Exhibit D

Research Project Requirement Template

Assessment of Wave Impacts on Highway Embankments due to Hurricanes/Tropical Storms in Coastal Louisiana

Recipient/Grant (Contract) Number: 69A3552348306 (CY1-LTU-03)

Center Name: Southern Plains Transportation Center (SPTC)

Research Priority: Improving the Durability and Extending the Life of Transportation Infrastructure

Principal Investigator(s): Jay X. Wang, Louisiana Tech University

Project Partners: Louisiana Tech University

Research Project Funding: Louisiana Tech University: $29,000 (Federal) and $29,000 (Match)

Proposed Start and End Date: 11/01/2023 to 10/31/2024

Project Description: Geosynthetic-reinforced highway embankments are often built on expansive clays along the Louisiana shorelines. An embankment is often reinforced using articulating concrete mats and geosynthetic separator fabrics, consisting of planar reinforcements arranged in horizontal planes in the fill to resist outward movements of the fill. Facing treatments ranging from vegetation to flexible armor systems are applied to prevent unraveling and sloughing of the face. These embankments are different from regular levees or embankments in the sense that they are subjected to high current and large wave pressures, as well as pore water pressure conditions, especially under extreme weather events such as hurricanes and tropical storms. This one-year study will only focus on the analysis of wave pressure analyses and the development of wave pressure envelopes that can be used for the design of coastal embankments as well as for assessing the vulnerability of existing embankments to hurricanes.

The PI and his graduate students have been collaborating with the Coastal Protection and Recovery Authorities of Louisiana (CPRA) on research projects funded by the Louisiana Sea Grant for more than ten years. In this project, long-term measurements provided by the CPRA on wave behavior and design parameters for containment dikes will be examined and applied to the present study on coastal highway embankments. The goal is to quantify the impact of wave pressure on highway embankments using innovative data analysis. The following commonly employed methods will be taken in these analyses: Goda Design Method, Minikin Design Method, and Blackmore and Hewson Design Method. Based on these analyses, a practical method for the distribution of wave pressure on embankments will be developed. These distributions will then be combined to produce wave pressure envelopes, which reflect the worst wave pressure conditions for selected hurricanes and tropical storms of different categories, experienced within the last 20 years. This research project will lead to a more accurate and reliable design approach for geosynthetic-reinforced embankments subjected to wave pressures from hurricanes or tropical storms.

The following tasks will be carried out in the one-year duration of this project: (1) Collect and review the integrated field observations and modeling data from ADV and wave gauges (e.g., wind wave, velocity, and water levels, etc.) at the specific sites in coastal Louisiana experienced during specific hurricanes, such as Hurricanes Katrina, Rita, and Ida; (2) Compute the time-dependent dynamic wave/current pressure distributions on the faces of selected highway embankments based on the measured

data from specific hurricanes, following the three methods noted above; (3) Find the maximum wave pressure at each point on the surface of the embankment based on the analyses in Task 2. Use these maximum wave pressure values to generate a wave envelope; (4) Develop two or three wave pressure envelopes corresponding to the hurricanes and tropical storms of different categories, which were recorded in coastal Louisiana during the past 20 years; (5) Recommend the developed wave pressure envelops to the Louisiana Department of Transportation and Development (LA DOTD) as standardized wave pressure loads for different categories of hurricanes, for future designs of coastal highway embankments as well as for vulnerability of existing embankments under future extreme events.

US DOT Priorities: The outputs of this research will be provided as recommendations to the LA DOTD in terms of estimation of typical wave pressure loading due to hurricanes and tropical storms. The proposed method will standardize the estimation of wave pressure loading due to hurricanes of different categories and tropical storms. Such standardization, based on long-term wave measurements, will make the wave load calculations and analyses more accurate and practical. The concept of wave pressure envelope will simplify and systemize the design of highway embankments in Louisiana and bolster designer confidence. The proposed method could be extended to other states. Improved designs are expected to positively impact the durability, safety, and reliability of coastal highways under weather extremes.

Outputs: The innovative idea of a pressure envelope leads to an improved method for wave pressure calculations. Step-by-step procedures will be provided in an MS Excel spreadsheet or a MATLAB-based tool. Both CPRA and LA DOTD are expected to be engaged and benefit from the outputs of this one-year study. The findings of this study could serve as a basis for seeking new funding from such agencies as NSF. In this regard, a proposal titled “Sustainability Study of Coastal Geosynthetic-Reinforced Highway Embankment on Expansive Soils Exposed to Localized Wave Forces” may be developed by the research team and submitted to NSF or other pertinent agencies.

Outcomes/Impacts: The implementation of standardized wave pressure loads for different categories of hurricanes is expected to make coastal embankment design more effective and accurate. Also, the MS Excel spreadsheet or a MATLAB-based tool can be used for assessing the vulnerability of existing embankments to future hurricanes of comparable strengths and for undertaking appropriate measures to reduce vulnerability and extend service life. Students participating in this project will gain valuable experience. Such experience is expected to encourage them to pursue advanced studies and potential careers in transportation. Moreover, the research team will take appropriate steps to advance the community engagement goals.

Final Research Report: