INDUSTRIAL COMMISSION OF NORTH DAKOTA

Doug Burgum
Governor

Drew H. Wrigley
Attorney General

Doug Goehring
Agriculture Commissioner

Thursday, May 25, 2023
Governor's Conference Room or Microsoft Teams – 12:30 p.m.
Join on your computer or mobile app
Click here to join the meeting
Or call in (audio only)
+1 701-328-0950,,744188804#

I. Office of the Industrial Commission – Karen Tyler/Reice Haase

A. **Consideration of April 25th, 2023 Industrial Commission meeting minutes** (Attachment 1)
B. Transition Update (Attachment 2)
C. Final Industrial Commission Report on 68th Legislative Session (Attachment 3)
D. Other Office of the Industrial Commission Business

(approximately 12:45 p.m.)

II. Bank of North Dakota – Todd Steinwand/Jared Mack (Eide Bailly)

A. Presentation of Beginning Farmer Revolving Loan Fund – December 31, 2022 (Attachment 4)
B. Presentation of North Dakota Guaranteed Student Loan Program – December 31, 2022 (Attachment 5)
C. Presentation of Independent Auditor's Report and Financial Statement- December 31, 2022 (Attachment 6)
D. Presentation of 2022 BND Annual Report (Attachment 7)
E. **Consideration for Approval of 2022-2024 BND Strategic Plan** (Attachment 8)
F. Presentation of March 15, 2023 Non-confidential Finance and Credit Committee Minutes (Attachment 9)
G. Presentation of March 16, 2023 Non-confidential Advisory Board Minutes (Attachment 10)
H. Other Bank of North Dakota business

Meeting Closed to the Public for Executive Session Pursuant to NDCC 6-09-35, 44-04-18.4, 44-04-19.1 and 44-04-19.2

(approximately 1:15 p.m.)

III. Bank of North Dakota Executive Session – Todd Steinwand

A. Presentation of Concentrations of Credit as of March 31, 2023 – Kirby Evanger (Confidential Attachment 11)
B. Presentation of March 15, 2023 Confidential Finance and Credit Committee Minutes (Confidential Attachment 12)
C. Presentation of March 16, 2023 Confidential Advisory Board Minutes (Confidential Attachment 13)
D. Attorney Consultation
E. Other Bank of North Dakota confidential business (as defined under N.D.C.C. 6-09-35)

(approximately 1:45 p.m.)

IV. North Dakota Mill and Elevator Executive Session – Vance Taylor/Cathy Dub

A. Attorney Consultation (Confidential Attachment 14)

(approximately 2:15 p.m.)

V. Department of Mineral Resources Executive Session – Steven Nelson

A. Negotiation strategy regarding Abandoned Well Plugging and Site Restoration Fund reimbursement

Meeting Returns to Public Session

(approximately 2:30 p.m.)

VI. Executive Session Formal Action Taken in Open Session

(approximately 2:40 p.m.)

VII. North Dakota Mill and Elevator – Vance Taylor/Cathy Dub

A. Review of Operation, 3rd Quarter Ended March 31, 2023 (Attachment 15)

(approximately 3:00 p.m.)

VIII. North Dakota Department of Mineral Resources – Lynn Helms

A. **Consideration of the following cases:**
   i. **Order 32474 for Case 29888** regarding an application of Blue Flint Sequester Company, LLC requesting consideration for the geologic storage of carbon dioxide in the Broom Creek Formation from the Blue Flint Ethanol Facility in the storage facility located in Sections 11, 12, 13, 14, and 24, Township 145 North, Range 83 West and

Sections 6, 7, 8, 17, 18, and 19, Township 145 North, Range 82 West, McLean County, North Dakota (Attachment 16)

ii. **Order 32475 for Case 29889** regarding a motion of the Commission to consider the amalgamation of the storage reservoir pore space in a storage facility to be operated by Blue Flint Sequester Company, LLC in Sections 11, 12, 13, 14, and 24, Township 145 North, Range 83 West and Sections 6, 7, 8, 17, 18, and 19, Township 145 North, Range 82 West, McLean County, North Dakota (Attachment 17)

iii. **Order 32476 for Case 29890** regarding a motion of the Commission to determine the amount of financial responsibility for the geologic storage of carbon dioxide from the Blue Flint Ethanol Facility in the storage facility located in Sections 11, 12, 13, 14, and 24, Township 145 North, Range 83 West and Sections 6, 7, 8, 17, 18, and 19, Township 145 North, Range 82 West, McLean County, North Dakota (Attachment 18)

iv. **Order 32559 for Case 29951** regarding a motion of the Commission to consider the name change of the Squaw Gap Field and any associated pools, McKenzie County, ND, and for such other and further relief as the Commission deems appropriate (Attachment 19)

B. Geological Survey Division Quarterly Report – Ed Murphy (Attachment 20)

C. Update on Litigation*:

i. Case No. 31-2020-CV-0018 - Northern Oil and Gas, Inc. vs. Continental Resources, Inc; Board of University and School Lands and ND Industrial Commission et al – Ordinary High Water Mark challenge

ii. Blue Appaloosa – appeal of Industrial Commission Order 31208

iii. Case No. 27-2022-CV-00305 - Blue Steel Oil and Gas, LLC v. North Dakota Industrial Commission, Slawson Exploration Company, Inc and White Butte Oil Operations, LLC – appeal of Industrial Commission Order 31501

iv. Dominek v Equinor et al – allocation of production from overlapping spacing units

v. Liberty Resources vs. NDIC et al – appeal of Industrial Commission Order 31792

vi. North Dakota Industrial Commission v. U.S. Department of Interior –quarterly lease sales

vii. Spec Tech v NDIC - appeal of Industrial Commission Order 31900

D. Update on Bureau of Land Management North Dakota Resource Management Plan revision
E. Update on Dakota Access Pipeline Environmental Impact Statement cooperating agency comments
F. **Consideration of submittal of agency comments related to the Bureau of Land Management proposed rule to re-define "conservation" in the context of land use** – Comments due June 20, 2023 (Attachment 21)
G. Other North Dakota Department of Mineral Resources business

* Possible Executive Session under N.D.C.C. 44-04-19.1(9) & 44-04-19.2 for attorney consultation

(approximately 4:00 p.m.)

IX. North Dakota Public Finance Authority – DeAnn Ament

A. **Consideration of amendment to 2022 Legacy Fund Infrastructure Program Bonds' Authorizing Resolution** (Attachment 22)
B. **Consideration of approval for the following loan applications:**
   i. **Grand Forks – Clean Water State Revolving Fund - $5,607,000** (Attachment 23)
   ii. **Jamestown Regional Airport Authority – Capital Financing Program - $565,000** (Attachment 24)
C. Presentation of State Revolving Fund loans approved by Advisory Committee:
   i. Milnor – Drinking Water State Revolving Fund - $218,000 (Attachment 25)
D. Other Public Finance Authority business

(approximately 4:20 p.m.)

X. Lignite Research, Development and Marketing Program – Jason Bohrer/ Mike Holmes

A. Presentation of the Lignite Research, Development and Marketing Program Project Management and Financial Report – Reice Haase (Attachment 26)
B. **Consideration of the following Lignite Research, Development and Marketing Grant Round 102 application:**
   i. **LRC-102A Lignite Energy Council: Education Program, $450,000** (Attachment 27)
   ii. **LRC-102B EERC: Redundancy Study for CO_2 Capture at Coal Creek Station, $837,313** (Attachment 28)
   iii. **LRC-102C UND & EERC: Coal Creek Carbon Capture: Geologic CO_2 Storage Complex Development, $6,119,690** (Attachment 29)
   iv. **LRC-102D Americarbon Products, LLC: Engineering Design and Feasibility Analysis for Commercial Graphite and Asphalt**

Manufacturing from Lignite-Derived Carbon Pitch, $700,000 (Attachment 30)

v. **LRC-102E UND & EERC: Williston Basin CORE-CM Initiative – Continued Assessment, $1,050,000** (Attachment 31)

vi. **LRC-102F UND: Assessment of Lignite-Based Industrial Residues for Value-Added Product Creation through CO_2 Mineralization, $250,000** (Attachment 32)

vii. **LRC-102G UND: Recovery and Refining of Rare Earth Elements from Lignite Mine Wastes, $2,000,000** (Attachment 33)

C. Other Lignite Research, Development and Marketing Program business

(approximately 4:40 p.m.)

XI. North Dakota Transmission Authority

A. **Consideration of the contract for the Transmission Authority Director** – Reice Haase (Attachment 34)

B. Update on legislative action regarding transmission projects – John Weeda and Claire Vigesaa (Attachment 35)

C. Other Transmission Authority business

(approximately 5:00 p.m.)

XII. Remaining Administrative Business and Adjournment

Next Meeting – Thursday, June 29th, 2023
Governor's Conference Room, Bismarck, ND

Minutes of a Meeting of the Industrial Commission of North Dakota

Held on April 25, 2023 beginning at 12:30 p.m.

CTE Conference Room 15th Floor – State Capitol

Present: Governor Doug Burgum, Chairman

Attorney General Drew H. Wrigley

Agriculture Commissioner Doug Goehring

Also Present: This meeting was open through Microsoft Teams so not all attendees are known.

Agency representatives joined various portions of the meeting.

Governor Burgum called the meeting of the Industrial Commission to order at approximately 12:30 p.m.

OFFICE OF THE INDUSTRIAL COMMISSION

Ms. Karen Tyler presented for consideration of approval the Industrial Commission meeting minutes for the March 28, 2023 Industrial Commission meeting.

It was moved by Commissioner Goehring and seconded by Attorney General Wrigley that the Industrial Commission approve the Industrial Commission meeting minutes for the March 28, 2023 meeting.

On a roll call vote, Governor Burgum, Attorney General Wrigley, and Commissioner Goehring voted aye. The motion carried unanimously.

Mr. Reice Haase gave an update on the 68th legislative session bills tracked by the Industrial Commission. He emphasized that the focus has been on HB 1014, the NDIC budget bill, and mentioned that the Senate appropriations committee had made a substantial number of cuts prior to the bill moving to the conference committee, but that they are working diligently to restore many of the cuts. The largest cut was to the Clean Sustainable Energy Authority where the Senate cut the grants down from $50 million to $30 million, along with cutting the loan authority completely out. Mr. Haase mentioned that the House has indicated that they are fully on board with restoring the CSEA loan authority, so it is up to the Senate to come to a compromise with the House. The Senate has also cut the Salt Cavern study which was originally at $22 million and is now sitting at $11 million, with $6 million coming from SIIF, and $5.3 million coming from ARPA dollars. The Rare Earth study which was originally at $3 million was cut to $1.5 million. The $30 million guarantee from SIIF for the Pipeline Authority to purchase capacity remains, but it has an effective date of next biennium. The Senate also cut the iPipe project down from $5 million to $3 million, currently coming from SIIF and the Transmission Authority items have remained in the budget as the House originally had in their version, so the match for the IIJA Grid Resilience grant program and $300,000 from the general fund to fund the next biennium's contract with the Transmission Authority are intact.

Mr. Haase asked the Commission members if they had any questions regarding the legislative update, and Governor Burgum asked what the Commission members could do to help restore some of the cuts that were made on the programs that have proven higher return on investment for taxpayer dollars and are essential to moving forward with value-added agricultural and value-added energy in North Dakota. Mr.

Haase said one of the most important items would be continuing to remind the Senate about the importance of these programs, not just for Western North Dakota, but for the entire state. He mentioned that it is also important to remind the legislators that these industries not only benefit our entire state, but also fund critical infrastructure statewide, so by investing back into these industries, it ensures that the industry can continue to grow in the future and continue to have higher returns.

Governor Burgum stated that there is no shortage of revenues, all the buckets are filled, and SIIF is going to have record deposits all the way through the end of June. He stated that there is capital available in SIIF to fund these smaller projects as was recommended in the original budget. Governor Burgum mentioned that it is important to remind people that it is an artificial scarcity argument that is being made rather than looking at the actual excess revenue streams that are currently pouring into the state.

Mr. Haase presented for consideration of approval the upcoming grant round schedule.

It was moved by Commissioner Goehring and seconded by Attorney General Wrigley that the Industrial Commission approves the following grant round schedule:

Clean Sustainable Energy Authority Grant Round 4:
Application Deadline – May 19, 2023
Technical Review Committee Meeting – July 18, 2023
Clean Sustainable Energy Authority Meeting – July 25, 2023

Outdoor Heritage Fund Grant Round 22:
Application Deadline – May 26, 2023
Technical Review Committee Meeting – June 9, 2023
Outdoor Heritage Fund Advisory Board – June 16, 2023

Renewable Energy Program Grant Round 51:
Application Deadline – May 26, 2023
Renewable Energy Council Meeting – June 22, 2023

Oil and Gas Research Council Grant Round 58:
Application Deadline – June 1, 2023
Oil and Gas Research Council Meeting – July 21, 2023

CLEAN SUSTAINABLE ENERGY PROGRAM

Mr. Haase presented for consideration of approval the termination of Contract C-01-01 Bakken Energy Dakota H_2 Hub. The letter requested that the Industrial Commission voluntarily terminate their contract and de-obligate the project. They were unable to come to terms with Basin Electric in negotiating the sale of Dakota Gasification Company (DGC), so their project is no longer going to move forward. To date they have spent $4.7 million of their $10 million grant, so $5.3 million remains available. Mr. Haase reminded the Commission that the grant was not typical CSEA dollars, but federal ARPA dollars that had been appropriated to CSEA during the 2021 special session, specifically for hydrogen.

It was moved by Commissioner Goehring and seconded by Attorney General Wrigley that the Industrial Commission approves the termination of Clean Sustainable Energy Authority Contract No. C-01-01 "Dakota H_2 Hub".

On a roll call vote, Governor Burgum, Attorney General Wrigley, and Commissioner Goehring voted aye. The motion carried unanimously.

LIGNITE RESEARCH, DEVELOPMENT AND MARKETING PROGRAM

Mr. Haase gave a report on Contract LRC-D96-3 Dakota Gasification Investment Agreement. Back in 1995, the Commission entered into an investment contract with Dakota Gasification Company (DGC) for $4.2 million from the Lignite Research fund, with the purpose of constructing an ammonia plant. According to the contract, it was to be repaid over time up to a total amount of $7.5 million, which was based on a formula of a percentage of the company's financial profits. Since 1995, DGC has been repaying that to the Commission and those funds have been deposited into the Lignite Research fund. This year, the final payment of $1.1 million was received, which satisfies that agreement. The Lignite Research Council now has an extra $1.1 million available today for more research projects. Governor Burgum stated that it is exciting to see a long-term contract come to full completion, and he credited both Basin and the NDIC office for keeping track of a contract for almost 30 years. Governor Burgum asked if anyone from industry had any comments before bringing this item to close, to which there were no comments. Mr. Haase commented that this now brings the estimated total uncommitted dollars for the next grant round to around $10.5 million. The next Lignite meeting is scheduled for May 11, 2023.

Under other business, Mr. Haase presented the new executive order related to the membership of the Lignite Research Council. This council is a bit unique, as it is appointed by executive order. This council has been operating under previous executive order from 2013 in the Dalrymple administration. The membership was becoming outdated, and quorum issues were becoming apparent as there were 32 voting members, which means a quorum of 17 was needed. Mr. Haase stated that they worked with industry, and the Lignite Research Council itself, to find recommendations on what the ideal new membership would look like. He stated that they are appreciative of the new executive order placed by Governor Burgum. The Governor extended his gratitude to Reice and others for their efforts, along with the industry representatives that are serving on the Lignite Research Council.

NORTH DAKOTA PUBLIC FINANCE AUTHORITY

Ms. DeAnn Ament presented for consideration of approval the following loan applications:

i. East Central Regional Water District – Drinking Water, $10,026,000 increase to previously approved $5,133,000 loan. The purpose of this project is to construct six miles of sixteen-inch pipe south of the District water treatment plant which will address both flow and pressure issues currently experienced during peak flow season. There are also improvements to provide capacity for peak day demands for Hatton, Grandin, and the District as well as provide back-up emergency flows for Hatton and Grandin and potentially another connection with Hillsboro. The requested loan term is 30 years, the District will issue revenue bonds payable with user fees for this loan, and the annual payment will average $217,691.

It was moved by Commissioner Goehring and seconded by Attorney General Wrigley that the Commission approve a $10,026,000 increase to a previously approved $5,133,000 Drinking Water State Revolving Fund Program loan (totaling $15,159,000) to the East Central Regional Water District.

On a roll call vote, Governor Burgum, Attorney General Wrigley, and Commissioner Goehring voted

aye. The motion carried unanimously.

A RESOLUTION WAS MADE

WHEREAS, the Industrial Commission has heretofore authorized the creation of a Drinking Water State Revolving Fund Program (the "Program") pursuant to N.D.C.C. chs. 6-09.4, 61-28.1, and 61-28.2; and

WHEREAS, the State Revolving Fund is governed in part by the Master Trust Indenture dated as of July 1, 2011 (the "Indenture"), between the North Dakota Public Finance Authority (the "NDPFA") and the Bank of North Dakota (the "Trustee"); and

WHEREAS, the East Central Regional Water District (the "Political Subdivision") has requested a $10,026,000 loan increase to their previously approved $5,133,000 loan (total $15,159,000) from the Program to construct six miles of sixteen-inch pipe south of the District water treatment plant which will address both flow and pressure issues currently experienced during peak flow season. Also, improvements to provide capacity for peak day demands for Hatton, Grandin and the District as well as provide back-up emergency flows for Hatton and Grandin and potentially another connection with Hillsboro; and

WHEREAS, NDPFA's Advisory Committee is recommending approval of the Loan; and

WHEREAS, there has been presented to this Commission a form of Loan Agreement proposed to be adopted by the Political Subdivision and entered into with the NDPFA;

NOW, THEREFORE, BE IT RESOLVED by the Industrial Commission of North Dakota as follows:

1. **The Loan is hereby approved, as recommended by the Advisory Committee.**

2. **The form of Loan Agreement to be entered into with the Political Subdivision is hereby approved in substantially the form on file and the Executive Director is hereby authorized to execute the same with all such changes and revisions therein as the Executive Director shall approve.**

3. **The Executive Director is authorized to fund the Loan from funds on hand in the Drinking Water Loan Fund established under the Indenture upon receipt of the Municipal Securities described in the Political Subdivisions bond resolution, to submit to the Trustee a NDPFA Request pursuant to the Indenture, and to make such other determinations as are required under the Indenture.**

4. **The Commission declares its intent pursuant to Treasury Regulations '1.150-2 that any Loan funds advanced from the Federally Capitalized Loan Account shall be reimbursed from the proceeds of bonds issued by the NDPFA under the Indenture.**

Adopted: April 25, 2023

ii. Dakota Rural Water District - Drinking Water, $2,952,000 increase to previously approved $1,000,000 loan. The purpose of this project is to expand the south water treatment plant to provide additional capacity for connecting to Hannaford and other recently added users. The requested loan term is 30 years, the District will issue revenue bonds payable from water user fees, and the annual payment will average $19,591.

It was moved by Commissioner Goehring and seconded by Attorney General Wrigley that the Commission approve a $2,952,000 increase to a previously approved $1,000,000 Drinking Water State Revolving Fund Program loan (totaling $3,952,000) to the Dakota Rural Water District.

On a roll call vote, Governor Burgum, Attorney General Wrigley, and Commissioner Goehring voted aye. The motion carried unanimously.

A RESOLUTION WAS MADE

WHEREAS, the Industrial Commission has heretofore authorized the creation of a Drinking Water State Revolving Fund Program (the "Program") pursuant to N.D.C.C. chs. 6-09.4, 61-28.1, and 61-28.2; and

WHEREAS, the State Revolving Fund is governed in part by the Master Trust Indenture dated as of July 1, 2011 (the "Indenture"), between the North Dakota Public Finance Authority (the "NDPFA") and the Bank of North Dakota (the "Trustee"); and

WHEREAS, the Dakota Rural Water District (the "Political Subdivision") has requested a loan in the amount of $3,952,000 from the Program to expand the south water treatment plant to provide additional capacity for connecting to Hannaford and other recently added users. The project will include a pipeline and a meter vault for the Hannaford water supply; and

WHEREAS, NDPFA's Advisory Committee is recommending approval of the Loan; and

WHEREAS, there has been presented to this Commission a form of Loan Agreement proposed to be adopted by the Political Subdivision and entered into with the NDPFA;

NOW, THEREFORE, BE IT RESOLVED by the Industrial Commission of North Dakota as follows:

1. **The Loan is hereby approved, as recommended by the Advisory Committee.**

2. **The form of Loan Agreement to be entered into with the Political Subdivision is hereby approved in substantially the form on file and the Executive Director is hereby authorized to execute the same with all such changes and revisions therein as the Executive Director shall approve.**

3. **The Executive Director is authorized to fund the Loan from funds on hand in the Drinking Water Loan Fund established under the Indenture upon receipt of the Municipal Securities described in the Political Subdivisions bond resolution, to submit to the Trustee a NDPFA Request pursuant to the Indenture, and to make such other determinations as are required under the Indenture.**

4. The Commission declares its intent pursuant to Treasury Regulations '1.150-2 that any Loan funds advanced from the Federally Capitalized Loan Account shall be reimbursed from the proceeds of bonds issued by the NDPFA under the Indenture.

Adopted: April 25, 2023

iii. City of Beulah – Clean Water, $4,184,000. The purpose of this project is to replace water mains, sanitary sewer mains, storm sewer mains, service lines, valves, hydrants and appurtenances along four blocks of Main Street. The requested term loan is 30 years, the City will issue an improvement bond in the amount of $2,092,000 and a revenue bond in the amount of $2,092,000. The annual payments will average $92,119 for the improvement bond and $88,715 for the revenue bond.

It was moved by Commissioner Goehring and seconded by Attorney General Wrigley that the Commission approve a $4,184,000 loan to the City of Beulah under the Clean Waster State Revolving Fund.

On a roll call vote, Governor Burgum, Attorney General Wrigley, and Commissioner Goehring voted aye. The motion carried unanimously.

A RESOLUTION WAS MADE

WHEREAS, the Industrial Commission has heretofore authorized the creation of a Clean Water State Revolving Fund Program (the "Program") pursuant to N.D.C.C. chs. 6-09.4 and 61-28.2; and

WHEREAS, the Clean Water State Revolving Fund is governed in part by the Master Trust Indenture dated as of July 1, 2011 (the "Indenture"), between the North Dakota Public Finance Authority (NDPFA) and the Bank of North Dakota (the Trustee); and

WHEREAS, the City of Beulah (the "Political Subdivision") has requested a loan in the amount of $4,184,000 from the Program to replace water main, sanitary sewer main, storm sewer main, associated services lines, valves, hydrants, and appurtenances along four blocks of Main Street; and

WHEREAS, the NDPFA's Advisory Committee is recommending approval of the Loan; and

WHEREAS, there has been presented to this Commission a form of Loan Agreement proposed to be adopted by the Political Subdivision and entered into with the NDPFA;

NOW, THEREFORE, BE IT RESOLVED by the Industrial Commission of North Dakota as follows:

1. The Loan is hereby approved, as recommended by the Advisory Committee.

2. The form of Loan Agreement to be entered into with the Political Subdivision is hereby approved in substantially the form on file and the Executive Director is hereby

authorized to execute the same with all such changes and revisions therein as the Executive Director shall approve.

3. **The Executive Director is authorized to fund the Loan from funds on hand in the Clean Water Loan Fund established under the Indenture upon receipt of the Municipal Securities described in the Political Subdivisions bond resolution, to submit to the Trustee a NDPFA Request pursuant to the Indenture, and to make such other determinations as are required under the Indenture.**

4. **The Commission declares its intent pursuant to Treasury Regulations '1.150-2 that any Loan funds advanced from the Federally Capitalized Loan Account shall be reimbursed from the proceeds of bonds issued by the NDPFA under the Indenture.**

Adopted: April 25, 2023

Ms. Ament gave a presentation of State Revolving Fund loans approved by Advisory Committee:

i. City of Beulah – Drinking Water, $1,923,000
ii. East Central Regional Water District - Drinking Water, $222,000 increase to $1,750,000
iii. City of St. John – Drinking Water, $920,000
iv. City of Minnewaukan – Clean Water, $270,000

Ms. Ament gave a NDPFA Legislative Update. The bills that are currently being tracked by the Public Finance Authority are HB 1014, HB 1015, HB 1070, HB 1012, HB 1024, and HB 1379.

NORTH DAKOTA TRANSMISSION AUTHORITY

Mr. John Weeda presented for consideration of approval the Industrial Commission Support Letter for a Midcontinent Independent System Operator Joint Targeted Interconnection Queue project.

The letter reads as follows:

"Dear Secretary Granholm,

The North Dakota Industrial Commission (Commission) strongly supports the Joint Targeted Interconnection Queue (JTIQ) transmission project application submitted in response to the Department of Energy's funding announcement titled "Grid Resilience and Innovative Partnerships (GRIP)".

The JTIQ project portfolio represents an innovative and highly promising solution to reliably interconnect new generation resources between the Midcontinent Independent System Operator (MISO) and Southwest Power Pool (SPP) independent system operators.

The collaborative planning by MISO and SPP, in cooperation with numerous utility, developer, and state partners, has led to the development of an effective ongoing process to continually identify and consequently successfully implement necessary grid infrastructure investments that greatly improve grid reliability, resilience, and affordability throughout our region.

The JTIQ transmission projects included in the application will solidly support both clean energy deployment in North Dakota and local robust economic development within and around communities in

southeast North Dakota. Furthermore, these projects will significantly improve grid reliability and resilience by substantially expanding interregional transfer capability between MISO and SPP.

The exceedingly industrious efforts of the dedicated project team in developing this process and corresponding application plainly demonstrate a stalwart commitment to ensuring that maximum grid reliability and cost benefits flow to all energy customers throughout both the MISO and SPP regions.

For these many salient reasons, the Commission fully supports and respectfully recommends DOE approve the JTIQ transmission project application.

Sincerely,

Governor Doug Burgum
Attorney General Drew Wrigley
Agriculture Commissioner Doug Goehring"

It was moved by Commissioner Goehring and seconded by Attorney General Wrigley that the Commission accepts the Support Letter for a Midcontinent Independent System Operator Joint Targeted Interconnection Queue project.

On a roll call vote, Governor Burgum, Attorney General Wrigley, and Commissioner Goehring voted aye. The motion carried unanimously.

Mr. Claire Vigesaa gave a NDTA Legislative Update. The bills of interest to the ND Transmission Authority included in the update were HB 1097, HB 1315, HB 1353, HB 1512, SB 2261, and HB 1014. Mr. Vigesaa also mentioned that they have been pleased to witness the recognition by our Governor, Leadership, and Legislative Assembly that grid stability and reliability is vital for the safety and well-being of our citizens and communities; further that robust economic growth will only occur within environments with stable, reliable, and affordable energy.

Under other business, Mr. Weeda, the current Director of the NDTA, recommended the Commission consider Mr. Vigesaa to be named the new Director of the NDTA, as he would like to step down from the position. Mr. Weeda stated that he would still like to play a role as the deputy director, or assistant, to Mr. Vigesaa. The Commission thanked Mr. Weeda for his service in the position, and for giving them time to plan accordingly for this transition. Action will be taken on filling the NDTA Director position at a future Industrial Commission meeting.

Mr. Weeda gave the following letter to the Commission members:

"Commission Members:

On July 1st, 2023, general funding is anticipated to be made available for the Commission to contract for the next biennium's Transmission Authority Director. This position is hired by the Commission as an independent contractor.

I have served in the role of Director of the North Dakota Transmission Authority since being appointed in early 2018. During that time the need for transmission development in North Dakota has grown. We are pleased to report that at this time we have eight transmission projects on the list of those expected to happen. As the workload grew, Claire Vigesaa joined the Transmission Authority as the deputy

director. His work has broadened the information that the Transmission Authority has been able to gather and share with the Commission and the legislature. He is well connected with the industry and government officials in North Dakota and has been much appreciated.

I would like to announce my desire to retire as Director of the North Dakota Transmission Authority, effective June 30th, 2023. I highly recommend that the Commission consider Claire Vigesaa for the role of Director, and I would respectfully request that the Commission allow me to continue with the Transmission Authority in the role of Deputy Director. If approved, it would be my intention to continue to support Claire in much the same way I have been recently for the foreseeable future. This change will be good for the future of the Transmission Authority and would allow me to gradually transition to full retirement over the next several years.

Thank you for your consideration.

John Weeda

Director, North Dakota Transmission Authority"

**Adjustments were made to the agenda order due to running ahead of schedule.

BANK OF NORTH DAKOTA

Mr. Todd Steinwand and Mr. Kelvin Hullet gave a BND Legislative Update. The bills of interest that impact BND Capital are HB 1014, HB 1003, HB 1242, SB 2009, and SB 2020. The bills of interest that impact State Agency Borrowing Authority from BND are HB 1012, HB 1014, HB 1199, SB 2008, SB 2016, SB 2019, SB 2020, and SB 2196. The bills of interest impacting Legislatively Directed Programs from BND through other funding sources are HB 1012, HB 1018, HB 1021, HB 1276, HB 1014, SB 2165, SB 2196, SB 2020, SB 2242, SB 2284, and SB 2330.

DEPARTMENT OF MINERAL RESOURCES

Dr. Lynn Helms presented for consideration of approval the following Orders and Cases:

i. Order 32506 for Case 29901 regarding an application of Oasis Petroleum North America LLC to establish an overlapping laydown 3840-acre spacing unit described as Sections 25, 26, 27, 34, 35 and 36, T.153N., R.102W., Williams and McKenzie Counties, ND, and authorize twelve horizontal wells to be drilled on such unit, or granting such other relief as may be appropriate.

ii. Order 32532 for Case 29927 regarding an application of Grayson Mill Operating, LLC to establish an overlapping 2560-acre spacing unit comprised of Sections 1, 12, 13, 24, T.153N., R.102W., Williams and McKenzie Counties, ND, authorizing the drilling of a total not to exceed four wells on said proposed overlapping 2560-acre spacing unit, and/or such further relief.

It was moved by Commissioner Goehring and seconded by Attorney General Wrigley that the Industrial Commission approves Order No. 32506 issued in Case No. 29901 establishing an overlapping laydown 1920-acre spacing unit described as Sections 25, 26, 27, T.153N., R.102W., Williams and

McKenzie Counties, ND, and an overlapping laydown 1920-acre spacing unit described as Sections 34, 35 and 36, T.153N., R.102W., Williams and McKenzie Counties, ND, and authorize six horizontal wells to be drilled on each unit within the Indian Hill-Bakken Pool, and Order No. 32532 issued in Case No. 29927 approving an application of Grayson Mill Operating, LLC for an order amending the field rules for the Hardscrabble-Bakken Pool, Williams and McKenzie Counties, ND, so as to create and establish an overlapping 2560-acre spacing unit comprised of Sections 1, 12, 13 and 24, T.153N., R.102W., authorizing the drilling of a total not to exceed four wells on said proposed overlapping 2560-acre spacing unit.

On a roll call vote, Governor Burgum, Attorney General Wrigley, and Commissioner Goehring voted aye. The motion carried unanimously.

iii. Order 32507 for Case 29902 regarding an application of Petro-Hunt, LLC for an order of the Commission construing and interpreting its past orders relating to the pooling and allocation of production from the USA 153-96-13A-24-1HS well (File No. 31793), drilled and completed on a spacing unit for the Charlson-Bakken Pool described as Sections 13 and 24, T.153N., R.96W. and Sections 18 and 19, T.153N., R.95W., McKenzie County, ND, Charlson and Keene Fields, including without limitation Order Nos. 30323 and 13922, or granting such other relief as may be appropriate.

It was moved by Commissioner Goehring and seconded by Attorney General Wrigley that the Industrial Commission issues Order No. 32507,in Case No. 29902, continuing the Commission's decision for 90 days in the matter of an application of Petro-Hunt, L.L.C. for an order of the Commission construing and interpreting its past orders relating to the pooling and allocation of production from the USA 153-96-13A-24-1HS well (File No. 31793), drilled and completed on a spacing unit for the Charlson-Bakken Pool described as Sections 13 and 24, T.153N., R.96W. and Sections 18 and 19, T.153N., R.95W., McKenzie County, ND, Charlson and Keene Fields, including without limitation Order Nos. 30323 and 13922.

On a roll call vote, Governor Burgum, Attorney General Wrigley, and Commissioner Goehring voted aye. The motion carried unanimously.

iv. Order 32534 for Case 29929 regarding an application of Continental Resources, Inc. for an order authorizing the use of an open receptacle to be located in the S/2 of Sections 5, T.145N., R.96W., Jim Creek Field, Dunn County, ND, for storage of produced water to allow fracture stimulation of the Micahlucas 5-5H well (File No. 39136), Micahlucas 6-5H1 well (File No. 39137), Micahlucas 7-5H well (File No. 39138), Micahlucas 8-5H1 well (File No. 39139), Micahlucas 9-5H well (File No. 39140), and Micahlucas 10-5H1 well (File No. 39141), as an exception to the provisions of Section 43-02-03-19.3 of the NDAC and such other and further relief.

v. Order 32535 for Case 29930 regarding an application of Continental Resources, Inc. for an order authorizing the use of an open receptacle to be located in the SESE of Section 5, T.145N., R.96W., Jim Creek Field, Dunn County, ND, for storage of produced water to allow fracture stimulation of the Micahlucas 11-5H well (File No. 39162), Micahlucas 12-5H1 well (File No. 39163), Micahlucas 13-5HSL well (File No. 39164), and Micahlucas 14-5HSL1 well (File No. 39165), as an exception to the provisions of Section 43-02-03-19.3 of the NDAC and such other and further relief.

It was moved by Commissioner Goehring and seconded by Attorney General Wrigley that the Industrial Commission approves Order No. 32534 issued in Case No. 29929 approving an application of Continental Resources, Inc. for an order authorizing the use of an open receptacle to be located in the S/2 of Section 5, T.145N., R.96W., Jim Creek Field, Dunn County, ND, for storage of produced water to allow fracture stimulation of the Micahlucas 5-5H well (File No. 39136), Micahlucas 6-5H1 well (File No. 39137), Micahlucas 7-5H well (File No. 39138), Micahlucas 8-5H1 well (File No. 39139), Micahlucas 9-5H well (File No. 39140), and, Micahlucas 10-5H1 well (File No. 39141), as an exception to the provisions of Section 43-02-03-19.3 of the NDAC, contingent upon approval of final design by the Director of the Department of Mineral Resources, and Order No. 32535 issued in Case No. 29930 approving an application of Continental Resources, Inc. for an order authorizing the use of an open receptacle to be located in the SE/4 SE/4 of Section 5, T.145N., R.96W., Jim Creek Field, Dunn County, ND, for storage of produced water to allow fracture stimulation of the Micahlucas 11-5H well (File No. 39162), Micahlucas 12-5H1 well (File No. 39163), Micahlucas 13-5HSL well (File No. 39164), and Micahlucas 14-5HSL1 well (File No. 39165), as an exception to the provisions of Section 43-02-03-19.3 of the NDAC, contingent upon approval of final design by the Director of the Department of Mineral Resources.

On a roll call vote, Governor Burgum, Attorney General Wrigley, and Commissioner Goehring voted aye. The motion carried unanimously.

Dr. Helms gave an update on litigation:

i. Case No. 31-2020-CV-0018 – Northern Oil and Gas, Inc. vs. Continental Resources, Inc; Board of University and School Lands and ND Industrial Commission et al – Ordinary High Water Mark challenge
ii. Blue Appaloosa – appeal of Industrial Commission Order 31208
iii. Case No. 27-2022-CV-00305 – Blue Steel Oil and Gas, LLC v. North Dakota Industrial Commission, Slawson Exploration Company, Inc and White Butte Oil Operations, LLC – appeal of Industrial Commission Order 31501
iv. Liberty Resources vs. NDIC et al – appeal of Industrial Commission Order 31792
v. North Dakota Industrial Commission v. U.S. Department of Interior – quarterly lease sales
vi. Dominek v Equinor et al – allocation of production from overlapping spacing units
vii. Spec Tech v NDIC – appeal of Industrial Commission Order 31900

Dr. Helms gave an update on the Bureau of Land Management North Dakota Resource Management Plan Revision. The deadline for comments was extended 30 days to May 20, 2023, and Dr. Helms said they have submitted all their comments to the special Assistant Attorney General who is also working with Lignite and Trust Lands. They are expecting a very robust set of comments.

Dr. Helms gave an update on the Dakota Access Pipeline Environmental Impact Statement cooperating agency comments. The deadline for comments was extended 30 days to May 6, 2023. There is a cooperating agency technical meeting on May 3, 2023. Dr. Helms said they have included every tribal nation upstream of St. Louis as a cooperating agency.

Dr. Helms gave a Department of Mineral Resources Legislative Update. There are still three bills that DMR has testified in favor of which are HB 1014, SB 2009, and SB 2089. Dr. Helms said that the Senate cut funding for the Salt Caverns from two to one project, funded from $6 million from SIIF and $5.3

million from decommitted ARPA funds, so there will be sufficent funds for at least one Salt Cavern. Governor Burgum stated that he was pushing hard for the full $22 million over the last couple days but was told from two different sources that some combination of DMR, NDIC, or the ND Petroleum Council said that only funding one Salt Cavern would be okay. Governor Burgum asked where the disconnect was, to which Ron Ness, a member of the audience, replied that he was the one who said it based on conversations with EERC and others. Governor Burgum stated that those comments are being used to disrupt his effort to get back to the $22 million since industry is saying they can live with just one Salt Cavern.

It was moved by Attorney General Wrigley and seconded by Commissioner Goehring that under the authority of North Dakota Century Code Sections 6-09-35, 44-04-18.4, 44-04-19.1, 44-04-19.2, the Industrial Commission enter into executive session for the purposes of negotiation strategy regarding Department of Mineral Resources Case 29036, for consideration of a Lignite Research, Development and Marketing Program confidentiality request pursuant to North Dakota Century Code 54-17.5-06, and for Bank of North Dakota confidential business.

On a roll call vote, Governor Burgum, Attorney General Wrigley, and Commissioner Goehring voted aye. The motion carried unanimously. The Governor stated:

The Commission is meeting in executive session regarding negotiation strategy for Department of Mineral Resources Case 29036. Only Commission members, their staff, Commission staff, and Department of Mineral Resources staff will participate in that executive session.

After the Department of Mineral Resources executive session, the Commission will meet in executive session to consider a Lignite Research, Development and Marketing Program confidentiality request pursuant to North Dakota Century Code 54-17.5-06. Only Commission members, their staff, Commission staff, and Lignite Research Council staff will participate in that executive session.

After the Lignite Research, Development and Marketing Program executive session, the Commission will meet in executive session regarding Bank of North Dakota business pursuant to N.D.C.C. 6-09-35 to consider those items listed on the agenda under Bank of North Dakota confidential business. Only Commission members, their staff, Commission staff, and BND staff will participate in that executive session.

Any formal action taken by the Commission will occur after it reconvenes in open session.

Governor Burgum reminded the Commission members and those present in the executive sessions that the discussion must be limited to the announced purposes which is anticipated to last approximately 1 hour and 15 minutes.

The executive session began at 2:40 p.m.

The Meeting Closed to the Public for Executive Session Pursuant to NDCC 6-09-35, 44-04-18.4, 44-04-19.1, 44-04-19.2, and 54-17.5-06.

DEPARTMENT OF MINERAL RESOURCES EXECUTIVE SESSION

Industrial Commission Members Present
Governor Doug Burgum
Attorney General Drew H. Wrigley
Agriculture Commissioner Doug Goehring

DMR Members Present
Lynn Helms
Bruce Hicks

Others in attendance

Ryan Norrell	Governor's Office
John Reiten	Governor's Office
Dutch Bialke	Dept. of Agriculture
Steve Nelson	Attorney General's Office
Karen Tyler	Industrial Commission Office
Reice Haase	Industrial Commission Office
Brenna Jessen	Industrial Commission Office

LIGNITE RESEARCH, DEVELOPMENT AND MARKETING PROGRAM EXECTUIVE SESSION

Industrial Commission Members Present
Governor Doug Burgum
Attorney General Drew H. Wrigley
Agriculture Commissioner Doug Goehring

Others in attendance

Ryan Norrell	Governor's Office
Dutch Bialke	Dept. of Agriculture
Karen Tyler	Industrial Commission Office
Reice Haase	Industrial Commission Office
Brenna Jessen	Industrial Commission Office

BANK OF NORTH DAKOTA EXECUTIVE SESSION

Industrial Commission Members Present
Governor Doug Burgum
Attorney General Drew H. Wrigley
Agriculture Commissioner Doug Goehring

Bank of North Dakota Members Present
Todd Steinwand, BND
Kelvin Hullet, BND
Craig Hanson, BND
Kirby Evanger, BND

Others in attendance

Ryan Norrell	Governor's Office
Dutch Bialke	Dept. of Agriculture
Karen Tyler	Industrial Commission Office
Reice Haase	Industrial Commission Office
Brenna Jessen	Industrial Commission Office

The executive session ended at 3:35 p.m. and the Commission reconvened in open session.

During the Department of Mineral Resources executive session, the Commission discussed negotiation strategy related to Case 29036.

During the Lignite Research, Development and Marketing Program executive session, the Commission considered a confidentiality request.

It was moved by Attorney General Wrigley and seconded by Governor Burgum that the Industrial Commission grant the confidentiality request for Grant Round 102 of the Lignite Research, Development and Marketing Program and determine that the information described in the request consists of trade secrets and proprietary information and is confidential pursuant to NDCC 54-17.5-06.

On a roll call vote, Governor Burgum, Attorney General Wrigley, and Commissioner Goehring voted aye. The motion carried unanimously.

During the Bank of North Dakota executive session, the Commission made a motion regarding two loan requests.

On a roll call vote, Governor Burgum, Attorney General Wrigley, and Commissioner Goehring voted aye. The motion carried unanimously.

BANK OF NORTH DAKOTA CONT.

Mr. Steinwand gave a presentation of the First Quarter 2023 Performance Highlights. BND ended Q1 2023 with total assets of about $10.3 billion which was about $111 million above budget. Commercial loans were lower than budget, but there was strong commercial participation in Q1, agriculture loans were below budget due to farmers and ranchers loan volumes, and student loans were down compared to budget by about $7.1 million. BND's leverage ratio, which shows financial strength, was at 12.01%, which reached the benchmark that BND had in place of 12.00%. BND's Net Loans to Earning Assets, which measures the liquidity of a financial institution, was at 53.98%, which was well within the benchmark that BND had in place of 90% or lower. Net loans increased 121 million, or 2.3%, since last quarter. A full financial report is available on the website.

Attorney General Wrigley asked Todd Steinwand and his staff members what guideposts they use to help maintain the financial strength of the Bank with so many legislators introducing legislation that proposes to take funds from BND profits. Attorney General Wrigley also commented that it appears the

Industrial Commission's authority to oversee the operations of BND is being imposed on from many directions. Mr. Steinwand said he agrees, and because BND is becoming more profitable, it is to the point where the Legislators are wanting to take more of BND's capital. Governor Burgum said it is an important question because it appears legislators are starting to look at the Bank from not just a legislatively directed program standpoint as they keep adding items for economic development, but as a tax type. Governor Burgum said they then try to allocate the Bank's profits as a revenue source, which he mentioned could make sense if ND financially needed those funds, but our fiscal health we do not, and the revenues that build in SIIF always exceed what is taken from BND.

Governor Burgum mentioned that North Dakota is one of the most well reserved states in the country between common schools, budget stabilization, legacy funds – which legislators can access in an emergency, foundation aide stabilization, general fund ending balances, and SIIF, so the Bank of North Dakota profits should not be looked at as a reserve fund. There was discussion around the potential of setting up parameters for taking bank profits prior to the 2025 legislative session. Ideas mentioned included setting a fixed "up to" percentage of profits that could be accessed each biennium, or accessing bank profits only if the existing buckets fall below a certain threshold. Further discussion will be had at a later date.

Mr. Steinwand presented for consideration of approval a Resolution Designating a Depository of the Bank of North Dakota for the following entities:

i. Federal Home Loan Bank
ii. JP Morgan Chase
iii. US Bank
iv. First Horizon National
v. Wells Fargo
vi. Federal Reserve Bank (Open Accounts)
vii. Federal Reserve Bank (Advances)

It was moved by Commissioner Goehring and seconded by Attorney General Wrigley that the Industrial Commission approve the Resolutions Designating Depositories of the Bank of North Dakota with the following institutions:

Federal Home Loan Bank
JP Morgan Chase
US Bank
First Horizon National
Wells Fargo
Federal Reserve Bank (Open Accounts)
Federal Reserve Bank (Advances)

On a roll call vote, Governor Burgum, Attorney General Wrigley, and Commissioner Goehring voted aye. The motion carried unanimously.

Mr. Steinwand gave a presentation of the February 15, 2023 Non-confidential Finance and Credit Committee Minutes.

Mr. Steinwand gave a presentation of the February 16, 2023 Non-confidential Leadership Development and Compensation Committee Minutes.

Mr. Steinwand gave a presentation of the February 16, 2023 Non-confidential Advisory Board Minutes.

With no further business, the Industrial Commission meeting adjourned at 4:14 p.m.

North Dakota Industrial Commission

Karen Tyler, Interim Director and Secretary

INDUSTRIAL COMMISSION OF NORTH DAKOTA

Doug Burgum
Governor

Drew H. Wrigley
Attorney General

Doug Goehring
Agriculture Commissioner

Memorandum

TO: Doug Burgum, Governor and Chairman
Drew Wrigley, Attorney General
Doug Goehring, Agriculture Commissioner

FR: Reice Haase, Deputy Executive Director

DT: May 25th, 2023

RE: Report on 68th Legislative Session

The 68th Legislative Session concluded on April 30th, 2023. Highlights relevant to the Industrial Commission are summarized as follows:

- All agency red-tape reduction items were approved
- Updated FTE Count:
  - Office of the Industrial Commission: 6 (+2)
  - PFA: 3.75 (+1)
  - DMR: 108 (+6.5)
  - BND: 187 (+14)
  - HFA: 54 (+5)
  - Mill: 170 (+14)
  - Total: 528.75 (+42.5)
- Office Digitization and IT:
  - $1.25 million for new grant management software
  - $75,000 for records digitization
  - $80,000 for DMR server transition to ITD cloud service
  - $804,278 for BND IT projects
- Litigation Expenses:
  - $3 million General Fund for lignite litigation expenses with emergency clause
  - $3 million General Fund for oil and gas litigation expenses with emergency clause
- CSEA:
  - $30 million for grants
  - $250 million available for loans ($30 million LOC paid off, extended another $140 million, $80 million decommitted from Bakken Energy CSEA project)
  - New co-chairs, one each from House and Senate
  - CSEA bucket removed from legacy streams
  - Funding from the North Dakota Development Fund that enhances clean energy must be first recommended by CSEA
  - CSEA directed to develop new fertilizer development incentive program:

        - Limited to $125 million
        - Must borrow from BND
        - Must use hydrogen produced by electrolysis of water
        - Must forgive loan once project is completed
        - Must request appropriation from SIIF to repay the loan
- Carbon Capture Education:
    - $100,000 each from lignite, oil and gas, and renewable energy funds
    - Councils to provide recommendations to Industrial Commission for carbon capture and utilization education and marketing
- Transmission Authority:
    - $300,000 from General Fund for contract employee(s)
    - $7.5 million federal IIJA Grid Resilience Grant, with $1.1million general fund match
    - Legislative intent for support of DC transmission line project
- SERC:
    - Expiration extended to 2027
    - Increased biennial appropriation from $5 million to $7.5 million
    - Salt Cavern, $6 million from SIIF, $5.3 million from decommitted Bakken project
    - Rare Earth study, $1.5 million from SIIF to SERC
- Pipeline Authority:
    - $60 million/year SIIF guarantee through BND's PACE program for pipeline capacity purchases
    - Effective 2025
- DMR/Oil and Gas:
    - OGRF cap raised by $3 million to $17.5 million
    - SB 2089: Converted natural gas capture tax credit into a grant program
    - iPipe, $3 million from SIIF
    - New well status for wells with future EOR potential
    - Tax credit to incent re-stimulation of wells
- Lignite:
    - Lignite Plant of the Future, $500,000
    - HB 1511: New sales and use tax exemption for rare earth or critical mineral processing
- BND:
    - 14 new FTEs for bank growth and valuation program
    - 93% of Bank profits transferred by the Legislature this budget cycle
    - Study of employee recruitment and retention program
    - Legislative intent regarding use of BND profits
- Housing Finance:
    - Transferred homeless grant program from Commerce
    - Single family housing now eligible under HIF
- Mill:
    - 14 new FTEs for adding 4th milling shift, 2nd grain mixing shift, and Midds operations
    - 50% of profits transferred to General Fund
- WAWS:
    - Oversight transferred from Industrial Commission to Water Commission

Sixty-eighth Legislative Assembly of North Dakota
In Regular Session Commencing Tuesday, January 3, 2023

HOUSE BILL NO. 1014
(Appropriations Committee)

AN ACT to provide an appropriation for defraying the expenses of the industrial commission and the agencies under its control; to amend and reenact sections 6-09.7-05, 54-17-40, and 54-17.7-01, subsections 3 and 4 of section 54-17.7-04, and subsection 3 of section 54-63.1-07 of the North Dakota Century Code and subsection 36 of section 1 of chapter 550 of the 2021 Special Session Session Laws, relating to fuel production facility loan guarantee reserve funding, the housing incentive fund, the powers of the North Dakota pipeline authority, definitions for the clean sustainable energy authority, a clean sustainable energy authority line of credit, and an appropriation from the state fiscal recovery fund; to provide a contingent appropriation; to provide for a transfer; to provide an exemption; to provide for a study; to provide for a report; to provide a statement of legislative intent; to provide an effective date; and to declare an emergency.

BE IT ENACTED BY THE LEGISLATIVE ASSEMBLY OF NORTH DAKOTA:

SECTION 1. APPROPRIATION. The funds provided in this section, or so much of the funds as may be necessary, are appropriated out of any moneys in the general fund in the state treasury, not otherwise appropriated, and from special funds derived from federal funds and other income, to the industrial commission and agencies under its control for the purpose of defraying the expenses of the industrial commission and the agencies under its control, for the biennium beginning July 1, 2023, and ending June 30, 2025, as follows:

Subdivision 1.

INDUSTRIAL COMMISSION

	Base Level	Adjustments or Enhancements	Appropriation
Salaries and wages	$23,698,119	($21,835,425)	$1,862,694
Operating expenses	5,119,958	(924,889)	4,195,069
Capital assets	0	1,250,000	1,250,000
Grants	0	8,623,893	8,623,893
Grants - bond payments	22,040,721	97,839,192	119,879,913
Total all funds	$50,858,798	$84,952,771	$135,811,569
Less estimated income	24,369,185	107,017,528	131,386,713
Total general fund	$26,489,613	($22,064,757)	$4,424,856
Full-time equivalent positions	108.25	(98.50)	9.75

Subdivision 2.

DEPARTMENT OF MINERAL RESOURCES

	Base Level	Adjustments or Enhancements	Appropriation
Salaries and wages	$0	$23,123,267	$23,123,267
Operating expenses	0	11,541,104	11,541,104
Capital assets	0	98,000	98,000
Total all funds	$0	$34,762,371	$34,762,371
Less estimated income	0	2,568,000	2,568,000
Total general fund	$0	$32,194,371	$32,194,371
Full-time equivalent positions	0.00	108.00	108.00

Subdivision 3.

BANK OF NORTH DAKOTA

	Base Level	Adjustments or Enhancements	Appropriation
Bank of North Dakota operations	$67,306,548	$2,760,519	$70,067,067
Capital assets	1,510,000	0	1,510,000
Total special funds	$68,816,548	$2,760,519	$71,577,067
Full-time equivalent positions	173.00	14.00	187.00

Subdivision 4.

HOUSING FINANCE AGENCY

	Base Level	Adjustments or Enhancements	Appropriation
Salaries and wages	$9,556,272	$1,556,933	$11,113,205
Operating expenses	6,109,060	4,794,823	10,903,883
Capital assets	150,000	(130,000)	20,000
Grants	42,975,200	5,829,910	48,805,110
Housing finance agency contingencies	100,000	0	100,000
Total all funds	$58,890,532	$12,051,666	$70,942,198
Less estimated income	58,890,532	9,551,666	68,442,198
Total general fund	$0	$2,500,000	$2,500,000
Full-time equivalent positions	49.00	5.00	54.00

Subdivision 5.

MILL AND ELEVATOR ASSOCIATION

	Base Level	Adjustments or Enhancements	Appropriation
Salaries and wages	$50,560,209	$3,290,171	$53,850,380
Operating expenses	36,817,000	5,574,653	42,391,653
Contingencies	500,000	0	500,000
Agriculture promotion	500,000	0	500,000
Total special funds	$88,377,209	$8,864,824	$97,242,033
Full-time equivalent positions	156.00	14.00	170.00

Subdivision 6.

TOTAL - SECTION 1

	Base Level	Adjustments or Enhancements	Appropriation
Grand total general fund	$26,489,613	$12,629,614	$39,119,227
Grand total special funds	240,453,474	130,762,537	371,216,011
Grand total all funds	$266,943,087	$143,392,151	$410,335,238

SECTION 2. ONE-TIME FUNDING - EFFECT ON BASE BUDGET - REPORT TO THE SIXTY-NINTH LEGISLATIVE ASSEMBLY. The following amounts reflect the one-time funding items approved by the sixty-seventh legislative assembly for the 2021-23 biennium and the 2023-25 one-time funding items included in the appropriation in section 1 of this Act:

One-Time Funding Description	2021-23	2023-25
Administration - transfer to clean sustainable energy fund	$25,000,000	$0
Administration - pipeline grant fund	150,000,000	0

Administration - hydrogen grants	20,000,000	0
Administration - new employee expenses	0	12,110
Administration - transmission authority consulting	0	300,000
Administration - electricity grid resilience federal grant	0	8,623,893
Administration - lignite litigation expenses	0	3,000,000
Administration - grant management software	0	1,250,000
Administration - carbon capture education	0	300,000
Administration - records digitization	0	75,000
Administration - inflationary increases	0	35,688
Mineral resources - paleontology and geological equipment	106,260	0
Mineral resources - abandoned well conversion program	3,200,000	0
Mineral resources - new employee expenses	0	68,335
Mineral resources - inflationary expenses	0	886,868
Mineral resources - drones and computers	0	83,648
Mineral resources - core and mineral analyses	0	100,000
Mineral resources - computer server transition	0	80,000
Mineral resources - abandoned well reclamation	0	2,300,000
Mineral resources - oil and gas litigation expenses	0	3,000,000
Bank of North Dakota - contingent loan repayment	17,500,000	0
Bank of North Dakota - bond proceed allocation	680,000,000	0
Bank of North Dakota - agriculture diversification fund	10,000,000	0
Bank of North Dakota - fuel production incentives	21,000,000	0
Bank of North Dakota - information technology projects	0	804,278
Housing finance agency - housing incentive fund	9,500,000	0
Housing finance agency - housing assessment	35,000	0
Total all funds	$936,341,260	$20,919,820
Less estimated income	874,235,000	9,155,335
Total general fund	$62,106,260	$11,764,485

The 2023-25 biennium one-time funding amounts are not part of the entity's base budget for the 2025-27 biennium. The industrial commission shall report to the appropriations committees of the sixty-ninth legislative assembly on the use of this one-time funding for the biennium beginning July 1, 2023, and ending June 30, 2025.

SECTION 3. BOND PAYMENTS. The amount of $119,879,913 included in subdivision 1 of section 1 of this Act in the grants - bond payments line item must be paid from the following funding sources, during the biennium beginning July 1, 2023, and ending June 30, 2025:

Infrastructure project and program bonds - legacy sinking and interest fund	$102,620,461
North Dakota university system	15,021,771
North Dakota university system - energy conservation projects	207,649
Department of corrections and rehabilitation	143,375
Office of management and budget	283,875
Attorney general's office	330,000
State historical society	592,375
Parks and recreation department	30,950
Agriculture research and extension service	242,205
Veterans' home	407,252
Total	$119,879,913

SECTION 4. APPROPRIATION - HOUSING FINANCE AGENCY - ADDITIONAL INCOME. In addition to the amount appropriated to the housing finance agency in subdivision 3 of section 1 of this Act, there is appropriated any additional income or unanticipated income from federal or other funds which may become available to the agency, for the biennium beginning July 1, 2023, and ending June 30, 2025. The housing finance agency shall notify the office of management and budget and the legislative council of any additional income or unanticipated income that becomes available to the agency resulting in an increase in appropriation authority.

SECTION 5. APPROPRIATION - TRANSFER - 2021-23 BIENNIUM - DEPARTMENT OF MINERAL RESOURCES - FULL-TIME EQUIVALENT POSITIONS.

1. There is appropriated out of any moneys in the general fund in the state treasury, not otherwise appropriated, the sum of $62,460, or so much of the sum as may be necessary, to the department of mineral resources for the purpose of employing full-time equivalent carbon capture positions for the period beginning with the effective date of this Act and ending June 30, 2023. The department is authorized three full-time equivalent positions pursuant to this subsection.

2. There is appropriated out of any moneys in the general fund in the state treasury, not otherwise appropriated, the sum of $15,000, which the office of management and budget shall transfer to the fossil excavation and restoration fund during the period beginning with the effective date of this Act and ending June 30, 2023.

SECTION 6. APPROPRIATION - TRANSFER - FOSSIL RESTORATION FUND - HOUSING INCENTIVE FUND - ONE-TIME FUNDING.

1. There is appropriated out of any moneys in the general fund in the state treasury, not otherwise appropriated, the sum of $250,000, which the office of management and budget shall transfer to the fossil excavation and restoration fund during the biennium beginning July 1, 2023, and ending June 30, 2025.

2. There is appropriated out of any moneys in the general fund in the state treasury, not otherwise appropriated, the sum of $13,750,000, which the office of management and budget shall transfer to the housing incentive fund during the biennium beginning July 1, 2023, and ending June 30, 2025.

3. The funding provided in this section is considered a one-time funding item.

SECTION 7. CONTINGENT FUNDING - HOUSING FINANCE AGENCY. The sum of $82,068 from other funds from the new and vacant FTE funding pool and one full-time equivalent position included in subdivision 4 of section 1 of this Act are available only in accordance with the provisions of this section. If mortgage loan production for the fiscal year ended June 30, 2024, exceeds $435,000,000, the housing finance agency may request the office of management and budget transfer up to $82,068 of other funds from the new and vacant FTE funding pool for salaries and wages for the full-time equivalent position identified in this section, and the agency may hire one full-time equivalent position. The housing finance agency shall notify the office of management and budget and the legislative council if the contingency is met.

SECTION 8. TRANSFER - ENTITIES UNDER THE CONTROL OF THE INDUSTRIAL COMMISSION TO INDUSTRIAL COMMISSION FUND - ADMINISTRATION - EXEMPTION.

1. The sum of $1,818,114, or so much of the sum as may be necessary, included in the appropriation in subdivision 1 of section 1 of this Act, may be transferred from the entities within the control of the industrial commission or entities directed to make payments to the industrial commission fund for administrative services rendered by the commission. Transfers must be made during the biennium beginning July 1, 2023, and ending June 30, 2025, upon order of the commission. Transfers from the student loan trust fund must be made to the extent permitted by sections 54-17-24 and 54-17-25.

2. The amount of $1,214,768 appropriated to the industrial commission in subdivision 1 of section 1 of chapter 42 of the 2021 Session Laws and transferred pursuant to section 7 of chapter 42 of the 2021 Session Laws is not subject to the provisions of section 54-44.1-11. Any unexpended funds from this appropriation are available to the industrial commission for administrative services rendered by the commission during the biennium beginning July 1, 2023, and ending June 30, 2025.

SECTION 9. TRANSFER - FUNDS UNDER THE CONTROL OF THE INDUSTRIAL COMMISSION TO INDUSTRIAL COMMISSION FUND - GRANT MANAGEMENT SOFTWARE. The sum of $1,250,000, or so much of the sum as may be necessary, included in the appropriation in subdivision 1 of section 1 of this Act, may be transferred from funds under the control of the industrial commission to the industrial commission fund for grant management software expenses. Of the $1,250,000, the industrial commission may transfer:

1. Up to $250,000 from the clean sustainable energy fund;
2. Up to $250,000 from the lignite research fund;
3. Up to $250,000 from the oil and gas research fund;
4. Up to $250,000 from the North Dakota outdoor heritage fund; and
5. Up to $250,000 from the renewable energy development fund.

SECTION 10. TRANSFER - FUNDS UNDER THE CONTROL OF THE INDUSTRIAL COMMISSION TO INDUSTRIAL COMMISSION FUND - CARBON CAPTURE EDUCATION. The sum of $300,000, or so much of the sum as may be necessary, included in the appropriation in subdivision 1 of section 1 of this Act, may be transferred from funds under the control of the industrial commission to the industrial commission fund to contract for carbon capture and utilization education and marketing in consultation with the lignite research council, the oil and gas research council, and the renewable energy council. Of the $300,000, the industrial commission may transfer:

1. Up to $100,000 from the lignite research fund;
2. Up to $100,000 from the oil and gas research fund; and
3. Up to $100,000 from the renewable energy development fund.

SECTION 11. TRANSFER - BANK OF NORTH DAKOTA PROFITS TO GENERAL FUND. The Bank of North Dakota shall transfer $140,000,000 from the Bank's current earnings and undivided profits to the general fund during the biennium beginning July 1, 2023, and ending June 30, 2025. The moneys must be transferred in the amounts and at the times requested by the director of the office of management and budget after consultation with the Bank of North Dakota president. For legislative council budget status reporting purposes, the transfer under this section is considered an ongoing revenue source.

SECTION 12. TRANSFER - BANK OF NORTH DAKOTA PROFITS TO ECONOMIC DEVELOPMENT PROGRAMS. During the biennium beginning July 1, 2023, and ending June 30, 2025, the Bank of North Dakota shall transfer the following amounts from the Bank's current earnings and undivided profits:

1. $39,000,000 to the partnership in assisting community expansion fund;
2. $5,000,000 to the agriculture partnership in assisting community expansion fund;
3. $1,000,000 to the biofuels partnership in assisting community expansion fund;
4. $15,000,000 to the beginning farmer revolving loan fund; and
5. $1,500,000 to the university of North Dakota for the North Dakota small business development center for the purpose of matching federal grants.

SECTION 13. TRANSFER - STRATEGIC INVESTMENT AND IMPROVEMENTS FUND - PIPELINE LEAK DETECTION AND PREVENTION PROGRAM - CLEAN SUSTAINABLE ENERGY GRANTS AND LOANS. During the biennium beginning July 1, 2023, and ending June 30, 2025, the

office of management and budget shall transfer the following amounts from the strategic investment and improvements fund:

1. $3,000,000 to the oil and gas research fund for a pipeline leak detection and prevention program;
2. $30,000,000 to the clean sustainable energy fund for grants; and
3. $30,000,000 to the clean sustainable energy fund to repay a line of credit and to provide funding for loans.

SECTION 14. TRANSFER - STRATEGIC INVESTMENT AND IMPROVEMENTS FUND TO STATE ENERGY RESEARCH CENTER FUND - RARE EARTH MINERALS STUDY - REPORT TO LEGISLATIVE MANAGEMENT.

1. The office of management and budget shall transfer the sum of $1,500,000 from the strategic investment and improvements fund to the state energy research center fund during the biennium beginning July 1, 2023, and ending June 30, 2025.
2. Pursuant to the continuing appropriation under section 57-51.1-07.9, the industrial commission shall distribute up to $1,500,000 from the state energy research center fund to the state energy research center for a study related to prospective in-state resources of economically feasible accumulations of critical minerals, including rare earth elements and other high-value minerals or materials that may be suitable for extraction and enrichment.
3. The study must include a review of in-state mineral accumulations, including coal deposits, ore bodies, oil and gas reservoirs, produced water from oil and gas development activities, saltwater zones, and shale formations. While conducting the study, the state energy research center shall collaborate with the North Dakota geological survey and active mineral lessors and developers.
4. During the 2023-24 interim, the state energy research center shall provide at least one report to the legislative management regarding the study.

SECTION 15. TRANSFER - STRATEGIC INVESTMENT AND IMPROVEMENTS FUND TO STATE ENERGY RESEARCH CENTER FUND - FEDERAL STATE FISCAL RECOVERY FUND - UNDERGROUND ENERGY STORAGE RESEARCH PROJECT - REPORT TO LEGISLATIVE MANAGEMENT.

1. The office of management and budget shall transfer the sum of $6,000,000 from the strategic investment and improvements fund to the state energy research center fund.
2. Pursuant to the continuing appropriation authority under section 57-51.1-07.9 and pursuant to subsection 36 of section 1 of chapter 550 of the 2021 Special Session Session Laws, as amended in section 24 of this Act and exempted in section 26 of this Act, the industrial commission shall distribute up to $6,000,000 from the state energy research center fund and up to $5,300,000 of federal funds from the state fiscal recovery fund to the state energy research center for a salt cavern underground energy storage research project.
3. The research project must include construction of up to two salt caverns in geological formations in North Dakota for the development of underground storage of energy resources, including natural gas, liquified natural gas, natural gas liquids, and hydrogen. The state energy research center may collaborate with other entities as needed on the research project. Prior to distributing the funding, the industrial commission must receive, from at least one nonstate entity, assurance of financial or other types of support that demonstrate a commitment to the research project.

4. During the 2023-24 interim, the state energy research center shall provide quarterly reports to the industrial commission and at least one report to the legislative management regarding the status and results of the research project.

SECTION 16. LIGNITE RESEARCH, DEVELOPMENT, AND MARKETING PROGRAM - LIGNITE MARKETING FEASIBILITY STUDY - REPORT TO THE SIXTY-NINTH LEGISLATIVE ASSEMBLY.

1. Pursuant to the continuing appropriation under section 57-61-01.6, up to $4,500,000 from the lignite research fund may be used for the purpose of contracting for an independent, nonmatching lignite marketing feasibility study or studies that determine those focused priority areas where near-term, market-driven projects, activities, or processes will generate matching private industry investment and have the most potential of preserving existing lignite production and industry jobs or that will lead to increased development of lignite and its products and create new lignite industry jobs and economic growth for the general welfare of this state. Moneys designated under this section also may be used for the purpose of contracting for nonmatching studies and activities in support of advanced energy technology and other technology development programs; for litigation that may be necessary to protect and promote the continued development of lignite resources; for nonmatching externality studies and activities in externality proceedings; or other marketing, environmental, or transmission activities that assist with marketing of lignite-based electricity and lignite-based byproducts. Moneys needed for the purposes stated in this section are available to the industrial commission for funding projects, processes, or activities under the lignite research, development, and marketing program.

2. The industrial commission shall report to the appropriations committees of the sixty-ninth legislative assembly on the amounts spent pursuant to this section.

SECTION 17. LIGNITE RESEARCH FUND - FUTURE LIGNITE ELECTRICAL GENERATION FACILITIES STUDY - REPORT TO LEGISLATIVE MANAGEMENT.

1. Pursuant to the continuing appropriation under section 57-61-01.6, up to $500,000 from the lignite research fund may be used for the purpose of contracting with the energy and environmental research center for a nonmatching study of future lignite electrical generation facilities.

2. The study must include consideration of an energy demand forecast for dispatchable electricity generation and the regulatory environment for future lignite electrical generation facilities, an analysis of the economic impact of future lignite electrical generation facilities and the value-added products or services that may result from those facilities, and other factors related to the development and operation of future lignite electrical generation facilities.

3. During the 2023-24 interim, the energy and environmental research center shall provide at least one report to the legislative management regarding the status of the study.

SECTION 18. AMENDMENT. Section 6-09.7-05 of the North Dakota Century Code is amended and reenacted as follows:

6-09.7-05. Establishment and maintenance of adequate guarantee funds - Use of strategic investment and improvements fund.

The Bank of North Dakota shall establish and at all times maintain an adequate guarantee reserve fund in a special account in the Bank. The Bank may request the director of the office of management and budget to transfer funds from the strategic investment and improvements fund created by section 15-08.1-08 to maintain one hundred percent of the guarantee reserve fund balance. Transfers from the strategic investment and improvements fund may not exceed a total of ~~eighty~~one hundred forty million dollars. Moneys in the guarantee reserve fund are available to reimburse lenders, including the Bank, for guaranteed loans in default. The securities in which the moneys in the reserve fund may be invested must meet the same requirements as those authorized for investment under the state investment

board. The income from such investments must be made available for the costs of administering the state guarantee loan program and income in excess of that required to pay the cost of administering the program must be deposited in the reserve fund. The amount of reserves for all guaranteed loans must be determined by a formula that will assure, as determined by the Bank, an adequate amount of reserve.

SECTION 19. AMENDMENT. Section 54-17-40 of the North Dakota Century Code is amended and reenacted as follows:

54-17-40. Housing incentive fund - Continuing appropriation - Report to budget section.

1. The housing incentive fund is created as a special revolving fund at the Bank of North Dakota. The housing finance agency may direct disbursements from the fund and a continuing appropriation from the fund is provided for that purpose.

2. a. After a public hearing, the housing finance agency shall create an annual allocation plan for the distribution of the fund as authorized under subsection 3. ~~At least ten percent of the fund must be used to assist developing communities to address an unmet housing need or alleviate a housing shortage. At least ten percent of the fund must be made available to prevent homelessness as authorized by subdivision d of subsection 3.~~

   b. The annual allocation plan must give priority to provide housing for individuals and families of low or moderate income. For purposes of this priority, eligible income limits are determined as a percentage of median family income as published in the most recent federal register notice. Under this priority, the annual allocation plan must give preference to projects that benefit households with the lowest income and to projects that have rent restrictions at or below department of housing and urban development published federal fair market rents or department of housing and urban development section 8 payment standards.

   c. At least ten percent of the fund must be used to assist developing communities to address an unmet housing need or alleviate a housing shortage.

