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New Hampshire DOT
Department of Transportation

THE STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION

Victoria F. Sheehan
Commissioner

William Cass, P.E.
Assistant Commissioner

Bureau of Materials & Research
March 5, 2019

His Excellency, Governor Christopher T. Sununu
and the Honorable Council
State House
Concord, New Hampshire 03301

REQUESTED ACTION

1. Authorize the Department of Transportation to enter into a **SOLE SOURCE** Cooperative Project Agreement with the University of New Hampshire Sponsored Programs Administration (vendor 177867), Durham, New Hampshire, for a fee not to exceed $99,970.00 for a cooperative observation and evaluation of a natural instream structures to replace conventional armoring solutions, effective upon Governor and Council approval through April 30, 2022. 100% Federal Funds.

2. Authorize the Department of Transportation to enter into a **SOLE SOURCE** Cooperative Project Agreement with the University of New Hampshire Sponsored Programs Administration (vendor 177867), Durham, New Hampshire, for a fee not to exceed $74,552.00 for a cooperative investigation to understand the hydraulic consequences of embedded culverts, effective upon Governor and Council approval through April 30, 2021. 100% Federal Funds.

Funding is available as follows for FY 2019 and is contingent upon the availability and continued appropriation of funds in FY 2020, FY 2021 and FY 2022, with the ability to adjust encumbrances through the Budget Office between State Fiscal Years if needed and justified:

04-96-96-962015-3036	FY 2019	FY 2020	FY2021	FY 2022
SPR Research Funds				
046-500464 General Consultants Non-Benefit	$122,166.00	$26,178.00	$21,178.00	$5,000.00

EXPLANATION

The following two (2) research studies will each address an immediate Department need, are unique to New Hampshire's environment and conditions, thereby requiring substantial local experience and are directly aligned with a particular area of University expertise. In addition, the Principal Investigator is a nationally recognized expert in his respective 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.

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) is a long-standing

cooperative relationship of 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 such improved pavement design, increased use of recycled materials, stormwater management evaluation, and rapid construction techniques.

Statewide-SPR 26962W, Log Jam Monitoring

The Department is collaborating with the University of New Hampshire (UNH) to conduct a cooperative research study, "Log Jam Monitoring", to document all salient aspects of engineered log jams relative to road planning, design, permitting, construction and maintenance. In addition, to document stream system changes resulting from the engineered log jam. This project is expected to identifying the benefits of natural instream structures to replace conventional armoring solutions which could result in significant cost savings on similar DOT projects for a total fee not to exceed $99,970.00 effective upon Governor and Council approval though April 30, 2022.

Statewide-SPR 26962Y, Assessment of Embedded Culvert Low Flow Hydraulics

The Department is collaborating with the University of New Hampshire (UNH) to conduct a cooperative research study, "Assessment of Embedded Culvert Low Flow Hydraulics", to understand the hydraulic consequences of embedded culverts, assess if traditional designs result in loss of aquatic organism passage via too porous sediments and synthesize current knowledge of embedment designs. This project is expected to provide information to modify design protocols to avoid such an undesirable consequence for a total fee not to exceed $74,552.00 effective upon Governor and Council approval though April 30, 2021.

These two (2) Agreements have been approved by the Attorney General as to form and execution. Copies of the fully-executed Agreements 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.

This project funding is 80% Federal Funds with 20% state match. Turnpike toll credit is being utilized for match requirements, effectively using 100% Federal Funds.

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

Sincerely,

Victoria F. Sheehan

Victoria F. Sheehan
Commissioner

Attachments

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 **4/30/22**. 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: **Log Jam Monitoring (SPR Project # 26962W)**

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: Ann Scholz	Name: Cheryl Moore
Address: NHDOT Bureau of Materials & Research 5 Hazen Dr. PO Box 483 Concord, NH 03302-0483	Address: University of New Hampshire Sponsored Programs Administration 51 College Rd. Rm 116 Durham, NH 03824
Phone: 603 271-1659	Phone: 603-862-1992

