

NCHRP 10-128 [RFP]

Multiple-Sensor Weigh-In-Motion Systems to Enhance Data Accuracy and Reliability

Posted Date: 11/9/2023

Project Data	
Funds:	\$450,000
Contract Time:	30 months <i>(includes 1 month for NCHRP review and approval of the interim report and 3 months for NCHRP review and for contractor revision of the final report)</i>
Authorization to Begin Work:	9/16/2024 -- estimated
Staff Responsibility:	Camille Crichton-Summers Phone: 202/334-1695 Email: ccrichton-summers@nas.edu
Comments:	In development
RFP Close Date:	1/3/2024
Fiscal Year:	2024

BACKGROUND

Weigh-in-motion (WIM) systems measure the axle weight of moving vehicles as they traverse WIM measurement sites. WIM data are essential for the design, assessment, and maintenance activities related to pavement and bridge infrastructure and may be used for monitoring and enforcing motor carrier truck weights and dimensions and collecting tolls.

WIM sensors vary from instrumented metal plates to piezoelectric, quartz, and strain gauge strip sensors. Their accuracy is evaluated with reference to static loads referenced in the American Society for Testing and Materials, Standard Specification for Highway Weigh-In-Motion (WIM) Systems with User Requirements and Test Methods, ASTM E1318-09 (2017) and is affected by the interaction between roadway roughness, vehicle dynamics, and speed. The narrow strip-type WIM sensors that sample a smaller part of the dynamic axle loads applied to the road may be strategically spaced to capture more data points of the dynamic axle load waveforms by using multiple strip sensors (two or more). The use of multiple strip sensors will potentially result in increased data reliability and more accurate estimates of the corresponding static axle loads, reduce measurement error, improve data quality, and reduce maintenance costs.

State departments of transportation (DOTs) require accurate and cost-effective WIM technology. Research is needed to assess and optimize multiple-sensor spacing and determine its benefits and feasibility.

OBJECTIVE

The objective of this project is to develop a model to determine the optimal number of WIM strip sensors and array layout, given specified levels of accuracy and reliability considering pavement, environmental, and traffic conditions.

Accomplishment of the project objective will require at least the following tasks.

TASKS

Task descriptions are intended to provide a framework for conducting the research. The NCHRP is seeking the insights of proposers on how best to achieve the research objective. Proposers are expected to describe research plans that can realistically be accomplished within the constraints of available funds and contract time. Proposals must present the proposers' current thinking in sufficient detail to demonstrate their understanding of the issues and the soundness of their approach to meeting the research objective.

When developing the research approach, consideration should be given, but not limited to, the following factors or concepts:

- Strip sensor specifications;
- The need for WIM sensor redundancy;
- Maintenance of WIM sites (i.e., pavement, controller, sensors);
- Durability of installed sensor array;
- A range of what state DOTs consider accurate and reliable; and
- Direct or automatic enforcement is defined as specified in the [ISWIM Guide for Users of WIM](#).

PHASE I

Task 1. Prepare a literature review related to multiple-sensor WIM technology.

Note: The literature review summary shall be presented in the Task 1 report.

Task 2. Prepare a summary report that describes the state of practice for WIM strip sensors and identifies a broad range of strip sensors that are accessible to state DOTs.

Note: The state of practices shall be summarized and presented in the Task 2 report.

Task 3. Identify the data inputs for the development and validation of a multiple-sensor WIM optimization model(s) that will be used for the development of a decision support spreadsheet tool, readily available to state DOTs and easy to use.

Task 4. Prepare an interim report that summarizes the findings from Tasks 1 through 3 and a detailed Phase II work plan that describes how the findings of Tasks 1 through 3 will inform the development of a multiple-sensor WIM optimization model(s) and practitioner's spreadsheet tool.

Note: NCHRP approval of the interim report and the proposed Phase II work plan is required prior to initiation. This shall occur at a face-to-face meeting with the NCHRP project panel to be convened in Washington, DC, at NCHRP offices. The NCHRP will cover the costs associated with meetings at NCHRP facilities, teleconference services, and panel member travel.

PHASE II

Task 5. Develop the multiple-sensor WIM optimization model(s) and validate it using field data. Provide the test criteria and procedures used to validate the model.

Task 6. Using the model developed in Task 5, develop a WIM optimization decision-support spreadsheet tool for practitioners that incorporates inputs related to pavement, environmental, and traffic conditions, and sensors. Within the spreadsheet tool, provide a graphical representation that shows the implications of alternative sensor layouts (i.e., sensor spacing and the number of sensors) and their impact on accuracy. End-user instructions should be included.

Note: Macros created for the spreadsheet tool must be documented and included as a final deliverable along with instructions for disabling them and future modifications.

Task 7. Identify a core group of subject matter experts to beta test the decision-support spreadsheet tool developed in Task 6 and conduct beta testing.

Note: Approval of the core group by NCHRP is required prior to initiating Task 7.

Task 8. Convene a virtual workshop to provide a tool demonstration and solicit additional feedback from the community of practice.