3. The housing finance agency shall adopt guidelines for the fund so as to address unmet housing needs in this state. Assistance from the fund may be used solely for:

   a. New construction, rehabilitation, preservation, or acquisition of a multifamily housing project;

   b. New construction, rehabilitation, preservation, or acquisition of a single-family housing project in a developing community or a community land trust project;

   c. Gap assistance, matching funds, and accessibility improvements;

   ~~c.~~d. Assistance that does not exceed the amount necessary to qualify for a loan using underwriting standards acceptable for secondary market financing or to make the project feasible; and

   ~~d.~~e. Rental assistance, emergency assistance, barrier mitigation, or ~~targeted supportive~~ services designated to prevent or end homelessness.

4. Eligible recipients include units of local, state, and tribal government; local and tribal housing authorities; community action agencies; regional planning councils; and nonprofit organizations and for-profit developers of ~~multifamily~~residential housing. Individuals may not receive direct assistance from the fund.

5. Except for subdivision d of subsection 3, assistance is subject to repayment or recapture under the guidelines adopted by the housing finance agency. Any assistance that is repaid or

recaptured must be deposited in the fund and is appropriated on a continuing basis for the purposes of this section.

6. The agency may collect a reasonable administrative fee from the fund, project developers, applicants, or grant recipients. The origination fee assessed to grant recipients may not exceed five percent of the project award.

7. Upon request, the housing finance agency shall report to the industrial commission regarding the activities of the housing incentive fund.

8. At least once per biennium, the housing finance agency shall provide a report to the budget section of the legislative management regarding the activities of the housing incentive fund.

SECTION 20. AMENDMENT. Section 54-17.7-01 of the North Dakota Century Code is amended and reenacted as follows:

54-17.7-01. North Dakota pipeline authority - Legislative intent.

There is created the North Dakota pipeline authority, which shall be governed by the industrial commission. It is the intent of the legislative assembly that the pipeline authority consider the operations, finances, and market positions of private entities engaged in pipeline activities while carrying out the purposes of this chapter to avoid competing with private entities to the extent possible.

SECTION 21. AMENDMENT. Subsection 3 of section 54-17.7-04 of the North Dakota Century Code is amended and reenacted as follows:

3. Acquire, purchase, hold, use, lease, license, sell, transfer, and dispose of an undivided or other interest in or the right to capacity in any pipeline system or systems, including interconnection of pipeline systems, within or without the state of North Dakota in order to facilitate the production, transportation, distribution, or delivery of energy-related commodities produced in North Dakota ~~as a purchaser of last resort. The obligation of the state may not exceed ten percent of the pipeline authority's acquisition or purchase of a right to capacity in any pipeline system or systems, or interconnection of pipeline systems, and the state's obligation is limited to the funding available from the oil and gas research fund~~. If the authority acquires, purchases, holds, uses, or leases capacity positions, the authority shall sell, transfer, release, or dispose of the capacity positions at intervals that are no more frequent than monthly and in an amount that is equal to or greater than the market rate, but only if the sale, transfer, release, or disposal of the capacity positions is sufficient to cover the expenses and obligations incurred. The authority's contract obligations for the capacity positions are limited to the capacity rates, charges, and terms.

SECTION 22. AMENDMENT. Subsection 4 of section 54-17.7-04 of the North Dakota Century Code is amended and reenacted as follows:

4. Borrow money and issue evidences of indebtedness as provided in this chapter, including borrowing from the Bank of North Dakota.

   a. The authority may borrow up to sixty million dollars through a line of credit from the Bank. The interest rate on the line of credit must be the prevailing interest rate charged to North Dakota governmental entities.

   b. The line of credit must be guaranteed by reserves under section 6-09.7-05.

   c. The line of credit may be used to support activities under subsection 3.

   d. The authority shall repay the line of credit from amounts available. If the amounts available on June 30, 2027, are not sufficient to repay the line of credit, the authority shall notify the director of the office of management and budget, and the director of the office of management and budget shall transfer funds from the strategic investment and

improvements fund to the Bank for the repayment pursuant to section 6-09.7-05 based on the amount certified by the Bank.

SECTION 23. AMENDMENT. Subsection 3 of section 54-63.1-07 of the North Dakota Century Code is amended and reenacted as follows:

3. The Bank of North Dakota shall extend a line of credit to the industrial commission to support loans or loan guarantees issued from the clean sustainable energy fund. The line of credit may not exceed ~~two~~three hundred ~~fifty~~ninety million dollars, and the interest rate associated with the line of credit must be the prevailing interest rate charged to North Dakota governmental entities. The industrial commission shall repay the line of credit from moneys available in the clean sustainable energy fund derived from payments received on loans issued under this chapter or other sources. If the moneys available from the clean sustainable energy fund on June 30, 2025, are not sufficient to repay the line of credit, the industrial commission shall request from the legislative assembly a deficiency appropriation to repay the line of credit or the industrial commission may repay the line of credit from other funds, as appropriated by the legislative assembly.

SECTION 24. AMENDMENT. Subsection 36 of section 1 of chapter 550 of the 2021 Special Session Session Laws is amended and reenacted as follows:

36. There is appropriated from federal funds derived from the state fiscal recovery fund, not otherwise appropriated, the sum of $20,000,000, or so much of the sum as may be necessary, to the industrial commission for the purpose of providing hydrogen development grants, as approved by the clean sustainable energy authority, and distributions to the state energy research center for an underground energy storage research project, for the period beginning with the effective date of this Act, and ending June 30, 2023. Of the $20,000,000, up to $5,300,000 is available for distributions to the state energy research center for an underground energy storage research project, and any remaining amounts are available for providing hydrogen development grants, as approved by the clean sustainable energy authority.

SECTION 25. EMPLOYEE RECRUITMENT AND RETENTION INCENTIVE PROGRAM STUDY - REPORT TO LEGISLATIVE MANAGEMENT. During the 2023-24 interim, the industrial commission and Bank of North Dakota shall study the feasibility and desirability of creating an employee recruitment and retention incentive program for the Bank of North Dakota. The industrial commission shall report its findings and recommendations to the legislative management by March 31, 2024.

SECTION 26. EXEMPTION - OIL AND GAS TAX REVENUE ALLOCATIONS - NORTH DAKOTA OUTDOOR HERITAGE FUND - OIL AND GAS RESEARCH FUND.

1. Notwithstanding the provisions of section 57-51-15 relating to the allocations to the North Dakota outdoor heritage fund, for the period beginning September 1, 2023, and ending August 31, 2025, the state treasurer shall allocate eight percent of the oil and gas gross production tax revenue available under subsection 1 of section 57-51-15 to the North Dakota outdoor heritage fund, but not in an amount exceeding $7,500,000 per fiscal year.

2. Notwithstanding the provisions of section 57-51.1-07.3 relating to the allocations to the oil and gas research fund, for the period beginning August 1, 2023, and ending July 31, 2025, the state treasurer shall allocate two percent of the oil and gas gross production tax and oil extraction tax revenues, up to $17,500,000, into the oil and gas research fund before allocating oil and gas tax revenues under sections 57-51.1-07.5, 57-51.1-07.9, and 57-51.1-07.10.

SECTION 27. EXEMPTION - UNEXPENDED APPROPRIATIONS. The following appropriations are not subject to the provisions of section 54-44.1-11 and may be continued into the biennium beginning July 1, 2023, and ending June 30, 2025:

1. The sum of $3,200,000 appropriated from the federal state fiscal recovery fund for an abandoned oil well conversion to water supply grant program in subsection 2 of section 1 of chapter 550 of the 2021 Special Session Session Laws;

2. The sum of $20,000,000 appropriated from the federal state fiscal recovery fund for hydrogen development grants and an underground energy storage research project in subsection 36 of section 1 of chapter 550 of the 2021 Special Session Session Laws as amended in section 24 of this Act; and

3. The sum of $800,000 appropriated from the strategic investment and improvements fund to the department of mineral resources for a survey review in section 2 of chapter 426 of the 2017 Session Laws and continued into the 2019-21 biennium pursuant to section 27 of chapter 14 of the 2019 Session Laws and into the 2021-23 biennium pursuant to section 33 of chapter 42 of the 2021 Session Laws.

SECTION 28. LEGISLATIVE INTENT - USE OF BANK OF NORTH DAKOTA PROFITS. It is the intent of the sixty-eighth legislative assembly that the sixty-ninth legislative assembly consider developing procedures or adopting legislative rules for introducing bills and amendments related to the use of Bank of North Dakota profits.

SECTION 29. LEGISLATIVE INTENT - ENERGY DEVELOPMENT PROJECTS. It is the intent of the sixty-eighth legislative assembly that the state provide support for an entity's application for federal funding to upgrade a high-voltage direct current transmission line in the state and that the state provide support for energy development projects in the state through the state's energy-related programs, including:

1. The clean sustainable energy authority;

2. The North Dakota pipeline authority;

3. The North Dakota transmission authority;

4. The lignite research council;

5. The oil and gas research council; and

6. The renewable energy council.

SECTION 30. EFFECTIVE DATE. Section 18 of this Act becomes effective July 1, 2025.

SECTION 31. EMERGENCY. The following are declared to be an emergency measure:

1. The sum of $3,000,000 from the general fund in the operating expenses line item included in subdivision 1 of section 1 of this Act and identified as one-time funding in section 2 of this Act for lignite litigation expenses.

2. The sum of $3,000,000 from the general fund in the operating expenses line item included in subdivision 2 of section 2 of this Act and identified as one-time funding in section 2 of this Act for oil and gas litigation expenses.

3. The sum of $230,000 from the general fund in the operating expenses line item included in subdivision 2 of section 1 of this Act for computer server transition.

4. The sum of $80,000 from the general fund in the operating expenses line item included in subdivision 2 of section 1 of this Act and identified as one-time funding in section 2 of this Act for computer server transition.

5. Sections 5 and 24 of this Act.

6. Senate Bill No. 2165, as approved by the sixty-eighth legislative assembly.

Dennis E Johnson
Speaker of the House

Tammy Miller
President of the Senate

Bull J Reich
Chief Clerk of the House

Brandon Moyan
Secretary of the Senate

This certifies that the within bill originated in the House of Representatives of the Sixty-eighth Legislative Assembly of North Dakota and is known on the records of that body as House Bill No. 1014 and that two-thirds of the members-elect of the House of Representatives voted in favor of said law.

Vote: Yeas 77 Nays 9 Absent 8

Dennis E Johnson
Speaker of the House

Bull J. Reich
Chief Clerk of the House

This certifies that two-thirds of the members-elect of the Senate voted in favor of said law.

Vote: Yeas 46 Nays 0 Absent 1

Tammy Miller
President of the Senate

Brandon Moyan
Secretary of the Senate

Received by the Governor at 9:19 PM. on April 29, 2023.

Approved at 5:59 PM. on May 5, 2023.

Doug Burgum
Governor

Filed in this office this 9 day of May, 2023,

at 1:07 o'clock P M.

Michael Howe
Secretary of State

Attachment 16

Docket for Hearing
Tuesday, March 21, 2023
N.D. Oil & Gas Division N.D. Oil & Gas Division 1000 East Calgary Avenue

Case No. 29888, Order No. 32474: Application of Blue Flint Sequester Company, LLC requesting consideration for the geologic storage of carbon dioxide in the Broom Creek Formation from the Blue Flint Ethanol Facility in the storage facility located in Sections 11, 12, 13, 14, and 24, Township 145 North, Range 83 West and Sections 6, 7, 8, 17, 18, and 19, Township 145 North, Range 82 West, McLean County, North Dakota pursuant to North Dakota Administrative Code Section 43-05-01.

Docket for Hearing
Tuesday, March 21, 2023
N.D. Oil & Gas Division N.D. Oil & Gas Division 1000 East Calgary Avenue

Case No. 29889, Order No. 32475: A motion of the Commission to consider the amalgamation of the storage reservoir pore space, in which the Commission may require that the pore space owned by nonconsenting owners be included in the geologic storage facility and subject to geologic storage, as required to operate the Blue Flint Sequester Company, LLC storage facility located in Sections 11, 12, 13, 14, and 24, Township 145 North, Range 83 West and Sections 6, 7, 8, 17, 18, and 19, Township 145 North, Range 82 West, McLean County, North Dakota, in the Broom Creek Formation, pursuant to North Dakota Century Code Section 38-22-10.

Docket for Hearing
Tuesday, March 21, 2023
N.D. Oil & Gas Division N.D. Oil & Gas Division 1000 East Calgary Avenue

Case No. 29890, Order No. 32476: A motion of the Commission to determine the amount of financial responsibility for the geologic storage of carbon dioxide from the Blue Flint Ethanol Facility in the storage facility located in Sections 11, 12, 13, 14, and 24, Township 145 North, Range 83 West and Sections 6, 7, 8, 17, 18, and 19, Township 145 North, Range 82 West, McLean County, North Dakota, in the Broom Creek Formation, pursuant to North Dakota Administrative Code Section 43-05-01-09.1.

Attachment 19

Docket for Hearing
Wednesday, April 26, 2023
N.D. Oil & Gas Division N.D. Oil & Gas Division 1000 East Calgary Avenue

Case No. 29951, Order No. 32559: In the matter of a hearing called on a motion of the Commission to consider the name change of the Squaw Gap Field and any associated pools, McKenzie County, ND, and for such other and further relief as the Commission deems appropriate.

GEOLOGICAL SURVEY QUARTERLY REPORT

January 1, 2023 to March 31, 2023
to the

NORTH DAKOTA INDUSTRIAL COMMISSION

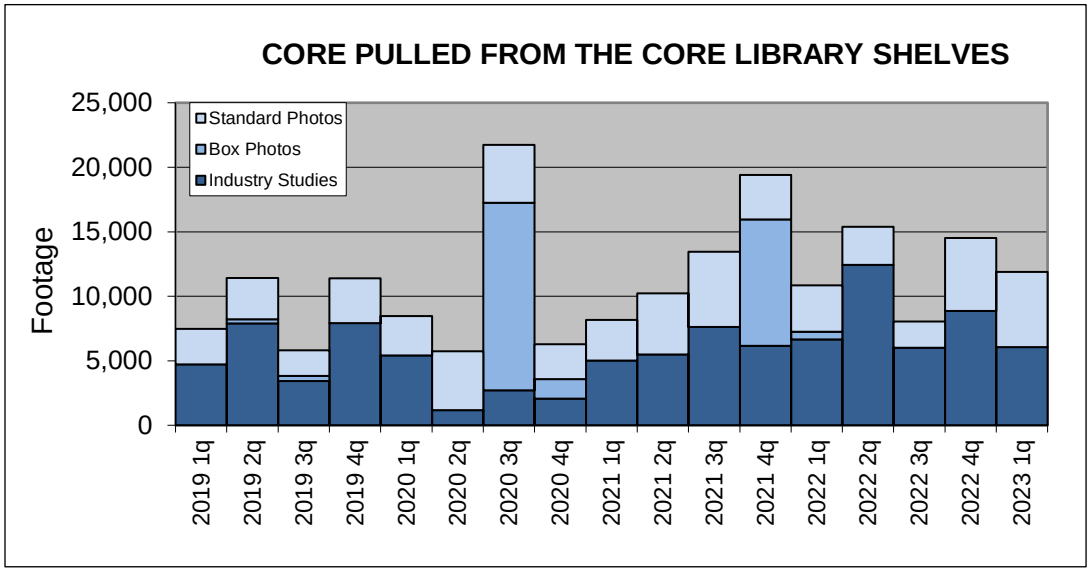
Edward C. Murphy
State Geologist
Geological Survey
Department of Mineral Resources
North Dakota Industrial Commission

May 25, 2023

Table of Contents

Wilson M. Laird Core and Sample Library

Geologists from two oil companies, two consulting geologists, and scientists from EERC and the Geological Survey, as well as students and professors from the UND Dept. of Geology and Geological Engineering, and Petroleum Engineering studied 6,049 feet of core during the first quarter of 2023. In addition, we photographed 5,846 feet of core generating 9,492 standard photographs for the subscription site.



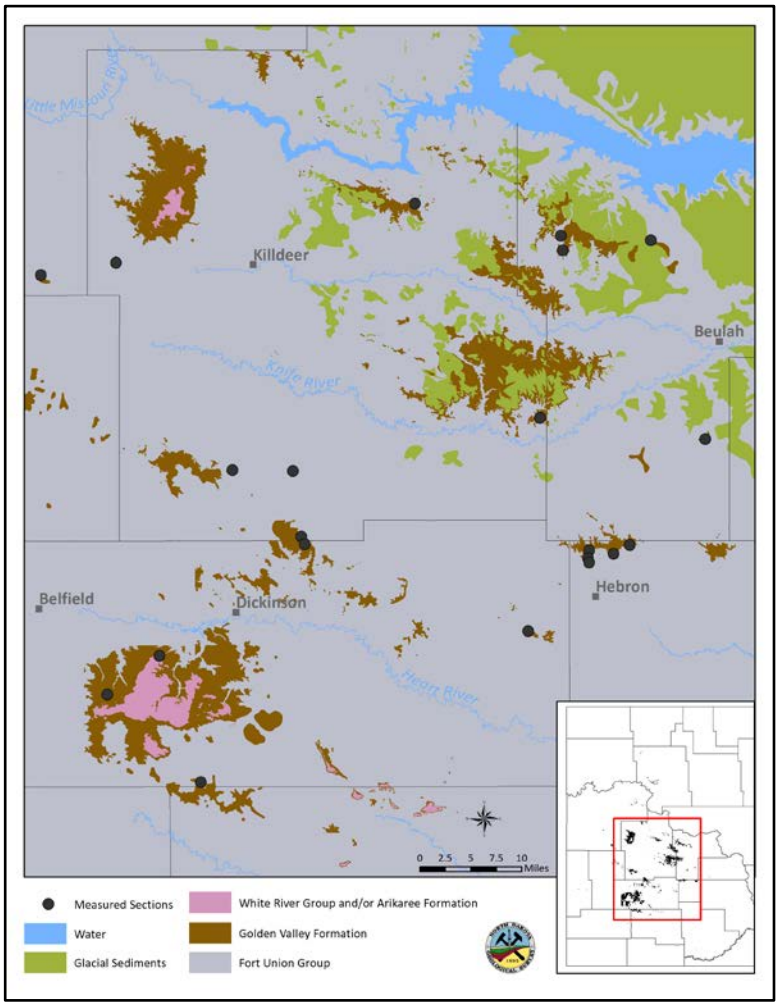
Workers pulled 11,895 feet of core from library shelves during the first quarter of 2023.

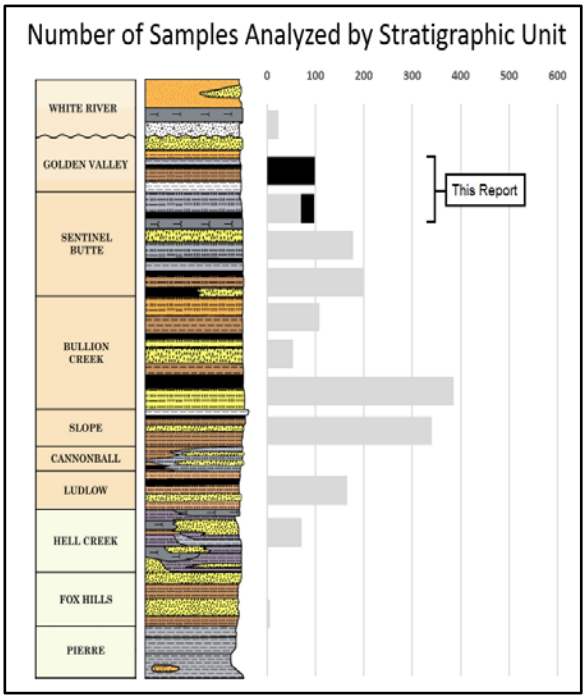
For 36 years, core at the Wilson M. Laird Core & Sample Library was loaded onto and taken off of the shelves by hand. The expansion of the full warehouse in 2016 gave us sufficient room that we could place the core onto pallets so it could be loaded and unloaded without having to restack the boxes each time. While this is significantly safer and has greatly reduced lower back and shoulder issues, it has decreased the amount of core that can be stored on the shelves by 25%.

Left: Core boxes are packed 80 to a bin in the old core library warehouse. Right: The shelving units are almost twice as high to accommodate the pallets in the new core library warehouse.

Critical Minerals Report

On April 25 we released our eighth critical minerals report in the last six years, Report of Investigation no. 133, "Elevated Critical Mineral Concentrations Associated with the Paleocene-Eocene Thermal Maximum, Golden Valley Formation." We measured 22 geologic sections from the upper part of the Sentinel Butte Formation into the overlying Golden Valley Formation and collected 122 rock samples for critical mineral analyses.

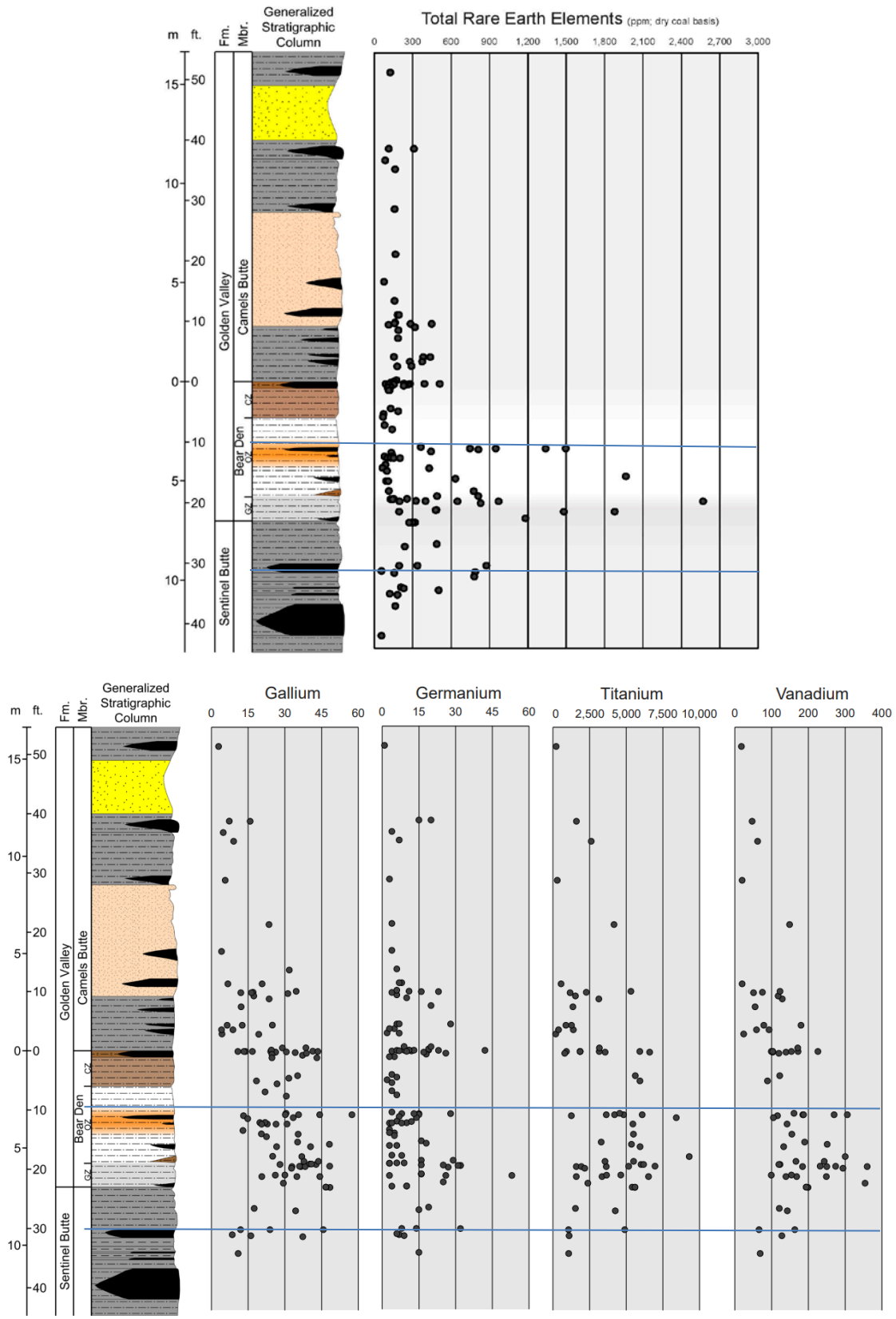




Left: A surface geology map of west-central North Dakota. The black dots are sample sites, the Golden Valley Formation is shown in brown. Right: The stratigraphic position and the number of samples for this report are highlighted in black.

The bright white bed is part of the Bear Den Member of the Golden Valley Formation. The Geological Survey has found elevated critical mineral concentrations in the lower half of the white bed, the underlying gray beds, and the upper part of the Sentinel Butte Formation (the latter is obscured by the vegetated slope in this photograph).

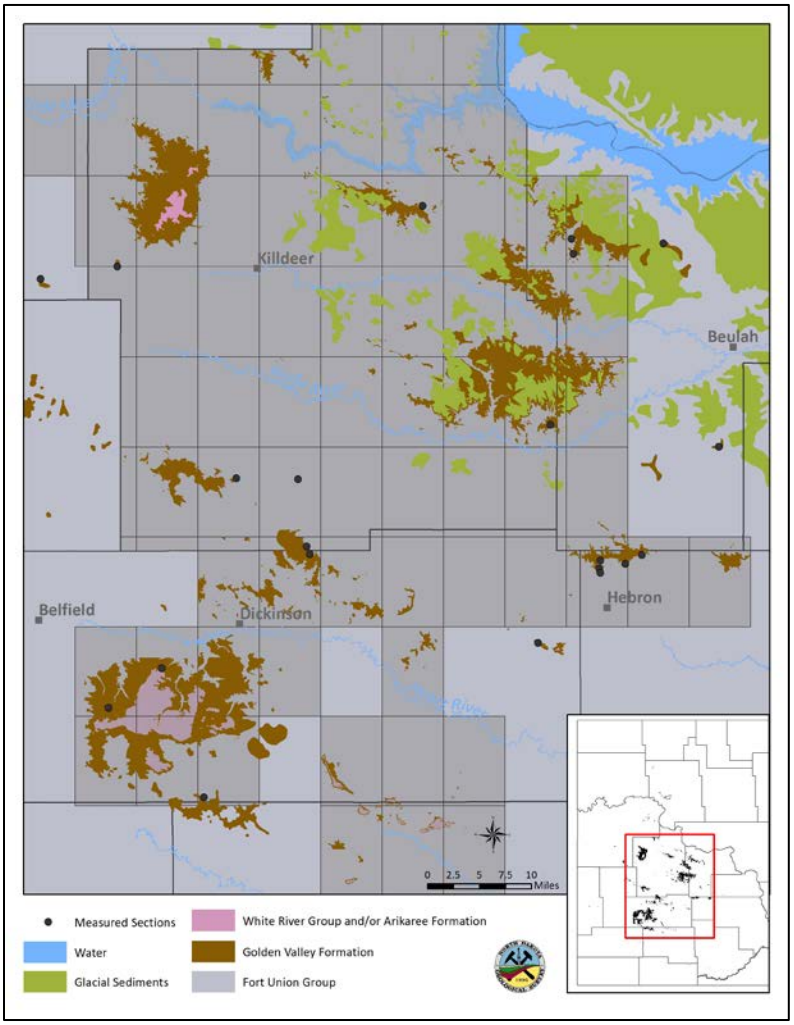
At this outcrop, the middle of the Bear Den Member is partially stained orange. The two, thin coals/carbonaceous mudstones beneath it had elevated rare earth element concentrations of 971, 1,482, and 1,880 ppm. The rocks beneath these organic-rich beds are part of the Sentinel Butte Formation.



Top: Rare earth elements concentrations plotted to a generalized stratigraphic column. Bottom: Gallium, germanium, titanium, and vanadium concentrations plotted to a generalized stratigraphic column.

Lignites in the lower Bear Den Member of the Golden Valley Formation contain the highest concentrations of rare earth elements yet reported from North Dakota. Additionally, these elevated concentrations were present in 60 – 70% of the lower Bear Den Member samples that were collected across a five-county area in west-central North Dakota. Where we previously had measured elevated rare earth concentrations in a bed over 10s or 100s of feet, we are now tracing high concentrations over 10s of miles. Making this 20-foot-thick zone in the lower Bear Den and upper Sentinel Butte the most widespread horizon for elevated rare earth element concentrations yet reported from our study. Enriched rare earth elements include neodymium, praseodymium, dysprosium, gadolinium, terbium, scandium. Additionally, enrichment was found in this horizon for a number of other critical minerals including gallium, germanium, vanadium, titanium, antimony, and molybdenum.

NDGS Report of Investigation no. 133 contains the highest rare earth element concentration yet reported for a North Dakota lignite at 2,570 ppm. Report of Investigation no. 134, the critical minerals report we are currently writing, contains 158 measured sections and 765 sample analyses, 567 of which are newly reported.



Over 85% of the Golden Valley Formation in North Dakota has been mapped in detail, the 1:24,000 scale quadrangles (the darker gray rectangles) on this map.

The Bear Den Member of the Golden Valley Formation in outcrop on the west side of the Killdeer Mountains.

White mudstone of the Bear Den Member is exposed in a road cut in northeastern Dunn County, west of Dodge.

White mudstone of the Bear Den Member of the Golden Valley Formation is exposed in the south road ditch east of Dickinson.

White rocks of the Bear Den Member are exposed along a ridge in a plowed field in southern Dunn County.

Regulatory Programs (January 1 to March 31, 2023)

Coal Exploration Program	No permit issued this quarter.
Subsurface Mineral Program	No permit issued this quarter.
UIC Class III Well Program	No permits issued this quarter.
Geothermal Program	Two permits (0 residential, 2 commercial) issued this quarter.
Paleontological Resource Program	Two permits issued this quarter.

Publications This Quarter (January 1 to March 31, 2023)

Anderson, F.J., 2023, Areas of Landslides Belfield NE Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Blfd NE - l.

Anderson, F.J., 2023, Areas of Landslides Fryburg NE Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Frbg NE - l.

Anderson, F.J., 2023, Areas of Landslides Gorham Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Grhm - l.

Anderson, F.J., 2023, Areas of Landslides Hungry Man Butte Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. HnMB - l.

Anderson, F.J., 2023, Areas of Landslides New Hradec South Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. NwHr S - l.

Anderson, F.J. and Gonzalez, M.A., 2023, Areas of Landslides Roosevelt Creek West Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. RsvC W - l.

Anderson, F.J. and Gonzalez, M.A., 2023, Areas of Landslides Roosevelt Creek East Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. RsvC E - l.

Anderson, F.J., Gonzalez, M.A. and Biek, R. F., 2023, Areas of Landslides Medora Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Mdra - l.

Anderson, F.J., Gonzalez, M.A. and Biek, R. F., 2023, Areas of Landslides Fryburg NW Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Frbg NW - l.

Anderson, Moxness, Maike, and York 2023, Areas of Landslides Crown Butte Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. CrnB - l.

Anderson, Moxness, Maike, and York 2023, Areas of Landslides Crown Butte NW Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. CrnB NW - l.

Anderson, F.J. and Murphy, E.C., 2023, Areas of Landslides Manning NW Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Mnng NW - l.

Anderson, F.J. and Murphy, E.C., 2023, Areas of Landslides Manning Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Mnng - l.

Anderson, F.J. and Murphy, E.C., 2023, Areas of Landslides Marshall Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Mrsl - l.

Anderson, F.J. and Murphy, E.C., 2023, Areas of Landslides Marshall NW Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Mrsl NW - l.

Anderson, F.J. and Murphy, E.C., 2023, Areas of Landslides Schaffner Creek Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. SfnC - l.

Anderson, F.J. and Murphy, E.C., 2023, Areas of Landslides Emerson Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Emrn - l.

Anderson, F.J. and Murphy, E.C., 2023, Areas of Landslides Ziner Butte Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. ZnrB - l.

Anderson, F.J. and Murphy, E.C., 2023, Areas of Landslides Killdeer Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Kldr - l.

Anderson, F.J. and Murphy, E.C., 2023, Areas of Landslides Lake Ilo Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. LkIo - l.

Anderson, F.J. and Murphy, E.C., 2023, Areas of Landslides Dunn Center Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. DnnC - l.

Anderson, F.J. and Murphy, E.C., 2023, Areas of Landslides Werner Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Wrnr - l.

Anderson, F.J. and Murphy, E.C., 2023, Areas of Landslides Rattlesnake Butte Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. RtsB - l.

Anderson, F.J. and Murphy, E.C., 2023, Areas of Landslides Manning SE Quadrangle, ND Quadrangle: North Dakota

Geological Survey 24K Map Series No. Mnng SE - l.

Anderson, F.J. and Murphy, E.C., 2023, Areas of Landslides Hirschville Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Hrvl - l.

Anderson, F.J. and Murphy, E.C., 2023, Areas of Landslides Taylor Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Tylr - l.

Anderson, F.J. and Murphy, E.C., 2023, Areas of Landslides Richardton Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Rchd - l.

Anderson, F.J. and Murphy, E.C., 2023, Areas of Landslides Boyle Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Byle - l.

Anderson, F.J. and Murphy, E.C., 2023, Areas of Landslides Willow Creek East Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. WlCr E - l.

Anderson, F.J. and Murphy, E.C., 2023, Areas of Landslides Willow Creek West Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. WlCr W - l.

Anderson, F.J. and Murphy, E.C., 2023, Areas of Landslides Fayette Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Fayt - l.

Maike, C.A., 2023, Areas of Landslides Hamilton Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Hmtn - l.

Maike, C.A., and Anderson, F. J., 2023, Areas of Landslides Mountain Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Mntn - l.

Maike, C.A., and Anderson, F. J., 2023, Areas of Landslides Leroy Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Lroy - l.

Moxness, L.D., 2023, Areas of Landslides Hamlin Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Hmln - l.

Moxness, L.D., 2023, Areas of Landslides Kreiser Lake Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. KrsL - l.

Moxness, L.D., Anderson, F.J., Maike, C.A., and York, B. C., 2023, Areas of Landslides Nelson Lake Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. NlsL - l.

Moxness, L.D., Anderson, F.J., Maike, C.A., and York, B. C., 2023, Areas of Landslides Harmon Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Hrmn - l.

Anderson, Moxness, Maike, and York 2023, Areas of Landslides Burnt Butte Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. BrtB - l.

Moxness, L.D., 2023, Areas of Landslides Moselle Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Msll - l.

York, B.C. and Maike, C.A., 2023, Areas of Landslides Cavalier NW Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Cvlr NW - l.

York, B.C. and Maike, C.A., 2023, Areas of Landslides Neche Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Nche - l.

York, B.C. and Maike, C.A., 2023, Areas of Landslides Bathgate Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Btgt - l.

York, B.C. and Maike, C.A., 2023, Areas of Landslides Bathgate NE Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Btgt NE - l.

York, B.C. and Maike, C.A., 2023, Areas of Landslides Cavalier Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Cvlr - l.

York, B.C. and Maike, C.A., 2023, Areas of Landslides Backoo Quadrangle, ND Quadrangle: North Dakota Geological Survey 24K Map Series No. Bkbo - l.

Presentations This Quarter (January 1 to March 31, 2023)

B. Barnes, Lab tour, Archaeology, Paleontology Lab, January 1.

C. Boyd, Dakota Lab Tour, general public, Paleontology Lab, January 10.

B. Barnes, Dakota Lab Tour, general public, Paleontology Lab, January 17.

B. Barnes, Dakota Lab Tour, general public, Paleontology Lab, January 17.

C. Boyd, M. Householder, Dakota Lab Tour, General Public, Sen. Erbele, Paleontology Lab, January 24.

T. Nesheim, Core Library Tour, UND Petroleum Geology class, Core Library, January 26.

J. Person, Dakota Lab Tour, General Public, Paleontology Lab, January 31.

C. Boyd, M. Householder Dakota Lab Tour, Home School Group, Paleontology Lab, January 31.
T. Nesheim, Madison Petroleum System(s) of the Williston Basin, Rocky Mountain Association of Geologists, Denver, CO, February 1.
T. Nesheim, Madison Petroleum System(s) of the Williston Basin, Wyo. Geological Assoc., Casper, WY, Feb. 3.
B. Barnes, Dakota Lab Tour, General Public Paleontology Lab, February 7.
J. Person, B. Barnes, Lab & Collections tour, Rita Murphy 3rd Grade, Paleontology Lab, February 10.
J. Person, Lab & Collections tour, General Public, Paleontology Lab, February 11.
J. Person, Dakota Lab Tour, General Public, Paleontology Lab, February 14.
B. Barnes, Dakota Lab Tour, General Public, Paleontology Lab, February 14.
J. Person, Exhibits, lab, and collections tour, Young Professionals Network, Heritage Center, February 15.
B. Barnes, Paleo Lab and Collections tour, General Public, Heritage Center, February 20.
B. Barnes, Dakota Lab Tour, General Public, Paleontology Lab, February 21.
T. Nesheim & B. Saini-Eidukat, Precambrian cores from Oliver County, ND Geological Society, February 28.
M. Householder, T. Ford, Dakota Lab Tour, General Public, Paleontology Lab, February 28.
M. Householder, T. Ford Dakota Lab Tour General Public, Paleontology Lab, February 28.
C. Boyd A new early bear from the Oligocene of North Dakota, General Public, Museum of the Rockies, March 1.
M. Householder, Paleontology School Presentation, Lewis and Clark Elementary, 5th Graders, March 2.
C. Maike, ND landslide mapping: mapping into the future, USGS Landslide Seminar, Virtual, March 8.
C. Maike, North Dakota landslide mapping: A complete 1:24,000 inventory and mapping into the future Geologic Mapping Forum Virtual, March 9.
C. Boyd, M. Householder Dakota Lab Tour, General Public, Sen. Erbele Paleontology Lab, March 14.
J. Person, C. Boyd, Dakota Lab Tour, General Public, Representative Mock, Paleontology Lab, March 14.
B. Barnes, T. Ford, Dakota Lab Tour, General Public, Grafton school, Paleontology Lab, March 21.
C. Boyd, J. Person, Dakota Lab Tour, General Public, Reps. Richter,and Hanson, Paleontology Lab, March 22.
T. Nesheim, Madison Petroleum System(s) of the Williston Basin, Montana Geo. Society, Billings, MT, March 23.
J. Person, Dakota Lab Tour, Ryan Dennis, Paleontology Lab, March 27.
J. Person, Dakota Lab Tour, Student leadership (local high school students), Paleontology lab, March 28.
C. Maike, ND Geological Survey Landslide Mapping: future mapping, ND Geological Society, March 28.
J. Person, Exhibits, lab, and collections tour, Univ. Mary capstone Biology class Heritage Center, March 30.
C. Boyd, J. Person, collections tour USFS management, Heritage Center, March 30.

Attachment 21 to be presented at the meeting

Draft: 5/18/2023

RESOLUTION AUTHORIZING CHANGE IN USE OF PROCEEDS OF

$320,915,000
NORTH DAKOTA PUBLIC FINANCE AUTHORITY
LEGACY FUND INFRASTRUCTURE PROGRAM BONDS,
FEDERALLY TAXABLE SERIES 2022

WHEREAS, the North Dakota Public Finance Authority (the "Authority") is duly constituted as an instrumentality of the State of North Dakota exercising public and governmental functions under the operation, management and control of the Industrial Commission of North Dakota (the "Industrial Commission"), pursuant to Chapter 6-09.4, North Dakota Century Code (the "Act");

WHEREAS, on July 19, 2022, the Authority issued its Legacy Fund Infrastructure Program Bonds, Federally Taxable Series 2022 in the aggregate principal amount of $320,915,000 (the "2022 Bonds"), pursuant to the Act and the resolution of the Industrial Commission adopted April 29, 2022 (the "2022 Resolution") with respect thereto, the proceeds of which were to be allocated by the Bank of North Dakota to the funding of certain infrastructure projects and programs;

WHEREAS, the 2022 Resolution authorized proceeds of the 2022 Bonds to be used to fund transfers to the Bank of North Dakota for allocation to, among other projects, the Highway Fund in the amount of $54,000,000; provided that the allocation to the Highway Fund was subject to Section 10 of HB 1431 enacted by the Sixty-seventh Legislative Assembly ("HB 1431") which provided that up to $35 million of the funds allocated to the Highway Fund not required to match federal funds for highway projects as of October 1, 2022 was to be transferred to the Infrastructure Revolving Loan Fund at the direction of the Office of Management and Budget (such provision of Section 10 of HB 1431 (codified as Section 10 of Chapter 80 of the 2021 Session Laws) is hereinafter referred to as the "Contingent Reallocation Clause");

WHEREAS, the transfer of the proceeds of the 2022 Bonds to the Bank of North Dakota for allocation to the Highway Fund is to be made pursuant to a Project Agreement dated as of July 1, 2022 (the "Project Agreement") between the Authority and the Bank of North Dakota;

WHEREAS, the $35 million portion of the proceeds of the 2022 Bonds that was subject to the Contingent Reallocation Clause remains on deposit in the Project Fund under the Indenture of Trust (the "Trust Indenture") dated as of July 1, 2022 between the Authority and the Bank of North Dakota, as trustee;

WHEREAS, Section 15 of HB 1012 enacted by the Sixty-eighth Legislative Assembly ("HB 1012") amended Section 10 of HB 1431 (codified as Section 10 of Chapter 80 of the 2021 Session Laws) to, among other things, delete the Contingent Reallocation Clause;

WHEREAS, the Industrial Commission desires to supplement and amend the 2022 Resolution to conform with the provisions of Section 15 of HB 1012 by deleting the Contingent Reallocation Clause from the 2022 Resolution and authorizing any necessary or appropriate supplements and amendments to the Trust Indenture, the Project Agreement and any other documents, agreements or instruments in connection with the 2022 Bonds to conform to the provisions of Section 15 of HB 1012;

NOW, THEREFORE, BE IT RESOLVED by the Industrial Commission of North Dakota as follows:

ARTICLE I

Authority and Definitions

Section 1.01. Resolution. This Resolution is adopted in accordance with the provisions of and pursuant to the authority contained in the Act.

Section 1.02. Definitions. All terms defined in Article I of the Trust Indenture, in the 2022 Resolution or in the Act shall have the same meanings, respectively, in this Resolution and with respect to the 2022 Bonds as such terms are given in said Article I of the Trust Indenture, in the 2022 Resolution or in the Act.

ARTICLE II

Amendment of 2022 Resolution

Section 2.01. Change in Use of Proceeds of 2022 Bonds. In conformity with the amendment of Section 10 of HB 1431 (codified as Section 10 of Chapter 80 of the 2021 Session Laws) by Section 15 of HB 1012, the 2022 Resolution is supplemented and amended to delete the Contingent Reallocation Clause, such that the fourth whereas clause of the 2022 Resolution is amended and restated in its entirety as follows:

> WHEREAS, the Authority proposes to issue up to $330,000,000 Legacy Fund Infrastructure Program Bonds in one or more series (the "Bonds") to fund transfers to the Bank of North Dakota for allocation to the Projects in the following estimated amounts:
>
> | | |
> |---|---|
> | Fargo Diversion Project | $216,500,000 |
> | Highway Fund | 54,000,000 |
> | NDSU Agriculture Products Facility | 35,000,000 |
>
> and to fund capitalized interest on the Bonds and provide for the payment of the costs of issuance of the Bonds;

Section 2.02. Effect on 2022 Bonds. Notwithstanding any other provision of this Resolution, nothing in this Resolution is intended to, nor shall anything in this Resolution be construed or interpreted to, adversely affect in any manner the authorization of the 2022 Bonds, the security for the 2022 Bonds or the payment of the 2022 Bonds. Section 2.01 of this Resolution affects only the use of the proceeds of the 2022 Bonds.

Section 2.03. Effect on 2022 Resolution. Except as specifically amended pursuant to Section 2.01 of this Resolution, all provisions of the 2022 Resolution are hereby ratified and shall remain in full force and effect.

ARTICLE III

Amendment of Documents

There is hereby approved and there shall be executed by the Chairman of the Industrial Commission, the Executive Director of the Authority or any Authorized Officer such supplements and amendments to the Trust Indenture, the Project Agreement, the Administrative Agreement or other document, agreement or instrument executed in connection with the issuance of the 2022 Bonds, if any, as may from time to time be deemed necessary or appropriate to conform such documents, agreements or instruments to the amendment of the 2022 Resolution as set forth in Article II of this Resolution, all and in each case as the Chairman of the Industrial Commission, the Executive Director of the Authority or the Authorized Officer may approve, which approval shall be conclusively evidenced by the execution thereof.

ARTICLE IV

Effective Date

This Resolution is effective immediately.

Adopted: May 25, 2023

_____
Doug Burgum, Governor
Chairman

Attest:

_____
Karen Tyler
Interim Director and Secretary

(Commission Seal)

May 16, 2023

PUBLIC FINANCE AUTHORITY ADVISORY COMMITTEE

RECOMMENDATION TO THE INDUSTRIAL COMMISSION

The Advisory Committee, at its May 16, 2023 meeting, reviewed and discussed, and recommends approval of a $5,607,000 Clean Water State Revolving Fund Program loan to the City of Grand Forks.

North Dakota Public Finance Authority
Advisory Committee

Keith Lund, Chairman
Linda Svihovec
John Phillips

North Dakota Public Finance Authority

Memorandum

To: Public Finance Authority Advisory Committee
Miles Silbert, Public Financial Management
Kylee Merkel, Bank of North Dakota

From: DeAnn Ament, Executive Director

Date: May 8, 2023

Re: City of Grand Forks
Clean Water State Revolving Fund

Purpose of the Project: Construct a domestic lift station and associated forcemains to serve a newly annexed area and provide additional redundancy for wastewater service to the City and East Grand Forks.

Project Amount:

CWSRF Request	$ 5,607,000

Population to Benefit from the Project: 59,166; $95 per resident
Population Served by the System: 59,166
Is the Project Area Within the Extraterritorial Jurisdiction of a City: No

The requested term for the Clean Water State Revolving Fund (CWSRF) loan is 30 years. The City of Grand Forks will issue revenue bonds payable with sewer user fees. The average annual payment for the revenue bonds will be $234,633. The 110% coverage requirement will be $258,096 and the required debt service reserve will be $253,750.

The City has 13,113 residential users that pay a monthly water base rate of $15.12 with a $3.51/1,000-gallon charge and 2,546 commercial users that pay a monthly sewer base rate of $16.05 with a $3.75/1,000-gallon charge. The City annually reviews and adjusts the base and volume rate.

Wastewater Fund:

	2019	2020	2021	Unaudited 2022
Interest Revenue	$196,437	$140,258	$12,380	$130,211
Operating Revenue	10,986,349	11,713,328	11,150,301	11,677,974
Operating Expenses	6,048,455	6,902,906	7,326,374	6,840,382
Net Operating Revenue	5,134,331	4,950,680	3,836,307	4,967,803
Transfer In	-	-	649,429	-
Adjusted Net Operating Revenue	$5,134,331	$4,950,680	$4,485,736	4,967,803
Revenue Bond Payments	$3,027,287	$3,025,338	$3,122,902	2,371,901
Net Operating Coverage	170%	164%	144%	209%
Proforma Rate Increase	$454,012	$454,012	$454,012	$454,012
Proforma CW Payments [1]	$2,015,168	$2,015,168	$2,015,168	$2,561,494
Proforma Net Operating Coverage	112%	108%	96%	111%

[1] Net of the 2021 final payment of an existing CW loan for 2019-2021 and includes previously approved 2022 CW loan payment, but the loan has not closed.

The existing coverage coupled with the regular rate increases will be sufficient to meet the 110% net operating coverage.

The City outstanding indebtedness as of December 8, 2022:

	Original Amount	Outstanding Amount
General Obligation Bonds	$ 2,735,000	$ 1,190,000
Special Assessment Bonds	123,331,708	93,146,978
Water/Sewer Revenue Bonds *	114,571,141	100,206,250
Sales Tax Revenue Bonds	40,380,000	26,455,000
	$ 281,017,849	$220,998,228

*All payments have been made as agreed. The City has three CWSRF and one DWSRF loan with outstanding balances of $72,750,000.

The City of Grand Forks is located in Grand Forks County 82 miles north of Fargo on Interstate 29. Based on the 2020 census, the total population is 59,166; this is an increase of 6,328 from the 2010 census. The largest employers in the City are Altru Health Services with 3,950 employees, University of North Dakota has 3,464 employees and Grand Forks Air Force Base employs 1,643.

K-12 School Enrollment:

2019-2020	2020-2021	2021-2022	2022-2023
7,465	7,423	7,407	7,439

The City's 2022 taxable valuation was $250,940,606. This is an increase of $25,043,950 over the 2018 taxable valuation.

Property Tax Collections 2/28/2023:

Levy Year	Dollar Amount of Levy	Amount Collected to Date of Application	Percentage Collected
2022	24,363,498	21,174,214	87%
2021	23,303,480	21,536,112	92%
2020	22,971,628	21,799,967	95%

Special Assessment Collections 2/28/2023:

Year	Dollar Amount	Amount Collected to Date of Application	Percentage Collected
2022	9,270,607	8,174,908	88%
2021	8,325,199	7,965,284	96%
2020	8,234,124	8,051,488	98%

Mill Levy History:

Year	City	School	Park District	State and County	Total for Each Year
2022	96.84	110.79	37.80	82.63	328.06
2021	97.02	111.00	37.88	79.29	325.19
2020	97.87	100.94	38.19	80.82	317.82
2019	98.67	101.00	39.00	82.20	320.87
2018	98.82	98.00	39.06	80.00	315.88

BND
Bank of North Dakota

PO BOX 5509, 1200 Memorial Hwy.
Bismarck, ND 58506-5509

800.472.2166
800.366.6888 TTY
701.328.5600

bnd.nd.gov

Memorandum

To: Industrial Commission

From: Kylee Merkel, Business Banker
Bank of North Dakota

Date: May 9, 2023

RE: City of Grand Forks
Clean Water State Revolving Fund Program

ND Public Finance Authority has delivered to BND their memo which recommends approval of a $5,607,000 loan to the City of Grand Forks under the Clean Water State Revolving Fund (CWSRF). The entire cost of the project is $5,607,000, with CWSRF financing the full project.

The project includes construction of a lift station and associated forcemains to service a newly annexed area and to provide redundant wastewater service for the City of East Grand Forks. The requested loan term is 30 years. The City will issue a revenue bond payable with sewer user fees. The annual payment will average $234,633.

Debt Service Coverage:

Wastewater Fund	**2019**	**2020**	**2021**	**Projected**
Operating Revenue	10,986,349	11,713,328	11,150,301	11,150,301
Rate Increase				454,012
Interest Revenue	196,437	140,258	12,380	12,380
Operating Expenses	-6,048,455	-6,902,906	-7,326,374	-7,326,374
Net Operating Revenue	5,134,331	4,950,680	3,836,307	4,290,319
Transfer In	0	0	649,429	649,429
Adjusted Net Operating Income	5,134,331	4,950,680	4,485,736	4,939,748
Current Debt Service	3,027,287	3,025,338	3,122,902	4,903,437
Proposed Debt Service				234,633
Total Debt Service				5,138,070
Debt Service Coverage	170%	164%	144%	96%

BND
Bank of North Dakota

PO BOX 5509, 1200 Memorial Hwy.
Bismarck, ND 58506-5509

800.472.2166
800.366.6888 TTY
701.328.5600

bnd.nd.gov

The City currently serves 13,113 residential connections that pay a monthly base rate of $15.12, and 2,546 commercial connections that pay a monthly base rate of $16.05. The existing revenues, combined with future rate increases, will generate sufficient net operating revenues to service both the new and existing debt. The City annually reviews and adjusts rates as needed to meet the coverage requirements.

Outstanding Debt (as of December 8, 2022):

	Original Amount	Current Balance
General Obligation Bonds	2,735,000	1,190,000
Special Assessment Bonds	123,331,708	93,146,978
Sales Tax Revenue Bonds	40,380,000	26,455,000
Water & Sewer Revenue Bonds	114,571,141	100,206,250
	281,017,849	220,998,228

Average annual debt service requirements are estimated at $20,101,231, which is an average of $339.74 per resident.

The current estimated population is 59,166. Historical census populations for the City of Grand Forks were 58,871 in 2020, 52,838 in 2010 and 49,342 in 2000. The largest employers in the City are Altru Health System, University of North Dakota and Grand Forks Air Force Base.

Based upon the PFA recommendation and the benefits obtained with this project, BND concurs with their evaluation and support of the request.

Kylee Merkel
Business Banker

50 South Sixth Street
Suite 2250
Minneapolis, MN 55402

612.338.3535
612.338.7264 Fax
www.pfm.com

pfm

Memorandum

TO: DeAnn Ament, Executive Director
North Dakota Public Finance Authority

FROM: PFM Financial Advisors LLC

DATE: May 16, 2023

RE: Marketplace Analysis - Clean Water State Revolving Fund Program
City of Grand Forks

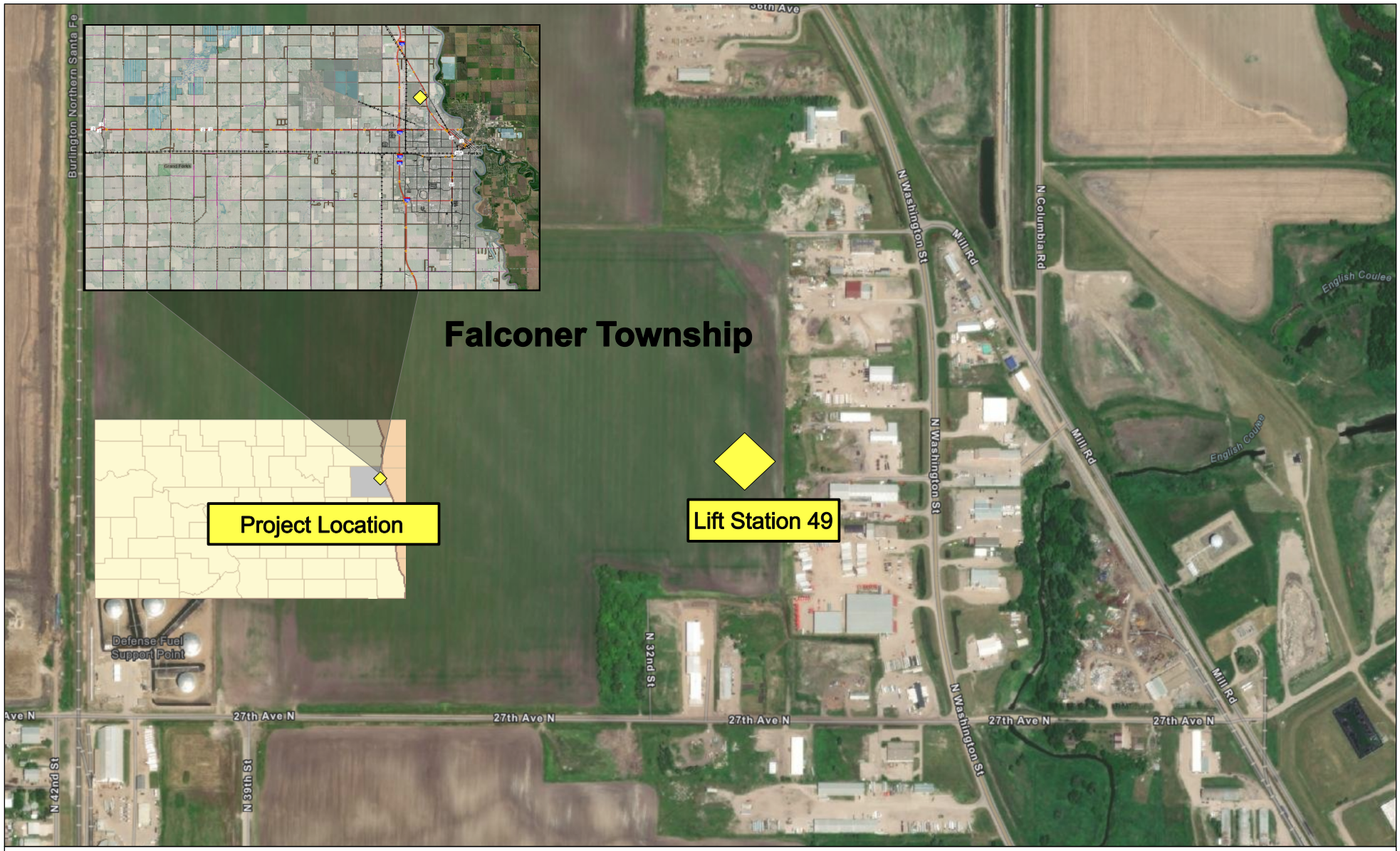
The City of Grand Forks ("City") has presented a request to the Authority and the North Dakota Department of Environmental Quality ("Department") for a $5,607,000 loan under the Clean Water State Revolving Fund Program ("CWSRF Program"). The CWSRF Program is used to make subsidized interest rate loans to political subdivisions for the purpose of constructing various wastewater treatment projects and landfill projects as approved by the Department in accordance with federal and state regulations and an updated Intended Use Plan prepared by the Department.

The City intends to use the proceeds to construct a domestic lift station and associated force mains to serve a newly annexed area and provide additional redundancy for wastewater service to the City and East Grand Forks.

The municipal securities to be acquired by the Authority will be revenue bonds payable from sewer user fees. The City's average annual payment under the proposed loan will be approximately $234,633 indicating a 110% net revenue coverage requirement of approximately $258,096. The City will be required to deposit $253,750 into a reserve fund with payments of $50,750 per year for the first five years of the loan. Net operating coverage of the wastewater fund was 1.70x, 1,64x, 1.44x and 2.09x for 2019-2022, respectively. The existing net operating revenues and annual adjustments to rates will provide sufficient net revenues to meet the 110% coverage requirement.

As of December 8, 2022, the City has $1,190,000 of General Obligation Bonds, $93,146,978 of Special Assessment Bonds, $26,455,00 of Sales Tax Revenue Bonds and $100,206,250 of Water/Sewer Revenue Bonds outstanding. The City currently has three Clean Water and one Drinking Water loans outstanding totaling $72,750,000. The City is current in its payments for its outstanding Authority loans.

Funding for the construction of the City's projects has been included in a list of approved projects as prepared and updated by the Department. As an authorized participant in the CWSRF Program, the City will benefit substantially from the subsidized fixed rate loans made under the Program. Consequently, no other financing mechanism can provide a greater cost advantage than that offered by the CWSRF Program.



Lift Station 49
City of Grand Forks

T152N, R50W, S29, Grand Forks County

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Date: 2/28/2023
Prepared by: BEW

RESOLUTION APPROVING
LOAN FROM CLEAN WATER STATE REVOLVING FUND

WHEREAS, the Industrial Commission has heretofore authorized the creation of a Clean Water State Revolving Fund Program (the "Program") pursuant to N.D.C.C. chs. 6-09.4 and 61-28.2; and

WHEREAS, the Clean Water State Revolving Fund is governed in part by the Master Trust Indenture dated as of July 1, 2011 (the "Indenture"), between the North Dakota Public Finance Authority (NDPFA) and the Bank of North Dakota (the Trustee); and

WHEREAS, the City of Grand Forks (the "Political Subdivision") has requested a loan in the amount of $5,607,000 from the Program to construct a domestic lift station and associated forcemains to serve a newly annexed area and provide additional redundancy for wastewater service to the City and East Grand Forks; and

WHEREAS, the NDPFA's Advisory Committee is recommending approval of the Loan; and

WHEREAS, there has been presented to this Commission a form of Loan Agreement proposed to be adopted by the Political Subdivision and entered into with the NDPFA;

NOW, THEREFORE, BE IT RESOLVED by the Industrial Commission of North Dakota as follows:

1. The Loan is hereby approved, as recommended by the Advisory Committee.

2. The form of Loan Agreement to be entered into with the Political Subdivision is hereby approved in substantially the form on file and the Executive Director is hereby authorized to execute the same with all such changes and revisions therein as the Executive Director shall approve.

3. The Executive Director is authorized to fund the Loan from funds on hand in the Clean Water Loan Fund established under the Indenture upon receipt of the Municipal Securities described in the Political Subdivisions bond resolution, to submit to the Trustee a NDPFA Request pursuant to the Indenture, and to make such other determinations as are required under the Indenture.

4. The Commission declares its intent pursuant to Treasury Regulations '1.150-2 that any Loan funds advanced from the Federally Capitalized Loan Account shall be reimbursed from the proceeds of bonds issued by the NDPFA under the Indenture.

Adopted: May 25, 2023

_____
Governor Doug Burgum, Chairman

Attest:

_____
Karen Tyler, Interim Executive Director and Secretary
Industrial Commission of North Dakota

May 16, 2023

PUBLIC FINANCE AUTHORITY ADVISORY COMMITTEE

RECOMMENDATION TO THE INDUSTRIAL COMMISSION

The Advisory Committee, at its May 16, 2023 meeting, reviewed and discussed, and recommends approval of a $565,000 Capital Financing Program loan to Jamestown Regional Airport Authority.

North Dakota Public Finance Authority
Advisory Committee

Keith Lund, Chairman
Linda Svihovec
John Phillips

Industrial Commission
of North Dakota

Doug Burgum
GOVERNOR

Drew H. Wrigley
ATTORNEY GENERAL

Doug Goehring
AGRICULTURE COMMISSIONER

North Dakota Public Finance Authority

Memorandum

To: Public Finance Authority Advisory Committee
Miles Silbert, Public Financial Management

From: DeAnn Ament, Executive Director

Date: May 10, 2023

Re: Jamestown Regional Airport Authority
Capital Financing Program

Purpose of the Project: Refinance the 2018 passenger parking lot mill and overlay which increased parking from 76 to 203.

Project Amount:

CFP Refinance Request	$ 565,000

The requested loan term is 5 years. The Authority will issue revenue bonds payable with passenger facility charge revenues as well as City and County mill levy. The average annual payment excluding the balloon payment will be $45,150.

The Authority charges $4.50 paid passenger facility fee (the Authority receives $4.39, and the airline receives $.11). The Authority will also pledge their City and County mill levy.

					1st Quarter
	2019	**2020**	**2021**	**2022**	**2023**
Annual Paid Boardings	11,175	5,655	11,142	11,203	898
Annual Revenue	$49,703	$23,820	$44,101	$50,715	$12,497

The passenger facility fee should provide sufficient revenue to meet the debt service requirements. If fees are insufficient, the mill levy revenues will be used to make up the deficit.

Change in Net Position:

			Unaudited
2019	**2020**	**2021**	**2022**
-$371,625	$2,049,343	$1,748,275	$93,298

Outstanding Debt:

	Original Amount	Outstanding Amount
Runway Rehab Revenue Bonds[1]	$ 126,500	$ 26,000
Terminal Revenue Bonds	325,000	108,677
T Hangar Revenue Bonds	633,000	548,266
Parking Lot Revenue Bonds[1,2]	700,000	595,000
Total	$ 1,784,500	$ 1,277,943

[1] All payments have been made as agreed. The Authority has two CFP bonds with outstanding balances of $621,000.
[2] Bond to be refinanced.

The Jamestown Regional Airport Authority is located in Stutsman County. The City population based upon the 2020 census is 15,849 which is an increase of 422 over the 2010 census. The County population based upon the 2020 census is 21,593 which is an increase of 493 over the 2010 census.

The largest employers are Collins Aerospace with 545 employees, ND State Hospital which employs 450 and Jamestown Public Schools has 370 employes.

School Enrollment for K-12:

2018-2019	2019-2021	2020-2021	2021-2022	2022-2023
2,138	2,192	2,187	2,122	2,145

The City's 2022 taxable valuation was $50,998,424. This is an increase of $6,970,182 over the 2018 taxable valuation. The County's 2022 taxable valuation was $83,478,508. This is an increase of $12,594,137 over the 2018 taxable valuation.

City Property Tax Levies and Collections 4/30/2023:

Levy Year	Dollar Amount of Levy	Amount Collected to Date of Application	Percentage Collected
2022	$204,484	$193,669	95%
2021	$194,124	$193,038	99%
2020	$189,823	$188,998	100%

County Property Tax Levies and Collections 4/30/2023:

Levy Year	Dollar Amount of Levy	Amount Collected to Date of Application	Percentage Collected
2022	$65,114	$62,328	96%
2021	$65,098	$64,656	99%
2020	$64,763	$64,584	100%

City Specials Assessed and Collected 4/30/2023:

Year	Dollar Amount	Amount Collected to Date of Application	Percentage Collected
2022	$44,368	$42,233	95%
2021	$41,736	$41,503	99%
2020	$41,286	$41,106	100%

Jamestown Regional Airport Authority Mill Levy Summary:

Mill Levy	2022	2021	2020	2019	2018
City Airport Levy	3.99	4.00	4.00	4.00	4.00
City Airport Special Assessments Levy	.87	.86	.87	.87	.87
County Airport Levy	.78	.80	.82	.86	.89

50 South Sixth Street
Suite 2250
Minneapolis, MN 55402

612.338.3535
612.338.7264 Fax
www.pfm.com

pfm

MEMORANDUM

TO: DeAnn Ament, Executive Director
North Dakota Public Finance Authority

FROM: Public Financial Management, Inc.

DATE: May 16, 2023

RE: Marketplace Analysis - Capital Financing Program
Jamestown Regional Airport Authority

The Jamestown Regional Airport Authority (the "JRAA") has presented a financing to the Authority for participation in the Capital Financing Program ("CFP"). The proposed financing for the JRAA exceeds $500,000 and, accordingly, a marketplace analysis has been included in the memorandum.

The JRAA has requested a 5-year loan totaling $565,000 for inclusion in the CFP. The proceeds of the loan will be used to refinance the 2018 passenger parking lot mill and overlay which increased parking from 76 to 203. The municipal securities to be acquired by the Authority would be passenger facility charge revenues as well as City and County mill levy.

A market analysis has been completed because the proposed size of the this issue requires the Industrial Commission ("Commission") to adopt a resolution which states that the Commission has determined that private bond markets will not be responsive to the needs of the political subdivision concerning its securities or which states other reasons if it appears that the municipal securities can be sold through private markets without the Authority's involvement.

Financing Alternatives

In general, there are three primary financing alternatives available to Political Subdivisions: competitive sale, negotiated sale and private placement.

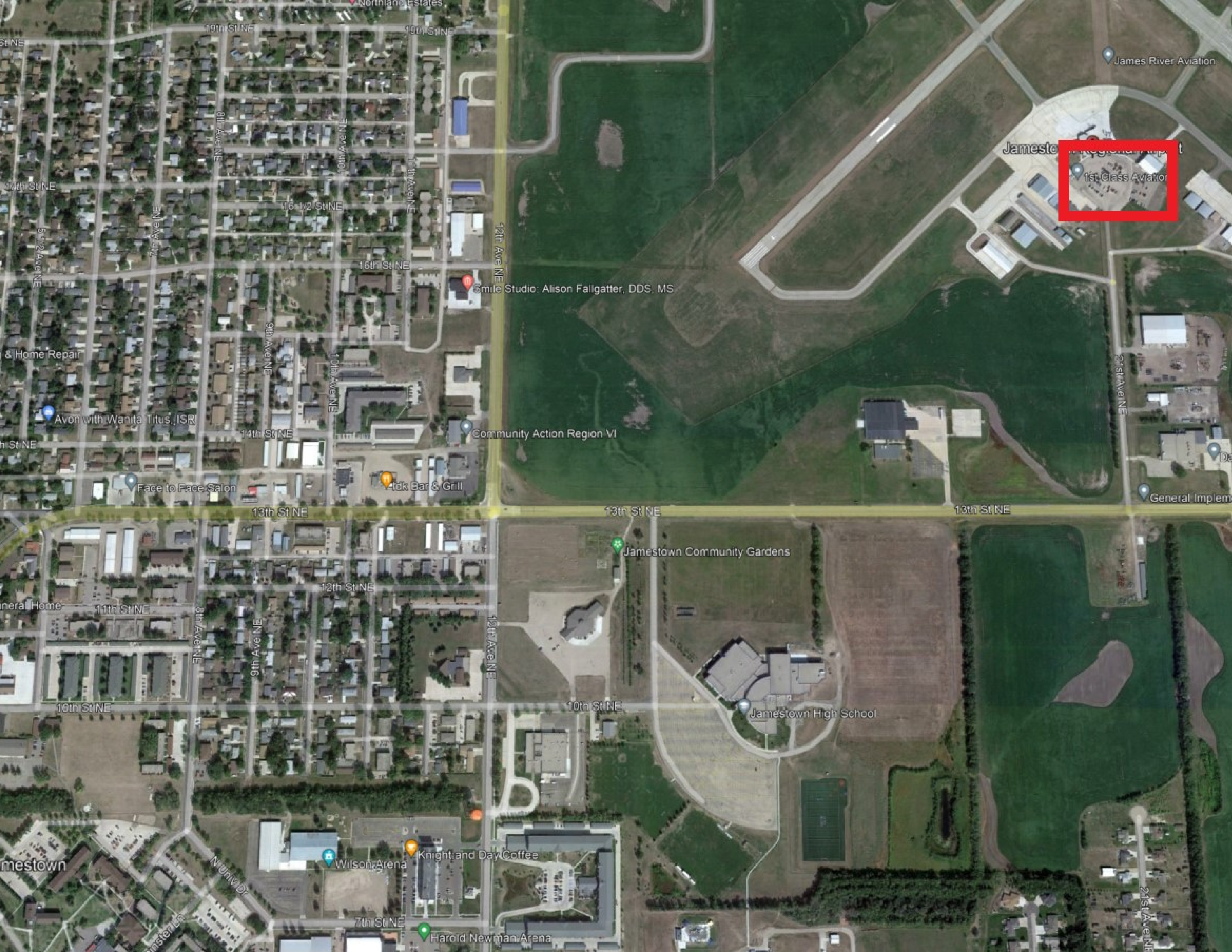
Each Political Subdivision has two options with respect to a competitive sale: they may choose to conduct a stand-alone public sale or they may sell their municipal securities competitively through the Authority's program. Under the competitive option, an official statement containing relevant disclosure information would be published and distributed to potential underwriters. These firms would be invited to submit competitive bids which conform to certain terms and conditions on a specified day and time.

With a negotiated financing, the Political Subdivision would likely select a single underwriting firm with which to negotiate all of the specific terms and conditions associated with the issue. Generally, certain parameters with respect to underwriting spread, or discount, interest rates and some structural features will be established by the issuer up front, with these details finalized at, or prior to, the time the bonds are priced.