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: Tobey Reynolds	Name: Dr. Thomas Ballestero
Address: NHDOT Bureau of Highway Design 7 Hazen Drive, PO Box 483 Concord, NH 03302-0483	Address: University of New Hampshire Gregg Hall, Room 238 Colovos Road Durham, NH 03824603 862-1405
Phone: 603 271-7421	Phone:

Campus Authorized Official KS
Date 2/28/19

F. Total State funds in the amount of **$99,970** 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 Federal Highway Administration** 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: Karen M. Jensen
Title: Manager, Sponsored Programs Administration
Signature and Date: 2/28/19

By An Authorized Official of:
Department of Transportation
Name: Peter E. Stamnas
Title: Director of Project Development
Signature and Date: 3/13/19

By An Authorized Official of: the New Hampshire Office of the Attorney General
Name: EMILY C. GOERING
Title: Assistant Attorney General
Signature and Date: 4/4/19

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

Campus Authorized Official KS
Date 2/28/19

EXHIBIT A

A. Project Title: Log Jam Monitoring (SPR Project # 26962W)

B. Project Period: Upon Governor and Council approval - 04/30/2022

C. Objectives:

Introduction

Many roads and highways exist close to streams that exhibit lateral instability (bank erosion). Conventional practices are to armor such locations (rip ap, concrete, sheet pile), and these solutions: are expensive, do not provide ecosystem value, and result in high mitigation fees. Natural channel design structures, such as engineered log jams, offer a greener, less expensive alternative to armor solutions. Route 16 in Errol, NH (locally known as Dam Road) is an example. Extreme bank erosion along the Magalloway River requires road relocation and streambank stabilization. An engineered log jam has been proposed at the site and is to be constructed during the summer 2019. This is the first NH DOT such installation. Identifying the benefits of natural instream structures to replace conventional armoring solutions could result in significant cost savings on similar DOT projects. For the project in Errol, streambank and channel impact mitigation costs are eliminated with the selection of the engineered log jam solution. Had conventional armoring been selected for this project, bank and channel impact mitigation costs were estimated to be $101,000. At this writing, there is no demonstrated and documented information about engineered log jam solutions in New Hampshire, and although employed in the Pacific northwest, there is very limited information nationally as well.

Objective

A three-year project is proposed that includes eight months of pre-construction monitoring and two years of post-construction monitoring. Monitoring is broken into the following facets: hydraulic, structural, flora, and fauna. In addition, the monitoring provides inspection information to DOT to assess any need for maintenance or repairs. The research objective is to document all salient aspects of engineered log jams relative to road planning, design, permitting, construction, and maintenance. In addition, to document stream system changes resulting from the engineered log jam.

D. Scope of Work: The the Scope of Work involves the following:

Kick off meetings and information gathering
Set-up monitoring controls and equipment; site survey; sample bank material; synthesize field data
As-built survey
Year 2 and 3 site monitoring
Report on site conditions and effects of log jam

Kick off meetings and information gathering will start with a meeting of the project Technical Advisory Group (TAG). The TAG membership will include professionals from UNH, NHF&G, NH DOT, and NHDES. If NH DOT believes that federal partners (COE, NOAA, EPA, etc.) should be included in the TAG, an invitation to those agencies can certainly be extended. This meeting will: review project objectives; describe the log jam design; and discuss the monitoring strategy. In conjunction with the TAG, a universe of monitoring variables will be developed and then winnowed to those most appropriate to understand the stability of the log jam itself as well as its ability to

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eliminate bank erosion. Associated with the streambank stability at the Route 16 project site is understanding if the log jam moved streambank attack to a different location. Existing site information and designs will be secured from NH DOT. Monitoring data gaps will be explored, for example bank geometry, particle size distribution, and stability index. A subsequent meeting will be held with NHF&G to identify target species (if any) and how best to monitor for such species as they relate to the log jam. Site hydrology will be collected including upstream and downstream dam operational information.

