



US DEPARTMENT OF TRANSPORTATION
RAISE 2022 GRANT APPLICATION
BERLIN, NH

RENEWING BERLIN WITH RENEWABLE ENERGY

The City that Trees Rebuilt

RENEWING BERLIN WITH RENEWABLE ENERGY

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2022 RAISE Grant Application
City of Berlin, NH

EXECUTIVE SUMMARY



The City of Berlin, New Hampshire sits just above Mount Washington; “home to the world’s worst weather” and the United States’ most prominent peak east of the Mississippi. Berlin is the state’s northernmost City (as well as Coös County’s only), serving as northern New Hampshire’s economic, cultural, and social hub. Settled on the banks of the mighty Androscoggin River, Berlin became New England’s center for the pulp and papermaking industry in the early 20th century. Berlin’s motto, “The City that Trees Built”, originates from this local wood-supplied papermaking industry. Once a thriving industrial



Typical snow storm clean up in Berlin, NH

community with a population of 20,000 (now 9,425), **Berlin is now considered an Area of Persistent Poverty** due to the rising unemployment rates from the demise of the local wood-supplied papermaking industry. Berlin is in the process of renewing itself; the City’s reinvention is now largely dependent on renewable energy production and tourism.

Today, the City of Berlin is unique in that it produces more clean energy than it consumes. In fact, we are proud to say that **Berlin, NH is the “Greenest City” in New England**. This status as a clean energy hub, combined with the City’s history and reinvented economy, perfectly set the stage for this proposed RAISE Grant project, **“Renewing Berlin with Renewable Energy...The City that Trees Rebuilt”**.

When Berlin’s pulp mill closed in 2006, plans were developed to convert the abandoned mill into a state-of-the-art renewable energy plant. Burgess BioPower, operational 2013, converts the local renewable energy source of wood chips into electricity. A cooling tower at the plant rejects “waste heat” from the generation process to the atmosphere. The City is looking to reinvigorate the region’s economic, cultural, and social hub by implementing a Downtown streetscape revitalization. As part of the streetscape project, the City would include an innovative snow-melt system to leverage the wasted renewable heat resource from Burgess Biopower. This project would provide numerous associated benefits in addition to renewing the Downtown Center of Berlin.

BENEFITS AND LONG-TERM OUTCOMES OF THIS UNIQUE PROJECT INCLUDE:

- » **Safety** – Improved safety for all users with the elimination of snow and ice during our long winter months.
- » **Environmental Sustainability** – Reduction of ~9 million gallons per year of make-up water for the cooling tower at Burgess BioPower and 23,028 megawatt-hours per year (MWh/yr) of thermal energy recovered.
- » **Emissions** – Avoid ~6,898 metric tonnes of annual CO₂e greenhouse gas emissions.
- » **Property Damage** – Reduction in automobile and building corrosion and damage with the elimination of salt in the Downtown area.
- » **Mobility, Community Connectivity & Quality of Life** – Improved ADA-compliant accessibility and other streetscape improvements will increase non-motorized mobility year-round while the snow-melt system will drastically improve mobility during the winter months for all users.
- » **Economic Competitiveness** – Elimination of foregone revenue from Downtown businesses due to accessibility issues associated with winter storm events.
- » **Improved Infrastructure Life-Cycle Costs** – Reconstruction of outdated infrastructure, paired with an innovative snow-melt system, will eliminate freeze-thaw and extend the life of the infrastructure.
- » **Operating Costs** – Reduction in operating costs by eliminating the need for snow removal and spring clean-up of salt and sand used to treat icy conditions on streets and sidewalks.
- » **Post-Construction Monitoring** – Both the University of New Hampshire (UNH) and the US Army Corps of Engineers Cold Regions Research and Engineering Laboratory (CRREL) have taken a strong interest in this innovative project and have committed to future monitoring of the project.

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I. PROJECT DESCRIPTION



I. PROJECT DESCRIPTION

Background

Situated on the banks of the powerful Androscoggin River in a heavily forested region, Berlin became New England's center of the pulp and papermaking industry in the early 20th century. With the steep gradient of the River, coupled with the construction of a railroad line through Berlin in the mid-1800s and the introduction of the turbine engine, the Androscoggin River Valley became an ideal place to locate a sawmill. For decades, Berlin, as well as the other NH communities that lie north of the White Mountains Presidential Range, relied heavily on the paper industry for their economic well-being. Between 1850 and 1930, Berlin's economic growth and population exploded. In 1930, Berlin's population peaked over 20,000 residents, making it the fourth largest city in NH at the time. The City's motto became "The City that Trees Built" due to the growth of the local wood-supplied papermaking industry.

Since then, Berlin's main industry has been in a long decline. Ownership of the pulp and paper mills changed hands several times until finally, in 2006, the Berlin pulp mill closed for good. Disinvestment in Berlin followed, creating high levels of vacancy, loss of employment, and rising taxes. Berlin's economy was in a downward spiral and scrambling to find "solid ground". Berlin's renewal is now largely dependent on renewable energy production and tourism.



*Jericho Mountain Wind Farm
14.25 MW Renewable Energy*



*Smith Hydro Station
18 MW Renewable Energy*

Renewable Energy

Berlin is home to four hydroelectric dams providing a total of 30 megawatts (MW) of renewable energy, a wind power farm on the top of Jericho Mountain providing 14.25 MW of renewable energy, and a new biomass-fueled power plant (Burgess BioPower) generating 75 MW of renewable energy. Today, the **Greenest City in New England** produces more clean energy than it consumes.



Burgess BioPower (75 MW Renewable Energy)

Burgess BioPower is the largest producer of Class I renewable energy in all of New England. It's impact on the stability of Berlin and the Northern NH region cannot be overstated. Burgess Biopower produces over 540,000 megawatt hours of clean, reliable, base load renewable energy each year. The energy produced by Burgess Biopower each year is sufficient to power

60,000 homes, about 10% of all homes in the state of NH. The plant supports over 240 jobs state-wide and results in over \$70M per year in state-wide economic activity. Of particular importance is Burgess's significant impact on the low-grade wood harvesting industry in New Hampshire which is a key element of sustainable forestry practices. Burgess purchases approximately 800,000 tons of low-grade wood per year

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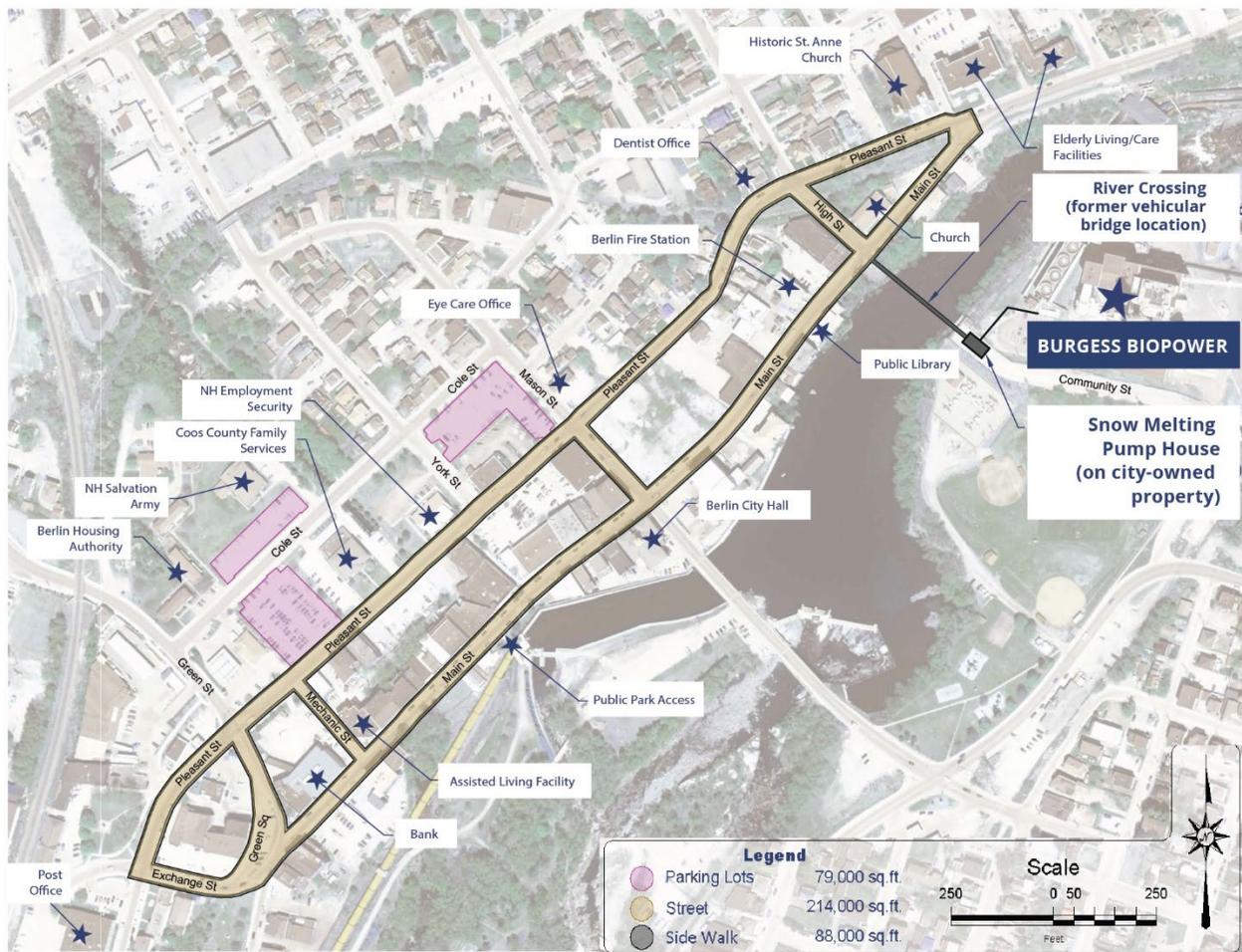


from every county in the state and more than 150 NH cities and towns. *Burgess's impact in Berlin is especially acute. The plant accounts for nearly 12% of real estate taxes, which is more than \$2 million each year. In addition, the plant accounts for 25% of annual water fees and 10% of annual sewer fees.* The partnership between the City of Berlin and Burgess BioPower is strong and paves the way for the project.

Project Details

Simply stated, the challenge to be addressed with this project is **improved accessibility, mobility and safety of Downtown Berlin, which is a disadvantaged Area of Persistent Poverty.** This streetscape project will drastically improve accessibility and safety in the project footprint, and the project takes a unique approach to leverage the City's renewable resource (waste heat from downtown renewable electric plant) to drive a snow-melting system to provide enhanced benefits of the project through the long winters in Northern New Hampshire. New Hampshire's northernmost City, Berlin, is located approximately 12 miles north of Mt. Washington. This peak is noted for the "world's worst weather," and with an average annual snowfall of 21.75 feet is also touted as one the snowiest places on earth.

