Executive Summary, Research Readiness Level Assessment, and Technology Transfer

Updating Rainfall Zones and Intensities in Nebraska for Improved Design of Non-Bridge-Sized Drainage Structures – Phase I

Research Objectives

Based on the findings, the necessary updates in the current approaches will be suggested. The specific objectives of the proposed research are listed below:

1. Compare the intensities in the rainfall data from 1961 against the intensities in the current data.
2. Review and update the current rainfall zones.
3. Review and update the IDF curves.
4. Provide updated calculation method for peak flow based on updated rainfall intensities applicable to Nebraska.
5. Provide recommendations for the practitioners.

Research Benefits

The project will result in updated rainfall zones and the associated IDF curves for the state of Nebraska for their use in the Rational Method to calculate peak flow. The results will clearly show the benefits of using updated rainfall information, which is expected to result in a more realistic estimation of flood peaks. A detailed guide will be provided, which will include all the specifics of the analysis and the outcomes. The copies of codes, data, and results prepared as a part of the work will be transferred to NDOT for archiving and further use. The new zones will be made available as shapefiles, and the corresponding IDF curves will be stored in an Excel file for easy interpretability and use. A demo computer program (not complete software) will be developed for demonstration purposes.

Background

NDOT utilizes the Rational Method to calculate peak design discharge flows for small drainage areas (less than 640 acres) when sizing culverts and storm sewers. This method requires information about land use, watershed travel time, and precipitation data for the location of interest. NDOT's current implementation of the Rational Method simplifies the precipitation data into three rainfall zones with intensity-duration-frequency (IDF) curves determined from UNL research completed in 1988. That research developed the three rainfall zones based on the National Weather System's Technical Paper 40 (1961) by using spatial analysis of the general pattern of rainfall isohyets shown in TP-40. Climate scientists typically define a climate normal in terms of 30-year averages, meaning that the 60 years old precipitation data being utilized by NDOT to date is likely not representative of the current climatic conditions in Nebraska.

Conclusion

This study assesses the effectiveness of precipitation zones and Intensity-Duration-Frequency (IDF) curves used by the Nebraska Department of Transportation (NDOT) for designing drainage structures. Twenty stations were selected for the analysis of revised IDF curves out of forty-two stations. Datasets have been considered from the National Center for Environmental Information (NCEI). By Comparing the new curves with existing ones, the study efforts examine the frequency, duration and severe rainfall. The results show that the IDF curves for various zones and stations varied noticeably from one another. Also, noticed that Zone A and B shows lower rainfall intensities in short to medium duration. While, Zone C shows higher rainfall intensities short to medium duration. The variation can be seen by a verification using ATLAS-14 IDF curves and historical data, suggesting the necessity for an updated methodology. Additionally, this study used the Kriging and Inverse Distance Weighting (IDW) approach to analyze rainfall spatially. The study employed the k-means clustering technique to identify if the new cluster was considered to be a rainfall zone. The studies show the development of three spatial zones and a new IDF is created based on this clustering analysis. The research being conducted provides crucial information to ensure the sustainability of the Nebraska transportation system and increase the accuracy of hydrological assessments

Principal Investigator
Rezaul Mahomood (P.I.)
Tirthankar Roy (Co P.I.)
University of Nebraska

NDOT Lead TAC Member
Julie Ramirez, **PE,** Roadway Design Engineer

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Final report is available at:
HERE

NDOT Recommendations Based Off Research Project - 2025

This research has demonstrated the need for updating rainfall intensities in current rational method calculations. Currently, the NDOT's rational method calculator uses rainfall intensity data from TP-40 which predates the 1960s and underestimates true rainfall intensities by about 10%. The research demonstrated the need to replace this data. The NDOT is considering ATLAS-14 historical dataset as the replacement. The Department is also looking to potentially update its rational method calculator or create a new one entirely. The research provided an updated calculation method for peak flow based on updated rainfall intensities; however, the code for this calculation did not use the Department's methodology for time of concentration utilizing the Kirpich equation and appropriate correction factors based on land use, nor did researchers provide a framework of incorporating their code into existing calculators. Nevertheless, research did demonstrate shortcomings with the calculator that need to be addressed. At this time, NDOT Roadway Hydraulics has identified possible paths forward that will utilize current ATLAS-14 Data.

- *As provided by Julie Ramirez, Lead TAC Member*

Research Readiness Level (RRL) Assessment

Level 5: Fully Understood

RRL 5

Technology Transfer

Principal Investigator did not have any technology transfer for this research project.

This brief summarizes Project SPR-FY23(018)

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Nebraska Department of Transportation Research Program