



The NAU Pine Project



GREEN FUND

Sustainability Through Student Innovation

Green Fund Mission Statement: “The NAU Green Fund promotes student participation in and provides funding for projects that reduce NAU’s negative impact on the environment and create a culture of sustainability on campus.”

Requirements for Funding:

- The project must be implemented on campus.
- The person submitting the project must be an NAU student, faculty, or staff member.
- Projects must provide all necessary documents, letters of support, and authorizations prior to submission.
- The Green Fund distributes funding on a **reimbursement basis**. Project teams should partner with an administrative office to provide upfront funding for the project. Once the project has been successfully completed, the Green Fund will reimburse the administrative partner.
- All project applications should be submitted to greenfund@nau.edu for review.

Disclaimer: All applications will go through a comprehensive vetting process. We highly recommend meeting with a Green Fund Committee member prior to submitting the application. The Green Fund Committee member will assist you with every step of writing your project application. If your project is approved, you may be asked to provide more detailed information regarding specific deliverables. The Green Fund is not responsible for acquiring the necessary permits, permissions, or approvals for a project, although we are happy to assist with this process if needed. Additionally, the Green Fund does not provide any ongoing maintenance costs. A sponsoring department must take responsibility for operations and management.

Review Process: Upon project application submission, the Green Fund will review your project within two weeks. At this time, the Green Fund will provide comments on the project. Incomplete applications will not be reviewed until all components are submitted. **Note:** The Green Fund Committee only meets during the academic year. All projects submitted outside of the regular academic year will be reviewed at the start of the next academic session.

Contact Information

Project name: The NAU Pine Project

Project Advisor Name: Curtis Smith / 928-523-5526 / curtis.smith@nau.edu

Project Advisor Name: Denielle Perry / 928.523.0361 / denielle.perry@nau.edu

Project leader: Matthew Derminio / 760.214.7230 / mjd382@nau.edu

Project Assistant: Ethan Hurtz / 443.223.8843 / eh627@nau.edu

Project Assistant: Ian Hall / 928.853.7192 / ikh2@nau.edu

Project Assistant: Jack Lewis / 928.449.1017 / jrl396@nau.edu

Sponsoring Department: School of Earth and Sustainability

Funding Provided by: College of the Environment, Forestry, and Natural Sciences

Project Overview

Executive Summary

Please provide a brief overview of your proposal. Please address how this project will support the goals of the Green Fund (student involvement, creating a culture of sustainability, and lessening NAU's impact):

The **NAU Pine Project** is a student-led project focused on how *Biodesigned* materials can assist in transitioning from a circular to a regenerative and even restorative economy by creating sustainably manufactured cost-competitive materials. *Biodesign*, an interdisciplinary field, operates at the intersection of science, technology, design, and society. The **NAU Pine Project** is not only focused on developing eco-friendly materials but also is meant to inform and inspire students, faculty, and the general public about the potential impacts of such climate stabilizing technology and the role each person can play. From the genesis of the project, a cradle-to-grave life cycle assessment of the **NAU Pine Project's** environmental impacts will be cataloged to show the lessening environmental impact of using perceived waste to create viable products that are locally sourced with minimal to no fossil fuel inputs to exponentially decrease carbon emissions.

Please answer the following questions detailing the components of your project:

- 1) Does your project require space or construction on campus? **Yes** If so, where?

The **NAU Pine Project** will not require space on campus for the research or construction. Once completed the results (furniture and planter beds) will be installed between Bldg 19 and 20 in the Atrium Garden which has been approved by the project lead, Dr. Perry.

- 2) Have you obtained all necessary approvals for this project? Please attach all **letters of support** to this application. Letters of support should include confirmation from the sponsoring department that the sponsoring department will cover all upfront expenses and work with the Green Fund Business Manager to acquire reimbursement after project completion. If any ongoing operations and maintenance are required of your project, provide a letter of support from the entity that will be covering those costs and/or services.