A private placement is a variation of the negotiated sale. In this scenario, an issuer, usually with the help of a financial advisor or placement agent, will attempt to place the entire issue directly with an investor. The investor will negotiate the specific terms and conditions associated with the financing before agreeing to purchase the issue.

In this case, given the short-term nature of the financing the JRAA is pursuing and the flexibility it needs for repaying the loan, the JRAA would be unable to sell on a competitive or negotiated basis. The JRAA may be able to seek a private placement with a local bank, but in the current market such financing may be unavailable or the terms unfavorable. Without pursuing a full procurement process, it is not possible to accurately estimate what the interest rate would be if the JRAA privately placed its certificate directly with a local bank.

Given the flexibility needed by the JRAA and the current state of the financial markets, the Authority provides the JRAA with an optimal financing at a reasonable cost. Further, the Authority offers the JRAA the ability to borrow without having to issue bonds. Consequently, based upon the information available at this time, it appears that completing this financing through the Authority's CFP program would offer a benefit to the JRAA.



Northland Estates
19th St NE
James River Aviation
Jamestown Regional Airport
1st Class Aviation
16 1/2 St NE
16th St NE
Smile Studio: Alison Fallgatter, DDS, MS
& Home Repair
Avon with Wanita Titus, ISR
14th St NE
Community Action Region VI
Face to Face Salon
Idk Bar & Grill
13th St NE
12th Ave NE
21st Ave NE
General Implem
Jamestown Community Gardens
12th St NE
11th St NE
10th St NE
Jamestown High School
7th St NE
Wilson Arena
Knight and Day Coffee
Harold Newman Arena
Jamestown
N Univ Dr
8th Ave NE
9th Ave NE
10th Ave NE

North Dakota Public Finance Authority

INDUSTRIAL COMMISSION OF NORTH DAKOTA
NORTH DAKOTA PUBLIC FINANCE AUTHORITY
RESOLUTION APPROVING
LOAN AND PURCHASE OF MUNICIPAL SECURITIES
WITH FUNDS HELD IN THE CAPITAL FINANCING PROGRAM
GENERAL BOND RESOLUTION OPERATING ACCOUNT

WHEREAS, Jamestown Regional Airport Authority (the "Political Subdivision") has requested a loan in the amount of $565,000 (the "Loan") from the North Dakota Public Finance Authority (the "NDPFA") to refinance the 2018 passenger parking lot mill and overlay; and

Whereas, the Political Subdivision will issue revenue bonds payable with passenger facility charge revenues as well as City and County mill levy to repay the loan;

Whereas, upon a review of the loan application, the NDPFA's Advisory Committee is recommending approval of the Loan; and

NOW, THEREFORE, BE IT RESOLVED by the Industrial Commission of North Dakota as follows:

1. The Loan is hereby approved.

2. The Executive Director is authorized to fund the Loan as an eligible investment with funds available under the NDPFA's Capital Financing Program General Bond Resolution Operating Account, upon receipt of the Municipal Securities described and authorized to be issued in the Resolution to be adopted by the Political Subdivision's governing body.

Adopted: May 25, 2023

_____
Governor Doug Burgum, Chairman

Attest:

_____
Karlene Fine, Secretary and Executive Director
Industrial Commission of North Dakota

Industrial Commission
of North Dakota

Doug Burgum
GOVERNOR

Drew H. Wrigley
ATTORNEY GENERAL

Doug Goehring
AGRICULTURE COMMISSIONER

North Dakota Public Finance Authority

Memorandum

To: Industrial Commission: Governor Doug Burgum, Attorney General Drew H. Wrigley, Agriculture Commissioner Doug Goehring

From: DeAnn Ament, Executive Director

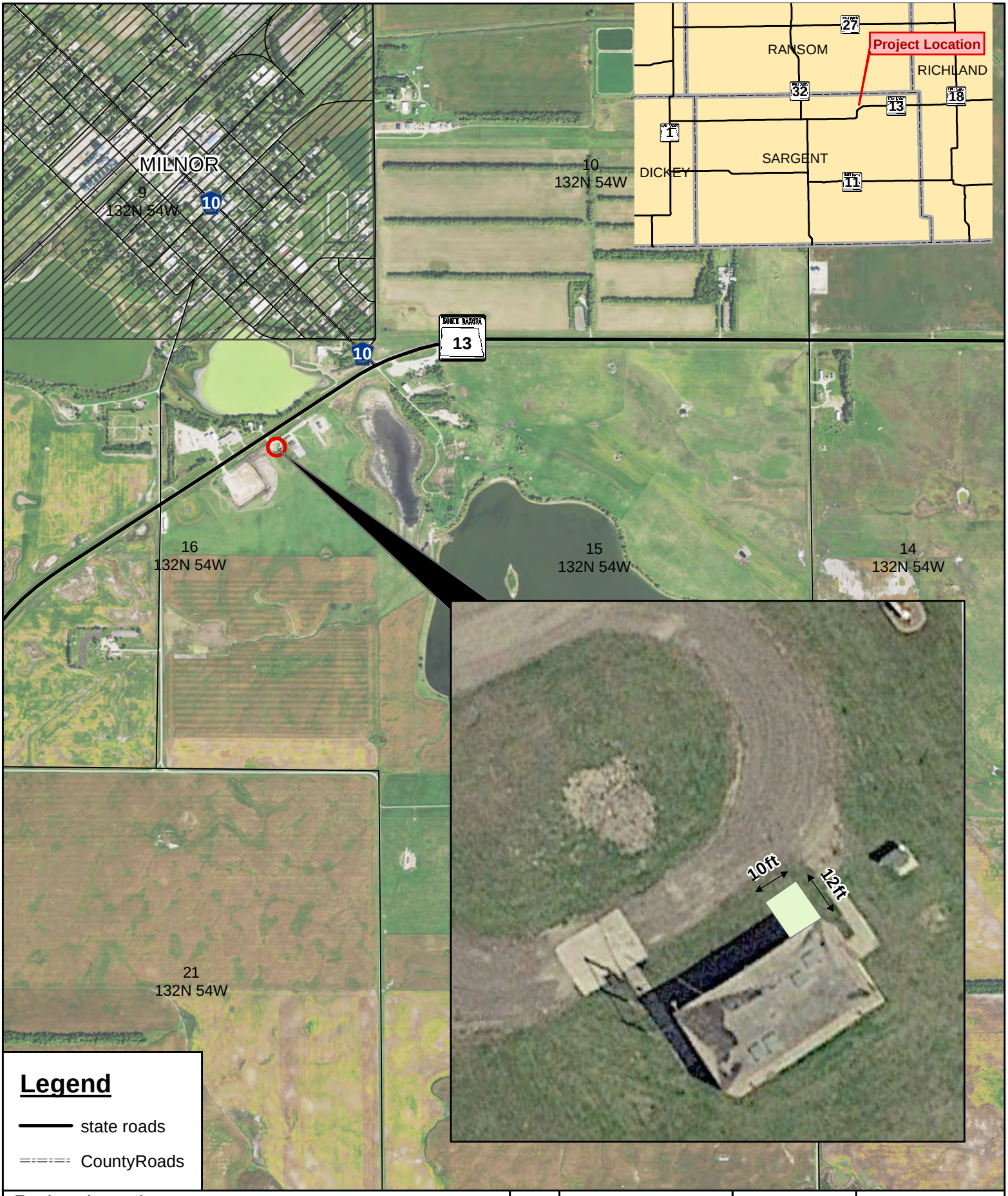
Date: May 16, 2023

Re: City of Milnor, Drinking Water State Revolving Fund

Under current policy, the Public Finance Authority can make loans under the State Revolving Fund Program in an amount not to exceed $2,000,000 and under the Capital Financing Program in an amount not to exceed $500,000 without seeking the final approval of the Industrial Commission. Within this policy, once the loan has been approved, the Public Finance Authority is required to provide the details of the loan to the Industrial Commission. Accordingly, the Public Finance Authority and its Advisory Committee used this policy to approve the following loans.

The committee reviewed a Drinking Water State Revolving Fund application from the City of Milnor for a $119,000 loan towards a $317,417 project. They will also receive a $98,175 grant from the ND Department of Emergency Services and use $100,242 of local ARPA funds. The project will update and incorporate the existing supervisory control system for the lift stations into the water control system. The requested term is 20 years. The City will issue revenue bonds payable with water user fees.

The Public Finance Authority's Advisory Committee approved the loan at their May 16, 2023, meeting.



Project Location Map
Water System Improvements District No. 2022-01
Milnor, ND

0 380 760 1,520 Feet

1 inch = 1,500 feet

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User Name: Tyler.Birchem Date Exported: 3/10/2022 11:32:34 AM Date Saved: 3/10/2022 11:31:03 AM
Units: Foot Coordinate System: NAD 1983 2011 StatePlane North Dakota South FIPS 3302 Ftl
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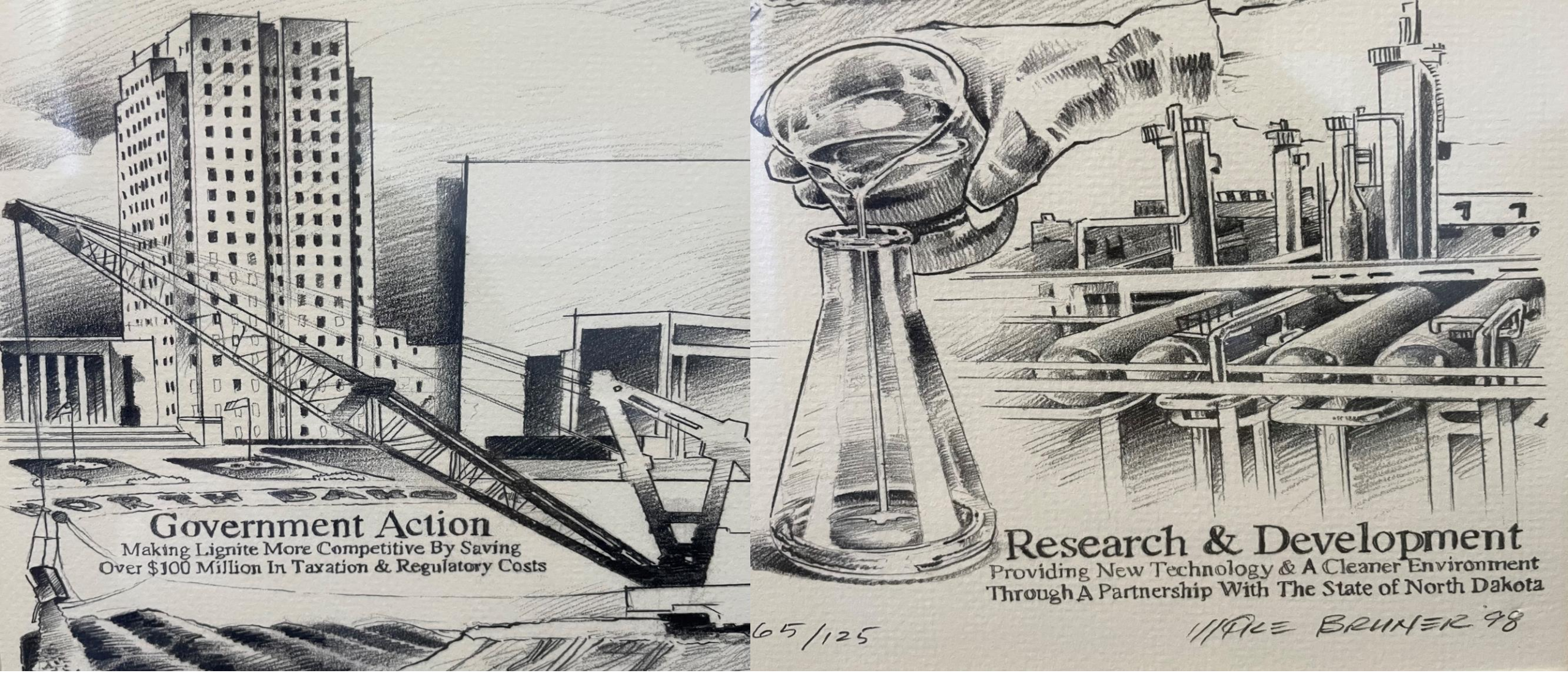

LIGNITE RESEARCH PROGRAM PROJECT MANAGEMENT AND FINANCIAL REPORT

Reice Haase, Deputy Executive Director, NDIC

May 25, 2023

NORTH Dakota
Be Legendary.™

Active Lignite Research Program Projects

29
Active Projects

$53 Million
Awarded Dollars

$19.2 Million
Outstanding Committed Dollars

Contract #	Project Name	Company	Total Project Cost	Original Commitment	Spent to Date	Balance
LMFS-20-42	Enhance, Preserve, and Protect Project-Phase VIII	Lignite Energy Council (LEC)	3,051,961.00	3,051,961.00	760,020.98	2,291,940.02
LMFS-22-43	Enhance, Preserve, and Protect Project-Phase VIIII	Lignite Energy Council (LEC)	3,519,189.00	3,519,189.00	-	3,519,189.00
FY08-63-161	Lignite Vision 21 Feasibility Project Phase IV-Engineering, Business Development and Design	Great Northern Power Development L.P.	38,967,950.00	5,123,619.00	3,755,941.00	1,367,678.00
FY16-80-204	Management Practices to Improve Soil and Vegetation Perimeters of Reclaimed North Dakota Coal Mine Lands	Department of Soil Science School of Natural Resource Sciences (NDSU)	1,156,374.00	578,187.00	507,113.99	71,073.01
FY19-88-220	Project Tundra-(FEED)	Minnkota Power Cooperative	46,006,695.00	20,000,000.00	18,000,000.00	2,000,000.00
FY20-90-221	Rare Earth Element Extraction and Concentration at Pilot-Scale from North Dakota Coal-Related Feedstocks	Institute for Energy Studies/University of North Dakota (UND)	7,158,555.00	1,075,000.00	915,000.00	160,000.00
FY20-90-222	Mitigation of Alkali Promoted Ash Deposition and Emissions from Coal Combustion	Barr Engineering Co.	4,999,412.00	400,000.00	351,112.12	48,887.88
FY20-91-224	Preliminary Front End Engineering and Design (pre-FEED) Study for a full-scale carbon dioxide capture system at Coal Creek Station (CCS2)	Great River Energy	8,478,000.00	4,239,000.00	4,217,721.04	21,278.96
FY20-91-225	Wastewater Recycling Using a Hygroscopic Cooling System	Energy & Environmental Research Center (EERC)	820,675.00	100,000.00	60,995.68	39,004.32
FY20-91-226	PCOR Initiative to Accelerate CCUS Deployment	Energy & Environmental Research Center (EERC)	12,504,348.00	2,000,000.00	883,895.87	1,116,104.13
FY20-92-227	Laboratory-Scale Coal-Derived Graphene Process	Energy & Environmental Research Center (EERC)	931,564.00	162,500.00	98,958.25	63,541.75
FY21-93-229	Naphtha and Tar Oil Overhead Refining Project	Dakota Gasification Company	285,000.00	142,500.00	-	142,500.00
FY21-94-230	Systematically Applied Research to Develop High Value Products from Coal	Semplastics EHC LLC and Affiliates	2,733,130.00	250,000.00	224,998.00	25,002.00
FY21-94-232	Lignite-Derived Carbon Materials for Lithium-Ion Battery Anodes	Institute for Energy Studies/University of North Dakota (UND)	667,465.00	75,000.00	44,125.92	30,874.08
FY21-94-233	Electrostatic Filtration of Large Lubricant Reservoirs	Institute for Energy Studies/University of North Dakota (UND)	350,948.00	151,494.00	150,897.02	596.98
FY21-94-234	Annual Lignite Energy Council Education Program	Lignite Energy Council (LEC)	412,000.00	200,000.00	90,000.00	110,000.00
FY21-95-235	North Dakota Rare Earth and Critical Element Resource Evaluation	Microbeam Technologies, Inc.	1,059,510.00	529,529.00	282,406.70	247,122.30
FY21-96-236	Williston Basin CORE-CM Initiative	University of North Dakota (UND)/Energy & Environmental Research Center (EERC)	2,450,000.00	750,000.00	-	750,000.00
FY21-96-237	Ammonia-Based Energy Storage Technology (NH3-BEST)	Energy & Environmental Research Center (EERC)	426,390.00	101,390.00	37,447.60	63,942.40
FY21-96-238	Determining Optimum Coal Bottom Ash Content for Sustainable Concrete Infrastructure	UND College Department of Civil Engineering	289,271.00	118,614.00	84,804.56	33,809.44
FY21-96-239	Continued Funding for Regional Lignite Energy Public Affairs Program	Lignite Energy Council (LEC)	3,600,000.00	1,800,000.00	237,000.00	1,563,000.00
FY22-97-240	Production of Germanium and Gallium Concentrates for Industrial Processes	Microbeam Technologies, Inc.	189,943.00	20,000.00	12,090.00	7,910.00
FY22-97-241	North Dakota Lignite Coal-Based Pitch for Production of High Value Carbon Products via AmeriCarbon liquid Carbon Pitch (LCP) Procsess	AmeriCarbon Products, LLC	1,209,794.00	550,000.00	187,702.63	362,297.37
FY22-97-242	Development of Novel Sintered Coal Building Materials	Microbeam Technologies, Inc.	649,407.00	62,500.00	19,415.00	43,085.00
FY22-98-243	Advanced Processing of Coal and Coal Waste to Produce Graphite for Fast-Charging Lithium Ion Battery Anode	University of North Dakota (UND)/Energy & Environmental Research Center (EERC)	1,545,000.00	500,000.00	-	500,000.00
FY22-99-244	Project Tundra “CREST” Study	Minnkota Power Cooperative	10,830,000.00	5,415,000.00	2,657,437.39	2,757,562.61
FY22-100-245	Incorporation of Coal and Coal Waste into High-Value Materials	Semplastics	742,050.00	150,000.00	36,825.00	113,175.00
FY22-100-246	Incorporation of Coal and Coal Waste into High-Value Materials	Semplastics	3,464,583.00	700,000.00	175,000.00	525,000.00
FY22-101-247	Lignite Resource Evaluation for Advance Utilization Opportunities	Microbeam Technologies, Inc.	2,477,994.18	1,238,994.18	-	1,238,994.18

Lignite Research Fund (314)
Financial Statement - Cash Balance
2021-2023
Lignite Research Council Meeting
5/11/2023

		Cash Balance	
July 1, 2021 Beginning Balance	$21,807,466.27		
$.02/ton Revenues through March 31, 2023		$817,012.96	
Coal Trust Fund Revenues through March 31, 2023		$1,756,855.16	
Coal Conversion Tax Revenues through March 31, 2023		$2,267,691.28	
Interest Income through March 31, 2023		$46,730.41	
Coal Severance Tax through March 31, 2023		$2,585,151.20	
Oil and Gas Tax Allocation		$10,000,000.00	
Repayments & Other Revenues through March 31, 2023*		$241,525.72	
Total Revenues		$17,714,966.73	
Small Research/Education Projects Expenditures through March 31, 2023		$2,997,869.43	
LV Demonstration Projects Expenditures through March 31, 2023		$0.00	
Advanced Energy Technology (AET) Projects through March 31, 2023		$6,018,301.84	
Marketing Contract Expenditures through March 31, 2023		$624,000.00	
Litigation Cost Expenditures through March 31, 2023		$0.00	
Non-Matching Project Expenditures through March 31, 2023		$547,309.19	
Administrative Expenditures through March 31, 2023		$643,900.86	
Total Expenditures		$10,831,381.32	
Cash Balance as of March 31, 2023			$28,691,051.68
Outstanding Contracted Small Research Project Commitments	$5,692,919.84		
Outstanding Contracted Marketing Project Commitments	$1,563,000.00		
Estimated Lignite Litigation Costs for 2021-2023 Biennium	$1,000,000.00		
Outstanding Non-Matching Project Commitment (EPP)	$5,811,128.81		
Outstanding LV 21 Demonstration Project Commitment	$1,367,678.00		
Outstanding AET Project Commitments	$4,778,841.57		
Estimated Administrative Expenses for 2021-2023 Biennium	$256,099.14		
		$20,469,667.36	
Non-Committed Cash Funding*			$8,221,384.32
Estimated Revenues for 2021-2023 Biennium			
$.02/ton Coal Severance Tax	$1,075,000.00		
Coal Development Trust Fund	$2,100,000.00		
Coal Conversion Tax	$2,250,000.00		
AET-15% of Coal Severance Tax	$3,000,000.00		
Oil and Gas Tax Allocation	$10,000,000.00		
Interest & Other Income	$250,000.00		
		$18,675,000.00	

2021-2023	Budgeted	Committed	Balance
Administration	$900,000.00	$900,000.00	$0.00
Non-Matching Studies (EPP)	$3,839,249.00	$6,358,438.00	($2,519,189.00)
Marketing Project	$2,187,000.00	$2,187,000.00	$0.00
LV 21 Demonstration Projects	$1,367,678.00	$1,367,678.00	$0.00
Small Research Projects	$10,806,395.00	$8,690,789.27	$2,115,605.73
Advanced Energy Technology Projects	$20,382,143.00	$10,797,143.41	$9,584,999.59
Litigation Costs	$1,000,000.00	$1,000,000.00	$0.00
	$40,482,465.00	$31,301,048.68	$9,181,416.32

* An additional $1,110,120 payment was made to the LRC in April 2023, and will show on the next financial statement. This amount is also available as non-committed cash funding.

5/11/23

2023-2025 BIENNIUM:

Estimated Income:

$18.5 million

Grant Management and Digitization Costs:

$250,000

Lignite Plant of the Future Commitment:

$500,000

CO2 Utilization Commitment:

$100,000

Non-Match Commitments:

$4.5 million

Total All Commitments:

$6.25 million

LONG APPLICATION RATING FORM

Reviewer's Identification Number: 102A-1 (no name please)

Date: April 11, 2023

Principal Investigator(s): Lignite Energy Council

Proposal Number: LRC-102-A

Application Title: Lignite Energy Council Education Program

Section A. Summary of Ratings:

Please complete the questions below, then fill in this summary.

	Statement	Circled Number		Weighting Factor		Subrating
1.	Objectives	5	X	9	=	45
2.	Achievability	5	X	9	=	45
3.	Methodology	5	X	7	=	35
4.	Contribution	3	X	7	=	21
5.	Awareness	4	X	5	=	20
6.	Background	4	X	5	=	20
7.	Project Management	3	X	2	=	6
8.	Equipment Purchase	5	X	2	=	10
9.	Facilities	4	X	2	=	8
10.	Budget	4	X	2	=	8
				Total: 50		218
						250 points possible

Note: While points are necessary to establish an overall rating, comments on the various criteria are critical to truly understanding the value of a proposed project. Please elaborate in the comment sections to the maximum extent possible.

Overall Recommendation: ____X_____ Fund

_____ Funding May Be Considered

_____ Do Not Fund

Section B. Ratings and Comments:

Please circle your response to each statement and transfer the number circled to the column entitled "Circled Number" on the first page of this form. Also, please comment on each criteria.

1. The objectives or goals of the proposed project with respect to clarity and consistency with North Dakota Industrial Commission/Lignite Research Council goals are: 1 – very unclear; 2 – unclear; 3 – clear; 4 – very clear; or 5 – exceptionally clear.

   Please comment: The application is very clear in goals of the proposed project and the project is very consistent the goals and objectives of the NDIC and the Lignite Research Council.

2. With the approach suggested and time and budget available, the objectives are: 1 – not achievable; 2 – possibly achievable; 3 – likely achievable; 4 – most likely achievable; or 5 – certainly achievable.

   Please comment: Based on the information provided in the application and the historical track record of Lignite Energy Council's "Education Program" the objectives can be achieved per the proposal identified in the application.

3. The quality of the methodology displayed in the proposal is: 1 – well below average; 2 – below average; 3 – average; 4 – above average; or 5 – well above average.

Please comment: The methodology is very clear, and enough detail was provided to understand how the program has worked well in the past and the list of proposed enhancements to the program were clearly laid out in the application.

4. The scientific and/or technical contribution of the proposed work to specifically address North Dakota Industrial Commission/Lignite Research Council goals will likely be: 1 – extremely small; 2 – small; 3 – significant; 4 – very significant; or 5 – extremely significant.

Please comment: The proposed work is not necessarily of a scientific or technical nature; however, the project is designed to help to ensure that there is an acceptance of the lignite energy industry going forward and highlights the contributions this industry provides to the state and region. Thee project is aligned with the goals and objectives of the North Dakota Industrial Commission and the Lignite Energy Council.

5. The principal investigator's awareness of current activities and published material as evidenced by material referenced in the proposal is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Please comment: The principal investigators are very aware of the challenges facing the lignite industry and their knowledge is clearly laid out in the application.

6. The background of the investigator(s) as related to the proposed work is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Please comment: The investigators have been delivering the "Lignite Energy Council Education Program" for numerous years and have been very successful in the program's development. The continued growth of the program as outlined in the application is very aligned with the experience and background of the investigators.

7. The project management plan, including a well-defined milestone chart, schedule, financial plan, and plan for communications among the investigators and subcontractors, if any, is: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – very good; or 5 – exceptionally good.

Please comment: In the application, there is enough information provided to understand the project plan and associate project financials. The application did not supply a detailed milestone chart or schedule; however, they did provide a high-level schedule for future seminars sessions.

8. The proposed purchase of equipment is: 1 – extremely poorly justified; 2 – poorly justified; 3 – justified; 4 – well justified; or 5 – extremely well justified. (Circle 5 if no equipment is to be purchased.)

Please comment: No equipment to be purchased.

9. The facilities and equipment available and to be used for the proposed work are: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – notably good; or 5 – exceptionally good.

Please comment: The use of the Bismarck State College dorms and the National Energy Center of Excellence are a great venue for the delivery of the Teacher Seminar and are a perfect back drop for the program. The remaining deliverables as outlined in the application do not require any special equipment or facilities to complete.

10. The proposed budget "value"[1] relative to the outlined work and the financial commitment from other sources is of: 1 – very low value; 2 – low value; 3 – average value; 4 – high value; or 5 – very high value. (See below)

Please comment: The completion of the proposed project work is a very cost-effective use of the proposed spend. The project builds on historical programs and leverages money that has been committed to the Lignite Energy Council Education Program.

Section C. Overall Comments and Recommendations:

Please comment in a general way about the merits and flaws of the proposed project and make a recommendation whether or not to fund.

[1] "Value" – The value of the projected work and technical outcome for the budgeted amount of the project, based on your estimate of what the work might cost in research settings with which you are familiar.

Financial commitment from other sources – A minimum of 50% of the total project must come from other than Industrial Commission sources to meet the program guidelines. Support less than 50% from Industrial Commission sources should be evaluated as favorable to the application.

General comments: The project as outlined in the application builds on a well-designed, effective and highly valued education program. The proposed work is aligned with the objectives of the North Dakota Industrial Commission's and the Lignite Energy Council's goals and objectives see that a lignite energy industry continues well into the future here in North Dakota. An overall recommendation for funding this project is "Yes".

LONG APPLICATION RATING FORM

Reviewer's Identification Number: 102A-2 (no name please)

Date: 04.17.2023

Principal Investigator(s): Lignite Energy Council

Proposal Number: LRC-102-A

Application Title: Lignite Energy Council Education Program

Section A. Summary of Ratings:

Please complete the questions below, then fill in this summary.

	Statement	Circled Number		Weighting Factor		Subrating
1.	Objectives	5	X	9	=	45
2.	Achievability	5	X	9	=	45
3.	Methodology	4	X	7	=	28
4.	Contribution	4	X	7	=	28
5.	Awareness	4	X	5	=	20
6.	Background	5	X	5	=	25
7.	Project Management	5	X	2	=	10
8.	Equipment Purchase	5	X	2	=	10
9.	Facilities	5	X	2	=	10
10.	Budget	5	X	2	=	10
				Total: 50		231

250 points possible

Note: While points are necessary to establish an overall rating, comments on the various criteria are critical to truly understanding the value of a proposed project. Please elaborate in the comment sections to the maximum extent possible.

Overall Recommendation: ✓ Fund

_____ Funding May Be Considered

_____ Do Not Fund

Section B. Ratings and Comments:

Please circle your response to each statement and transfer the number circled to the column entitled "Circled Number" on the first page of this form. Also, please comment on each criteria.

1. The objectives or goals of the proposed project with respect to clarity and consistency with North Dakota Industrial Commission/Lignite Research Council goals are: 1 – very unclear; 2 – unclear; 3 – clear; 4 – very clear; or (5) – exceptionally clear.

Please comment:

The objectives and goals are very clear in the proposal.

- Improve perception of lignite as energy resource
- Increase Awareness of regional lignite economy
- Increase understanding of future Growth opportunities

In addition, the Key Audiences of the program are well defined and fit well into the IC & ND LEC goals. The applicant proposes to teach the teacher and provides a variety of ways for educators to take the information back to the classroom.

The Deliverables are well listed on page 9 of the application which show a well thought out relationship to the objectives.

2. With the approach suggested and time and budget available, the objectives are: 1 – not achievable; 2 – possibly achievable; 3 – likely achievable; 4 – most likely achievable; or (5) – certainly achievable.

Please comment:

The approach to educate teachers and other Key audiences with the proposed time and available budget is very Achievable. What has the most opportunity to help this program succeed is the multi year timeframe.

The applicant builds on the in-person seminars with additional tools such as the Vidio series and the proposed software to Connect teachers allowing for sharing lesson plans and information

The budget of $908K seems reasonable and one would expect the lignite Energy Council and its members will Contribute whatever in-Kind Contributions of time or funding that are needed to make the program successful.

In particular the lignite learn and associated Activities have merit in creating a program with Consistency and staying power.

3. The quality of the methodology displayed in the proposal is: 1 – well below average; 2 – below average; 3 – average; (4) – above average; or 5 – well above average.

Please comment:

The Lignite Energy Council has established a well thought out methodology for the program. In particular the LEC has a strong strategy to recruit educators - and then ensure the program meets their needs for continuing education and utilizing funding to cover expenses that could be a barrier to participation.

After recruiting educators the methodology to educate the educators and provide a variety of tools and follow up mechanisms

To close the loop on the methodology, the LEC has created very specific out come goals of 70 % thresholds related the key objectives

4. The scientific and/or technical contribution of the proposed work to specifically address North Dakota Industrial Commission/Lignite Research Council goals will likely be: 1 – extremely small; (2) small; ~~3~~ 3 significant; 4 – very significant; or 5 – extremely significant.

Please comment:

This particular out come is more difficult to measure as the proposal is for an education program. However, the STEM technology grant component does play into providing some scientific and technical contribution to those students who participate in the program.

Page 15 does provide some insight into the applicants perception of how the program fits into the LERC goals. In particular how the program seeks to preserve and create jobs; ensure economic stability & growth of the industry and maintain a stable and reliable tax Base.

5. The principal investigator's awareness of current activities and published material as evidenced by material referenced in the proposal is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Please comment: The LEC demonstrates a knowledge of the current activities related to providing an educational program of this magnitude

What is most noted in this criteria is the proposal to purchase and implement software related to the learning check. which provides easy access for teachers to not only develop lesson plans and access materials but the expansion to ready to deliver curriculum and the opportunity to present stand alone hands on activities practiced by staff of the LEC

6. The background of the investigator(s) as related to the proposed work is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Please comment:

The background of the staff that will be delivering the program is very strong and represents a key component of how this program can be successful.

- Matteen has an extensive background in higher education in addition to her academic credentials. Not noted but I am also aware of her media background that will contribute to her presentation skills and knowledge to assist in preparing materials. She is the "fresh eyes".
- Kay DeCee has worked with the summer since 2008 and serves as the institutional memory for the program.
- Jason Bohrer and Mike Holmes background speak for themselves
- In addition the various experts to assist the program from the Duquite Energy Industry contributes an invaluable component to the educational experience.

7. The project management plan, including a well-defined milestone chart, schedule, financial plan, and plan for communications among the investigators and subcontractors, if any, is: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – very good; or (5) – exceptionally good.

Please comment: The plan is well laid out with identified objectives Activities and measurable outcomes. The plan is easy to understand which means there is a strong Chance of successful implementation.
Page 9 states the standards of success
Page 16 is the time table and budget to include page 17.

8. The proposed purchase of equipment is: 1 – extremely poorly justified; 2 – poorly justified; 3 – justified; 4 – well justified; or (5) – extremely well justified. (Circle 5 if no equipment is to be purchased.)

Please comment: While not exactly "equipment" in the traditional thought process. The applicant does want $199,200 for purchase of software to build on the implementation of Sujita learn.
In particular the ability to host interactive courses and the teacher online refresher course seem to have real merit. It also provides a cost effective way to deliver activity kits and updated materials. The emphasis on hands on learning is a unique aspect.

9. The facilities and equipment available and to be used for the proposed work are: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – notably good; or (5) – exceptionally good.

Please comment: The applicant will use BSC for the in-person seminar at the National Energy Center. This is an exceptional facility well suited to the proposed training.
The NEC provides top quality equipment that will contribute to the overall learning experience.

10. The proposed budget "value"[1] relative to the outlined work and the financial commitment from other sources is of: 1 – very low value; 2 – low value; 3 – average value; 4 – high value; or (5) – very high value. (See below)

Please comment: As proposed the LEC will contribute $458 K on a grant application of $450K from the Research Council. In addition there is noted additional sponsorships provided by ND and MN Cooperatives to assist with travel expenses and travel for participants. The Industry also contributes 150 hours for recruitment, Activities and seminar presentation.
If the LERC were to try to contract for this service and not use the proposal, the anticipated cost would be substantially higher if not almost impossible to conduct.

Section C. Overall Comments and Recommendations: did estimate a comparable program in the $2m to $3m range if contracted separately.

[1] "Value" – The value of the projected work and technical outcome for the budgeted amount of the project, based on your estimate of what the work might cost in research settings with which you are familiar.

Financial commitment from other sources – A minimum of 50% of the total project must come from other than Industrial Commission sources to meet the program guidelines. Support less than 50% from Industrial Commission sources should be evaluated as favorable to the application.

Please comment in a general way about the merits and flaws of the proposed project and make a recommendation whether or not to fund.

General comments:

This proposal is well thought out with a strong methodology to define the objectives, activities and outcomes. The activities proposed show value for the participants while delivering on the goals of the LERC and it's objective of supporting the lignite coal industry in North Dakota.

The budget is well planned out with an achievable timeline that builds on itself over a 3-year period. The in-kind contribution by the industry could not be replicated by any other contractor without a substantial increase in cost.

The background and qualifications of the management and presenters is excellent and demonstrates that just a knowledge of the industry but also how to deliver the content.

Developing an on line component will help to ensure the longetivity of the program and creates a continuous feedback loop which delivers timely materials. This combined with the STEM events and hands-on components completes a comprehensive approach.

Recommendation is to provide full funding.

Lignite Energy Council Education Program

Grant Submitted by
Lignite Energy Council

Principal Investigator
Lignite Energy Council

Grant Deadline: April 1, 2023
Amount Requested: $450,000

Table of Contents

Abstract

The Lignite Energy Council's (LEC) Education Program continues to build on the ongoing success of the more than thirty years of the Lignite Education Seminar as well as education initiatives to educate teachers and students about the regional lignite industry including energy production and the economic and environmental impacts of lignite.

Through the Lignite Energy Council's Lignite Education Seminar, Lignite Learn E-Campus, and other education-focused outreach efforts, the expected outcomes of the Education Program include:

- Improved perception of lignite coal as an energy resource;
- Increased awareness of the regional lignite economy; and
- Increased understanding of future growth opportunities within the lignite industry.

These outcomes will be achieved through deliverables that facilitate open communication and awareness, expand the use of educational hands-on activities in classroom settings, and through providing multi-day, expert-level education for teachers and administrators. Ultimately, the Lignite Education program achieve the overarching goal of educating teachers and students about the lignite industry in the region.

The funding request is for a three-year program with a project start date of April 1, 2023 to allow the ongoing work of industry and the Lignite Energy Council to be included in the overall scope. The total budget for the Education Program as described is $908,000, of which $450,000 is requested from the Lignite Research Council. The matching funding for the Education Program comes from the Lignite Energy Council and in-kind services from the Lignite Energy Council and representatives of the lignite industry.

Project Summary

The goal of the Lignite Education Program is to educate teachers and students about the lignite industry through in-person connection, community outreach events, and online educational and awareness opportunities. Ensuring the Program invests resources in multiple avenues and mediums is crucial in ensuring that many subsets of the target audience is reached, and that the message is reinforced through repetition and various delivery modalities.

The flagship piece of the Education Program has long been the Lignite Education Seminar. The four-day Seminar, which is held each June in Bismarck, includes tours of mines, power plants, and other coal-related facilities along with instruction on issues such as history, geology, mining and reclamation, the conversion of lignite to electricity or synthetic natural gas, and the economics of the lignite industry. The seminar also includes panel discussions and presentations regarding industry-related career opportunities, environmental challenges, transmission needs and research and development topics.

Education about the regional lignite industry is essential in fostering a positive and favorable view of the industry which is rooted in facts, which aids in favorable regulatory, business and career climates for the industry. Access to educational opportunities and easily consumable industry information is crucial in providing awareness about the industry, especially with younger generations. Teaching the teachers and providing them with accurate information about lignite coal and the positive impacts of the industry on North Dakota and the region ensures that they are providing accurate instruction to their students.

This grant application will expand the timeline of the grant to a three-year initiative, allowing for continued flexibility due to technological upgrades, including the ability to educate teachers and students with up-to-date materials reflecting any potential regulatory or other changes. The expanded grant also shows a commitment to continued education regarding lignite coal as an energy resource for today and tomorrow. The expanded timeline will also allow for investments in Year 1 (including encumbered expenses to be included as Year 1 match) that will positively impact the effectiveness of the program in Year 2 and Year 3.

Project Description

Over the past several years, the Lignite Energy Council, with support from the Lignite Research Council and industry partners have continued to expand the impact and breadth of its educational efforts through digital assets and community outreach initiatives. Targeted audiences include community groups, business leaders, and potential lignite industry employees. As planning continues to broaden the reach and impact of the Lignite Education Program and Lignite Education Seminar, this budget will reflect similar opportunities to remain flexible with the program and broaden its impact in response to any changing conditions.

The ability to reach and impact more educators and students through the Education program will be increased through the purchase and implementation of a management software system, which will add value to the program, improve management efficiencies, and serve as a platform for wider dissemination of educational resources to teacher and students.

Opportunities to engage in continued educational programming to these identified communities will be within the scope of this application, including those outlined below:

- Lignite Education Seminar
- Educational Video Series
- Lignite Education Foundation and License Plates
- STEM Technology Grant
- Lignite Learn
- Direct community and school engagement

Lignite Education Seminar

Future Lignite Education Seminars are scheduled to be held at the National Energy Center of Excellence on the campus of Bismarck State College in Bismarck, ND, on June 12 – 15, 2023, June 10 – 13, 2024, and June 9 – 12, 2025. The annual Seminar has historically attracted educators primarily from a four-state area – North Dakota, South Dakota, Minnesota and Montana. School superintendents, principals and teachers of all grade levels from elementary to senior high are encouraged attend the four-day Seminar. Approximately 75 - 110 educators attend annually.

Teachers attending the Seminar will create lesson plans based on their learning from the event, with the intention that they use these lesson plans in their classrooms. Through a new online platform, teachers will begin to have the opportunity to share completed lesson plans with others who have attended the Seminar, increasing the impact of the Seminar outcomes back in the classroom for years to come.

Lignite Educational Video Series

In 2017, the Lignite Energy Council, with support and matching grant funding from the Lignite Research Council began work on a four-part video series. To date, three videos have been completed and are available for viewing on the Lignite Energy Council YouTube account as well as being featured at the North Dakota Heritage Center. The videos are also made available to

teachers via the Lignite Education Seminar – Teachers website. The videos are aimed to match the four major areas of the Lignite Education Seminar as well as match with information presented in the North Dakota Studies Energy Curriculum.

- Lignite 101: An Introduction: https://youtu.be/8Ucg5hzyvvQ
- Mining & Reclamation: https://youtu.be/QLinfDcZez4
- Coal Conversion and Electricity Production: https://youtu.be/aJL8yxOJjOo
- Environmental Impacts & Stewardship: currently in production

These videos will continue to be maintained and updated as needed.

Lignite Education Foundation and License Plates

The LEC also established a charitable 501(c)(3) organization. The Foundation provides funds for educational programs and activities which educate about the coal industry, processes, and economic impact; promote industry-related career opportunities; and aim to facilitate opportunities to actively engage students with the industry.

One program that the Lignite Energy Council is most proud of is the North Dakota license plate program. Funding for the scholarship program is derived, in part, through a special-interest license plate available from the North Dakota Department of Transportation. Today, more than $15,000 has been raised through the license plate program.

STEM Technology Grant

While teachers play a valued role in sharing information learned during the Seminar with students, the educational leaders and career counselors in schools play a vital role in the eventual college-and-career search that students undergo. Therefore, the Lignite Energy Council sought to target school principals and career counselors through the offering of a STEM technology grant.

The grant was successfully awarded once, to an elementary principal and counselor from Strasburg Public School, who used the grant to implement LEGO Robotics at the school. Future administrator/non-teacher attendees at the Seminar will be invited to enter to win a $1,000 STEM Technology Grant for their school or district, awarded from the Lignite Energy Foundation.

Lignite Learn

While the COVID-19 pandemic presented many challenges to the Seminar, it did present a unique opportunity to initiate work and the preliminary substantial investment in an online learning hub for educators and students. Work began on developing additional resources to further the impact of the in-person Seminar.

These resources include:

I. Lignite Learn Interactive Courses

Plan, create, design and develop an interactive learning management system which will host courses for students and teachers. Courses will be primarily interactive in learning approach with elements that attract and appeal to 4 – 8th grade learners as a target audience.
This portion was completed and resources are available online at learn.lignite.com

II. Teacher Online Refresher Course
Create an online course for teachers to refresh their in-person learning experience from a past seminar attendance. Each lesson will aim to capture the experience of the live course by providing engaging presentations offered by subject matter experts in the field. Four of five courses are built and are currently in the review stage. Content for the fifth course is under development. Once all are complete, these interactive courses will be marketed to teachers for use in their classrooms.
Targeted Completion: March 31, 2023

III. Teacher Activity Kits
Develop and share classroom lesson plans and activity resources directly to teachers for use in the classroom. Kits have been completed and are currently in an ongoing distribution process.
Targeted Completion: October 31, 2023

The expanded scope of this grant will allow for further enhancements and developments in the Lignite Learn project. Content and information in Lignite Learn will continue to be updated and maintained throughout the duration of the program. Additional modules of the project will be developed and deployed, including:

I. Lignite Learn Curriculum
Design and develop stand-alone Lignite-focused lesson plans for easy deployment in the classroom. These lesson plans will be available as a resource for virtual learning days as needed due to illness or weather-related closures, or as a resource for substitute teachers.

II. Guest Presentations
Implement stand-alone hands-on classroom activities to be proctored by the Lignite Energy Council Education Director or other individual when requested by schools or other student-focused groups.

Direct Community and School Engagement

Career exploration opportunities have become a popular way for schools to expose students to opportunities after high school. School leaders often offer such programs to middle and high school students. Some school districts employ “Career Advisors” in addition to traditional school counselors, and all North Dakota high schools are required to provide two units of career and technical education to students.

This emphasis on hands-on, career-oriented learning opportunities frequently results in teachers looking for guest presentations and activities provided by industry experts. Through the Education Program, the Lignite Energy Council will be able to be a resource to facilitate in-person engagement with schools and other community groups such as the Boy Scouts of America or after-school STEM clubs when requested.

Standards of Success

Success of the Education Program is evaluated based on the objectives and outcomes of the goal of the program: Educate regional teachers and students about the lignite industry in the area.

Objectives

- Increase awareness of the regional lignite industry among teachers, administrators and students.
- Improve the favorability of the regional lignite industry among teachers, administrators and students.
- Demonstrate improved understanding of the regional lignite industry among teachers, administrators and students.

Deliverables

- Produce a multi-day, in-person Lignite Education Seminar which provides expert-level instruction on the facets of energy, economics and the environmental impacts of the regional lignite industry.
- Add and expand Lignite Learn student activities that educate about energy, economics and the environmental impacts of the regional lignite industry.
- Add and expand digital and online consumable assets such as videos, graphics and lesson plans which educate about energy, economics and the environmental impacts of the regional lignite industry.
- Provide avenues for dialog and open communication between target audiences and industry personnel such as tours and panels.
- Identify and promote job and career opportunities in the regional lignite industry.

Outcomes

- Participation of 75 educators and/or administrative staff in the Lignite Education Seminar
- Facilitate or provide quarterly in-person educational activities to teachers, students or student groups.
- Target audience will be able to demonstrate more than 70% comprehension of sources of energy/electricity and pros/cons of each.
- Target audience will indicate more than an 70% agreement that coal is vitally important to our region’s power supply.
- Target audience will report more than an 70% favorability of the use of coal to produce electricity.
- Target audience will be able to identify possible career paths available.

As online tools and Lignite Learn online resource are implemented into the Education Seminar as well as classroom use, the Lignite Energy Council anticipates additional areas of measurement as well as improvements in the program's overall outcomes.

Background

The Lignite Energy Council has been offering the Seminar since 1986. The Seminar will be coordinated and reviewed by Retha Mattern, Education & Membership Director with the Lignite Energy Council. Retha will also serve as the Instructor of Record for the Seminar, eliminating the need for an outside faculty contract. The various presenters work in the industry and speak from experience on their various topics.

Each participating teacher is eligible to receive two graduate credits, paid for by the Lignite Energy Council, from the North Dakota University System (UND, NDSU and Minot State University) upon the completion of the Seminar and submission of a lesson plan. Teachers also receive ancillary information for classroom work including classroom activities, videos about generation, mining and reclamation and samples of coal and coal combustion byproducts.

The Seminar focuses on sending teachers home with practical and applicable information and classroom tools. It places an emphasis on technology and hands-on learning to help the teachers prepare lesson plans. The anticipation is that teachers will implement these activities in their own classroom and share them with peers, increasing the reach and impact of the Education Program.

More than 3,500 teachers representing more than 600 schools have completed the Seminar. As a direct result, an estimated 60,000+ students have received some education about lignite and its role in the regional economy every year. More than 750 teachers have attended from out of state.

Recruitment

Each year, the Seminar's administrator works closely with recruitment representatives from electric utilities with customers in targeted states. The Lignite Energy Council provides these recruiters with printed and electronic promotional material. The recruiters then assist in disseminating information about the Seminar to schools and teachers within their service territories. Applicants are directed to the Lignite Energy Council's website (https://www.lignite.com/teachers) to complete an online application.

Recruitment in North Dakota consists of a printed direct-mail poster and letter sent to 2,000 licensed teachers in the state, followed by a recruitment postcard. The Lignite Energy Council also engaged in a multi-phased email campaign encouraging attendance. Emails were directed towards teachers and administrators, with administrators also receiving a digital poster to print and display. Teachers in Minnesota who are served by member cooperatives were targeted through a three-part email campaign, as well as through targeted digital ads including video ads on social media.

Seminar Attendance

Accommodations are made at Bismarck State College to house teachers in dorm rooms on campus. This cost is paid for out of the Seminar budget. Sponsorships are available for transportation reimbursement to and from the Seminar for eligible teachers in Montana, South Dakota, Minnesota and Iowa. North Dakota teachers are responsible for their own transportation costs to and from the Seminar but are eligible for housing during the Seminar.

The Seminar is open to those who teach kindergarten through 12th grade, or are administrators at such schools, from North Dakota, South Dakota, Minnesota or other states where North Dakota lignite-based electricity is used. Teachers are accepted on a first-come, first-served basis; however, preference may be given to those who teach math, science or social studies.

As part of the industry's in-kind contribution, North Dakota and Minnesota cooperatives and investor-owned utilities provide sponsorships for out of state teachers to attend. These sponsorships typically cover transportation and meal costs incurred during travel to and from the Seminar. Additionally, industry devotes more than 150 hours for recruitment, activities, Seminar presentations and tours.

Qualifications

The Lignite Energy Council will be responsible for managing the Seminar. The Lignite Energy Council is a regional trade association representing the interests of producers and users of lignite and conducts programs in four separate areas including: government action; research and development; public relations and marketing; and education. Through these programs, the Council seeks to maintain a viable lignite industry and enhance development of North Dakota's abundant lignite resources in a clean, economical and efficient manner. These programs provide timely, accurate information that enables elected officials, government leaders and the public to make sound, informed decisions on lignite issues.

Retha Mattern joined the Lignite Energy Council in September 2022 as the Education & Membership Director. Retha holds a Master of Science in Management from Minot State University and a Bachelor of Arts in Journalism from the University of Maryland, College Park. Retha previously worked in higher education as the Admissions Director at Bismarck State College, the Business Outreach Coordinator for the college's National Energy Center of Excellence, and as the Director of the Great Plains Energy Corridor. Retha also served on the North Dakota State Board of Higher Education from 2019-2022. Retha will serve as the lead instructor for the Seminar in 2023.

Kay LaCoe serves as the Vice President of Marketing & Communications for the Lignite Energy Council. Kay has a Bachelor of Science Degree in Business Communications from the University of Mary, where she is also completing a Master of Organizational Leadership. She worked extensively with the Seminar since 2008 and served as the program administrator and project manager from 2014-2022.

Representatives of the Lignite Energy Council who also serve as presenters at the Seminar include:

- **Jason Bohrer** serves as President and CEO of the Lignite Energy Council. He also serves as the Chairman of the Lignite Research Council (LRC) which includes government, research, environmental and industry representatives. The LRC assists with development and administration of North Dakota's Lignite Research, Development and Marketing Program by providing recommendations to the Industrial Commission.

- **Mike Holmes** joined the Lignite Energy Council in December 2016 as the vice president of research and development. He had been the director of Energy Systems Development at the Energy & Environmental Research Center (EERC) in Grand Forks, where he oversaw fossil energy research areas. His principal areas of interest and expertise include CO2 capture; fuel processing; gasification systems for coproduction of hydrogen, fuels, and chemicals with electricity; process development and economics for advanced energy systems; and emission control technologies. Prior to his work at EERC, Holmes spent 15 years working on coal-related research and development and commercial

projects for Babcock & Wilcox, a major supplier of advanced energy and environmental technologies for the power industry. He received a Master of Science degree in chemical engineering from the University of North Dakota and a Bachelor of Science degree in chemistry and mathematics from Mayville State University. He is a member of the National Coal Council and has been an Executive Member and served on the Board of Directors of the Fuel Cell and Hydrogen Energy Association.

In addition to Lignite Energy Council staff, the LEC relies on the expertise provided by industry and education representatives to provide the bulk of instruction for the Seminar.

Value to North Dakota

The North Dakota Legislature has a long history of supporting the lignite energy industry. Specifically, the North Dakota Legislature has enacted legislation which " … declares that it is an essential government function and public purpose to assist with the development … of North Dakota's vast lignite resources … in order to maintain and enhance development of North Dakota lignite and its products; preserve and create jobs involved in the production and utilization of North Dakota lignite; ensure economic stability, growth and opportunity in the lignite industry; and maintain a stable and competitive tax base for our state's lignite industry for the general welfare of North Dakota … "

The lignite energy industry is vital to North Dakota's economic health. Annual lignite production has been approximately 30 million tons since 1988, making North Dakota one of the 10 largest coal producing states in the nation. In 2019, an NDSU economic study showed that 3,800 North Dakotans are directly employed in the lignite industry and another 10,200 indirectly. The industry is expected to generate almost $5.7 billion in annual business activity, as well as $130 million in annual local and state tax revenues.

This Education Program is part of the larger LEC mission which seeks to:

- Preserve and create jobs involved in the production and utilization of North Dakota lignite;
- Ensure economic stability, growth and opportunity in the lignite industry; and
- Maintain a stable and competitive tax base for North Dakota's lignite industry for the general welfare of North Dakota.

The Program will also curate and share content gleaned through the program's administration with other efforts in which the Lignite Energy Council engages, furthering the impact of information, curriculum, and resources developed through the Program.

Management

The Lignite Energy Council will manage and oversee the Seminar and its Board of Directors has authorized the program and budget. Retha Mattern, Education & Membership Director, is the primary person responsible for the Seminar and will also serve as the Instructor of Record for the Seminar. Retha reports to Jason Bohrer, President and CEO of the Lignite Energy Council.

The University of North Dakota, North Dakota State University and Minot State University have approved the program for eligibility of two graduate credits for the Seminar. The Seminar will be held on the campus of Bismarck State College in Bismarck, ND, with options for housing and meals for participants facilitated through the campus as needed.

Timetable

The Lignite Energy Council's Teacher Education Program described in this grant request runs from April 1, 2023 through March 31, 2026.

Budget

The Lignite Energy Council's Teacher Education Program grant budget, including in-kind services, from April 1, 2023, through March 31, 2026 is $908,000.

The Education Program budget encompasses four main areas – expenses for program management; expenses for the Seminar logistics, venue and Seminar management; expenses for professional service;s and expenses regarding the outreach of the program.

Items within the budget include, but are not limited to the following:

- Program Management:
  - Includes 50% of the program director's pay and benefits,
  - Costs for expanded educational community outreach opportunities,
  - Ccosts related to implementation of an administrative software system for improved program management and seminar participant registration.
- Teachers Education Seminar Logistics and Venue:
  - Facility rental fees,
  - Recruitment efforts,
  - Attendee transportation and meals,
  - Speaker fees,
  - Attendee credits.
- Professional Services
  - 50% of professional services provided by Kent Ellis, the North Dakota Energy Career Awareness Coordinator. Mr. Ellis provides expertise, advisement, speaking, in-classroom presentations and curriculum development for the Education Program.
- Program Materials, Supplies & Digital Assets
  - All classroom materials available to teachers or used in class facilitation,
  - Website and Lignite Learn development and maintenance,
  - Maintenance and creation of video and/or digital assets,
  - Program expansion efforts.

Lignite Energy Council Education Program Budget

3/7/2023

Income

	LRC Share	Applicant's Share	Applicant's In-Kind	
Program Management & Seminar Logistics	$383,000	$300,000	$75,000	**$758,000**
Professional Services	$34,000	$41,000		**$75,000**
Program Materials	$33,000	$42,000		**$75,000**
TOTAL	**$450,000**	**$383,000**	**$75,000**	
TOTAL PROGRAM EXPENSES				**$908,000**

Grant Request	**$450,000**
Lignite Energy Council	**$383,000**
Industry In-Kind	**$75,000**
TOTAL PROGRAM FUNDING	**$908,000**

Expenses

1	Program Management	*3 years*			
	LEC Administrative Expenses (Labor & Equipment)	$387,000			
	LEC Administrative Software	$199,200			
	Additional Staff Resources & Contingency (Labor)	$6,000			
			$592,200		
2	Teachers Education Seminar Logistics and Venue	*3 years*			
	Recruitment (Materials & Services)	$21,000			
	Facility Rental (Fees)	$39,800			
	Meals	$50,000			
	Credits (Fees)	$24,000			
	Programming (Fees, Transp., Meals & Services)	$31,000			
			$165,800		
3	Professional Services (Labor)	*3 years*			
	ND Energy Career Awareness Program	$75,000			
			$75,000		
4	Program Materials, Supplies & Digital Assets	*3 years*	$75,000		
				$908,000	

Matching funds

The Lignite Energy Council and its members will provide in-kind services and funding of at least $450,000 over three years to match the Industrial Commission's funding of up to $450,000 for three years. Total funding requested for the three-year period is $450,000, which will be matched by the Lignite Energy Council and its members.

Tax liability

I, Retha Mattern, certify that the Lignite Energy Council is not delinquent on any tax liability owed to the State of North Dakota.

Confidential information

No confidential information is included in this proposal.

_____

Retha Mattern, Education & Membership Director
Lignite Energy Council

TECHNICAL REVIEWER RATINGS SUMMARY

LRC-102B: "Redundancy Study for CO_2 Capture at Coal Creek Station"

Submitted by: EERC
Principal Investigator: Jason Laumb
Project Duration: 5 months
Request for: $700,000
Total Project Costs: $1,400,000

Rating Category	Weighting Factor	Technical Reviewer Rating 33-01	33-02	33-03	Average Weighted Score
Objective	9	4	4	4	
Availability	9	4	4	4	
Methodology	7	5	4	4	
Contribution	7	4	4	3	
Awareness	5	4	4	4	
Background	5	5	5	5	
Project Management	2	5	5	4	
Equipment Purchase	2	5	5	4	
Facilities	2	5	4	5	
Budget	2	3	4	5	
Average Weighted Score:		216	209	202	**209**

Maximum Weighted Score:	250

OVERALL RECOMMENDATION:

FUND		**X**	**X**	**X**	
FUNDING MAY BE CONSIDERED					
DO NOT FUND					

TECHNICAL REVIEWERS' COMMENTS

1. **OBJECTIVES**

The objectives or goals of the proposed project with respect to clarity and consistency with North Dakota Industrial Commission/Lignite Research Council goals are: 1 – very unclear; 2 – unclear; 3 – clear; 4 – very clear; or 5 – exceptionally clear.

Reviewer 33-01 (Rating: 4) *The objective of the proposed study is to incorporate redundancy into the REC FEED study for carbon capture at the Coal Creek Station. The proposed study is consistent with Statutory Goals & Purpose and Priorities of NDIC/LRC/LRP.*

Reviewer 33-02 (Rating: 4) *The project clearly aligns with the goals*.

Reviewer 33-03 (Rating: 4) *The objectives are clear. Redundancy of new equipment is imperative to continue the high-capacity factor. Page 10 highlights long lead-time equipment or varying cost to justify inventory decisions.*

2. **ACHIEVABILITY**

With the approach suggested and time and budget available, the objectives are: 1 – not achievable; 2 – possibly achievable; 3 – likely achievable; 4 – most likely achievable; or 5 – certainly achievable.

Reviewer 33-01 (Rating: 4) *The objectives of the proposed study are most likely achievable given the suggested time and budget.*

Reviewer 33-02 (Rating: 4) *The timeline and budget seem to be thoughtfully developed*.

Reviewer 33-03 (Rating: 4) *Only area of concern is the one-month window for process engineering. Is this possible due to the majority of work completed in FEED study to date?*

3. **METHODOLOGY**

The quality of the methodology displayed in the proposal is: 1 – well below average; 2 – below average; 3 – average; 4 – above average; or 5 – well above average.

Reviewer 33-01 (Rating: 5) *The quality of the proposal is well above average. The proposal defines a Statement of work and relates objects, goals and tasks and the proposal defines tasks with lead PI's and organizations.*

Reviewer 33-02 (Rating: 4) *The method is logical, and the approach is well thought out.*

Reviewer 33-03 (Rating: 4) *I like the continuous overlap with BOP impacts throughout study.*

4. **CONTRIBUTION**

The scientific and/or technical contribution of the proposed work to specifically address North Dakota Industrial Commission/Lignite Research Council goals will likely be: 1 – extremely small; 2 – small; 3 – significant; 4 – very significant; or 5 – extremely significant.

Reviewer 33-01 (Rating: 4) *The proposal relates objectives of redundancy and reliability to specific needs of the lignite industry and power generation needs.*

Reviewer 33-02 (Rating: 4) *The technical contribution satisfies goals by informing future design for other plants.*

Reviewer 33-03 (Rating: 3) *This work is critical to REC, and this will likely be useful throughout the ND lignite industry in the future. Regarding specific goals, the only knock is that CC on post-combustion contributes to the economics and sustainability, but does not increase efficiency.*

5. **AWARENESS**

The principal investigator's awareness of other current research activity and published literature as evidenced by literature referenced and its interpretation and by the reference to unpublished research related to the proposal is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Reviewer 33-01 (Rating: 4) *The PI's and organizations awareness of current research appear through resumes and descriptions of organization qualifications.*

Reviewer 33-02 (Rating: 4) *The principal investigator is well informed and experienced in this area.*

Reviewer 33-03 (Rating: 4) *Very few references, which is assumed due to very new technology and few examples across the industry.*

6. **BACKGROUND**

The background of the investigator(s) as related to the proposed work is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Reviewer 33-01 (Rating: 5) *The exceptional background of the PI's and organizations appear in the resumes and qualifications of partners.*

Reviewer 33-02 (Rating: 5) *The team is well versed in CO2 capture, design, and redundancy.*

Reviewer 33-03 (Rating: 5) *Between EERC and MHI, the experience in this field is phenomenal. Both entities have been in carbon capture for 30 years. The proposal highlighted 13 commercial systems around the globe from MHI.*

7. **PROJECT MANAGEMENT**

The project management plan, including a well-defined milestone chart, schedule, financial plan, and plan for communications among the parties involved in the project, is: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – very good; or 5 – exceptionally good.

Reviewer 33-01 (Rating: 5) *The project management plan is exceptionally good as appropriate management tools are used throughout the proposal.*

Reviewer 33-02 (Rating: 5) *The plans as proposed demonstrate a logical approach with adequate communication to support a successful outcome providing the deliverables on time and within budget.*

Reviewer 33-03 (Rating: 4) *No comment*

8. **EQUIPMENT PURCHASE**

The proposed purchase of equipment is: 1 – extremely poorly justified; 2 – poorly justified; 3 – justified; 4 – well justified; or 5 – extremely well justified. (Circle 5 if no equipment is to be purchased.)

Reviewer 33-01 (Rating: 5) *No comment*

Reviewer 33-02 (Rating: 5) *N/A*

Reviewer 33-03 (Rating: 4) *No equipment was called out, but many engineering and research hours for this project. Is there additional equipment required?*

9. **FACILITIES**

The facilities and equipment available and to be purchased for the proposed research are: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – notably good; or 5 – exceptionally good.

Reviewer 33-01 (Rating: 5) *The facilities are exceptional at EERC and in the industrial partners.*

Reviewer 33-02 (Rating: 4) *The team has the capability to provide the work product with existing equipment and facilities.*

Reviewer 33-03 (Rating: 5) *EERC facility is well-equipped for this project.*

10. **BUDGET**

The proposed budget value relative to the outlined work and the financial commitment from other sources is of: 1 – very low value; 2 – low value; 3 – average value; 4 – high value; or 5 – very high value.

Reviewer 33-01 (Rating: 3) *The financial commitment is average with a 1 to 1 commitment.*

Reviewer 33-02 (Rating: 4) *The 50% cash contribution from Rainbow Energy demonstrates a commitment to this study work. The value for LRC members is apparent.*

Reviewer 33-03 (Rating: 5) *Considering the 45Q tax credit and its impact to power plants, reliability of this system is very cost effective for 95% capture rate.*

OVERALL COMMENTS AND RECOMMENDATIONS:
Please comment in a general way about the merits and flaws of the proposed project and make a recommendation whether or not to fund.

Reviewer 33-01 (Rating: FUND)
The strengths or merits of this proposal include;

- *The needs of power generation to ensure reliability*
- *The experience and capability of the Lead PI and organizations*
- *The quality of the proposal*

Flaws or weaknesses of the proposal include:

- *The low level of commitment*
- *The degree of increase or need for reliability could be quantified*

This proposal is directed at a timely concern of industry and consumers. Increasing reliability and availability are important consideration for all sectors industry and the public. I recommend FUND.

Reviewer 33-02 (Rating: FUND) *This reviewer recommends funding the project as proposed. The most cost-effective level of redundancy will be key to successful project economics and a successful outcome. Once the capital expenditures have been made, the CO2 capture system must maximize the product which generates revenue to overcome the annual cost and satisfy the initial investment.*

(We pulled some additional comments that were typed on the actual proposal. Please see below) On page 2 the reviewer added, "50% of total budget requested." On page 8, "You would think required redundancy would have been included in the FEED study incorporating lessons learned from Petra Nova. On page 9, "to ensure maximum revenue potential from CO2 captured for project economics."

Reviewer 33-03 (Rating: FUND) *I believe this project should be funded due to its positive impact to a significant project. REC's investment for carbon capture will be significant. This cost is reasonable for potential positive economic impact and helps keep base load production reliable.*

Redundancy is a high priority for baseload facilities. One comment to consider is not only the redundancy of CC system, but consider the redundancy of the existing plant output. Priority should also be set for critically high demand times to have the ability to push maximum load to the grid. Will this system be designed to turn down and allow 100% of MW's to go out? Considering the high parasitic load, this should also be a consideration when discussing reliability and redundancy of coal-fired generation.

Energy & Environmental Research Center
15 North 23rd Street, Stop 9018 • Grand Forks, ND 58202-9018 • P. 701.777.5000 • F. 701.777.5181
www.undeerc.org

April 14, 2023

Mr. Reice Haase
Deputy Executive Director
ATTN: Lignite Research Program
North Dakota Industrial Commission
State Capitol – 14th Floor
600 East Boulevard Avenue, Department 405
Bismarck, ND 58505-0840

Dear Mr. Haase:

Subject: EERC Proposal No. 2023-0146 Entitled "Redundancy Study for CO_2 Capture at Coal Creek Station"

The Energy & Environmental Research Center (EERC) of the University of North Dakota is pleased to submit the subject proposal in partnership with Rainbow Energy Center (REC), Mitsubishi Heavy Industries, Burns & McDonnell, and Kiewit. The application solicits the support of the Lignite Research Program for the execution of a redundancy study effort to complement the current front-end engineering design (FEED) study currently being conducted for the planned carbon capture plant at the REC Coal Creek Station. This proposal focuses on providing critical cost-benefit data for utilizing targeted equipment redundancy to reduce the technological risk associated with investing in a postcombustion capture retrofit project.

The $100 application fees for this proposal and EERC Proposal No. 2023-0147 are provided through ACH transaction number 252483. The EERC is committed to completing the project as described in the proposal if the Commission makes the requested grant. If you have any questions, please contact me by phone at (701) 777-5114 or by e-mail at jlaumb@undeerc.org.

Sincerely,

DocuSigned by:
Jason Laumb
2898A1DC4D60449...

Jason D. Laumb
Director of Advanced Energy Systems Initiatives

Approved by:

DocuSigned by:
Tami Votava
E7468BBB3DE440E...

for

Charles D. Gorecki, CEO
Energy & Environmental Research Center

JDL/kal

Attachment

Lignite Research, Development and Marketing Program

North Dakota Industrial Commission

Application

Project Title: Redundancy Study for CO_2 Capture at Coal Creek Station

Applicant: University of North Dakota Energy & Environmental Research Center

Principal Investigator: Jason D. Laumb

Date of Application: April 14, 2023

Amount of Request: $837,313

Total Amount of Proposed Project: $1,674,627

Duration of Project:

July 1, 2023 – March 31, 2024

Point of Contact (POC): Jason D. Laumb

POC Telephone: (701) 777-5114

POC Email: jlaumb@undeerc.org

TABLE OF CONTENTS

ABSTRACT

Objective: The objective of this project by the Energy & Environmental Research Center (EERC) is to support Rainbow Energy Center's (REC) Coal Creek Station carbon capture plant front-end engineering design (FEED) study through incorporation of redundant pieces of equipment. This first-of-kind, at-scale North Dakota plant brings with it a higher degree of operational risk in an industry where supplying baseload power depends on high reliability and availability. The FEED study, commenced on February 1, 2022, has identified several drivers that necessitated a redundancy study to reduce risk.

Expected Results: Key outcomes from this focused study will highlight the impacts to 1) cost and reliability and 2) the project execution schedule for the proposed REC capture plant. The results of the study are expected to provide REC with essential information to perform a cost-benefit analysis for design with equipment redundancy. This effort also supports the original REC Coal Creek Station carbon capture project intent to 1) reduce the technological and economic risks associated with investing in a postcombustion capture retrofit project and 2) provide information and learnings that will enable evaluation and deployment of similar North Dakota facilities.

Duration: 9 months (July 1, 2023 – March 31, 2024).

Total Project Cost: The proposed total cost is $1,674,627, with REC contributing $837,314 as cash cost share and $837,313 requested from the Lignite Research Program (LRP).

Participants: The project lead is the EERC, with the project conducted in partnership with the North Dakota Industrial Commission (NDIC) through LRP, REC, Mitsubishi Heavy Industries America (MHIA), Burns & McDonnell (BMcD).

PROJECT SUMMARY

The Energy & Environmental Research Center (EERC) proposes a redundant equipment design study to complement the ongoing front-end engineering design (FEED) underway at Coal Creek Station. This project will support Rainbow Energy Center's (REC) Coal Creek Station carbon capture plant FEED study through incorporation of redundant pieces of equipment. This first-of-kind, at-scale North Dakota plant brings with it a higher degree of operational risk in an industry where supplying baseload power depends on high reliability and availability.

The FEED study that is currently underway commenced on February 1, 2022. The basic engineering design document (BEDD), generated as part of the FEED study, specified that each carbon capture train follow its boiler's operations while maintaining high CO_2 capture efficiency. During the hazard and operability (HAZOP) review, the team identified potential single points of failure that must be addressed through equipment redundancy, also known as sparing.

PROJECT DESCRIPTION

Objectives

The objective of this project is to support REC's Coal Creek Station carbon capture plant FEED study through incorporation of redundant pieces of equipment. This first-of-kind, at-scale North Dakota plant brings with it a higher degree of operational risk in an industry where supplying baseload power depends on high reliability and availability. The FEED study, commenced on February 1, 2022, has identified several drivers that necessitated a redundancy study to reduce risk.

Redundancy will use an n+1 approach to sparing. Furthermore, a 2× 100% configuration scenario will be used at single points of equipment failure that have been identified. The resulting carbon capture system (CCS) design and, where appropriate, balance-of-plant (BOP) integration and design will reflect the updated redundant equipment. Specifically, changes will occur to the CCS plant layout, piping and supports, electrical design (power distribution center), design of the structural/building steel and,

possibly, the plant footprint and foundation. These changes will also be reflected in an updated design package that includes general arrangement drawings; process flow diagrams; P&IDs (piping and instrumentation diagrams); electrical diagrams; tie-in list; equipment list; and preliminary structural, civil, and architectural drawings.

Methodology

Three tasks have been identified for this proposed equipment redundancy study. The results will dovetail with the current FEED study. This proposed study has a modest 9-month performance period. Additional details can be found in Appendix A, which contains proposals from Mitsubishi Heavy Industries (MHI) and Burns & McDonnell (BMcD).

Task 1.0 – Management, Planning, and Reporting

This task will be performed by EERC personnel over the project period of performance and includes communication of project activities and direction to the project team and providing updates and obtaining inputs to maintain project focus. Specific activities will include task coordination, risk management/mediation, planning and executing project status meetings, managing the study budget resources, and preparation of a redundancy study focused final report according to North Dakota Industrial Commission (NDIC) requirements.

Task 2.0 – Design Redundancy (Sparing) of Carbon Capture Plant Equipment

This task will focus on modifying the CCS plant layout, and associated engineering, to incorporate redundant equipment into the CCS inside the battery limits. The bulk of this design work will be performed by MHI with design reviews performed by REC, the EERC, and BMcD (where appropriate). Keiwit will provide high-level guidance on constructability. Findings from this subtask will be used in Task 3.0.

Task 3.0 – BOP Impacts

This task will focus on the impact of CCS plant redundancy design on the BOP with work performed by BMcD. At this time, electrical switchgear connecting to the substations is the only equipment outside the battery limits identified for redundancy.

While plant layout and support infrastructure will be modified, the implementation of redundant equipment will not impact the following FEED study inputs or outputs:

- The fundamental design, function, and operation of the CO_2 capture technology.
- The steam cycle configuration, integration, or efficiency.
- Permitting strategies for air emissions, water discharges, or waste disposal planning.
- Heat and material balances.

Anticipated Results

The CCS design packages to be revised include 1) site plan: civil and architectural, 2) electrical, 3) instrumentation, 4) controls, 5) machinery, 6) piping, 7) structural, 8) tie points, 9) cost, and 10) schedule. Key outcomes from this focused redundancy study will highlight the impacts to cost, reliability, and the CCS project execution schedule which will allow REC to move forward swiftly upon commencement of the redundancy study and existing FEED. As with the current CCS FEED study, results from this study will support the mission of the Lignite Research Program (LRP) to concentrate on near-term, practical research and development projects that provide the opportunity to preserve and enhance development of our state's abundant lignite resources. A final report and quarterly reports will summarize the findings of this study.

Facilities

The EERC has over 254,000 square feet of facilities for technology demonstration, process modeling, and project execution. Subcontractors BMcD and MHI maintain office and computing facilities in Kansas City,

Kansas, and Houston, Texas, respectively. REC maintains offices in Bismarck, North Dakota, and at the Coal Creek Station between Underwood and Washburn, North Dakota.

Resources

The FEED study team of industry experts, BMcD (the plant owner's engineer) and MHI (the CCS technology owner), will perform all project design activities. Industry sponsor and plant owner REC will provide review of designs and advisory services. The primary project administrative services will be provided by the EERC. The project team is committed to providing all necessary personnel and resources to ensure the timely completion of all activities outlined in this proposal.

The EERC's engineering and scientific research staff is equipped with state-of-the-art analytical, modeling, and engineering facilities to address a wide variety of energy, environmental, and mineral resource research topics.

MHI and BMcD have been a part of project teams that have executed similar project scopes of work focused on North Dakota utilities. MHI (with assistance from Kiewit, the designated CCS detailed engineering, procurement, and construction contractor) brings experience gained from design and construction of the 240-MW system at the Petra Nova facility in Texas as well as another dozen commercial projects around the world.

Techniques to Be Used, Their Availability, and Capability

The primary technique for data generation under this project will be to use recognized and generally accepted good engineering practices (RAGAGEP) and costing techniques. The individual partners and subcontractors mentioned within the proposed project represent decades of experience in CO_2 capture and coal plant operations. All project participants have committed the necessary resources to execute this project, as evidenced by the letters of support in Appendix B. These same industry experts have been a part of several pre-FEED and FEED projects on similarly sized systems within the state of North Dakota.

Environmental and Economic Impacts While Project Is Underway

The proposed work is a paper study and will not change any of the environmental impacts of the FEED to the study area or partner facilities. The proposed work will, however, change economic impacts through increased reliability and availability.

Why the Project Is Needed

The 2019 Polar Vortex (which caused severe limitations of wind power generation capacity and natural gas availability) that swept through the Midwest in early 2019 and the 2021 ERCOT challenges are profound reminders of why we need to keep our entire power generation mix on the table; CCS can serve as a long-term solution to carbon emissions, while also provide firm baseload generation to mitigate the impact of intermittent renewables on grid reliability. The Coal Creek Station can serve as a model and learning opportunity for the rest of the nation's existing coal fleet and provide baseload power with reduced CO_2 emissions.

Ultimate Technological and Economic Impacts

The proposed redundancy/sparing study is a necessary due diligence process in project development and will provide information to secure financing for CO_2 capture at the Coal Creek Station. Financing and CCS project business cases continue to be reliant on federal 45Q tax incentive programs that require projects must begin construction by January 1, 2033. Continued investment in this project ensures that this initiative can successfully move along the project development path and subsequent demonstrations will be better informed and more likely to succeed and make progress toward Governor Burgum's goal of North Dakota carbon neutrality by 2030. The cost of later projects will benefit by being provided key information relating to considerations for redundancy and sparing, as well as information on specific carbon capture technologies. By seeking a way to cost-effectively use lignite in a carbon-constrained world, this project supports the core mission of the LRP to develop large-scale commercial

projects that reduce environmental impacts and increase sustainability of energy production and delivery.

Maintaining and adding jobs will also be a key economic factor for long-term implementation of CCS in North Dakota. The power industry and a newly created CCS industry will preserve and gain new jobs as a result of the proposed project. If North Dakota can produce a lower-carbon-intensity power product by implementing CCS at utilities, the state will be able to maintain a reliable baseload power source that can be used to complement existing wind/renewable generation in the state, adding thousands of direct, long-term jobs in the process. If the proposed work moves into construction and deployment phases, Coal Creek Station and the Falkirk Mine will keep the current 700 direct/indirect jobs and add approximately 35 to 40 direct jobs. Additionally, short-term construction jobs are likely to be over 2000 direct/indirect jobs.

STANDARDS OF SUCCESS

This project is a necessary next step on the development path for CO_2 capture at Coal Creek Station. Successful outcomes for the project include a design that incorporates sufficient redundancy to address possible single-point failures within each capture island and provide critical input to calculate a detailed project cost for 95% CO_2 capture at the Coal Creek Station. The project team's vision is that recommendations provided by the proposed project will influence the current FEED, improving the long-term reliability and availability of the CCS. In doing so, the team will have sufficient detail to support a final investment decision (FID) and immediate procurement of critical, long lead-time equipment whose costs are especially susceptible to price increases and maintain a timeline required to be eligible for 45Q tax incentives.

BACKGROUND/QUALIFICATIONS

Background

The EERC previously led a retrofit pre-FEED study and is leading the current FEED study of installing a CCS at Coal Creek Station. As with the pre-FEED, MHI is the technology provider in the current FEED study and in the proposed redundancy study. MHI is a globally recognized expert in amine-based carbon capture and was the technology provider for the Petra Nova project at the WA Parish plant in Texas, which is the world's largest postcombustion carbon capture facility installed on an existing 240-MW coal-fueled power plant. The lessons learned from this full-scale experience have proved invaluable for assessing best methods and control technologies for use at Coal Creek Station.

The pre-FEED study for Coal Creek Station included design packages, cost and performance estimates, and a process hazard analysis (PHA, commonly called HAZOP) for both the capture facility and for BOP systems, including, among others, the following:

- Flue gas extraction and handling
- Steam extraction and power recovery
- Cooling water supply
- Electrical distribution systems
- Fire protection
- Plant and instrument air
- Process control systems
- Demineralized water supply

The results from the pre-FEED study provided a solid foundation for the project team to build directly into the current FEED study. The proposed redundancy study will support efforts to improve reliability/availability of the carbon capture facility and will run concurrently with the current FEED study.

Along with the pre-FEED design package, the EERC independently developed a process model for Coal Creek Station to use for quick analysis of different capture and steam integration options. This model can be used to generate high-level performance and cost data in a matter of hours to rapidly assess the feasibility of different capture scenarios. This tool will allow the project team to evaluate potential changes to the design at a high level without impacting the project timeline or budget.

Slipstream Capture Testing

Although solvent-based carbon capture is common in gas processing, postcombustion carbon capture from low-rank coal-fired power stations remains a very new technology at the scale proposed in the ongoing FEED study. With any new technology, there is always a risk that full-scale performance will not be as expected. The EERC and MHI have previously demonstrated long-term solvent performance at Coal Creek Station using a slipstream system installed on Unit 1 of the plant. During this testing, solvent was sampled weekly and analyzed for a wide variety of materials known to be concerns for solvent degradation. Over the course of more than 2 months of continuous operation, accumulation of these materials was within expected bounds and was not of concern. The solvent performance also remained steady without indications of any significant loss of capture capacity. This experience lends assurance that MHI's KS1™ and KS-21™ solvent technology is likely to perform as expected at Coal Creek Station and that the unique flue gas from this plant does not contain levels of problematic contaminants that might lead to accelerated solvent degradation.

One key factor that has arisen as a concern for postcombustion carbon capture at coal-fired power plants in recent years is solvent loss to aerosol formation. Although this is not a major source of amine loss in traditional CO_2 capture units for natural gas, the very fine fly ash from coal-fired power plants provides surface area where volatile amines can condense to form submicron aerosols. This aerosol mist is difficult to recover using conventional methods. In flue gas from low-rank coals, this

aerosol formation can lead to amine losses that are much higher than would be expected from traditional vaporization losses.

During on-site slipstream testing at Coal Creek Station, the EERC worked with MHI to test MHI's amine emission reduction (AER) technology for minimizing aerosol losses. During operation with the AER unit, amine was below the 0.1-ppm detection limit at the system outlet, and daily sampling of the solvent over the course of more than 2 months of operation showed that amine content was stable within the expected range. By contrast, during short-term operation with conventional demisting technology, the aerosol and amine contents were significantly higher. Moreover, measurements conducted on the same system using a conventional monoethanolamine (MEA) solution and a traditional water wash section showed large increases in aerosol content through the capture system. These results demonstrate that MHI's proprietary combination of solvent and AER technologies are likely to be highly effective at limiting amine losses to aerosols at Coal Creek Station.

Together, the combination of long-term solvent testing and long-term aerosol emission monitoring using the slipstream system provides assurance that MHI's technology is likely to perform as expected at Coal Creek Station. This experience using actual flue gas, solvent, and aerosol control technologies at the site of choice is unique to the EERC and MHI and demonstrates that this team is qualified to conduct the FEED study and a redundancy study at the Coal Creek Station with a level of assurance in expected performance that cannot be offered by any other group.

Qualifications

As lead for the current FEED project, the EERC will serve as the lead organization for the proposed project, with Mr. Jason Laumb as the overall project manager. Mr. Jason Laumb, Director of Advanced Energy Systems Initiatives, will focus on ensuring the overall success of the project by providing experienced management and leadership to all activities within the project. Mr. Laumb will ensure that the project is carried out within budget, schedule, and scope. Mr. Laumb will also be responsible for

communication with project partners and EERC project personnel. Qualifications of key personnel can be found in Appendix C. The organizational chart for the redundancy study is shown in Figure 1.

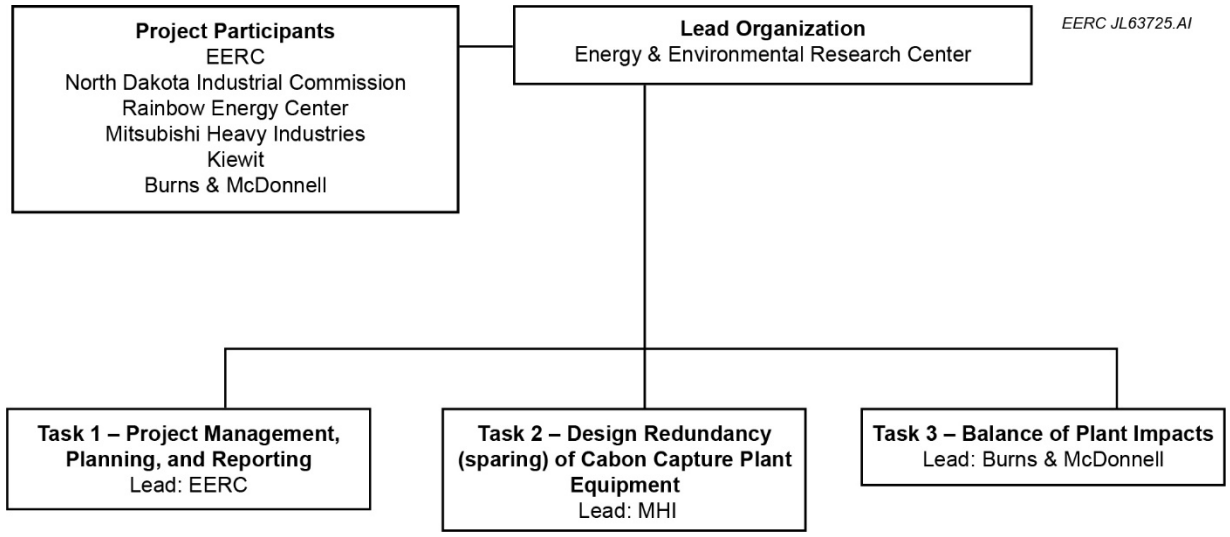

Figure 1. Project organizational chart.

Mitsubishi Heavy Industries America, Inc., and Mitsubishi Heavy Industries Engineering, Ltd., are subsidiaries of Mitsubishi Heavy Industries, Ltd., of Japan (together referred to as MHI). MHI will be responsible for the CCS scope. Starting in the early 1990s, MHI jointly developed with Kansai Electric Power Company (KEPCO) the proprietary Kansai Mitsubishi Carbon Dioxide Recovery Process (KM CDR Process™) for carbon dioxide removal from combustion gas exhaust streams. MHI's KM CDR Process™ is an amine-based CO_2 capture process that uses MHI proprietary solvents. The CO_2 capture system is capable of recovering 95% of the CO_2 from the flue gas and compressing the treated CO_2 to adequate pipeline conditions. MHI has provided 13 commercial CO_2 capture systems around the world, including the world's largest postcombustion system capturing 5265 stons/day from a coal-fired power plant in Thompsons, Texas (Petra Nova) for EOR. Key personnel from MHI include Mr. Tim Thomas (Senior Vice President and Deputy General Manager), Mr. Shingo Watanabe (Project Manager), and Mr. Atsushi Yoshitomi (Engineering Manager).

BMcD will be responsible for BOP engineering. BMcD is a fully integrated engineering, architecture, construction, environmental, and consulting firm with a multidisciplinary staff of more than 7600 professionals. Founded in 1898, its singular mission has been to make its clients successful. Because BMcD is relationship-focused and dedicated to creating amazing success for its clients, it has a 90% repeat-business rate and client partnerships that span multiple decades. Being 100% employee-owned means that everyone has an ownership stake in the success of the clients and all team members are driven to find great solutions. Key personnel from BMcD include Mr. Aaron Bennett, Project Manager, and Ms. Patricia Scroggin-Walker, Carbon Capture Director.

REC is the proud owner and operator of Coal Creek Station. The REC team works to maximize efficient energy production and sound energy management to unlock the energy sector's full potential. REC is working diligently to capitalize on innovative technologies so that future generations have sustainable energy solutions. REC is committed to providing reliable, low-carbon, baseload power to North Dakota and the region. Carbon capture is vital to the success and continued operation of Coal Creek Station, and REC is committed to delivering carbon capture that will serve as a showcase for future projects around the world. Key personnel from Rainbow Energy include Stacy Tschider (President), Jeff Jonson (Executive Vice President), Chris Faul (VP Operations), Lyndsey Roemmich (VP Finance), Ryan Davis (Energy Director), and John Bauer (current Plant Manager).

VALUE TO NORTH DAKOTA

The proposed redundancy and the ongoing FEED projects primary value to North Dakota will be maintaining and adding new jobs to the state and local economies in areas where current and new regulation threaten to significantly reduce activity in coal utilization, one of the state's most vital resources. The power industry and a newly created CCS industry will preserve and gain new jobs as a result of these projects. If North Dakota can produce a lower-carbon-intensity power product by implementing CCS at utilities, the state will be able to maintain a reliable baseload power source that

can be used to complement existing wind/renewable generation in the state, adding thousands of direct, long-term jobs in the process. If the proposed work moves into construction and deployment, Coal Creek Station and the Falkirk Mine will keep the current 700 direct/indirect jobs and add approximately 35 to 40 direct jobs. Additionally, short-term construction jobs are likely to be over 2000° direct/indirect jobs.

Beyond the plant, the lignite-fired power plants in North Dakota present an opportunity to economically demonstrate the large-scale feasibility of CCS for the existing domestic coal fleet. The North Dakota plants are optimally located near both appropriate geologic storage and fields amenable to EOR operations. The economic health of the central region of North Dakota is tied to energy jobs in the area. Currently, the lignite industry directly employs 3623 people, with another 9500 indirect employees supported by the industry, accounting for over $5.4 billion in economic impact. Technology advances that continue the responsible use of lignite and bring new industries to the region are critically needed to sustain and grow these jobs. Based on a recent study by the EERC, the economic impact to a state such as North Dakota from development of a new carbon capture and EOR industry would be tremendous if deployed statewide: $2.5 billion to $3.0 billion in annual economic activity, state revenue increase of $160 million per year, and creation of approximately 8000 (Stanislowski et al., 2019) long-term jobs.

At a project level, the cost and benefits of a redundancy/sparing approach to the ongoing FEED project will benefit the entire lignite fleet. The project will also provide a basis for identifying and evaluating those systems, equipment, and parts essential to maintaining high availability and reliability of the installed CO_2 capture system. Because space limitations exist at all utility sites, results from this study will identify probable changes to the support structure and overall equipment layout required to implement a redundancy/sparing approach to the completed design. This project will reduce risks: both technological and economic risk associated with investing in a postcombustion capture retrofit project.

MANAGEMENT

The EERC is the lead organization for this project and will oversee all tasks and management activities associated with this project. The EERC will schedule regular internal and external meetings with project staff and advisors to ensure that the project is conducted using acceptable scientific methodologies and practices in accordance with the project plan (budget, schedule, deliverables, and milestones) and is meeting quality objectives. The EERC will keep all partners informed of project progress and coordinate activities as necessary for the execution of a successful project and will be responsible for timely submission of all project deliverables and transfer of data and products to the team.

Once the project is initiated, the project team will engage in weekly conference calls to review project status and future directions. Quarterly reports and a final report will be prepared and submitted to project sponsors for review.

The primary deliverable for the project will be a completed evaluation of equipment needs and the costs associated with implementing an N+1 redundancy to the current FEED project. The evaluation will include, but not be limited to, finalization of the redundant equipment list, a revised plant layout, process flow diagrams, P&IDs, pipe routing, potential changes to electrical equipment and power distribution, an evaluation of possible civil and structural changes required to support the additional equipment recommended within each CCS island, tie points and BOP changes to accommodate the redundancy recommendations, impacts on scheduling, and the cost data associated with these changes to the current design. It is expected that the tasks associated with the proposed study may be accomplished over a 6-month period running concurrently with the ongoing FEED project.

Project milestones include completion of 1) redundant equipment layout and redesign of the capture system inside the battery limits, 2) redesign of the BOP equipment, and 3) cost estimates and schedule impacts to incorporate the N+1 strategy.

Project progress will be measured by completion of milestones and deliverables as noted in the project timeline in Figure 2. The milestones and deliverables are at key times during the project design, permitting, and costing components of the project. The deliverables are indicated where key design documents and reports are noted, while the milestones are noted as key accomplishments during the project's progress.

TIMETABLE

The overall project timeline can be found in Figure 2. The proposed redundancy study is expected to require 9 months, with a projected start date of July 1, 2023. Work would begin prior to the start of NDIC's July 1 funding to maintain the project momentum and schedule. This funding will be provided by REC matching funds, in advance of the official NDIC start of funding. This timeline is necessary to maintain a schedule that could allow for construction activities to begin before January 1, 2033. The team anticipates the redundancy project reports will be available from MHI and BMcD by the end of Month 8 of the project.

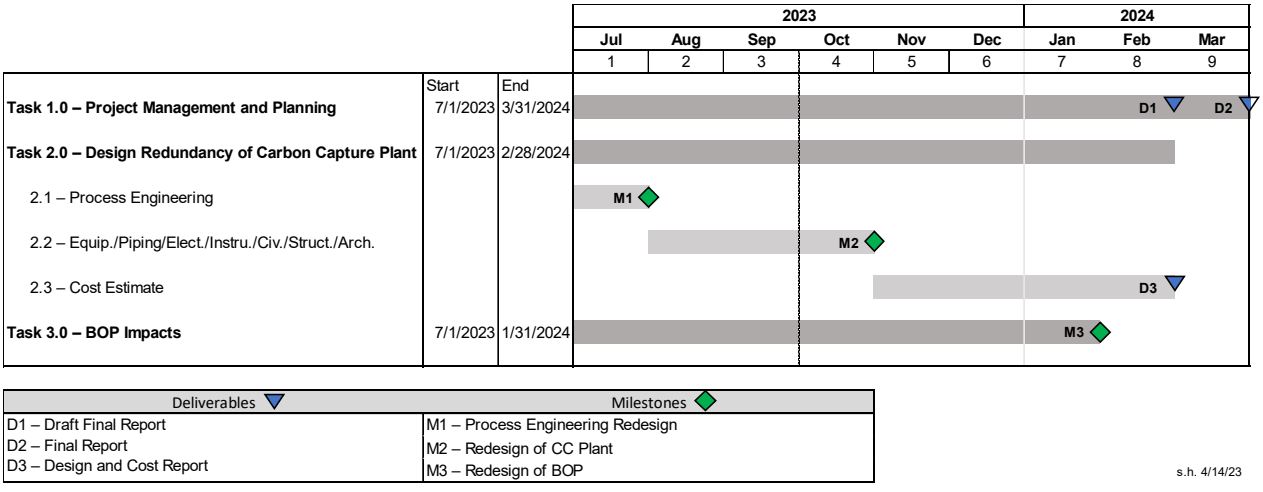

Figure 2. Project Gantt chart.

BUDGET

The proposed budget is $ 1,674,627, with $837,313 from NDIC and $837,314 cash from REC. The budget includes subcontracts for MHI and BMcD as well as funds to the EERC for project management. Funding for one conference to present results of this redundancy study are included. The detailed breakdown is shown in Table 1. Budget notes can be found in Appendix D.

MATCHING FUNDS

Cash cost share in the amount of $837,314 will be provided by REC.

Table 1. Redundancy Project Budget

Project Associated Expense	NDIC Share (Cash)	REC Share (Cash)	Total Project
Labor	$187,596	$0	$187,596
Travel	$3,515	$0	$3,515
Supplies	$250	$0	$250
Subcontractor – MHIA	$421,613	$837,314	$1,258,927
Subcontractor – Burns & McDonnell	$115,700	$0	$115,700
Communications	$90	$0	$90
Printing & Duplicating	$131	$0	$131
Laboratory Fees & Services			
EERC Document Production Services	$4,746	$0	$4,746
EERC Engineering Services Fee	$2,347	$0	$2,347
Total Direct Costs	$735,988	$837,314	$1,573,302
Facilities & Administration	$101,325	$0	$101,325
Total Cash Requested	**$837,313**	**$837,314**	**$1,674,627**

TAX LIABILITY

The EERC, a department within the University of North Dakota, is a state-controlled institution of higher education and is not a taxable entity; therefore, it has no tax liability to the state of North Dakota or any of its political subdivisions.

CONFIDENTIAL INFORMATION

No confidential information is contained in this proposal.

REFERENCES

Stanislowski, J.J.; Folkedahl, B.C.; Jensen, M.D.; Musich, M.A. *Regional Impacts of Carbon Capture and Sequestration in the State of North Dakota*; Final Report for Lignite Energy Council; EERC Publication 2019-EERC-02-07; Energy & Environmental Research Center: Grand Forks, ND, Feb 2019.

TECHNICAL REVIEWER RATINGS SUMMARY

LRC-102C: "Coal Creek Carbon Capture: Geologic CO_2 Storage Complex Development"

Submitted by: UND Energy & EERC
Principal Investigator: Amanda Livers-Douglas
Project Duration: 39 months
Request for: $6,120,000
Total Project Costs: $50,400,000

Rating Category	Weighting Factor	Technical Reviewer Rating 33-04	33-05	33-06	Average Weighted Score
Objective	9	5	5	5	
Availability	9	4	4	4	
Methodology	7	5	5	5	
Contribution	7	5	5	5	
Awareness	5	5	4	5	
Background	5	5	5	5	
Project Management	2	5	4	5	
Equipment Purchase	2	5	5	5	
Facilities	2	5	5	5	
Budget	2	5	5	5	
Average Weighted Score:		241	234	241	**239**

Maximum Weighted Score:	250

OVERALL RECOMMENDATION:

FUND		**X**	**X**	**X**	
FUNDING MAY BE CONSIDERED					
DO NOT FUND					

TECHNICAL REVIEWERS' COMMENTS

1. **OBJECTIVES**

The objectives or goals of the proposed project with respect to clarity and consistency with North Dakota Industrial Commission/Lignite Research Council goals are: 1 – very unclear; 2 – unclear; 3 – clear; 4 – very clear; or 5 – exceptionally clear.

> **Reviewer 33-04 (Rating: 5)** *The objective of this proposal is to advance development of a geological CO_2 storage complex in central ND to store CO_2 from the Coal Crook Station. Stated two objectives are 1) site characterization and (2D) modeling and 2) fully characterize and site permitting of the storage site. The objectives are exceptionally clear.*
>
> **Reviewer 33-05 (Rating: 5)** *The proposed project has as its goal exploring the technical and commercial viability of applying carbon capture to the Coal Creek Station. This is critically important to the North Dakota Lignite industry and therefore is fully consistent with the goals of the North Dakota Industrial Commission/Lignite Research Council. This work is critically important to the long-term viability of the ND Lignite industry and will ensure a critically needed base load source of power for this region.*
>
> **Reviewer 33-06 (Rating: 5)** *The proposed effort clearly hits one of the most important issues facing the ND lignite industry.*

2. **ACHIEVABILITY**

With the approach suggested and time and budget available, the objectives are: 1 – not achievable; 2 – possibly achievable; 3 – likely achievable; 4 – most likely achievable; or 5 – certainly achievable.

> **Reviewer 33-04 (Rating: 4)** *Given the suggested time and budget, the objectives are most likely achievable.*
>
> **Reviewer 33-05 (Rating: 4)** *The proposed work I believe is most likely achievable with the time and budget available. Experience of the assembled team on similar projects supports that conclusion. The approach outlined has been successful in previous projects and supports this reviewer's belief that the work will result in a successful outcome.*
>
> **Reviewer 33-06 (Rating: 4)** *This is a big project. The team has experience with similar work, and it is expected based upon their past performance that they can deliver within the budget and time allocated to the project.*

3. **METHODOLOGY**

The quality of the methodology displayed in the proposal is: 1 – well below average; 2 – below average; 3 – average; 4 – above average; or 5 – well above average.

> **Reviewer 33-04 (Rating: 5)** *The methodology displayed in this proposal is well above average. The objectives are identified with specific goals; goals are identified with specific tasks; tasks are identified with manpower, timeframes, and budget.*

Reviewer 33-05 (Rating: 5) *Building on two successful projects with similar goals and objectives I believe the methodology noted with lead to a successful project.*

Reviewer 33-06 (Rating: 5) *The end goal is a permit for the geological storage of CO2. The steps proposed and with the team assembled their approach should reach their end goal.*

4. **CONTRIBUTION**

The scientific and/or technical contribution of the proposed work to specifically address North Dakota Industrial Commission/Lignite Research Council goals will likely be: 1 – extremely small; 2 – small; 3 – significant; 4 – very significant; or 5 – extremely significant.

Reviewer 33-04 (Rating: 5) *Carbon dioxide capture and sequestration are critical issues for the NDIC/LRC and lignite industry. This study is an important element for continual operation of the Coal Creek Station. The study is extremely significant for Coal Creek Station specifically and the entire lignite industry generally.*

Reviewer 33-05 (Rating: 5) *The scientific and technical contributions of the proposed work is critically import to the long-term viability of the North Dakota Lignite industry. The industry is under attack by many forces that seek to reduce or eliminate the use of Lignite coal. To maintain or potentially grow this industry creative ways to greatly reduce the carbon footprint of these operations must be found. This project is focused on doing precisely that.*

Reviewer 33-06 (Rating: 5) *Having a permitted storage site is crucial for the continued operation of the Coal Creek station, and this project is therefore extremely important to the State.*

5. **AWARENESS**

The principal investigator's awareness of other current research activity and published literature as evidenced by literature referenced and its interpretation and by the reference to unpublished research related to the proposal is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Reviewer 33-04 (Rating: 5) *The awareness of the PI's is clearly evident in the resumes and expertise of the partnering entities. The PI's are exceptionally qualified as are the organizations participating in the study.*

Reviewer 33-05 (Rating: 4) *The team assembled is recognized around the world as a leader in carbon capture /sequestration and as such a leader in publishing material in this field. They are well aware of current research and literature in this field.*

Reviewer 33-06 (Rating: 5) *The team is extremely well published in this area and are leaders in the understanding and development of this technology.*

6. **BACKGROUND**

The background of the investigator(s) as related to the proposed work is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Reviewer 33-04 (Rating: 5) *The background of the PI in this area and in project management of this type of study is exceptional.*

Reviewer 33-05 (Rating: 5) *The team assembled for this world class. The success they have had in similar projects is testament to the applicability of the background of the team.*

Reviewer 33-06 (Rating: 5) *The team has been working in this area for decades and are recognized internationally for the knowledge and experience in this area.*

7. **PROJECT MANAGEMENT**

The project management plan, including a well-defined milestone chart, schedule, financial plan, and plan for communications among the parties involved in the project, is: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – very good; or 5 – exceptionally good.

Reviewer 33-04 (Rating: 5) *The project management plan is exceptionally good with the inclusion of appropriate organization, Gantt chart, and budget tables. The proposers have included necessary project management tools.*

Reviewer 33-05 (Rating: 4) *The project management plan with allow the stakeholders for this activity to be kept abreast of progress toward the stated goals. This includes plans for communication between the team assembled.*

Reviewer 33-06 (Rating: 5) *This is a large and complex project. The material presented in the proposal indicates the team has a solid plan to complete the proposed work. Their success with other similar projects provides confidence that the management and communication plan is solid and will lead to success.*

8. **EQUIPMENT PURCHASE**

The proposed purchase of equipment is: 1 – extremely poorly justified; 2 – poorly justified; 3 – justified; 4 – well justified; or 5 – extremely well justified. (Circle 5 if no equipment is to be purchased.)

Reviewer 33-04 (Rating: 5) *No comment*

Reviewer 33-05 (Rating: 5) *No equipment will be purchased with NDIC funds. Total equipment purchased with the entire $50 million dollar effort is just over $7000 and will be purchased with DOE funds.*

Reviewer 33-06 (Rating: 5) *There is essentially no new equipment proposed for this work.*

9. **FACILITIES**

The facilities and equipment available and to be purchased for the proposed research are: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – notably good; or 5 – exceptionally good.

Reviewer 33-04 (Rating: 5) *The facilities and equipment through EERC and the participating partners are exceptional.*

Reviewer 33-05 (Rating: 5) *The facilities available from the assembled team have all the capabilities necessary for a successful project.*

Reviewer 33-06 (Rating: 5) *The EERC and its team have been working in this area for decades and have built up excellent facilities to complete the proposed work.*

10. **BUDGET**

The proposed budget value relative to the outlined work and the financial commitment from other sources is of: 1 – very low value; 2 – low value; 3 – average value; 4 – high value; or 5 – very high value.

Reviewer 33-04 (Rating: 5) *The value of the proposed project through stages 1 and 2 with DOE participation is of high value. Without DOE participation the project is not high value.*

Reviewer 33-05 (Rating: 5) *The financial commitments from other sources is almost 88% of the total budget which is very high. The value of the proposed work is very high as the industry sees CO2 management as a critical issue.*

Reviewer 33-06 (Rating: 5) *REC is matching the NDIC request with a 1:1 dollar match. The NDIC contribution to the overall project is 12%. This is a good value to the State, especially considering the importance to the long-term operation of the Coal Creek Station.*

OVERALL COMMENTS AND RECOMMENDATIONS:

Please comment in a general way about the merits and flaws of the proposed project and make a recommendation whether or not to fund.

Reviewer 33-04 (Rating: FUND)

General comments: FUND

The general merits of this proposed study are:

- *This is a critical area for the NDL industry and Coal Creek Station specifically,*
- *The participation of the various partners is exceptional,*
- *The funding by DOE makes this an outstanding value.*

General weakness of this proposed study is:

- *The value of the proposed study depends on DOE participation,*
- *The project may have only limited value for the entire NDL industry,*
- *Lack of participation by other members of the NDL industry.*

Reviewer 33-05 (Rating: FUND) *The state of North Dakota is blessed with amazing natural resources including its Lignite Coal. The opportunity to continue to take advantage of these resources is currently being challenged. Identification and application of technologies to control CO2 emissions is critically important to the long-term viability of this critically important North Dakota industry. This project will develop a road map to accomplishing this goal in both a technically and commercially viable way. Building on years of work to understand how best to achieve these goals this work will develop a road map for this critical facility that can be used with other ND plants to explore similar activities at those facilities in the future.*
I strongly support this investment to the benefit of this industry and the State of North Dakota!

Reviewer 33-06 (Rating: FUND) *This project is critically important to the continued operation of the Coal Creek Station, and in the State's quest to become a zero-carbon emitting state. Funding should be of the highest priority.*

Energy & Environmental Research Center
15 North 23rd Street, Stop 9018 • Grand Forks, ND 58202-9018 • P. 701.777.5000 • F. 701.777.5181
www.undeerc.org

April 14, 2023

Mr. Reice Haase
Deputy Executive Director
ATTN: Lignite Research Program
North Dakota Industrial Commission
600 East Boulevard Avenue
State Capitol, 14th Floor
Bismarck, ND 58505-0840

Dear Mr. Haase:

Subject: EERC Proposal No. 2023-0147 Entitled "Coal Creek Carbon Capture: Geologic CO_2 Storage Complex Development"

Attached for your consideration is a proposal to advance development of a geologic carbon dioxide (CO_2) storage complex in central North Dakota to store CO_2 captured from the Coal Creek Station power plant. A portion of the requested funds would be used as cost share for a proposal submitted to the U.S. Department of Energy (DOE) Carbon Storage Assurance Facility Enterprise (CarbonSAFE) Initiative in November 2022 to characterize and permit the proposed geologic CO_2 storage complex. This portion of the requested funding would be contingent on the project being selected for funding by DOE. DOE has indicated selection of CarbonSAFE awards will occur in Quarter 2 of 2023.

The $100 application fees for this proposal and EERC Proposal No. 2023-0146 are provided through ACH Transaction Number 252483. The Energy & Environmental Research Center (EERC), a research organization within the University of North Dakota, an institution of higher education within the state of North Dakota, is not a taxable entity; therefore, it has no tax liability.

This transmittal letter represents a binding commitment by the EERC to complete the project described in this proposal. If you have any questions, please contact me by telephone at (701) 777-5344 or by e-mail at alivers@undeerc.org.

Sincerely,

DocuSigned by:
Amanda Douglas
C2EB5748889F49B...

Douglas
Assistant Director for Integrated Subsurface Projects

Approved by:

DocuSigned by:
Tami Votava
E7468BBB3DE440E...

for
Charles D. Gorecki, CEO
Energy & Environmental Research Center

AJL/rlo

Attachment

Lignite Research, Development and Marketing Program

North Dakota Industrial Commission

Application

Project Title: Coal Creek Carbon Capture: Geologic CO_2 Storage Complex Development

Applicant: University of North Dakota Energy & Environmental Research Center

Principal Investigator: Amanda J. Livers-Douglas

Date of Application: 4/14/2023

Amount of Request: $6,119,690

Total Amount of Proposed Project: $50,387,901

Duration of Project: 39 months

Point of Contact (POC): Amanda J. Livers-Douglas

POC Telephone: (701) 777-5344

POC: Email: alivers@undeerc.org

POC Address: 15 North 23rd Street, Stop 9018

Grand Forks, ND 58202-9018

ABSTRACT

Objective: The objective of this study is to advance development of a geologic carbon dioxide (CO_2) storage complex in central North Dakota to store CO_2 captured from Coal Creek Station power plant. The project will consist of two stages. The objective of Stage 1 is to conduct a set of activities necessary to advance site characterization, including evaluation of existing two-dimensional (2D) seismic data, geologic modeling, and CO_2 injection simulations to inform placement and design of a stratigraphic test well. The objective of Stage 2 is to fully characterize and permit the geologic CO_2 storage complex. The Energy & Environmental Research Center (EERC) submitted a proposal to the U.S. Department of Energy (DOE) Carbon Storage Assurance Facility Enterprise (CarbonSAFE) Initiative in November 2022 for 80% of the funding to support Stage 2 efforts. DOE has indicated selection of CarbonSAFE awards will occur in Quarter 2 of 2023.

Expected Results: Results from Stage 1 will inform a provisional storage facility-permitting area (pore space lease area); the geologic storage prospects to be targeted for additional characterization (e.g., Madison, Interlake, Red River, Deadwood) in Stage 2; and the location, engineering design, drilling program, and data acquisition program for a stratigraphic test well to be drilled as part of Stage 2. Successful completion of Stage 2 will result in a fully characterized storage complex and permitted geologic CO_2 storage complex that is ready to transition to construction and operation.

Duration: 39 months (June 1, 2023 – September 1, 2026)

Total Project Cost: The total value of the currently scoped project is $50,387,901 (Stage 1: $2,700,000 and Stage 2: $47,687,901). This proposal requests a total of $6,119,690 from the North Dakota Industrial Commission Lignite Research, Development, and Marketing Program (LRDMP). Project partner, Rainbow Energy Center (REC), will provide $6,119,691. DOE will provide $38,148,520.

Participants: The project lead is the EERC, and the project will be conducted in partnership with LRDMP, DOE, REC, and Neset Consulting Service, Inc.

PROJECT SUMMARY

The Energy & Environmental Research Center (EERC) and project partners, Rainbow Energy Center (REC) and Neset Consulting Service, Inc. (Neset), propose to characterize and permit a geologic carbon dioxide (CO_2) storage complex in central North Dakota to store up to 200 million metric tons (MMt) of CO_2. Successful completion of the proposed project will result in a fully characterized and permitted storage complex that is ready to transition to construction and operation. The proposed project will advance the development of carbon capture and storage (CCS) at Coal Creek Station power plant (Coal Creek), which will reduce the CO_2 emissions from the plant by 95%, representing a 19% reduction of CO_2 emissions from North Dakota's stationary sources and, in turn, provide Coal Creek with a pathway to low-carbon energy, resulting in resiliency against future legislation, regulations, and/or taxes associated with carbon emissions by providing for safe, reliable, affordable, environmentally prudent baseload energy generation for the United States. Additionally, the development of CCS at Coal Creek will create approximately 35–40 long-term jobs and over 2000 direct/indirect short-term construction jobs. The proposed project will facilitate attracting, training, and retaining a skilled and well-qualified workforce for these new and existing jobs. The proposed project is also designed to provide internship opportunities to students from minority-serving institutions and tribal colleges.

The project will consist of two stages. The objective of Stage 1 is to conduct a set of activities necessary to advance site characterization, including evaluation of existing two-dimensional (2D) seismic data, geologic modeling, and CO_2 injection simulations to inform placement and design of a stratigraphic test well to be drilled in Stage 2. The objective of Stage 2 is to fully characterize and obtain a permit for one or more geologic CO_2 storage facilities sufficient for storing 200 MMt of CO_2. Stage 2 is contingent on the EERC accepting cofunding through the U.S. Department of Energy's (DOE's) Carbon Storage Assurance Facility Enterprise (CarbonSAFE) Initiative to which the EERC submitted an application that is pending decision. As part of Stage 2 efforts, the EERC and project team will prepare and submit

applications for underground injection control (UIC) Class VI storage facility permit(s) sufficient for the Coal Creek development scenario. Near-surface and subsurface data will be acquired and analyzed to fully characterize the proposed storage complex. The EERC will oversee acquisition and processing of three-dimensional (3D) seismic data; drilling, coring, logging, testing, and completion of a stratigraphic test well; and collection of baseline water quality data from underground sources of drinking water (USDWs). Geologic modeling and reservoir simulation will incorporate characterization data to delineate the extent of pore space necessary to store CO_2 and determine the area of review (AOR). In addition, the project will include a pipeline front-end engineering and design (FEED) study and assess National Environmental Policy Act (NEPA)-related issues for the project's capture, transport, and storage site.

PROJECT DESCRIPTION

Objectives

The objective of the proposed effort is to advance development of CCS at Coal Creek by characterizing and obtaining a permit for a storage complex capable of accommodating 200 MMt of CO_2. This would provide Coal Creek with a pathway to low-carbon energy which would provide Coal Creek with resiliency against future legislation, regulations, and/or taxes associated with carbon emissions. Development of CCS at Coal Creek would allow Coal Creek to continue to provide safe, reliable, affordable, and environmentally prudent baseload energy. Successful completion of the proposed project would also position Coal Creek to be eligible to apply for hundreds of millions of dollars through loan programs or funding made available through the Bipartisan Infrastructure Law and Inflation Reduction Act to support construction of capture facilities.

Methodology

Stage 1: The proposed Stage 1 scope of work (SOW) includes activities necessary to plan and design a stratigraphic test well to characterize the prospective geologic CO_2 storage complex; the Broom Creek, Madison, Interlake, Red River, and Deadwood Formations; and associated upper and lower confining

zones. To inform site selection for the stratigraphic test well and support the well design, the geologic storage complex will be evaluated for the ability to geologically store up to 200 MMt of CO_2 to be injected over 20 years. Prior regional characterization work conducted by the EERC will be leveraged to inform site selection through reservoir simulation and location-specific screening. Additionally, the EERC has identified existing 2D seismic data in the project area that are available for licensing. Interpretation of the 2D seismic data will be used to support the stratigraphic test well site selection and design of the 3D seismic survey. Stage 1 is divided into five tasks: Task 1.0 site selection, geologic modeling, and simulations; Task 2.0 stratigraphic well design; Task 3.0 seismic acquisition design and planning; Task 4.0 material recommendation and testing; and Task 5.0 project management.

Detailed descriptions of the proposed tasks are considered confidential. Appendix A contains the confidential information request form associated with the confidential task descriptions which are included in Appendix B. The information in Appendix B is confidential.

Stage 2: The Stage 2 SOW will advance characterization, development, and permitting of a large-scale geologic CO_2 storage complex in central North Dakota to store up to 200 MMt of CO_2. Stage 2 is contingent upon the EERC accepting cofunding associated with a companion proposal submitted to DOE's CarbonSAFE Initiative. As such, the objectives and SOW are designed to align with the format and requirements of the CarbonSAFE Initiative. The objectives of the first 18 months of Stage 2 are to fully characterize the proposed storage complex; prepare and submit a North Dakota storage facility permit application in accordance with the UIC Class VI permitting program administered under North Dakota State primacy; prepare U.S. Environmental Protection Agency (EPA) NEPA documentation; and implement a community benefits plan (CBP) to engage a diverse, inclusive set of community stakeholders and help build the values of diversity, equity, inclusion, and accessibility (DEIA); environmental justice; broad-based community engagement; and worker support more deeply into all project activities. The objectives of the second 18 months of Stage 2 are to compile the necessary

information to inform a final investment decision and prepare the CCS project for transition into construction and operation through completion of a pipeline FEED study, finalization of a storage field development plan, and creation of business and financial plans.

Stage 2 is divided into nine tasks to align with the project format prescribed by the DOE CarbonSAFE Initiative and included in the proposal to DOE. Task 1.0, a project management, planning, and reporting activity, will span the duration of the project and ensure that all subsequent tasks and activities are completed according to specified timelines and provides for both LRDMP and DOE reporting. Task 2.0 covers NEPA compliance and submittal of an environmental information volume (EIV). Task 3.0 will develop permitting documents necessary to construct and operate a commercial geologic storage hub. Permitting documents will be developed specific to North Dakota's UIC Class VI primacy program. Modeling and simulation activities will be conducted as part of Task 3.0 to address UIC Class VI regulations, predict the boundaries of the injected CO_2 plumes at the proposed site, and determine each AOR to support Class VI permits and inform development of monitoring plans. Task 4.0 includes activities required to characterize the CO_2 storage complex of the proposed project, including drilling/coring/testing/logging one new stratigraphic test well, acquisition and analysis of a new 3D seismic survey, and characterization of core and data from the new stratigraphic test well and offset well(s). Task 5.0 will develop a storage field development plan to inform commercialization of the storage hub. Task 6.0 will conduct CO_2 source feasibility studies to demonstrate due diligence and include all necessary information to support development of the Class VI permit applications. These CO_2 source feasibility studies will build on ongoing and existing FEED studies conducted by the EERC and project partners. Task 7.0 will initiate a pipeline FEED study to include pipelines needed to connect CO_2 sources to the storage site. Task 8.0 will direct collaborative efforts with project partners for development of business and financial plans as entry requirements for future CarbonSAFE funding. Task 9.0 includes a societal considerations and impacts assessment and plans that incorporate DEIA;

Justice 40 (J40) Initiative; community, labor, and stakeholder engagement; and quality jobs. Proposed tasks are described in greater detail in Appendix B.

Anticipated Results

Results from Stage 1 will inform a provisional storage facility-permitting area (pore space lease area); the geologic storage prospects to be targeted for additional characterization (e.g., Madison, Interlake, Red River, and Deadwood Formations) in Stage 2; and the location, engineering design, and drilling program for a stratigraphic test well to be drilled as part Stage 2. Stage 1 results will also include a provisional design for a 3D seismic survey to be conducted as part of Stage 2. Successful completion of Stage 2 will result in a fully characterized and permitted geologic CO_2 storage complex that is ready to transition to construction and operation.

Facilities, Resources, Techniques to Be Used, Their Availability and Capability

The EERC has all necessary office, laboratory, and computer resources that are immediately available to complete the proposed SOW. Laboratory resources include the Analytical Research Laboratory, Applied Geology Laboratory, and Natural Materials Analytical Research Laboratory, which are equipped to process, test, and analyze the near-surface (e.g., groundwater, soil gas) and reservoir (e.g., core, fluids) materials needed to characterize the storage facility. Computer resources include industry-standard modeling, simulation, and geophysical analysis software and high-performance workstations capable of running this software. Project partner, Neset, has a state-of-the-art facility, including office space, a full-service shop, total on-site electrical power backup, and a geosteering operations center capable of providing service across the entire Williston Basin and beyond. This capability ensures Neset will be able to provide drilling support services no matter when the wells are ultimately drilled. Project partner, REC, has extensive office and computer resources at its headquarters in Bismarck, North Dakota. The general area anticipated to contain the project field site encompasses a 314-square-mile area in McLean, Mercer, and Oliver Counties near Coal Creek. The majority of the land within this area is owned by REC

and North American Coal Corporation (NACCO), which have each provided the EERC with field site access commitment letters (Appendix C).

The individual partners mentioned within the proposed project represent decades of experience in drilling, geological consulting services, subsurface data collection, CCS project development, and coal plant operations. All project participants have committed the necessary resources to execute this project, as evidenced by the letters of support in Appendix C.

The industry-standard techniques to be used to accomplish the proposed SOW are discussed in the Methodology section and are further described in Appendix B.

Environmental and Economic Impacts while Project Is Underway

Field activities for the proposed project will include baseline soil gas and groundwater sampling, drilling a dedicated groundwater-monitoring well, drilling a stratigraphic test well, and acquisition of a 3D seismic survey and survey of potential flowline routes. All field activities will be conducted in accordance with state and local laws, and field crews will follow industry-standard safety practices. The project team will work with landowners to get permission to access their land for field activities and will work with landowners to minimize any inconveniences. No permanent adverse environmental impacts associated with field activities are anticipated.

Baseline soil gas and groundwater sampling will consist of a crew of one to two people on-site for a week four different times of the year. The crew will utilize handheld equipment to collect samples and a small pickup truck to travel while on-site.

A 400- by 400-ft well pad and access road will be constructed for drilling the stratigraphic test well. This will involve heavy equipment, drill rig, trailers, logging trucks, etc. Pad construction is anticipated to take a month, and drilling activities are anticipated to take 2 months. No area outside this 400- by 400-ft well pad and access road is anticipated to be disturbed. Drilling activities will be carried out under a permit issued by the North Dakota Industrial Commission (NDIC).

A small truck-mounted drill rig will be used to drill the dedicated groundwater-monitoring well. This well will be drilled on the stratigraphic test well pad.

The 3D seismic survey will comprise a network of vibrational sensors and two source trucks (called vibroseis trucks). Small sensors will be inserted 2–3 inches into the ground every ~165 ft along lines that are spaced approximately 330 ft apart to record reflected vibrations generated during the survey. The sensors will be pressed into the ground by hand by field crews walking and driving small pickup trucks or all-terrain vehicles (ATVs). Once installed, the sensors remain in place up to 2 weeks, as the large vibroseis trucks travel through the survey area along lines spaced 660 ft apart, until the survey is finished. At 165-ft intervals along lines, the trucks will stop and vibrate the ground for 1–2 minutes. The trucks will not vibrate the ground within 300 ft of buildings and other infrastructure. A low-level noise similar to that of a large passing truck will be generated at each location from the vibrating truck-mounted vibrating plates. A person standing 100 ft from the source will not feel ground vibration. The project team will acquire a geophysical permit issued by NDIC, contact landowners before the survey work to request permission to drive vehicles and place sensors on their land, and follow all geophysical permit requirements. Care will be taken to avoid or minimize any environmental impacts and maintain normal traffic flow.

Surveying potential flowline routes will be done by a one- to two-person crew utilizing handheld equipment. The crew will use a small pickup truck to travel while on-site.

During the project, it is anticipated that field crews will be lodging, shopping, and eating at local establishments, which will have a positive economic impact on local communities.

Ultimate Technological and Economic Impacts

The lignite-fired power plants in North Dakota present an opportunity to demonstrate the economic feasibility of large-scale CCS for the existing domestic coal fleet, as they are optimally located near both appropriate geologic storage and oil fields amenable to enhanced oil recovery (EOR) operations. The

economic health of the central region of North Dakota is tied to energy jobs in the area. Currently, the lignite industry directly employs 3623 people, with another 9500 indirect employees supported by the industry, accounting for over $5.4 billion in economic impact. Technology advances that continue the responsible use of lignite and bring new industries to the region are critically needed to sustain and grow these jobs. Based on a recent study by the EERC, the economic impact to a state such as North Dakota from development of a new carbon capture and EOR industry would be tremendous if deployed statewide: $2.5 billion to $3.0 billion in annual economic activity, state revenue increased by $160 million per year, and creation of approximately 8000 long-term jobs (Stanislowski et al., 2019). At Coal Creek alone, approximately 35 to 40 direct jobs will be created.

With this project, the project team aims to perform the work necessary to develop large-scale CCS associated with Coal Creek that will reduce environmental impacts and increase sustainability of energy production and delivery. This project will fully characterize the site and obtain the permits for a storage complex for storage of up to 200 MMt of CO_2, which will accommodate CO_2 captured from Coal Creek and will have excess capacity for additional future sources that could provide further economic opportunity, optionality, and resilience for both the facility and the region.

To date, CO_2 storage evaluations and operations have focused exclusively on sandstone formations. Carbonate formations also offer significant CO_2 storage potential in North Dakota but have not yet been sufficiently evaluated to realize their potential. This project will include characterization of several carbonate formations for CO_2 storage. Understanding the storage capacity and technical challenges associated with CO_2 storage in carbonates will provide the critical information needed to support the business case for other CCS projects looking to store CO_2 in a carbonate formations. As the number of commercial CCS projects being developed in North Dakota increases, CO_2 storage in carbonate reservoirs will be absolutely vital for optimizing use of pore space. Future CCS projects in North Dakota will benefit through the key information relating to the storage potential and

characteristics of carbonate formations in the Williston Basin that will be generated through the proposed work.

Why the Project Is Needed

The Polar Vortex (which caused severe limitations to wind power generation capacity and natural gas availability) that swept through the Midwest in early 2019 and the 2021 Electric Reliability Council of Texas (ERCOT) challenges are profound reminders of why we need to keep our entire power generation mix on the table; CCS can serve as a long-term solution to carbon emissions while also providing firm baseload generation to mitigate the impact of intermittent supply from renewables on grid reliability. Ultimately, Coal Creek can serve as a model and example for the rest of the nation's existing coal fleet and provide baseload power with reduced CO_2 emissions.

Investing in this project ensures that this initiative can successfully move down the project development path, and anticipated subsequent projects in North Dakota will be better-informed and more likely to succeed and make progress toward Governor Burgum's goal of North Dakota carbon neutrality by 2030.

STANDARDS OF SUCCESS

The proposed study is to advance development of CCS at Coal Creek. The study will result in a fully characterized and permitted storage complex that is ready to move to construction. Successful outcomes for the project include obtaining a North Dakota UIC Class VI storage facility permit(s) for the storage complex. Additionally, at the end of the project, all required leases, development plans, business plans, and other agreements related to the storage complex will be in place to inform a final investment decision. By the end of the project, Coal Creek will meet the prerequisites to apply for additional funding through the DOE CarbonSAFE project to support construction of pipeline, compressors, injection wells, and other associated infrastructure.

BACKGROUND/QUALIFICATIONS

Background

The project site and surrounding area have a solid foundation of existing data and models, which the project team can immediately take advantage of to support the proposed Stage 1 activities. The EERC has access to a catalogue of geologic materials, data, and interpretations collected through publicly funded research efforts in the region. In addition, the EERC has worked with Midwest AgEnergy (MAG) to characterize, design, and develop a UIC Class VI storage facility permit application for the Brook Creek Formation within the project area to store CO_2 from the Blue Flint Ethanol plant. These efforts resulted in the collection of core samples; well logs; and seismic, petrophysical, geomechanical, and geochemical data sets from several of the prospective storage formations that are applicable to the proposed effort. The data collected by MAG for a subset of the prospective storage formations are specific to the area of interest being investigated and are available to the project through existing agreements between REC and MAG.

MAG worked with the EERC to conduct feasibility studies in the project area in 2019 that included the construction of geologic models and the numerical simulation of CO_2 injection to estimate the viability of subsurface CO_2 storage within the area surrounding Blue Flint Ethanol, including nearby Coal Creek. The main input data for the geologic models, including geophysical well logs and formation top depths from legacy wells, were obtained from NDIC's publicly available online database. In 2020, MAG worked with the EERC and the LRDMP to drill, core, and log a stratigraphic test well, MAG 1, and conducted a 3D seismic survey to begin collecting site-specific data to characterize the subsurface for CO_2 storage to support permitting of a UIC Class VI storage facility capable of storing CO_2 associated with the Blue Flint Ethanol plant. Data were compiled from characterization and modeling efforts to prepare and submit a UIC Class VI permit application to NDIC, which demonstrates that the Broom Creek Formation is capable of safely storing approximately 200,000 Mt of CO_2 per year. Simulation scenarios

run as part of this effort demonstrated a potential for upwards of 1 MMt of CO_2 per year to be injected annually into the Broom Creek Formation in a single injection site without exceeding the regulatorily defined maximum bottomhole pressure constraint of 90% of the formation fracture pressure gradient.

Also, geologic characterization that was previously completed as part of a separate CarbonSAFE Phase II North Dakota Integrated Carbon Storage Complex Feasibility Study funded by DOE associated with Project Tundra showed the potential of permanently and safely storing at least 50 MMt of CO_2 within 30 years within a CO_2 storage complex located approximately 20 miles to the southwest of Coal Creek. The results of that project show that two of the prospective formations within the storage complex, the Broom Creek and Black Island–Deadwood Formations, are capable of storing large amounts of CO_2. Data sets generated from that project include the drilling, coring, logging, testing, sampling, and characterization of a stratigraphic test well (BNI 1) and interpretation of an existing 9-mi^2 3D seismic survey.

Additionally, efforts associated with Project Tundra eventually led to a CarbonSAFE Phase III award. As part of the ongoing CarbonSAFE Phase III efforts associated with Project Tundra, geologic characterization data were collected from drilling, coring, logging, testing, and sampling of two recent stratigraphic test wells approximately 20 miles to the southwest of Coal Creek (J-LOC 1 and Liberty 1). An injection test was also conducted at this site along with the acquisition of a 12-mi^2 3D seismic survey.

The characterization data collected from Project Tundra complement the information available from MAG. These data sets confirm the regional potential of the Broom Creek and Black Island–Deadwood to store well over 200 MMt. However, although characterization and modeling studies conducted by MAG are sufficient to permit the Broom Creek storage complex to meet MAG's 200,000 Mt/year target injection volumes, local geology within the Broom Creek needs to be further assessed relative to the much larger injection rates associated with the Coal Creek CCS scenario. Furthermore, geologic uncertainties still exist within deeper storage prospects such as the Madison,

Interlake, Red River, and Black Island–Deadwood Formations, which will likely be required, in addition to the Broom Creek Formation, to achieve the 200 MMt storage target associated with Coal Creek's development scenario. Collection and analysis of additional data as part of the proposed Stage 2 scope of work will reduce uncertainties present in each of the prospective storage formations and will provide the data necessary to design, optimize, and permit a storage complex to meet the target injection volumes of the proposed Coal Creek development scenario.

Qualifications

The EERC will lead the project, with support from project partners, REC and Neset. The principal investigator (PI) is Ms. Amanda Livers-Douglas, EERC Assistant Director for Integrated Subsurface Projects. In this role, she will handle project management, planning, and reporting activities; coordinate and direct subcontractor activities; and ensure successful completion of the project on schedule and budget. Ms. Livers-Douglas has served as PI on several commercial CCS projects and as task lead on DOE projects at the EERC. She has broad expertise in CO_2 geologic storage, including geologic site characterization, regulatory compliance, and North Dakota UIC Class VI permitting and will help guide project activities.

Each of the proposed tasks will be led by qualified individuals from the EERC who will work with the project partners as appropriate to accomplish task goals and corresponding project goals. Key personnel are listed in Figure 1, and resumes of key personnel are provided in Appendix D. The project team also includes multiple project advisors with decades of combined CCS experience and/or relevant industry experience who will support the PI. Three project advisors from project partners, Neset and REC, will also advise the PI on technical and nontechnical issues to effectively meet the proposed project goals and timelines.

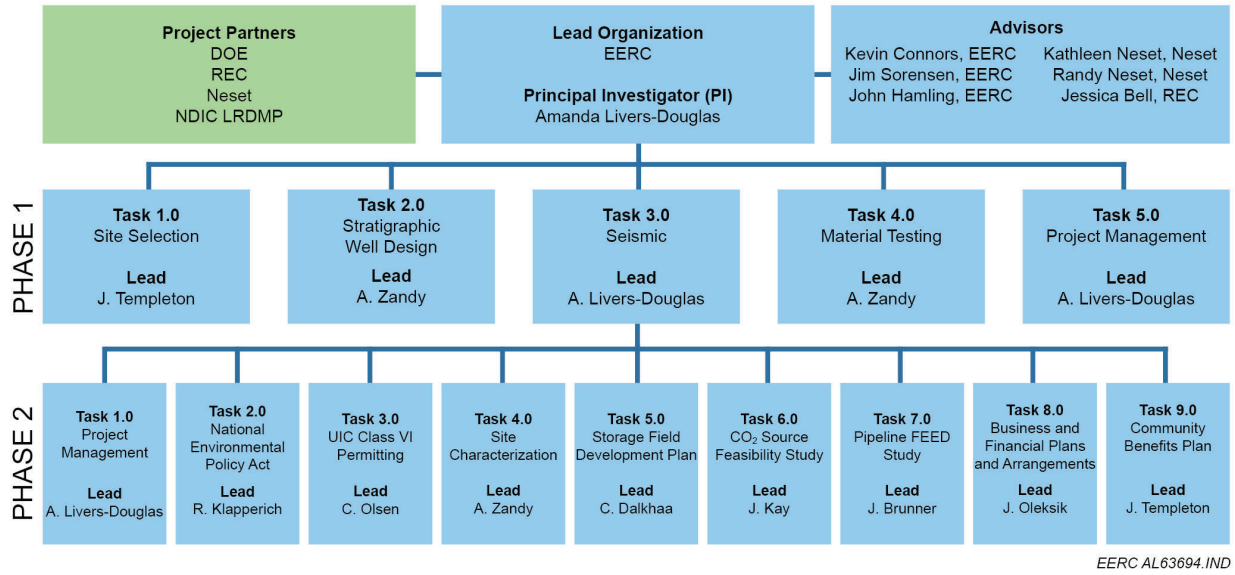

Figure 1. Project organizational chart showing key personnel.

The EERC has the experience and capabilities necessary to lead and carry out the proposed project through a wide variety of previous work. The research, field experience, and partnership investment that have been built through the EERC-led Plains CO_2 Reduction (PCOR) Partnership enable the EERC to confidently propose and execute the proposed project. The PCOR Partnership has covered all aspects of developing CO_2 storage projects and has led directly to developing new CCS storage programs in the region. For example, the EERC worked with Red Trail Energy to obtain a UIC Class VI storage facility permit and assisted with implementing the project, which became operational in June 2022. Red Trail Energy's Class VI permit was the first issued by the state of North Dakota and the third issued in the United States. Additionally, the EERC led DOE CarbonSAFE Phase II and Phase III projects in partnership with Project Tundra which resulted in UIC Class VI storage facility permits to accommodate 4 MMt/year of geologic storage for another lignite power generation facility in North Dakota, Milton R. Young Station. Additionally, the EERC has been exploring development of CCS around Blue Flint Ethanol and Coal Creek through prefeasibility, feasibility, and site characterization studies in collaboration with

MAG since 2019. Also, the EERC conducted a pre-FEED capture study and is currently leading a capture FEED study at Coal Creek in collaboration with REC.

REC owns and operates Coal Creek and has committed to developing the world's largest postcombustion CO_2 capture facility, which will capture 95% of Coal Creek's CO_2 emissions, totaling 8.9 MMt/year. This substantial investment in resources and infrastructure goes hand in hand with the proposed effort to characterize and develop the CO_2 storage resources for the site. REC also has strategic partnerships outside of the proposed work that are key to the success of the larger CO_2 capture and storage program. REC has agreements in place with MAG to utilize geologic and demographic information collected by MAG to advance development of CCS at Coal Creek. REC's partnership with NACCO provides the land access necessary to characterize and permit the storage complex site proposed by this work. Finally, REC has committed to providing the appropriate cost share and resources necessary to complete the proposed effort, as described in its letter of support (Appendix C).

Neset has provided drilling, production, and geological consulting services to operators in the Williston Basin for over 40 years. Neset will provide the resources and know-how to plan, permit, and complete characterization wells to be drilled as part of this proposed effort. Neset's consultants will ensure high-quality data and samples are collected from the characterization wells and use their experience to maximize the successful collection of samples and data from multiple horizons. Neset has committed to providing the appropriate personnel and resources needed for the project as described in its attached letter of support.

The EERC and Neset are currently partnered on efforts funded by the state of North Dakota to characterize the potential to develop underground storage of natural gas and related gases in subsurface salt formations. Through these efforts, the EERC and Neset have experience in working together to budget, plan, and carry out well-drilling, coring, and logging activities in the Williston Basin, experience that is directly applicable to the proposed effort.

VALUE TO NORTH DAKOTA

Establishment of CCS at Coal Creek will reduce 95% of the CO_2 emissions from the plant, which represents a 19% reduction of CO_2 from North Dakota's stationary sources, providing an important step in helping reach Governor Burgum's goal for North Dakota to achieve net-zero carbon emissions by 2030. Capturing emissions from coal-based processes at REC will remove greenhouse gases that would otherwise enter the atmosphere; improve resiliency of Coal Creek against future legislation, regulations, and/or taxes associated with carbon emissions; allow Coal Creek to continue to provide safe, reliable, affordable, and environmentally prudent baseload energy; and contribute to continued energy independence in domestic markets. If future project phases are realized and the project is ultimately implemented, the life of the plant will be extended, ensuring continued quality jobs in the region. Coal Creek and NACCO's Falkirk Mine, which feeds the plant, support 700 direct/indirect jobs. Development of CCS at Coal Creek will result in approximately 35 to 40 direct long-term jobs and over 2000 direct/indirect short-term construction jobs.

Additionally, results from the project including subsurface data and information related to the storage capacity and technical challenges associated with CO_2 storage in carbonates will greatly benefit other CCS project developers in North Dakota. This information will be made publicly available through the NDIC Department of Mineral Resources (DMR) website and project reports, and can be used to support the development of future projects.

MANAGEMENT

The project team comprises researchers from the EERC and staff and project advisors from Neset and REC. The EERC will schedule regular internal and external meetings with project staff and advisors to ensure that the project is conducted using acceptable scientific methodologies and practices in accordance with the project plan (budget, schedule, deliverables, and milestones) and is meeting quality objectives. The EERC will keep all partners informed of project progress and coordinate activities as

necessary for the execution of a successful project and will be responsible for timely submission of all project deliverables and transfer of data and products to the team.

REC will coordinate efforts to support site characterization activities, including providing access to land within the area of interest and existing characterization data. REC will also assist with NEPA documentation and business financial plans and arrangements.

Neset will serve as primary point of contact for obtaining quotes and materials for drilling operations and help plan and participate in community outreach events.

Project progress will be measured by completion of milestones and deliverables as noted in the project timeline in Figure 2. The milestones and deliverables are at key times during the design, site characterization, permitting, and commercial development components of the project. The deliverables are indicated where key documents and reports are noted, while the milestones are noted as key accomplishments during the project's progress. Quarterly reports will be provided to LRDMP throughout the duration of the project. A final report for Stage 1 and Stage 2 will be provided in addition to interim reports including a geologic catalog of materials, detailed site and subsurface characterization storage resource/capacity assessment, and UIC Class VI storage facility permit application(s).

TIMETABLE

The project timeline for Stage 1 and Stage 2 can be found in Figure 2a and 2b. The project is scheduled for 39 months, with a projected start date of June 2023.

Figure 2a: Project Gantt chart for Stage 1.

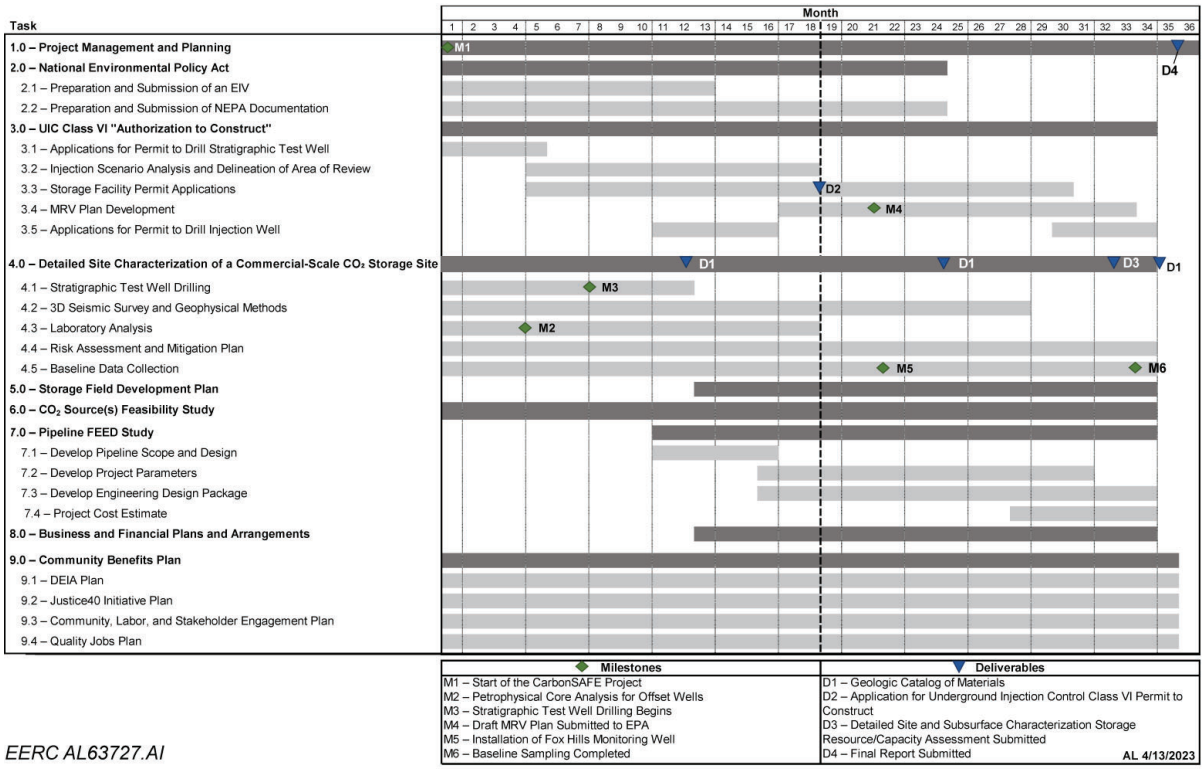

Figure 2b: Project Gantt chart for Stage 2. Note: deliverables for Stage 2 are prescribed by DOE.

BUDGET AND MATCHING FUNDS

Table 1 shows a summary of the proposed budget. Letters of commitment for the cost share from REC can be found in Appendix C. Budget notes can be found in Appendix E. If less funding is available than requested, changes to the scope will be considered.

TAX LIABILITY

The EERC, a department within the University of North Dakota, is a state-controlled institution of higher education and is not a taxable entity; therefore, it has no tax liability.

CONFIDENTIAL INFORMATION

Confidential Information is contained in Appendices A and B.

REFERENCES

Stanislowski, J.J.; Folkedahl, B.C.; Jensen, M.D.; Musich, M.A. *Regional Impacts of Carbon Capture and Sequestration in the State of North Dakota*; Final Report for Lignite Energy Council; EERC Publication 2019-EERC-02-07; Energy & Environmental Research Center: Grand Forks, ND, Feb 2019.

Table 1. Budget Breakdown

Project-Associated Expense	NDIC STAGE 1 Share (cash)	REC STAGE 1 Share (cash)	NDIC STAGE 2 Share (cash)	REC STAGE 2 Share (cash)	DOE STAGE 2 Share (cash)	NDIC Project Share (cash)	REC Project Share (cash)	Total Project
Labor	$178,342	$333,221	$0	$0	$9,344,930	$178,342	$333,221	$9,856,493
Travel	$489	$716	$0	$0	$274,148	$489	$716	$275,353
Equipment > $5000	$0	$0	$0	$0	$7,832	$0	$0	$7,832
Supplies	$380,559	$226,810	$0	$0	$966,449	$380,559	$226,810	$1,573,818
Subcontractor – Neset	$0	$16,500	$0	$0	$0	$0	$16,500	$16,500
Subcontractor – Stress Engineering	$410,000	$0	$0	$0	$0	$410,000	$0	$410,000
Subcontractors – DOE Award	$0	$0	$4,769,690	$4,754,691	$18,420,767	$4,769,690	$4,754,691	$27,945,148
Rental	$0	$0	$0	$0	$600	$0	$0	$600
Repairs	$0	$0	$0	$0	$2,200	$0	$0	$2,200
Contract Services – TetraTech	$0	$255,000	$0	$0	$0	$0	$255,000	$255,000
Contract Services – Earth Signal Processing	$46,765	$0	$0	$0	$0	$46,765	$0	$46,765
Communications	$0	$25	$0	$0	$970	$0	$25	$995
Printing & Duplicating	$0	$289	$0	$0	$1,870	$0	$289	$2,159
Food	$0	$0	$0	$0	$21,240	$0	$0	$21,240
Professional Development	$0	$0	$0	$0	$6,400	$0	$0	$6,400
Freight	$0	$0	$0	$0	$2,500	$0	$0	$2,500
Laboratory Fees & Services								
EERC Natural Materials Analytical Research Lab	$0	$0	$0	$0	$558,005	$0	$0	$558,005
EERC Process Chemistry & Development Lab	$0	$0	$0	$0	$30,816	$0	$0	$30,816
EERC Document Production Services	$7,051	$2,350	$0	$0	$397,758	$7,051	$2,350	$407,159
EERC Shop & Operations	$0	$0	$0	$0	$10,199	$0	$0	$10,199
EERC Software Solution Services	$0	$3,283	$0	$0	$6,591	$0	$3,283	$9,874
EERC Engineering Services Fee	$0	$98	$0	$0	$37,229	$0	$98	$37,327
EERC Field Safety Fee	$418	$0	$0	$0	$104,094	$418	$0	$104,512
EERC Geoscience Services Fee	$448	$5,458	$0	$0	$111,851	$448	$5,458	$117,757
Outside Labs	$0	$0	$0	$0	$1,090,952	$0	$0	$1,090,952
Total Direct Costs	$1,024,072	$843,750	$4,769,690	$4,754,691	$31,397,401	$5,793,762	$5,598,441	$42,789,604
Facilities & Administration	$325,928	$506,250	$0	$15,000	$6,751,119	$325,928	$521,250	$7,598,297
Total Cash Requested	**$1,350,000**	**$1,350,000**	**$4,769,690**	**$4,769,691**	**$38,148,520**	**$6,119,690**	**$6,119,691**	**$50,387,901**

TECHNICAL REVIEWER RATINGS SUMMARY

LRC-102D: "Engineering Design and Feasibility Analysis for Commercial Graphite and Asphalt Manufacturing from Lignite-Derived Carbon Pitch"

Submitted by: AmeriCarbon Products, LLC
Principal Investigator: David Berry
Project Duration: 18 months
Request for: $700,000
Total Project Costs: $1,400,000

Rating Category	Weighting Factor	Technical Reviewer Rating 33-07	33-08	33-09	Average Weighted Score
Objective	9	4	5	4	
Availability	9	4	4	4	
Methodology	7	4	4	5	
Contribution	7	3	4	4	
Awareness	5	5	5	4	
Background	5	5	5	4	
Project Management	2	5	4	4	
Equipment Purchase	2	5	5	5	
Facilities	2	5	5	4	
Budget	2	4	5	5	
Average Weighted Score:		209	225	211	**215**

Maximum Weighted Score:	250

OVERALL RECOMMENDATION:

FUND		**X**	**X**	**X**	
FUNDING MAY BE CONSIDERED					
DO NOT FUND					

TECHNICAL REVIEWERS' COMMENTS

1. **OBJECTIVES**

The objectives or goals of the proposed project with respect to clarity and consistency with North Dakota Industrial Commission/Lignite Research Council goals are: 1 – very unclear; 2 – unclear; 3 – clear; 4 – very clear; or 5 – exceptionally clear.

Reviewer 33-07 (Rating: 4) *This 2nd phase of a three phase project to develop engineering & design for a commercial scale North Dakota facility that converts ND lignite to carbon pitch, graphite, and battery grade graphite. Phase 1 NDIC supported demo successfully demonstrated the initial technical and economic feasibility. Phase 3 will involve construction of a commercial scale facility in McClean County.*

Reviewer 33-08 (Rating: 5) *Already having demonstrated the feasibility of the proposed process, this proposal takes the next step by developing a full engineering design of a commercial-scale facility in North Dakota. Assuming no unsurmountable barriers are uncovered during the engineering design, this work should lead to the next logical step, final design, permitting and construction of a new plant in North Dakota. The addition of a new lignite processing plant in North Dakota would meet most if not all of the goals of the NDIC and LRC.*

Reviewer 33-09 (Rating: 4) *Clearly would benefit lignite if this technology were to be applicable and financially feasible. Unclear if it only benefits specific lignite.*

2. **ACHIEVABILITY**

With the approach suggested and time and budget available, the objectives are: 1 – not achievable; 2 – possibly achievable; 3 – likely achievable; 4 – most likely achievable; or 5 – certainly achievable.

Reviewer 33-07 (Rating: 4) *This 18-month phase is likely achievable because of retaining the Phase 1 partnerships and is asking for $700,000 for this $1.4M phase from the NDIC. American Carbon Products, LLC and its partners will supply the other half of the budget.*

Reviewer 33-08 (Rating: 4) *The proposed approach is logical and the assembled team has good capabilities to meet the proposed objectives. Both the timeline and the budget match the proposed work scope.*

Reviewer 33-09 (Rating: 4) *No comment*

3. **METHODOLOGY**

The quality of the methodology displayed in the proposal is: 1 – well below average; 2 – below average; 3 – average; 4 – above average; or 5 – well above average.

Reviewer 33-07 (Rating: 4) *Five major tasks and six major milestones have been listed as well as methodology to accomplish them based on the initial success of the 1st phase.*

Reviewer 33-08 (Rating: 4) *The team has selected a respected engineering firm to complete the primary feasibility study. The additional experimental work proposed to verify the additional by-products of asphalt-binder and graphite should provide additional verification and marketing data to show the breadth of products (in addition to the primary product of pitch) that can be produced from the proposed plant. The methodology proposed for the experimental portion of the work and the depth of experience of the team indicated a strong probability of success.*

Reviewer 33-09 (Rating: 5) *Good support behind the research and development path forward.*

4. **CONTRIBUTION**

The scientific and/or technical contribution of the proposed work to specifically address North Dakota Industrial Commission/Lignite Research Council goals will likely be: 1 – extremely small; 2 – small; 3 – significant; 4 – very significant; or 5 – extremely significant.

Reviewer 33-07 (Rating: 3) *American Carbon Products, LLC patents and prior work by UND on North Dakota lignite forms a reasonable team for success. Success should result in another major use for North Dakota resources and ND jobs to operate the conversion facility.*

Reviewer 33-08 (Rating: 4) *The end-goal of this proposed work is the eventual building of a lignite to pitch plant in North Dakota, to include the production of high-value by-products. The addition of a new processing facility in North Dakota meets most of the NDIC/LRCC goals including developing new products for ND lignite and the creation of new jobs which should help add stability to the lignite industry and enhance the tax base of the State.*

Reviewer 33-09 (Rating: 4) *Very applicable to Enhance, Preserve, and Protect strategy*

5. **AWARENESS**

The principal investigator's awareness of other current research activity and published literature as evidenced by literature referenced and its interpretation and by the reference to unpublished research related to the proposal is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Reviewer 33-07 (Rating: 5) *Mr. David A. Berry is President of American Carbon Products and holds numerous patents on hydrocarbon conversion technology. Before that he was Associate Director of the NETL, Research Leader, Technical Manager, and Project Manager beginning in 1984.*

Reviewer 33-08 (Rating: 5) *The proposal includes an up-to-date review of the literature in the proposed area. The project team has been very active in this area for a number of years, and published articles noted in the attached resumes indicate they are not only aware of the current research activity, but are leaders in the development of the technology.*

Reviewer 33-09 (Rating: 4) *No comment*

6. **BACKGROUND**

The background of the investigator(s) as related to the proposed work is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Reviewer 33-07 (Rating: 5) *American Carbon Products, LLC has the only known continuous pilot-scale coal liquefaction-based pitch production facility in the world. They have patented Liquid carbon Eco-pitch process which uses flexible feedstocks versus the Chinese bituminous derived method. Partner UND has a battery test center, Materials Characterization and analytical research Labs. Barr Engineering has varied project research and project cost of construction experience in North Dakota. NACCO owns rights and knowledge inn regard to McClean County and other North Dakota lignites.*

Reviewer 33-08 (Rating: 5) *The research team has been performing work in this area for years. They have been awarded a number of patents and have a strong publication record. They are highly qualified to perform the proposed work. The addition of an Engineering firm to lead the feasibility study provides assurance that the results of the work will be a valid step towards the eventual building of a new lignite processing plant in North Dakota.*

Reviewer 33-09 (Rating: 4) *Lots of history with this team that is applicable to the project.*

7. **PROJECT MANAGEMENT**

The project management plan, including a well-defined milestone chart, schedule, financial plan, and plan for communications among the parties involved in the project, is: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – very good; or 5 – exceptionally good.

Reviewer 33-07 (Rating: 5) *The plan presented includes all the elements mentioned as well as milestones and feedback loops to delineate next steps and communication to the NDIC and other partners.*

Reviewer 33-08 (Rating: 4) *The team has successfully worked together on past projects. The proposed plan includes a reasonable timeline and distribution of work. The risk management plan is a little weak identifying only two of the potential risks to the project.*

Reviewer 33-09 (Rating: 4) *No comment*

8. **EQUIPMENT PURCHASE**

The proposed purchase of equipment is: 1 – extremely poorly justified; 2 – poorly justified; 3 – justified; 4 – well justified; or 5 – extremely well justified. (Circle 5 if no equipment is to be purchased.)

Reviewer 33-07 (Rating: 5) *$15,779 is budgeted for a lignite coal dryer/grinder and another $17,450 is budgeted for chemical, solvents, lubricants, heat tracing, insulation, piping, fittings, seals, and gaskets. The budget is quite detailed.*

Reviewer 33-08 (Rating: 5) *The project proposes the purchase of a graphitization furnace. While there is the potential to rent a furnace and/or subcontract the graphitization portion of the project, this would likely have significant impacts on the timing of the project and limit the scope of the work. Having the capabilities on-site will allow the team to fully explore the entire*

envelope of graphitization conditions and optimize those to deliver the best graphite product. The lack of this equipment would be a great hinderance to the project.

Reviewer 33-09 (Rating: 5) *No comment*

9. **FACILITIES**

The facilities and equipment available and to be purchased for the proposed research are: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – notably good; or 5 – exceptionally good.

Reviewer 33-07 (Rating: 5) *The 12,000 sq-ft facility in Morgantown, UND Labs, and mine access are all world class facilities with experienced personnel available to operate.*

Reviewer 33-08 (Rating: 5) *The project team has been working on this area for many years and have fully developed facilities to perform the proposed research.*

Reviewer 33-09 (Rating: 4) *The sites conducting the research appear well equipped to manage the project and possible modifications needed for success.*

10. **BUDGET**

The proposed budget value relative to the outlined work and the financial commitment from other sources is of: 1 – very low value; 2 – low value; 3 – average value; 4 – high value; or 5 – very high value.

Reviewer 33-07 (Rating: 4) *The patented ECO-Pitch process produces 99% less carbon emissions than the conventional bituminous coal derived coal tar pitch which is a 5% byproduct of steel production. The asphalt binder produces more durable asphalt, potential for a domestic battery grade domestic graphic production facility, hydrocarbon byproducts, and rare earth element production from the ash all have the potential to improve North Dakota value from lignite. That and the addition of 70 technical jobs to operate the McClean County facility.*

Reviewer 33-08 (Rating: 5) *This project proposes a 1:1 match of the NDIC funds. With the ultimate end goal of this project being the building of a new lignite processing plant in North Dakota, this project has high value to the State. It is worth noting that while most projects have the end goal of a commercial plant, this project is much closer to reaching that goal, and the chance of achieving that goal is high.*

Reviewer 33-09 (Rating: 5) *Good amount of cost share making the project attractive for ND investment.*

OVERALL COMMENTS AND RECOMMENDATIONS:
Please comment in a general way about the merits and flaws of the proposed project and make a recommendation whether or not to fund.

Reviewer 33-07 (Rating: FUND) *The 1st Phase of this Multi-Million dollar project was successful and now this 2nd phase proposes to validate the commercial viability of constructing and operating a lignite to pitch plant in McClean County. An expert team headed by patent holder American Carbon Products, LLC and supported by UND, Barr, and NACCO have supplied a good plan and budget to address these next steps. American Carbon Products, LLC has contributed $566,000 of their own money. There is a high potential to succeed, make the US less dependent on China and others for materials we now buy from them. I have two questions: is it cheaper to produce ECO-pitch vs. the conventional method and/or from bituminous coal? The proposed Plant's goal is to produce 15,000 tons/year of primary products and 13,500 ton/year of hydrocarbons and REE's. What does that mean in dollar value? I would still recommend supporting the next phase due to the potential added value to North Dakota.*

Reviewer 33-08 (Rating: FUND) *This project builds upon the successful completion of years of research, including a most recent project funded by the NDIC. Assuming the results reported to the NDIC for that project have been positive, the proposed work is the next step towards having a commercial plant built in North Dakota. The proposed plant represents a new use for lignite coal in an expanding market clearing meeting the goals of the NDIC and the LRC. Their chance of success is high, making this project worth funding.*

Reviewer 33-09 (Rating: FUND) *The proposal was well written, with a direct impact summary on how this research, process, and ultimate end product can be valuable to North Dakota and the Lignite industry. This avenue of research is important to finding alternative solutions for the use of lignite, and our enhance, preserve, protect strategy.*

The proposal did jump around a bit on the outcome of whether actual engineering design will be completed for this facility and the work to be done within this proposal compared to previous work already completed under an NDIC project. The proposal discussed completing a Front End Loading Engineering study, which should include some initial design. It also talked about completing process development studies for readiness in supplying product samples to customers, but said that customers have already assessed the product in the previous NDIC technical readiness project funded by the state, which was a basis behind why this technology was deemed ready to move to the next level and seek this current funding.

It would be good for the proposer to clarify the background of data and findings that justify this next level of project development, and this next request for state funding supporting their initiative, and to make clear what will be included in their FEL results.

It was also unclear whether this process and the tailored design to come from this project will benefit all North Dakota lignite, or specifically only that from the designated mine chosen to supply samples. Is the process mine-specific, or generic to all lignite?

AmeriCarbon

April 1, 2023

State of North Dakota
The Industrial Commission
State Capitol
Bismarck, ND 58505
ATTN: Lignite Research Program

RE: Transmittal Letter

This transmittal letter is to set forth a binding commitment on behalf of AmeriCarbon Products, LLC to complete the project as described in the accompanying application if the North Dakota Industrial Commission makes the grant requested therein.

Sincerely,

Greg Henthorn
Vice President of Corporate Development
AmeriCarbon Products, LLC

(888) 367-1650

www.americarbon.com

3001 City View Drive
Morgantown, WV 26501

AmeriCarbon

Submitted To:	State of North Dakota The Industrial Commission State Capitol Bismarck, ND 58505 ATTN: Lignite Research Program
Project Title:	Engineering Design and Feasibility Analysis for Commercial Graphite and Asphalt Manufacturing from Lignite-Derived Carbon Pitch
Applicant:	AmeriCarbon Products, LLC
Principal Investigator:	David A. Berry
Date of Application:	April 3, 2023
Amount of Request:	$700,000

Table of Contents

1. Abstract

In January 2022, AmeriCarbon began work under the project titled *North Dakota Lignite Coal-Based Pitch for Production of High Value Carbon Products via AmeriCarbon Liquid Carbon Pitch (LCP) Process*, which is funded by the NDIC, AmeriCarbon, and NACoal. The fundamental purpose of that project is to demonstrate the technical and financial feasibility of converting lignite into carbon pitch, an intermediate feedstock used in the manufacture of many carbon products. Currently, industry uses bituminous coal exclusively for such material as a by-product of the coking process in steel production; in contrast, AmeriCarbon's patented and proprietary Liquid Carbon Pitch (LCP) process focuses on carbon pitch production and has flexibility in terms of feedstock and can be tailored to produce different pitch properties for various applications.

Having demonstrated successful production of commercial grade lignite-derived carbon pitch, the primary objective of the current proposal is to build on the work completed in the first project by developing the engineering design for a commercial scale facility in North Dakota that converts coal to carbon pitch, asphalt, and battery grade graphite. By-products will also include a concentrated ash that contains rare earth elements (REEs) and certain hydrocarbon liquids, converting nearly all of the lignite feedstock into saleable products.

Combined with the engineering design contributed to the project by AmeriCarbon as cost share, the expected results of the proposed project will be to have a set of preliminary engineering design documents and drawings that cover the following processes: (i) conversion of lignite to carbon pitch, (ii) conversion of carbon pitch to asphalt, and (iii) conversion of carbon pitch to battery-grade graphite. The proposed $1.4 million project (including $700,000 requested from NDIC) will span 18 months upon initiation and involves the following primary participants: AmeriCarbon Products, LLC (applicant), the Institute for Energy Studies at the University of North Dakota, Barr Engineering, and The North American Coal Corporation. Each of the participating parties have committed cost share to the project.

2. Project Summary

AmeriCarbon and its North Dakota collaborators have initiated efforts to design, construct, and operate a commercial scale carbon products manufacturing facility in McLean County, North Dakota ("McLean Plant").[1] The McLean Plant will use North Dakota lignite in AmeriCarbon's patented and proprietary Liquid Carbon Pitch (LCP) process to manufacture *Eco-Pitch™*, a 100% domestic sourced alternative to coal tar pitch, a critical supply material for the production of synthetic graphite and other carbon materials.

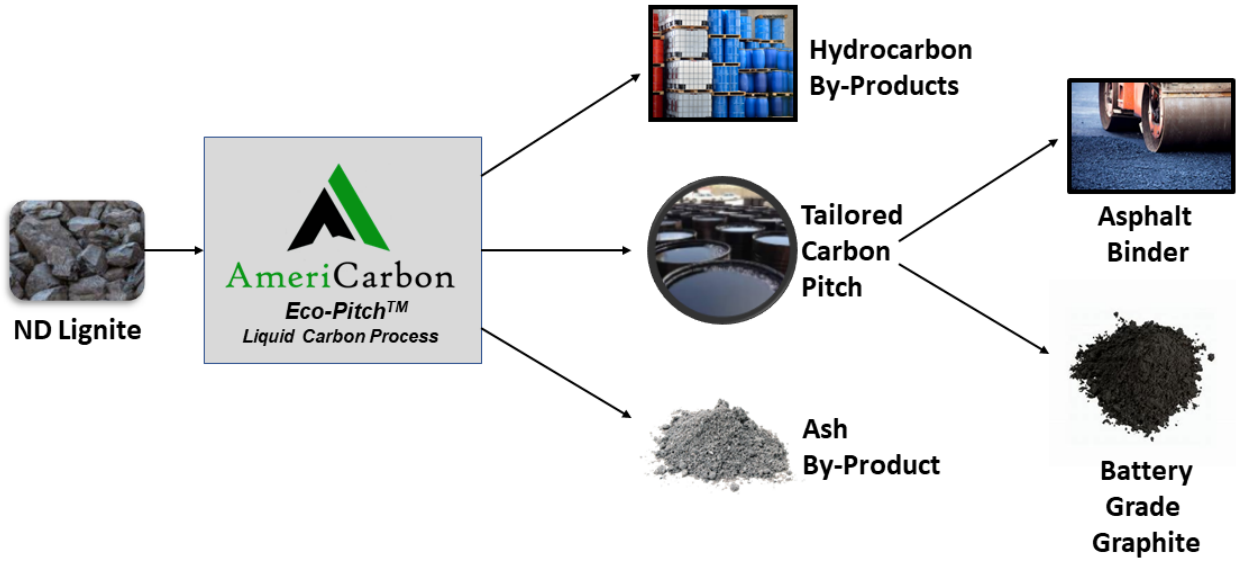

Figure 1. *McLean Plant simplified product summary.*

The currently proposed project would leverage work that already has been completed to validate the commercial feasibility of manufacturing carbon products from lignite (the technical and economic feasibility assessment initially funded in part by NDIC) as well as ongoing work on the engineering design of a base module of AmeriCarbon's LCP process. Figure 2 depicts these items along with the currently proposed project and the detailed engineering and construction of the McLean Plant on an overall timeline of commercialization.

[1] AmeriCarbon has also referred to the facility as the "Battery Materials Center".

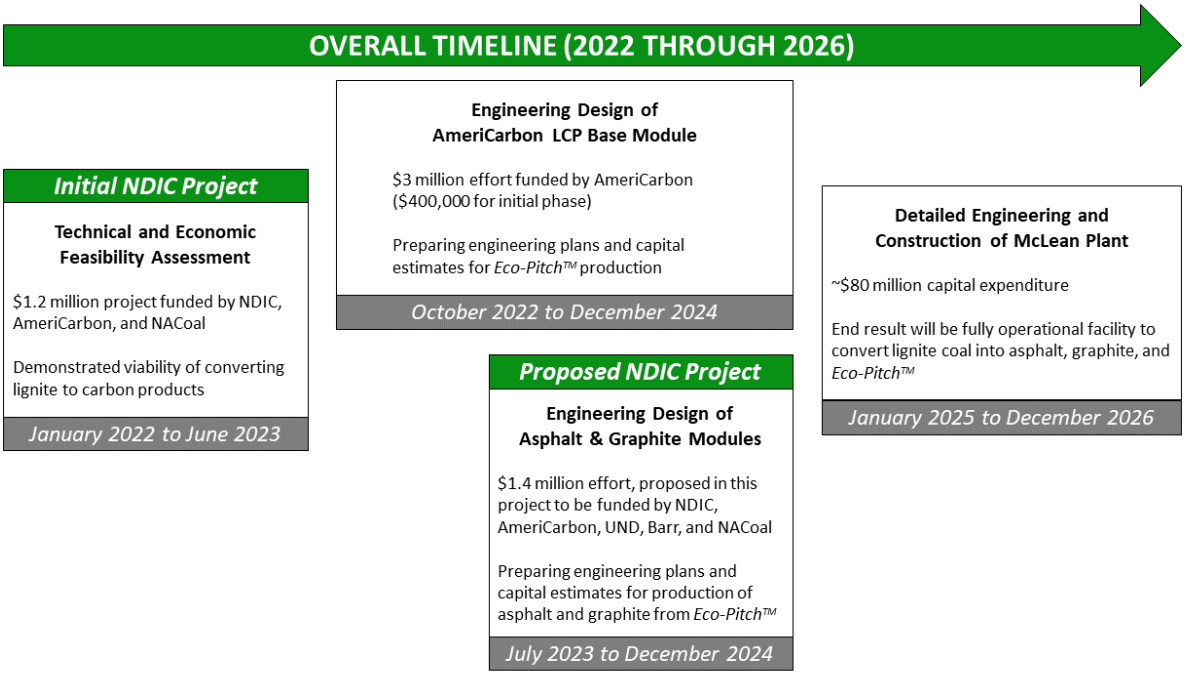

Figure 2. *Overall commercialization timeline.*

In March 2023, AmeriCarbon submitted a concept paper under the Bipartisan Infrastructure Law that seeks a $27.5 million subsidy for the AmeriCarbon LCP Base Module at the McLean Plant. The federal government has a number of additional programs in the works to subsidize the construction of facilities, and AmeriCarbon is working diligently to identify and position the McClean Plant for those awards. Having engineering and feasibility studies completed and in process improve the competitive position of DOE proposals, and the currently proposed project, if awarded by the Lignite Research Council, would provide a major step forward in such competitiveness.

The Planned McLean Plant and Its Products

The AmeriCarbon LCP process is highly efficient and produces minimum waste; the following products and by-products, referenced in Figure 1 above, will be produced at the McLean Plant after it is designed, financed, constructed, and commissioned:

1. ***Eco-Pitch™***. A coal tar pitch substitute that can be tailored for specific desired properties in the AmeriCarbon LCP process, *Eco-Pitch™* will be both an intermediate product and an end product of the McLean Plant. As an intermediate, it will be further processed into asphalt binder and battery-grade graphite. As an end product, it will be sold as binder pitch and impregnating pitch, with applicability in the electric vehicle (EV) battery market and other immediate markets where there is a shortage of supply due in part to reliance on foreign supply (principally China). Industry currently relies on coal tar pitch to be produced from coal tar, a ~5% by-product of coking ovens in legacy steel manufacturing processes. Displacement of current coal tar pitch supply with lignite-derived *Eco-Pitch™* will reduce greenhouse gas emissions content by more than 99% compared to current sources.[2]
2. **Asphalt binder**. Current demand for asphalt is met with a blend of aggregate with petroleum derived binder; coal-derived asphalt binder has been demonstrated to have certain superior qualities to petroleum-derived asphalt binder, such as with respect to adhesion, hardness, and anti-aging properties. AmeriCarbon is developing an asphalt binder based on lignite that can be blended with petroleum-based binder to improve quality and durability while integrating with existing supply infrastructure.
3. **Graphite**. The demand for graphite is increasing rapidly, and the United States government has designated graphite as a critical supply material. Meanwhile, there is currently not any domestic industrial supply of battery-grade graphite. The Inflation Reduction Act created significant tax incentives for EV battery manufacturers that can demonstrate certain levels of domestic material supply, and AmeriCarbon's ability to directly convert coal into provides a viable and scalable pathway to meeting the demand growth with a fully domestic source with abundant supply.

[2] *Technical Summary: Estimated Greenhouse Gas Emissions for AmeriCarbon's Coal Tar Pitch Versus Coal Tar Pitch Produced in China*, Downstream Strategies, September 27, 2021, submitted to NDIC on 10/01/2021 as Appendix 2-I in AmeriCarbon's proposal titled *North Dakota Lignite Coal-Based Pitch for Production of High Value Carbon Products via AmeriCarbon Liquid Carbon Pitch (LCP) Process*.

4. **Hydrocarbon by-products**. The AmeriCarbon LCP process produces a fraction of light hydrocarbons that can be separated and sold into existing markets, adding to the financial viability and material efficiency of the process.
5. **Ash by-product**. The AmeriCarbon LCP process separates solid material into a concentrated ash that contains rare earth elements (REEs) and other minerals. This ash can be sold for various applications, including REE extraction and can be used as filler in certain material applications such as cement production.

The McLean Plant will be an important commercial scale demonstration of the production of critical materials while creating sustainable employment in high tech manufacturing. The McLean Plant will provide full manufacturing capability with a capacity to produce 15,000 tons of primary products (*Eco-Pitch*™, asphalt binder and graphite) annually and an additional 13,500 tons of by-products, while demonstrating AmeriCarbon's proprietary and commercially viable technology for future expansion and replication in additional coal impacted communities.

Existing AmeriCarbon Facility and Background

The roots of AmeriCarbon's proprietary and patented LCP process date back to 2009, when a predecessor organization built a pilot-scale unit for broad coal liquefaction applications. AmeriCarbon has re-engineered the facility to create the LCP process for intentional production of tailored isophase and mesophase coal pitch intermediates and needle cokes. AmeriCarbon has produced pitch from lignite, bituminous and sub-bituminous coals and has also produced needle coke in the facility.

AmeriCarbon has the only known ***continuous*** pilot-scale, coal liquefaction-based, pitch production facility in the world. The facility, detailed later in this proposal, is a 12,000 sq-ft facility that contains infrastructure for laboratory through pilot-scale R&D. This allows for immediate and directly scalable engineering data from applied research generated to be confidently translated to a commercial scale plant. In our discussions with future customers, nearly all have expressed concerns about a lack of supply availability and desire to secure a domestic source of economical coal-derived pitch/chemical intermediate. Collaborative agreements are being formulated to pursue those opportunities.

The Initial NDIC Project: Technical and Economic Feasibility Assessment

Since January 2022, AmeriCarbon has been executing on a project titled *North Dakota Lignite Coal-Based Pitch for Production of High Value Carbon Products via AmeriCarbon Liquid Carbon Pitch (LCP) Process*, which was funded in part by NDIC. At the onset of that project, AmeriCarbon and its collaborators had technical theories and reason to believe that it would be technically feasible to convert North Dakota lignite coal into a coal tar pitch product. Implementation of the project has yielded the following results:

- ✓ Identified and quantified specific market applications
- ✓ Gained an understanding of desired product specifications
- ✓ Conducted chemical formulation and process evaluation studies
- ✓ Produced carbon products from lignite coal that have been tested and confirmed to meet market and customer specifications
- ✓ Evaluated by-products that contribute to the commercial viability of the liquid carbon process
- ✓ Developed a technoeconomic model that meets investor return thresholds

Under the initial project, AmeriCarbon and its project collaborators have demonstrated that the production of carbon pitch from North Dakota lignite coal is technically feasible for multiple applications.

Engineering Design of AmeriCarbon LCP Base Module

In October 2022, AmeriCarbon engaged an engineering design contractor to develop an engineering design for the AmeriCarbon LCP process, focused on the production of *Eco-Pitch*™, hydrocarbon by-products, and ash by-product. **The scope of that engagement does NOT include the further processing of *Eco-Pitch*™ into asphalt binder and graphite products**.

Under that ongoing project, which has been funded to date exclusively by AmeriCarbon, preliminary engineering designs have been developed and are being refined; the effort includes cost estimates for equipment and other capital expenses required for construction and operation of the base module to produce *Eco-Pitch*™ and its referenced by-products. The work product from this effort will achieve one of the key critical requisites for developing a commercial scale facility such as the McLean Plant.

Currently Proposed Project: Engineering Design of Asphalt and Graphite Modules

The primary objective of this proposed project is to initiate engineering design and validate economic viability for the asphalt and battery modules of the McLean Plant. This builds on the prior effort funded by

the NDIC in January 2022, which identified and demonstrated the technical potential of asphalt and battery grade graphite derived from lignite coal utilizing AmeriCarbon's patented/proprietary LCP process.

Unlike the current engineering design of the LCP base module, which is not coal type specific, the work product of the proposed project will be specially designed for processing *Eco-Pitch™* produced from North Dakota lignite. The physical and chemical properties of lignite result in an *Eco-Pitch™* that is unique and specific, and therefore the engineering design of the asphalt and graphite modules will have aspects that are specific to lignite coal and a North Dakota facility.

The following are expected project results and deliverables:

- Front End Loading Engineering (FEL 1) to provide opportunity assessment and design basis for a commercial plant in North Dakota;

- Experimental process development studies to provide basis for the engineering design/study, technology readiness and the supply of product samples for customer assessment; and

- Technoeconomic evaluation study to verify business case for commercial plant.

The ultimate end goal of the project is to position the commercialization efforts of AmeriCarbon and its collaborators to secure funding from public and private sources to complete the design and construction of the McLean Plant, with the intention of beginning commercial operation of the facility in approximately three years.

3. Project Description

The project involves two primary areas where attention will be focused:

(a) **Asphalt binder production**. This will involve optimizing the parameters of the AmeriCarbon LCP base module for manufacturing ideal commercial compositions of

lignite-derived asphalt binder, as well as designing the material handling operations required for commercial production. UND will lead this aspect of the project with close input and interaction with AmeriCarbon.

(b) **Graphite production**. This involves the design of unit operations to convert three separate *Eco-Pitch*^{TM} compositions into battery grade graphite to be sold to EV battery assemblers. Barr Engineering will lead this effort with input from UND and AmeriCarbon.

Additional background regarding these two aspects of the project, followed by project details, are provided below.

Asphalt Binder Market and Considerations

Construction and maintenance costs for U.S. roadway infrastructure are about $100 billion annually, and asphalt paving is the largest component thereof, representing about 20%. Traditionally, asphalt binders are produced mainly by petroleum refiners, and is viewed as a simple, convenient, and profitable way to use the residual material from the refinery operation.

Although being a convenient solution, petroleum binders are plagued with different performance issues like poor adhesion, aging, elastic deformation, and also material issues like rigid physical parameters (e.g., softening point). Moreover, the demand for asphalt binders is increasing exponentially to meet new infrastructure requirements both in the U.S. and globally. But at the same time, the refinery operations are not increasing their capacities owing to environmental concerns and government regulations. Figure 3 illustrates an estimate of the deficit in the supply-demand chain for the asphalt industry.

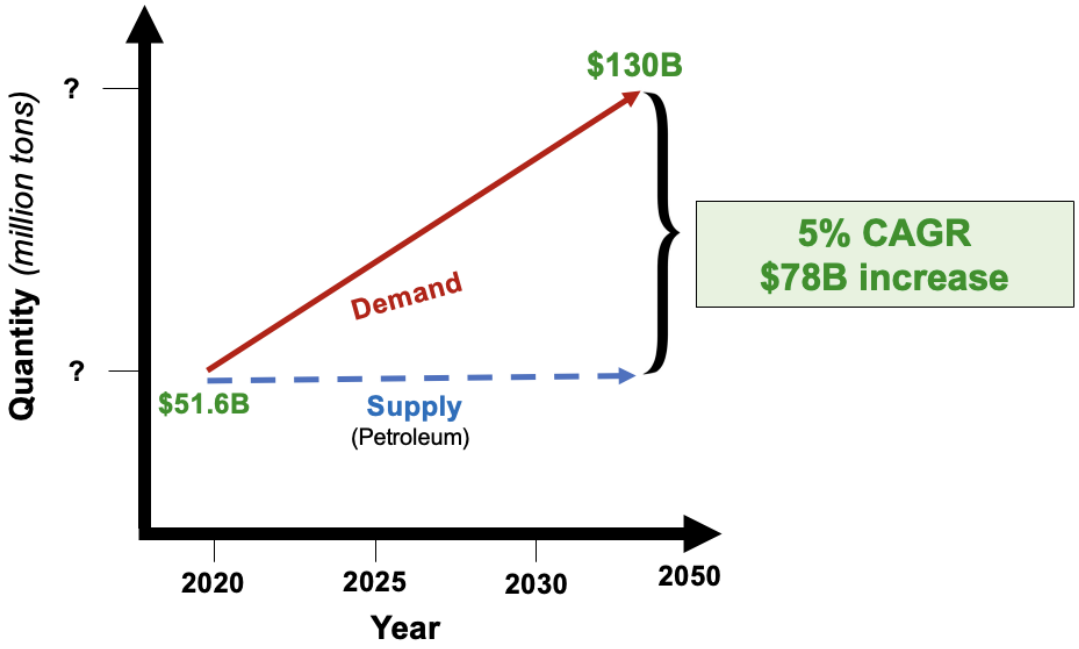

Figure 3: *Indicative supply-demand curve for asphalt binder products.*

Petroleum binders are devoid of necessary resin and asphaltene structure, which is inherent based on the origin of the material. This shortcoming of the physical properties is addressed by modifications using polymer additives mixed with petroleum binders to provides more resinous structure, but that approach is not a sustainable solution.

Asphalt binder derived from carbon pitch provides a robust solution to address the issues of physical drawbacks and declining availability. Carbon pitch based binder material has several advantages including wetting and adhesion to stone and mineral aggregates, corrosion resistance, a higher coefficient of friction for safety, lower elastic deformation, less susceptibility to aging, less expensive compared to petroleum asphalt, and can be more environmentally friendly *(Andreikov et al. 2010, Chambrion et al. 1995)*.[3]

Another important aspect to consider is the source of coal (coal rank) used for manufacturing coal-based asphalt binder. Lignite, owing to its structural composition, is an ideal coal for asphalt applications.

[3] Chambrion, P., Bertau, R., and Ehrburger, P. (1995). *Effect of polar components on the physico-chemical properties of coal tar*, Fuel, 74 (9): 1284–1290.

Lignite has loosely bound heterogeneous bonds in the structure, which requires less energy to break down in the liquefaction process, and thus becomes economically attractive.

In our initial project funding in part by NDIC, AmeriCarbon is recommending pursuit of this market opportunity and accelerating towards manufacturing lignite coal derived asphalt binder grade pitch at commercial scale using its unique and environmentally friendly tailored LCP process. This process will allow the manufacture of *Eco-Pitch*™ with targeted physical properties that can be used in different grades of asphalt binders and is adaptable to future needs.

Researchers have explored the blending of coal-based and petroleum-based binders and found that adding a coal-based pitch helps in fulfilling performance gaps by improving adhesion to the filler material (from the asphalt mix), reduces elastic deformation (improves crack resistance) and also improves working life (anti-aging) of the asphalt (*Xue et al. 2017).*[4] Complete replacement of petroleum asphalt with coal-based binders has not yet been extensively explored but is a possible future optimization of the opportunity.

AmeriCarbon has developed relationships with asphalt industry participants and university researchers to accelerate the efforts to position lignite-derived carbon pitch in the asphalt binder supply chain. In late 2022, AmeriCarbon was brought into a proposal submitted by a defense contractor under the U.S. Department of Transportation Federal Highway Administration Exploratory Advanced Research (EAR) Program 2022. Under the proposal, AmeriCarbon has provided lignite-derived asphalt binder pitch produced in our pilot facility for an advanced research project involving next generation roadway materials. AmeriCarbon's inclusion in the proposal followed evaluation of our carbon pitch by the defense contractor's university partner and is a form of validation of our approach and concept.

AmeriCarbon also has a collaborative relationship with Dr. James Bryce at West Virginia University. Based on the requirements of the asphalt binder industry as we have learned through our discussions, AmeriCarbon has generated a series of lignite-derived asphalt pitches which are being evaluated for performance and key indicators.

[4] Xue, Y., Ge, Z., Li, F., Su, S., & Li, B. (2017). *Modified asphalt properties by blending petroleum asphalt and coal tar pitch*, Fuel, 207: 64-70.

Battery Grade Graphite Market and Considerations

Graphite is a critical material for the production of lithium-ion batteries (LIBs) and electric vehicles (EVs). *Eco-Pitch™* will be tailored into three different forms, each of which will be graphitized into a new product derived from lignite and 100% domestically sourced.

The LIB market size has dramatically increased, promoted by rapidly increasing demands for EVs, electronics, grid-level energy storage, and other industrial applications. In recent years, the global LIB electrode material demand and production capacity has exceeded its forecasted CAGR, and this trend is expected to persist as the EV market continues to rapidly expand. The global EV battery market, estimated at ~$28 billion in 2021, projected to grow to $155 billion by 2028 at a CAGR of 28% (Fortune Business Insights, 2021).[5] According to the University of North Dakota, if all the graphitic carbon in the anode is 100% carbon-ore derived, 100 million tons of coal and coal waste would be consumed.

Graphite is among the U.S. government's targeted critical materials. Currently, there is no material domestic production of synthetic graphite for EV batteries. The supply of binder pitch and impregnating pitch is reliant on the supply of coal tar from Asia, principally China, as a by-product of the coking process in steelmaking. With current supplies of coal tar pitch consumed by existing traditional applications, it is unclear where the rising demand due to EV batteries is going to be fulfilled, placing the United States at a significant geopolitical disadvantage. AmeriCarbon's approach in general – and this project specifically, addresses this concern directly by providing a complete domestic supply chain for carbon.

In the past, the United States had significant coking ovens for steel making that also produced coal tar pitch as a by-product. This was sufficient at the time, but two things have since changed that has caused a shortage in U.S. coal-tar pitch supply: (i) U.S.-based coke ovens have largely closed due to loss of the U.S. steel industry and environment challenges with the coke ovens; and (ii) rapid and projected exponential growth of the carbon-based materials industry. China has significant coke oven operations and currently supplies the

[5] *Electric Vehicle (EV) Battery Market Size, Shar & COVID-19 Impact Analysis, by Battery Type (Lithium-ion, Lead Acid, Nickel Metal Hydride, and Others), by Vehicle Type (Battery Electric Vehicles, Plug-In Hybrid Electric Vehicles, and Hybrid Electric Vehicles), and Regional Forecasts, 2022-2029*, Fortune Business Insights, 2021.

majority of the world's pitch supply. AmeriCarbon has recognized this opportunity and is applying its liquefaction background in coal-to-chemicals to demonstrate its innovative pilot-scale coal-to-pitch process.

Working closely with the University of North Dakota, AmeriCarbon has developed a viable approach for commercial production of battery grade graphite from lignite coal. Among various coal types, lignite has demonstrated that it is reactive and adaptive to structural change upon chemical processing, which is a critical step in graphite production. The AmeriCarbon/UND approach for graphite anode production provides a much better fast-charging capability, which has been identified as a major roadblock to wide scale EV deployment. The AmeriCarbon/UND approach will also result in a higher packing density and thereby higher energy density.

UND and AmeriCarbon have presented a portion of their joint approach to manufacturing battery-grade graphite from lignite in a recent paper titled Coal Derived High-Performance Anode Materials for Lithium-Ion Batteries, which is attached as Appendix 3-I.

Statement of Work and Project Objectives

The primary objective of this proposed project is to initiate engineering design and validate economic viability for the asphalt and battery modules of the McLean Plant. The following are expected project results and deliverables:

- Front End Loading Engineering (FEL 1) to provide opportunity assessment and design basis for a commercial plant in North Dakota;

- Experimental process development studies to provide basis for the engineering design/study, technology readiness and the supply of product samples for customer assessment; and

- Technoeconomic evaluation study to verify business case for commercial plant.

The project will address two primary design areas: (i) asphalt production and (ii) graphite production. Simplified schematic diagrams of each are shown in Figures 4 and 5 below.

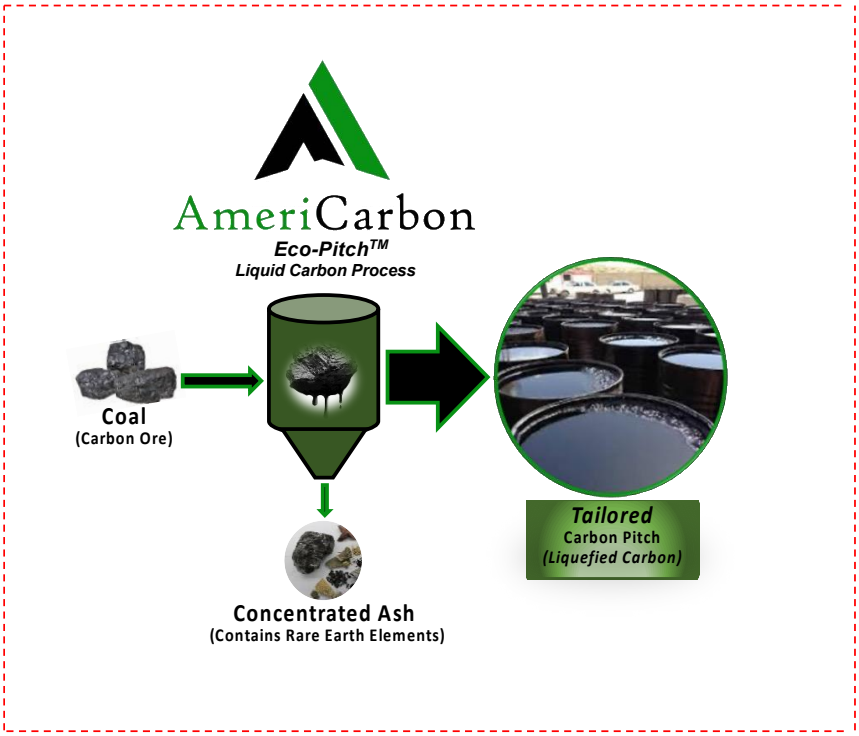

Figure 4: *High level schematic diagram of the AmeriCarbon LCP process, which will be optimized for asphalt binder production.*

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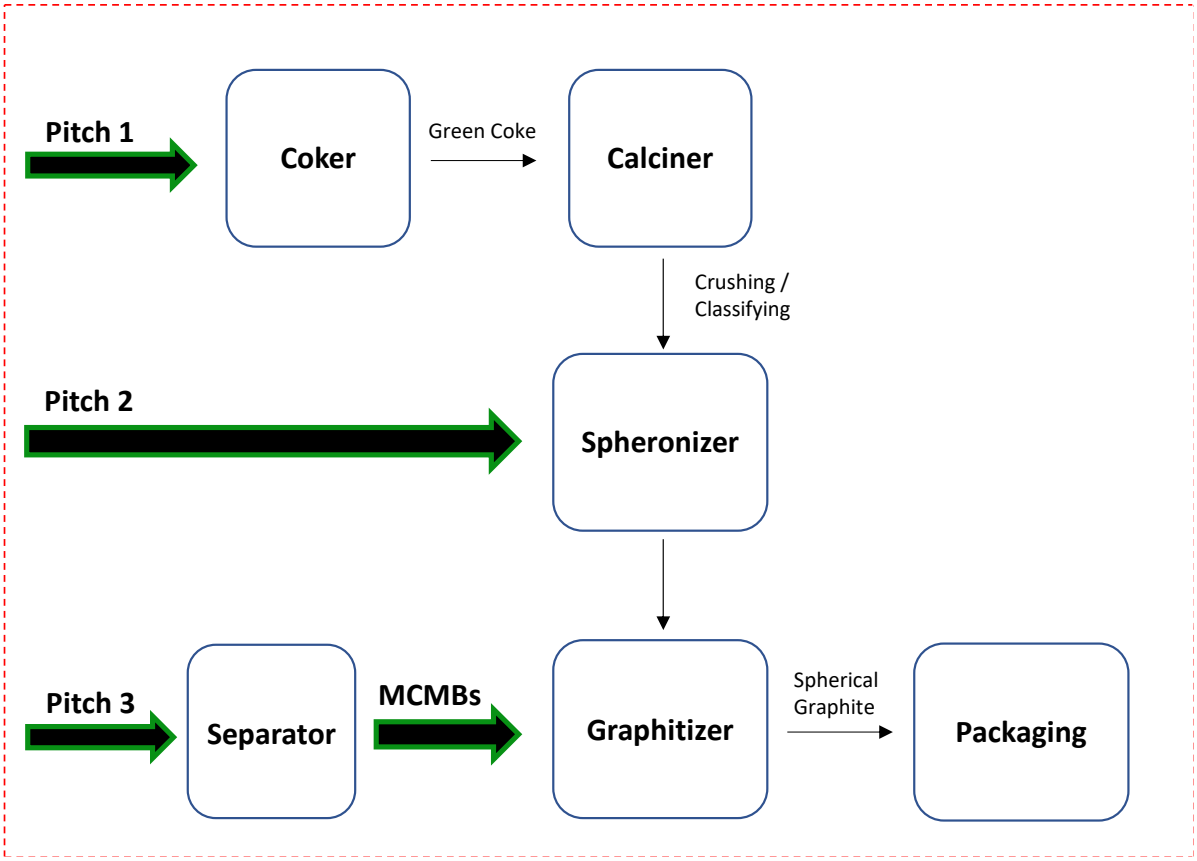

Figure 5: *High level schematic diagram of the planned graphite production module.*

The project will be led by AmeriCarbon, with participation from additional performers including the University of North Dakota (UND), Barr Engineering, and The North American Coal Corporation (NACoal). The following are task statements for the project:

Task 1: ***Engineering Feasibility Study*** – An FEL-1 engineering design/study will be conducted on a commercial scale lignite coal fed facility to be located in North Dakota based on AmeriCarbon's LCP *Eco-Pitch*^{TM} process. The plant will consist of a base pitch production module producing asphalt and pitch which feeds an integrated graphite conversion module for the production of battery grade graphite. Based on output of the engineering design, a Class 5 level capital cost estimate as defined by AACE International will be generated. Barr Engineering and AmeriCarbon will be the principal performers with input from experimental Task 3 and Task 4.

Primary unit operations considered may include but not be limited to:

- Coal Material Handling
- Eco-Pitch Liquefaction and Storage
- Concentrated Carbon Handling (Byproduct)
- Pitch Transport
- Coker
- Calciner
- Separator
- Spheronizer
- Graphitizer
- Super Sack Packaging
- Air Emissions Cleanup
- Waste Disposal
- Wastewater treatment and discharge

Task 2: ***Coal Feedstock Supply and Characterization*** – NACoal will supply North Dakota lignite coal to AmeriCarbon for processing into pitch at their Morgantown, WV facility. These coals will be exclusively used in the experimental development and generation of asphalt and graphite products generated in Task 3 and Task 4. Shipped coal shall be dried to lower moisture levels to practical extent possible prior to shipping. Potential inerting with nitrogen will be considered to minimize degradation of the lignite over timeframe of the project. Ultimate and proximate analysis will be conducted and supplied with the coal.

Task 3: ***Asphalt - Experimental Product Development, Evaluation and Process Design Studies*** – The objectives of this project are (1) to manufacture Lignite Pitches with targeted specifications (based on the federal and state DOT regulations), (2) assess its use to replace petroleum asphalt partially and fully with or without using modifiers, and (3) to test the lignite binder-based asphalt mix for performance evaluation. An iterative approach will be used between physical and mechanical properties assessment and Lignite pitch development, to optimize the *Eco-Pitch*^{TM} specifications that will be produced by AmeriCarbon. Lignite pitch binders and petroleum asphalt are 100% compatible with each other, and existing literature will be used as a guidance for formulating blends. Superpave grade is the commonly used pavement grade used in the state of North Dakota as well as rest of the US and will be used for benchmarking. Specific activities can include but not be limited to:

- Lignite Pitch Development
- Binder Evaluation and Process optimization
- Performance Evaluation (Bench Scale)
- Correlating Binder and Mix Properties

This task will be performed by the University of North Dakota and AmeriCarbon. Samples as appropriate will be shared with potential customers and governing agencies to promote the use of lignite coal-based binders into the commercial marketplace.

Task 4: ***Graphite - Experimental Product Development, Evaluation and Process Design Studies*** – AmeriCarbon and the University of North Dakota will build on its success in 2022 in converting lignite coal into graphite. The primary objective of this task is to support the engineering design activity in Task 1 and additionally demonstrate the viability of a domestic supply chain for battery grade graphite. Various forms of graphite and/or carbon materials (pitch, needle coke, MCMBs) are needed to specifically make spherical "battery grade graphite". Success in Task 4 would represent the only demonstrated domestic graphite produced exclusively from lignite-coal and enable the United States in reducing its dependence on off-shore foreign suppliers for this critical strategic material.

This task is highly integrated through iterative feedback optimization between the coal conversion and graphite product quality. It leverages AmeriCarbon's unique ability to produce tailored pitches exhibiting distinct physical and chemical properties that are necessary to produce at least three distinct pitch types leading to the primary intermediate carbons to make the battery grade graphite including needle coke and meso carbon micro beads (MCMB's). Task activity includes but is not limited to:

- Identification of optimal pitch formulations and manufacturer of required pitch quantities.
- Optimization of AmeriCarbon's needle coke procedure for battery-grade graphite production.
- Development of UND's MCMB extraction/separation process
- Fabrication of spherical battery-grade graphite
- Fabrication of UND designed coin-cell batteries for graphite performance testing and comparison to commercial graded graphite

The University of North Dakota and AmeriCarbon combined have the facilities to execute this task but may engage third party services as required. Samples as appropriate will be shared with potential customers and governing agencies to promote the use of lignite coal-based binders into the commercial marketplace.

Task 5: Technoeconomic Study – A study will be conducted to evaluate the commercial potential of the subject North Dakota Lignite Coal-Based Asphalt/Graphite commercial plant. Input will be based on existing AmeriCarbon information, prior studies and results from Tasks 1-4.

Deliverables:

- Pitch Samples: Identified in Task 3 and Task 4 as necessary throughout the project
- Quarterly Interim Reports
- Task 5: Technoeconomic Report
- Final Report

Environmental and Economic Impacts of the Project

With respect to the conduct of the proposed project, environmental impact will be minimal. Existing facilities will be used, with the exception of the purchase of a graphitization furnace. The facilities used in the project will operate within reasonable parameters of waste and energy consumption that are consistent with their current usage levels.

In terms of economic impact, the project budget of [$1.4 million] will include $551,000 to UND for work to be performed in North Dakota, and $200,000 to Barr Engineering for work performed primarily in Minnesota and North Dakota.

Future potential impacts are significant. *Eco-Pitch*™ is a quantum leap forward in terms of improved environmental impact compared to current supplies. Due to AmeriCarbon's efficient and low temperature process, greenhouse gas emissions are reduced by more than 99% compared to coal tar pitch produced as a by-product of coking ovens in the steelmaking process (Downstream Strategies, 2021). Further, because AmeriCarbon's process operates at lower temperatures, certain carcinogenic compounds and other harmful chemicals are not generated in the process.

4. Facilities & Equipment

The project will be conducted at existing facilities that are operated by the project's performers. The facilities are outlined below.

AmeriCarbon Research and Pilot Demonstration Facility

Figure 6: *AmeriCarbon's Research and Pilot Demonstration Facility in Morgantown, West Virginia.*

AmeriCarbon operates a state-of-the-art 12,000 sq-ft facility in the Morgantown Industrial Park (Morgantown, West Virginia) that contains infrastructure for laboratory through pilot-scale R&D. The facility contains six commercial flame suppression laboratory hoods and a wet chemistry area along with multiple high-bay areas for pilot-level research and demonstration.

Figure 7: *AmeriCarbon's pilot scale unit operations that underpin the LCP process.*

AmeriCarbon Equipment

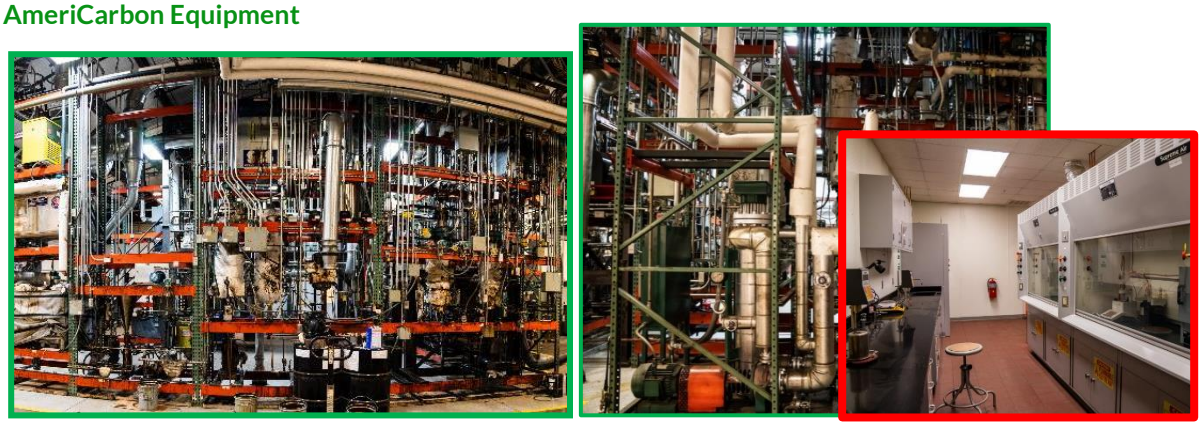

Figure 8: *AmeriCarbon's pilot scale and research equipment.*

AmeriCarbon's equipment includes: coal liquefaction & coker train capable of processing 10 tons per day; capable of producing custom coal pitch, needle coke, and advanced carbon products; product separation and collection train; both trains are fully automated and managed by an industry standard computer / software system; six commercial hood laboratory with flame suppression and exhaust system; fully equipped for benchtop lab research and development. The facility is heavily instrumented and managed by a PLC control system with continuous monitoring.

Barr Engineering

Barr Engineering is headquartered in Minneapolis, and has offices in several locations in the United States and Canada. Barr Engineering's Bismarck, North Dakota office opened in 2008, serving clients in North and South Dakota, Wyoming, Montana, and Saskatchewan. Barr Engineering's well-rounded team of engineers and scientists represent a variety of disciplines such as mechanical, mining, structural, civil, and environmental engineering. With a deep local perspective, Barr Engineering helps clients navigate challenges, like a cold-weather climate, unique to the upper Midwest.

Barr Engineering's Bismarck staff are members of professional societies such as the North Dakota Petroleum Council, North Dakota Water User Association, Bismarck Mandan Chamber of Commerce, North Dakota Geological Society, Lignite Energy Council, and American Council of Engineering Companies of North

Dakota. Barr Engineering cares about community and participates in service activities with organizations like Gateway to Science and Toys for Tots North Dakota.

Figure 9: *Barr Engineering's Bismarck office.*

University of North Dakota

Founded in 1883, six years before the state itself was established, UND gave North Dakota its name when the former Dakota territories separated into two distinct states. Today, UND is a busy 521-acre campus, the state's largest. UND has emerged as a leader in engineering, medicine, aviation, space, and unmanned aircraft systems.

The following facilities at UND will have applicability to the proposed project:

Battery Assembly and Test Center (UND-IES). The center can fabricate and test various batteries, from small-size CR2032 coin-type cells to full-size pouch cells and up to 48V battery packs. The cylindric cell fabrication facility consists of a set of machines for electrode coating, rolling press, vacuum drying, slitting, ultrasonic spot welding, winding, grooving, and sealing. The center houses a Neware CT-4008 Battery Analyzer for coin-type cells, CT-3008n and BTS4000-5V30A Battery analyzers for pouch cells, an HYNN-BP600A battery testing

system for battery packs, and high/low temperature chambers (Espec) and electrochemical workstations (Gamry) with capabilities including charge/discharge characteristic tests, capacity tests, cycle life tests, Cyclic Voltammetry (CV), Electrochemical Impedance Spectroscopy (EIS) analysis, and battery standard dynamic tests.

Materials Characterization Lab (UND-IES). The MCL was established to support UND research and educational activities, support industry research and sample analysis needs, and serve as a regional satellite lab. The laboratory is supported by experienced technicians and analytical chemists and has a vast array of analytical equipment and capabilities, including a field-emission scanning microscope (FE-SEM) FEG 650 (FEI, USA), x-ray powder diffraction (XRD) Smartlab (Rigaku, Japan), Thermo Scientifics' Nicolet NXR 9650 FT-Raman spectrometer, x-ray fluorescence spectrometer Supermini 200 (Rigaku, Japan), Thermogravimetric analyzer SDT-Q600 (TA, USA), and a computer-controlled scanning electron microscope S3400 (Hitachi, Japan) with EDS (IXRF, USA). The MCL will be used to examine the crystal purity, chemical composition, morphology, and particle-size distribution of the anode materials, as well as the MPP feedstock.

UND-IES Lab. This lab is equipped to perform chemical synthesis and processing steps and has a small autoclave (Parr) for MCMB synthesis, an atmosphere-controlled TFM2 2-Zone tube furnace (Across International, USA), and a bench-scale muffle furnace (KJ-a1200-27L, China) for carbonization steps, and an atmosphere-controlled glove box (MBraun LABstar MB) for battery construction.

Environmental Analytical Research Laboratory (UND-IES). The equipment available for the proposed project includes a lab muffle furnace with atmosphere control, a carbon analyzer TOC SSM 5000A analyzer (Shimadzu, Japan), Ion Chromatography (Dionex 100), and an inductively coupled plasma optical emission spectroscope ICP-OES 5510 (Agilent, USA).

Sample Preparation Laboratory (UND-IES). UND has a fully equipped sample preparation lab that will be used to take advantage of the above equipment, with all of the necessary capabilities for the project's required sample preparation. Available equipment includes a Mixer/Mill 8000 M (SPEX, USA), a LaboPol-21 polisher (Sturers Inc.), an X-press sample presser (SPEX, USA), a K-1 flux (SPEX, USA), a shatter box (SPEX, USA), and a Micronizing mill (McCrone).

Additional Equipment

The team proposes to acquire a graphitization furnace for this project which would be housed at the University of North Dakota. The project team has identified multiple toll graphitization service providers but due to the low availability and long waiting time, having a graphitization furnace at UND enables the project team to more efficiently conduct the necessary research for the proposed project in a timely manner.

5. Standards of Success

The project will support the onshoring of the manufacture of advanced carbon products, an emerging industry in the United States which has the potential to grow to 480,000 jobs over the next three decades, according to April 2021 testimony in the U.S. Senate Energy and Natural Resources Committee. By using lignite coal as a raw material for manufacturing and connecting the dots in the supply chain all the way to valuable finished products, AmeriCarbon and our collaborators have the potential to significantly reduce the amount of embedded carbon in a wide array of finished products with double digit compound annual growth rates.

This project will serve a foundational role in laying the groundwork for the development of commercial scale manufacturing facilities in North Dakota to capture the state's rightful share of the economic opportunity brought about by the onshoring of advanced carbon product manufacturing. The production of carbon pitch from lignite coal is a linchpin that will lead to additional manufacturing

opportunities where lignite-derived carbon pitch is the feedstock for further value-added refinement into valuable carbon materials and products. Long term, this can lead to several million dollars of capital investment, the creation of thousands of new jobs with sustainable employment, and reduced greenhouse gas emissions from the U.S. manufacturing sector.

The long-term success of this project, therefore, will be measured by the following:

1. *Commercial pitch production facilities*. How many commercial scale pitch production facilities will be located in North Dakota and in what time frame? Our hope, pending successful technical results, would be to enable at least one commercial facility located in North Dakota within three years with an installed capacity of 28,500 tons of production annually (including all products and by-products).

2. *Downstream manufacturing facilities*. How many additional advanced carbon products manufacturing facilities will be located in North Dakota that use carbon pitch as a feedstock, and what will be their economic impact? Our hope is that within five years, there could be a network of manufacturers locating in North Dakota, leading to hundreds of jobs during construction and facility operations.

In order to achieve the desired economic impacts, the project must produce certain tangible technical results. Specifically, these can be summarized as follows:

a. *Technical results*. The desired technical results are to develop a series of engineering plans for the McLean Plant with respect to the asphalt and graphite modules described herein.

b. *Techno-economics*. Capital expenses will be estimated and evaluated in the context of techno-economics to be able to project the commercial viability of the different carbon manufacturing applications.

The standards success for the technical results will be whether the project has resulted in a series of drawings, technical formulations, and capital expense budget for commercial construction and operation of the McLean Plant. We believe that financial projections for such a facility would target an internal rate of return (IRR) sufficient to attract private sector financing of a first-of-its-kind facility; in the alternative, a lower projected IRR could also be considered successful if certain federal incentives and subsidy could be leveraged.

6. Background

The basis for AmeriCarbon's LCP process is derived from long-standing coal liquefaction technology. Coal liquefaction was first successful developed and implemented in Germany around the time of the World War because of abundance of coal reserves and the need to find alternative resources to petroleum-based transportation fuel for military vehicles like tanks, airplanes and warships. Friedrich Bergius, a German chemist, was the first to invent direct coal liquefaction to convert lignite to fuel in 1913 [22]. Bergius developed a process that required high pressure (70 MPa) and temperature (> 500^0C) using iron-based catalyst. The indirect coal liquefaction process was later developed in 1923, famously known as Fischer-Tropsch process. In this process, the coal is first converted into "synthesis gas" (syngas) which is mainly a mixture of H_2 and CO, which is then converted into light hydrocarbon liquid fuel through a series of steps. Both these methods, direct and indirect coal liquefactions, were developed primarily to covert different types of coal into a fuel source[23, 24]. The third way of coal is pyrolysis in which coal is converted partly into liquid hydrocarbon and remining into gaseous hydrocarbon and coke. This liquid hydrocarbon is commonly known as "coal tar", which served as a starting material for lot of chemical and material development[25, 26]. After Germany, United States and Japan also embarked on all three different ways of coal liquefaction; direct, indirect and pyrolysis simultaneously. Unfortunately, the research exploration is this field started to cease as an enormous supply of petroleum was identified in Middle East in 1950. Currently, the only major liquefaction plants worldwide are operated by Sasol (syngas, indirect liquefaction) in South Africa and by Shenhua (direct liquefaction) in China[27].

To date, there has not been a critical demand to pursue coal-liquefaction technology in the United States. However, recent efforts both in the United States and globally to exploit the superior properties of advanced carbon materials have prompted AmeriCarbon to leverage prior liquefaction efforts with its own innovations to produce the key intermediate chemical linking carbon-rich coal to manufactured carbon products…coal tar pitch. In the past, the United States had significant coking ovens for steel making that also

produced coal tar pitch as a by-product. This was sufficient at the time, but two things have since changed that has caused a shortage in US coal-tar pitch supply:

- US-based coke ovens have largely closed due to loss of the US steel industry and environment challenges with the coke ovens;
- Rapid and projected exponential growth of the carbon-based materials industry

China has significant coke oven operations and currently supplies over 72% of the worlds pitch supply. AmeriCarbon has recognized this opportunity and is applying its 10-yr liquefaction background in coal-to-chemicals to demonstrate its innovative pilot-scale coal-to-pitch process…liquid coal pitch (LCP).

AmeriCarbon is on an aggressive path to commercialize this technology and is currently focused on completing research/development and optimizing the process to allow intentional pitch plants to be scaled for specific coals.

Please refer to the Project Summary section for additional background regarding the project and the associated technologies.

7. Qualifications

AmeriCarbon Team Members

AmeriCarbon has assembled a credentialed project team and has developed a portfolio of strategic alliances with innovative developers, research institutions, and industry partners. Its executives bring expertise in the technical subject matter of hydrocarbon conversion, advanced coal products, technology scaleup and commercialization, and business and project finance.

Our team contributes the following to the proposed project:

- Technical Expertise. The AmeriCarbon team is led by David Berry, who is serving as principal investigator for the project. Dave has numerous patents and patents pending through more than three decades of institutional research experience with the U.S. Department of Energy and U.S. Department of Defense that are focused on hydrocarbon conversion technologies. Dave has

extensive experience from the laboratory through the pilot-scale and has surrounded himself with world class researchers and innovative thinkers which have contributed to AmeriCarbon's unique technology. Dr. Chetan Tambe will serve as a senior researcher during the project. Dr. Tambe has a decade of experience in process design and development with a focus on hydrocarbon liquid processing. Mark Scafella will serve as senior chemical technician. Mr. Scafella constructed the AmeriCarbon LCP pilot facility and has 10 years operating experience in the facility conducting coal liquefaction to various fuels, chemicals and pitch.

- Scale Up Capability. AmeriCarbon's business executives have spent the majority of their decades-long careers working in the realm between laboratory scale research and industrial development. The skills required to commercialize technology through the pilot demonstration phase are invaluable and contribute to AmeriCarbon's special capabilities in technical innovation and application.
- Commercial Track Record. Implementing innovation at pilot and industrial scale requires experience in large commercial transactions and the ability to manage capital with discipline. These qualities are the hallmark of AmeriCarbon's financial and commercial team members, who have raised and managed several hundred million dollars in the energy and materials sectors. Greg Henthorn formally serves as AmeriCarbon's vice president of business development and will continue to lead these activities in addition to providing project management and business operations support for the project. Chad Green is the company's CFO and has been involved in several billion dollars in commercial finance, including private equity and public markets.

University of North Dakota Team Members

Project members from UND include the following:

- **Dr. Daba Gedafa** is the Chair and Michael & Sitney Lodoen Endowed Professor of Civil Engineering at the University of North Dakota. He has an extensive research experience with coal byproducts including bottom ash, slag, and fly ash for sustainable asphalt and concrete

infrastructure. He determined the amount of fly ash that can be used to replace asphalt binder and mineral fillers for sustainable asphalt pavements. He has also determined the optimum content of bottom ash and ground bottom ash with and without nano clay as a fine aggregate and cement replacement, respectively by comparing it to the compressive strength of cement-based concrete. Fresh properties, mechanical properties, and durability of optimum bottom ash and ground bottom ash-based concrete were determined. He also determined the maximum amount of cement that can be replaced by fly ash with and without nanomaterials while providing the equivalent or higher performance of concrete as compared to the control (cement-based concrete). He has published more than 70 peer-reviewed articles. He is a registered professional engineer, Envision Sustainability Professional, and a fellow of the American Society of Civil Engineers.

- **Dr. Xiaodong Hou,** Research Assistant Professor, is a material chemist at UND-IES with over 15 years of experience synthesizing and characterizing advanced functional materials. He has over 40 peer-reviewed publications in the field of chemistry materials and holds five patents. Dr. Hou has been directing multiple projects directly related to developing advanced electrode materials for LIBs. One of the technologies aimed at developing coal-derived carbon materials for composite electrode materials for LIBs has finished its pilot-scale test and is in the process of licensing.
- **Dr. Daniel Laudal**, Director of UND-IES, has 16 years of R&D leadership related to energy systems. Dr. Laudal is an expert in lignite organic/inorganic chemistry and utilization processes and has been working on projects related to lignite and carbon-based projects for most of his career. He was previously the project manager for Minnkota Power Cooperative's Project Tundra, a $ 1.5 billion world-scale CO_2 capture and storage project in ND. Dr. Laudal also served as the Environmental Manager for Minnkota and coordinated the project's complex legal, environmental, technical, and financial development. The proposed project will benefit from Dr. Laudal's extensive project management and development experience.