Overall Project Plan



I. PROJECT DESCRIPTION



With numerous government and health-related services, elderly living facilities and the majority of the local retail sector located in Downtown Berlin, accessibility, mobility and safety are primary considerations. Improvements to accessibility, mobility and safety are proposed to be addressed through the reconstruction of the Downtown streetscape coupled with an innovative snow-melt system that will eliminate snow and ice on roads, sidewalks, and municipal parking areas. These improvements are anticipated to “renew” and “revitalize” Downtown Berlin. Look no further than Holland, Michigan, the largest municipal snowmelt system in North America, to understand the beneficial impacts of implementing a snowmelt system in a Downtown setting. Since 1988, residents and visitors of Holland have enjoyed snow-free streets and sidewalks throughout Downtown in the winter season. City and business leaders there will tell you the snowmelt system has been the essential component of the revitalization of Downtown Holland and continues to be the major marketing tool for investment in their Downtown.

Streetscape/Infrastructure Improvements

Reliable, functional, accessible, safe, and maintainable are common threads in successful infrastructure improvements for any downtown revitalization project. The proposed project is no different. A unique and innovative aspect of this project, the snow-melting system, accomplishes all of these goals with the added benefit of long-term sustainability as well as enhancing the liveability for residents and visitors.

Through the implementation of the snow-melting system, the roadway system within the project area will be reconstructed, including the base gravels and pavement section. Similarly, the sidewalks will be reconstructed and will include new concrete pavers consistent with the vision of Downtown and recently completed improvements further north on NH Route 16 within the City. Sidewalk reconstruction will improve pedestrian accessibility and safety, as well as remove ADA barriers. Additionally, the concrete pavers will provide efficient thermal conductivity for the proposed snow-melt system.



Recently completed NH Route 16 improvements just north of proposed project.

Since Downtown is a series of one-way streets (Main Street and Pleasant Street), resiliency and reliability of the corridor are critical to the movement of traffic and goods. Therefore, the project proposes the rehabilitation of the two bridges associated with the Dead River. In addition to the bridge rehabilitations, the aging drainage infrastructure in the project area is proposed to be replaced. Many sections of the drainage infrastructure in the project area are over a century old and undersized, often leaving portions of Downtown flooded or inaccessible during winter/early spring seasons. Replacement of the drainage system and rehabilitation of the bridges within the project area will improve stormwater quality, increase the capacity of systems, and have a positive impact on the environment and surrounding watershed.

As part of creating an accessible and safe streetscape, the project will include components such as enhanced lighting, street/shade trees, engineered crosswalks, intersection improvements, and various other elements. At the same time, incorporating various traffic calming and roadway crossing elements into the project will improve pedestrian/vehicular sightlines and the effectiveness of active roadway crossings, as well as reduce vehicular and pedestrian conflicts. These elements will enhance the accessibility and circulation to Downtown businesses while providing a safe pedestrian environment.



I. PROJECT DESCRIPTION

Snow-Melt System

The City is now on a path of renewal and the Downtown is at the heart of this effort. The City is uniquely positioned with a large electricity generation plant near the center. This plant consumes renewable fuel to generate electricity and, in the process, also generates enough available waste heat to provide Berlin an innovative solution to a problem it must address every winter; snow and ice removal. Berlin's Public Works



*Sidewalks after snow removal
in Berlin, NH*

Department (PWD) is responsible for managing over sixty miles of paved streets, as well as sidewalks and several municipal parking lots. In the winter, this includes plowing and snow removal. After the winter season, sand buildup from snow management practices must be removed from the Downtown streets and sidewalks.

Even with this effort, there are many times when the condition of Downtown roads and sidewalks present negative impacts to businesses simply due to the logistics and realities around snow management efforts in such a cold climate. Further, there are unavoidable impacts from sand and salt applied throughout the winter and into the spring until cleanup can be accomplished. [This video](#) provides a brief glimpse into the scale of the snow removal efforts and its impact on Downtown.

The snow-melting system will use condenser water from Burgess BioPower, which will be circulated to the Downtown area and

then back to the plant. This will effectively cool the water, as is needed by the power plant while heating the Downtown surfaces. Water will be pumped across the Androscoggin River to the north end of the Downtown area by 24-inch HDPE piping mains running on a new pipe bridge. This pipe bridge will be in the same location as the former Community Street vehicular bridge. HDPE piping will split into two mains, each with a supply and return line, traveling underneath Main Street and Pleasant Street to serve multiple snow-melting zones.

For each zone, a 3-inch HDPE supply and return line will tee off of the mains to valve-less HDPE manifolds. The loop tubing is made of cross-linked polyethylene (PEX) material, 1 inch in diameter, and is flexible enough to bend into different layout patterns. Typical zone layouts are provided in the Snow-Melt Feasibility study. For sidewalk construction, PEX tubing will be installed in a compactable layer of sand, with pavers installed over the sand layer. Wire mesh is placed over the compacted base layer and tubing laid out and fixed to the wire mesh. After installation of the tubing, a compactable sand bed is applied to provide 2 inches of cover above the tubing, and pavers are



*Examples of heated sidewalks
in Holland, MI*

I. PROJECT DESCRIPTION



installed over top. A cross-sectional diagram of sidewalk construction is presented in Figure 1.

For street and parking lot construction, PEX tubing will be installed in a compactable layer of sand or stone dust, and asphalt courses installed over the sand/stone dust layer. A cross-sectional diagram of construction is presented in Figure 2. Please note that detailed preliminary design of the snow-melting system, pump house, backup heating, and interconnection with the BioPower facility has been completed, and is included in the Feasibility Study to which there is a link provided later in this section.

The referenced Feasibility Study concluded that the low-temperature condenser water will provide satisfactory performance for snow-melting in Downtown Berlin and that the Burgess BioPower facility has far more waste heat available than is required for the Downtown snow-melting system. This waste heat is currently being exhausted to the atmosphere and is a local resource from renewable energy that can be captured for local benefit. The initial proposed scope of approximately 381,000 square feet would **only use about 8% of the waste heat available from the power plant**, providing the opportunity for significant future expansion of the snow-melting system. Recovery of useful heat from the plant's cooling water loop will further improve the overall efficiency of Burgess and will help the state meet its goals to have at least 2% of the energy distributed in the state come from qualified thermal renewable energy sources.

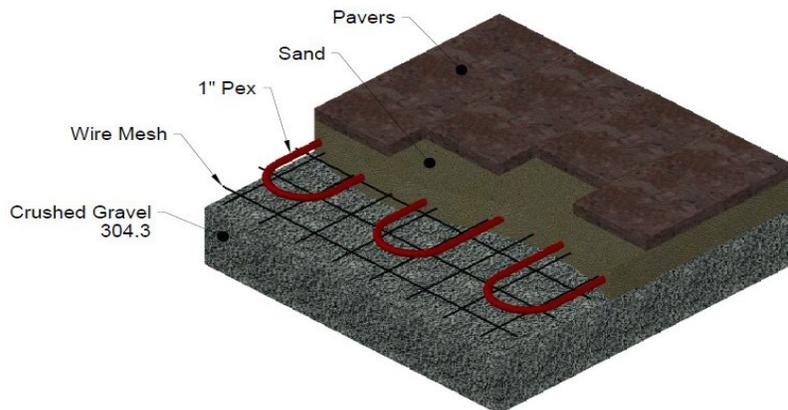


Figure 1: Sidewalk Cross-Section

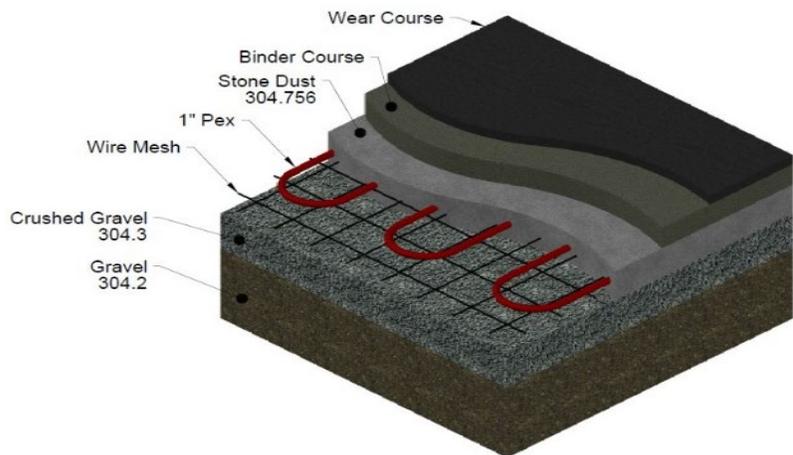


Figure 2: Street & Parking Cross-Section

This system can keep the Downtown streets and sidewalks free from snow during the winter season. The system would provide a marked improvement over current snow management practices in terms of time to clear and remove snow from streets and sidewalks. The system would also provide snow clearing benefits during all snowfall events, including smaller storms that are not currently cleared. This is expected to promote activity in the Downtown area, vastly improve walking conditions, extend the street and sidewalk life, and reduce manual snow clearing of building fronts and custodial costs from clean-up of salt, sand, and snow tracking inside buildings.

I. PROJECT DESCRIPTION



Previous Completed Work

When the paper industry finally shuttered its operation in Berlin in 2006, the City was faced with transitioning its economy and “re-inventing” itself. Since that time, the City has developed several strategies to move the City forward. All strategies point to the revitalization of Berlin’s Downtown area as a priority.

The studies include:

- » ***Moving Downtown Forward (2012)*** - [View full pdf here.](#)
Economic and Design Strategies for Downtown development.
- » ***Snow-Melting System Feasibility Study (2018)*** - [View full pdf here.](#)
A study to investigate options for the development of a snow-melting system that would keep Downtown streets and sidewalks clear of snow and ice during the winter months.
- » ***Route 16 Reconstruction (2018)*** - [View full pdf here](#)
\$7M investment in the reconstruction of a 2.5-mile stretch of the Route 16 corridor just north of the Renewing Berlin with Renewable Energy project limits to upgrade severely deteriorated roadway, sidewalk and utility infrastructure.
- » ***Economic Development & Marketing Strategy (2019)*** - [View full pdf here.](#)
Assessment of current assets, analysis of economic data, and identification of specific implementation opportunities that will have the greatest impact for the City of Berlin.
- » ***Berlin Community Profile (2019)*** - [View full pdf here.](#)
The Community Profile is a process by which communities take stock of where they are today and develop an action plan for how they want to operate in the future.

In addition to promoting the overall need for renewing the downtown infrastructure, the Economic Development and Marketing Strategy report specifically identifies the pursuit of a street and sidewalk snow melting system. Similar citations are found in the **Berlin Community Profile** facilitated and compiled by the University of New Hampshire (UNH) Extension Service. Both reports were developed with direct and broad stakeholder input and are considered the foundational pieces to the City’s ongoing Master Plan update.

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II. PROJECT LOCATION



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The project is located in the Downtown center of Berlin along NH Route 16, a major north-south highway through New Hampshire (NH). The Downtown core of Berlin is located within an “Urban Compact” area which delegates the ownership and associated maintenance of the roadway to the City versus the State. Therefore, the City has control of the Right-of-Way within the project limits. Within the Downtown area, NH Route 16 splits into two one-way corridors with Main Street heading north and Pleasant Street heading south. The limits of the proposed project generally include Main Street and Pleasant Street within the two one-way corridors, providing direct access to many essential County and City services. Additionally, the project is located in the middle of two adjacent corridor improvement projects. In 2018, the City of Berlin completed reconstruction of 2.5 miles of the NH Route 16 corridor north of the project limits and the NH Department of Transportation has included the reconstruction of the adjacent southerly 0.5-mile stretch of the NH Route 16 corridor in their Ten-Year Plan, slated to begin in 2027. **The Renewing Berlin with Renewable Energy project will complete the “renewal” of over four miles of the NH Route 16 corridor.**



The location of the Burgess BioPower, uniquely positioned in the Downtown, is what makes the snow-melt aspect of the project possible. The “waste” heat generated by Burgess BioPower can be efficiently utilized in the Downtown area to provide snow-melt for the roads and sidewalks, as well as low-cost district heating opportunities. This “forward-thinking” project leverages the energy assets of an adjacent renewable energy facility to create a unique Downtown streetscape solution.

With a population of 9,425 as of the [2020 Census](#) and located within a [Qualified Opportunity Zone, Census Tract 9506, Coös County, NH](#), the project meets both a “Rural” and “Area of Persistent Poverty” classification. A KML file of the project location can be found [here](#). Additionally, 24.2% of Coös County is over 65 years old ([2019 Population and Housing Unit Estimates Tables](#)). Safe access to essential services is important for this demographic.

III. GRANT FUNDS, SOURCES & USES OF ALL PROJECT FUNDING



III. GRANT FUNDS, SOURCES, AND USES OF ALL PROJECT FUNDING

The City of Berlin, New Hampshire requests \$19.53 million of grant funding to support the **Renewing Berlin with Renewable Energy** project. These funds will be used to “renew” outdated infrastructure within Downtown Berlin, paired with an innovative snow-melt system to improve accessibility, mobility, quality of life, and economic sustainability for residents and visitors alike. While the City of Berlin is categorized as a “rural area” and as such, is eligible for a federal cost share of 100% of requested funding, the City has partnered with Burgess BioPower and Berlin Water Works (BWW) to provide matching funds for the project.

Burgess BioPower has committed to providing a \$50,000 “in-kind” match to fund engineering services related to the snowmelt system interface connection with the biomass facility. BWW, a municipal utility entity, has committed to providing a “force account” match to the project through the construction phase of the project. BWW’s force account match includes the full installation cost of the section of new waterline on north Main Street as well as the cost savings of force account installation of the remaining waterline installation and snow-melt system supply and return HDPE mains. Due to the fact BWW has lower overhead costs and does not incorporate profit into project costs, BWW can provide the City with costs savings for pipe installation. Based on information gathered by BWW, calculated savings are 25% over General Contractor pricing. Additionally, BWW has exclusively installed HDPE several miles of waterline throughout the City over the past 10 years and is very experienced in this installation so it makes sense for BWW to assist. **Commitment letters from both Burgess Biopower and BWW are attached.**

The commitments from both Burgess BioPower and BWW represent an approximately 5% match to the RAISE Grant funds. Berlin ranks 225 out of a total 228 communities for the highest tax rate per \$1,000 assessment in the State of NH. Additionally, NH communities rely primarily on property taxation for funding most of its operations and services as NH does not have an income or sales tax. **Berlin is in need of RAISE Grant funds to move this project forward.** The City and its leadership (City Council) is in full support of this project and is prepared to provide capital funding or utilize bonding capacity to supplement the grant funding as necessary to accommodate any cost overruns or other unforeseen costs. If awarded, the City of Berlin would immediately secure interim financing to address the gap between work completed and reimbursement, and the City has extensive experience in construction financing for similar projects where reimbursement grants were a major portion of the project funding.

A summary of project costs is listed in the table below:

Renewing Berlin with Renewable Energy - Grant Summary		
<i>"The City that Trees Rebuilt"</i>		
Allocation of Project Funds		Funding Amount
Engineering & Permitting		\$1,590,322.58
	<i>Burgess BioPower In-Kind Match</i>	<i>(\$50,000.00)</i>
Snowmelt System Construction		\$7,895,790.84
	<i>Berlin Waterworks Force Account Match</i>	<i>(\$500,000.00)</i>
Roadway/Streetscape Improvements		\$11,020,617.70
	<i>Berlin Waterworks Force Account Match</i>	<i>(\$422,340.00)</i>
Total Project Cost		\$20,506,731.12
Total RAISE Grant Request	95.26%	\$19,534,391.12
<i>Total Non-Federal Match</i>	<i>4.74%</i>	<i>\$972,340.00</i>



IV. MERIT CRITERIA

The **Renewing Berlin with Renewable Energy** project aligns with all merit criteria and provides significant long-term benefits to the rural area of northern New Hampshire. This streetscape improvement project leverages the asset (waste heat) of the City's most strategic partner, Burgess BioPower, to support a renewal of Berlin's Downtown center. The support will be in the form of a snow-melt system which will keep the new infrastructure free of snow and ice during the winter months and provide opportunities for low-cost heat for buildings. This will create an attractive and unique Downtown area that will be the catalyst for Berlin's Renewal!

A. SAFETY

This project goes way beyond common design and construction practice to drastically improve infrastructure conditions by constructing an improved transportation corridor in Downtown Berlin to mitigate systemic safety issues, primarily by eliminating snow and ice in the corridor during the winter months. This improved corridor will reduce the number and severity of transportation-related accidents and provide greatly improved pedestrian access and mobility in an area of persistent poverty. Detailed benefits include:

Crashes, Fatalities, and Injuries Among Users

Removal of snow and ice from roadways in this underserved community will provide a safer corridor by reducing vehicle crashes associated with winter conditions. Utilizing crash data provided by the Berlin Police Department from 2018, there were five crash incidents where there was no apparent cause other than snow or ice on the roadway, another three crash incidents where snow or ice were noted as a major contributing factor, and one accident where winter conditions were identified as a minor contributing factor. It is anticipated these types of incidents will be eliminated with the proposed project.

Downtown Berlin is the heart of the City and serves the retail, government, and professional service businesses in the area. Also, there is a recent trend to provide housing within the Downtown area, mainly through apartments above first-floor commercial spaces. Downtown Berlin sees a high volume of pedestrian activity compared to other areas of the City. The winter work orders from Berlin Public Works for 2018 and 2019 indicate as many as 30 work order requests related to snow and ice on sidewalks and parking areas. This project will keep pedestrian connection points, including public parking areas, bus stops, EV charging stations, and sidewalks, in the Downtown area free from snow and ice, virtually eliminating slip and fall incidents.

As the City transitions from a paper mill economy to a recreation and tourism industry, improved accessibility to the services Downtown will be critical. One of the major benefits of this project will be improved access to public parking and Downtown businesses during and after storm events. Downtown occupancy and business activity dictate that snow removal take place overnight, and thus, the time of removal depends on when snowfall occurs. Snowbanks from late night/early morning snow storms are often not removed from the Downtown until the next night, leaving business patrons to negotiate the snowbanks for an entire day before they are removed. Snowstorms in and around major shopping days have the biggest negative impact. Improved safety has been identified by all local business owners as a critical benefit of a snow-melting system. In addition to slip and fall incidents, participants also identified that snowbanks can block passage on sidewalks requiring pedestrians to walk down the road until an access point can be reached and that snowbanks cause visibility concerns for both pedestrians and motorists.

Vulnerable Roadway Users and Victim Inequities

The proposed project area is one of the only non-vehicular accessible areas in the City; as a result, many citizens and visitors with limited mobility and non-motorized travelers utilize the area. Snow and ice, as well as poor ADA compliance, contribute to dangerous conditions for these users in the downtown area. The snowmelt system would virtually eliminate the buildup of snow and ice which would create significantly safer conditions for all users, but especially users with limited mobility. These benefits are discussed in detail above.

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IV. MERIT CRITERIA



In addition to benefits related to winter conditions, there are several safety benefits of this project which will be experienced throughout the entire year with the proposed streetscape renovations. The proposed project includes improved pedestrian crosswalk safety utilizing curbed bump-outs to narrow pedestrian crossings, installation of high-visibility crosswalk markings, and new street trees. The project will also incorporate new ADA-compliant accessibility throughout the Downtown area, and allow safe access to public EV charging stations year round (as opposed to snow drifts blocking them).

The City process of picking up snow Downtown delays pick up in other areas; particularly around schools. Transportation to and from City schools is often made dangerous by adverse snow and ice conditions. The proposed project would allow the City to prioritize snow removal around schools, reducing or eliminating this current safety concern.

Highway/Rail Grade Crossings

The proposed project area does not include any active highway/rail grade crossings. The proposed project would not be anticipated to have any benefits concerning these types of crossings.

Roadway Design and Technology

The proposed snow-melt system, the benefits of which are discussed in detail above, has only been constructed at this scale a very limited number of times in North America. This technology and associated design would help significantly decrease adverse safety conditions in the project area. In addition to the safety benefits associated directly with this project, the City has partnered with the U.S. Army Cold Regions Research and Engineers Laboratory (CRREL) and the University of New Hampshire (UNH) to monitor the long-term effectiveness of the project. These partnerships are discussed in detail in the Partnerships section of this application, but the study of the unique safety benefits associated with the snow-melt system could have wide-reaching impacts across the country and elsewhere for future implantation in other communities.

Hazardous Material Release Prevention

The proposed project area has little to no existing unintended hazardous material release. The proposed project would not be anticipated to have any measurable impact on the prevention of these types of releases.

B. ENVIRONMENTAL SUSTAINABILITY

The proposed project would have significant long-term benefits with respect to environmental sustainability. The project will result in reduced energy usage and associated emissions; significant reductions in road salt and sand runoff and associated air and water discharges; reductions in potable water usage for biomass plant cooling; electric vehicle (EV) infrastructure installation; continued management of the health of regional forests; improved climate resiliency; and will avoid almost all impacts to wetlands, protected shorelands, and endangered or threatened species.

Berlin is prioritizing the long-term environmental sustainability of the community to drive economic sustainability. This approach is critical to ensuring the long-term vitality of Berlin and the surrounding region. This project is a key example of how Berlin is leveraging local environmental assets and renewable energy benefits to improve all aspects of the region. In this case, the critical Downtown streetscape and road infrastructure improvements are being integrated with and supported by increased efficiency in the Downtown renewable energy plant, Burgess BioPower. Berlin hopes that this proposed project can continue to make the City an example of what sustainable cities of the future could look like. Berlin is continuing to prove that not only can cities become sustainable, but they can also make themselves better and more viable as they do so. Detailed environmental sustainability considerations include:



Berlin sits nestled within a virtually pristine natural environment



Climate Action Plan

The proposed project directly supports the [2009 New Hampshire Climate Action Plan](#) in many ways, including forest health preservation and greenhouse gas emission reduction. No local or regional Climate Action Plans exist at this time.

Sustainable forest management activities, as practiced by the low-grade wood suppliers to Burgess BioPower, ensure the health of the region's forests (managed for pests, fire, ecology, water quality, etc.). This sustainable forest management generates low-grade residues (wastes) and having an outlet for these is the largest limiting factor to the scale of management activities that can be conducted. If these residues were left in the woods to decay, rather than being used for beneficial renewable energy, they would generate methane emissions with a global warming potential of 28 times that of CO₂. The state-of-the-art renewable energy plant in Berlin beneficially uses the residues of sustainable forest management and forest product industry activities. The long-term viability of the renewable energy plant is critical to sustainable forest management activities. The project enhances the efficiency of the plant and would help ensure its continued benefits for the forests. Greenhouse gas emissions reductions are discussed in the Energy Efficiency section below.

Equitable Development Plan

Although no local, regional, or state Equitable Development Plan exists at this time, the proposed project could help provide critical access for the disadvantaged community of Berlin. See the Environmental Justice Communities section below.

Environmental Justice Communities

The proposed project area is home to and supports several at-risk environmental justice communities. The proposed project has been designed with these communities in mind and aims to minimize and/or avoid any adverse impacts to these communities. Some of the concerning environmental and demographic indicators in the project area include Lead Paint Indicator (89th percentile in the USA), Superfund Proximity (97th percentile in the USA), RMP Proximity (77th percentile in the USA), low-income Population (79th percentile in the USA), and Population over 64 years of age (74th percentile in the USA).

While the proposed project would not specifically remedy any of these Environmental Justice issues, it would have a measurable positive impact on the accessibility of the downtown area which would directly benefit these communities.

Energy Baseline Study

The proposed project would directly support the [2020 New Hampshire Potential Study](#); Volumes III & IV of which provide residential and non-residential baseline studies respectively. The proposed project would provide a low-cost, sustainable heating option to businesses and residences throughout the project area. This opportunity would help reduce fuel oil consumption. No local or regional Energy Baseline Studies exist at this time.

Modal Shift / Demand Management

Although the proposed project would not support a modal shift, nor utilize demand management strategies, to reduce travel demand or emissions; it would create increased opportunities for non-motorized travel year-round in the downtown area, and would reduce congestion and idling of vehicles during the winter months. Although these benefits are un-quantified at this time, they would be anticipated to reduce emissions within the project area as a result of the proposed project.

Electric Vehicle Charging Stations

The proposed project would include the installation of several Electric Vehicle (EV) charging stations, and ensure accessibility to these stations by melting snow in the Downtown (normally snow drifts would block access). Public EV charging stations are virtually non-existent in the northern part of New Hampshire and these stations would represent a dramatic increase in the availability of this technology for both residents and visitors of Berlin.



Energy Efficiency

The proposed project would directly address and improve energy efficiency in the downtown area. The snow-melt system will reduce the use of fossil fuels for snow removal and treatment equipment. Current snow removal practices involve significant fuel consumption through the use of plow trucks, bucket loaders, dump trucks, and other equipment. This fuel consumption averages 7,576 gallons per year and results in the direct emission of 77 metric tons of CO₂ equivalent (mtCO₂e) each year. Electrifying the heating of the downtown buildings using high efficiency heat pumps driven by the hot water loop from Burgess Biopower would eliminate the use of 62,500 gallons of #2 fuel oil (diesel) annually, reducing direct emission of 638 (mtCO₂e). The snow-melt system itself puts the heat resource that is currently rejected from Burgess BioPower to work for the City, avoiding the use of 605,000 gallons of #2 fuel oil annually to drive the snow-melt system and 6,183 mtCO₂e/yr. Factors for CO₂ equivalent were obtained from the Environmental Protection Agency (EPA) and in addition to CO₂, they include CH₄ and N₂O adjusted for their 100-year global warming potentials relative to CO₂. The total annual GHG avoided is 6,898 mtCO₂e/yr.

Renewable Energy Supply Chain

The proposed project would serve the renewable energy supply chain. This is discussed in the Climate Action Plan section above.

Disaster Preparedness / Resiliency

A major objective of the proposed project is to improve climate resiliency of the downtown infrastructure. As part of the proposed project, the City would be making significant upgrades to stormwater infrastructure as well as two bridges within the project area. These improvements would help the downtown area handle increasingly large and frequent storm events associated with the changing climate, and would help prevent damage to public and private property as a result of these storm events. Additionally, as freeze-thaw cycles become more frequent during warming winters, the proposed snow-melt system would play a crucial role in protecting infrastructure. Not only would the system help prevent icing on the surface, which would provide safety benefits, but it would help prevent heaving which causes major deterioration of the roadway infrastructure each year.

Adverse Environmental Impacts

The project as proposed will have little to no impacts on sensitive environmental resources and would significantly reduce salt and sand application in the project area and associated discharge into the environment. A detailed discussion of natural resource impact avoidance is discussed in the Environmental Risk Section of this application.

Berlin uses up to 2,000 tons of salt and 4,000 tons of sand for de-icing and traction along streets and sidewalks each year (5% of which is applied in the Downtown area) resulting in significant negative impacts on health and the environment. Contaminates from road salt dissolve and are carried away by runoff, where they enter ground or surface water. Much of the drainage from the project area is directly discharged into the Dead River and the Androscoggin River. Contaminants from road salt, primarily sodium and chloride, can have significant impacts on human health, pets, wildlife, aquatic life, vegetation, and soil.

Sand use on roads can also significantly increase airborne particulate matter, especially PM₁₀ as vehicles grind the sand into a fine dust and distribute it up into the air, which deteriorates air quality. Particulate matter causes health hazards for those with respiratory problems like asthma. This is compounded in the Downtown area where there is increased pedestrian traffic. Sand can also clog stormwater infrastructure as runoff carries it away before it can be swept up. Sand can also increase the turbidity of water or settle out on the stream beds, both of which hurt aquatic life.

The proposed project would virtually eliminate the need for any road salt or sand application within the project limits.

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Repair Existing Infrastructure

The proposed project would be constructed largely within the limits of existing infrastructure and would significantly reduce the adverse impacts this infrastructure has on the environment.

The proposed snow-melt system would help increase the efficiency of the Burgess BioPower Plant by using 10 to 30 MMBtu per hour throughout the winter season. This represents between 2.3% and 7.0% of the total heat typically rejected at the cooling tower when operating at plant capacity. This equates to approximately 20 to 60 gallons per minute in reduced evaporation and makeup at the cooling tower. Throughout an average 151-day heating season, from November through March, water consumption at the plant would be expected to be reduced by approximately nine million gallons.

Energy-Efficient and Location-Efficient Buildings

The proposed project would provide the tempered loop fed by renewable heat needed to allow cost-effective electrification (heat pumps) for existing buildings and new buildings, keeping them from using #2 fuel oil (diesel) for heating. Project funds would not be used in the construction of any energy-efficient or location-efficient buildings, but the hope would be that the revitalized downtown area would directly promote renovation and construction within the project area.

Recycled or Carbon-Reducing Materials

Although the proposed project does not currently propose the use of recycled materials, nor materials known to reduce or reverse carbon emissions, the proposed project's use of by-products from forest industry, discussed in the Climate Action Plan, would have significant carbon reduction benefits. Not only does this energy source produce significant quantities of energy with minimal carbon production, but it also helps improve forest health which aids with their natural carbon sequestration ability.

C. QUALITY OF LIFE

The proposed project will improve the quality of life of residents and visitors of Berlin and Coös County. Improvements anticipated include access to essential services including primary care, the pharmacy, local government, downtown shops, restaurants, and other retail locations which provide food and essential products. In addition to these items, the Downtown snowmelt system is expected to yield quality of life benefits like those experienced in Holland, MI, and enhance the unique characteristics of the community for the underserved area of persistent poverty in the project footprint. These benefits also include exercise and social interaction during the winter months when these activities are inhibited by ice and snow in northern New Hampshire's severe environment.

Berlin is Coös County's largest municipality and is its only city. It has been the largest center of commerce in the County since it experienced rapid growth in the 1800s. Although the population across the County has declined over the last several decades, Berlin remains the most populated community with the largest center of business and employment in the County. As such, residents of Coös and beyond come to the city for basic services. In defining Quality of Life impacts, the City has not conducted a racial equity impact analysis.

Primary Care and Dentistry

Coös County Family Health Services (CCFHS) is a Federally Qualified Health Care Center that serves the many communities in the region. Their primary patient clinic is located directly adjacent to the proposed project. In addition to some onsite parking, patients utilize a municipal parking lot that borders the CCFHS facility. Both of these parking areas would be reconstructed and hooked up to the snowmelt system, reducing winter conditions which often inhibit access to the clinic by staff and patients. CCFHS also operates a dentistry practice within the limits of the project.

Pharmacy

The only commercial pharmacy service in Berlin is located within the project limits and across Pleasant Street from a municipal parking lot. Many residents and non-residents rely on this location to obtain their prescriptions and other over-the-counter medications.

RENEWING BERLIN WITH RENEWABLE ENERGY

The City That Trees Rebuilt

2022 RAISE Grant Application
City of Berlin, NH

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Local Government

Berlin City Hall, the Berlin Public Library, and the Berlin Fire Station are all within the project area. Residents access City Hall for motor vehicle registrations, paying tax and utility bills, marriage licenses, birth certificates, and accessing the various offices of the City Manager, Community Development, Public Works, Finance and Tax Collection, Assessing, City Clerk, and Building Code. Welfare clients access essential services at this location as well. Berlin's full-time fire department is dispatched to emergencies from their location on Main Street.

Downtown Services

In addition to the services already mentioned, Berlin's Downtown includes offices, restaurants, building supplies, financial services, insurance services, banking, veteran facilities, a bowling alley, a dance studio, gift stores, apparel, newspaper, commercial printing, state unemployment services, hair salons, churches, and a variety of other downtown shops and services. Patrons of these services include the residents of three senior housing facilities. In total, these facilities are home to approximately 140 seniors and/or disabled residents who walk to downtown services year-round. Additionally, 16% of Berlin households do not have a vehicle according to the American Community Survey. These households rely on Berlin's streets and sidewalks for all of their needs year-round and this project will benefit these residents greatly. These services are also utilized by residents from the smaller Coös County communities. As the tourism industry grows, we expect that more tourist-centered services will seek to establish locations in the Downtown, particularly within the project area.

Exercise and Well Being

Coös County has a median age of 48 years. Many residents are of and beyond retirement age. The proposed project will provide a safe sidewalk network available during the long winter months that is expected to enhance the quality of life and promote significant health benefits. In Holland, MI, the network of clear sidewalks is used for regular exercise and outdoor socialization for residents and nearby non-residents. The Assistant City Manager of Holland reports that communities that lie within a 1-hour radius bring senior groups to Holland for planned recreational walking. Berlin's project will create a new 1-mile snow and ice-free loop which will bring walkers and runners to the downtown in winter. Like Holland, Berlin expects to extend pedestrian snow-melt radially out to surrounding residential neighborhoods in future expansion projects to increase access. In this way, Berlin intends to encourage a healthier community through these healthy and safe pedestrian connections.

In addition to walking, Holland has developed a robust winter running culture. An [article in Runner's World Magazine](#) has highlighted the attraction of runners to this northern Michigan city.

In Berlin, NH, snow generally falls between the six months of November and April. During this period, the average low temperature is 15.9 degrees F and the average high temperature is 36.6 degrees F. These conditions combined with snow and ice, lead people, particularly seniors, to spend most of their time indoors. Creating a walkable winter Downtown will improve the physical, emotional, and economic health of the City and County.

Due to Berlin's northern climate and severe winter weather, rolling access to downtown services is greatly hindered by snow and ice. The Project will provide greatly improved rolling access to the downtown, including critical services, to the disabled during the winter months.



Photo from 'Runners World' article featuring Holland, MI.



D. MOBILITY AND COMMUNITY CONNECTIVITY

The exact purpose of this project is to provide community connectivity and increased mobility for the areas of persistent poverty in and around Downtown Berlin. Through implementing a streetscape project for the Downtown that uses Universal Design principles to provide these mobility and connectivity benefits for the community, Berlin will encourage economic development and investment in Downtown and create a thriving community for where individuals can work, live, and play.

The project will increase accessibility for all users of the Downtown area. The streetscape project follows universal design principles to provide ADA-compliant accessibility throughout Downtown, and make the Downtown safer and walkable through the traffic calming and other design approaches. The snow-melting component of the project makes the Downtown accessible for pedestrians, and in particular the underserved residents in and around Downtown during the long winter months. The only stop for the regional bus system is in the streetscape project footprint, and those in and around Downtown currently access this stop in a way that is unsafe, particularly in the winter. Further, all of the services for the City and surrounding region, such as City Hall, Banks, Healthcare, Medical Facilities, Pharmacy, and Retail are in Downtown. By improving the accessibility of the Downtown to meet ADA requirements, Downtown will clearly be much safer for local residents (including those in the senior living centers Downtown), driving economic participation in the Downtown by non-motorized and motorized travelers alike.

E. ECONOMIC COMPETITIVENESS AND OPPORTUNITY

The main purpose of this project is to improve economic competitiveness for this underserved region of rural New Hampshire. Downtown Berlin suffers from persistent poverty, and census tract 9506 is included in DOT's list of Areas of Persistent Poverty. The community has coalesced in recent years around leveraging its renewable energy resources (hydro, solar, and forest management residues) to become a model for renewable energy development that improves the quality of life for low-income residents while creating jobs.

This project is the keystone in the overall Economic Development strategy for the region and allows for redevelopment and revitalization of the rural main street of Downtown Berlin. Downtown transportation infrastructure is outdated, beyond its useful life, and contributes to the number of vacant buildings and lack of businesses and services. Berlin has been working on reinventing itself over a number of years after losing much of its industrial manufacturing base and has begun to leverage its local assets to support key investments in renewable energy and tourism. However, the region lacks a vibrant downtown area that is needed to truly attract visitors from outside the region. Berlin has successfully used its New Market Tax Credit and Opportunity Zone designations to attract investment, including the Burgess BioPower renewable energy plant, which remediated and redeveloped a brownfield paper mill and was completed in 2013. This renewable energy plant is a major driver of regional economic development and also provides an opportunity to use renewable energy to solve issues for downtown. These items, coupled with access to unequalled outdoor recreation opportunities and investments in other renewable energy technologies (solar, wind, and hydro) by public and private entities, have set up Berlin with the potential to drive investment around recreation and ecotourism.

Berlin recently completed a public stakeholder-driven process resulting in the October 2019 Economic Development and Marketing Strategy developed by Camoin Associates of Saratoga, NY. The plan states "there is significant opportunity for Berlin in the outdoor recreation and tourism industry, if the right goods and services are made available." The four primary goals resulting from the Camoin effort are:

- 1) Expand outdoor recreation, tourism, community health initiatives, and related business opportunities.
- 2) Reconceptualize the Downtown area to improve community appearance and business vibrancy.
- 3) Support and develop business and workforce to enhance economic development.
- 4) Recognize and promote Berlin's quality of life through internal and external community marketing initiatives.

In addition to promoting the overall need for renewing the Downtown infrastructure, the Economic Development and Marketing Strategy report specifically identifies the pursuit of a street and sidewalk snow-

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melting system. Abundant renewable heat, currently wasted, from the adjacent Burgess BioPower facility makes this innovative snow and ice removal system a viable solution to the annual problem of snow and ice removal. Similar citations are found in the Berlin Community Profile facilitated and compiled by the University of New Hampshire (UNH) Extension Service in 2019. Both reports have been developed as foundational pieces to the City's Master Plan update, which is underway, and both were developed with direct, broad stakeholder input and Environmental Justice considerations.

Based on the guidance of the Economic Development and Marketing Strategy, Berlin is aggressively pursuing revitalizing Downtown with the proposed streetscape project in this application.

Transportation Cost and Access to Jobs

This project will reduce transportation costs for accessing downtown and jobs for Areas of Persistent Poverty (census tract 9506), but Berlin does not have specific data available and thus, it is difficult to quantify the level of reduced transportation costs. The project will improve access in the winter months to the downtown businesses, but data is also not available to quantify the benefits of providing reliable and timely access to the downtown work opportunities. The project will spur business investment in Downtown, making higher-wage jobs available to the low-income residents that live within walking distance of downtown. The project will make access for these residents to the new jobs safer, particularly in the winter.

Cost, Efficiency, and Reliability Improvements for Movement of Workers and Goods

The project will reduce the cost and improve the efficiency and reliability of moving workers and goods in and out of Berlin's downtown. Due to the size of the community, Berlin does not have specific data available that allows the extent of this to be quantified. This benefit will come from improving the road conditions, traffic flow, pedestrian access, and parking for downtown through the streetscape project to replace old and failing road infrastructure. Downtown is the only location with key services (medical, financial, etc.) for this rural area with persistent poverty. This reliability and efficiency will be further enhanced by improving overall snow removal capacity for the City, and lengthening the life of the road infrastructure downtown by removing the freeze-thaw cycle.

Strengthening Regional Economics and Driving Tourism Opportunities through Improvements in Economic Productivity of Land, Capital, and Labor

Downtown Berlin is an area of the region that struggles with poverty. A revitalized streetscape that is snow and ice free during the winter is a way for Berlin to drastically increase the economic productivity of the existing Downtown, bridge gaps for access to services for low-income residents' year-round, allow for public and private entities to deploy capital more efficiently, and allocate labor resources of the City to snow management efforts in other priority areas.

Land - Access to the Downtown in the winter will go from being quite dangerous for pedestrians and vehicles to being safe, with Downtown becoming one of the most ideal places to be for economic activity in the winter. Currently, the City does not have the resources to perform snow plowing and snow removal for any snowstorms less than three inches. This results in unsafe conditions in the Downtown, which has critical services such as City Hall, Banks, Healthcare, Medical Facilities, Pharmacy, and Retail. By improving mobility and accessibility through this project, Downtown will be much more economically productive. This increased productivity will not just be for the existing critical infrastructure especially important to the most vulnerable residents of the City, but will also come from increased development and the revitalization and use of abandoned buildings throughout the project area.

Capital - The deployment of capital in the Downtown area will become more economically productive as well. This will occur through the increased revenue for businesses available from Downtown development and economic activity, as well as the reduction in annual operating costs for investments made Downtown. The snow-melting system will be set up to allow for business owners to obtain low-cost, renewable heat when they redevelop the vacant or underutilized buildings Downtown, which would allow more productive use of capital investment in these buildings. Additionally, maintenance costs related to snow removal, interior cleaning from tracked salt and sand, and property damage resulting from salt and sand, will all be reduced.

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The revitalization of the Downtown for Berlin will provide a much-needed destination for the region, and thus, the deployment of capital in the Downtown will have a multiplier effect, driving increased overall recreation tourism and ecotourism to the region.

Labor - The economic productivity of labor will be improved in two ways. First, for the City's employees for winter road maintenance and snow management. Currently, labor considerations limit snow plowing and removal efforts to only certain snowfall events, and Downtown use considerations limit when snow removal can be completed. The snow-melting system would provide the following improvements for the Downtown area with regard to opportunity cost for labor: i) removal of snow in snowfalls under 3 inches (not currently done); ii) remove the need for snow removal in the Downtown area to free of resources to remove snow elsewhere; iii) reduce labor requirements for snow removal to allow staff to perform their normal duties (snow removal crews have other jobs for the City, but are pulled to snow removal during snow events).

Second, new jobs in the downtown area will be available to the low-income residents that can access downtown as pedestrians. This will reduce commute times for those residents to their current jobs, which require driving, making their time more economically productive.

Supporting Long-Term Job Creation and Union Jobs

This project will result in long-term job creation and other economic opportunities. Berlin Water Works (BWW) has a union labor force and would look to take on a significant portion of the infrastructure and snow-melting system installation. This project would be a major investment in the local union labor force and higher-wage BWW jobs. The City of Berlin is **seeking to maximize the economic impact locally and to the US by rigorously following domestic preference laws, using project labor agreements/registered apprenticeship by the union providing BWW's labor force, and including local and preferential hiring provisions/requirements in the contracting effort.**

Looking at examples from other communities, like Holland, MI, that have leveraged their local asset of waste heat to provide low-cost district heating and snow-melting for a downtown area, shows that there are major marketing, economic development, safety, and public health benefits to this approach. Berlin takes this one step further by offering renewably sourced heat energy to businesses located Downtown. Further, evaluating other rural downtowns that have drastically improved accessibility, safety, and walkability through streetscape projects shows that there are major economic and associated job creation benefits.

The job creation associated with new businesses Downtown (restaurants, shops, etc.) to serve the increasing tourist industry the City is attracting will be significant. The City views this project as the keystone for its economic development plan for Downtown and the City overall. Another specific item is that using local, renewably sourced heat will decrease the annual export of wealth outside the region for the purchase of fossil fuels for heating. This money will stay in the local economy and result in well-paying local jobs.

US Global Competitiveness through Innovation/Facilitating Efficient and Reliable Freight Movement

Companies and industries that are developing the technologies and innovations of tomorrow are seeking cost-efficient areas for investment that have access to low-cost renewable energy, high-speed broadband, EV charging, and a vibrant local economy and quality of life that allows for the attraction and retention of highly skilled workers. With smart investments in key infrastructure, Berlin can be that destination for key companies that will develop the technologies and innovations of tomorrow. This is particularly true following the pandemic and the improved mobility of workers and their desire for access to recreation and a work-life balance. For rural communities that have in the past seen a flight of industry and the persistent poverty that goes with it, this type of approach to reinvigorating the local economy is critical for the US to be competitive globally. Berlin has the opportunity to leverage improved downtown transportation infrastructure from this project to drive its transformation into a destination for companies that rely on high-speed connectivity and highly skilled workers that are seeking quality of life and lower costs of living that may not be offered to them in the more urban areas of the US. The City of Berlin does not have specific data for freight movement through downtown Berlin that is needed to assess the impact of the project directly on this metric. However, this project would specifically help with the movement of freight into and out of downtown through an improvement in roadway infrastructure and winter access.



Leveraging Renewable Energy to Bring Lasting Economic Benefit to the US and Rural NH and Driving Opportunities for Tourism in Northern NH

This project looks holistically at the assets of a rural City needing to reinvent itself and transition from an industrial hub to other economic drivers. This project improves the efficiency of a downtown renewable energy plant that in and of itself is a regional economic driver, and uses the renewable heat from the facility to drive economic activity and long-term resiliency for Downtown transportation infrastructure. The Downtown streetscape itself, coupled with the benefits of the integrated snow-melting and low-cost district heating system will drive economic development and support the outdoor recreation and ecotourism sector. The renewable heat district will allow cost-effective electrification of building heating downtown through heat pumps, **driving efficient affordable housing development downtown that is also location efficient, next to the services and jobs in the revitalized downtown/Area of Persistent Poverty.** The result is an integrated system that leverages local assets in a way that drives economic development and improved transportation infrastructure in a smart and sustainable way for the City and region. This project combines all of these items with investment in broadband access and EV charging infrastructure in a way that maximizes the use of local labor, including union labor. This type of transformation is critical for rural areas of the US that have seen industry leave at a devastating pace.

Bridging Gaps for Services in Rural NH through Renewable Energy

This project directly targets the invested resources and subsequent benefits to low-income and disadvantaged communities underserved by affordable transportation in Berlin. The project will make downtown accessible to all residents, and particularly the neighboring low-income communities that can access the Downtown on foot. Making downtown an attractive place for businesses through improved infrastructure will not only result in additional access to services for low-income residents, but also in jobs they can access by walking. **Revitalizing this downtown infrastructure is important for creating jobs in these low-income communities given the limited affordable public transportation in rural NH.**

Additionally, through the execution of this project, there will be good opportunities for residents to have well-paying union jobs. The project delivery approach plans to use BWW's union crews to install major portions of the snow-melting system. Not only does this save money on the project based on the past performance of these union crews, but it also is a major amount of work for this group. This helps justify increased training, hiring, and other direct investment in the BWW union employees, providing stable and well-paying local jobs.

Critically, this project will improve the access to services for the low-income communities surrounding Downtown Berlin. These benefits are discussed above in the Quality of Life section.

In addition to bridging a major gap in services for low-income communities, the project will result in a concurrent and complementary expansion of private economic development. Downtown Berlin has the advantage of currently having low-cost real estate, which coupled with the proposed infrastructure enhancements, will drive businesses to locate Downtown.

Over the last decade, Berlin's leadership has proven to be adept at leveraging local resources to drive private economic development. Berlin used its New Markets Tax Credit (NMTC) area status to attract investors to its shuttered paper mill to develop a \$180 Million state of the art renewable energy plant. Berlin was successful in obtaining the Opportunity Zone designation and can use this to leverage investment for a portion of Downtown. With similar approaches to those taken before to encourage private economic development, and the addition of the new and attractive downtown infrastructure, a full revitalization of the downtown can occur through significant private economic development.

The Holland Michigan Example

Holland, Michigan has been operating a snow-melting system in their downtown using waste heat from their municipally-owned power plant since the 1980s. The system currently covers over 600,000 square feet of surface area, which is mostly sidewalks and a section of downtown streets. Holland continues to invest millions into its snowmelt system, which is a clear testament to its value as an economic driver in the City.

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An informal survey of several businesses within the areas served by the snow-melting system in Holland, MI was conducted as part of the snow-melt Feasibility Study. Holland businesses are very happy with their snow-melting system. Safety (particularly for the elderly), downtown aesthetics during the winter season, and increased business were all emphasized as valuable benefits of the snow-melting system. It was noted the snow-melting system encourages residents to walk or jog, or otherwise spend time downtown.

Discussions with Holland staff were also conducted during the study. The system itself is maintained by the City of Holland and expansion to private businesses is subsidized by the City. City staff stated that the system has been used as a major marketing tool for the City and the downtown in particular. City staff members were asked what would be the reaction if the system were no longer operated and the response was that this would not be an option due to the popularity of the system. Given that Holland has made major investments at the power plant specifically for the snow-melting system and, more importantly, continues to invest significantly in its expansion, indicates its substantial value to the City (see this [article](#) for some examples and Holland's [website](#) on its snow-melting system).

F. STATE OF GOOD REPAIR

As typical with most rural municipalities, maintaining infrastructure in a state of good repair is very challenging due to increasing costs. When you compile this with decreasing revenues due to a transitioning economy from manufacturing to tourism, you end up in a situation similar to Berlin, NH. Deferred capital improvements are a common phrase used in Berlin as capital improvement budgets are generally the first to be cut during the tough, annual budgeting process. The sad reality is Berlin currently has one of the highest tax rates in the State of NH (ranked 225 out of a total of 228 communities). Under these conditions, maintaining the tax rate becomes the driving force behind budgeting, which unfortunately impacts capital improvement expenditures as compared to necessary services. With this understanding, it is no surprise the existing conditions of the transportation infrastructure are in need of investment. Without future investment, the accessibility of goods and people will continue to be limited which is directly related to the lack of economic growth Berlin has seen in the Downtown area. Detailed benefits include:



PHOTOS: Current Downtown Berlin Road Damage and Repairs

Transportation Maintenance Plans

While the proposed project has not been included in the New Hampshire Department of Transportation (NHDOT) 10-Year Transportation Improvement Plan, a project directly adjacent to the south is slated for inclusion in the forthcoming 2022 Plan. That project would provide resurfacing and rehabilitation of the corridor up to the southern limits of this proposed project and both projects would tie together well. Additionally, NHDOT currently has a proposed Riverwalk project in the City, just north of the downtown area, included in the 10-Year Plan. Upgrades along this corridor in the City are a priority of NHDOT's.

No-Build Threats to Mobility and Growth

As discussed above, the proposed project area requires improvements to accessibility and safety for non-motorized users, access/opportunity for the underserved population in the persistent poverty area of the project, and repair due to years of underfunding and delayed maintenance. Without improvement of this



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corridor, the infrastructure would soon pose a significant threat to the network efficiency, mobility of goods, accessibility and mobility of people, and economic growth.

The roadway and sidewalk conditions within the proposed project area vary but are generally in poor condition. Drainage infrastructure is outdated and needs to be replaced with improved treatment measures. There are two bridges associated with the Dead River on Main Street and Pleasant Street which are also in need of repair. In addition, the City currently does not meet ADA requirements for accessibility.

Project Capitalization

Design, permitting, and construction costs for the proposed project would be funded through the USDOT RAISE Grant program with contributions from Berlin Water Works and Burgess BioPower. This capitalization scheme is discussed in detail in the Grant Funding section of the application. Capitalization of long-term maintenance, provided by the City of Berlin and Burgess Biomass, is discussed in detail in the Maintenance Cost Revenue section below.

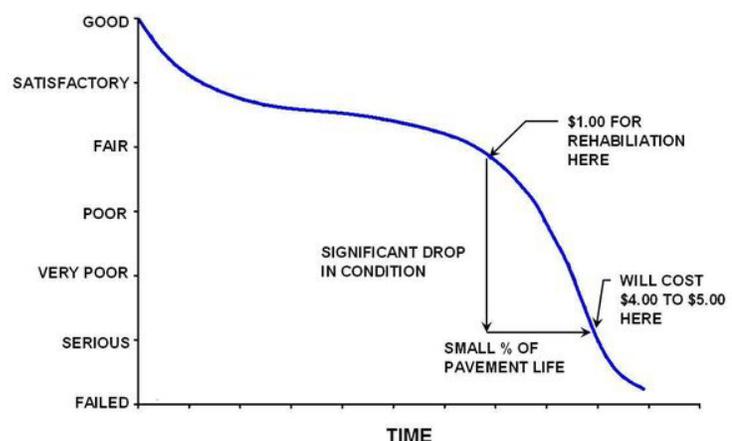
Maintenance Cost Revenue

Maintenance of the proposed project corridor would be funded through standard City of Berlin Department of Public Works (DPW) funding. This funding is allocated during annual budgeting in the City. The proposed project would result in reduced maintenance needs, making future funding of maintenance well within DPW's current level of budgeting.

One of the larger benefits of the proposed project includes improved resiliency to the roadway and sidewalk infrastructure through the snow-melt system which will eliminate the freeze-thaw cycles experienced throughout the winter season which are major drivers of maintenance costs in the City. The proposed snow-melt system would virtually eliminate this problem and associated maintenance costs.

As a result of the proposed project, the need for the ultimate replacement of the pavement system would be pushed further into the future providing additional substantial benefit to the life cycle cost. This concept is illustrated in the adjacent graph which shows that as pavement nears the end of its useful life, deterioration increases rapidly, significantly increasing the cost of maintenance. A snow-melting system would have the effect of extending this curve, and therefore extending the life of the pavement and lowering average maintenance costs during its life.

According to an informal survey of several businesses Downtown, most businesses spend a significant amount of time and money in keeping business entrances and parking free of snow. Most estimates ranged from 15 to 100 hours per winter season. These maintenance requirements would be significantly reduced as a result of the proposed project.



Typical Pavement Life Cycle Curve
Source: [Federal Aviation Administration](#)

In addition to the maintenance of the downtown corridor, maintenance of the pump house and other snow-melt system infrastructure would be required. This infrastructure would be constructed on Burgess Biopower property and would be maintained by Burgess. The costs associated with this maintenance are outlined in the attached Snow-Melting System Feasibility Study and would be funded through available Renewable Energy Credits (RECs) that would be available to Burgess as a result of operating the system.



Border Security Functions

While the proposed project is only 61 miles from the U.S. Customs and Border Protection Beecher Falls Port of Entry, it would not be anticipated to have any noticeable impact on border security functions.

State of Good Repair Maintenance

As discussed in the Maintenance Cost Revenue section above, the maintenance needs of the downtown area would be reduced as a result of the proposed project. The maintenance of this corridor would be carried out by the City of Berlin DPW. Maintenance of the snow-melting system pump house and associated infrastructure would be carried out by Burgess Biomass. Not only does Burgess have the expertise to carry out this maintenance, but they also have the required funding through the RECs. Specific maintenance needs are outlined in the attached Snow-Melting System Feasibility Study.

G. PARTNERSHIP AND COLLABORATION

The City has undergone a multi-year public engagement process to identify a path forward for the Downtown with regard to economic development, access for its underserved population to key services, addressing climate change, and other key quality of life issues. Please refer to the “Previous Completed Work” section of the Project Description in this narrative. This effort of public and stakeholder engagement has resulted in this streetscape and downtown revitalization project as the cornerstone of the City’s plan. The Team assembled to execute the project demonstrates strong collaboration among a range of stakeholders. The collaboration between Burgess BioPower and the City provides a unique public-private partnership where both parties are equally motivated to perform and achieve the economic and other benefits associated with the project. The City has also brought the University of New Hampshire and the US Army’s Cold Regions Research and Engineering Laboratory to the project to lend their expertise in project design and operational monitoring.

As currently conceived, the City will fund, construct, and own all the project equipment and Burgess will operate and maintain the pump house and equipment located adjacent to the Burgess plant. The City will provide the resources and expertise of the Berlin Water Works to help construct the subsurface piping systems. Burgess will provide their engineering resources to support detailed project design specifications and construction of the interfaces to the power plant’s cooling water system. This arrangement leverages the skill sets and primary focus of both entities and represents a significant investment of time and resources by all parties.

Burgess BioPower

Since its inception, Burgess BioPower has worked closely with the City of Berlin in many areas including permit conditions, plant operations, property taxes, water supply, and wastewater management. Burgess has worked with the City and its engineers for over two years to support the feasibility analysis of the heat recovery and snow-melt system.

Burgess BioPower is a wood-fired power plant rated at 75MW gross generation that utilizes a state-of-the-art bubbling fluidized boiler with the most advanced combustion and emissions control technology available. The facility is the largest generator of renewable energy in the state of New Hampshire and the proposed project will result in the generation of over 23,000 MWh of thermal renewable energy certificates (“T-RECs”). The T-RECs were established to incentivize thermal energy recovery and efficient energy use from renewable generators like Burgess. In 2018, the NH Public Utility Commission issued [a report on the status of the State’s Renewal Portfolio Standard programs](#) that noted the need for additional thermal efficiency projects to meet the state’s goals.

RENEWING BERLIN WITH RENEWABLE ENERGY

The City That Trees Rebuilt

2022 RAISE Grant Application
City of Berlin, NH

IV. MERIT CRITERIA



Burgess BioPower facility has 27 direct employees, the majority of whom live in the City of Berlin. A recent economic impact study showed the facility results in another 323 jobs state-wide and over \$65MM in overall economic activity. Of particular importance is Burgess's significant impact on the low-grade wood harvesting industry in New Hampshire which is a key element of sustainable forestry practices. Burgess purchases approximately 800,000 tons of low-grade wood per year, with about 60% coming from NH and resulting in over 100 jobs in the industry.

Berlin Water Works

Berlin Water Works (BWW) has a team of skilled employees and associated equipment that maintain over 50 miles of water delivery systems throughout the City. The BWW team has implemented system improvements that have significantly reduced high water flows. In the past five years, BWW has installed over 29,000 feet of new HDPE water mains. The BWW team's installation of the subsurface piping systems represents a significant in-kind investment by the City that will reduce external costs significantly. In addition, BWW is familiar with working directly with State and Federal Funding Agencies and one of the only municipal entities in New Hampshire with this expertise.

University of New Hampshire

As New Hampshire's flagship public research university, UNH has taken a strong interest in this unique project which incorporates advanced technologies. Should the project move forward, UNH has committed to seek funding to monitor the performance of the operating snow-melt system. Performance characteristics such as lifecycle costs, efficiency measurements, and numerous snow and ice related incidents are anticipated to be monitored. This post-construction performance monitoring will provide concrete data on the actual performance of the system as compared to anticipated design performance which is an added benefit to this project.

Cold Regions Research and Engineering Laboratory (CRREL)

The U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) researches and develops advanced science and engineering to complex environments, materials, and processes. CRREL is a national resource focused on solving specific, customer-driven problems and conducting innovative research. CRREL operates a specialized facility in Hanover, NH with national recognition for cold region research and development.

The City of Berlin is thrilled with CRREL's interest in the proposed project. CRREL's involvement in the project will include guidance through the development of the snow-melt system design as well as performance monitoring of the snow-melting efficiency, cost of operation, and the impact of the system on pavement structural performance.



H. INNOVATION

The City of Berlin is using innovation in its streetscape project to drive towards a revitalized Downtown. The strategy is to utilize this streetscape project to develop an integrated City infrastructure system (high-speed internet, renewable/low-cost building electrification via district heating, snow-melting system for an entire Downtown, improved efficiency of renewable energy plant, Electric Vehicle (EV) charging stations, and best practices for traffic safety in a walkable rural Downtown). This project looks holistically at the assets of a rural City needing to reinvent itself and transition from an industrial hub to other economic drivers. The result is an integrated system that leverages local assets in a way that drives economic development and improves transportation infrastructure in a smart and sustainable way for the City and the region.

IV. MERIT CRITERIA



Innovative Technologies

The streetscape project will incorporate all the current best design practices for downtown accessibility, traffic flow, and safety. Of particular interest for this project on the technology side will be the incorporation of the snow-melting and low-temperature district heating using excess heat from the renewable power plant. Snow-melting technology is well commercialized on smaller scales, but the scale, access to renewable waste heat to improve the efficiency of the existing renewable energy plant, and controls methodology for this project are unique and advanced. The use of low-temperature heat currently rejected from the renewable energy plant requires a novel approach to the control of the temperature at the surfaces and in the various road, parking, and walkway systems.

Given the low temperatures, the typical approach of using higher temperatures with very high energy input rates is not possible, and the design of the heat recovery, heat distribution, control in various surfaces, subgrade cross-sections, and systems controls requires specialized attention. Berlin has worked with the UNH Civil Engineering department to conceptualize the idea of large-scale snow-melting. The Department's expert on research of the life cycle costs and functionality of paving systems, Eshan Dave, Ph.D., plans to develop a number of long-term studies to evaluate quantitatively the impacts of this approach on the functionality and life cycle costs for managing snow in a downtown for cold climate communities.



Innovative Project Delivery

This innovative project accomplishes both the streetscape redevelopment and the introduction of a renewably sourced heat through major snow-melting infrastructure. One innovation with this project is the project delivery approach, which optimizes the execution of both of these key infrastructure upgrades to minimize the overall permitting and timeline for delivering the combined project.

Another innovation on the project delivery approach is to incorporate the Berlin Water Works (BWW) union crews into the project. These union crews are highly skilled and can execute significant portions of the project scope. This does three things: 1) it reduces the overall project costs compared to outside contractors that carry overhead, profit, and travel costs when executing work (BWW estimates a 25% savings when it self-performs work with its union crews over outside contractors). 2) It drives investment in local union jobs. 3) It allows for flexibility in the construction scheduling with key portions of the work being able to be completed at the best time for the schedule while not needing to wait on any procurement hurdles that go along with using outside contractors. BWW is a committed partner to the project and BWW's employees are key members of the community that this project supports. This approach to the project integrates the community and the community's investment into the overall project and City revitalization effort.

Innovative Financing

This project provides other revenue sources for streetscape work including, renewable energy credits, incentives for renewable energy technology deployment, and low-interest financing for renewable energy technology deployment. This holistic view of energy systems for the benefit of rural and urban areas is well adopted in northern European countries, but not yet here in the US, mostly due to the difference in energy pricing. In Denmark for instance, the law requires that power plant development must be done where there can be district energy development and use of heat rejected from the power plant. This results in power generation plant thermal efficiencies that approach 90% or higher while most US power plants send 55% to 75% of the energy that is consumed out to the atmosphere in the form of rejected heat. This project leverages the value of that heat, increasing the efficiency of the renewable energy plant, and creating another value stream (district heating) for renewable energy plant development. Taking this same approach, and using this project as a model, allows the financing of future renewable energy facilities to leverage more revenue streams from the same energy purchase to run the plant. This completely changes the financing picture and approach for these facilities.

V. PROJECT READINESS: ENVIRONMENTAL RISK



State and Local Approvals

As discussed above, the proposed project would require permitting through the NHDES Wetlands Bureau. Preliminary discussions with NHDES, and experience with similar projects in the recent past, indicate that receiving the required permit would not be expected to be particularly challenging.

Based on experience with recent corridor improvements projects, it is anticipated the proposed project would not face significant hurdles during the required NHDES Alteration of Terrain (AoT) permitting.

Federal Transportation Requirements Affecting State and Local Planning

The proposed project is not required to be included in State, metropolitan, or local planning documents. The proposed project area is within the urban compact zone (municipally controlled ROW) and does not require inclusion in the Statewide Transportation Improvement Program (STIP) or other planning documents. Several letters of support from State and local officials for the proposed project have been included in this application.

Assessment of Project Risks and Mitigation Strategies

The proposed project does not include significant material risks. The proposed project does not require the acquisition of any land, vehicles, or abnormal construction materials. The greatest risks that the proposed project faces are continued escalation of construction costs and unanticipated shortages of construction labor or materials. While these risks are difficult to prevent, steps have been taken to mitigate the potential impacts of these risks. Conservative estimates for construction unit costs have been utilized to determine the overall project cost estimate and appropriate annual inflation rates have been applied to the costs. Additionally, the proposed project schedule is relatively conservative and would allow ample time for bidding and Contractor procurement of necessary materials.

Financial and Technical Capacity

The City of Berlin regularly completes State and Federally aided projects, and has completed numerous such projects in the last several years. The City is very familiar with, and capable of handling, the administrative activities that would be required for the proposed project.

Bidding materials for the proposed project would include all required federal documents and provisions, including Buy America and Davis-Bacon Wage Rates.

Although significant effort has been taken to avoid unanticipated cost overruns or change orders, the City is well poised to handle unanticipated changes and potential cost overruns. While the City's budget, similar to most municipalities, has a tight annual budget; thanks to good financial management and resources, the City has the ability and willingness to appropriate or bond any funds needed to complete the project should cost exceed the estimated budget. Although the City is refraining from depending on not-yet-secured funds; the project team feels strongly that the proposed project would qualify for additional non-federal energy grants, as well as Northern Borders Regional Commission grants, following RAISE Grant funding obligation.

The City of Berlin is the largest community in Coos County and is the center of norther New Hampshire's commerce and transportation networks. City staff have a depth of experience and resources to both understand and adhere to the regulations and oversight requirements associated with a project of this magnitude. The City is responsible for the maintenance of all the nearly 60 miles of roads within the community, which include a designated truck route carrying large volumes of trucks. In addition to the roadways within the community, the City is charged with running the Berlin Regional Airport. To maintain all of this infrastructure, the City utilizes municipal funding as well a wide variety of State and Federal funding opportunities. Funding organizations for recent, successful projects include NHDOT, Federal Aviation Administration (FAA), FHWA, and Northern Borders Regional Commission. In addition to working with a variety of funding agencies, the City has extensive experience working with numerous consultants and contractors to carry out largescale infrastructure improvement projects.



VI. BENEFIT-COST ANALYSIS

VI. BENEFIT-COST ANALYSIS

The Renewing Berlin with Renewable Energy Project is anticipated to result in significant benefits for the region and environment as a whole. The benefits would arise from the proposed creation of a safe, user-friendly, environmentally friendly snow-melting system for the Downtown area; which requires reduced maintenance, inflicts less damage on private property and automobiles, and encourages increased economic spending. The calculated BCA for the proposed project is 1.26, with the benefits and costs of the proposed project outweighing the cost to implement it. Below is a brief discussion of the detailed Benefit-Cost Analysis conducted by the City of Berlin for the proposed project. Detailed discussion and supporting documentation and calculations can be found in the Appendix.

No-Build Alternative

In its current state, Downtown Berlin has deteriorating infrastructure, requires frequent and significant snow removal, and can be unsafe and inaccessible due to snow and ice build-up. Left unchecked, the Downtown area would continue to deteriorate resulting in further maintenance costs as well as continued damage to property, continued safety issues, and reduced economic spending.

Proposed Project Costs

The proposed project would cost \$20,506,731.12. Pre-construction activities would occur over a three-year period and construction would occur over the following three-year period. Final completion would be anticipated in the Fall of 2028. The project costs are summarized in Table 1 and the accompanying summary narratives. Detailed cost estimates and discussions can be found in Appendix.

Snow-melt System Costs

Snow-melt system costs associated with the proposed project can be broken up into two categories, Fixed Costs and Non-Fixed Costs. The Fixed Costs include construction of the pumphouse building, construction of the river crossing, and connection to the Burgess BioPower plant. These costs must be incurred fully prior to any of the snow-melt system going online. The Non-Fixed Costs are a per square-foot cost for the construction of the snow-melt system throughout the project area. These costs primarily include the installation of the capillary heating system.