Notes:

1. Approval of the workshop attendees by NCHRP is required prior to initiating Task 8.

2. Workshop results should be summarized in a report and presented to NCHRP prior to moving to Task 9.

Task 9. Modify the multiple-sensor WIM optimization model and the spreadsheet tool as needed based on feedback solicited during beta testing and the virtual workshop.

Note: Approval by NCHRP is needed prior to making changes to the model and the spreadsheet tool.

Task 10. Prepare the final deliverables, which must include the following:

1. A stand-alone deliverable that includes the multiple-sensor WIM optimization model(s) and related model source code, data, and all notes and comments documenting decisions related to model development;

Note: If applicable, include any source code, databases, programs, and cleaned datasets developed under this project in USB, Dropbox, SharePoint, or other preapproved format.

2. WIM optimization decision-support spreadsheet tool and macros;

3. End user's instructions for the WIM optimization decision-support spreadsheet tool;

4. A final report documenting the entire research effort including recommendations for future research;

5. A PowerPoint presentation describing the background, objectives, research approach, findings, and conclusions;

6. A stand-alone technical memorandum titled "Implementation of Research Findings and Products" (see Special Note J for additional information); and

7. A draft article suitable for publication in *TR News* (Information regarding *TR News* publication may be found on the TRB web page <http://onlinepubs.trb.org/onlinepubs/trnews/info4contributors.pdf>).

Proposers may recommend additional deliverables to support the project objective.

Notes:

1. All data, source code, and macros derived from this study must be delivered to the NCHRP at the conclusion of the study.

2. No commitment by NCHRP to publish a *TR News* article is implied.

3. Following receipt of the draft final deliverables, the remaining 3 months shall be for NCHRP review and comment and for research agency preparation of the final deliverables.

SPECIAL NOTES

A. The selected contractor shall provide protocols for testing, maintenance, and troubleshooting and deliver the following derived products if applicable: (1) developed computer databases, (2) models, (3) spreadsheets (including source code, object code listings, design details, algorithms, processes, flow charts, formulae, and related material), and (4) documentation related to models and spreadsheet tools developed during this research study. These deliverables shall become the exclusive property of the National Academies of Sciences, Engineering, and Medicine.

B. The [Information and Instructions for Preparing Proposals for the Transportation Research Board's Cooperative Research Programs](#) were revised in May 2023. Please take note of the new and revised text which is highlighted in yellow.

C. Proposals must be submitted as a single PDF file with a maximum file size of 10 MB. The PDF must be formatted for standard 8 ½" X 11" paper, and the entire proposal must not exceed 60 pages (according to the page count displayed in the PDF). Proposals that do not meet these requirements will be rejected. For other requirements, refer to chapter V of the [instructions](#).

D. The [Information and Instructions for Preparing Proposals for the Transportation Research Board's Cooperative Research Programs](#) have been modified to include a revised policy and instructions for disclosing Investigator Conflict of Interest. For more information, refer to chapter IV of the [instructions](#). A detailed definition and examples can be found in the [CRP Conflict of Interest Policy for Contractors](#). The proposer recommended by the project panel will be required to submit an Investigator Conflict of Interest and Disclosure Form as a prerequisite for contract negotiations.

E. Proposals will be rejected if any of the proposed research team members work for organizations represented on the project panel. The panel roster for this project can be found at <https://www.mytrb.org/OnlineDirectory/Committee/Details/6916>. Proposers may not contact panel members directly; this roster is provided solely for the purpose of avoiding potential conflicts of interest.

F. Proprietary Products - If any proprietary products are to be used or tested in the project, please refer to Item 6 in the *Information and Instructions for Preparing Proposals*.

G. Proposals are evaluated by the NCHRP staff and project panels consisting of individuals collectively knowledgeable in the problem area. The project panel will recommend their first choice proposal considering the following factors: (1) the proposer's demonstrated understanding of the problem; (2) the merit of the proposed research approach and experiment design; (3) the experience, qualifications, and objectivity of the research team in the same or closely related problem area; (4) the plan for ensuring application of results; (5) how the proposer approaches inclusion and diversity in the composition of their team and research approach, including participation by certified Disadvantaged Business Enterprises; and, if relevant, (6) the adequacy of the facilities. A recommendation by the project panel is not a guarantee of a contract. The National Academy of Sciences (NAS - the contracting authority for the National Academies of Sciences, Engineering, and Medicine) will conduct an internal due diligence review and risk assessment of the panel's recommended proposal before contract negotiations continue.

Note: The proposer's approach to inclusion and diversity as well as participation by Disadvantaged Business Enterprises should be incorporated in Item 11 of the proposal.