Year 1 set-up of monitoring controls and equipment; site survey; sample bank material; synthesize field data this is to execute field implementation of the monitoring network and capture pre-construction information. This will be performed in the first year of the project. Unless already established by NHDOT as part of the Route 16 relocation design, local benchmarks will be established (x, y, z coordinates) with which to tie field measurements. Bank and river geometry (above and below the waterline). Above the waterline, topography will be developed from LiDAR products available in GRANIT or conventional topographic surveying techniques. Below the waterline, bathymetry will be measured with an automated boat-mounted sonar system (Zego Boat survey system). This system includes, a 14-foot vessel equipped with the hydrographic survey equipment of a 240 kHz Imagenex Delta-T multibeam sonar and Applanix 320 POS-MV GPS-aided inertial measurement system. The bathymetric surveys will be conducted with approximately 20-50 cm horizontal resolution and are accurate to about +/- 10 cm vertical resolution (depending on the nature of the substrate). A GPS reference base station will be deployed during each survey for differential corrections necessary for improving the accuracy of the GPS data to survey grade quality. Digital elevation maps will be constructed with custom post-processing software.

Bank erosion pins will be installed near and away from the log jam, and at the same time streambank soil samples collected for subsequent particle size distribution analysis. These analyses will be performed at/proximal to the location of the engineered log jam as well as nearby at a "reference" location where there is also bank erosion but away from the effects of the log jam. The reference site is to be used to compare not only the effectiveness of the log jam to arrest bank erosion, but also its role as habitat. Above and below water trail cameras will be deployed to monitor how species interact with the log jam. The trail cameras will also provide construction images to be used for more long-term assessments of log jam and streambank stability. Current measurements will be taken at various location in the reach at and near the log jam with a Vectrino profiler and an electromagnetic current gage.

As-built survey-in coordination with NHDOT efforts, UNH will take field measurements like those above, within 3 months after the log jam construction is completed. Depending on NHDOT as-built measurements, there may not be as much effort by UNH to get above or below water topographic information. Below-water trail cameras will additionally be located on the log jam itself.

Two winter trips are planned to assess the effects of ice on the log jam as well as at the reference site.

Years 2 and 3 site monitoring-In months 12-15 and 20 - 23 after completion of the log jam, additional above and below water geometry will be taken. Routinely, it is estimated that every 3 – 4 months, trail camera SD cards will be replaced, and images downloaded and catalogued. Erosion pins will be read annually. One trip each winter are planned to assess the effects of ice on the log jam as well as at the reference site.

A TAG meeting will be planned for spring of the second year (2020), to review data to date and solicit the TAG for input or suggestions on data collection or the monitoring network.

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Report on site conditions and effects of log jam. The last item will be to synthesize all collected field data to address the fundamental questions of log jam and bank stabilities. The topographic (above and below water) data will be compared for each snapshot in time into depictions of geometric changes (erosion or deposition), along the reach of river that includes the log jam and the reference site. In addition, comparisons will be made of habitat use, especially between the log jam and reference sites. Erosion pin data will be very site specific erosion rates that may then be compared to the more large scale topographic maps.
Another TAG meeting will be planned to present the project results to the TAG and obtain feedback/comments.

Guidance will be proposed on improvements to engineered log jams in New Hampshire and their potential at other NH DOT sites. This will then lead to design specifications and recommended inspection, maintenance, and monitoring protocols. In the long term UNH will assist NHDOT in using this site as a demonstration site for professionals, municipal officials, and agency personnel.

D. **Deliverables Schedule:**

Date	Deliverable
Spring 2019	Kickoff TAG meeting
September 2019	Quarterly Report 1
December 2019	Quarterly Report 2
March 2020	Quarterly Report 3
May 2020	TAG meeting
June 2020	Quarterly Report 4
September 2020	Quarterly Report 5
December 2020	Quarterly Report 6
March 2021	Quarterly Report 7
May 2021	TAG meeting
June 2021	Quarterly Report 8
September 2021	Quarterly Report 9
December 2021	Quarterly Report 10
March 2022	DRAFT Final Report and TAG meeting
April 2022	Final Report, one-page project brief and poster will be prepared for the NHDOT website.