The **NAU Pine Project** is focused to work in harmony with the Secret Atrium Garden Project lead by Denielle Perry. After the NAU Pine Project is successfully completed and the furniture is installed into this space then it can be applied to other areas on campus.

- 3) Will this project provide funding for student wages?

Yes, a portion of the funds, \$8,000.00, will be paid to the undergraduate students working on the project. The justification for this expense is the necessary labor and time the students will invests in this project to successfully complete the NAU Pine Project in the projected time.

Each student will be compensated \$12.15 USD per hours in accordance with the NAU Student Employment Handbook. The anticipated hour per week over the remainder of the semester (roughly eight weeks) is 20-21 hours per week by each of the four undergraduate students involved. The sum of the labor costs is \$2,000.00 per student multiplied by four totaling in \$8,000.00. These projected labor expenses are cautious to ensure enough assistance will be available to complete the project in the specified timeline. Once the NAU Pine Project is operational labor hours may be modified as needed. The students will only be paid for hours they have worked and logged. Any savings will be returned to the sponsoring department and the budget will reflect such activity.

- 4) Please list all additional sources of funding you have pursued. Include departments, grants.

N/A

- 5) Have any of the Green Fund Committee members been involved in this project? a. If Yes, please identify all committee members:

N/A

Project Specifics

Please address the following questions. One or more of these questions may not apply to your particular application. Answer as many questions as are applicable to your project.

Relationship to NAU Climate Action Plan (CAP)

- How does your project align with one of the seven CAP categories (Energy, Water, Transportation, Waste Minimization, Sustainable Landscaping, Environmental Justice, Communication)?

The **NAU Pine Project** aims to develop sustainably manufactured 100% bio-based building materials for landscaping purposes. The process of developing this material will minimize waste by repurposing pine needles as filler in a 100% bio-based composite. The methods used to examine the lifecycle of a product from cradle to grave adhere to environmental justice practices.

Community

- Is there a public outreach plan? How will faculty, staff, and students learn about this? Once the space is complete, we will send a news briefing to NAU via the Green Flash and NAU News to let people know it exists.

The outdoor furniture in the Atrium Garden will function as an installation with an information card provided to inform viewers about the **NAU Pine Project**. The research project will be documented and data cataloged for digital dissemination through platforms like YouTube and Instagram. Potentially partnering with Terra Birds and other local organizations and the city of Flagstaff to retrofit existing furniture, planter beds, and other items with this sustainable eco-friendly building material.

- Are you working with other groups on or off campus? If so, describe your partnership.

I am collaborating with a local plastic recycling company called AZ Custom Plastics who has collaborated with Regen Consulting Services to allow me to modify machinery and repurpose it for this project. Regen Consulting Services owns the machinery and is advising and assisting with the long-term application potential of this novel material. Each of the companies is based in Flagstaff, AZ and are invested in the growth of our community.

Project Parameters

- What are the environmental cost and benefits associated with your project?

NAU has an abundance of pine needles behind the facility service building on south campus minimal transportation will be required decreasing gas emissions. Repurposing a perceived waste product into a viable product adheres to circular/regenerative economic models. Utilizing local materials to manufacture local products for local solutions decreases shipping/transportation cost and emissions. Pine needles are a major contributing factor to the rapid spread and ferocity of wildfires by utilizing repurposing pine needles the potential for decreasing wildfires grows and collaboration with the forest service, independent environmental groups, and indigenous community, to gather pine needles, decrease potential wildfires and possible bring income to rural areas is this venture grows into a scalable.

- Provide an economic cost/benefit analysis for your project. Focus on identifying specific costs savings.

Pine Needles are a perceived waste product, repurposing a waste product into a viable product offer potential to generate income on material gather. Opposed to traditional purchasing of materials for composites materials, repurposing waste offers the economic benefit from the earliest phases. Nearly all tools and machines are being donated to the NAU Pine Project free of charge. AZ Custom Plastics and Regen Consulting Services have offered machinery and the project leader is proving all other tools. The projected expenses for material development and manufacturing are low, and the application potential is diverse. Possible application are roof shingles, exterior wall tiles or siding, floor tiles, exterior and interior furniture, and more.

