project flood damage reduction benefits for reconnaissance studies, feasibility studies and preconstruction planning and engineering studies involving existing levees that do not meet Army Corps of Engineers criteria. This guidance does not pertain to levees containing structural extensions such as a T-wall or I-wall.

2. Background: Problems have often arisen in the benefit evaluation of flood damage reduction studies when there are existing levees of uncertain reliability. Specifically, the problem is one of engineering judgment but has implications for benefit evaluation: engineering opinion may differ or be uncertain on the ability of the levees to contain flows with water surface elevations of given heights. This may lead to difficulty in arriving at a clear reasonable and agreed upon without project condition.

3. General: Investigations for flood damage prevention involving the evaluation of the physical effectiveness of existing levees and the related effect on the economic analysis shall use a systematic approach to resolving indeterminate or arguable, degrees of reliability. Reasonable technical investigations shall be pursued to establish the minimum and, to the extent possible, the maximum estimated levels of physical effectiveness. Necessary information and summary of analyses shall be included in report presentations of plan formulation and shall be documented in appropriate supporting materials.

4. Sources of Uncertainty: Studies involving existing levees will focus on the sources of uncertainty (likely causes of failure). Other than overtopping, levees principally fail due to one or a combination of four causes: surface erosion, internal erosion (piping), under-seepage, and slides within the levee embankment or foundation soils. Reasonable investigations, commensurate with the level of detail suitable to the planning activity underway, shall determine the condition of existing levees with respect to the factors that can lead to failure, if this information does not already exist.

5. Performance Record: Existing levees either have or have not failed during previous flood events or have shown evidence of distress such as various degrees of piping, under-seepage and sloughing. Information regarding their performance is relevant and vitally important in forming judgments regarding future performance. However, it should not be assumed that because a levee has passed a flood of a given frequency it will always do so in the future or vice versa, assuming the levee has been repaired.

6. Reliability:

a. Reliability judgments should be based solely on physical phenomena. The question to be answered is: what percent of the time will a given levee withstand water at height x? This means that considerations such as degree of protection, induced damages,
induced flood heights, potential for increased risk of loss of life due to false sense of security, etc., are not included. These considerations will be dealt with separately during the plan formulation process.

b. The purpose of reliability determination is to be able to estimate the without-project damages. Its purpose is not to make statements about the degree of protection afforded by the existing levees Major subordinate commands (MSC) and district commands (DC) making reliability determinations should gather information to enable them to identify two points on the existing levees. The first point is the highest vertical elevation on the levee such that it is highly likely that the levee would not fail if the water surface elevation were to reach this level. This point shall be referred to as the Probable Non-failure Point (PNP). The second point is the lowest vertical elevation on the levee such that it is highly likely that the levee would fail. This point shall be referred to as the Probable Failure Point (PFP). As used here, "highly likely" means 85+ percent confidence. As defined, the PNP will be at a lower elevation than the PFP. When there are unresolved uncertainties or differences of opinion, consideration should be given to having the range of uncertainty extend from the lower of arguable PNPs to the higher of arguable PFPs. Because of lack of information or other reasons, if the PFP cannot be determined then the PFP shall be the low point in the levee where the levee is first overtopped. When determining the low point in the levee, MSC and DC shall assume that closure actions have taken place.

c. Further technical guidance on reliability determinations will be issued in the near future in Engineering Technical Letter 1110-2-328, Stability Evaluation of Existing Levees for Benefit Determination.

7. Benefit Evaluation Procedure: Even if no degree of protection is claimed for an existing levee, it does, most likely, provide some benefits. Assessment of these benefits must be in some degree arbitrary in the absence of illuminating engineering or statistical analyses. The function of identifying the probable failure and non-failure points is to create a range of water surface elevations on the levee over which it may be presumed that the probability of levee failure increases as water height increases. The requirement that as the water surface height increases, the probability of failure increases incorporates the reasonable assumption that as the levee becomes more and more stressed it is more and more likely to fail. If the form of the probability distribution is not known, a linear relationship as shown in the enclosed example is an acceptable approach for calculating the benefits associated with the existing levees. For benefit evaluation, assume all flood damages will be prevented below the PNP; and no damages will be prevented above the PFP.

8. Reconnaissance Phase: The performance of existing levees will be acknowledged in the economic analysis accomplished in the reconnaissance phase. The analysis shall reflect the appropriate level of effort for the reconnaissance phase work and critical or non-critical nature this determination has on project justification. The analysis may in some cases be limited to the general guidance contained in this Policy Guidance Letter (i.e., review past performance, establish the PNP at or near the natural ground elevation and assign the PFP at the lowest point in the crest of the levee) However, in other cases more investigations may be required to show Federal interest In any case, a sensitivity analysis will be accomplished in relation to key assumptions and presented in the reconnaissance report.

FOR THE COMMANDER:
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Benefit Determination Involving Existing Levees Example

The conventional damage calculation, that is with no question of levee reliability, would multiply the probability of given damages times the damages. This same probability (of damages) is also associated with a given elevation, and ultimately with a given discharge. Typically the probability is expressed over an interval, as in the attached figure, and is multiplied by the midpoint or average damages (D) associated with that probability range. In this case, the damages would be:

Expected Damages = (P1 - P2) (D) = (.10) (D)

The procedure would be repeated over all intervals for which damages occur; the damages for the intervals would be summed to produce average annual damages.

When there is a levee of uncertain reliability, there is an additional factor in the calculation. The levee may or may not fail when the discharge that would produce the given damages occurs. This probability is read from the levee reliability probability graph, also shown on Figure l. In preparing this graph the PFP should be assigned the appropriate probability of failure of between 0.85 and 0.99. Likewise the PNP should be assigned a probability between 0.01 and 0.15. As in this example, if sufficient information is not available to make the assignments then the PFP will be assigned 0.85 and the PNP will be set at 0.15. In this example, the discharge would produce a water surface elevation on the levee of E, and this elevation would have an associated probability of failure of:

PRf = .40

The probability that damages would occur, given this discharge, is the product of the probability the discharge occurs times the probability the levee fails, and the expected damages are equal to:

Expected Damages = (P1 - P2) (PRf) (D)

= (.10) (.40) (D)

As in the first case, the procedure would be repeated over all intervals for which damages occur, and the damages for the intervals would be summed to produce average annual damages for a levee of uncertain reliability.