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New Hampshire DOT Department of Transportation

THE STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION

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William Cass, P.E.
Commissioner

David Rodrigue, P.E.
Assistant Commissioner

Her Excellency, Governor Kelly A. Ayotte
and the Honorable Council
State House
Concord, New Hampshire 03301

Bureau of Materials and Research
March 21, 2025

REQUESTED ACTION

Authorize the Department of Transportation to enter into a **Sole Source** Cooperative Project Agreement with the University of New Hampshire Sponsored Programs Administration (vendor 315187), Durham, New Hampshire, for a fee not to exceed $286,610, for a cooperative evaluation to laboratory test and evaluate the field performance of Hot Mix Asphalts (HMA) mixtures effective upon Governor and Council approval through December 31, 2027. 100% Federal Funds.

Funds are available in the following account for Fiscal Year 2025, and are anticipated to be available in Fiscal Years 2026 and 2027, upon the availability and continued appropriation of funds in the future operating budgets, with the authority to adjust encumbrances between fiscal years within the price limitation through the Budget Office, if needed and justified:

04-96-96-962015-3036	FY 2025	FY 2026	FY 2027
SPR Research Funds			
046-500464 General Consultants Non-Benefit	$120,000	$120,000	$46,610

EXPLANATION

The following research study will address an immediate Department need; is unique to New Hampshire's environment and conditions, thereby requiring substantial local experience; and is directly aligned with a particular area of University expertise. In addition, the Principal Investigator is a nationally recognized expert in his field. As such, the proposed work does not lend itself to a selection process that includes private industry or out-of-state organizations, and it is in the Department's and the State's best interest to work directly with the University of New Hampshire, requiring this agreement to be **Sole Source**.

This work is part of the Department's Statewide Planning and Research (SPR) program. The Department of Transportation and the University of New Hampshire (UNH) have a long-standing cooperative relationship in transportation research. This relationship has been mutually beneficial, culminating in savings to the State while enhancing work force development and maintaining New Hampshire's position on the leading edge of new technology. Research studies conducted by UNH for the Department have led to numerous innovations in the highway and bridge industry, including improved pavement design, increased use of recycled materials, stormwater management evaluation, and rapid construction techniques.

Statewide-SPR 42372Q, Laboratory Testing & Field Performance of NHDOT HMA Mixes

The Department is collaborating with UNH to conduct a cooperative research study, "Laboratory Testing & Field Performance of NHDOT HMA Mixes." Since 2016, UNH has performed testing on over 60 NHDOT HMA mixtures. These tests provide measurements of stiffness, fatigue cracking, low temperature cracking, and overall durability. The information gathered from these tests can be used in mechanistic-empirical pavement design and various indices can estimate the relative performance of the mixture in the field under real-world applications. This research will compare the laboratory performance predictions to year-to-year field collected pavement condition data.

- Evaluate correlations between mix design attributes, performance properties, and field performance to support specification updates
- Develop predictive models for estimating mixture performance properties from mix design attributes to support BMD and PavementME implementation in NH
- Develop a model to estimate longevity of different mixture and pavement types in NH. This in future can support on-going NHDOT AMPS effort on asset management performance models.
- Provide recommendations on how NHDOT can improve processes (e.g. mix design and material specifications)

This project builds upon work conducted under previous projects that conducted extensive testing and developed appropriate laboratory conditioning methods for HMA mixtures to simulate NH conditions. The results of this project will help NHDOT better understand the performance of HMA mixes and inform decisions by lowering life cycle costs and increasing service life and mix performance.

The Bureau of Materials & Research presented the problem statement that was selected by the NHDOT Research Advisory Council in January 2025.

The funding is 80% Federal Funds with 20% state match. Turnpike toll credits are being used for the match requirement, effectively using 100% Federal Funds. The Capital Budget Overview Committee approved the use of Turnpike Toll Credits on September 13, 2021.

This Agreement has been approved by the Attorney General as to form and execution. Copies of the fully-executed Agreement are on file at the Secretary of State's Office and the Department of Administrative Services, and subsequent to Governor and Council approval will be on file at the Department of Transportation.

It is respectfully requested that authority be given to enter into these sole-source Agreement for consulting services as outlined above.