- Is this a one-time expense or will you require future funding?

Yes, this is a one-time expense.

- When your project members no longer attend NAU, who will be responsible for running the project?

At the conclusion of the spring 2022 semester the NAU Pine Project will reach its conclusion. The outdoor furniture will not need maintenance, but will be monitored along with the entire atrium garden by the ENV 181 course as part of their curriculum.

- How will you monitor the impact of your project after implementation?

Since the outdoor furniture will be monitored along with the entire Atrium Garden by the ENV 181 course as part of their curriculum.

An abstract of the project's goals, expected results, and broader impacts to the NAU campus community; 200-300 words.

The NAU Pine Project will identify and evaluate the feasibility and application of a 100% bio-based renewable alternative building material. The purpose of the project is to develop a viable 100% bio-based building material for NAU to use, specifically in the new Atrium Secret Garden project, in the form of outdoor furniture (NAU Green Fund Approved project in 2022.) The broader potential implications of this *Biodesign* project to the NAU campus and greater community at large include utilizing this material/product across campus to retrofit existing outdoor furniture, roof tiles, exterior wall tiles, interior wall tiles, floor coverings, countertops, and outdoor decking.

From the genesis of the project, a cradle-to-grave life cycle assessment of the **NAU Pine Project's** environmental impacts will be cataloged. We will analyze the energy, resource input, and emission output from material harvesting, manufacturing, distribution, and disposal. Cataloging this information will reflect the benefit of utilizing local renewable material to develop solutions to address regional issues of wildfires and provide a cost competitive construction material with a fraction of the carbon emissions compared to standard supplies.

Detailed project proposal (1-2 pages), with specific information about current literature, research goals, methods, and how this research will improve sustainability at NAU.

Over the last year there has been increasing problems in the economy: material cost increase, massive supply chain disruptions, and a severe shortage in building materials. From lumber to steel, traditional construction materials have been outsourced from other national and international economies for decades. The outsourcing of building supplies adds additional steps to production, thereby increasing carbon emissions while draining support from local economies. Additionally, with oil prices continuously increasing, climate change, and other natural resources

diminishing, making locally sourced materials that feed into local economies are needed now more than ever. Solutions can be found in an emerging industry called *Biodesign*; an interdisciplinary field operating at the intersection of science, technology, design, and society. Recent technological advances have allowed material scientists and designers to harness the self-replicating manufacturing systems existing in organisms like algae, bacteria, yeast, and fungi to grow alternative products. From organic textiles to concrete substitutes, organic bio-based materials reduce carbon emissions and minimize waste destined for landfills. Many biobased materials can be added to a compost pile at the end of life and add beneficial nutrients to the soil demonstrating the regenerative properties of these types of products.

Northern Arizona University is located in the largest ponderosa pine forest in the world and few options have been found for utilizing pine needles as a viable product or resource. With construction materials having large environmental footprints, damaging toxins, and supply shortages, alternatives are needed and pine needles can be just that. Additionally, with forest fires being a persistent threat in northern Arizona communities, turning pine needles into a climate-positive solution can be both sustainable and lucrative; cleaning the forest floor, the potential severity of wildfires is decreased, reducing carbon emissions and simultaneously giving this potentially hazardous waste value.

From an economic perspective, the advantages of manufacturing plant-based composites from pine needles have relatively low costs while providing the desired functional properties. Plant-based composites can be manufactured by the existing machinery and significantly decrease the environmental impacts and footprint compared to lumber and fossil fuel plastics. By reducing the number of virgin resources used for NAU construction and remodels, the university can be a leader in regenerative and innovative design practices.

Current Literature

According to a study conducted by North Carolina State University “For the needles, thermogravimetric analysis (TGA) and TGA/Fourier transform infrared spectroscopy (TGA/FTIR) were performed to investigate their structures and thermal resistance, as required for the composite processing methods.” (Barton-Pudlik, 2016). This study used polypropylene (a type of plastic) and ethylene-propylene as the binding material for the composite. A bio-based resin has been found and is made by Entropy Resins that test very similar to polypropylene. Therefore, the data gathered by the NC State is very applicable to the **NAU Pine Project**. The tensile strength, water absorption, and microscopic analysis results from the tests conducted by NC State show that pine needles tested the best across the board. The metric used in this study will be the basis for **The Pine Projects** experiments that will use the resin binder.