F. **Budget and Invoicing Instructions:** 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. State will pay Campus within 30 days of receipt of each invoice. Campus will submit its final invoice not later than 60 days after the Project Period end date. State may withhold 10% of funds until receipt of final report form Campus. State will provide final payment within 30 days of receipt of the accepted final report.

Campus Authorized Official KS
Date 2/28/19

Budget Items	State Funding	Cost Sharing	Total
1. Salaries & Wages	55,300	0	55,300
2. Employee Fringe Benefits	8,041	0	8,041
3. Travel	4,900	0	4,900
4. Supplies and Services	11,100	0	11,100
5. Equipment	0	0	0
6. Facilities & Admin Costs	20,629	0	20,629
Subtotals	99,970	0	99,970
In Kind Contribution		0	0
Total Project Costs:			99,970

Campus Authorized Official KS
Date 2/28/19

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 **Uniform Guidance issued by the Office of Management and Budget (OMB) in lieu of Circulars listed in paragraph above.** .

Campus Authorized Official KS
Date 2/28/19

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 **4/30/21**. 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: **Assessment of Embedded Culvert Low Flow Hydraulics (SPR Project # 26962Y)**

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: Ann Scholz	Name: Cheryl Moore
Address: NHDOT Bureau of Materials & Research 5 Hazen /drive PO Box 483 Concord, NH 03302-0483	Address: University of New Hampshire Sponsored Programs Administration 51 College Rd. Rm 116 Durham, NH 03824
Phone: 603-271-1659	Phone: 603-862-1992

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: Kirk Mudgett	Name: Dr. Thomas Ballestro
Address: NHDOT Bureau of Highway Design 7 Hazen Drive, PO Box 483 Concord, NH 03302-0483	Address: University of New Hampshire Gregg Hall, Room 238 Colovos Road Durham, NH 03824
Phone: 603 271-1598	Phone: 603 862-1405

Campus Authorized Official KJ
Date 2/28/19

F. Total State funds in the amount of **$74,552** 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 Federal Highway Administration**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: Karen M. Jensen
Title: Manager, Sponsored Programs Administration
Signature and Date: 2/28/19

By An Authorized Official of:
Department of Transportation
Name: Peter E. Stamnas
Title: Director of Project Development
Signature and Date: 3/13/19

By An Authorized Official of: the New Hampshire Office of the Attorney General
Name: EMILY C. GOETZINGER
Title: Assistant Attorney General
Signature and Date: Emily C. Goetzinger 4/4/19

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

Campus Authorized Official KJ
Date 2/28/19

EXHIBIT A

A. Project Title: Assessment of Embedded Culvert Low Flow Hydraulics (SPR Project # 26962Y)

B. Project Period: Upon Governor and Council approval through 04/30/2021

C. Objectives: Introduction

In 2010, New Hampshire adopted new rules for the permitting of stream crossings. One aspect is that new culverts should have natural materials located at the stream bed to better accommodate the passage of aquatic and other organisms. Geomorphically-designed embedded culverts are in general more resilient to climate change and also are intended to provide aquatic organism passage. In culverts that are not open bottom, for example a circular concrete pipe, this means oversizing the culvert and then partially filling the bottom with natural material (sands/gravels/rock) thereby essentially burying the bottom of the culvert. This partially in-filled culvert is known as an embedded culvert. Often the material placed in the embedded culvert is specifically sized to match the native material in the stream as well as to be stable. This can result in very coarse sediments placed in the culvert that exhibit high porosity and permeability. As such, at low flows water can completely disappear into these sediments leaving no aquatic habitat: a dry streambed makes it impossible for fish to move upstream or downstream. Thus, while culverts are recommended to be embedded, the practice is criticized for its impact on aquatic habitat.

Objectives

The objectives of this research are to: understand the hydraulic consequences of embedded culverts; assess if traditional designs result in loss of aquatic organism passage via too porous sediments; synthesize current knowledge of embedment designs, and modify design protocols to avoid such an undesirable consequence.