Sincerely,

William Cass

William J. Cass, PE
Commissioner

Attachments

JOHN O. MORTON BUILDING • 7 HAZEN DRIVE • P.O. BOX 483 • CONCORD, NEW HAMPSHIRE 03302-0483
TELEPHONE: 603-271-3734 • FAX: 603-271-3914 • TDD: RELAY NH 1-800-735-2964 • INTERNET: WWW.NHDOT.COM

COOPERATIVE PROJECT AGREEMENT
between the
STATE OF NEW HAMPSHIRE, **DEPARTMENT OF TRANSPORTATION**
and the
University of New Hampshire of the UNIVERSITY SYSTEM OF NEW HAMPSHIRE

A. This Cooperative Project Agreement (hereinafter "Project Agreement") is entered into by the State of New Hampshire, **Department of Transportation**, (hereinafter "State"), and the University System of New Hampshire, acting through **University of New Hampshire**, (hereinafter "Campus"), for the purpose of undertaking a project of mutual interest. This Cooperative Project shall be carried out under the terms and conditions of the Master Agreement for Cooperative Projects between the State of New Hampshire and the University System of New Hampshire dated November 13, 2002, except as may be modified herein.

B. This Project Agreement and all obligations of the parties hereunder shall become effective on the date the Governor and Executive Council of the State of New Hampshire approve this Project Agreement ("Effective date") and shall end on **12/31/27**. If the provision of services by Campus precedes the Effective date, all services performed by Campus shall be performed at the sole risk of Campus and in the event that this Project Agreement does not become effective, State shall be under no obligation to pay Campus for costs incurred or services performed; however, if this Project Agreement becomes effective, all costs incurred prior to the Effective date that would otherwise be allowable shall be paid under the terms of this Project Agreement.

C. The work to be performed under the terms of this Project Agreement is described in the proposal identified below and attached to this document as Exhibit A, the content of which is incorporated herein as a part of this Project Agreement.

Project Title: **Laboratory Testing & Field Performance of NHDOT Hot Mix Asphalt**

D. The Following Individuals are designated as Project Administrators. These Project Administrators shall be responsible for the business aspects of this Project Agreement and all invoices, payments, project amendments and related correspondence shall be directed to the individuals so designated.

State Project Administrator	**Campus Project Administrator**
Name: David D. Gaylord	Name: Gretchen Swain
Address: NHDOT - Materials & Research 5 Hazen Drive PO Box 483 Concord, NH 03302-0483	Address: 51 College Road, Service Building Durham, NH 03824-2620
Phone: 603-271-1659	Phone: N/A

E. The Following Individuals are designated as Project Directors. These Project Directors shall be responsible for the technical leadership and conduct of the project. All progress reports, completion reports and related correspondence shall be directed to the individuals so designated.

State Project Director	**Campus Project Director**
Name: Eric S. Thibodeau	Name: Jo Sias
Address: NHDOT - Materials & Research 5 Hazen Drive PO Box 483 Concord, NH 03302-0483	Address: Kingsbury Hall-33 Academic Way, Durham, NH 03824-2620
Phone: 603-271-1750	Phone: 603-862-3277

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F. Total State funds in the amount of **$286,610** have been allotted and are available for payment of allowable costs incurred under this Project Agreement. State will not reimburse Campus for costs exceeding the amount specified in this paragraph.

Check if applicable

☐ Campus will cost-share % of total costs during the term of this Project Agreement.

☒ Federal funds paid to Campus under this Project Agreement are from Grant/Contract/Cooperative Agreement No. **NA** from **USDOT FHWA** under CFDA# **20.205**. Federal regulations required to be passed through to Campus as part of this Project Agreement, and in accordance with the Master Agreement for Cooperative Projects between the State of New Hampshire and the University System of New Hampshire dated November 13, 2002, are attached to this document as Exhibit B, the content of which is incorporated herein as a part of this Project Agreement.

G. Check if applicable

☐ Article(s) of the Master Agreement for Cooperative Projects between the State of New Hampshire and the University System of New Hampshire dated November 13, 2002 is/are hereby amended to read:

H. ☒ State has chosen **not to take** possession of equipment purchased under this Project Agreement.

☐ State has chosen **to take** possession of equipment purchased under this Project Agreement and will issue instructions for the disposition of such equipment within 90 days of the Project Agreement's end-date. Any expenses incurred by Campus in carrying out State's requested disposition will be fully reimbursed by State.