Research Goals

Northern Arizona University is known for being a pioneer in environmental and sustainable studies. Ideas like the **NAU Pine Project** can help pave the way to the commercialization and integration of climate stabilizing technology and inspire future students to continue this necessary work. Sharing this knowledge through digital platforms to bring awareness to the industry of *Biodesign* and how it can help transition our society from a degenerative, extractive culture into a regenerative, circular one.

Another goal of the project is to find local solutions to global problems by utilizing native, natural, and organic resources. The final goal of the project is to develop functional prototypes for furniture and garden planters that can be applied to a variety of future NAU facilities and landscaping projects. The **NAU Pine Project** addresses the growing global

environmental challenges and can create many economic opportunities locally in the sustainable bio-based material sector.

Methods

The research methods for this project are influenced by the Material Driven Design Method, which seeks to understand the technical characteristics of a proposed material. Through testing the material characteristics, the observer can then understand the potential applications of the material.

The **NAU Pine Project** will consist of harvesting pine needles from the NAU recycle complex which the city generously adds to. Shredding pine needles into varying sizes, making molds in different dimensions to be filled with the pine needle particles and cast with epoxy resins a biobased epoxy in the molds. Test will be conducted to understand functional differences and material properties.

AZ Custom Plastics and Regen Consulting Services, local business have approved usage for The **NAU Pine Project** to use a small-scale plastic shredding machine designed to work symbiotically with a thermoforming compression machine. These tools were originally designed for plastic production, but recently have been converted to assist in the manufacturing of bio-based composite. The provided mold can make sheets of composite material sized at 8.5 inches by 11 inches and 3.5 millimeters thick.

Questionnaire

1. How will your research benefit the mission statement of the Green Fund and improve sustainability on NAU's campus?

The **NAU Pine Project** will benefit the mission statement of the Green Fund by developing and eco-friendly materials, inform and inspire students, faculty, and the general public about the potential impacts of such climate stabilizing technology and the role each person can play. From the genesis of the project, a cradle-to-grave life cycle assessment of the **NAU Pine Project's** environmental impacts will be cataloged to show the lessening environmental impact of using perceived waste to create viable products, that are locally sourced using minimally to no fossil fuel inputs to exponentially decrease carbon emissions. The potential insulation applications across campus are vast only starting with landscaping function and could complete substitute for the need for traditional lumber building materials.

2. Will your research require the utilization of any spaces or infrastructure on campus? If so, identify the specific locations and/or infrastructure, how much of the space you require, and what each space will be used for.

The NAU Pine Project will not require space on campus for the research or construction. Once completed the results (furniture and planter beds) will be installed between Bldg 19 and 20 in the Atrium Garden which has been approved by the project lead, Dr. Perry.

3. Will other departments on campus (other than your own) be needed to assist in this project (i.e. Facility Services, Campus Transit)? If so, identify department partnerships.

N/A

Project Budget

Please respond to the following funding question, and complete a thorough breakdown of all project costs in the provided Line Item Budget below. **Include a 5% line item for contingency.**

1. Does this project have any other sources of funding, and/or have you applied for other sources of funding? If so, list all additional sources of funding, both confirmed and potential, outside of the funds being requested from the Green Fund.

Sponsoring Department: School of Earth and Sustainability

Funding Provided by: College of the Environment, Forestry, and Natural Sciences

Item	Price	Quantity	Total
Entropy Resin 15 gallon + Creator's accessory kit	\$1,186.00	4	\$4,744.00+ tax
Labor – Student	\$2,000.00	4	\$8,000.00
Mold supplies	\$3,000.00	---	\$3,000.00 + tax
Contingency	5%	---	\$787.20
Tax	--	---	\$568.00
Total Expenses	--	--	\$17,099.22

Explanation of labor cost - Each student will be compensated \$12.15 USD per hours in accordance with the NAU Student Employment Handbook. The anticipated hour per week over the remainder of the semester (roughly eight weeks) is 20-21 hours per week by each of the four undergraduate students involved. The sum of the labor costs is \$2,000.00 per student multiplied by four totaling in \$8,000.00. These projected labor expenses are cautious to ensure enough assistance will be available to complete the project in the specified timeline. Once the NAU Pine Project is operational labor hours may be modified as needed. The students will only be paid for hours they have worked and logged. Any savings will be returned to the sponsoring department and the budget will reflect such activity.

Project Timeline

The **NAU Pine Project** is projected to be completed by the end of the spring 2022 school semester. Hours will be logged on the table below to record the student's labor per phase.

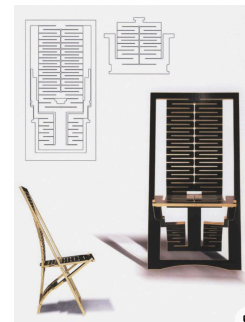
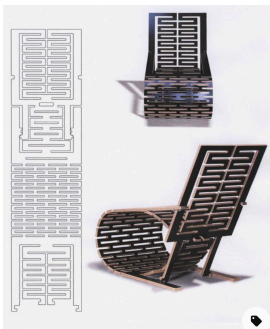
Dates	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6
Steps	Harvest/Shred	Make Molds	Cast Molds	Manufacturing	Assembly	Installation
Matthew						
Ethan						
Ian						
Jack						

- **Phase 1 (03/06/22 – 03/18/22)**
 - Harvesting pine needles from NAU compost and organic waste area behind facility services, next shredding the pine needles into three sizes.
- **Phase 2 (03/14/22 – 03/28/22)**
 - Molds will be made and prepared for casting.
- **Phase 3 (03/28/22 – 04/18/22)**
 - Molds will be filled with the shredded pine needle particles and cast in the mold with the bio-based resin to make sheets.
- **Phase 4 (04/04/22 – 04/29/22)**
 - The material will be removed from the mold and the manufacturing phase will begin. Utilizing CNC routers digital designs will be cut into the sheets to the desired specifications.
- **Phase 5 (04/18/22 – 04/29/22)**
 - Will include the assembly of the machined parts into functional prototype.
- **Phase 6 (05/02/22 – 05/06/22)**
 - Transported to the Atrium Garden on NAU campus and installed

Examples of materials made by pine needle



Examples of Potential Furniture Design



Appendix

Barton-Pudlik, J., & Czaja, K. (2016). *Conifer Needles as thermoplastic composite fillers: Structure and properties*. NC State. Retrieved November 1, 2021, from <https://bioresources.cnr.ncsu.edu/resources/conifer-needles-as-thermoplastic-composite-fillers-structure-and-properties/>.

Mengual, A., Juárez, D., Balart, R., & Ferrándiz, S. (2017, October 5). *Mechanical characterization of composite materials based on pine needle residues processed by thermocompression*. Procedia Manufacturing. Retrieved November 5, 2021, from <https://www.sciencedirect.com/science/article/pii/S2351978917307163>.

Data results from the NC State study

Table 3. Dominant Volatiles from Different Conifer Needles

Needles	Wavenumbers (cm ⁻¹) of Dominant Volatiles					
	H ₂ O	CO ₂	CO	alkanes (methane)	CH ₃ OH	CH ₃ COOH
Pine	1554	2353	2188	2932 3024	1005	1157 1755
Fir	1531	2349	2188	-	1056	1166 1765
Spruce	1520	2333	2179	2991 3015	1096	1188 1773
Cedar	1540	2325	2179	2953 3014	1028	1174 1771

Table 2. Thermal Analysis of Needle Test Samples

Sample	Temp. <100 (°C)	Weight Loss (%)	Temp. 100-300 (°C)	Weight Loss (%)	Temp. 301-400 (°C)	Weight Loss (%)	Temp. >400 (°C)	Weight Loss (%)
Pine	80	5.1	-	-	340	54.1	403	15.4
Fir	86	4.6	-	-	354	52.4	410	14.2
Spruce	78	4.7	-	-	347	49.8	405	15.0
Cedar	77	5.2	151 218 254 269	9.7 4.5 6.3 29.4	335	9.8	431	5.5

Commitment to Present Research

Please read and sign the statement below, acknowledging your commitment to present the findings of your research.