Barr Engineering

Barr Engineering is an industry-leading provider of engineering and environmental consulting services. Employee owned since 1966, Barr Engineering traces its origins to the early 1900s. Its engineers, scientists, and technical specialists help clients across North America and around the world benefit their communities by responsibly developing, managing, processing, and restoring natural resources. Key team members for this project include the following:

- **Ryan Rayda** has more than 15 years of experience providing structural engineering services for industrial, municipal, commercial, and public clients. He manages projects and designs structures related to power plants, mining and minerals processing facilities, pipelines, water treatment facilities, pumping stations, schools, hospitals, and commercial developments. Ryan also provides lifting and rigging design.
- **Dan Palo** has 25 years of experience with process design, plant improvement, project management, and research and development for processes that involve minerals, chemicals, fuels, and manufactured products. From research and development through scoping and prefeasibility studies to basic and detailed design, Dan's work spans the mining life cycle. He routinely helps clients to develop both greenfield and brownfield projects from full plant evaluations to the assessment and improvement of existing circuits.
- **Nicole Nguyen** has more than a decade of process engineering experience working with energy, fuels, and power clients. She has served as a lead process-design engineer, startup and commissioning field engineer, project manager, and instrumentation and controls engineer. Nicole has experience as project manager and task lead in detailed design for power projects as well as developing detailed cost estimates and performing budgetary feasibility studies for power, mining, and fuels projects. She has been involved with equipment procurement and selection, contract management, process and controls design, and commissioning.

Note: Detailed resumes from AmeriCarbon, UND, and Barr Engineering are included in Appendix 7-I.

8. Value to North Dakota

The proposed project will contribute to onshoring the supply chain of advanced carbon products – with current feedstock demand being largely met by China – and connect the dots all the way from raw materials (in the form of lignite coal) all the way to a finished product, reducing our nation's reliance on foreign suppliers to fuel growth in this strategic area. This economic activity can leverage North Dakota's rich and abundant supply of lignite by using it as a highly valuable raw material feedstock for value-added manufacturing.

The proposed project plays a necessary and critical role in the development of the McLean Plant. Upon breaking ground, the McLean Plant will have immediate, near term, and long-term impacts with respect to the creation of high wage employment for McLean County, North Dakota and the surrounding region. The facility is projected to create 40 high wage full time jobs when the facility opens, with growth to 70 jobs at full capacity. The created jobs will be manufacturing and engineering jobs with high wages and located in and near economically distressed regions. The company has entered into a Memorandum of Understanding regarding a Project Labor Agreement regarding the McLean Plant. AmeriCarbon is committed to workforce development as a major pillar of the company's activities in North Dakota.

The proposed project will enhance the use of North Dakota lignite coal by providing an alternative commercial use other than electricity. In the event that coal-fired electricity generation remains steady over time, this project could also lead to an opportunity to grow the coal industry and provide funds for increased research, jobs, and economic growth and development.

Products of the McLean Plant can be used to create electric vehicles parts and electrodes as well as to keep up with the growing demand for charging stations around the state. It can also lead to additional asphalt production that could extend beyond the state's borders. The McLean Plant will help to preserve existing coal jobs by ensuring demand for the product in case of an economic downturn in the coal industry. The proposed project will also lead to job growth in the coal sector due to the additional demand for lignite coal to be used for carbon pitch. Demand for advanced carbon products is growing annually and when

combined with the AmeriCarbon LCP process, the underlying opportunity is to convert a $50-150/ton resource into a $5,000-$25,000/ton product. Job growth can also come from the resurgence of domestic production of carbon pitch in the United States.

9. Management

From an organization/company point of view, AmeriCarbon will serve as the point organization and will manage the project, including all vendors and personnel who are performers under the project. From an individual perspective, David Berry will be the Principal Investigator and lead the project team.

The project will have a flat organizational structure reporting to a single authority, the Principal Investigator. This is intended to streamline project communication and decision making, facilitating the performance of the tasks and achievement of the objectives described in the proposal, including in the Statement of Project Objectives section in a timely and efficient manner, and in the timeframe outlined in the proposal.

The project team's flat organizational structure will allow for efficient and rapid response to questions and challenges that may arise in the performance of the project. Communication will occur largely via videoconferences and telephonic conferences on regularly scheduled and ad hoc bases throughout the project as needed. The principal investigator has considerable experience in managing teams in different locations, managing project scope, and ensuring technical direction without veering off track. This will provide a disciplined approach to project timelines and budgeting while avoiding scope creep challenges. The principal investigator will be responsive to incoming requests from NDIC and is prepared to schedule videoconferences, telephonic meetings, or in-person meetings as desired.

As noted in the attached resumes, which may be found in Appendix 7-1, the principal investigator has more than three decades of research experience, including the management of cross functional teams with diverse skills and competencies. All members of the team have considerable experience managing and performing in similar teams spanning multiple decades.

Risk Management Plan

AmeriCarbon continually identifies risks and challenges to the project, including financial, technical, performance, schedule, and regulatory compliance. Strategies for mitigating and managing these risks include developing contingency plans, conducting risk assessments, and implementing quality assurance and quality control measures. Regular communication and collaboration with stakeholders and team members is essential to keep everyone informed of progress and address any issues or concerns.

Table 1. Perceived Risks and Mitigation Strategies

Perceived Risk	Risk Rating			Mitigation/Response Strategy
	Probability	Impact	Overall	
	(Low, Med, High)			
Financial Risks:				
Vendors or supplies	Low	Med	Med	*Alternate suppliers.* Although the technology and research is at cutting edge, alternative vendors/suppliers have been identified for most equipment utilized and carbon processing companies.
Cost/Schedule Risks:				
Major equipment failure	Low	High	Med	*Alternate funding sources.* Pilot-scale facilities can be costly to repair. The majority of project equipment utilized on this project is comprised of multiple smaller components and often can be repaired or replaced in reasonable fashion. AmeriCarbon is sufficiently capitalized to have near-term ability to mitigate most facility failures of this nature.

10. Timetable

The proposed project is anticipated to take 18 months from project initiation. The following is a timeline Gantt chart with milestones, milestone table and suggested deliverables (higher resolution versions are found in Appendix 10-I):

			2023				2024			
Task	Task Title	Duration (Mo)	QTR 1	QTR 2	QTR 3	QTR 4	QTR 1	QTR 2	QTR 3	QTR 4
1	Engineering Feasibility Study	9								M1.2
2	Coal Feedstock Supply and Characterization	1				M2.1				
3	Asphalt - Experimental Prod Dev, Eval…Studies	18				M3.1		M3.2		
4	Graphite - Experimental Prod Dev, Eval…Studies	18							M4.1	
5	Technoeconomic Study	6								M5.1

The following are the deliverables and timeline:

Task	Milestone Title & Description	Planned Completion Date	Verification Method
1	M1.1 - Engineering Design Study	Project Completion	Topical Report
2	M2.1 - Coal Supply & Characterization	60 d after award	Shipped/Delivered
3	M3.1 - Initial Pitch Samples for Test	3 mo after award	Shipped/Delivered
3	M3.2 - Optimized Pitch Samples for Test	12 mo after award	Shipped/Delivered
4	M4.1 - Optimized Battery Grade Graphite Testing	14 mo after award	Final Report
5	M5.1 - Technoeconomic Results	Project Completion	Final Report

11. Budget

The project budget totals $1,400,000, with $700,000 being requested from NDIC, $20,000 in in-kind services provided by NACoal, $100,000 cost share provided by University of North Dakota, $14,000 in-kind services provided by Barr Engineering and $566,000 provided as in-kind services from AmeriCarbon. A detailed budget was prepared using the standard U.S. Department of Energy budgeting model. Key tables from the budget are included in Appendix 11-1.

12. Matching Funds

Support letters for matching funds are included in Appendix 12-1, including a cost share commitment of $20,000 from NACoal, $100,000 from University of North Dakota, $14,000 from Barr Engineering and $566,000 from AmeriCarbon, for a total cost share resulting in a combined cost share of $700,000, representing 50% of the budget.

13. Tax Liability

The applicant does not have any past due tax liability with the State of North Dakota. An affidavit is attached in Appendix 13-1.

14. Confidential Information

Not applicable.

15. References

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16. Appendices

Attached.

TECHNICAL REVIEWER RATINGS SUMMARY

LRC-102E: "Williston Basin CORE-CM Initiative - Continued Assessment"

Submitted by: UND Energy & EERC
Principal Investigator: John Kay
Project Duration: 16 months
Request for: $1,050,000
Total Project Costs: $2,100,000

Rating Category	Weighting Factor	Technical Reviewer Rating 33-10	33-11	33-12	Average Weighted Score
Objective	9	5	4	4	
Availability	9	4	5	4	
Methodology	7	5	4	4	
Contribution	7	4	4	4	
Awareness	5	4	3	4	
Background	5	5	4	4	
Project Management	2	5	4	3	
Equipment Purchase	2	5	5	3	
Facilities	2	5	5	5	
Budget	2	4	3	5	
Average Weighted Score:		227	206	200	**211**

Maximum Weighted Score:	250

OVERALL RECOMMENDATION:

FUND		**X**	**X**	**X**	
FUNDING MAY BE CONSIDERED					
DO NOT FUND					

TECHNICAL REVIEWERS' COMMENTS

1. **OBJECTIVES**

The objectives or goals of the proposed project with respect to clarity and consistency with North Dakota Industrial Commission/Lignite Research Council goals are: 1 – very unclear; 2 – unclear; 3 – clear; 4 – very clear; or 5 – exceptionally clear.

Reviewer 33-10 (Rating: 5) *The proposed work has as its goal to collect information that will help define the potential for a new industry in North Dakota that is based on Rare earth Element and Critical Minerals from lignite and associated materials. This is consistent with the goals of the ND Industrial Commission/Lignite Research Council.*

Reviewer 33-11 (Rating: 4) *The proposal aligns with goals to preserve existing jobs, create new jobs, develop baseline information, and seek partnerships and marketing strategies.*

Reviewer 33-12 (Rating: 4) *An ongoing effort of the DOE, NDIC (LRDMP), and coal mine partners to identify areas of potential for development of a new industry that will produce REE's, CM's, and CBP's from lignite and its ash. 1st phase of a proposed three phase investigation.*

2. **ACHIEVABILITY**

With the approach suggested and time and budget available, the objectives are: 1 – not achievable; 2 – possibly achievable; 3 – likely achievable; 4 – most likely achievable; or 5 – certainly achievable.

Reviewer 33-10 (Rating: 4) *This reviewer believes that the approach, time and budget suggested can reasonably be expected to result in achieving the objectives noted. The previous experience of the assembled team supports this observation.*

Reviewer 33-11 (Rating: 5) *This extension of the initial Phase I proposal seems achievable.*

Reviewer 33-12 (Rating: 4) *A 16-month Phase 1, expected to begin June '23, is expected to cost $2,100,000. "Timeline detail will develop as the project evolves"!*

3. **METHODOLOGY**

The quality of the methodology displayed in the proposal is: 1 – well below average; 2 – below average; 3 – average; 4 – above average; or 5 – well above average.

Reviewer 33-10 (Rating: 5) *Reviewing the approach noted and the success of this organization in successfully completing similar activities I fully expect a successful outcome.*

Reviewer 33-11 (Rating: 4) *The proposal does a nice job of describing the deliverables/plans to be developed and breaking down the identified tasks.*

Reviewer 33-12 (Rating: 4) *This Phase will involve data compilation, analysis, dissemination, and characterization of coal and ash samples. Waste streams will be evaluated for reuse and stakeholder outreach is also planned. Methodology was given in "Standards of Success" and specific tasks as well as responsible Task leader provided.*

4. **CONTRIBUTION**

The scientific and/or technical contribution of the proposed work to specifically address North Dakota Industrial Commission/Lignite Research Council goals will likely be: 1 – extremely small; 2 – small; 3 – significant; 4 – very significant; or 5 – extremely significant.

Reviewer 33-10 (Rating: 4) *Successful completion of the proposed work offers significant value to the state of ND and is consistent with the stated goals of the NDIC/LRC. The ND lignite industry is facing significant challenges and the opportunity represented by rare earth elements is very significant both for the state and the nation.*

Reviewer 33-11 (Rating: 4) *Work to identify additional partners, infrastructure and supply chain gaps, technology evaluation, and further resource characterization will provide baseline information on which a potential REE-CM industry in the region will rely.*

Reviewer 33-12 (Rating: 4) *There is a potential for very significant economic benefit to North Dakota and additional use of the lignite resource if significant REE, CM, and CBP's are found in the carbon ore, ash, and waste streams. The proposal states "$500M/year in state taxes based on excise tax alone". In addition, dependence on foreign suppliers, primarily China, for these materials decreases and lignite industry jobs will be saved. (those dollars were not provided).*

5. **AWARENESS**

The principal investigator's awareness of other current research activity and published literature as evidenced by literature referenced and its interpretation and by the reference to unpublished research related to the proposal is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Reviewer 33-10 (Rating: 4) *The PI and the assembled team are very aware of current research activities in this area.*

Reviewer 33-11 (Rating: 3) *I did not see references in the proposal, but assume the awareness of current research activity to be adequate at minimum.*

Reviewer 33-12 (Rating: 4) *Mr. John Kay, EERC Principal Engineer, has over 28 years of coal research experience and project management. He has led the development of advanced analytical techniques for coal characterization. He was also project manager for the Plains CO2 Capture (PCO2C) Program.*

6. **BACKGROUND**

The background of the investigator(s) as related to the proposed work is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Reviewer 33-10 (Rating: 5) *The assembled team is extremely well qualified to the complete the proposed work. Their success in completing similar activities in support of development*

projects leading to new opportunities in ND is proof of the quality of the proposed team of experts.

Reviewer 33-11 (Rating: 4) *A fine group of qualified professionals.*

Reviewer 33-12 (Rating: 4) *Names were provided for several Tasks from either EERC or UND analytical departments. All with coal characterization and sampling experience and primarily North Dakota based. Notwithstanding, EERC has extensive experience in understanding, sampling, characterization, analysis, and processing lignite for many applications since the 1950's. 30 partners were provided in a list with proposed task responsibilities given.*

7. **PROJECT MANAGEMENT**

The project management plan, including a well-defined milestone chart, schedule, financial plan, and plan for communications among the parties involved in the project, is: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – very good; or 5 – exceptionally good.

Reviewer 33-10 (Rating: 5) *The proposal included a well-defined set of milestones and financial plan. In addition, they have outlined how they will assure communication of the results to stakeholders within the state.*

Reviewer 33-11 (Rating: 4) *No comment*

Reviewer 33-12 (Rating: 3) *The management plan, financial plan, and communications plan were all provided. The schedule shown is "preliminary" with "additional timetable detail…developed as the program evolves". Task's were listed on the schedule along with the preliminary timeline. Meetings were mentioned to provide updates to all stakeholders.*

8. **EQUIPMENT PURCHASE**

The proposed purchase of equipment is: 1 – extremely poorly justified; 2 – poorly justified; 3 – justified; 4 – well justified; or 5 – extremely well justified. (Circle 5 if no equipment is to be purchased.)

Reviewer 33-10 (Rating: 5) *No equipment will be purchased.*

Reviewer 33-11 (Rating: 5) *No equipment is to be purchased.*

Reviewer 33-12 (Rating: 3) *The Budget Breakdown table mentions Supplies, Printing & Duplicating, Food, Rents & Leases, and Field Driller Fee (TBD).*

9. **FACILITIES**

The facilities and equipment available and to be purchased for the proposed research are: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – notably good; or 5 – exceptionally good.

Reviewer 33-10 (Rating: 5) *The facilities noted for completion of the project are world class.*

Reviewer 33-11 (Rating: 5) *The team members provide excellent facilities and equipment.*

Reviewer 33-12 (Rating: 5) *EERC has eight laboratories and extensive analytical capability as previously stated. UND laboratory has also extensive experience with North Dakota lignite and advanced spectrometers. Over 2400 samples have been previously analyzed for REE content.*

10. **BUDGET**

The proposed budget value relative to the outlined work and the financial commitment from other sources is of: 1 – very low value; 2 – low value; 3 – average value; 4 – high value; or 5 – very high value.

Reviewer 33-10 (Rating: 4) *The proposed work will result in critical information for the lignite industry as if works to expand the opportunities for new revenue streams to meet the challenges it currently faces. Diversifying the revenue streams from this resource is critical to its continued viability. The proposed budget meets the requirement for "at least a 50/50 match with non-state dollars.*

Reviewer 33-11 (Rating: 3) *Request of $1,050,000. DOE providing $500,000. $550,000 in-kind cost share from industry partners. The combined federal and private industry investment matches the request of funding from the lignite research fund.*

Reviewer 33-12 (Rating: 5) *There is a potential for many millions of dollars of revenue from REE, CM, CBP extraction from lignite and its waste streams if found to be in significant quantity. And, as previously stated, reliance of foreign countries to provide them versus this domestic supply would be significant. That and retaining North Dakota lignite industry jobs is indeed valuable.*

OVERALL COMMENTS AND RECOMMENDATIONS:

Please comment in a general way about the merits and flaws of the proposed project and make a recommendation whether or not to fund.

Reviewer 33-10 (Rating: FUND) *The proposed work will meet a critical need for the long term viability of ND's lignite industry. By focusing on uses and revenue streams not currently available with the ND lignite resources the state could see very significant growth in tax revenue and employment opportunities. In addition, the work identifies a unique opportunity of the state to provide for a domestic source of minerals of critical importance to the US that are currently provided by unfriendly sources, namely China.*

This reviewer strongly supports funding of this critical project.

Reviewer 33-11 (Rating: FUND) *The studying of North Dakota's lignite potential as a source for REE-CM is ahead of that from most of the other coal producing regions of the United States. It is important to continue building upon the planning, strategies, partnerships, technologies, and infrastructure needs to support the new industry, and strengthen our existing mining operations.*

The proposal states the additional funds and time extension from the DOE arose because of the recognition that much of the data throughout the US was not collected using modern methods of evaluation and analysis. I would like to see the DOE's criteria for modern methods.

I recommend funding the proposal.

Reviewer 33-12 (Rating: FUND) *Development of an additional business and use for the extensive North Dakota lignite industry is significant and so is reducing foreign dependence. In addition, leveraging the $500,000 DOE or Federal commitment is also significant. A good team of 30 different stakeholders and contractors was provided. North Dakota is providing the bulk of the financial support but does have the potential to reap significant financial benefit! On page 22 a comment was made that if less funding is available, changes to the scope can be considered. I suggest a discussion about that be completed as to what those changes are since the ND commitment is quite significant for this single phase. Also, curious what has been learned from the 2400 previous samples? What specifically is the predicted potential from those previous samples? Recommend funding after the discussion on how the budget might be curbed is resolved.*

Energy & Environmental Research Center
15 North 23rd Street, Stop 9018 • Grand Forks, ND 58202-9018 • P. 701.777.5000 • F. 701.777.5181
www.undeerc.org

March 31, 2023

Mr. Reice Haase
Deputy Executive Director
ATTN: Lignite Research Program
North Dakota Industrial Commission
600 East Boulevard Avenue
State Capitol, 14th Floor
Bismarck, ND 58505-0840

Dear Mr. Haase:

Subject: EERC Proposal No. 2023-0144 Entitled "Williston Basin CORE-CM Initiative – Continued Assessment"

The Energy & Environmental Research Center (EERC) of the University of North Dakota is pleased to submit the subject proposal. The ACH transaction number is 252060 for the $100 application fee. The EERC is committed to completing the project as described in the proposal if the Commission makes the requested grant.

If you have any questions, please contact me by telephone at (701) 777-4580 or by email at jkay@undeerc.org.

Sincerely,

DocuSigned by:
John Kay
6E1D21EBB3594A6...
John P. Kay
Principal Engineer Emissions
and Carbon Capture

Approved by:

DocuSigned by:
Tami Votava
E7468BBB3DE440E...
Charles D. Gorecki, CEO
Energy & Environmental Research Center

JPK/bjr

Attachment

Lignite Research, Development and Marketing Program

North Dakota Industrial Commission

Application

Project Title: Williston Basin CORE-CM Initiative – Continued Assessment

Applicant: University of North Dakota Energy & Environmental Research Center

Principal Investigator: John P. Kay

Date of Application: April 1, 2023

Amount of Request: $1,050,000

Total Amount of Proposed Project: $2,100,000

Duration of Project: 16 months

Point of Contact (POC): John P. Kay

POC Telephone: (701) 777-4580

POC Email: jkay@undeerc.org

POC Address: 15 North 23rd Street, Stop 9018
Grand Forks, ND 58202-9018

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ABSTRACT

The University of North Dakota (UND) Energy & Environmental Research Center (EERC) is continuing to lay the foundation for a new industry in the Williston Basin focused on producing rare-earth elements (REEs), critical minerals (CMs), and nonfuel carbon-based products (CBPs) from Williston Basin coals. This has been an ongoing effort since October 2021, with the U.S. Department of Energy (DOE) award of the "Williston Basin CORE-CM Initiative," also supported by the North Dakota Industrial Commission (NDIC) Lignite Research, Development and Marketing Program (LRDMP). DOE will be providing an additional $500,000 to the program for continued characterization of carbon ore, ash, and waste streams within the basin, expected to be in place by June 1, 2023, along with project partners BNI Energy (BNI) and North American Coal Company (NACCO) providing $500,000 and $50,000 in-kind cost share, respectively. **Objective:** The goal of the additional funding is to collect current, field-derived data through sampling and identifying areas that show potential for the development of a new industry as well as drive the expansion and transformation of the existing coal and coal-based resources industry in the Williston Basin to produce REEs, CMs, and CBPs. **Expected Results:** This program is the first phase of an expected DOE-funded three-phase effort. Phase 1 is focused on gathering and assessing data for REEs, CMs, and CBPs in the Williston Basin and identifying gaps and developing strategies necessary to move forward with demonstrations along the entire supply chain.

Duration: 16 months (June 1, 2023 – September 30, 2024)

Total Project Cost: The total value of this continued effort is $2,100,000. The proposal requests a total of $1,050,000 from NDIC LRDMP. DOE will provide $500,000. Project partners BNI and NACCO will provide $500,000 and $50,000 of in-kind costs share, respectively.

Participants: DOE, NDIC LRDMP, BNI, and NACCO, along with continued input from the original coalition of nearly 30 partners, formed under the formation of the program in 2021.

PROJECT SUMMARY

Through the creation of the Williston Basin CORE-CM (carbon ore, rare earth, and critical minerals) Initiative in 2021, the University of North Dakota (UND) Energy & Environmental Research Center (EERC) formed and continues to lead a diverse and experienced coalition team of nearly 30 partners, encompassing all value chain segments, focused on laying the foundation for a new industry for the Williston Basin and expanding the use of coal and coal-based products to produce rare-earth elements (REEs), critical minerals (CMs), and nonfuel carbon-based projects (CBPs) in the Williston Basin. REEs have become a critical topic within the United States as they are used extensively in modern electronics, batteries, and other materials, with the majority of REEs being imported from China. The Williston Basin is centered in western North Dakota with portions reaching into South Dakota, Montana, and Canada. The primary development to date of Williston Basin lignite coal has been in North Dakota, with the coal resources being used by a series of power facilities for electricity generation.

This effort is the first phase of an expected much larger program as defined by the U.S. Department of Energy (DOE). As shown in Figure 1, the first phase is intended to lay the foundation by assembling the existing information, identifying information gaps, developing strategies to move the opportunity forward, and initiating outreach. Phase 2 will focus on filling any remaining information gaps and initiating the overall strategy developed in Phase 1. Phase 3 will implement the outlined strategy developed in Phases 1 and 2, launching the development of the new industry within the Williston Basin. The federal funding expected for each phase is also shown in Figure 1. The coalition team has extensive experience and expertise in lignite coal, REE and CM analysis, REE and CM extraction and enrichment, and developing nonfuel CBPs. Additionally, the EERC has a long history of bringing together regional and national stakeholders to tackle critical and complex topics, involving large

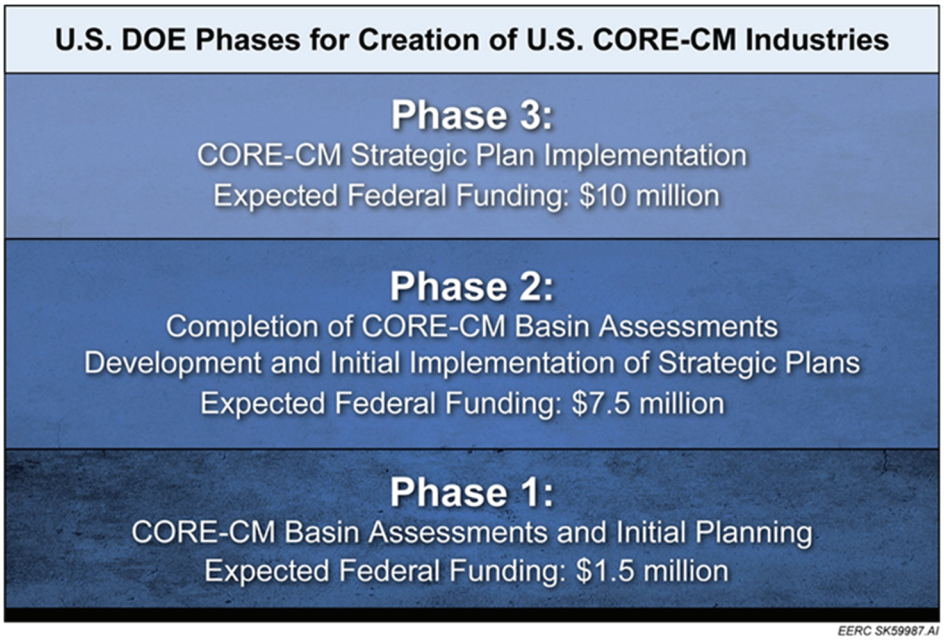


Figure 1. DOE phases for creation of the U.S. CORE-CM industries.

partnerships in the Williston Basin. The coalition team includes research organizations, state entities, coal producers, mineral processers, business and financial partners, end users, policy experts, and more to guide future opportunities in the Williston Basin.

At the onset of this program, one of the Williston Basin CORE-CM Initiative's goal was to compile existing data and information on REE and CM content within the Williston Basin, identifying gaps and developing plans to drive future DOE phases. However, through this exercise, DOE has recognized that much of the existing data throughout the United States was not collected using modern methods of evaluation and analysis, calling into question its accuracy. Therefore, for all 13 existing CORE-CM programs, DOE is providing additional funds and time extension to collect new samples and analyze them for REE and CM content. Building upon the opportunity, the Williston Basin CORE-CM Initiative desires to expand upon the original goals of the DOE CORE-CM program by 1) further assessment of the Williston Basin resource for coal and waste streams; 2) providing an additional business development assessment; and 3) continuing stakeholder engagement.

PROJECT DESCRIPTION

The EERC will continue to lead the diverse and experienced coalition team of nearly 30 partners, encompassing all segments of the REE/CM/CBP value chain, focused on laying the foundation for a new industry in the Williston Basin by expanding and transforming the use of coal and coal-based resources to produce REEs, CMs, and nonfuel CBPs. The Williston Basin CORE-CM Initiative has harnessed coalition team experience and Williston Basin resources and infrastructure to begin the development of a new industry that will catalyze economic growth and job creation in the region and enhance national and economic security as well as support the existing coal and coal-based resource industry. The proposed work constitutes additional focus on aspects of the first phase of a long-term program to enhance and transform the use of coal and coal-based resources within the Williston Basin.

Objectives: The goal of the updated project remains the same, which is to set the stage for future expansion and transformation of coal and coal-based resource utilization within the Williston Basin to produce REEs, CMs, and nonfuel CBPs. The objectives have been updated to 1) generate new information for resource characterization and waste streams, with a focus on BNI Energy (BNI) mine property; 2) enhance existing business development conducted under the original program, focusing on job creation and specifics of supply chain potential; and 3) continue stakeholder engagement through informative webinars, and provide annual in-person meetings to expand upon the highly successful Critical & Rare-Earth Elements Symposium, held on October 11, 2022.

Methodology: Building upon this opportunity, the Williston Basin CORE-CM Initiative wants to expand upon the characterization of BNI mining operations, continued collaboration with exploration being performed by the North Dakota Geological Survey (NDGS), provide more examination of fly ash as a potential source of REEs and CMs, and continue to develop plans that will drive future phases of REE/CM/CBP development within the Williston Basin. The Williston Basin CORE-CM Initiative has been

performing work through seven tasks. The continued work under this proposal will be conducted under several subtasks, denoted by italics.

Task 1.0 – Project Management, Planning, and Reporting. The EERC manages and directs the project in accordance with the scope of work to meet all technical, schedule, and budget objectives and requirements. Interim and final reports summarize the activities of the project and include key findings, results, and lessons learned. *Additional information gathered will be included in an additional interim report and the final reports. The project team will also be participating in DOE-led Working Groups. The intent of the Working Groups is to share lessons learned across all DOE project awardees as well as aid in the development of best practices manuals.*

Task 2.0 – Assessment of CORE-CM Resources. Existing Williston Basin REE and CM data are being compiled and coupled with detailed stratigraphic data. Machine learning algorithms are being applied to identify correlations between REE and CM occurrence and stratigraphy within the Williston Basin. *Using continued funding, additional sampling will be conducted to gather new samples across the basin to further refine REE and CM occurrence and to assist BNI and North American Coal Company (NACCO) with insight into the potential for their resources to be an economic source for REEs and CMs. Throughout 2023 and 2024, BNI and NACCO will be evaluating their minable resources for upcoming production. Drill core samples from these assessments will be provided to the project for analytical analysis for REE and CM content. It is expected that BNI will select between 30–60 drill cores for this assessment. Additionally, in conjunction with NDGS and based upon its guidance, additional drill core will be obtained and analyzed from locations in western North Dakota and around the current mines in North Dakota to further clarify REE and CM concentrations at selected sites. It is expected to obtain roughly 18–24 drill cores under this continued effort.* This information is being used to develop an initial geologic information system (GIS)-based geologic model, identifying data gaps and helping target promising locations for additional sample collection and analysis in a future project phase.

***Task 2.1 – Data Survey and Acquisition*.** Existing REE and CM characterization data throughout the Williston Basin are being collected and compiled from the following material types: 1) coal (lignite) beds, leonardite deposits, and sedimentary layers associated with coal beds; 2) coal combustion products (CCPs); 3) coal mine refuse; 4) coal-related acid mine drainage (where present); and 5) other materials including shale deposits, gasifier char material, and oil and gas produced water. The data are being compiled into a database format conducive to developing the geologic model (as discussed in Subtask 2.2) and conducting machine learning analyses, which will help in targeting promising formations. *Results from additional drill cores will be included in this subtask.*

***Task 2.2 – Geologic Model Development*.** A GIS-based geologic model of the coal-bearing Williston Basin strata is being constructed using available data, including stratigraphic sequence information from the North Dakota Industrial Commission (NDIC) and National Coal Resources Data System (NCRDS) and data compiled in Subtask 2.1 (*including additional drill cores*). The geologic model is being constructed to leverage its use in predicting REE and CM resources in future phases.

***Task 2.3 – Identification of Data Gaps*.** Data gaps are being assessed to identify what key CM species are missing from the existing characterization data. CM species are targeted or excluded based on the various parent resource materials in the Williston Basin. The gap analysis results will be used to target additional coal, coal-related sediment, and CCP locations for sampling and for specific CM analyses.

***Task 2.4 – Development of R&D Plan to Fill Data Gaps*.** The results of the data gap assessment will be used to develop a characterization and data acquisition plan for sampling efforts in a future phase. Whereas the data gap analysis is based heavily on geologic factors that are likely to influence the occurrence of CMs in certain parent material types, the research and development (R&D) plan will rely on the results generated in Task 5.0 and include factors such as the practical, logistical, and/or economic potential of the parent material to be mined and/or collected as well as the potential extractability of the CMs from the parent material. These data will be provided in the initial basinal resource assessment.

Task 3.0 – Assessment for Reuse of Waste Streams. The coalition team is working with federal, state, and local entities to identify potential waste streams available and appropriate for reuse in developing the Williston Basin production of REEs, CMs, and nonfuel CBPs. A preliminary waste stream reuse plan is being developed through the following subtasks.

Task 3.1 – Identification of Federal, State, and Local Partners. The coalition team is contacting and working with multiple agencies at the federal, state, and local level to acquire the necessary information. Discussions focus on ensuring accessibility of the relevant information and, where appropriate, that it is able to be cross-referenced to other source data. The agencies contacted include project partners as well as other entities.

Task 3.2 – Compilation of Data Sets. A database of resources that may be available in each state for use in advancing technologies for REEs, CMs, and CBPs is being compiled. The database will be searchable and include waste stream identification (chemical and physical), potential use in respective technologies, volume of waste, associated costs, regulatory issues, location, and enabling technologies to bring to commercialization as well as other information to evaluate the materials' potential.

Task 3.3 – Identification of Data Gaps. Once the potential waste streams are identified and compiled into a searchable database, an analysis of the potential waste streams that could be processed with technologies aimed at REE, CM, and CBP production within the basin will be performed. Data gaps will be identified where adequate characterization and/or quantification of the waste streams is not available as well as where technology performance for extraction/recovery is not understood. From this initial assessment, a hierarchy of best potential waste streams will be developed. Limited chemical analyses on minimal samples may be required to assist in verifying cost and process validity.

Task 3.4 – Development of R&D Plan to Fill Data Gaps. Based on the data gaps identified, a plan will be developed to characterize and quantify waste streams where current information is not adequate. This

may include laboratory and small-scale pilot testing where appropriate. Results of this subtask will be presented in the initial waste stream reuse plan.

Task 4.0 – Strategies for Infrastructure, Industries, and Business. The current infrastructure and businesses that could support a new REE, CM, and CBP industry in the Williston Basin are being identified and a high-level economic impact and a critical industry gap analysis conducted. This task is focused on examining all the links necessary in a complete supply chain to support the development of this industry.

Task 4.1 – Identification of Existing Basinal Infrastructure. Any limitations in the capacity of the existing infrastructure are being identified. The region's infrastructure (roads, rail, industries), abundant natural resources (mining, natural gas), and history of exporting both raw and refined commodities are being catalogued and assessed for their potential to support the development of carbon-based minerals and REEs. Development of tight oil production in the Bakken provides additional insight and bolsters existing basinal infrastructure.

Task 4.2 – Identification of Businesses/Industries. Existing and potential businesses/industries that may use CMs as well as those industries that may provide extraction and enrichment capabilities are being identified. Potential strategic partners, resource customers, and specific end-use purchasers of materials generated in this region are being identified. *Additional discussion to refine potential businesses will be conducted as analytical results from Task 2.0 clarify potential within the Williston Basin.*

Task 4.3 – Analysis of Value Chain Segments. The results of the prior subtasks are being compiled, along with a high-level analysis of all the existing and potential components along the entire value chain from mining to end-product utilization. The analysis includes the availability of infrastructure, industries, regulatory environment, financial institutions, markets, and more. *A key question remaining from the current funding will be further investigated: what value chain segments are most probable in the near and long term for the basin? Unlike other industries that begin with extraction from the ground, there is*

minimal required geographic concentration of activities. In such a situation, North Dakota could look to insert itself into the value chain at any or, potentially, all stages. There are several factors, typical to most economic development discussions in North Dakota and elsewhere, creating headwinds for this activity:

1) *Labor force availability*
2) *Investment capital*
3) *Regulatory hurdles*

Task 4.4 – Infrastructure and Supply Chain Gap Identification. Gaps identified in infrastructure and supply chains that have become evident during assessments made in previous subtasks are being compiled into the results of the basinal strategies for infrastructure, industries, and business assessment. Discussions with potential customers and the economic assessment identify locations/markets/needs and distances from potential resources in the Williston Basin. An analysis of data gaps will then be completed. *Additional analysis developing job creation potential within the Williston Basin will be conducted under this proposal. Additional conversation will also take place with potential users identified with previous funding.*

Task 5.0 – Technology Assessment, Development, and Field Testing. This task focuses on technology assessment and identification of suitability criteria for each technology class for further field testing/demonstration, if needed.

Task 5.1 – Technology Discovery. Technology assessment efforts begin with a technology discovery phase where a combination of literature review and a request for information to technology providers will be used to gather many potential REE, CM, and CBP technologies for evaluation. These efforts will not be selective to feedstock type. Specific items of information required from each technology include 1) feedstock requirements and target products, 2) current state of the technology and scale and intellectual property holder (if any), 3) flow diagram of the process with estimated flow rates and/or

economic landscape of the technology, and 4) intended usage/deployment mechanism for the technology (small modular plants, large centralized). These technology descriptions will be fed into a sortable database.

Task 5.2 – Technology Evaluation – Current State of the Technology. Technology assessment is occurring by determining/aggregating technology performance information, current state of development, feedstock applicability for the technologies, and available economics. Additional performance assessments are being developed using Aspen Plus, METSIM, and engineering costing methods for each process as available, and a cost-to-utilize for each resource is being developed. This is aimed to take the form of a GIS-based modeling algorithm for cost to extract/utilize a resource and is overlaid among the REE, CM, and CBP data generated in Tasks 2.0 and 3.0.

***Task 5.3 – Technology Assessment, Development, and Field-Testing Plan*.** Using the technologies identified in Subtask 5.2, an initial technology assessment, development, and field-testing plan will be created for future phases. This plan will identify areas within the basin accessible for testing and identify suitably based feedstocks for technology validation.

Task 6.0 – Technology Innovation Centers. A detailed and comprehensive plan to create a technology innovation center (TIC) for the Williston Basin is being developed. A TIC is intended to bring together industry, regulators, technology developers, and others to help accelerate the development of the industry as a whole. We anticipate creating one or more TICs based on the outcomes of information gaps identified in Task 2.0, the technology needs related to waste streams in Task 3.0, supply chain in Task 4.0, technology commercialization in Task 5.0, and education and outreach in Task 7.0.

Task 6.1 – Identify Potential TIC Areas. Based on the preliminary results from Tasks 2.0–5.0, key topics that would benefit from the creation of a TIC are being identified (such as a TIC around ore refinement and purification).

Task 6.2 – Creation of TIC Plans. Based on the identified TIC areas, plans are being developed to create the public–private partnership. This effort is led by the EERC, with support from a smaller core group of advisors relevant to the TIC area(s). The initial technology innovation center plan will include the TIC organizational structure, governance, and prospective participants.

Task 7.0 – Stakeholder Education and Outreach. Education and outreach activities inform and educate CORE-CM stakeholders of project learnings through regular correspondence and meetings. Stakeholders include current coalition team members; potential future members of the coalition team; and other interested parties including legislators, entrepreneurs, general public, and others. These activities facilitate knowledge sharing and support for program goals.

Task 7.1 – Stakeholder Identification and Engagement. Stakeholders with interest in the activities and assets of the Williston Basin across economic, governmental, and academic sectors are being identified and engaged. This includes seeking out existing resources and synergies with other R&D projects that are relevant to the CORE-CM Initiative and potential partners integral to the education and training of technicians; middle-skills workers; and science, technology, engineering, and math (STEM) professionals. One stakeholder engagement meeting was held to launch the effort and provide initial networking opportunities.

Task 7.2 – Stakeholder Education and Outreach Plan Development. An outreach and education plan is being developed to support CORE-CM economic development activities. The plan incorporates best practices from previous EERC research projects to identify target audiences, articulate messaging, define materials, delineate engagement strategies, and establish a process to track and gauge outreach effectiveness. The initial stakeholder outreach and education plan lays the groundwork for workforce training and education for technicians, middle-skills workers, and STEM professionals.

Task 7.3 – Initial Plan Implementation. Key outreach materials are being developed and deployed to encourage audience understanding and engagement. An informative website and engaging documents

describe the CORE-CM Initiative and explain what REEs, CMs, and CBPs are, their significance to national security and economy, and more. A project-focused event booth and single-page fact sheets have been used at targeted meetings and regional networking events to describe the initiative's key aspects to stakeholders and potential partners. *To date, three webinars have been conducted to inform stakeholders and the general public on topics as explained above. Under this proposal, additional webinars targeted toward topics relevant to concerns in developing REE and CM supply chain segments within the Williston Basin will be conducted. It is anticipated that an additional five webinars will be planned. On October 11, 2022, the Critical & Rare-Earth Elements Symposium was held in Bismarck, North Dakota to provide an in-person platform to meet and discuss REE and CM potential in the Williston Basin. It provided an opportunity for legislators, regulators, industry, researchers, and the general public to collaborate in an open forum. Under this proposal, the symposium would also be held in the fall of 2023 and in late summer of 2024 to disseminate data, information, and analysis collected under the CORE-CM Program.*

Anticipated Results: The Williston Basin CORE-CM Initiative will establish the foundation to develop a new industry as well as play a vital role in expanding and transforming the use of coal and coal-based resources within the Williston Basin. As the first phase of an anticipated three-phase program, this phase will create an overall strategy that comprises a series of discrete plans to guide the next steps of development. These plans include 1) an initial basinal assessment; 2) a characterization and data acquisition plan; 3) a waste stream reuse plan; 4) results of the basinal strategies for infrastructure, industries, and business assessment; 5) a technology assessment, development, and field-testing plan; 6) TIC plan(s); and 7) a stakeholder outreach and education plan.

Facilities: The EERC employs a multidisciplinary staff of about 275 and occupies a research complex consisting of 254,000 square feet of laboratories, fabrication facilities, technology demonstration

facilities, and offices. It has large meeting facilities as well as capabilities to host remote meetings if needed. The EERC houses eight laboratories with extensive analytical capabilities.

Resources: Collectively, the coalition team has significant experience characterizing potential CM resources in various Williston Basin deposits and/or waste streams. Over 2400 samples have been previously analyzed for REE content, and UND has laboratory equipment for analyzing additional samples, if needed, including an inductively coupled plasma (ICP)–optical emission spectrophotometer and an ICP–mass spectrometer.

Techniques to Be Used, Their Availability, and Capability: The techniques to be used and their capabilities are described in the methodology section. The CORE-CM Initiative will harness the knowledge of the diverse coalition team through collaboration, meetings, reports, etc., to assess the opportunity and solve technical and nontechnical challenges. The initiative will leverage existing REE data for resources and mining, processing, and upgrading technologies.

Environmental and Economic Impacts While Project Is Underway: The proposed scope of work will have minimal environmental impact. This effort consists primarily of data compilation, analysis, and dissemination by the EERC and coalition team members, with limited sample characterization and analysis at UND laboratories. Economic impacts will also be minimal during this project phase; however, as opportunities are identified, the CORE-CM Initiative has the potential to create large economic benefits to North Dakota and the Williston Basin region.

Ultimate Technological and Economic Impacts: The ultimate impacts of the proposed CORE-CM Initiative have the potential to be enormous, including expanded support for the existing coal industry as well as establishing a new North Dakota industry. The existing coal industry supports over 3600 direct jobs, provides over $70 million in state tax revenue, and has an overall economic impact of $1.8 billion. Supporting and strengthening the current lignite industry has the potential to save significant jobs and regional and state revenues, especially in the event of a future carbon tax or cases where other social or

economic impacts are felt. A future REE industry has the potential to provide significant revenue to the state through employment opportunities and state and regional excise and sales taxes. Based on Version 1.0.2 of the North Dakota energy sustainability model developed at the EERC, a fully developed REE industry itself could contribute $500 million per year in state taxes based on an excise tax alone.

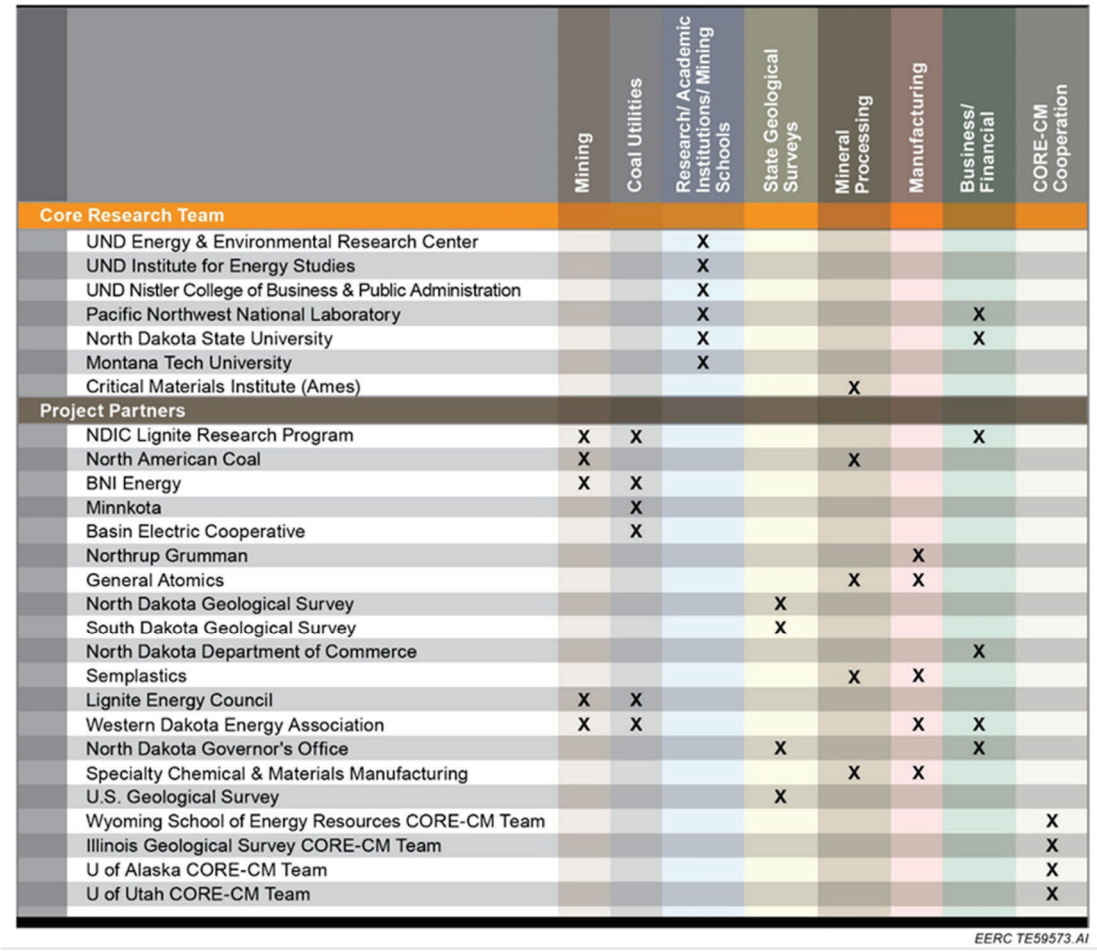
Why the Project Is Needed: The production of REEs is of critical importance to the national security of the United States. A REE industry, along with CMs and CBPs, would strengthen and support the existing North Dakota coal industry, provide an additional revenue stream and employer in North Dakota, and reduce the country's dependence on REE and CM imports.

STANDARDS OF SUCCESS

The success of this project will be measured by advancing to Phase 2 of the DOE program, resulting in further development of this opportunity in the Williston Basin. To accomplish this, we must successfully 1) acquire the information necessary for initial assessment, 2) identify information gaps, and 3) develop plans to drive the future opportunity forward. Products that together will create the overall strategy to move into Phase 2 include 1) the initial basinal assessment; 2) characterization and data acquisition plan; 3) waste stream reuse plan; 4) results of the basinal strategies for infrastructure, industries, and business assessment; 5) technology assessment, development, and field-testing plan; 6) TIC plan(s); and 7) stakeholder outreach and education plan. Information presented through discussions, webinars, and the symposium has already been successful in highlighting the potential of REEs and CMs within the Williston Basin.

BACKGROUND/QUALIFICIATIONS

The coalition team includes nearly 30 partners across all value chain segments, including over 70 years of experience in supporting coal development and utilization within the Williston Basin. A complete list of the coalition team members can be found in Figure 2, and letters of support are included in



	Mining	Coal Utilities	Research/ Academic Institutions/ Mining Schools	State Geological Surveys	Mineral Processing	Manufacturing	Business/ Financial	CORE-CM Cooperation
Core Research Team								
UND Energy & Environmental Research Center			X					
UND Institute for Energy Studies			X					
UND Nistler College of Business & Public Administration			X					
Pacific Northwest National Laboratory			X				X	
North Dakota State University			X				X	
Montana Tech University			X					
Critical Materials Institute (Ames)					X			
Project Partners								
NDIC Lignite Research Program	X	X					X	
North American Coal	X				X			
BNI Energy	X	X						
Minnkota		X						
Basin Electric Cooperative		X						
Northrup Grumman						X		
General Atomics					X	X		
North Dakota Geological Survey				X				
South Dakota Geological Survey				X				
North Dakota Department of Commerce							X	
Semplastics					X	X		
Lignite Energy Council	X	X						
Western Dakota Energy Association	X	X				X	X	
North Dakota Governor's Office				X			X	
Specialty Chemical & Materials Manufacturing					X	X		
U.S. Geological Survey				X				
Wyoming School of Energy Resources CORE-CM Team								X
Illinois Geological Survey CORE-CM Team								X
U of Alaska CORE-CM Team								X
U of Utah CORE-CM Team								X

EERC TE59573.AI

Figure 2. List of coalition team members.

Appendix A. The core research members of the coalition team will be responsible for the day-to-day research being performed. All of the partners will provide advisory guidance in the areas noted, and the following have also provided cash cost share: NDIC, NACCO, BNI, Minnkota Power Cooperative, and Basin Electric Power Cooperative. Under this proposal for additional funding, BNI is providing in-kind cost share and DOE is also providing funding.

John Kay, EERC Principal Engineer, serves as principal investigator (PI). Mr. Kay has over 28 years of experience in coal research and has extensive project management and leadership experience. He has led the development of advanced analytical techniques for coal characterization and was the project manager (PM) for the Partnership for Plains CO_2 Capture (PCO_2C) Program. Other key personnel were

chosen for their roles because they have successfully managed similar work. Key personnel are listed in Table 1, and resumes of key personnel are provided in Appendix B.

Table 1. Key Personnel Roles

Key Personnel	Role(s)	Key Personnel	Role(s)
John Kay	PI; Task 1	Nolan Theaker, UND Institute for Energy Studies (IES)	Task 5 colead
Todd Brasel	Task 2 lead	Charlene Crocker	Task 7 lead
Bruce Folkedahl	Tasks 3 and 7 lead and Task 5 colead	John Harju	Project advisor
Jason Laumb	Task 4 lead		

The EERC has extensive experience in understanding, sampling, characterizing, and processing lignite coal for a wide variety of applications. From the earliest existence of the EERC in the 1950s, a significant component of its work has been on Williston Basin lignite coal. More recently, the EERC has successfully led numerous programs that bring together regional stakeholders to advance new concepts. One of the most successful programs is the Plains CO_2 Reduction (PCOR) Partnership. Similar to the vision of the CORE-CM Initiative, the PCOR Partnership, over the course of 15+ years, has advanced the concept of carbon capture, utilization, and storage from a regional assessment to commercial demonstration (e.g., Project Tundra in North Dakota). The EERC has also led and/or participated in numerous projects within the last few years focused on REE/CM characterization, extraction, and concentration of REEs/CMs and the production of graphene and carbon-based building materials in conjunction with Semplastics.

UND IES has been conducting REE and CM extraction research from coal-based materials for 4 years and has been involved in conventional and novel processes ranging in scale from proof of concept to pilot demonstrations. IES has specific expertise in the available extraction mechanisms for REE from coal-based materials, specifically on the mode of occurrence within the material and identifying nontraditional ore bodies and/or associations. Additional support is provided by the following research

groups: Pacific Northwest National Laboratory, which will aid in technology evaluation in Task 5.0; UND Nistler College of Business & Public Administration and North Dakota State University (NDSU), which will assist with Task 4.0; Montana Tech University, which will support Tasks 2.0 and 5.0; and the Critical Materials Institute at Ames Laboratory, which will support Task 5.0. In addition to the members named above, the coalition team has an extensive group of cooperating partners and cost-share providers.

VALUE TO NORTH DAKOTA

Advancement of a REE industry from Williston Basin coal in North Dakota has the potential to support and strengthen the existing coal industry and develop a new industry in North Dakota, providing employment opportunities and regional and state revenues. This first phase of a longer-term effort will provide the basis to move forward and develop the strategy, further resulting in significant investment in the Williston Basin by DOE. As noted previously, this industry, fully developed, could provide $500 million in state tax revenues alone.

MANAGEMENT

The EERC manages over 200 contracts a year, with over 1330 clients in 53 countries. Systems are in place to ensure that projects are managed within budget, schedule, and scope. Mr. Kay will oversee the entire program, including integration of tasks, collaboration with stakeholders, and organization of meetings. The task leads are shown in Table 1. Regular meetings will be scheduled to provide updates on research activities and discuss the direction of future activities.

TIMETABLE

This effort is proposed as a 16-month program (June 1, 2023 – September 30, 2024). Figure 2 summarizes the preliminary program timetable. Additional timetable detail will be developed as the program evolves.

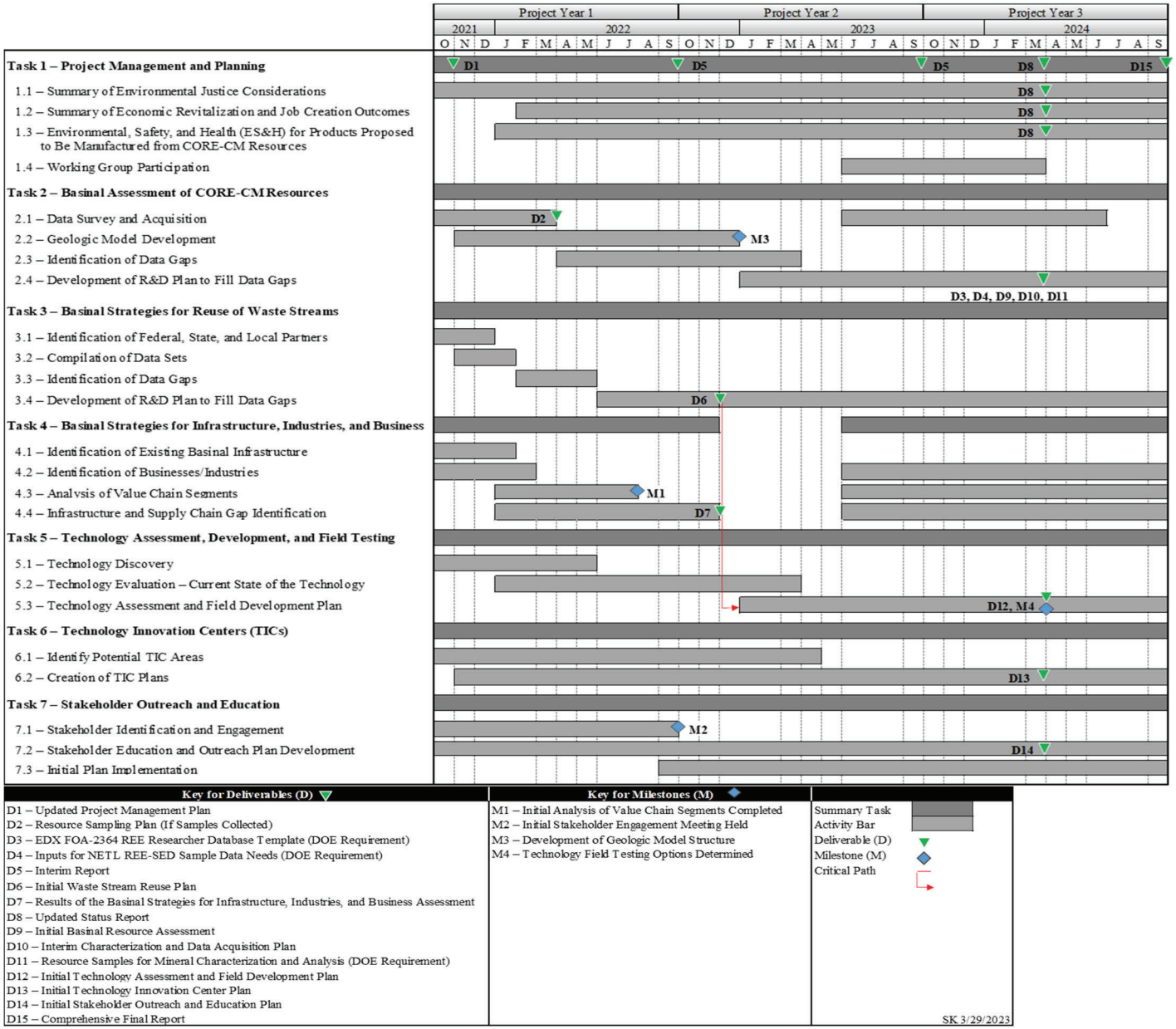


Figure 2. Preliminary timetable.

BUDGET AND MATCHING FUNDS

The estimated cost for the proposed effort is $2,100,000. The budget breakdown is given in Table 2. $1,050,000 of cash cost share is requested from NDIC's Lignite Research, Development and Marketing Program. BNI will provide in-kind cost-share funding in the amount of $500,000, with NACCO providing in-kind cost-share funding in the amount of $50,000. A letter of commitment for the cost share provided by BNI and NACCO can be found in Appendix A. Budget notes can be found in Appendix C. If less funding is available than requested, changes to the scope will be considered. $125,000 of this cash cost-share request will be used to match the existing DOE Williston Basin CORE-CM Initiative, which is planned to end March 31, 2024. Deliverables for this program at that time will be delivered to NDIC's Lignite Research, Development and Marketing Program as interim reports with a final comprehensive report at the end of the project, September 30, 2024.

Table 2. Budget Breakdown

Project Associated Expense	NDIC Share (Cash)	DOE Share (Cash)	Total Project
Labor	$172,000	$265,374	$437,374
Travel	$18,937	$18,360	$37,297
Supplies	$0	$500	$500
Subcontractor - NDSU	$20,000	$0	$20,000
Communications	$100	$100	$200
Printing & Duplicating	$119	$108	$227
Food	$10,620	$0	$10,620
Rents & Leases - Bismarck State College	$5,000	$0	$5,000
Fee - Field Driller (TBD)	$320,000	$0	$320,000
Laboratory Fees & Services			
Natural Materials Analytical Research Lab	$14,943	$1,600	$16,543
Analytical Research Lab	$124,851	$39,446	$164,297
Document Production Services	$8,841	$1,533	$10,374
Engineering Services Fee	$555	$2,914	$3,469
Outside Lab	$572	$1,191	$1,763
Total Direct Costs	$696,538	$331,126	$1,027,664
Facilities & Administration	$353,462	$168,874	$522,336
Total Cash Requested	**$1,050,000**	**$500,000**	**$1,550,000**
In-Kind Cost Share			
BNI Energy	$500,000	$0	$500,000
North American Coal	$50,000	$0	$50,000
Total In-Kind Cost Share	**$550,000**	**$0**	**$550,000**
Total Project Costs	**$1,600,000**	**$500,000**	**$2,100,000**

TAX LIABILITY

The EERC, a department within UND, is a state-controlled institution of higher education and is not a taxable entity; therefore, it has no tax liability to the state of North Dakota or any of its political subdivisions.

CONFIDENTIAL INFORMATION

This proposal has no confidential information.

TECHNICAL REVIEWER RATINGS SUMMARY

LRC-102F: "Assessment of Lignite-Based Industrial Residues for Value-Added Product Creation through CO_2 Mineralization"

Submitted by: UND
Principal Investigator: Johannes van der Watt
Project Duration: 24 months
Request for: $250,000
Total Project Costs: $1,250,000

Rating Category	Weighting Factor	Technical Reviewer Rating 33-13	33-14	33-15	Average Weighted Score
Objective	9	4	3	4	
Availability	9	4	4	4	
Methodology	7	4	4	4	
Contribution	7	4	3	4	
Awareness	5	4	3	4	
Background	5	5	4	5	
Project Management	2	4	3	4	
Equipment Purchase	2	5	5	5	
Facilities	2	5	3	5	
Budget	2	4	4	3	
Average Weighted Score:		209	177	207	**198**

Maximum Weighted Score:	250

OVERALL RECOMMENDATION:

FUND		**X**	**X**	**X**	
FUNDING MAY BE CONSIDERED					
DO NOT FUND					

TECHNICAL REVIEWERS' COMMENTS

1. **OBJECTIVES**

The objectives or goals of the proposed project with respect to clarity and consistency with North Dakota Industrial Commission/Lignite Research Council goals are: 1 – very unclear; 2 – unclear; 3 – clear; 4 – very clear; or 5 – exceptionally clear.

Reviewer 33-13 (Rating: 4) *The project aligns clearly with the goals to increase the sustainability of the industry and to find new and innovative ways to bring value to lignite generation and lignite by-products.*

Reviewer 33-14 (Rating: 3) *No comment*

Reviewer 33-15 (Rating: 4) *The goal of turning coal plant waste into a saleable product, while capturing some CO2, is certainly in line with the Council's goals. Reducing wastes and associated liabilities while producing new income streams is a win-win scenario.*

2. **ACHIEVABILITY**

With the approach suggested and time and budget available, the objectives are: 1 – not achievable; 2 – possibly achievable; 3 – likely achievable; 4 – most likely achievable; or 5 – certainly achievable.

Reviewer 33-13 (Rating: 4) *The budget seems more than adequate and the timeline is very realistic to perform the project tasks and reports*.

Reviewer 33-14 (Rating: 4) *This proposed cost shared work to a DOE award is a good investment.*

Reviewer 33-15 (Rating: 4) *The timeline and budgets appear to be adequate to achieve the stated objectives.*

3. **METHODOLOGY**

The quality of the methodology displayed in the proposal is: 1 – well below average; 2 – below average; 3 – average; 4 – above average; or 5 – well above average.

Reviewer 33-13 (Rating: 4) *Novel approach to several issues and detailed description of the methods.*

Reviewer 33-14 (Rating: 4) *Methodology is sound and what is needed to achieve project success.*

Reviewer 33-15 (Rating: 4) *The proposal sets out a solid plan and methodology.*

4. **CONTRIBUTION**

The scientific and/or technical contribution of the proposed work to specifically address North Dakota Industrial Commission/Lignite Research Council goals will likely be: 1 – extremely small; 2 – small; 3 – significant; 4 – very significant; or 5 – extremely significant.

Reviewer 33-13 (Rating: 4) *It will be more significant as time moves forward and future emissions controls and environmental issues challenge the industry*.

Reviewer 33-14 (Rating: 3) *Beneficiation is a desired goal of the NDIC/LRC and this proposed work has potential in this area.*

Reviewer 33-15 (Rating: 4) *If successful, the contribution of this project will definitely be a significant achievement in meeting NDIC's goals. The project could solve problems for the coal-fired power plants in North Dakota while creating new economics.*

5. **AWARENESS**

The principal investigator's awareness of other current research activity and published literature as evidenced by literature referenced and its interpretation and by the reference to unpublished research related to the proposal is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Reviewer 33-13 (Rating: 4) *Excellent knowledge of the current research and thorough list of the literature.*

Reviewer 33-14 (Rating: 3) *No comment*

Reviewer 33-15 (Rating: 4) *The PI has a worldclass team that is very knowledgeable and well versed on the literature and research related to the proposal.*

6. **BACKGROUND**

The background of the investigator(s) as related to the proposed work is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Reviewer 33-13 (Rating: 5) *Superb*

Reviewer 33-14 (Rating: 4) *The background of the project team is known in this area.*

Reviewer 33-15 (Rating: 5) *As stated above, the project team has very strong backgrounds as related to the proposal.*

7. **PROJECT MANAGEMENT**

The project management plan, including a well-defined milestone chart, schedule, financial plan, and plan for communications among the parties involved in the project, is: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – very good; or 5 – exceptionally good.

Reviewer 33-13 (Rating: 4) *Included the information needed to layout achievable milestones and completion. The researchers have worked together before successfully.*

Reviewer 33-14 (Rating: 3) *As support for a DOE award, this proposed work is adequate support.*

Reviewer 33-15 (Rating: 4) *The management plan presented is very good and is typical of previous proposals by UND. A suggestion is the PI may want to include a few representatives from the sponsoring power plant companies as advisors. They may have input to help keep the project in line with industry needs and their involvement would keep the companies involved and informed.*

8. **EQUIPMENT PURCHASE**

The proposed purchase of equipment is: 1 – extremely poorly justified; 2 – poorly justified; 3 – justified; 4 – well justified; or 5 – extremely well justified. (Circle 5 if no equipment is to be purchased.)

Reviewer 33-13 (Rating: 5) *No equipment needed to be purchased*

Reviewer 33-14 (Rating: 5) *No equipment proposed.*

Reviewer 33-15 (Rating: 5) *No equipment proposed for purchase.*

9. **FACILITIES**

The facilities and equipment available and to be purchased for the proposed research are: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – notably good; or 5 – exceptionally good.

Reviewer 33-13 (Rating: 5) *Excellent facility available.*

Reviewer 33-14 (Rating: 3) *Facilities to be utilized have been shown adequate through previous work produced.*

Reviewer 33-15 (Rating: 5) *UND has worldclass laboratories that contain equipment to meet the reasonable needs of the proposed research.*

10. **BUDGET**

The proposed budget value relative to the outlined work and the financial commitment from other sources is of: 1 – very low value; 2 – low value; 3 – average value; 4 – high value; or 5 – very high value.

Reviewer 33-13 (Rating: 4) *It is at the level typical of DOE collaboration and is good.*

Reviewer 33-14 (Rating: 4) *High value for cost sharing with a DOE award. Financial support from industry would have boosted value.*

Reviewer 33-15 (Rating: 3) *Given the early state of the proposed research, the 80% DOE and 20% NDIC funding is reasonable. If successful, the research will return many times the budget.*

OVERALL COMMENTS AND RECOMMENDATIONS:
Please comment in a general way about the merits and flaws of the proposed project and make a recommendation whether or not to fund.

Reviewer 33-13 (Rating: FUND) *I recommend funding. I think there will be considerable changes in the value brought for the materials from this process will increase dramatically over time if they are successful in showing it is commercially viable.*

Reviewer 33-14 (Rating: FUND) *Beneficiation is an area that continuously needs to be addressed, especially in the current realm of energy transition. The potential to provide facilities with additional options and possible revenue streams should be a primary overall goal of project awards. With award notification received from the DOE, this proposal for the required cost share is justified and the dollar amount is not outlandish. This reviewer believes that this work should be funded. Serious focus should be placed on the techno-economic and life cycle analyses and I encourage the LEC to examine them carefully, if the project is awarded.*

Additional comments added to the proposal by the reviewer:
Page 7 "This is at a level of what the Coyote Station emits in a few days so the sequestration aspect is not a selling point of this work. It is good to see the author recognize this."

Page 7 "What level is deemed significant? Additionally, what is considered a large liability?"

Page 10 "Are the power plants not designed to operate at a designated output and work most efficiently at a constant load? Many maintenance outages are directly related to load swinging."

Page 22 "It would be expected that the TEA needs to consider disposal vs. sale of the mineralized product. Logistical reality of the quantity of product produced and effect to market is extremely important. Do the authors already have specific markets in mind?"

Reviewer 33-15 (Rating: FUND) *While the proposed research faces many challenges and has many hurdles to overcome, it's success would be significant for the power plants in North Dakota. I recommend funding the project.*

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April 3, 2023

Reice Haase, Deputy Director
North Dakota Industrial Commission
State Capitol – 14th floor
600 East Boulevard Avenue, Dept. 405
Bismarck, ND 58505-0840

Subject: "Assessment of Lignite-Based Industrial Residues for Value-Added Product Creation through CO_2 Mineralization," Proposal to the Lignite Research, Development and Marketing Program by Dr. Johannes van der Watt, Principal Investigator

Dear Mr. Haase:

On behalf of the University of North Dakota, I am pleased to submit Dr. Johannes van der Watt's proposal on "Assessment of Lignite-Based Industrial Residues for Value-Added Product Creation through CO_2 Mineralization," for consideration by the NDIC's Lignite Research, Development and Marketing Program. Dr. Van der Watt is a Research Assistant Professor in UND's College of Engineering and Mines and is the Principal Investigator for this project. Dr. Van der Watt is proposing a two-year project with a total requested amount from NDIC of $250,000. The NDIC funding is being requested as a match to the DOE portion of the project, which is currently in the process of being awarded for $1,000,000. The total value of the overall project would thus be $1,250,000. We anticipate a start date in approximately July 2023.

Please contact Dr. Van der Watt with any technical questions about the project at (701) 777-5177 or johannes.vanderwatt@und.edu. If the NDIC selects this proposal for an award, please send any award documents and related communications to Sherry Zeman at sherry.zeman@und.edu for processing on behalf of UND. The $100 application fee is being handled as an electronic payment by UND and should reach your office in a timely manner. Thank you very much for your consideration of this proposal.

Sincerely yours,

Karen Katrinak

Karen Katrinak, Ph.D.
Proposal Development Officer, Research & Sponsored Program Development
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ASSESSMENT OF LIGNITE-BASED INDUSTRIAL RESIDUES FOR VALUE-ADDED PRODUCT CREATION THROUGH CO_2 MINERALIZATION

Total Project Cost: $1,250,000

NDIC Funding Request: $250,000

Date of Application: April 3, 2023

Principal Investigator:

Johannes van der Watt, Ph.D.

Assistant Research Professor

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UNIVERSITY OF NORTH DAKOTA

COLLEGE OF ENGINEERING & MINES

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ABSTRACT

Objective: The University of North Dakota (UND) College of Engineering & Mines (CEM) and Envergex LLC are proposing to assess the techno-economic feasibility of using carbon dioxide mineralization (CO2M) as an enabling pathway to beneficiation of ashes and dry sulfur scrubber residues produced at lignite-fired power plants that, today, represent both economic and environmental liabilities for the plant owners. This work will be part of a larger Department of Energy funded project (DE-FE0032244) that will be performing a resource assessment of industrial wastes for CO2M combined with beneficial uses.

The project will specifically target the beneficiation of materials that are today not sold for cement replacement and will develop and test process schemes with potential to cost-effectively make these ashes suitable for concrete applications, all while also capturing and permanently sequestering a fraction of the plant's CO_2 emissions. CO2M has the potential to open new economic pathways to address key challenges such as high levels of soluble alkalis, calcium sulfite content and unburned carbon content.

To achieve the goal of developing new cost-effective pathways to beneficiating lignite-based ashes, we will: **1)** identify lignite-based ashes that have alkaline or other CO_2-reactive content and prioritize those that are present in significant volumes and/or represent large liabilities for the plant owner(s), **2)** perform a rigorous analytical characterization of the selected materials to determine their chemical composition and morphology to inform development of process schemes for CO2M and pre- and post-processing, **3)** perform a comprehensive laboratory-scale experimental evaluation involving CO2M testing, product characterization and application performance verification, and **4)** perform a high-level techno-economic assessment and carbon lifecycle analysis for selected materials and process schemes.