This Project Agreement and the Master Agreement constitute the entire agreement between State and Campus regarding this Cooperative Project, and supersede and replace any previously existing arrangements, oral or written; all changes herein must be made by written amendment and executed for the parties by their authorized officials.

IN WITNESS WHEREOF, the University System of New Hampshire, acting through the **University of New Hampshire** and the State of New Hampshire, **Department of Transportation** have executed this Project Agreement.

By An Authorized Official of:
University of New Hampshire
Name: Dianne Hall
Title: Manager PreAward Compliance
Signature and Date: Dianne Hall Digitally signed by Dianne Hall Date: 2025.02.26 10:00:59 -05'00'

By An Authorized Official of:
NH Department of Transportation
Name: William J. Oldenburg
Title: Director of Project Development
Signature and Date: [signature] 4/30/25

By An Authorized Official of: the New Hampshire Office of the Attorney General
Name: Robert Pearce
Title: Attorney
Signature and Date: [signature] May 5, 2025

By An Authorized Official of: the New Hampshire Governor & Executive Council
Name:
Title:
Signature and Date:

Campus Authorized Official DH
Date 2/26/25

EXHIBIT A

A. Project Title: Laboratory & Field Performance of NHDOT HMA Mixes

B. Project Period: March 1, 2025 – August 31, 2027

C. Background and Objectives:

NHDOT invests approximately $100M annually in the paving program across the state. The overall condition of the NHDOT roadways (Figure 1) has plateaued in the last few years and strategies other than additional funding are needed to continue to make condition improvements across the network.