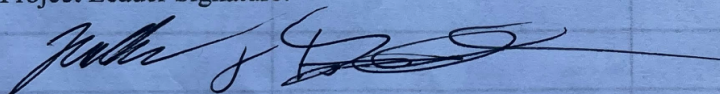
If selected as a recipient of the 2021 Green Fund Student Research Grant, regardless of the outcome of my research project, I Matthew Vermint commit to presenting the status of

my research described in this application in the form of both an oral presentation to the Green Fund Committee and a poster/exhibit presentation at the Undergraduate or Graduate Symposium, no more than 1 year after receiving notification of funding.

The oral presentation to the Green Fund Committee will consist of an approximately 10 minute long PowerPoint that includes the following aspects of your project:

- Original goal and purpose of research
- Conflicts or changes to the original purpose
- Results/Conclusion
- All relevant graphical displays of data

Project Leader Signature:



Thank you for your submission. We deeply appreciate your commitment to sustainability at NAU, and we look forward to reviewing your application. Please direct any further questions to GreenFund@nau.edu.





School of Earth and Sustainability

625 Knoles Dr,

Flagstaff, AZ 86011

928-523-4561 phone

928-523-9220 fax

November 14, 2021

Subject: Letter of Support – NAU Pine Project

Dear Green Fund Committee:

I write in strong support of Matthew Derminio's proposed NAU Pine Project. Matthew's vision for creating sustainably manufactured construction material dovetails perfectly with the Secret Garden Atrium Conversion project that I am leading. Matthew and I both imagine the products being showcased in this campus greenspace. After meeting him, I was impressed by Matthew's knowledge of the Biodesign industry, his vision for the NAU Pine Project, and his future potential for sustainability products on campus.

The NAU Pine Project will identify and evaluate the feasibility and application of a 100% biobased renewable alternative building material. The project aims to experiment with ponderosa pine needles as the filler for composite material bound by 100% bio-based resin. The purpose of the project is to test the durability and functionality of the composite material. Matthew will also examine the physical properties of the composites to determine the versatility of application potential. The expected results of this project are to develop a viable 100% biobased building material for use in the newly restored Atrium greenspace.

Matthew has already been awarded the OURCA mini-grant and is currently working with mycelium to grow materials. The cradle-to-grave product life cycle assessment proposed in the NAU Pine Project sets a new precedent for the student research project.

Student led research projects like the NAU Pine Project are essential and align with the mission of the green fund. I am fully supportive of Matthew Derminio receiving funds to continue his research as a representative for School of Earth and Sustainability.

Most sincerely,

A handwritten signature in black ink, appearing to read 'Denielle Perry', written in a cursive style.

Dr. Denielle Perry

Assistant Professor, School of Earth and Sustainability

Director, Free-flowing Rivers Lab

Northern Arizona University
Denielle.Perry@nau.edu
Letter of Recommendation

Hello Green Fund Grant Review Committee,

I have worked with Matt Derminio on several projects, most recently as an advisor for his current OURCA Mini-Grant Funded project that will test ceiling tiles made from mycelium grow kits. In another recent project, I worked with him on was an idea he had that would use sustainable 3D-print filament and/or alternatives to plastic to create prescription medical containers.



Matthew also acted as a consultant and helped us design and create the 3D printed trophies for Jacks' Big IDEA, spring 2020 (photo below). For these wanted something that captured the spirit of innovation and was a striking contrast to existing trophy designs. After consulting and helping us with our decisions we used models for chess pieces and Matthew modified these into trophies and created the 3D-printable final project files. After printing Matthew painstakingly cleaned,

fixed, and prepared the trophies for the showcase. They were a highlight of the awards ceremony.