D. Scope of Work:

The proposed research has two fundamental thrusts: to field study constructed embedded culverts in NH, and a thorough literature review. The project will begin with a TAG kickoff meeting to provide context for the study and to fine tune the scope. The office portion of the research will begin with the literature review. Lines of communication (phone, e-mail) will also be opened with regulating entities in other states (in neighboring states and Pacific northwest and Alaska) to solicit their experiences with embedded culverts. This will include gathering design specifications from those jurisdictions. The research team will also collect and sift through the technical guidance documents for other states, FHWA, and countries and compare to NH guidance. The construction community will be interviewed to determine if there are limitations in the supply or placement of the embedment material available in New Hampshire. NH DOT will provide a list of its embedded culverts and NH DES can augment the list with permitted and constructed non-DOT structures. NH DOT personnel will be interviewed to determine where they have installed embedded culverts and to collect their design plans. The NHDES permit database will also be searched for all embedded culverts installed in New Hampshire. The embedded culverts from the DOT and DES sources will all be targeted for field visits. Knowledge of the location of each culvert will allow investigation into watershed and hydrologic characteristics at the site of each culvert. These characteristics will be documented via online resources such as StreamStats and GRANIT. The DOT and DES culvert databases will also yield embedded culvert metadata such as: year constructed, embedment particles size distribution, embedment depth, etc.

Campus Authorized Official KS
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For the field assessment portion of the research, all identified constructed embedded culverts will be inspected. Bed sediments will be sampled for particle size distribution analysis. Embedment depth will be measured. If possible, culverts will be visited at low flows to assess permeability and loss of above ground streamflow. The bed sediment particle size distribution and depth of infill at the time of inspection will be compared to that of the design. Aquatic organism passage will be assessed using standard geometric indicators as well as field observations at low flows.

Embedded culverts that demonstrate lack of infill imbrication and/or loss of aboveground flow will be forensically studied to determine: the fundamental nature for the lack of intended performance; the designs facets leading to this performance; and potential remedies. One interesting aspect will be to understand if there is a "maturing" phase necessary for the infilled sediments to ultimately perform as natural stream sediments, where finer sediments ultimately clog large pores and inhibit the loss of surface waters.

All research results, office and field, will be presented to the TAG and documented in a final report. Findings will also be presented to a meeting of appropriate NH DOT and NHDES personnel involved with culverts.

E. **Deliverables Schedule:** Project work products will be submitted in compliance with the following Table. Expected Project start date is following Governor and Council approval (Spring 2019). A two-year project timeline is envisioned. Office efforts may be completed year-round, whereas field efforts will be constrained to May through October.

Date	Deliverable
Spring 2019	Kickoff TAG meeting
September 2019	Quarterly Report (if applicable)
December 2019	Quarterly Report
March 2020	Quarterly Report
May 2020	TAG meeting
June 2020	Quarterly Report
September 2019	Quarterly Report
December 2020	Quarterly Report
March 2021	DRAFT Final Report
March 2021	Final TAG meeting, one-page project tech brief, and poster will be prepared for the NHDOT website.

F. **Budget and Invoicing Instructions:** 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. State will pay Campus within 30 days of receipt of each invoice. Campus will submit its final invoice not later than 60 days after the Project Period end date. State may withhold 10% of funds until receipt of final report from UNH. State will provide final payment within 30 days of receipt of the accepted final report, poster, and technical fact sheet.

Campus Authorized Official [signature]
Date 2/28/19

Budget Items	State Funding	Cost Sharing	Total
1. Salaries & Wages	48,720	0	48,720
2. Employee Fringe Benefits	7,648	0	7,648
3. Travel	1,200	0	1,200
4. Supplies and Services	1,600	0	1,600
5. Equipment	0	0	0
6. Facilities & Admin Costs	15,384	0	15,384
Subtotals	74,552	0	74,552
In Kind Contribution		0	0
Total Project Costs:	74,552	0	74,552

Campus Authorized Official

Date 2/28/19

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 **Uniform Guidance issued by the Office of Management and Budget (OMB) in lieu of Circulars listed in paragraph above.** .

Campus Authorized Official KS
Date 2/28/19