Expected Results: The project will identify materials types, their locations and quantities and develop feasible process schemes for CO2M and creation of value-added products. This will lead to significant waste elimination for the lignite industry, new revenue sources, and contribution to the environmental sustainability of cement/building products industry.

Duration: 24 months (tentative start date July 2023). **Participants:** UND CEM and Envergex LLC

Total Project Cost: $1,250,000 ($250,000 requested from NDIC and $1,000,000 awarded by U.S. DOE)

PROJECT SUMMARY

The University of North Dakota (UND) College of Engineering & Mines (CEM) and Envergex LLC are proposing to assess the techno-economic feasibility of using carbon dioxide mineralization (CO2M) as an enabling pathway to beneficiation of ashes and dry sulfur scrubber residues produced at lignite-fired power plants that, today, represent both economic and environmental liabilities for the plant owners.

This work is part of a new award from the United States (U.S.) Department of Energy (DOE) (DE-FE0032244) that focuses on a broader range of industrial residues/wastes for the purpose of evaluating the resource potential for CO2M and the ability to use CO2M to reduce waste and/or create new products. The broader DOE project will include evaluation of several industrial wastes, including lignite ashes/residues, recycled concrete, cement kiln dust, iron and steel slag, copper slag, and biomass wastes. For the lignite industry focus, the project will specifically target the beneficiation of materials that are today not sold for cement replacement and will develop and test process schemes that have the potential to cost-effectively make these ashes suitable for concrete applications, all while also capturing and permanently sequestering a fraction of the plant's CO_2 emissions.

The biggest factors contributing to the low quality of ashes from lignite combustion are unacceptable high levels of unburnt carbon and soluble alkalis. SO_3 content, particularly for dry scrubber ashes, could also be a challenge. The excessive accumulation of unburnt carbon in fly ash can result in several issues, including reduced strength, longer setting time, and decreased workability of the concrete. Additionally, excessive amounts of soluble alkalis in concrete can lead to abnormal expansion and cracking of the concrete.

Figure 1 outlines the innovative technology pathway we are proposing to upgrade lignite ashes. By using a combination of mild processing and accelerated CO2M technologies to eliminate impurities and alter the ash morphology and mineralogy, we can create an additional source of revenue for plant owners from ashes that are currently being disposed onsite. Fly ash, dry scrubber ash and mixtures of these with sorbents used for boiler ash deposit mitigation[1] (described in more detail later), represent the feedstocks for the upgrading process. Our mild processing removes unburnt carbon and soluble alkalis in the residues in

a first step which is then either succeeded or preceded by a CO2M process that captures/sequesters CO_2 emissions from the plants' flue gas or from the pure CO_2 stream generated by plants that implement large-scale CO_2 capture in the future. High SO_3 content can be addressed through physical separations/blending and during the CO2M process through transformations of the sulfite/sulfate phases.

In combination with the mild processing, the above-identified accelerated CO2M reactions between the ashes and CO_2 permanently sequester the CO_2 in mineral form and transform the ashes into highly sought after supplementary cementitious materials adhering to strict American Society for Testing and Materials (ASTM) requirements for class C/F fly ash. The upgraded residues composition is also suitable for use in valuable Limestone Calcined Clay Cement (LC^3), a low-carbon, mainstream general-use cement in the global cement market. This two-step upgrade approach (Figure 1) is specifically tailored to North Dakota utilities burning lignite coal and their unique operating configurations.

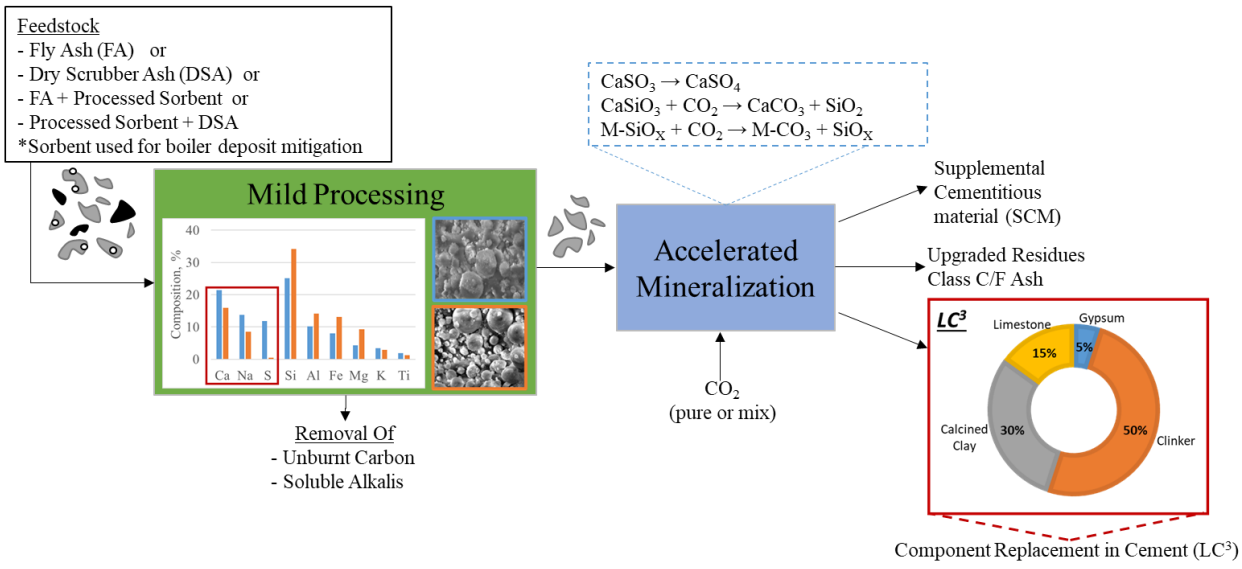


Figure 1: CO2M for cost-effective ash beneficiation.

In addition to the primary benefit of beneficiating ashes for valuable use as cement replacement (and potentially other products), there are other benefits to be realized, described below:

- **Reducing CO_2 emissions**: Ongoing testing of our team's novel CO2M technology has indicated that 100 grams of a typical ash containing suitable alkaline materials can sequester up to 18 grams of CO_2

(18wt% CO_2 capture capacity). For example, according to Otter Tail Power Company (OTP) (see attached letter of support in Appendix B), the Coyote Station typically produces about 100,000 tons/year of dry scrubber ash that needs to be disposed. While only representing a small fraction of the total Coyote CO_2 emissions (~3.5 million tons/year), our testing indicates that we could sequester about 18,000 tons/year of Coyote's CO_2 using CO2M with their dry scrubber ash. **We note:** we recognize that the value proposition of CO_2 emissions reductions at this scale is not large. The value this project brings is in leveraging the CO2M process and the resulting physicochemical changes to the ashes (and any carbon benefits, i.e. tax credits or offsets) to enable ash beneficiation that would not otherwise be cost-effective.

- **Waste reduction**: Most lignite power plants in North Dakota (ND) today are forced to landfill their ash residues onsite, representing both an economic and environmental liability. As a striking example of this liability, the EPA recently indicated that North Dakota's largest power plant, Coal Creek Station, may be facing the possibility of a multi-year outage to meet requirements under the EPA's coal combustion residuals regulation.[2] As depicted in Figure 1, our approach has the potential to address lignite ash beneficial use challenges. Our goal is to eliminate or drastically reduce the amount of newly landfilled ash, with the possibility of also enabling reclaiming of already landfilled ashes. Ash landfill reclaiming is not the focus of this project, but it will be evaluated at a cursory level.

In order to achieve the overall objective of cost-effective beneficiation of lignite combustion residues for use in existing commercial applications (i.e., concrete), we propose a series of **four technical tasks**:

1) We will identify lignite-based ashes that have alkaline or other CO_2-reactive content and prioritize those that are present in significant volumes and/or represent large liabilities for the plant owner(s). This will involve obtaining multiple samples of lignite-derived ashes from Ottertail Power Company, Minnkota Power Cooperative, and Basin Electric Power Cooperative (see attached letters of support in Appendix B).

2) We will perform a rigorous analytical characterization of the selected materials to determine their chemical and physical characteristics to inform development of process schemes for CO2M and pre- and post-processing. Based on the literature, our knowledge and prior related work, we have already identified tested processes that will be examined in greater detail. This task will enhance the available information to more exhaustively determine the possibilities.

3) We will perform a comprehensive laboratory-scale experimental evaluation involving CO2M testing with and without pre- and post-processing, as well as product characterization and application performance verification. This will involve using our team's accelerated direct CO2M approach (see Appendix A: Confidential Information) to perform screening tests for each of the selected ashes. We will then evaluate the physical and chemical properties of the resulting mineralized products and conduct performance tests for those materials that may be applicable to certain commercial end uses, such as in concrete.

4) We will perform a high-level techno-economic assessment (TEA) and carbon lifecycle analysis (LCA) for selected materials and process schemes. This will involve integrating all task findings to determine the system and process requirements and estimated costs for a full-scale beneficiation process. This will help us to determine the feasibility of our approach and will guide future scale-up.

PROJECT DESCRIPTION

Background

***Transition to a circular economy*:** The concept of circular economy has gained traction as a way to minimize waste and pollution by promoting the reuse and recycling of materials, and it is increasingly important for industries to find innovative ways to utilize their waste streams, such as the industrial residues generated by coal-fired power plants.

In recent years, there has been an increasing interest in the use of industrial residues for CO2M, which not only reduces greenhouse gas emissions but also creates value from waste materials. Lignite coal ash and dry sulfur scrubber residues are two potential feedstocks for CO2M as they contain metal oxides

and metal silicates that can react with CO_2 to form stable carbonate phases, thus offering a promising solution for reducing carbon emissions and moving towards a more circular economy. However, the use of these materials for CO_2 capture at power plants is ignored since the generated residues can only capture a small fraction of the CO_2 emitted by the power plants. Therefore, on its own, CO2M application at coal plants is unlikely to be a complete solution.

Coal fly ash is known for improving the durability and workability of concrete mixes. It is used as partial cement replacement if its composition adheres to strict standards such as those reported by the American Society for Testing and Materials (ASTM) C618 for Class C and F fly ash.[3] Fly ash that does not conform to the ASTM C618 standards, typically due to impurities such as soluble alkalis, unburnt carbon, or semi-dry and dry flue gas desulfurization impurities, is typically disposed of in onsite ash ponds or landfills. This is a concern due to the increasing costs of ash storage and landfilling, as well as the potential for contamination of surface waters caused by leaking ash ponds.[4]

Furthermore, the American supply of fly ash has rebounded from a low in 2020, but its supply, specifically for use in concrete, remains constrained due to coal plant closures and movement towards other fuels.[5] This highlights the need to develop fly ash and dry scrubber ash beneficiation technologies to help keep up with this demand and better utilize the currently unused ashes.

Within North Dakota, we are aware of Basin Electric Power Cooperative's Leland Olds Station and Rainbow Energy Center's Coal Creek Station that provide fly ash for the construction industry. However, other power plants have to dispose of their ashes. Plants with ashes suitable for concrete applications have a significant economic advantage over those that do not. Our goal is to develop a technology pathway to make beneficiation of unsuitable ashes economic by leveraging the CO2M process.

Growing need for CO_2 capture: The push to reduce carbon emissions and combat climate change has led to an increased focus on carbon capture technologies for power plants that combust fossil fuels. With competition from renewable energy sources, these facilities must find ways to stay viable while reducing their carbon footprint.

However, one important consideration is the need to operate these coal-fired power plants at high capacity factors to repay the capital investment in carbon capture technology that relies on the 45Q tax credit. Previously, power plants had the flexibility to operate at lower loads, allowing for the removal of ash deposits from within the boiler at the "cooler" operating temperature. However, with the need to operate at high capacity factors, this operating flexibility is diminished, leading to increased ash fouling. This is particularly challenging in places like North Dakota, where high alkali-content lignite is combusted. Low rank coals contain significant amounts of sodium (Na) and potassium (K) which lower the ash melting point and can lead to the formation of sticky deposits on heat transfer surfaces.

One of the ways to overcome this challenge is by removing the vapor-phase alkali components in the flue gas by sorbents, as shown by Nguyen *et al.* (2022)[1], as part of a Department of Energy Project to mitigate the formation of alkali-induced aerosols at Minnkota Power Cooperative's Milton R. Young Station. The results from the full-scale demonstration showed the efficacy of the approach (i.e. injecting sorbent to capture vapor phase alkali species) and the added sorbent mixed in with the fly ash could be beneficial for use as partial cement replacement. Specifically, the combination of the fly ash and the sorbents that would be collected in the plant's particulate control devices, have properties that are desirable in LC^3 cements (see Figure 1).

***Challenges of using lignite ashes for cement*:** We consider two general categories of lignite ashes in this proposal: 1) fly ash and 2) dry scrubber ash.

Fly ash: To use fly ash as a partial cement replacement, it must adhere to the standards set forth in ASTM C618. As mentioned previously, the high alkali content in low rank coals such as lignite means utilities employ various strategies to use the coal effectively. For example, Minnkota Power Cooperative's Milton R. Young Station uses a cyclone-fired boiler. Cyclone-fired boilers burn coal at high combustion temperatures (~1650°C) and exhibit relatively high, but quite variable, fly ash unburnt carbon levels.[6] The unburnt carbon levels increase the ash's loss on ignition value, which is required to be below 6% as per ASTM C618.

Compared to cyclone-fired systems, pulverized coal fired systems generally have lower levels of unburnt carbon content in the ash. This is because the coal fed into the boiler is finer in size, which facilitates combustion that is more complete.

In addition, the combustion of coals with high alkali levels creates a unique challenge including elemental partitioning (most significant in high-temperature cyclone furnaces), with volatilization of the alkali compounds (Na and K) as demonstrated by Benson *et al.* (2014)[7]. Some of the vaporized alkali condenses (heterogeneously or homogeneously) as soluble alkali sulfates and are known to "coat" the fly ash resulting in relatively high alkali sulfate concentrations. High-alkali fly ashes (> 5% Na_2O equivalent) are not recommended for use with reactive aggregates for concrete mixes[8], making it unsuitable for concrete applications. Combined, these two criteria (unburned carbon and soluble alkali content) represent major challenges for the use of fly ash in concrete for plants with cyclone boilers.

Dry scrubber ash: Coyote Station (Otter Tail Power) and Antelope Valley Station (Basin Electric Power Cooperative) both have boilers that use a dry SO_2 scrubber and fabric filter for SO_2 capture and particulate control. A dry scrubber injects a slurry of hydrated lime, which reacts with the SO_2 to form a solid phase. The *partially* sulfated lime (mixture of uncreated lime, calcium sulfite and calcium sulfate) then mixes with the fly ash and is separated in the fabric filter. This mixture of solid particulate is referred to as dry scrubber ash.

The inherent concern with using dry scrubber ash as cement replacement is related to the same issues of unburnt carbon (if using cyclone-fired boiler) and high levels of soluble alkalis in the fly ash since it can contain 70%-85%[9] fly ash by weight. What makes dry scrubber ash also challenging is the presence of approximately 15%[9] hannebachite ($CaSO_3.0.5H_2O$) and 9% gypsum ($CaSO_4$).[13] Together, these contribute to the overall SO_3 content in the ashes. As per ASTM C618 for Class F/C fly ash, the SO_3 content cannot be greater than 5%. This restriction is in place to prevent hydration and durability issues during curing caused by the delayed formation of ettringite.[10] Compared to gypsum, hannebachite also exhibits greater stability in terms of reactivity and could therefore cause even more issues during curing when using

dry scrubber ash in concrete. As such, dry scrubber ashes frequently get disposed of on the power plant's premises or in landfills.[11]

***Ash beneficiation and CO2M state-of-the-art technologies*:** We provide a brief review of the relevant background on ash beneficiation and CO2M in the following sections.

Ash Beneficiation: No commercial method is known for mitigating high alkali sulfates beyond fly ash blending[12]. Blending is only applicable when a suitable low alkali-fly ash is available. This limits applicability of this solution. Our technology proposes a novel method for separating the alkali/sulfate/sulfite content from fly ash by exploiting the the fact that SO_3-rich phases precipitate during a different stage of the combustion process than the formation of fly ash particles.[4,13] This occurrence provides us the opportunity to separate alkali/sulfate/sulfite components from the fly ash.

For high unburned carbon (LOI) in fly ash, several commercial solutions exist.

- ***Triboelectric Separation[14]:*** This is an effective electrostatic-based technology for beneficiating a wide variety of fly ashes with high LOI (> 30%). The cost of separation is estimated at $4-$7 per ton fly ash[15]. However, the associated maintenance and operating costs are also high due to erosion of the conveyor components originating from the highly abrasive fly ash. Even though this process is considered the best for carbon removal for fly ash, lignite-based fly ash exhibits LOI values closer to about 10%[9].
- ***Thermal Processes:*** Burning the carbon represents the simplest form of carbon removal. This process is best suited for high LOI fly-ash (> 7%) to ensure self-sustaining combustion, but is expensive compared to the other processes (estimates of $10-$20 per ton of fly ash[16]).
- ***Classification:*** Mechanical and pneumatic classification are commonly used methods that can be employed to remove coarse particles from fine particles but are most effective as a pre-processing step, due to their low efficiency for sub-45μm sized particles. They are relatively inexpensive ($1-$3 per ton fly ash).[12]

CO2M: Mineralization brings unique changes to materials, such as the release of nanoscale silicate minerals and extremely fine limestone. Not only does this process capture CO_2, but it generates materials that are highly suitable as cement replacements and additives. For example, the fine limestone released via this process can be used to combat the deleterious effects of hannebachite and gypsum as noted previously since it coats these particles and accelerates hydration reactions.[13] CO2M is therefore an extremely powerful ash beneficiation technology. Current state-of-the-art technologies for CO2M relate to either in-situ or ex-situ technique.

- **In-situ mineralization**: In this technique, CO_2 is injected into underground reservoirs to promote reaction between CO_2 and minerals present in the geological formation to form carbonates. This technique is not relevant to the proposed application and is not discussed further.
- **Ex-situ mineralization:** Ex-situ refers to processes where the carbonation reaction occurs above ground, within a separate reactor or industrial process.[17,18] Ex-situ CO2M costs using CaO-and MgO-rich industrial wastes have been estimated at $70-$140 per ton of captured CO_2 based on the waste type, state and processing requirements. [18,19] The CO_2 mineralization costs can be offset by the sale of the beneficiated materials and this is precisely what we aim to achieve in this project.

Ex-situ CO2M can be subdivided into *direct* carbonation and *indirect* carbonation. Direct carbonation can be achieved by mineralization in aqueous solutions or gas-solid reactions, whereas indirect CO2M routes require the use of extraction agents such as acids and salts. According to Veetil & Hitch (2020)[17], ex-situ aqueous mineral carbonation represents one of the most promising and viable options for carbon capture and storage at the small-to-medium industrial scale.

While most CO2M reactions are thermodynamically favorable, they do exhibit significant kinetic and mass transfer limitations, making their overall reaction rates slow. An example of current ex-situ CO2M technology available in the U.S. is from Blue Planet Systems. Blue Planet Systems manufactures "Upcycled Aggregate", a by-product of demolished and recycled concrete that the company exposes to a calcium extraction process and then uses in concrete mix. The "Upcycled Aggregate" offers significant benefit

compared to virgin aggregate in terms of strength and carbon footprint.[20] The process uses CO_2 and an aqueous capture medium such as ammonia, resulting in a CO_2 sequestered product and an aqueous ammonium salt. The aqueous ammonium salt is then treated with an alkaline waste product to regenerate the capture ammonia.[21] The main drawback to this technology is it requires energy intensive recovery of the solvent.

Carbon To Stone[22] is a new entrant into CO2M and proposes to directly capture CO_2 from air using regenerable solvents. This indirect ex-situ process would also likely require a costly solvent regeneration process that the company claims can be fulfilled by using heat or pressure changes from the process. The mineralization reactions are exothermic and this heat integration approach could prove extremely beneficial in the future.

Although state-of-the-art technologies for CO2M offer great potential, using solvents such as ammonia and the resulting ammonium salts can be corrosive and require recycling, complicating the process and making it challenging to implement on a large scale. Therefore, a simple process that can circumvent the use and recovery of solvents is necessary to achieve similar results in CO_2 removal and upgraded waste quality while being easily implementable on a large scale. In addition, such a technology would enable companies to adopt CO2M more easily, particularly in remote regions with limited access to large quantities of solvents.

Accelerated CO2M for cost-effective ash beneficiation: The proposed project will involve the use of our team's novel accelerated direct ex-situ CO2M technology, which is currently being demonstrated at lab-scale in a USDA funded project led by Envergex (USDA-NIFA-SBIR-008541)[23]. Our technology drastically increases carbonation reaction rates, through use of a novel contacting system and low-cost and benign additives. In addition to the ultra-fast reaction rates (high CO_2 loadings in a matter of a few minutes or less under optimized conditions), our technology's unique contacting design brings about morphology changes and the release of fine reactive silica and limestone in the reaction products, making them

extremely valuable as cement replacement. Additional details can be found in Appendix A: Confidential Information.

Summary of the Background and Key Research Problems to be Addressed: As discussed in the previous sections, the proposed project combines mild ash processing and CO2M to achieve cost-effective ash beneficiation, targeting cement replacement application. Our project will address the following key research problems to achieve this objective:

- Lignite ash disposal represents significant costs and real environmental liabilities for plant owners. We are targeting a circular approach, whereby ash can be beneficially used, reducing/eliminating disposal costs, creating new revenue streams, and contributing to the sustainability of the construction industry.
- Our approach can beneficially integrate with alkali ash fouling control strategies that may become necessary as lignite plants adopt large-scale CO_2 capture systems (i.e., Project Tundra), such as through sorbent injection that has been successfully demonstrated at full scale at Milton R. Young Station.
- While some lignite plants already sell a portion of their ash for concrete applications, there are some plants whose ash contains certain impurities (LOI, alkali, SO_3) that make them unsuitable for these applications. Our approach leverages the physicochemical changes that occur through CO2M (along with any potential carbon reduction benefits) to open up new economic pathways for ash beneficiation/processing.
- To make CO2M reaction rates feasible for ex-situ CO_2 capture, novel technologies are needed. These are often complex and/or require expensive solvents and regeneration techniques. Our team is developing a novel CO2M technology that combines simplicity, ultra-fast reactions, and reaction product mineralogy and morphology that is beneficial for concrete applications.

Methodology

We propose to use two mild processing steps to lower the LOI and alkali sulfate content in the lignite ashes to levels suitable for use in concrete. The CO2M step is intended to capture CO_2, form stable carbonate species, alter the ash mineralogy and morphology (i.e., increase particle surface area), and liberate fine

reactive silica. This extremely fine silica is a pozzolanic material that is typically used in industry to enhance the strength of concrete. The CO2M process is also known to be able to transform calcium sulfites (hannebachite) into soluble bicarbonate and bisulfite salts.[4] This allows an additional step whereby the sulfur content in dry scrubber ash can be reduced/tailored for easier blending with cement. Ultimately, the mild processing and accelerated CO2M steps are applicable to both fly ash and dry scrubber ash, with final blending of the upgraded scrubber ash with upgraded fly ash providing the last step in conforming to the maximum allowable SO_3 content of 5.0% in class C/F fly ash as per ASTM C618.

Additional details of our full approach are provided in Appendix A: Confidential Information. However, the following sections provide a brief description of the mild processing and accelerated CO2M based on the literature and our prior and ongoing work.

LOI reduction step: A simple physical separation step can be used to separate high LOI ash from low LOI ash, as shown in Figure 2. In this example, we were able to segregate fly ash from the Milton R. Young Station into fractions with LOI of <1wt% and >30wt%.

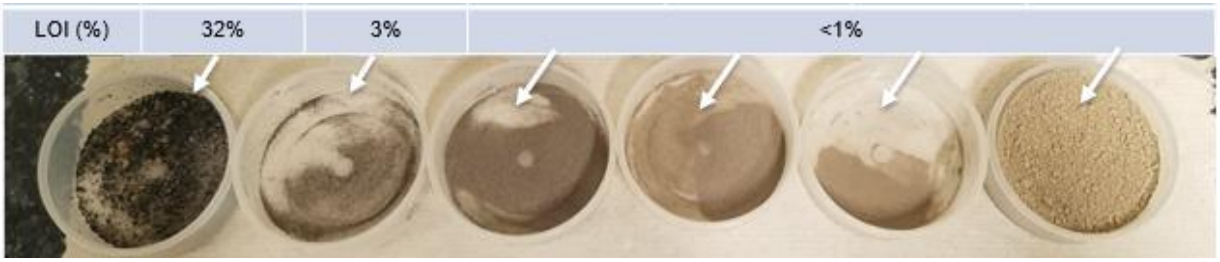
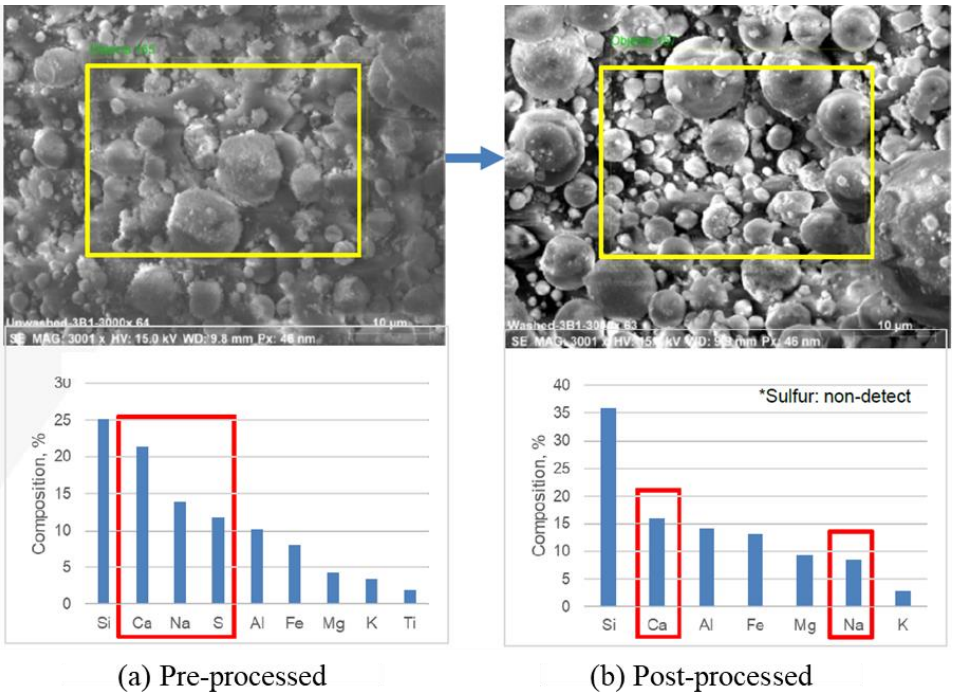


Figure 2: Ash partitioning into high LOI (>30%) and low LOI (<1%) contents.

Alkali reduction step: The effect of a second mild processing step is given in Figure 3, which shows the changes in the Na, S and K content before (a) and after (b) processing. It is clear that the processing reduced the Na and K content by about 40% and 30% respectively. The S removal was effectively 100% since no S was detected in the post-processed sample. The scanning electron microscopy images in Figure 3 show the morphological changes to the fly ash before (a) and after (b) the mild processing step. The mild processing step removed contaminants from the fly ash as the spherical nature of the fly ash is clearly visible in the post-processed material.



(a) Pre-processed (b) Post-processed

Figure 3: SEM-EDS results before and after mild processing of lignite derived fly ash samples.

Accelerated CO2M step: Envergex and UND have developed an innovative method for direct CO2M, which eliminates the additional expenses and complications associated with indirect routes. Figure 4 displays the performance of our CO2M technique on dry scrubber ash provided by Otter Tail Power, showing a significant improvement in CO_2 loading over baseline methods from just under 2wt% to nearly 18wt% CO_2 in the ash post mineralization.

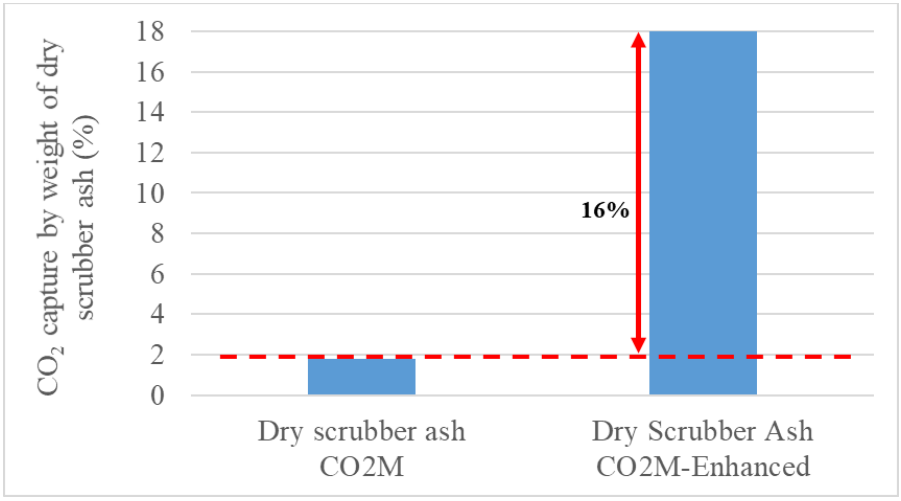


Figure 4: CO_2 loading on dry scrubber ash (Otter Tail Power) for baseline CO2M (left) vs. our accelerated CO2M technology (right).

This result, coupled with the existing 45Q tax credit, means that the residue could generate over $15 per tonne of dry scrubber ash through mineralization alone. However, the true value lies in the mineralogical and morphology transformations the material undergoes, as well as the added beneficiation that enables it to meet the suitable ASTM 618 requirements for use in concrete. Considering the current cost of cement at $130 per tonne, there is a clear demand and value for products that can partially replace cement in concrete.

***Tasks to be Completed**:* We propose five tasks that integrate with the larger DOE program and focus in our descriptions below on the specific activities related to evaluating the lignite-related resources.

Task 1.0 – Project Management and Planning

UND will manage and direct the project in accordance with the Project Management Plan to meet all technical, schedule and budget objectives and requirements in combination with DE-FE0032244. In addition, the purpose of this task is coordination and planning of the project with the other stakeholders, including the NDIC technical advisor and the DOE program manager. UND will lead this task with support from Envergex to address all items related to monitoring and control of project scope, cost, and schedule. UND will compile quarterly technical reports, topical reports, participate in meetings and make presentations at conferences as required.

Task 2.0 – Characterization of Coal-Combustion Residues

Detailed characterizations will be performed to define all relevant properties of the materials that will be required to develop processing schemes. We will specifically evaluate materials within the context of understanding their properties related to amenability to CO2M and why the materials may or may not be suitable for concrete applications today.

Subtask 2.1 – Sample Procurement

We have received support letters (see Appendix B) from Minnkota, Otter Tail and Basin Electric who will provide representative samples of ashes (fly ash, bottom ash, dry scrubber ash) from their lignite-fired power plants. We will work with these entities to collect 3-4 samples of each material type from each facility that are representative of the typical or most common operating modes for the plants (incoming coal

quality, plant load, time before the next cleaning outage, etc.). We also have access to samples of fly ash mixed with alkali control sorbent from our team's prior commercial demonstration of alkali vapor capture at the Milton R. Young Station.[1]

Subtask 2.2 – Sample Characterization

The focus of this task is on determining properties that will impact CO2M process performance and/or required process conditions and why and to what extent each selected material is currently unsuitable for cement replacement by comparing it to relevant ASTM standards.

We will use multiple characterization methods following ASTM standards where appropriate: loss on ignition, bulk ash composition (XRF), minor and trace elements composition (ICP-OES), particle size distribution (sieving and Malvern analysis), morphology and chemical composition (SEM-EDS, including computer controlled SEM) and grindability (milling).

Within the context of evaluating the suitability for CO2M, a theoretical CO_2 uptake formula will be used to rank materials and the ranking value will be used to express conversion efficiency after mineralization experiments in Task 3.

Subtask 2.3 – Process Scheme Development

Based on the analyses results for promising ash materials, we will develop process schemes incorporating CO2M and any pre- and/or post-processing required to generate salable products. The techniques discussed in the confidential section of this proposal, Appendix A, will be utilized for these purposes.

Task 3.0 – Experimental Evaluation

We will perform a rigorous experimental evaluation of selected ash materials following the process schemes developed in Subtask 2.3 and following the process methodologies we described previously in Figure 1 and in more detail in Appendix A: Confidential Information. This task will be done in parallel with Task 4 to facilitate an iterative approach, where the product characterization results (Task 4) will inform the experimental test plan (Task 3) to generate optimized process schemes and conditions.

The lab-scale CO2M testing will utilize a mineralization process and test setup that has been developed from a separate project (USDA-NIFA-SBIR-008541). A representative sample from each of the selected industrial residues will be subjected to semi-batch testing – solids in batches with a continuous flow of reacting gases. The key performance metric will be CO_2 uptake, which will be evaluated as a function of pressure, operating temperature, H_2O/dry residue ratio, exposure duration, and CO_2 concentration. CO_2 concentrations typical of combustion flue gas will be evaluated in addition to higher concentrations or pure CO_2. We will measure the CO_2 uptake by determining the post-mineralization sample weight gain in combination with analytical techniques (total inorganic carbon analyzer).

Experimental evaluation of the ash processing steps (LOI reduction and alkali/sulfur reduction) will also be performed in this task via an iterative approach between CO2M testing and the Task 4 product characterization. More details of our processing methodologies are provided in Appendix A: Confidential Information.

Task 4.0 – Mineralized Product Characterization and Evaluation

To provide a quantification of the benefits of the proposed approach, we will perform analyses to compare the mineralized products to relevant ASTM standards to determine suitability for cement replacement. We will also use select ASTM tests to determine the performance of the resulting materials and further refine how they can be modified to meet the necessary requirements. The information obtained from Task 4 will be used to assist with the high-level techno-economic assessment (TEA) and carbon lifecycle analysis (LCA) in Task 5.

Subtask 4.1 – Reaction Product Characterization

We will assess the chemical composition, mineralogy, and microstructure of the reacted residues and compare the data to the unreacted/unprocessed materials. In addition, the mineralized materials will be assessed for toxicity/leachability and appropriateness for use as construction materials or landfilling.

Subtask 4.2 – Product Performance Testing

Cementitious material properties will be used for concrete mix design. The optimum content of the cementitious material (products generated in Task 3) will be determined using compressive strength as the

criterion as compared to the control (cement-based concrete). The effect of optimum content on the fresh properties (slump, air content, unit weight), mechanical properties (compressive, flexural, tensile, and modulus of elasticity), and durability of concrete (freeze-thaw, air void content of hardened concrete, Rapid Chloride Ion Penetration, etc.) will be determined and compared to the control. At least three specimens will be tested for each property for statistical analysis purposes. Air void content of fresh concrete using Super Air Meter will be compared to the air void content of hardened concrete using Linear Traverse. Table 1 shows concrete properties, curing periods, ASTM standards, and major equipment for concrete testing.

Table 1: Concrete properties, ASTM standards, and equipment for concrete testing.

Property		**Curing Period (days)**	**ASTM Standard**	**Equipment**
Fresh Properties	Slump	0	C143	Slump content
	Unit weight		C138	Super Air Meter
	Air content		C231	
Mechanical Properties	Compressive strength	7, 28, 56, 90	C39	Universal Testing Machine
	Flexural strength		C78	
	Tensile strength		C496	
	Modulus of elasticity		C469	
Durability	Freeze-thaw Resistance		C1202	Rapid Freeze-thaw Cabinet
	Chloride penetration		C666	Rapid chloride penetration
	Air content		C457	Linear Traverse

Task 5.0 – Techno-Economic Assessment

This task combines the project findings into a feasibility study to identify and cost the viable usage pathways for the lignite coal ashes.

Subtask 5.1 – Develop Alternative-Processing Schemes

Results from Tasks 2-4 will be used to develop conceptual residue processing schemes applied at commercial scale. Process modeling (Aspen Plus) will be used in conjunction with experimental testing results from previous tasks to simulate commercial performance and mass and energy balances.

Subtask 5.2 – Develop Process Flow Diagrams (PFDs)

The simulations will be converted to preliminary PFDs incorporating mass and energy balances, equipment lists/sizing, and utility requirements.

Subtask 5.3 – Technical and Economic Analysis

The PFDs will be used to conduct a high-level TEA (i.e., Class V – Concept Screening, according to the Association for the Advancement of Cost Engineering (AACE) International) of the processes for comparison to each other and evaluation of their overall economic merit. Capital and operating cost factors will be used to estimate the economic viability of evaluated processes. This work will provide key information for future resource utilization decisions and will identify key targets to focus on and address scale-up considerations.

Subtask 5.4 – CO_2 Lifecycle Assessment (LCA)

The LCA will follow ISO 14040-14044 to establish a cradle to grave LCA for process schemes identified as viable. The LCA will evaluate the effects of using carbon dioxide from the facilities and using the processed materials for cement replacement or additives, or safer landfilling. The LCA will be broken up into three stages: **1)** industrial residue generation, **2)** processing and generation of mineralized residues, and **3)** sale and use or disposal of mineralized residues. This work will be coupled with TEA results to show tradeoffs between material processing targets and techno-economic feasibility. The LCA will be performed using the SimaPro 7.2 software. Inventory data from the GREET model will be prioritized; if data is not available the EcoInvent Database will be used.

Anticipated Results

The proposed project will deliver a comprehensive understanding of the economic and environmental benefits of lignite coal ash beneficiation through robust analytical and experimental evaluation of new pathways enabled by CO2M. The combination of detailed analytical characterization, experimental testing, LCA, and TEA will provide stakeholders with a complete picture of the costs and benefits of the proposed approach. This will enable stakeholders to evaluate the economic and environmental impacts of using

CO2M as a method for reducing waste disposal burdens on utilities and maximizing the reuse of coal wastes in the construction industry. We will generate results that are both broadly applicable to the ND lignite industry and specific to each of the individual lignite plants who are participating in this program.

Facilities and Resources

UND CEM houses the Advanced Materials Characterization Laboratory[24], which has all of the analytical equipment needed for the characterization efforts in Tasks 2 and 4. UND CEM also has experimental research facilities that will be available for the project, including the existing CO2M experimental test system and the concrete mixing, curing and evaluation testing facilities. Other facilities available to the proposed project include process simulators; UND has several relevant resources, including ASPEN Plus® and HSC Chemistry, that will respectively be used for establishing heat and mass balances for use in the TEA, and chemical equilibrium calculations to compare the theoretical conversion of chemicals to the experimental results.

Techniques to Be Used, Their Availability and Capability

This information was provided previously in the Methodology section in the description of the tasks to be performed. All of the techniques to be used have been well established in our previous technology development, via the use of various ASTM standards, and in previous successful projects involving similar subject matter.

Environmental and Economic Impacts while Project is Underway

No environmental or economic impacts are anticipated during project execution.

Ultimate Technological and Economic Impacts

We recognize that utilities and researchers have worked for many years on beneficial ash utilization and that many ND lignite plants today are still landfilling their ash. The key advancement/differentiator that our project brings is the leveraging of the CO2M process. We aim to demonstrate that CO2M opens up new economic pathways to ash beneficiation that would not otherwise be possible.

The ultimate technological and economic impacts of this project are significant. The project promotes the economical, efficient, and clean use of lignite combustion residues by creating a circular economy within North Dakota, where coal-derived residues are seen as a valuable resource that can be recycled in a sustainable and environmentally friendly manner. This project can create new job opportunities and ensure economic stability and opportunity in the lignite industry. It can also contribute to the effective marketing of lignite and the by-products associated with it by demonstrating the development of marketable products with a high probability of near-term commercialization.

As the EPA and environmental groups mount additional pressure on utilities relating to coal ash disposal and the construction industry demands more and more high-quality coal ash for cement replacement, it is clear the economic benefits that could be realized if our approach is successful: 1) reduced or eliminated landfilling and its associated environmental and economic liabilities, 2) new significant revenue streams for the power plants, and 3) additional volume of coal ash to offset manufacturing of fresh Portland cement and improved sustainability of the construction industry.

Why the Project is Needed

Coal ash is a large current liability for coal plants, as strikingly evidenced in the recent news about the potential multi-year outage Coal Creek Station might be facing. The project is needed because it offers a sustainable and environmentally friendly solution for the management of coal ashes that are traditionally landfilled at several of North Dakota's lignite plants. This approach not only offers economic benefits for the lignite industry but also promotes sustainable development and use of North Dakota's fossil resources.

STANDARDS OF SUCCESS

The following standards will determine the success of this project:

1) **Identify and verify the characteristics of lignite ash materials that make them unsuitable for cement replacement**: The project should perform a rigorous analytical characterization of the selected materials to determine their chemical composition and morphology and compare against ASTM

standards relating to coal ashes for cement replacement. This will allow us to target specific material properties in the development of beneficiation process schemes.

2) **Demonstrate the technical feasibility of beneficiating lignite ashes to ASTM standards through a process route involving CO2M**: The project should demonstrate the feasibility of CO2M technology for beneficiation of ashes and dry sulfur scrubber residues produced at lignite-fired power plants. The testing should demonstrate achievement of relevant ASTM standards for fly ash for cement replacement and optimize the content of the beneficiated ashes for concrete application.
3) **Demonstrate positive economic and environmental impact**: The project should perform a high-level techno-economic assessment and carbon lifecycle analysis for selected materials and process schemes. The assessment should demonstrate the economic viability of the proposed pathways and quantify the environmental benefits, such as reduction in CO_2 emissions and waste elimination associated with the lignite industry.

BACKGROUND

Since 2008, UND CEM and Envergex LLC have partnered numerous times on successful projects of similar size and in related technical areas and have a strong history of development of innovative products in the energy and environmental field. This team was responsible for the development of the alkali solid sorbent-based CACHYS™ platform for CO_2 capture, of which the proposed accelerated direct CO2M screening tool is an extension, via multiple DOE-funded projects (DE-FE0007603 and DE-SC0010209) totaling over $4.7 million. Envergex and UND-CEM are partnering on the recently awarded SBIR project "Novel materials and Methods to Increase Soil Carbon", a Department of Agriculture funded project (USDA-NIFA-SBIR-008541), to upgrade biomass conversion residues using the team's accelerated direct CO2M technology to generate a product to be used for soil amendment. Additionally, both organizations were key technical subcontractors on a $5 million DOE- and NDIC-funded project to develop an alkali aerosol mitigation technology for high alkali coals (DE-FE00031756), with the technology used developed via a Phase I SBIR project that was awarded to Envergex LLC (DE-SC0015737). The findings of this alkali

control technology will also be incorporated into the proposed project. Finally, the UND team also has world-class expertise, honed through a series of DOE- and NDIC-funded projects totaling more than $10 million, on rare earths and critical minerals, specifically relating to their recovery from unconventional resources.

Each of these ongoing and previous projects demonstrates the strong successful collaboration between UND and Envergex as well as the required technical background (CO_2 capture, gas-solid reaction systems, materials characterization, etc.). Our team has also secured the interest from several industry supporters who add significantly to the project's likelihood of success, both in providing samples for testing and information to direct our efforts.

QUALIFICATIONS

Dr. Johannes van der Watt is a Research Assistant Professor at UND CEM and will serve as Principal Investigator (PI) on the project. He brings over 5 years of energy research experience, particularly in chemical looping combustion sorbent manufacturing and testing (DE-FE0031534). He was an integral part of the development of the SBIR/STTR Phase II (DE-SC0011984) program to develop an evaluation methodology and classification system of oxygen carriers for Chemical Looping Combustion systems. Dr. van der Watt is an expert in gas-solid reaction systems, process modeling, and techno-economic assessments, which are key aspects of the proposed technical approach and scope of work.

Dr. Daba Gedafa is the Chair and Michael & Sitney Lodoen Endowed Professor of Civil Engineering at UND CEM. He has an extensive research experience with coal byproducts including bottom ash, slag, and fly ash for sustainable concrete and asphalt infrastructure. He has determined the optimum content of bottom ash and ground bottom ash with and without nano clay as a fine aggregate and cement replacement, respectively by comparing it to the compressive strength of cement-based concrete. Fresh properties, mechanical properties, and durability of optimum bottom ash and ground bottom ash-based concrete were determined. He also determined the maximum amount of cement that can be replaced by fly ash with and without nanomaterials while providing the equivalent or higher performance of concrete as

compared to the control (cement-based concrete). He also determined the amount of fly ash that can be used to replace asphalt binder and mineral fillers for sustainable asphalt pavements. He is a registered professional engineer, Envision Sustainability Professional, and a fellow of the American Society of Civil Engineers.

Dr. Srivats Srinivasachar, He has 35 years of experience in power generation and manufacturing (coal combustion, cement, activated carbon, gypsum). At Envergex, and previously at ALSTOM Power, he developed and commercialized multiple technologies for power plant operations. At Envergex, he has developed products and services in three main areas: CO_2 capture; value-added product manufacturing; and control of mercury and alkali. Dr. Srinivasachar holds sixteen patents. Dr. Srinivasachar is also the inventor and lead developer of the CACHYS™ platform for CO_2 capture, including the accelerated direct CO2M technology based on the CACHYS™ platform and that is incorporated in this project.

Dr. Dan Laudal, Research Professor and Executive Director of the CEM Research Institute will assist Dr. Van der Watt in the management of the project. In addition to his management oversight role, Dr. Laudal will serve as a technical advisor to the project. He has 17 years of experience associated with management and execution of a wide range of energy-related R&D programs. Dr. Laudal was previously the lead research engineer on development of the CACHYS™ technology for CO_2 capture and has broad expertise in gas-solid reactions. Prior to his current role at UND CEM, he managed Minnkota Power Cooperative's development of Project Tundra[25] and served as Minnkota's environmental manager (2019-2021). As such, he has intimate familiarity with the operations of the Milton R. Young Station.

VALUE TO NORTH DAKOTA

The proposed project is part of a broader DOE-funded effort to evaluate an array of industrial wastes for CO2M and beneficial uses, but a major focus of the project will be on North Dakota's interests (lignite ashes), representing excellent leveraging of non-state funding. North Dakota lignite is unique in several key ways and power plants that use it as fuel have been designed to manage and take advantage of these unique properties. Some of the existing lignite plants, due to their fuel characteristics, boiler designs and air-

pollution control device operations, are unable today to take advantage of the lucrative market for coal ash as partial cement replacement. This project targets these plants and proposes a new enabling pathway to beneficiate these ashes in a cost-effective approach, opening access to cement replacement markets. Importantly, this also has the benefit of eliminating or greatly reducing ash disposal costs and environmental liabilities.

Finally, in today's carbon constrained electric generation industry, several power plants are considering large capital investments in carbon capture technology. On its own, our proposed CO2M approach isn't expected to make a large impact on the plants' CO_2 emissions (but can provide a material revenue stream via carbon reduction benefits, e.g. 45Q). However, our approach integrates efficiently with alkali aerosol control strategies that could become a necessity to manage alkali ash fouling that is likely to be exacerbated by the high capacity factor operations plants will need to maintain after adding CO_2 capture.

MANAGEMENT

Dr. Van der Watt will serve as the project PI and the contact person for UND and will be responsible for the coordination of project activities. He will lead Tasks 1, 2, 3 and 5, and serve as technical advisor for Task 4. ***Dr. Laudal*** will support the PI in project management and will work with the project team to ensure all personnel, equipment, and other resources are available to conduct the project efficiently. He will also serve as a technical advisor across all project tasks. ***Dr. Gedafa*** will lead Task 4 focused on evaluating the properties and performance of the products for concrete applications. ***Dr. Srinivasachar*** will serve as the contact person for Envergex (see Appendix C). He will be involved in all tasks as a technical advisor. The Envergex team will also provide research engineers that will work on-site in the UND laboratories to support the experimental and analytical work proposed. The proposed project will also involve the training of multiple students, who will be mentored and advised by the senior personnel identified above. *The team's resumes are included in Appendix H.*

The organization chart is provided in Figure 5. The project management team is expected to include close coordination with the Lignite Energy Council's technical advisor to the NDIC and the DOE program

manager. UND will also provide a resource manager who will be responsible for budget tracking and other administrative support functions.

Upon project initiation, the following items will be addressed throughout the project: 1) Monitor project scope, schedule, cost, and risk; 2) Update project plans periodically to reflect changes in scope, schedule, cost/risk; 3) Provide quarterly technical reports, participate in meetings, and present at conferences as required. We have prepared a preliminary risk chart, as presented in Table 2.

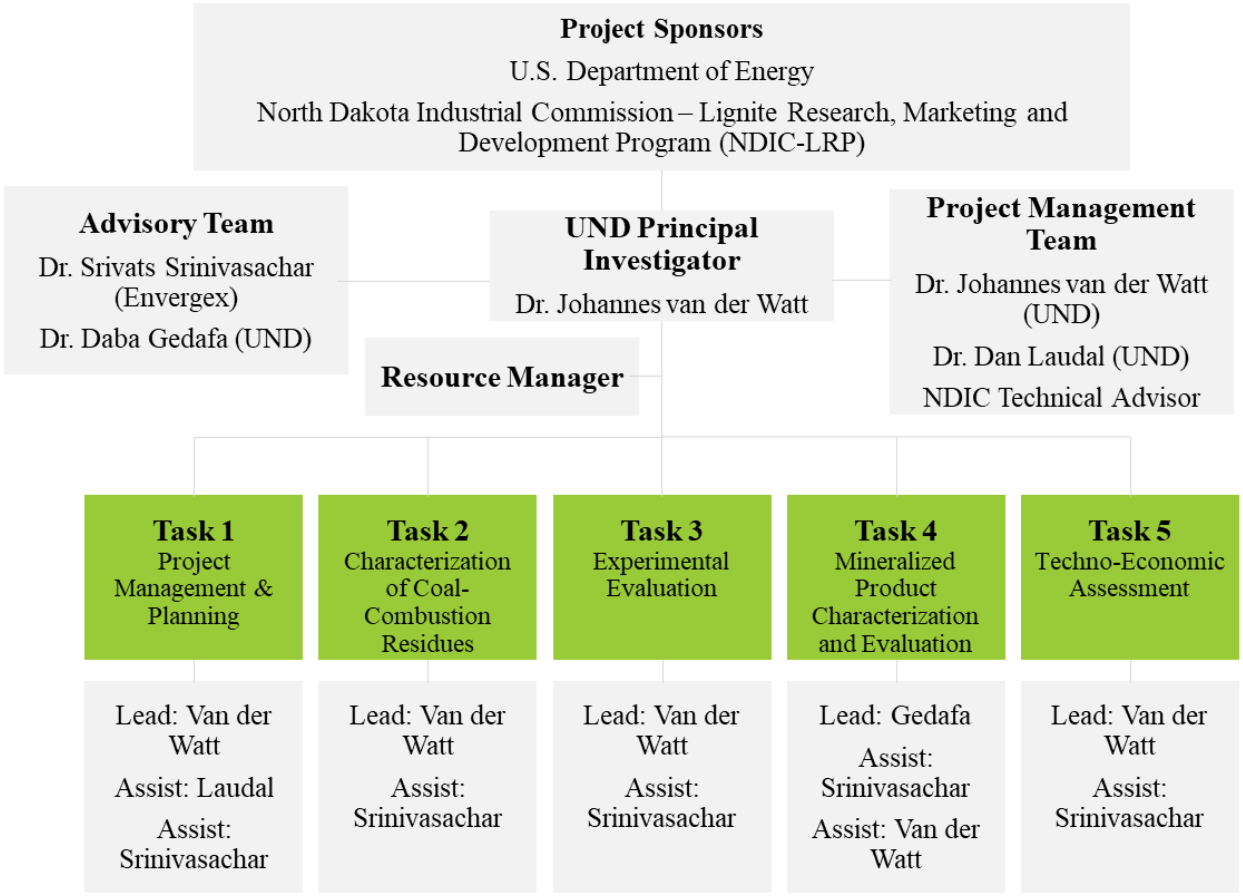


Figure 5: Organization chart.

Table 2: Perceived risks and mitigation strategies.

Perceived Risk	Risk Rating (Low, Med, High)			Mitigation/Response Strategy
	Probability	Impact	Overall	
Financial Risks:				
1 – A crucial activity unexpectedly requires substantial additional funds	Low	High	Low	Project and task managers will determine if any modification is possible to reduce cost and still meet project objectives. Additional funding will be sought if necessary.
Cost/Schedule Risks:				
1 – Task costs are overrun	Low	Med	Low	Budgets for each participant will be developed before work will begin. Costs will be monitored and if necessary, adjustments will be made to stay within the overall project budget.
2 – Task schedules are not met	Low	Med	Med	Schedules for each participant will be developed before work will begin. Regular internal review meetings will be held to stay on track. Additional personnel resources can be allocated to tasks that are behind schedule.
Technical/Scope Risks:				
1 – Unable to procure enough samples for assessment	Low	High	Low	We have secured letters of support from industry entities that have agreed to supply the necessary samples. We will also seek out additional samples from other entities throughout the project, as needed.
2 – Low performance potential determined from sample characterization and testing	Med	Low	Low	This study aims to perform a resource assessment. Poor performance is a valid result. We will adjust our focus to other types of materials or processes if one type is ruled out as being infeasible for this application.
3 – Equipment unavailable for analysis/testing	Low	High	Low	UND has access to all of the necessary equipment to complete the proposed scope. In the event of equipment malfunction, we will seek external options.
Management, Planning, and Oversight Risks:				
1 – Personnel availability	Low	High	Low	Utilize wide range of personnel expertise available at UND and project partners. UND has access to labor in the form of undergraduate/graduate students. Consider hiring of new personnel, as needed. All key personnel identified are committed and available to the project at their specified number of labor hours.
2 – Communication	Low	High	Low	Coordinate and schedule meetings and strictly follow communications plan.
3 – Cost tracking	Low	High	Low	A resource manager will be assigned to the project to assist the PI in tracking costs. Utilization of a project cost tracking system.
4 – Scheduling/meeting milestones	Low	High	Low	Planning system and communication implementation.

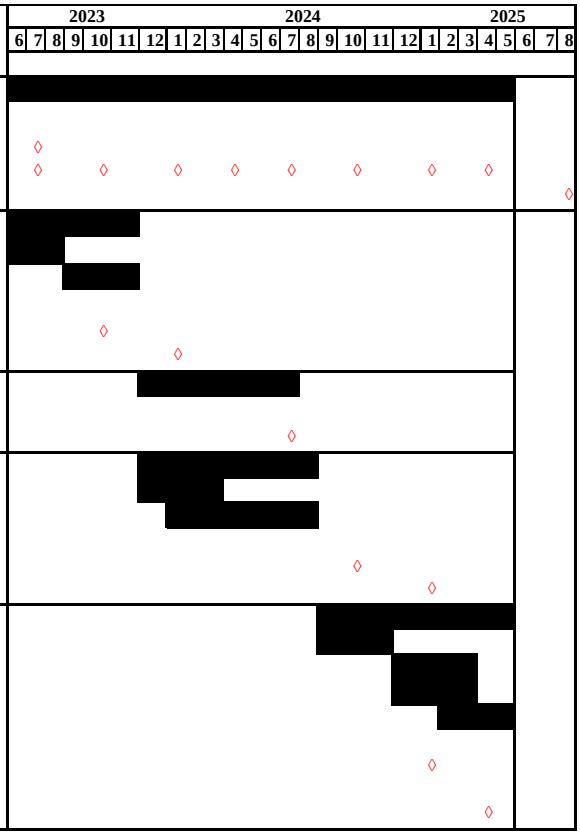
ES&H Risks:				
1 – Emissions	Low	Moderate	Low	Testing will be performed at small-scales and all emissions will be appropriately vented/treated according to UND's policies.
2 – Staff injuries resulting from system operation	Low	High	Low	Safety training according to UND and College of Engineering policies is required for all personnel who use laboratory equipment. An operational review meeting will be conducted prior to project testing.
External Factor Risks:				
1 – Unforeseen risks, e.g. natural disasters; social, legal, or technical changes; project economics; or changes in the political climate	Low	High	Low	Regular updates with project sponsors and project partners to solve issues as they arise.

TIMETABLE

This project has a duration of two years, tentatively starting on June 1, 2023, with the timetable, milestones and deliverables depicted in Table 3.

Table 3: Project timetable.

Task/Subtask/Milestone Description	Tentative Start Date	Tentative End Date
Task 1 - Project Management & Planning	06/01/23	05/31/25
Milestones/Deliverables		
Kickoff Meeting		**06/30/23**
Quarterly Report		**Quarterly**
Final Technical Report (90 days after project end date)		**08/29/25**
Task 2 - Characterization of Coal-Combustion Residues	06/01/23	11/28/23
Subtask 2.1 - Residue Procurement	06/01/23	08/30/23
Subtask 2.2 - Residue Characterization	08/30/23	11/28/23
Milestones/Deliverables		
Procure and prepare residues		**10/31/23**
Procure, prepare, characterize residue materials		**01/31/24**
Task 3 - Experimental Evaluation	11/29/23	05/27/24
Milestones/Deliverables		
Evaluate performance of residues in lab scale system		**07/31/24**
Task 4 - Mineralized Product Characterization and Evaluation	11/29/23	08/31/24
Subtask 4.1 - Reaction Product Characterization	11/29/23	03/31/24
Subtask 4.2 - Product Performance Testing	01/01/24	08/31/24
Milestones/Deliverables		
Description of residue and byproduct properties		**10/31/24**
Summary of product performance		**01/31/25**
Task 5 - Techno-Economic Assessment	09/01/24	05/29/25
Subtask 5.1 - Develop Alternative-Processing Schemes	09/01/24	11/30/24
Subtask 5.2 - Develop Process Flow Diagrams	11/30/24	03/30/25
Subtask 5.3 - Technical and Economic Analysis	11/30/24	03/30/25
Subtask 5.4 - Lifecycle Assessment (LCA)	02/01/25	05/29/25
Milestones/Deliverables		
Complete carbon lifecycle assessment		**01/31/25**
Developed alternative-processing schemes, process flow diagrams and technical-economic analysis		**04/30/25**



BUDGET

The amount of $250,000 (20% of total project cost) is requested from the NDIC. The breakdown of the budget into the DOE share and NDIC share of the funding along with the allocation of the funding is given in Table 4. Budget notes for UND are provided in Appendix D. Additional information about the Envergex commitment to the project and budget can be found in Appendix C.

Table 4: Cost breakdown.

Cost Category	DOE Share	NDIC Share	Total Project
Personnel	$222,242	$115,622	$337,864
Fringe Benefits	$35,439	$30,614	$66,053
Travel	$9,888	$519	$10,407
Materials/Supplies	$6,594	$3,400	$9,994
Equipment	$0	$0	$0
Envergex Subcontract	$449,878	$0	$449,878
Other Direct Costs	$123,944	$30,954	$154,898
Indirect Costs	$152,016	$68,890	$220,906
Total Project	**$1,000,000**	**$250,000**	**$1,250,000**

MATCHING FUNDS

The Department of Energy (DOE) Office of Fossil Energy and Carbon Management (FECM) will provide $1,000,000 in funding for project DE-FE0032244, with an 80/20 ratio match requirement. The DOE contract is currently being negotiated with UND. The award selection letter from DOE is included in Appendix E. For our DOE application, submitted several months ago, we were able to secure NDIC-LRP's provisional cost share commitment letter, which we include in Appendix F.

The DOE funding requires a 20% cost share, which we are requesting from NDIC in this proposal. In the event that the NDIC does not approve this funding request, the DOE project may be in jeopardy, as we will need to seek the required 20% cost share from other non-federal sources.

TAX LIABILITY

A copy of UND's Tax Liability Statement is provided in Appendix G

CONFIDENTIAL INFORMATION

Confidentiality request and confidential information is provided in Appendix A.

APPENDICES

Appendix A: Confidential Information

Appendix B: Letters of Support

Appendix C: Envergex Letter of Commitment and Budget Notes

Appendix D: Budget Notes for UND

Appendix E: DOE Award Selection Letter

Appendix F: NDIC – LRP Provisional Cost Share Commitment Letter

Appendix G: Tax Liability Statement

Appendix H: Resumes

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TECHNICAL REVIEWER RATINGS SUMMARY

LRC-102G: "Recovery and Refining of Rare Earth Elements from Lignite Mine Wastes"

Submitted by: UND Institute for Energy Studies
Principal Investigator: Dan Laudal
Project Duration: 15 months
Request for: $2,000,000
Total Project Costs: $7,999,999

Rating Category	Weighting Factor	Technical Reviewer Rating 33-16	33-17	33-18	Average Weighted Score
Objective	9	4	5	5	
Availability	9	4	3	4	
Methodology	7	5	4	5	
Contribution	7	5	5	4	
Awareness	5	5	4	5	
Background	5	5	4	5	
Project Management	2	5	4	4	
Equipment Purchase	2	3	5	5	
Facilities	2	5	5	5	
Budget	2	5	5	5	
Average Weighted Score:		228	213	232	**224**

Maximum Weighted Score:	250

OVERALL RECOMMENDATION:

FUND		**X**		**X**	
FUNDING MAY BE CONSIDERED			**X**		
DO NOT FUND					

TECHNICAL REVIEWERS' COMMENTS

1. **OBJECTIVES**

The objectives or goals of the proposed project with respect to clarity and consistency with North Dakota Industrial Commission/Lignite Research Council goals are: 1 – very unclear; 2 – unclear; 3 – clear; 4 – very clear; or 5 – exceptionally clear.

Reviewer 33-16 (Rating: 4) *A successful project would move ever closer to a new market for lignite coal and the critical minerals extracted from it, giving value to materials often otherwise discarded with overburden and stabilizing mining jobs and creating new jobs.*

Reviewer 33-17 (Rating: 5) *Project objectives are clearly laid out, which align with the statutory goals and purposes of the NDIC/LRC.*

Reviewer 33-18 (Rating: 5) *The Rare Earth Elements and Critical Minerals that would be produced if a plant is built as a result of this study are seriously needed domestically for the security of the future of US power, transportation and numerous other industries. Having a source in North Dakota definitely applies directly to the economic development opportunities for North Dakota.*

2. **ACHIEVABILITY**

With the approach suggested and time and budget available, the objectives are: 1 – not achievable; 2 – possibly achievable; 3 – likely achievable; 4 – most likely achievable; or 5 – certainly achievable.

Reviewer 33-16 (Rating: 4) *No comment*

Reviewer 33-17 (Rating: 3) *The 15-month technical period to achieve the goals of the proposed project is quite aggressive. I recommend clarifying the potential implications of schedule risk, and what additional resources can be pulled in if tasks are behind.*

Reviewer 33-18 (Rating: 4) *The background research that has been done clearly leads us to this step of assessing the first commercial scale demonstration of this research*

3. **METHODOLOGY**

The quality of the methodology displayed in the proposal is: 1 – well below average; 2 – below average; 3 – average; 4 – above average; or 5 – well above average.

Reviewer 33-16 (Rating: 5) *Quite descriptive and complete.*

Reviewer 33-17 (Rating: 4) *No comment*

Reviewer 33-18 (Rating: 5) *The team that is to be engaged in this project is very well founded in the research and demonstrations of the technology. It is a well-rounded team that can contribute to an accurate assessment of the cost of a commercial scale installation.*

4. **CONTRIBUTION**

The scientific and/or technical contribution of the proposed work to specifically address North Dakota Industrial Commission/Lignite Research Council goals will likely be: 1 – extremely small; 2 – small; 3 – significant; 4 – very significant; or 5 – extremely significant.

Reviewer 33-16 (Rating: 5) *This will be a very big step forward by taking the marginal coal material as it is at the mines, fine-tuning the technology, and finding partners to support a new industry.*

Reviewer 33-17 (Rating: 5) *Understanding the ability and economics to recover rare earth elements and critical minerals from North Dakota Lignite is a clear match with NDIC and LRC goals.*

Reviewer 33-18 (Rating: 4) *The researchers that are part of this project are well qualified to in their respective fields and put together in a team here to get a complete picture of how to make the technology a commercial success.*

5. **AWARENESS**

The principal investigator's awareness of other current research activity and published literature as evidenced by literature referenced and its interpretation and by the reference to unpublished research related to the proposal is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Reviewer 33-16 (Rating: 5) *No comment*

Reviewer 33-17 (Rating: 4) *No comment*

Reviewer 33-18 (Rating: 5) *The principal investigator is well qualified to bring the pieces of these technologies together into an integrated look at commercializing each step of the process.*

6. **BACKGROUND**

The background of the investigator(s) as related to the proposed work is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Reviewer 33-16 (Rating: 5) *The investigators have an extensive history with the project and are extremely qualified to move it forward.*

Reviewer 33-17 (Rating: 4) *No comment*

Reviewer 33-18 (Rating: 5) *Each of the investigators involved and the consultants and contractors that will be part of the process of developing the FEED study are well known and respected in their field of expertise.*

7. **PROJECT MANAGEMENT**

The project management plan, including a well-defined milestone chart, schedule, financial plan, and plan for communications among the parties involved in the project, is: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – very good; or 5 – exceptionally good.

Reviewer 33-16 (Rating: 4) *All the above are included along with a project risk table.*

Reviewer 33-17 (Rating: 4) *The plan is laid out nicely. It will take a total team effort to execute all the deliverables within the 15-month technical period.*

Reviewer 33-18 (Rating: 4) *The management of the project well-presented and very likely to succeed. With the number of parties contributing to the final product, it will be important to keep the project management pieces in the proper order to assure completion on schedule.*

8. **EQUIPMENT PURCHASE**

The proposed purchase of equipment is: 1 – extremely poorly justified; 2 – poorly justified; 3 – justified; 4 – well justified; or 5 – extremely well justified. (Circle 5 if no equipment is to be purchased.)

Reviewer 33-16 (Rating: 4) *Equipment purchases to modify the existing UND pilot system to test modified leaching approach and to pilot test metallization technology.*

Reviewer 33-17 (Rating: 5) *Per Table 5, no equipment is to be purchased from the NDIC share.*

Reviewer 33-18 (Rating: 5) *Not applicable.*

9. **FACILITIES**

The facilities and equipment available and to be purchased for the proposed research are: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – notably good; or 5 – exceptionally good.

Reviewer 33-16 (Rating: 5) *No comment*

Reviewer 33-17 (Rating: 5) *No comment*

Reviewer 33-18 (Rating: 5) *Each entity involved has facilities and equipment that will serve the needs to complete the project.*

10. **BUDGET**

The proposed budget value relative to the outlined work and the financial commitment from other sources is of: 1 – very low value; 2 – low value; 3 – average value; 4 – high value; or 5 – very high value.

Reviewer 33-16 (Rating: 5) *I think there is a high value to the proposed work. The project is highly leveraged with federal funding, and possible additional private in-kind cost share by partners.*

Reviewer 33-17 (Rating: 5) *With DOE's nearly $8M commitment, a $2M commitment from NDIC - while quite significant - is a high value. As laid out, the $2M would fund the 28,856 hours of work for UNO personnel, which is a high value.*

Reviewer 33-18 (Rating: 5) *The value of the work product seems very realistic. Investing $9,999,999 in a FEED study on bringing a whole new industry to North Dakota and a domestic supply chain can be a huge return both financially and to the security of the nation.*

OVERALL COMMENTS AND RECOMMENDATIONS:

Please comment in a general way about the merits and flaws of the proposed project and make a recommendation whether or not to fund.

Reviewer 33-16 (Rating: FUND) *The merits of the proposed project include taking a waste stream from the mines and developing methods which can sort out the best material for mineral extraction while incurring the least disruption to mine operations and extracting target volumes of concentrate from material initially <200 ppm in rare earths, but also extracting higher value critical elements like gallium and germanium. A flaw is the uncertainty of price for off-take of produced metals and a lack of current partners ready to purchase them.*

I recommend the proposed project be funded.

Reviewer 33-17 (Rating: FUNDING MAY BE CONSIDERED) *This is an exciting opportunity for North Dakota to understand a potential new market for lignite coal. The $8M DOE grant award - and the opportunity to compete for a much larger Phase 2 DOE award - speaks volumes. One caution is that this will likely be a challenge to execute this project within the timeframe laid out, and I encourage the NDIC to further understand the schedule risks and ensure there are adequate UNO personnel available to execute the project. My recommendation is "Funding May Be Considered", pending satisfactory answers to this schedule risk concern. If that is resolved, my recommendation would be changed to "Fund".*

Reviewer 33-18 (Rating: FUND) *This is the appropriate time to take this step toward commercialization of the recovery and processing of these minerals. The research behind the process has been methodical and brings the pieces together to make this happen. The need for these materials in the US is well demonstrated and timely. The potential it brings to the mines in North Dakota at a critical time in their existence makes it a very exciting opportunity for the state. My overall rating left a few points on the table, but it would not be unrealistic to give this project the full 250 potential points.*

UNIVERSITY OF NORTH DAKOTA

UND.edu

Vice President for Research & Economic Development
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264 Centennial Drive Stop 8367
Grand Forks, ND 58202-8367
Phone: 701.777.6736
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April 14th, 2023

Reice Haase, Deputy Director
North Dakota Industrial Commission
State Capitol – 14th floor
600 East Boulevard Avenue, Dept. 405
Bismarck, ND 58505-0840

Subject: "Recovery and Refining of Rare Earth Elements from Lignite Mine Wastes," Proposal to the Lignite Research, Development and Marketing Program by Dr. Daniel Laudal, Project Director and Mr. Nolan Theaker, Principal Investigator

Dear Mr. Haase:

On behalf of the University of North Dakota, I am pleased to submit Dr. Daniel Laudal's and Mr. Nolan Theaker's proposal on "Recovery and Refining of Rare Earth Elements from Lignite Mine Wastes," for consideration by the NDIC's Lignite Research, Development and Marketing Program. Dr. Laudal is the Executive Director of the UND's College of Engineering and Mines' Institute for Energy Studies and is the Project Director for this project. Mr. Nolan Theaker is a Senior Research Manager in the UND Institute for Energy Studies, and is the Principal Investigator. Dr. Laudal and Mr. Theaker are proposing a 15-month project with a total requested amount from NDIC of $2,000,000. The NDIC funding is being requested as a match to the DOE portion of the project, which is currently in the process of award negotiation for $7,999,999. The total value of the overall project would thus be $9,999,999. We anticipate a start date in approximately August 2023.