Matt is a linear actor and thinker. He brings several years of arts, entrepreneurship, and hustle to the table and through this all there runs a line of sustainability and desire to do good with his skills and expertise. For example, the recent project he's working on in the mycelium space will be creating sample tiles with grow kits. He selected tiles because they're easy to work with but also ubiquitous and offer the potential for scale. Not only will Matt grow and test these tiles, but he will also turn the tests into pieces of art that will, hopefully, raise awareness of both his efforts and the broader field of mycelium as an alternative building material.

Matthew is a driven, and entrepreneurial artist. I say entrepreneurial in the sense that he turns his talents into value in the world—value that has multiple bottom lines, the most important of which is not mere dollars but his deep concern for the world and society. He is mature, as I noted, and from the work, he has done for me and the works he has created in the New Media program, I consider him a very capable artist.

Career-wise, Matt has eyes on the intersection of technologies like this and sustainability. This would be a great opportunity for him to prove himself and build a growing portfolio in this field. Along with this personal impact, I'm confident this project would leave a positive impact here on our NAU community and campus.

I highly recommend Matthew for this grant. Thanks for considering him. If you have any questions feel free to get in touch at: curtis.smith@nau.edu

Thanks,

Curtis Smith

Director, Boundaryless Innovation & Entrepreneurship



404 W. Santa Fe Ave.
Flagstaff, AZ 86001
regenconsultingservices@gmail.com

02/24/2022

Re: NAU Green Fund

To Whom It May Concern:

I am writing this letter to express REGEN Consulting Services' commitment to serving as the primary technical advisor for **The NAU Pine Project** and will provide machinery to assist with this project.

REGEN supports **The NAU Pine Project's** goal of developing and manufacturing a sustainable construction material to be installed on NAU's Flagstaff campus. We anticipate that this work will expose new audiences through physical displays on how to innovate and use a common waste product in Flagstaff.

REGEN will advise and assist with the use of the machines for the project. We will work to enable the long-term application potential of this novel material. The machines are housed in a local workshop and **The NAU Pine Project** will have access to them. REGEN is based in Flagstaff, AZ, and is invested in the growth of our community.

We approve of **The NAU Pine Project** to use a small-scale plastic shredding machine designed to work symbiotically with a thermoforming compression machine. These tools were originally designed for plastic production but recently have been converted to assist in the manufacturing of bio-based composite. The provided mold can make sheets of composite material sized at 8.5 inches by 11 inches and 3.5 millimeters thick.

With years of experience in plastics. REGEN will provide **The NAU Pine Project** with the needed industry knowledge for the project.

Darren Bingham, MA.
Founder and CEO

A handwritten signature in black ink, appearing to read "Darren Bingham", written in a cursive style.



Office of the Dean
nau.edu/cefns

928-523-2408 office
PO Box 5621
Flagstaff, AZ 86011

March 1, 2022

Re: Matthew Derminio's proposal of the NAU Pine Project

Dear Green Fund Committee:

On behalf of the CEFNS Dean's office, I would like to confirm our support for this project. Sustainability is of great importance to NAU and our students. The proposed project falls perfectly into the mission of the NAU Green fund by identifying and evaluating the feasibility and application of 100% biobased renewable building material, primarily from ponderosa pine needles. The project is expected to develop outdoor furniture for the new Atrium Secret Garden.

While SES is the sponsoring department, the Dean's office agrees to provide the funds requested if the project is awarded by the Green Fund, with the understanding that the funds will be reimbursed by the Green Fund.

Please do not hesitate to contact me if there are any questions.

Sincerely,

A handwritten signature in black ink, appearing to read "Tinna Traustadóttir", is written over a horizontal line.

Tinna Traustadóttir, PhD

Interim Associate Dean for Research, CEFNS
Associate Professor, Biological Sciences
Chair, Institutional Review Board
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Flagstaff, AZ 86011
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