H. Copyrights - All data, written materials, computer software, graphic and photographic images, and other information prepared under the contract and the copyrights therein shall be owned by the National Academy of Sciences. The contractor and subcontractors will be able to publish this material for non-commercial purposes, for internal use, or to further academic research or studies with permission from TRB Cooperative Research Programs. The contractor and subcontractors will not be allowed to sell the project material without prior approval by the National Academy of Sciences. By signing a contract with the National Academy of Sciences, contractors accept legal responsibility for any copyright infringement that may exist in work done for TRB. Contractors are therefore responsible for obtaining all necessary permissions for use of copyrighted material in TRB's Cooperative Research Programs publications. For guidance on TRB's policies on using copyrighted material please consult Section 5.4, "Use of Copyrighted Material," in the Procedural Manual for Contractors.

I. Proposals should include a task-by-task breakdown of labor hours for each staff member as shown in Figure 4 in the *Information and Instructions for Preparing Proposals*. Proposals also should include a breakdown of all costs (e.g., wages, indirect costs, travel, materials, and total) for each task using Figures 5 and 6 in the brochure. Please note that TRB Cooperative Research Program subawards (selected proposers are considered subawards to the National Academy of Sciences, the parent organization of TRB) must comply with 2 CFR 200 – *Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards*. These requirements include a provision that proposers without a "federally" Negotiated Indirect Costs Rate Agreement (NICRA) shall be subject to a maximum allowable indirect rate of 10% of Modified Total Direct Costs. Modified Total Direct Costs include all salaries and wages, applicable fringe benefits, materials and supplies, services, travel, and up to the first \$25,000 of each lower tier subaward and subcontract. Modified Total Direct Costs exclude equipment, capital expenditures, charges for patient care, rental costs, tuition remission, scholarships and fellowships, participant support costs and the portion of each lower tier subaward and subcontract in excess of \$25,000.

J. The required technical memorandum titled "Implementation of Research Findings and Products" should (a) provide recommendations on how to best put the research findings/products into practice; (b) identify possible institutions that might take leadership in applying the research findings/products; (c) identify issues affecting potential implementation of the findings/products and recommend possible actions to address these issues; and (d) recommend methods of identifying and measuring the impacts associated with implementation of the findings/products. Implementation of these recommendations is not part of the research project and, if warranted, details of these actions will be developed and implemented in future efforts.

The research team will be expected to provide input to an implementation team consisting of panel members, AASHTO committee members, the NCHRP Implementation Coordinator, and others in order to meet the goals of *NCHRP Active Implementation: Moving Research into Practice*, available at http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP_ActiveImplementation.pdf

K. If the team proposes a Principal Investigator who is not an employee of the Prime Contractor, or if the Prime Contractor is proposed to conduct less than 50% of the total effort (by time or budget), then section five of the proposal should include: (1) a justification of why this approach is appropriate, and (2) a description of how the Prime Contractor will ensure adequate communication and coordination with their Subcontractors throughout the project.

L. All budget information should be suitable for printing on 8½" x 11" paper. If a budget page cannot fit on a single 8½" x 11" page, it should be split over multiple pages. Proposers must use the Excel templates provided in the [Information and Instructions for Preparing Proposals for the Transportation Research Board's Cooperative Research Programs](#).

**Proposals must be uploaded via this link: <https://www.dropbox.com/request/gEK3IFQCWV110H268TPy>
Proposals are due not later than 5:00 p.m. Eastern Time on 1/3/2024.**

This is a firm deadline, and extensions are not granted. In order to be considered for award, the agency's proposal accompanied by the executed, unmodified Liability Statement must be in our offices not later than the deadline shown, or the proposal will be rejected.

Liability Statement

The signature of an authorized representative of the proposing agency is required on the unaltered statement in order for TRB to accept the agency's proposal for consideration. **Proposals submitted without this executed and unaltered statement by the proposal deadline will be summarily rejected.** An executed, unaltered statement indicates the agency's intent and ability to execute a contract that includes the provisions in the statement.

Here is a fillable PDF version of the [Liability Statement](#). A free copy of the Adobe Acrobat PDF reader is available at <https://www.adobe.com>.

General Notes

1. According to the provisions of Title 49, Code of Federal Regulations, Part 21, which relates to nondiscrimination in federally assisted programs, all parties are hereby notified that the contract entered into pursuant to this announcement will be awarded without discrimination on the grounds of race, color, religion, sex, national origin, or disability.
2. The essential features required in a proposal for research are detailed in the current brochure entitled "[Information and Instructions for Preparing Proposals](#)". **Proposals must be prepared according to this document, and attention is directed specifically to Section IV for mandatory requirements. Proposals that do not conform with these requirements will be rejected.**
3. The total funds available are made known in the project statement, and line items of the budget are examined to determine the reasonableness of the allocation of funds to the various tasks. If the proposed total cost exceeds the funds available, the proposal is rejected.
4. All proposals become the property of the Transportation Research Board. Final disposition will be made according to the policies thereof, including the right to reject all proposals.
5. Potential proposers should understand that follow-on activities for this project may be carried out through either a contract amendment modifying the scope of work with additional time and funds, or through a new contract (via sole source, full, or restrictive competition).

To create a link to this page, use this URL: <http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=5509>

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