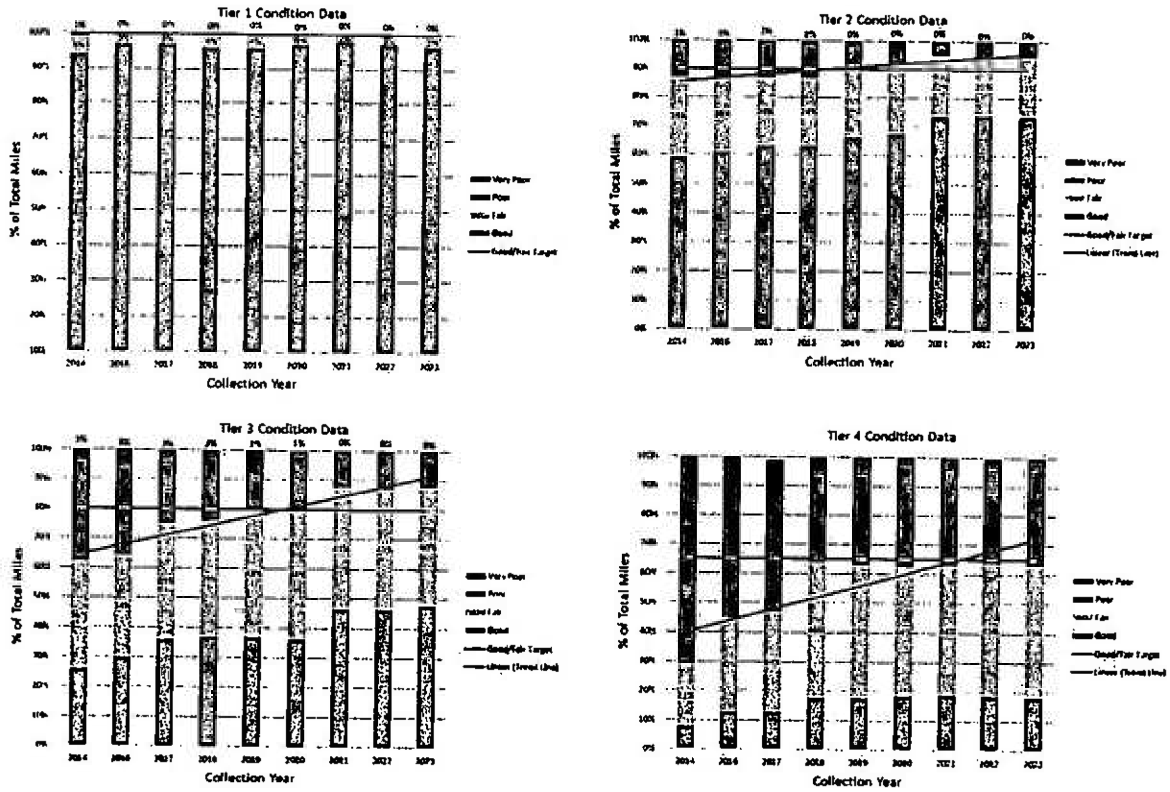

Figure 1. Overall pavement condition data by year for NHDOT Roads by Tier

Since 2016, UNH has performed in-depth laboratory testing on over 60 NHDOT Hot Mix Asphalt (HMA) mixtures. Testing has included resilient modulus, complex modulus, Illinois flexibility index (I-FIT (semi-circular bend, SCB), direct tension cyclic fatigue, and disk-shaped compact tension (DCT) tests. These tests provide measurements of the mixture's stiffness, fatigue cracking, low temperature cracking, and overall durability properties. The information gathered from these tests can be used in mechanistic-empirical pavement design and various indices can estimate the relative performance of the mixture in the field under real-world applications. While the testing on the wide range of mixtures used by NHDOT has been conducted, analysis of the data as a whole and in combination with the field condition data that NHDOT has collected has not been conducted.

This research project will conduct a thorough analysis of the data and compare the laboratory performance predictions to the year-to-year pavement condition data that NHDOT has collected. Specifically, the objectives of this project are to:

- Evaluate correlations between mix design attributes, performance properties, and field performance to support specification updates
- Develop predictive models for estimating mixture performance properties from mix design attributes to support BMD and PavementME implementation in NH
- Develop a model to estimate longevity of different mixture and pavement types in NH. This in future can support on-going NHDOT AMPS effort on asset management performance models.
- Provide recommendations on how NHDOT can improve processes (e.g. mix design and material specifications)

The results of this research will help NHDOT better understand the performance of HMA mixes to enable more informed decisions by lowering life cycle costs and increasing service life and mix performance. The focus of the study will be on high volume Tier 1 and Tier 2 roadways, but the results will also be applicable to lower Tier roadways. It is anticipated that the research will result in some specification and/or mix design changes over a 2- to 4-year time frame. Also, this project builds upon, and uses results from, the work conducted under previous NHDOT Projects 15680R, 26962O, and 26962N. These projects conducted extensive testing of NHDOT mixtures along with some field performance data and also developed appropriate laboratory conditioning methods for HMA mixtures to simulate NH conditions.

D. Scope of Work

To address the objectives, this study will undertake the following major research tasks:

Task 1: Material and Data Selection and Sampling
The UNH research team will work with NHDOT to select mixtures from the 2025 and 2026 construction seasons for sampling. NHDOT will sample the mixtures at the plant and deliver sampled loose mixtures to the UNH labs, with the assistance of the research team. NHDOT will provide approved job mix formulas for all sampled mixtures to UNH. The research team will fabricate the test specimens from the sampled loose mixtures. NHDOT will fabricate and deliver gyratory specimens from the sampled 2024 construction season mixtures to the UNH labs, also providing the gyratory fabrication information for all specimens. NHDOT will provide pavement cross section information for the field placement of all mixtures included in the study, historic performance data that includes IRI, rutting, and cracking. NHDOT will collect additional IRI, rutting, and cracking data, and all relevant material test reports including binder testing and plant reports for field sections as may be needed for the purposes of the project.

Task 2: Testing
In this task, the UNH research team will conduct performance tests on approximately 30 mixtures sampled by NHDOT during the 2024, 2025, and 2026 construction seasons. Performance tests will include complex modulus for rheological characterization (AASHTO T 342) and to provide required inputs to PavementME and FlexPave, direct tension cyclic fatigue (DTCF) for fatigue properties (AASHTO T 400) and provide input to FlexPave, IDEAL-CT (ASTM D8044) and Semi-circular bending (SCB, I-FIT protocol, AASHTO T 393) for intermediate temperature fracture properties, and disk-shaped compact tension, DCT (ASTM D 7313) for low temperature fracture properties. Testing on the mixtures sampled during 2025 and 2026 will be conducted at two conditions: reheated and long-term aged at 95°C for 5-10 days (following method C of AASHTO R 121). The exact conditioning time and temperature will be selected in collaboration with NHDOT and following the results and aging model developed under the previous NHDOT aging project (Project No. 26962O). The test data will be analyzed to calculate properties and indices from each of the tests for analysis in subsequent tasks. Through this study, companion testing between NHDOT and UNH will be conducted using the IDEAL-CT and IDEAL-RT tests to support NHDOT's future balanced mix design implementation efforts

Task 3: Database Generation and Aging Condition Adjustment

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The data gathered from Task 1 will be combined with the data generated from the testing conducted in Task 2. All of the data will be organized into a database and outlier analysis conducted to provide organized data sets for further analysis in subsequent tasks. Mixtures with failing lab and/or binder tests will also be flagged.