Streetscape Costs

Streetscape costs associated with the proposed project are broken down into four areas; Main Street, Pleasant Street, Side Streets, and Municipal Parking Lots. These costs include reconstruction of the

Calendar Year	Sum of Project Benefits and Costs (\$2020)	Sum of Discounted Project Benefits and Costs at 7%, CO2 Emissions at 3%	Project Investment Costs (\$2020)	Discounted Project Investment Costs at 7%
2023	\$0	\$0	(\$530,108)	(\$530,108)
2024	\$0	\$0	(\$530,108)	(\$495,428)
2025	\$60,096	\$52,490	(\$530,108)	(\$463,016)
2026	\$0	\$0	(\$9,385,301)	(\$7,661,201)
2027	\$813,950	\$621,179	(\$5,873,567)	(\$4,480,916)
2028	\$1,255,348	\$895,581	(\$3,657,540)	(\$2,607,776)
2029	\$2,138,749	\$1,426,912	\$0	\$0
2030	\$2,262,703	\$1,412,214	\$0	\$0
2031	\$2,248,296	\$1,313,211	\$0	\$0
2032	\$2,303,357	\$1,259,318	\$0	\$0
2033	\$2,358,609	\$1,207,378	\$0	\$0
2034	\$2,414,052	\$1,157,368	\$0	\$0
2035	\$2,549,382	\$1,144,101	\$0	\$0
2036	\$2,452,074	\$1,030,266	\$0	\$0
2037	\$2,453,504	\$964,995	\$0	\$0
2038	\$2,454,219	\$903,507	\$0	\$0
2039	\$2,454,934	\$846,010	\$0	\$0
2040	\$2,455,649	\$792,245	\$0	\$0
2041	\$2,456,364	\$741,966	\$0	\$0
2042	\$2,457,079	\$694,947	\$0	\$0
2043	\$2,457,794	\$650,974	\$0	\$0
2044	\$1,892,724	\$473,416	\$0	\$0
2045	\$1,893,439	\$443,892	\$0	\$0
2046	\$1,894,154	\$416,271	\$0	\$0
2047	\$1,894,869	\$390,429	\$0	\$0
2048	\$1,895,584	\$366,250	\$0	\$0
2049	\$1,896,299	\$343,625	\$0	\$0
2050	\$1,897,014	\$322,453	\$0	\$0
2051	\$1,898,444	\$302,953	\$0	\$0
2052	\$1,898,444	\$284,098	\$0	\$0
30-Year Present Value Totals		\$20,458,048		(\$16,238,445)
Project Overall Net Present Value				\$4,219,603
Benefit-Cost Ratio (7% Discount)				1.26



VI. BENEFIT-COST ANALYSIS

roadway, sidewalk and drainage systems, rehabilitation of two vehicle bridges as well as general streetscape improvements. The sidewalk and streetscape improvements will include improved pedestrian & ADA accessibility as part of an appealing streetscape while the roadway improvements will incorporate traffic calming, enhanced lighting and intersection improvements.

Proposed Project Benefits

Benefits of the proposed project would be a result of both the installation of snow-melt infrastructure, as well as the overall reconstruction and improvement of the Downtown area. A large percentage of the anticipated benefits would be realized following the first phase of construction, while the remainder would be fully realized after completion of the following two phases. Benefits that could be quantified were calculated using the best available information and unquantifiable benefits are discussed qualitatively. Project benefits are summarized in Table 2 and the accompanying summary narratives. Detailed benefit analysis and discussions can be found in the Appendix.

Operating Cost Benefits

Operating Cost Benefits would result from both the installation of the snow-melt system, as well as the reconstruction of the roadway system. The installation of the snow-melt system would significantly reduce the operating costs required for snow removal during the winter months. The cost of snow removal in the proposed project area, as well as required spring cleanup of the streets as a result of salt and sand application, in a typical year totals \$128,193 (base case). The need for these snow removal efforts in the downtown area would be eliminated by the implementation of the proposed project, and thus, the result would be dropping these specific costs to \$0 by implementing the project. While the snowmelt system would cost \$72,512 to operate annually, there would be a net operating cost savings of \$55,682.

The reconstruction of the roadway and streetscape would reduce future roadway maintenance costs. It is anticipated that within the lifetime of the proposed project, the entire facility would require a pavement mill & overlay if the proposed project is not implemented. This overlaying of the roadways and parking lots would total \$227,395 (base case). These, and other maintenance activities, would not be required should

Table 2: Project Benefits		Total Discounted (7%) Benefits Over Project Term, CO ₂ at 3%
Snow/Ice O&M Cost Savings		
The snowmelt system costs less to operate and maintain as compared to the current method of clearing snow with heavy equipment.		\$504,089
Transportation O&M Cost Savings		
The improved roadway infrastructure will eliminate the need for projected maintenance including mill & overlay of the pavement in the project areas.		\$139,155
Safety Cost Savings		
Roadways, sidewalks and municipal parking lots free of snow & ice will reduce both vehicle and pedestrian accidents within the project area.		\$2,857,125
Emissions Cost Savings		
Eliminating the need for winter maintenance activities and sand & salt applications will reduce particulate matter emissions.		\$1,863,552
CO₂ Emissions Cost Savings		
Eliminating diesel fuel and heating fuel oil usage associated with snow clearing activities in the project area and building heating will reduce CO ₂ emissions from mobile and stationary combustion equipment.		\$656,828
Maintenance and Property Damage Cost Savings		
Infrastructure free of salt and potholes, due to the lack of freeze-thaw, will reduce property damage on vehicles and buildings.		\$507,495
Foregone Retail Revenue Cost Savings		
Improved accessibility to Downtown through the winter months will have a significant impact of business revenue within the project area.		\$8,575,313
Leisure Benefits		
Infrastructure free of snow and ice during the winter months would increase leisure opportunities for residents and visitors of Berlin, NH.		Qualitative
Mobility and Community Connectivity Benefits		
Snow-melt system installation and the streetscape improvements would provide significant mobility and community connectivity benefits for all residents and visitors, but in particular underserved and/or disabled users.		Qualitative
Building Heating Costs		
The snow-melt system will be used to provide low-cost heat to public buildings in the downtown area, saving fuel costs.		\$1,764,045
Value of Thermal RECs		
Use of renewable biomass energy provides generation of Renewable Energy Certificates under NH PUC, which are marketed during the project term.		\$3,590,446
Total Discounted Value of Benefits		\$20,458,048

VI. BENEFIT-COST ANALYSIS



the proposed project be implemented, and thus the result is that these specific costs will be \$0 annually once the project is implemented.

Safety Benefits

Safety benefits associated with the proposed snow-melt system would be anticipated to be significant. These benefits would be the result of a reduction in both automobile accidents, as well as slip and fall accidents. Automobile accident data from the proposed project area during the winter of 2018 shows that there were five accidents where snow/ice was the only apparent cause, three accidents where snow/ice was a major contributing factor, and one accident where snow/ice was a minor contributing factor.

Reductions in the number and severity of these accidents as a result of the implementation of the proposed project would be anticipated to have benefits totaling \$222,480.00 annually. Slip and fall accident data from the proposed project area during the winter of 2019 shows that there were two reported slip and fall accidents as a result of snow/ice. Elimination of these accidents as a result of the implementation of the proposed project would be anticipated to have benefits totaling \$93,118.94 annually.

Emissions Benefits

Implementation of the proposed project would be anticipated to have benefits with respect to CO₂, criteria pollutants, and water quality. The City currently uses 7,500 gallons of diesel fuel annually for snow removal efforts in the downtown (base case). The elimination of snow removal efforts in the Downtown area would drop the diesel fuel to 0 gallons annually for snow removal downtown, saving 7,500 gallons per year. Currently, the downtown buildings that are assumed to be connected to the snow-melt/district heat system have heat demands for 62,500 gallons of fuel oil annually. The new system would replace this fuel oil use with renewable heat from the system, and would drop this oil use to 0 gallons per year. This would be a reduction in heating oil usage in the order of 62,500 gallons annually. The implementation of the proposed project would result in significant reductions in fossil fuel consumption and the associated airborne pollutants.

The elimination of sand and salt application would also have fugitive dust (PM_{2.5}) benefits. Based on information provided by the Environmental Protection Agency (EPA), these benefits would be anticipated to have a value of \$205,849 annually. Snow and ice management within the proposed project area currently requires the use of approximately 100 tons of salt and 200 tons of sand annually (base case). Much of the stormwater in the proposed project area is discharged directly in the adjacent Dead and Androscoggin Rivers. The implementation of the proposed project would eliminate the need for application of these materials and the associated negative impacts on water quality in the rivers.

Property Damage/Maintenance Benefits

Property damage/maintenance benefits associated with the proposed project would result from both the installation of the snow-melt system as well as the reconstruction of the facility. As mentioned above, the installation of the snow-melt system would eliminate the need for the significant quantity of salt applied to roadways within the facility. The current rates of salt application have significant corrosion impacts on vehicles utilizing the facility. These losses are valued at \$29,112.34 annually. Implementation of the proposed project would eliminate this economic impact entirely.

The reconstruction of the roadway system, as well as the elimination of the freeze-thaw cycle, would be anticipated to eliminate potholes within the project area. Current levels of losses as a result of pothole damage within the project limits are valued at \$26,945.77 annually. Implementation of the proposed project would eliminate this economic impact entirely.

VI. BENEFIT-COST ANALYSIS



Revenue Foregone Benefits

Revenue Foregone benefits associated with the proposed project are the most significant benefit anticipated. During the winter months in Berlin, businesses in the Downtown area are virtually inaccessible. There is a distinct and quantifiable reduction in retail sales during and after snow events. Many of these shopping trips are not simply delayed, but foregone entirely. This foregone revenue makes owning and operating a business in Downtown Berlin extremely difficult and has caused numerous businesses to close or move elsewhere. The value of this revenue foregone totals \$931,532.00 annually within the proposed project limits. Increased accessibility and associated traffic in the Downtown area would likely create a greater increase in retail spending that is currently foregone. The value utilized in this analysis is assumed to be conservative.

Leisure Benefits

The proposed project would be anticipated to result in significant benefits with respect to leisure and recreation, particularly in the winter months. The only other large-scale municipal snow-melt system known to exist within the United States, Holland, MI, has seen significant benefits as a result of the installation of their snow-melt system. Holland, MI has become renowned as a winter recreation destination. The city, and its snow-melt system, were recently featured in Runner's World Magazine. The city has become a hub for those looking to recreate outdoors in the winter and the city now has a robust weekly year-round running club. Beyond the ability to run during the winter months, the ability to walk safely and enjoy the Downtown area during the winter would be a significant societal benefit in the City of Berlin.

Mobility and Community Connectivity Benefits

The proposed project would result in significant tangible mobility and community connectivity benefits. The proposed project would realize these benefits through both the implementation of the snow-melt system and the streetscape improvements. The snow-melt component of the project would make the Downtown area safer and more accessible for all users, but particularly underserved or disabled users of the facility, throughout the winter months. The streetscape improvements would follow universal design principals and would significantly improve ADA compliance throughout the downtown area. Again, these improvements would benefit all users, but would particularly benefit underserved and/or disabled users who require access through downtown to access critical services.

Building Heating

The proposed project, specifically the installation of the snow-melt system, would allow the opportunity for buildings within the project area to utilize the waste heat for space heating. Both public and private buildings would be able to install water-source heat pumps in place of their typical fuel oil boilers. This would significantly reduce heating costs for participating property owners. The base case is that owners are spending \$311,575 annually on fuel oil for heating. The anticipated cost of running the water source heat pumps is \$38,625 annually. This results in a net benefit valued at \$272,950 annually.

Thermal RECs

The installation of the proposed snow-melt system and the associated useful thermal energy generation would qualify for State of New Hampshire Renewable Energy Certificates (RECs). These RECs are calculated based on megawatt-hours (MWh) of useful thermal energy produced. RECs associated with the proposed project would be a result of both the snow-melt system itself and use of the building heating system. Currently there are no RECs generated by the City (base case). The system once installed will generate 23,028 RECs annually. The combined value of these credits is anticipated to be \$566,500 annually.