Aging ratios for the range of test properties and indices will be determined for various families of mixtures (based on binder type) for the 2025 and 2026 mixtures as well as those tested under the previous NHDOT aging project. These will be used to estimate the values of the aged properties and indices that have not been directly measured in previous testing. The estimated values will be used in the analysis and model development in subsequent tasks.

Task 4: Correlation Analysis
This task will undertake data analysis to make statistical correlations between asphalt mixture lab measured performance properties, pavement field performance measures (IRI, rutting and cracking measures) and mix design attributes (binder grades, mix volumetric measures, aggregate gradations, design traffic levels etc.). Pavement structural attributes (layer types, layer thicknesses, traffic levels, subgrade type) will also be considered within the correlation analysis. Correlations will be conducted on data from both the unaged (reheated condition) and aged conditions, using estimated aged values as needed from Task 3.

Data analysis will employ statistical analyses techniques for hypothesis testing including correlation matrices (both linear and non-linear), Tukey's honestly significant difference and ANOVA testing. The scope of statistical analysis will consider the independent effect of each factor and interactive effects. This will be used to investigate the relationships between the mix performance properties and mix attributes (e.g. two-way interaction of different variables) and pavement in-service performance data, and further identify the most promising factors, or combination of factors, that show the strongest correlations with the available field performance. To do this, the Tukey's honestly significant difference and ANOVA testing as well as other significance analysis methods including F-ratio and Stepwise models will be employed. Then, the correlation matrices will be generated to explore the correlations/functions between the identified parameters and the pavement performance.

The parameters that show the strongest correlations with the pavement performance will be proposed as the mix performance indices from this project. It is anticipated that such performance index (or indices) will combine the lab measured performance properties with pavement structural attributes (and any other statistically significant parameter). In addition to accomplishing necessary steps to accomplish model development activities of Task 5, a tangible outcome of this task will be in the form of correlations between asphalt mix design attributes (binder grade, design traffic levels, mix volumetrics etc.) and the field performance. This will aid NHDOT in updating their asphalt mixture specifications to improve field performance.

Task 5. Model Development
This task is designated to develop a predictive model for the asphalt mixture lab measured performance properties, as well as the statistical model to effectively predict the pavement performance in the field using mix design attributes. Modelling will be conducted on data from both the unaged (reheated condition) and aged conditions, using estimated aged values as needed from Task 3. Clustering techniques will be adopted for development of the threshold values associated with the lab measured performance indices identified by the correlation analyses in Task 4. Probabilistic analyses will be employed to provide a measure of reliability and the allowable deviations from the threshold. This is critical to develop standard practice guidance whereby a risk estimate for false positives or false negatives is important for specifiers, designers, and contractors.

The statistical analyses conducted in Task 4 will be supplemented with an innovative method of using a machine learning (ML) framework to develop a model to effectively predict the pavement performance in the field. The approach consists of Principal Component Analysis (PCA), and suitable ML algorithms

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such as artificial neural network (ANN), full quadratic model (FQM) and Support Vector Machines (SVM). The PCA analysis will be used to identify the key mixture design information for determining the lab measured pavement performance indices. Then, the ML algorithms will be employed to use these important mix design variables to develop a model to predict the proposed performance indices. Furthermore, the correlation/functions between the performance indices and the pavement field performance as explored from Task 4 will be used as the "transfer function" to relate the predicted indices to actual pavement performance considering both cracking distress severity and quantity. The biggest advantage of this method is that the mixture cracking performance can be evaluated using the developed model a priori, without preparing specimens and conducting the performance tests. In addition, based on the evaluation results, NHDOT and construction contractors have the information to be able to adjust the important mix variables and re-run them through the model to meet the proposed threshold values and the desired field performance.

Simultaneously, a similar procedure as described above will be utilized to develop a predictive model for asphalt mixture complex modulus using mix design attributes as inputs. Dynamic modulus and phase angle mastercurve shape parameters will be used as the predicted variables in this effort.

Task 6. Model Validation
This effort will undertake validation of the models developed in Task 5 through independent laboratory testing of select mixtures to ensure reliability of the complex modulus predictive model as well as models for predicting lab measured performance properties (those that correlate best to field performance). It is anticipated that mixtures sampled and provided by NHDOT from the 2026 construction year will be used in this task.

Task 7. Reporting and Final Deliverables
Quarterly reports will be submitted through the duration of the project, interim progress reports will be submitted at regular intervals during the project and a final report summarizing and fully documenting the experimental, analysis, and modeling work will be prepared. The research team will also meet with NHDOT semi-annually to discuss progress and results and receive direct feedback and will also present the research progress and results at AASHTO and other professional meetings as requested by NHDOT at least twice during the project period.

The final deliverables for the project will include:

- Final Report presenting results, findings, and recommendations along with a 1-page Tech Brief and a poster.
- Formal presentation to NHDOT at conclusion of project
- Predictive model for complex modulus to support PavementME implementation
- Correlations between mix design attributes and mix performance properties as well as mix field performances to support specification updates
- Model to estimate serviceability and longevity of different mix and pavement types

E. Project Schedule

Tasks	2025										2026												2027							
	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
Task 1: Material and Data Selection and Sampling	■	■	■	■	■	■	■									■	■	■	■											
Task 2: Testing		■	■	■	■	■	■	■	■	■	■	■					■	■	■	■	■	■								
Task 3: Database Generation				■	■	■	■	■	■	■	■	■	■	■																
Task 4. Correlation Analysis											■	■	■	■	■	■														
Task 5. Model Development													■	■	■	■	■	■	■	■	■	■								
Task 6. Model Validation																							■	■	■	■	■			
Task 7. Reporting																														
Quarterly Reports			■			■			■			■			■			■			■			■			■			
Final Report																												■	■	■

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F. Budget and invoicing instructions

Budget Item	State Funding	Cost Share	Total
1. Salaries and Wages	152,569	0	152,569
2. Employee Fringe Benefits	6,047	0	6,047
3. Travel	2,000	0	2,000
4. Supplies and Services	16,000	0	16,000
5. Equipment	0	0	0
6. Tuition	48,179	0	48,179
7. Facilities & Admin Costs	61,815	0	61,815
Subtotals	286,610	0	286,610
Total Project Costs:			286,610

Campus will submit invoices to State on regular Campus invoice forms no more frequently than monthly and no less frequently than quarterly. Invoices will be based on actual project expenses incurred during the invoicing period, and shall show current and cumulative expenses by major cost categories as shown. State will pay Campus within 30 days of receipt of each invoice. State may withhold 10% of funds until receipt of the accepted final report. Campus will submit its final invoice not later than 60 days after the Project Period end date.

G. Expected Benefits / Implementation

The proposed study directly addresses the FHWA high-priority goal of enhancing the sustainability and resilience of transportation systems. Additionally, it will help NHDOT continue to improve their network performance/condition by decreasing life cycle costs and performing less frequent maintenance and rehabilitations. Improved ride quality will result in decreased fuel costs for users. Changes in specifications and mixture design processes are expected to be implemented as a result of this research.

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EXHIBIT B

This Project Agreement is funded under a Grant/Contract/Cooperative Agreement to State from the Federal sponsor specified in Project Agreement article F. All applicable requirements, regulations, provisions, terms and conditions of this Federal Grant/Contract/Cooperative Agreement are hereby adopted in full force and effect to the relationship between State and Campus, except that wherever such requirements, regulations, provisions and terms and conditions differ for INSTITUTIONS OF HIGHER EDUCATION, the appropriate requirements should be substituted (e.g., OMB Circulars A-21 and A-110, rather than OMB Circulars A-87 and A-102). References to Contractor or Recipient in the Federal language will be taken to mean Campus; references to the Government or Federal Awarding Agency will be taken to mean Government/Federal Awarding Agency or State or both, as appropriate.

Special Federal provisions are listed here: ☐ None or **X Uniform Guidance issued by the Office of Management and Budget (OMB) in lieu of Circulars listed in paragraph above.**

Campus Authorized Official DH
Date 2/26/25