Please contact Mr. Theaker with any technical questions about the project at (859) 319-4635 or nolan.theaker@und.edu. If the NDIC selects this proposal for an award, please send any award documents and related communications to Sherry Zeman at sherry.zeman@und.edu for processing on behalf of UND. The $100 application fee is being handled as an electronic payment by UND and should reach your office in a timely manner. Thank you very much for your consideration of this proposal.

Sincerely yours,

Karen Katrinak

Karen Katrinak, Ph.D., Proposal Development Officer
Karen.katrinak@und.edu 701-777-2505

UNIVERSITY OF NORTH DAKOTA
COLLEGE OF ENGINEERING & MINES

RECOVERY AND REFINING OF RARE EARTH ELEMENTS FROM LIGNITE MINE WASTES

Total Project Cost: $9,999,999

NDIC Funding Request: $2,000,000

Date of Application: April 14, 2023

Project Director:
Daniel Laudal, PhD
Research Professor & Executive Director
College of Engineering & Mines Research Institute
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2844 Campus Rd. Stop 8153. Grand Forks, ND 58202-8153

Principal Investigator:
Nolan Theaker
Senior Research Manager
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UNIVERSITY OF NORTH DAKOTA
COLLEGE OF ENGINEERING & MINES

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ABSTRACT

Objective: The College of Engineering & Mines (CEM) at the University of North Dakota (UND), in collaboration with a comprehensive team of technical, business and host-site partners and with funding support from the U.S. Department of Energy (DOE), proposes to build on prior technology development to complete a Front-End Engineering & Design (FEED) study and develop business and financial plans for a commercial demonstration facility to recover and refine rare earth elements (REE) and critical minerals (CM) from North Dakota (ND) lignite mine wastes. The overall objective of this Phase 1 project is to produce an investment quality project and a committed team that is ready to execute the construction and operation of the REE Demonstration Facility in Phase 2 (~$250 Million).

Expected Results: The previous pre-FEED study and prior development completed by the project team identified key technical gaps. The proposed project will enable closing of those gaps to de-risk the commercialization pathway. The primary impact of the proposed project will be the advancement of a unique set of technologies that can enable cost-competitive North Dakota-based ore-to-metal rare earth elements and critical minerals production with significantly reduced environmental impact.

Duration: The total project duration is 21 months, with a 15-month technical period. The DOE will have a 6-month administrative period for the down-selection for Phase 2.

Total Project Cost: $9,999,999 ($7,999,999 from DOE and a request of $2,000,000 from NDIC)

Participants: Major participants and their project role are listed below.

Organization	Role/Competency
UND (Applicant)	Lignite mine waste REE/CM concentrate technology provider and overall lead
Barr Engineering Co. / McCarl's	Engineering, Procurement, and Construction team
WSP Golder	Wastewater treatment/disposal engineering and environmental
Rare Earth Salts Separation & Refining LLC	REE/CM separation and metallization technology provider; host site provider for separations and metallization facility; preliminary owner/operator of the separations and metallization facility
Microbeam Technologies, Inc.	Technology provider for lignite mine waste feedstock analysis/sorting and germanium and gallium separations
North American Coal Corp.	Host site provider (Falkirk Mine)
Rainbow Energy Center	Host site provider (Coal Creek Station)
BNI Coal, Ltd.	Host site provider (Center Mine)
Minnkota Power Cooperative	Host site provider (Milton R. Young Station)

Note about Nomenclature

Throughout this proposal, we use the phrase lignite mine wastes to describe the lignite-based feedstock that we use as the rare earth elements and critical minerals (REE/CM) resource. We do this to be consistent with the DOE funding opportunity (DE-FOA-0002618) requirements, which had certain limitations around the types of feedstocks that were eligible. Our feedstock represents the lignite materials that are located near the margins of the coal seams (i.e. top/bottom 6-12 inches). These materials are typically higher in ash yield and not suitable as thermal coal for the power plants. In many cases, these materials, particularly the top of the coal seams, are considered the 'cleanings' in today's lignite mining practices, which are scraped off separately and then returned into the mine pits with the overburden materials. Alternatively, we also target thin lignite seams that are not currently economic for thermal coal mining. These are typically 'mined through' and are discarded with the overburden. Because these materials are, in most cases, not provided to the power plants today, they meet DOE's feedstock eligibility criteria. We do not intend to convey any negative connotation or inaccuracy in our use of the phrase lignite mine wastes within the context of this project.

PROJECT SUMMARY

Project Objectives

The College of Engineering & Mines (CEM) at the University of North Dakota (UND), in collaboration with a comprehensive team of technical, business and host-site partners and with funding support from the U.S. Department of Energy (DOE), proposes a Phase 1 project that builds on prior technology development to complete a Front-End Engineering & Design (FEED) study to recover and refine rare earth elements (REE) and critical minerals (CM) from North Dakota (ND) lignite mine wastes. ***The end of project goal is to have an investment quality project and a committed team that is ready to execute the construction and operation of a commercial REE Demonstration Facility in Phase 2.***

Our team was recently selected for a Phase 1 award under DE-FOA-0002618 (BIL – Rare Earth Element Demonstration Facility) as ***one of only two awardees*** (West Virginia University) ***that will compete for a much larger Phase 2 opportunity (expected ~$250 Million)***. This proposal to NDIC is to provide cost share to the Phase 1 DOE award, which is currently in negotiation and is expected to begin in August 2023.

To achieve the end of project goal stated above, the Phase 1 objectives are as follows: **1)** Quantify the proposed project's job benefits and evaluate how to attract, train, and retain a qualified workforce. **2)** Identify specific DEIA goals, targeted outcomes, and implementation strategies. **3)** Ensure that the project will provide meaningful benefits to disadvantaged communities and will not result in an increased burden to the disadvantaged community. **4)** Identify and implement methods for project stakeholder engagement. **5)** Develop information for all required permit applications and other regulatory approvals, including the Environmental Assessment information for NEPA review, by the end of Phase 1. **6)** Develop an AACE Class 3 FEED study for the REE Demonstration Facility to advance the project to investment quality. **7)** Perform limited R&D to de-risk certain technology subsystems. **8)** Develop the Phase 2 business and financing plans to formalize the overall commercial structure and secure construction financing.

Project Structure

The project's preliminary organization is summarized in **Figure 1**. Additional details are provided below.

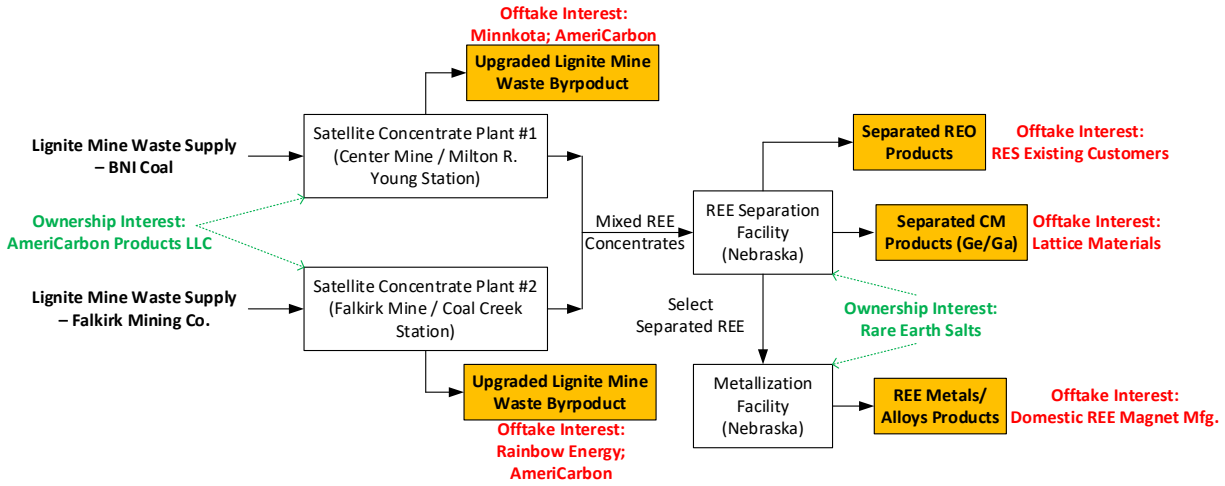

Figure 1. Preliminary structure of the REE Demonstration Facility

Mixed Rare Earth Concentrate (MREC) Plants

This project will evaluate two ND host sites producing two or more products: 1) MREC with a purity of at least 75wt% REE on an oxide or salt basis and 2) a unique lignite carbon ore that could be used as a blending fuel for the power plants or as a feedstock for high-value carbon products. We will evaluate host sites near the Center Mine / Milton R. Young Station (MRYS) and near the Falkirk Mine / Coal Creek Station. As indicated in **Figure 1**, we have received interest from project partner AmeriCarbon LLC in being part of the ownership venture should the project be selected for Phase 2. We have also received letters of interest from the lignite mines and from the power plant owners to provide feedstock (lignite mine waste) to the MREC plants and to purchase the lignite carbon ore product. The MREC plants will be designed to produce at least 1 metric ton per day (mtpd) of total MREC. The MREC is planned to be trucked to the existing REE separation facility of project partner Rare Earth Salts Separation & Refining LLC (RES) located in Nebraska.

A ***preliminary mass balance for the two ND host sites*** is presented in the following section. ***Approximately 1.1 mtpd of MREC will be produced*** (assuming a typical plant on-line / capacity factor).

Preliminary Center Mine MREC Site Mass Balance**:** The site will produce approximately 37% of the total REE. Processing 1.26 million mt/yr of lignite mine waste results in an estimated 134 mt/yr of 75% purity MREC. Assumptions are: 50% REE recovery, average ore grade containing 114 ppm REE on a dry, whole-coal-waste basis, and collecting 90% of the coal waste exposed during existing mining operations, assuming some lost recovery during mining.

Preliminary Falkirk Mine MREC Site Mass Balance**:** The site will produce approximately 63% of the total REE. Processing 1.89 million mt/yr lignite mine waste results in an estimated 233 mt/yr of 75% purity MREC with an average REE ore grade of 132 ppm (same assumptions as above).

The REE-extracted lignite co-product would represent ***<20% of the total coal fired*** by the adjacent power stations, resulting in an ***ideal quantity of high-quality blending fuel to manage ash fouling/slagging challenges***. In addition, the above REE production rates do not account for the

significant and economically important production quantities of CM, specifically, an ***estimated total production of high purity Ge and Ga at 45 mt/yr*** (combined).

REE Separation and Metallization Plants

RES plans to expand its existing commercial REE separation facility's footprint and capacity and already has land acquired or available to enable this expansion. We plan to co-locate a metallization facility that will use selected individually separated rare earth oxides (REO) from the RES facility to manufacture metals or metal alloys that would be direct feeds to commercial products, such as rare earth magnets. RES has a metallization technology in development that will be the focus of this proposed effort.

Figure 1 indicates that the germanium and gallium (Ge/Ga) concentrate products would be produced at the RES facility. However, this could also be completed at one or both of the ND host sites. The proposed project will examine the most cost-effective integration approach for the Ge/Ga products. **Lattice Materials**, a Montana-based manufacturer of Ge products, has expressed strong interest in purchasing the Ge/Ga products (see letter in Appendix 5).

RES is interested in owning/operating the separations and the metallization plants. RES already has domestic and international customers that purchase their REO products and we expect to be able to leverage those relationships for product offtake (favoring domestic customers).

Because the current domestic REE magnet manufacturing capacity is limited (or zero), the domestic market for the rare earth metals/alloys products is less certain. We will work with project partners to identify potential offtakers during the Phase 1 project. The establishment of North Dakota-based REE magnet manufacturing capacity would be a huge win for the state and opportunities for this will be explored in the proposed project in connection with other complimentary projects at UND (i.e., the Williston Basin CORE-CM project partly sponsored by NDIC).

Our team has had initial discussions with AmeriCarbon LLC about their interest (see letter in Appendix 5) in owning one or both of the two ND concentrate plants. AmeriCarbon is commercializing its

Eco-Pitch™ technology[1], which cost-effectively produces tailored pitches from domestic coal that can be used for numerous end-use applications. AmeriCarbon is currently pursuing business plans and fundraising for the first commercial pitch plant in North Dakota, which would use lignite coal as the feedstock. Lignite has several unique features compared to other coal types that are advantageous for the Eco-Pitch™ process. ***AmeriCarbon is very interested in using the REE-extracted lignite material as a feedstock*** in their in-development commercial Eco-Pitch™ plant based on early discussions with our team and initial analysis of the REE-extracted lignite materials that our technology produces. The company is interested in evaluating the technical and business opportunity of integrating the two processes at a single site to maximize the synergy between REE extraction and pitch production. AmeriCarbon will engage with our team during Phase 1 to provide technical and economic/business input for this evaluation and will consider being a key member of the owner/investor/operator team that would move forward to Phase 2.

Engineering, Procurement and Construction (EPC) Team

Barr Engineering will lead the engineering effort in Phase 1, maintaining continuity from previous projects including the pre-FEED. We have chosen to engage, from the start, the construction lead, McCarl's, for our project as well. McCarl's will evaluate the constructability of the Facility in Phase 1 and support the cost estimating. We believe this approach will be more effective than developing a design package in Phase 1 and bidding out construction. Barr will lead the FEED study during Phase 1 with the support of McCarl's. These roles would switch during Phase 2, with McCarl's leading the procurement and construction effort and Barr supporting the engineering effort. ***The EPC team is committed to using local contractors/labor whenever practical***.

Barr Engineering also has a comprehensive Environmental practice and will be able to lead the efforts around NEPA and drafting the permit applications on behalf of the project owner(s) and the federal agency. WSP Golder (Golder) will lead efforts associated with wastewater disposal at the two planned ND concentrate plant locations, preliminarily planned via Class I injection (Underground Injection Control

(UIC) program). Golder previously designed the existing operational Class I well at the Coal Creek Station site, one of our proposed ND host sites, and recently worked with Minnkota on designing and permitting a Class I well at the MRYS site, the second of the proposed ND host sites. The team has everything needed to design, permit, and construct the proposed facilities.

Our team has the support of the ND Building Trades Unions[2] (see letter in Appendix 5) through discussions with President, **Jason Ehlert**. McCarl's is a union shop; therefore, it was critical to engage with the local unions early in this project to ensure support and that the necessary skilled crafts and labor will be available when needed. Our project team's intent is to use union labor whenever possible, and we are happy to have the commitment of the NDBTU to support our project, including helping us develop the Community Benefits Plan and working towards executing a Project Labor Agreement in Phase 1.

Project Team Members and Roles

We have formed a comprehensive technical, environmental and commercial team to execute this project and position us for a future Phase 2 selection. The table below provides the project team members and their key roles in the Phase 1 project.

Organization	**Role/Competency**
UND (Applicant)	Technology provider, process engineering, project management/coordination
Barr/McCarl's	FEED study lead, NEPA and permitting lead
Golder	Wastewater treatment/disposal lead, including NEPA and permitting
RES	REE/CM separations and metallization lead, host site and preliminary owner/operator
Microbeam Technologies, Inc.	Technology provider for mine waste feedstock analysis/sorting and Ge/Ga separations
North American Coal	Host site provider (Falkirk Mine)
Rainbow Energy	Host site provider (Coal Creek Station)
BNI Coal	Host site provider (Center Mine)
Minnkota	Host site provider (Milton R. Young Station)
AmeriCarbon	Preliminary owner of the ND REE concentrate plants & offtake for REE-extracted lignite mine waste byproduct
Envergex LLC	Greenhouse gas lifecycle analysis and process modeling
Dennis James Consulting	Technical consultant - mining
MLJ Consulting	Commercial consultant
Odney	Community Benefits Plan development and implementation consultant
U.S. DOE	Project sponsor

PROJECT DESCRIPTION

Background

Lignite Mine Waste as the Feedstock

Our prior work in developing the lignite mine waste resource and our proposed MREC technology has identified the numerous performance and environmental benefits made possible by the unique properties of our proposed feedstock.[3,4,5 & 6] These are summarized as follows:

1) The organic binding of the REE/CM enables extremely rapid and highly selective REE/CM extraction with mild acids via a cation exchange process. ***Within only a few minutes of contact time, high leaching efficiencies are achieved*** while also significantly limiting the impurities (i.e., Fe, Al, Th, U) that are extracted with the REE/CM.

2) The actinides (Th, U) also appear to have an organic association in the lignite mine wastes, but one that is stronger than the REE and target CM (Ge/Ga). Therefore, ***our tuned leaching process is able to leave behind the large majority of the actinides in the lignite material where it does not represent a concern, thereby avoiding actinide up-cycling concerns within our process.***

3) High total REE concentrations have been identified at numerous sites, including the existing mines. The key unique feature of our lignite mine wastes, however, is the enrichment in the more valuable heavy REE (i.e. Dy, Tb) as compared to traditional mineral ores and other unconventional resources (i.e., higher rank coal-based materials). We are ***uniquely able to target the extremely high value applications for high-temperature REE magnets (high Dy, Tb content).***

4) We have the ability to cost-effectively co-produce very large quantities of the critical semiconductor metals Ge and Ga. We are not aware of any significant domestic production capability of these CM. The previous AACE Class 4 study indicated that ***a single MREC plant (Falkirk Mine site) would produce more than 30% of the annual domestic Ge demand***. No other coal-based resource that we are aware of is

afforded this opportunity. Our previous studies have indicated that Ge/Ga represent a major portion of our total projected revenues, offering the ability to insulate against REE market pricing fluctuations.

5) Our technology is also unique because we are able to not only recover valuable REE/CM from the lignite mine waste, but we are also able to upgrade it into a unique carbon-based ore for use as a low ash (~zero-sodium (Na)) blending fuel for thermal coal or for carbon-based products manufacturing. This provides a very large new revenue stream while also ***improving overall lignite mine resource recovery/utilization and ultimately reducing the environmental impact of mining.***

MREC Facility and Associated Technologies

The MREC facility uses technologies developed by Microbeam Technologies, Inc (MTI) and UND, and the margins of lignite seams and thin, currently uneconomic seams, as the feedstock (lignite mine wastes). These materials are typically high ash yield and not suitable for thermal coal. The first step in the process is selectively mining these materials, which is currently performed today as the 'cleanings' step the lignite mines use to generate a clean seam top. These 'cleanings' are temporarily stockpiled while the thermal coal is excavated and then later discarded to the mine pits. Our proposed plant will use those materials as the REE feedstock instead of discarding them. Because the lignite feedstock represents a major portion of the project's O&M costs, ***it will be key to the economics of the project that we minimally disrupt the existing mining operations and mine plans of our lignite mine partners.*** Selecting only the cleanings fraction, which is already separated today in current practice, will allow us to achieve this requirement.

We will use MTI's analysis and sorting technology to separate high REE from low REE materials and enable blending to achieve a stable feedstock grade once the lignite mine wastes are recovered. MTI's analysis algorithm has been tested on a range of REE concentrations and shows sensitivity to the 10s of parts per million (ppm) (**Figure 2**). The feed can be further concentrated using density-based separations (spiraling) to recover the REE-rich organic materials and reject the REE-depleted (and impurity-enriched) mineral matter before or after blending. This REE-rich organic material, similar in bulk chemical

composition to the mined thermal coal (ash content), is then sent for mild acid leaching.

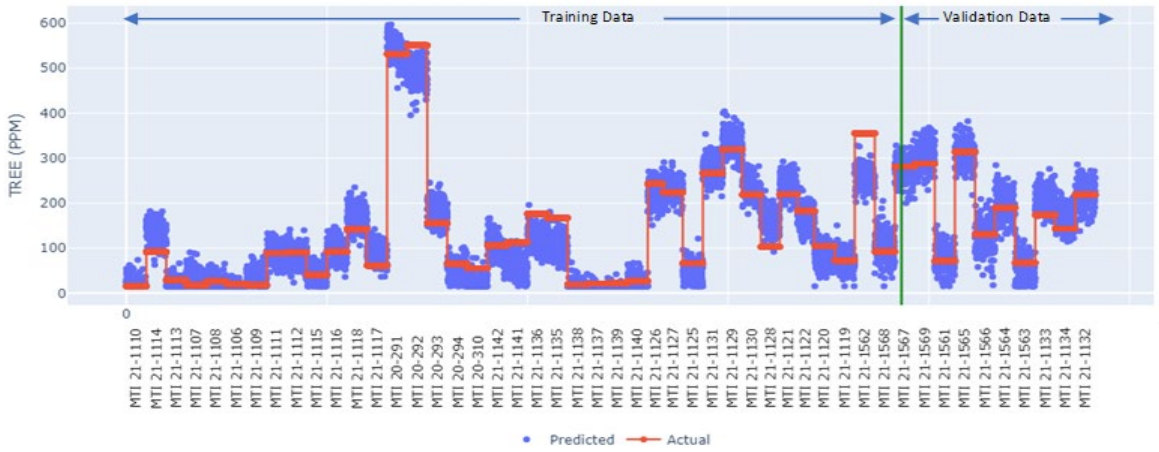

Figure 2. Ore analysis algorithm training/validation from MTI's previous development using PGNAA-DGA

The leaching leverages the organic bonding of the REE/CM in the lignite waste materials[4], extracting the REE/CM and other inorganic materials into a pregnant leach solution (PLS). The lignite material structure is essentially unchanged, except for a near complete removal of the organically bound inorganic elements. The solution is a dilute mineral acid and we maximize slurry density to reduce possible PLS dilution effects and minimize wastewater volume. **Figure 3** shows leaching efficiency (including Th/U).

The REE-extracted lignite is washed in multiple stages to recover the acid and REE/CM contained in the pore volume, then dewatered (filter press). This REE-extracted lignite material is a unique carbon-based material that is a high-value blending fuel (low ash and, importantly, near-zero sodium). This material is also an ideal feedstock for carbon-based products manufacturing, with an organic ash content between 0.25-0.5%, down from ~6% in the raw ore. **Figure 4** is a schematic of the above process steps.

The process then uses a mixture of hydrometallurgy and pyrometallurgy to recover the REE/CM product streams from the filtered PLS. A base is added to the PLS to increase the pH and precipitate iron-rich impurities. Oxalic acid is then added, along with a base to maintain the desired pH, to selectively precipitate two REE-oxalate mixtures: one with high REE purity and one enriched in scandium (Sc) and HREE (**Figures 5 & 6**). Direct precipitation purities of the first concentrate in excess of 75% have been produced using suitable process controls.

The oxalates are roasted to produce rare earth oxides (REO), which are re-dissolved in mineral acid (Ce is mostly rejected, beneficially, at this stage due to insoluble +4 oxidation state) and passed through a selective ion-exchange column to increase REE concentration to >75wt% (**Figure 7**) (reject primarily Ca & Al). The purified REE solution is then mixed with a precipitant to recover the high-purity MREC products. The Ge and Ga are volatilized during roasting and are then selectively condensed to form Ge and Ga concentrates as oxides via MTI's technology and subsequently processed to high-purity via conventional processes.[7,8] The products are at least 1 mtpd of the MREC products and the >99.99% separated Ge and Ga products. Additionally, the produced wastes, Fe-rich precipitates and wastewater, are RCRA-compliant, non-hazardous wastes, reducing potential environmental burdens associated with the process. **Figure 8** is a schematic of the PLS processing and product recovery steps.

The data presented in the preceding sections and figures below and on the next page regarding UND's MREC technology are based on bench-scale testing. We note that the bench-scale testing, while successful, also identified several opportunities/approaches for process improvement, including higher efficiency leaching and reduced chemicals consumption. These improvement opportunities are a focus in our ongoing pilot project and will be further refined in the proposed Phase 1 project.

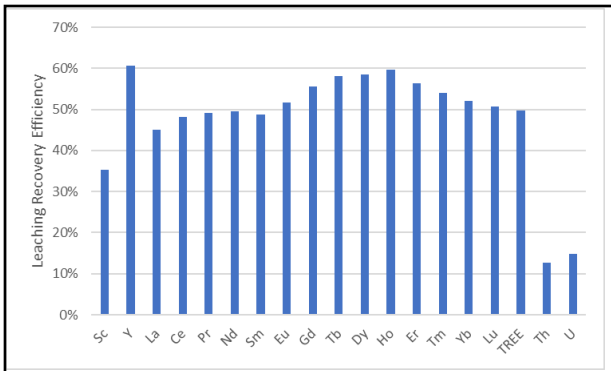

Figure 3. Leaching recovery efficiency for REEs and actinides. Improvement is expected at scale due to improved dewatering efficiency.

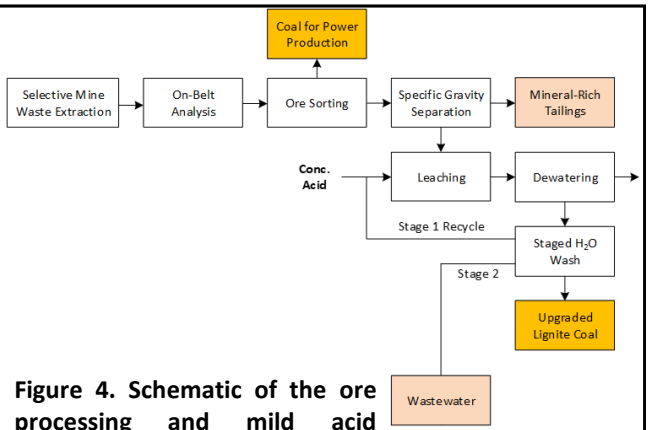

Figure 4. Schematic of the ore processing and mild acid leaching steps.

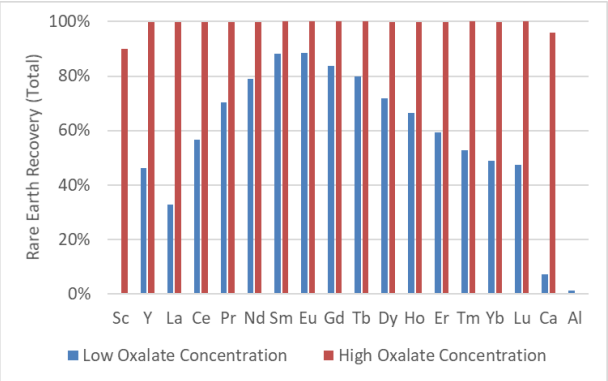

Figure 5. Oxalate precipitation recovery via UND's 2-step process. Two stages enables a high REE purity 1st product and high Sc concentration 2nd product.

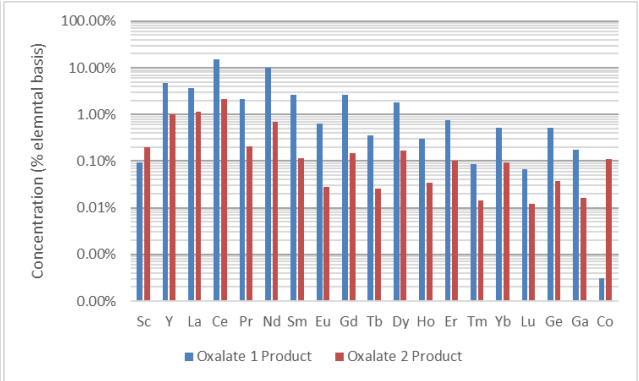

Figure 6. Oxalate precipitation purity for each of two products. Note the significant enrichment of Sc into the second product, relative to the lanthanides.

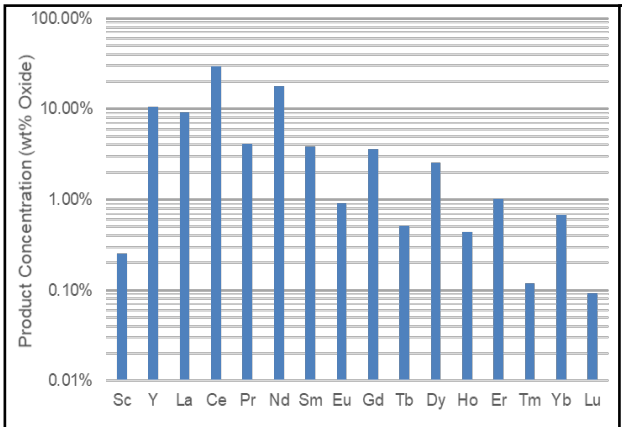

Figure 7. Product purity after calcination and ion exchange treatment. Total REE > 85%.

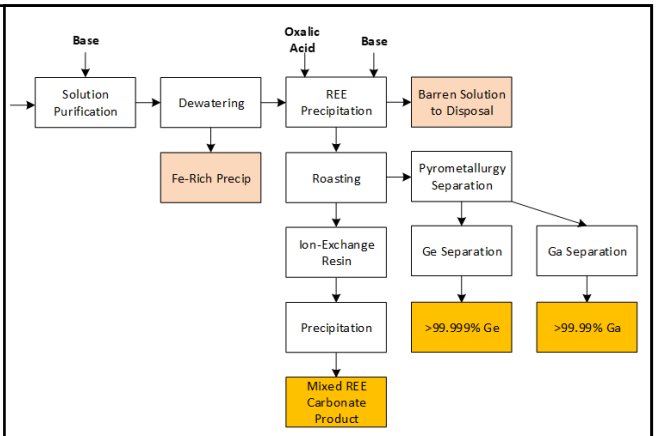

Figure 8. PLS processing and MREC and Ge/Ga product recovery steps.

Methodology

The project objectives identified previously will be achieved through the implementation of five primary efforts during the 15-month technical period: **1)** Development and execution of a Community Benefits Plan; **2)** Development of the technical and environmental information for NEPA reviews and drafting of all relevant permit applications; **3)** AACE Class 3 FEED study for the proposed REE Demonstration Facility; **4)** Limited de-risking R&D, including: a) testing MTI's feedstock analysis and sorting technology to increase to technology readiness level (TRL) 6 and optimize for this application, b) confirming the suitability of Class I injection for MREC plant wastewater disposal, c) testing RES' metallization technology with next

generation cell design to de-risk scale-up for the proposed application, and d) pilot testing in UND's existing pilot facility for host-site-specific lignite mine waste feedstocks; and **5)** Development of the business and financing plans for Phase 2 construction and operation for the REE Demonstration Facility. This work is divided into 7 tasks, described below.

Task 1 – Project Management and Planning: This task will involve all project management activities necessary to meet all technical, schedule, budget objectives, and requirements, including updating the project management plan (PMP) and the technology maturation plan (TMP). UND will lead this task with support from all project team members.

Task 2 – Community Benefits Plan: This task involves developing, updating, and the continuous review and implementation of four plans: **1)** Quality Jobs Plan, **2)** Diversity, Equity, Inclusion and Accessibility (DEIA) Plan, **3)** Justice40 Initiative (J40) Plan, **4)** Community, Labor, and Stakeholder Engagement Plan. UND will lead this task with support from Odney and our host site partners.

Task 3 – National Environmental Policy Act (NEPA): This task involves updating the Environmental Volume submitted previously with the DOE application and developing an Environmental Assessment that will provide the federal agency with the information to determine a Finding of No Significant Impact. We assume an Environmental Impact Statement will not be required since all host sites are on existing industrialized land. Barr will lead this task with support from Golder, UND and host site partners.

Task 4 – Permits for Construction and Operation: We have identified the applicable permits listed in the table below for the two ND host sites (MREC plants) based on a preliminary assessment. We have initially assumed that the existing permits for the existing RES facility (to be expanded in Phase 2) will need to be reviewed and modified. This task will develop all information necessary to draft ready-to-submit permit applications by the end of Phase 1. Barr will lead this task with support from Golder, UND and our host site partners.

Agency	Permit/Authorization
U.S. Army Corps of Engineers	Section 404 Authorization (Nationwide Permit)
ND DEQ	Section 401 Water Quality Certification (issued for Nationwide Permit)
ND DEQ	Air Quality Permit to Construct
ND DEQ	Construction Stormwater General NDPES Permit (NDR11-0000)
ND DEQ	Industrial Stormwater General Permit (NDR05-0000)
ND Department of Water Resources	Water Appropriation Permit
ND DEQ	Class I (Underground Injection Control Program) Injection
U.S. EPA	Aquifer Exemption Request & Approval for Class I injection

* ND DEQ: North Dakota Department of Environmental Quality

Task 5 – AACE Class 3 FEED Study: The FEED study will follow the requirements outlined in Appendix B in the FOA and will encompass the two ND MREC sites and the REO separation and metallization facility in NE. These requirements will be completed by specified leads in the following disciplines: Process Engineering, Mechanical Engineering, Electrical Engineering, Structural Engineering, Civil Engineering, Environmental Engineering, and Cost Estimation Engineering. This effort will be led by Barr Engineering and will be highly coordinated with the technology developers (UND, RES, MTI) and our construction partner (McCarl's). The division of responsibility for this task is provided in **Table 3** (found within the Management section of this proposal).

Task 6 – Circuit De-Risking Research: This task is dedicated to limited R&D on certain subsystems of the overall technology package that present the highest risk for the successful construction and operation of the REE Demonstration Facility in Phase 2. Four subtasks are included.

6.1) Ore Concentration De-Risking: MTI will lead this subtask to perform performance verification testing of their lignite mine waste online (on-belt) analysis and sorting technology. The goal will be to advance to TRL 6 by testing host-site-specific feedstock on commercial-scale analysis equipment to verify the performance of MTI's proprietary analysis algorithms and determine the most cost-effective sorting/blending configuration to include in the FEED. MTI will work with commercial equipment vendor, Energy Technologies, Inc., on this subtask.

6.2) MREC Plant Wastewater Disposal De-Risking: The previous pre-FEED study identified that

wastewater disposal was a significant component of the total plant O&M costs. Our team has since identified Class I deep well injection as a suitable and significantly lower-cost option. Golder will perform a feasibility assessment based on pre-FEED data and existing geologic characterization data available from our host site partners' CO_2 geologic storage project developments to confirm the technical and economic feasibility. This subtask will determine whether Class I injection is chosen for the FEED or another disposal option is needed.

6.3) Metallization De-Risking for Scale-Up: This subtask will leverage and expand upon existing metallization research conducted by RES to produce XRD-verified rare earth metals and enable the low-risk scale-up required for the proposed REE Demonstration Facility. The goal of this testing is to utilize newer, more environmentally controllable electrolysis cells that are commercial for other metals instead of the high-temperature, manual-based process currently used worldwide. The successful de-risking of this technology would involve using a standard electrolysis cell for similar, high-melting, and reduction point metals with minimal alterations at a scale of at least $1/10^{th}$ of the proposed demonstration scale. The standard molten salt electrolysis method will be chosen for the FEED if this de-risking is not successful.

6.4) Pilot Testing of Host-Site-Specific Lignite Mine Wastes: This task has two goals: **1)** piloting with site-specific feedstocks (previous/ongoing bench-scale testing and piloting involved substantially similar feedstocks but from other mines/locations) will provide for more accurate performance data for the FEED, which propagates from the MREC plants through the metallization facility, and **2)** we propose testing a modified leaching setup that will recycle a portion of the leachate, increasing the concentration of the REE/CM and limiting wastewater volume. Testing will examine the performance of this modified approach and will also determine any detrimental impacts, such as upcycling of contaminants (including Th, U), and increasing the solution's anionic strength. Approximately 75 tons from each of our ND host sites will be piloted. UND will lead this testing.

Task 7 – Financing and Business Plan Development and Implementation: An in-depth analysis of existing

business engagements, contracts, and financial options will be performed to most effectively prepare the project team and stakeholders for the successful construction and operation of the REE Demonstration Facility. This analysis would significantly reduce future project risk to all parties. We will develop detailed business and financing plans and implement them to close on all business and financial agreements/ contracts prior to Phase 2. We have identified a tentative commercial structure for Phase 2 (**Figure 1**). This task will build on the initial concepts to finalize and formalize our project for Phase 2 consideration.

Anticipated Results

Anticipated results will include the de-risking and deep examination of a first-of-a-kind (FOAK) REE/CM Demonstration Facility, advancement of technologies to prepare for commercial deployment at a measurable market capacity, and the development of a business and ownership model for deployment of the technologies into the US market. All of this will be accomplished with the goals of maximizing the positive impacts, such as jobs and opportunities, to the communities involved in the project, and minimizing environmental impacts.

FOAK De-Risking

REE/CM technologies focusing on unconventional resources, such as coal and coal byproducts, present FOAK risks associated with the technologies themselves and the feedstocks. We have also identified the key technical gaps that remain today, despite the several years of development of these technologies. As such, both the AACE Class 3 FEED study and the proposed de-risking R&D (Task 6) will be pursuing the mitigation/elimination of the most highly impactful risks to commercial deployment. These include items such as feasibility of permitting at the proposed scales, practicality of equipment size and chemical intake mechanisms with local infrastructure, as well as a detailed economic case, outlining a number of possible scenarios of facility operation to identify and quantify most probable scenarios of revenue. Ideal project results point towards a technically, economically, and environmentally feasible REE production facility, including a business and ownership strategy to carry forward the project into construction in Phase 2.

Increasing Technology Readiness Level

Each of the proposed technologies has been demonstrated at high TRL levels, with some sub-components at commercial scale (**Figure 9**). All subsystems, except for ore analysis (MTI) and REE metallization (RES), will be at TRL 6 or higher by the start of Phase 1. We note that some of these subsystems are less than TRL 6 today; however, these subsystems will achieve TRL 6 by the end of the ongoing pilot-scale testing at UND (DE-FE0031835; Summer 2023). We propose de-risking R&D in Phase 1 for the two subsystems currently lower than TRL 6, increasing them to TRL 6 and de-risking the overall integrated process circuits.

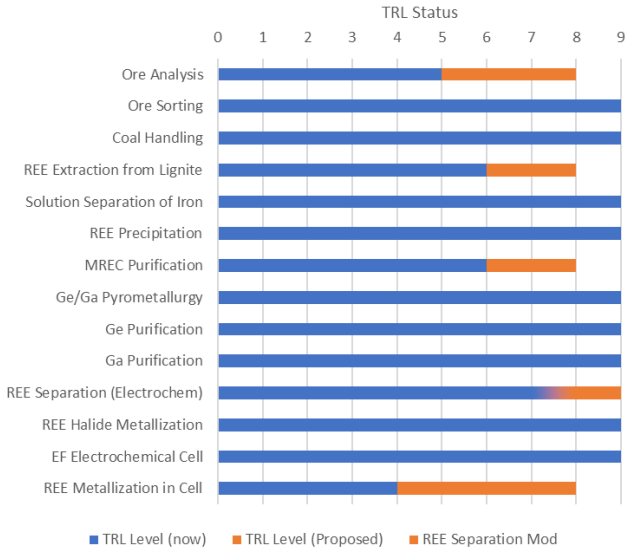

Figure 9. TRL level of each technology subsystem, current and proposed (end of Phase 2).

With the completion of the Phase 1 project, the proposed technologies would each reach a minimum of TRL 6 (having undergone prototype-scale production), and will enable the deployment to the commercial scale in the Phase 2 effort. Additionally, the evaluation of all process parameters and equipment through the lens of an AACE Class 3 FEED study will significantly improve the ability to rapidly deploy the proposed facility concept into the FOAK facility, and follow-on facilities as applicable.

Development of a Business Strategy for REE Market Deployment

The development of a robust and stable business and ownership strategy for the deployment of the proposed facility concept in a Phase 2 effort is as critical as the anticipated technical results. Task 7 is devoted entirely towards the establishment and management with new and existing contracts surrounding ownership, off-take, and other contracts to best develop a coherent, integrated business strategy, as well as the securement of financing for the deployment of the Phase 2 effort. A favorable project result for this effort would detail a strong business strategy, including identification of

owner/operators of all REE/CM-related facilities; business contracts between mines, MREC plant, coal off-taker, REE off-taker, CM off-taker, and any downstream processors; and the securement of all financing required for the construction, commissioning, and continued operation of a REE/CM production supply chain from lignite mine waste.

Facilities and Resources

UND has world-class laboratory and pilot experimental research facilities, including the pilot-scale REE/CM extraction system that is currently in operation. UND also has a commercial license for Aspen Plus, which will be used to develop mass and energy balances for the proposed FEED study. RES has 25,000 ft^2 of commercial facility and laboratory spaces and exceptional analytical capabilities. MTI has existing lab- and bench-scale facilities and world-class analytical capabilities. Host site partners, North American Coal/Rainbow Energy, BNI Coal/Minnkota, and RES have existing industrial operations that will be able to support the integration of the proposed REE Demonstration Facility. The proposed FEED study will undertake the task of identifying the most cost-effective plot space location and integration for the two proposed MREC plants and the separation and metallization facility. UND and project partners have the necessary office and computing facilities for the proposed project. We propose purchasing a limited amount of equipment in Phase 1 to modify the existing UND pilot system, which would enable us to test a modified leaching approach (de-risking R&D) and perform pilot testing for RES' metallization technology.

Techniques to Be Used, Their Availability and Capability

FEED Study

Two MREC plant sites are planned. We will evaluate each site separately, retaining the items that are common to both and updating those items that are not. For instance, the two sites will likely have different transportation, storage, feedstock blending, and waste management needs that arise from their locations and the lignite mine waste feedstock used, including high/low clay, moisture, and waste types. The separation and metallization plant will also be evaluated and incorporated.

The environmental aspects of each distinct site will affect the engineering requirements and costs for each site. An example of this is the disposal of tailings, where one site near existing permitted disposal facilities may be more easily constructed and permitted than another site requiring additional infrastructure to meet requirements for a “green field” permit.

A different Design Basis report and Process Philosophy will be developed for each site. The plans, specifications, and vendor quotes will vary between the two sites. The third site will be independent and likely similar regardless of which site is used for the final concentrate processing. The Design Basis report will include the environmental considerations as well as the technical requirements for the assumptions made with the ore body. The ore body may not be fully defined, and the Design Basis report will incorporate the robustness needed to process varying degrees of ore grade.

Our approach to these plans is to maintain a robust work breakdown structure (WBS) that maintains the separation of design documents for each site but allows for leveraging the commonalities between them. We will enhance this WBS approach by building a robust process model that addresses the requirements and differences for each site, which will translate to custom designs and documents for the two MREC sites; however, these may be more similar for the third site that processes the concentrate. The custom designs and documents for the three sites will affect all engineering disciplines.

The site-specific deliverables described in the previous section will form the basis for developing material take-offs (MTOs) and other quantities that form the basis of the AACE Class 3 opinion of installed capital cost. The resultant capital cost will be substantiated with a thorough Basis of Estimate document that indicates details such as how each of the quantities were estimated and which materials and rates were used. The Basis of Estimate will provide documentation for the cost values, including equipment and material quotes, local labor rates, references to previous projects, and industry databases. The accuracy of each line item will be estimated based on the source of the costing data, which will be aggregated to an overall estimate of cost accuracy. A similar approach will be used for the operational cost estimate.

These items will be a separate deliverable for each host site.

Circuit De-Risking Research

The research to de-risk technical areas of the project will be performed at the locations of each primary lead from Tasks 6.1 to 6.4. UND will utilize the existing pilot facility located in Grand Forks for piloting the site-specific feedstocks, capable of 1,000 lbs/hr of feed capacity. RES will utilize their existing facilities in Beatrice, NE for metallization and electrochemical research, scaling up to a prototype system of metals production, at least 10% of planned production capacity. MTI will perform on-belt analysis of lignite coal and lignite mine waste for their REE analysis and sorting mechanism at a to-be-determined mine site, and will utilize existing or new commercial sensor equipment.

Environmental and Economic Impacts while the Project is Underway

Environmental and economic impacts will be primarily limited to the project participants and project execution locations during the execution of the Phase 1 project, although the distribution of information on the potential Phase 2 project and other pertinent activities as described in the Community Benefits Plan will involve some wider distribution. Minimal environmental impacts will primarily be related to the collection, transportation, and any process wastes associated with the piloting of the REE concentrate technology, as well as limited environmental impacts associated with the other research tasks.

Economic impacts include employment opportunities for the project team members, which include several ND-entities (UND, MTI, Barr, Envergex, Odney). Several graduate and undergraduate students will also be provided valuable training opportunities, both in hands-on pilot scale demonstrations and the detailed engineering and business efforts required to develop a large-scale industrial project.

Ultimate Technological and Economic Impacts

The ultimate impacts of a successful project would be the selection of our project for Phase 2 award, which would entail a FOAK REE Demonstration Facility on the order of $250 Million. We expect that if this

first project is successful and the Demonstration Facility is able to create a sustainable operating model, then next-generation facilities will be installed at other lignite mines or low-rank coal mines. This would also provide the opportunity for downstream processing facilities and product manufacturing capacity to be 'bolted on' to expand the supply-chain footprint in a single location.

This project and its follow-on effects has the potential to provide the US a politically and environmentally stable supply chain of REE and CM, particularly of the rarer HREE and Ge/Ga, as well as developing a new major market for lignite resources. Additionally, our process generates a unique lignite carbon ore that has numerous end-use applications in carbon-based products. We describe more fully the suite of possibilities in the following paragraphs.

Market Transformation Plan

The target marketable products for the proposed plant include the magnet REEs (Nd, Pr, Tb, Dy – focusing on the Tb and Dy), Gd, Sc, Ge, Ga, and the upgraded lignite carbon ore. Other CM may be produced (i.e., Co) but are not the primary goals of this effort. Planned markets to service are the Ge and Ga semiconductor and high-purity crystal markets, the magnet markets for high-temperature applications (those that utilize significant amounts of Tb and Dy), and the blend lignite fuel and carbon-based products markets. We have secured the interest from AmeriCarbon to purchase the lignite co-product for their commercial coal tar pitch facility, which is currently in planning.

No domestic competitor exists for the production of any of the major target products (Dy/Tb, Sc, Ge, Ga); however, MP Materials[9] has a significantly larger portion of the Nd/Pr market. Little competition for high-grade pitch feedstocks exists, primarily in the form of unique, bituminous resources. Distribution channels for the carbon-based products will be co-location strategies, avoiding the costly transport of lignite; host site power plants and AmeriCarbon are potential identified customers. Distribution of REE/CM products will occur using trucking with controlled-atmosphere containers to limit REM or CM metal spoilage. Market penetration into the domestic markets is viewed as low risk, assuming a domestic

magnet industry is developed, which is the highest barrier known for domestic market involvement. RES can arrange some off-take agreements for magnet materials to non-domestic, allied nation partners, which could be a short-term option for our project until a robust domestic market appears.

Product development will be based on specific off-take agreements, primarily regarding purity and form, discussions for which are expected to be initiated early in Phase 1. Product marketing will take place through targeted marketing events and participation in conferences. The upgraded lignite co-product, with its unique properties, represents the largest potential product/value growth opportunity. Higher-value opportunities (compared to thermal fuel) for this product are expected to grow as the carbon-based product market develops.

The proposed product suite, alongside a general schematic of our process, is shown on the next page in **Figure 10**. ***We encourage reviewers of this proposal to spend some time with this figure to be able to grasp the breadth and scale of the opportunity. If this project is successful, lignite mine waste and the proposed set of technologies and partners can spawn truly exciting economic and industrial development in North Dakota and the surrounding region.***

Why the Project is Needed

This project combines elements of financial and technical de-risking that we view as essential to be able to entice private sector investment in a Phase 2 project and any follow-on projects. If we are successful in Phase 1 in developing a strong technical and business case and securing a committed team and financing, we will be eligible for a much larger Phase 2 opportunity (~$250 Million). The successful implementation of this Phase 1 project, and subsequent down-select for a Phase 2 facility, would significantly expedite the establishment of a ND-focused REE/CM industrial sector (i.e., **Figure 10**).

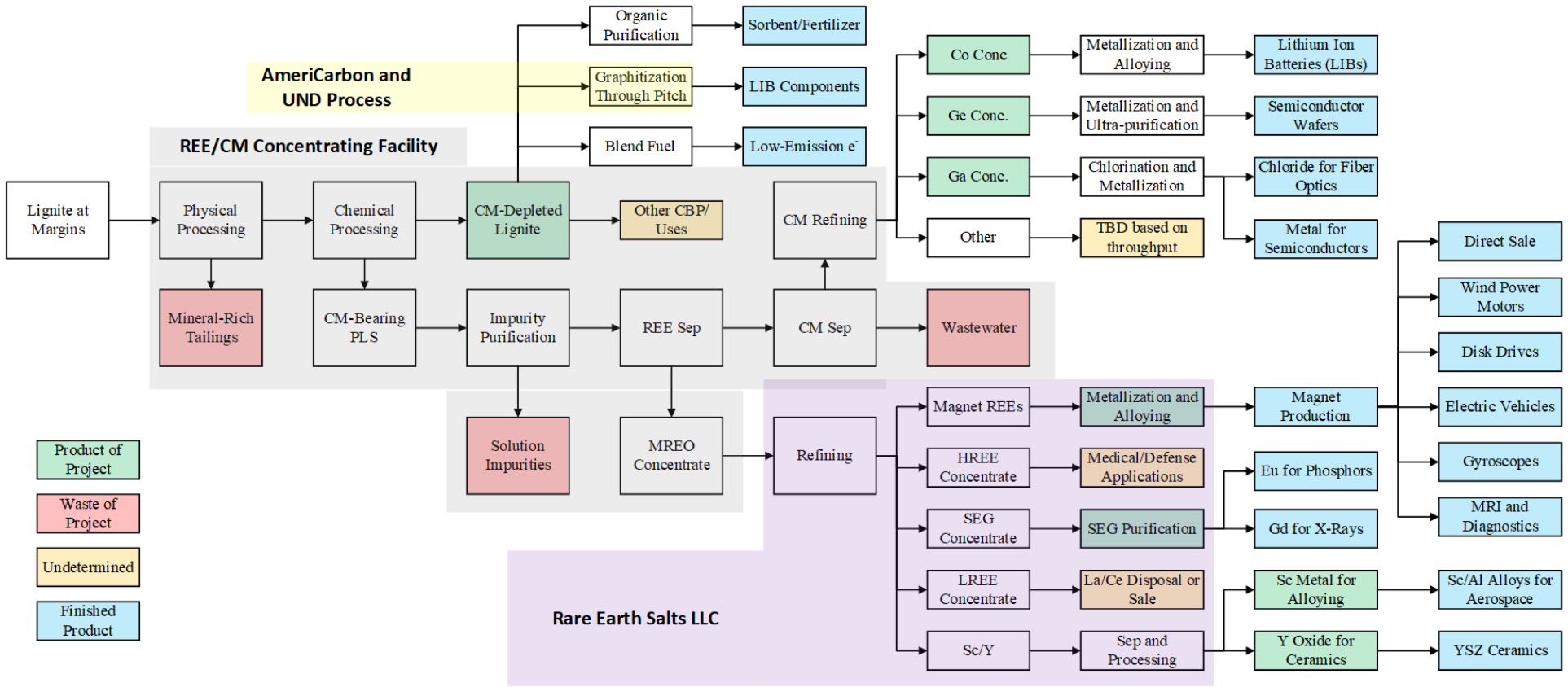

Figure 10. Overall general process schematic with project products, wastes, and planned finished products markets identified. Locations or entities involving each process have been noted. Magnet REEs are Nd, Pr, Tb, and Dy. HREE concentrate refers to the lanthanides of Ho → Lu. LREE concentrate refers to a La/Ce mixture. SEG concentrate refers to Sm, Eu, ang Gd, of which Sm is not expected to be a product of significant value.

STANDARDS OF SUCCESS

The overall standard of success is being selected by the DOE to move on to the construction and operation in Phase 2. Specific targets we will need to meet by the end of Phase 1 to achieve this standard are:

1. Successfully implement the community benefits plan that creates meaningful benefits for local communities, engages and incorporates feedback from stakeholders, and advances DEIA initiatives.
2. Complete all NEPA reviews, including the preparation of an environmental assessment (expected), and obtain a Finding of No Significant Impact by the federal agency.
3. Prepare and submit all applicable permit applications.
4. Completion of an AACE Class 3 FEED study to progress the project to investment quality
5. Increase each of the proposed technologies and technology subsystems to TRL 6.
6. Develop the business and financing plans for Phase 2; have a committed team and financing secured.

BACKGROUND

The development history of the background technologies that will be the subject of the proposed study, and ultimately the Phase 2 REE Demonstration Facility, are discussed in the following sections.

UND's Technology Development

In 2016, UND was among the first teams selected for DOE funding to evaluate REE recovery technologies for coal and coal byproducts (FOA 1202; DE-FE0027006). Our team learned/achieved the following during this initial lab-scale project (2016-2017):

- Identified numerous samples of lignite and associated materials with REE concentrations exceeding DOE's target of 300 parts per million (ppm) on a whole rock mass basis.
- Established that REE were most concentrated near the coal seam margins (roof/floor) or in thin seams in almost all cases. These materials in the existing/operational ND lignite mines are not

commonly recovered for thermal coal (power production) and are discarded with the overburden. As such, they meet DOE's definition of mine waste (an eligibility requirement for this program).

- The REE and several other high-value elements found in lignites are organically associated as complexes of carboxyl groups. This form enabled the conceptualization and initial proof-of-concept for a new technology to recover REE from the lignite mine wastes.
- Our new technology was demonstrated at the lab-scale (~60-gram batches of feedstock) and proven to be able to meet DOE's target of 2wt% REE concentration using a simple leaching process with a dilute mineral acid. The initial techno-economic assessment (TEA) indicated promising economic potential.

Our team was selected in 2017 by the DOE (competitive down-selection) to continue to a bench-scale demonstration based on the initial lab-scale project's success (DE-FE0027006). Our team learned/achieved the following during the bench-scale project (2017-2019):

- Performed additional drill core sampling/analysis to further confirm that economically relevant REE/CM concentrations exist in lignite mine waste materials in multiple locations.
- Demonstrated and optimized our lignite mine waste REE leaching process at the bench-scale (50 kg batches and 28 kg/hr semi-continuous). Also incorporated/demonstrated/optimized several additional processing steps to produce MREC products and a high-value upgraded carbon material with unique properties. We achieved a mixed REE purity of 85% during the bench-scale program and identified opportunities to improve efficiency further and reduce chemical consumption during future development phases.
- The semiconductors Gallium (Ga) and Germanium (Ge), both CM, were identified as particularly economically important co-products. Ge/Ga are also organically associated in lignite and are recovered alongside the REE during the leaching step.
- The TEA further confirmed the economic potential based on the bench-scale tests.

- The following UND-owned intellectual properties (IP) were developed and protected via patent filings, in addition to a significant amount of art, based on DE-FE0027006.
    - "Rare Earth Element Extraction From Coal," U.S. Patent No. 10,669,610
    - "Rare Earth Element Extraction From Coal," International Patent Application No. PCT/US2018/022398
    - "Generation of Rare Earth Elements From Organically-Associated Leach Solutions," U.S. Patent Application No. 17/519,346
    - "Method for Leaching Rare Earth Elements and Critical Minerals From Organically Associated Materials," U.S. Patent Application No. 17/519,341

Our team was selected by the DOE in 2019 to scale-up to pilot scale (FOA 2003; DE-FE0031835) based on the success of the lab- and bench-scale developments. The testing phase of this project is scheduled to end in 2023, with key achievements to date as follows:

- Significant additional drill core collection and analysis to further confirm economically relevant concentrations of REE/CM in lignite mine waste materials
- Design and construction of a fully integrated/continuous pilot facility (500 kg/hr lignite mine waste feed rate)
- The commissioning and initial operation of the pilot system is currently ongoing, with full operation scheduled to begin in May 2023. ***Our team is confident that high-quality pilot-scale testing/performance data will be available before the start of the proposed Phase 1 FEED study – currently slated for August 1st.***

Rare Earth Salts' Technology Development

RES was founded in 2012 with the objective of developing a cost-effective, environmentally friendly domestic supply of rare earth compounds. The company filed its first patent in 2013 (WO2014066668A1 - Method for rare earth and actinide element recovery, extraction, and separations from natural and

recycled resources) and received its first patent in 2019 (US 10,494,694 – Method for extraction and separation of rare earth elements). RES also recently filed a third patent application for the efficient separation of light rare earth elements.

In 2017, RES was a subcontractor on the DOE-funded project DE-FE0031529 awarded to Battelle Memorial Institute for extracting, concentrating, and separating rare earth elements from coal combustion by-products. Issues with the extraction and concentration of the rare earth elements only allowed time for the separation and purification of cerium and lanthanum oxides from the rare earth concentrates at 99+% purity, samples of which were provided to the DOE.

In 2019, RES was awarded a contract through the DOD DLA (DLA Strategic Materials Contract SP8000-19-P-0010) to investigate the separation of a SEG+ material. Key outcomes were:

- Separation of europium as europium oxide (purity 99.9%; third party verified)
- Separation of yttrium as yttrium oxide (purity 99.8%)
- Separation of samarium as samarium oxide (purity ~60%)
- Thorium concentrated with heavy rare earth fractions in the separations process
- RES' cell design at the time allowed aluminum to penetrate into the rare earth half-cell, causing a problematic solution gelling. This predicament had not occurred in the laboratory cells or the light rare earth concentrates they had been working with previously.

RES received funding in 2019 (amended 2020) through the DLA SBIP RIF program (SP4701-19-C-0010) to assist in commercializing their patented separations process. Key outcomes include:

- Expanding the RES facility from 10,000 ft^2 to 25,000 ft^2
- Obtaining several critical pieces of equipment to expand to full commercial scale
- Improving the electrowinning cell design to avoid aluminum transfer
- Developing a proprietary technology to separate cerium and lanthanum from rare earth mixtures at high purity and significantly reduced cost, both capital and O&M

- Developing a new approach to extract and separate rare earths from recycled fluorescent light bulb materials

UND engaged with RES on our current pilot project (FOA 2003; DE-FE0031835) based on the success of RES' separations technique with Battelle. Key achievements related to RES' work to date are as follows:

- Scaling equipment to effectively work with the amount of MREC provided by UND
- Initial studies at laboratory scale on samples provided by UND to determine problematic impurities and develop strategies to avoid issues at scale

RES is currently in the process of commissioning two separate rare earth separation and purification lines in their Nebraska facility in addition to the funded projects. The first line will separate cerium (>97% purity), lanthanum (>99% purity), and didymium (> 99.5% purity, a mixture of neodymium and praseodymium) from a light rare earth concentrate. The second line will process recycled fluorescent light bulb phosphor to obtain cerium, lanthanum, europium (>99% purity), yttrium (~99.9% purity), and terbium (~99.5% purity). These lines are both expected to be operational in Q2 2023. RES has also had one commercial sale of 17.5 MT of separated lanthanum with 99.95 - 99.99% purity.

Microbeam's Technology Development

Efforts to develop low-cost REE/CM feedstock analysis and sorting methods were initiated in 2018 through support from the NDIC and ND industry (NDIC contract FY18-LXXXIII-213). The initial REE/CM fingerprinting algorithm was developed for use in x-ray fluorescence systems and was able to predict REE concentrations. The potential for prompt gamma neutron activation elemental analysis and dual gamma attenuation (PGNAA-DGA) to distinguish between low and high-level REE samples was promising. The algorithms were trained on over 50 coals for use in a full cross-belt analysis system based on PGNAA-DGA through an SBIR award (DE-SC0021837) in 2021. Analysis using the factory equipment had very low errors for total, light, and heavy REE on challenge samples, with an overall average mean absolute error (MAE) of 0.05. The PGNAA-DGA combined the REE/CM fingerprinting algorithm integrated with ore tracking and

sorting systems and can be used to sort and blend feedstocks based on REE/CM content. The IP developed and protected for the REE predictive algorithm and the integrated sorting technology includes the following patent applications:

- "System and Method for Predicting the Presence of Rare Earth Elements," U.S. Patent Application No. 63/367,859, July 2022
- "System and Method for Predicting Abundance of Rare Earth Elements with Handheld X-Ray Fluorescence," U.S. Patent Application No. 63/148,292, February 2022
- "System and Method for Predicting the Presence of Rare Earth Elements," U.S. Application No. 17/650,773, February 2021
- "Energy System Performance Manager," U.S. Patent Application No. 63/159762, March 2022.

The Ge/Ga separation technology originated from earlier work at MTI from 2004-2007 under a National Science Foundation project (Award No. 0422050) to recover Ge from gasifier ash materials. MTI applied this technology based on the earlier work to recover Ge/Ga from mixed rare earth concentrates in project DE-FE00032124 (FOA 2404). The technology involves vaporization and selective condensation that is projected to produce an 81% Ga_2O_3 concentrate and 89% GeO concentrate from the UND-mixed REE concentrate. The Ge/Ga concentrates are further refined to 99.9999 to 99.99999% purity using known commercial methods. The IP developed and protected includes the following patent application:

- "System and Method for Producing Critical Minerals - Germanium and Gallium," U.S. Patent Application No. 17/812,484, February 2021

Joint Efforts (UND, RES & MTI)

The core technology team, consisting of UND, RES, & MTI, has collaborated for several years. This team recently partnered to complete an AACE Class 4 (pre-FEED) study using the above-discussed technologies as the basis for DOE contract 89243320RFE000032. Barr Engineering led the engineering work for the pre-FEED. A summary of the effort and key findings are as follows:

- A single REE concentrate plant, near the Falkirk Mine near Underwood, ND, was evaluated that processed 3,900 metric tons per day (mtpd) of lignite mine waste to produce 1 mtpd of a MREC at 75% purity.
- The MREC product was then separated into individual rare earth oxides (REO) at the RES processing facility in Beatrice, NE. Select REO were metallized using commercially available fused salt electrolysis at a co-located facility.
- The economic analysis results are presented in **Table 1**.

Sensitivity analyses identified that sale price of the REE-extracted lignite material is the most important factor, followed by the wastewater treatment costs associated with the MREC plant. The wastewater treatment costs, in particular, represent a large potential source of improvement. The pre-FEED assumed water treatment and disposal as the method of managing the wastewater, representing 20-30% of the annual O&M; however, deep well injection (Underground Injection Control – Class I) is expected to be a significantly less expensive ($1-5/1000 gal vs. $60-250/1000 gal for treatment and disposal – based on Golder's significant experience) and more effective option. The proposed FEED study will include the evaluation and design/costing of the Class I injection option. Additionally, the expansion of purification and metallization to include more elements has the potential of significantly increasing REE/CM-based revenues (by up to 150%, based on the elements).

Table 1. AACE Class 4 pre-FEED economic metrics

Category	**Cost/Revenue ($ millions)**
Total Capital Cost	142-305
Annual O&M	184-394
Annual REE Sales Revenue	22-57
Annual REE-extracted Lignite Material Revenue	23-258
10-year NPV (best- & worst-case scenarios)	+$550 Million to -$1,270 Million

In summary, the pre-FEED indicated a negative NPV under most (but not all) scenarios; however, our team is confident that the proposed REE Demonstration Facility (Phase 2) can be profitable with DOE support (~50% of capital and project costs during the first years of operation), drastically lower cost wastewater

management (Class I injection), and the integration of product off-takers who are willing to pay a premium for the unique REE-extracted lignite material. As we described earlier, AmeriCarbon LLC, who is developing a commercial coal tar pitch production facility in ND is interested in purchasing this co-product as a feedstock to their pitch plant. Carbon-based product manufacturing (such as pitch) is a far better economic option than thermal coal. The proposed FEED study and Phase 2 business and financing plans will further refine and quantify the value of this option/opportunity.

Technical Gaps to be Addressed in the Proposed Project

The previous AACE Class 4 study identified key technical gaps that will be addressed in the proposed Phase 1 project. Specific goals related to addressing these gaps and targeting specific improvements to the baseline technologies and their economic/technical performance are:

1) The AACE Class 4 pre-FEED study was based on bench-scale testing data and incomplete information related to MREC separations using the RES and MTI technologies. The proposed FEED study will have UND pilot-scale data (more refined and commercially relevant) available, as well as the complete testing data from RES and MTI based on the MREC produced from UND's pilot testing. Combining these three new data sources will reduce contingencies and provide a commercially realistic evaluation. **Critical Success Factors**: a) availability of reliable pilot/testing data prior to the Phase 1 award and b) ability to pilot limited quantities (~75 tons) of site-specific feedstock (Center Mine and Falkirk Mine) as a part of Phase 1.

2) Significant additional resource characterization (drilling/analysis at the existing ND lignite mines) has been completed since the completion of the AACE Class 4 study, and an extensive drilling/analysis campaign will be completed ahead of and in parallel (separate efforts) to the early stages of the proposed FEED study. Locations have already been identified with a higher concentration of REE/CM (notably higher Ge/Ga) than were used as the basis for the pre-FEED. Ongoing projects, such as the Williston Basin CORE-CM effort as well as the extensive sampling plan outlined by MTI and North American Coal will further

enable more accurate long-term revenue projections. **Critical Success Factors**: a) REE/CM data available at both ND host sites sufficient to meet the DOE FOA requirement of five years of feed availability, and b) REE/CM data sufficient to develop a commercially viable mining plan and project feedstock costs.

3) The AACE Class 4 study identified wastewater treatment from the MREC production plant(s) as a major O&M component. We have identified Class I deep well injection as a far superior economic option since the completion of the earlier study. We have established that the geology at the two proposed ND host sites is favorable for injection, and our team (Golder) has extensive site-specific experience with designing and permitting Class I wells at the two proposed ND host sites. The proposed FEED study will evaluate and confirm the suitability of Class I injection and develop an AACE Class 3 design and cost estimate. **Critical Success Factors**: a) Class I injection is identified as feasible at both sites (very high likelihood); b) geologic information is available to support the design and permitting (available from host-site partners through their existing CO_2 geologic storage projects), and c) ability to permit the wells and obtain EPA aquifer exemption approval.

4) The AACE Class 4 study identified feedstock analysis/sorting as an area for significant improvement potential. Project partner MTI is developing novel analysis algorithms based on commercially existing sensor technology. Coal and associated materials are well-known for their heterogeneity. We will be able to a) increase the REE concentration in the incoming feed and/or b) blend the incoming feed to stabilize the REE concentration into a narrow range by analyzing the incoming REE-containing lignite waste materials for REE concentration and then sorting/stockpiling into ranges, such as low, med, and high. Increasing REE concentration would obviously reduce the amount of feedstock necessary to achieve desired REE production. Narrowing the REE concentration variability via blending would improve process control/reliability and reduce the equipment oversizing factor and capital costs required to guarantee production requirements, such as 1 mtpd. The proposed Phase 1 FEED study will include two key efforts: a) additional de-risking R&D associated with MTI's lignite mine waste analysis/sorting technology and b)

optimizing and integrating the feedstock analysis/sorting/blending design into the FEED based on this R&D and previous development. **Critical Success Factors**: a) prove that MTI's technology works in an on-belt/commercial configuration and b) leveraging existing performance data, generate reliable performance data and design criteria to perform the FEED and determine cost-effectiveness.

5) The AACE Class 4 study identified a need to qualify a REE metallization process to de-risk the current magnet supply chain. The technologies identified as possibilities used fluoride chemicals and were not environmentally desirable. RES has identified and conceptualized a production methodology to produce high-purity metals continuously and in a closed-loop production cycle, leading to the possibility of a fully zero discharge separation and refining facility. The proposed project will allow RES to test a standardized method of metallization at pilot scale with a modified chemical recovery/scrubber system that has been developed and tested along with the determination of final materials compatible with the final reactor design. **Critical Success Factors**: a) Successful demonstration of the proposed metallization technology at a scale of at least 1/10th the proposed REE Demonstration Facility, and b) Provide reliable performance data and design criteria to incorporate into the AACE Class 3 study.

QUALIFICATIONS

The following highlights the qualifications of the team member organizations and key personnel. The team assembled for the Phase 1 effort is uniquely qualified to successfully achieve the project objectives and ultimately execute the construction/operation of the REE Demonstration Facility in Phase 2.

University of North Dakota

UND is the technology developer and IP holder of the technology upon which this project is based. In 2016, UND was among the first teams to be awarded funds from the DOE (FOA 1202, DE-FE0027006) to develop technologies to recover REE from coal and coal byproducts. Our team has successfully advanced the technology from the lab-scale to a pilot-scale system under DE-FE0031835 (500 kg/hour of mine waste

feed). UND also previously led a successful project to perform a conceptual design and feasibility study (AACE Class 4) to produce 1 mtpd of REE using the proposed technology (contract 89243320RFE000032). The UND team is led by the College of Engineering & Mines (CEM), which has extensive experience in technology development, scale-up and techno-economic assessments in the areas of advanced power generation systems, CO_2 capture, desalination/water treatment, battery technologies, carbon-based products, and critical minerals. Our team has also led or been involved in many additional REE/CM-related projects in addition to the base technology and its associated DOE-funded projects noted previously: DE-FE0032060, DE-FE0032053, DE-FE0029007, DE-FE0031490, & DE-FE0032124. Our team is recognized as a leader in REE/CM related to unconventional resources. Key personnel from UND are highlighted below.

Dr. Daniel Laudal, Research Professor and Executive Director of the College of Engineering & Mines Research Institute, will be the project director (PD). He will support the project as a technical advisor and lead project management and coordination. Dr. Laudal was the technical lead for UND's original lab-scale project and the original PI for the bench-scale project (DE-FE0027006). His Ph.D. research/dissertation[4] was the foundation for the proposed technology/project. Dr. Laudal has been PI, Co-PI, or key personnel on numerous DOE, State, and Industry-funded projects, primarily focusing on technology development and scale-up, including several efforts related to REE/CM. Prior to rejoining CEM in 2021, Dr. Laudal was the Environmental Manager for Minnkota Power Cooperative (one of our host-site partners). Dr. Laudal was also the Project Tundra project development manager while at Minnkota (2019-2021). He was responsible for coordinating the efforts of a team comprised of Minnkota staff and external contractors and consultants to advance the development of the $1.5B carbon capture and geologic storage project. Key efforts that Dr. Laudal managed were: **1)** completing a FEED study for the carbon capture system, **2)** developing and submitting permit applications for air/water/waste, **3)** NEPA assessments, **4)** developing the geologic characterization information and submitting the permit applications for the CO_2 geologic storage facility, **5)** stakeholder engagement, and **6)** developing the business and financing plans. Dr. Laudal

managed a ~$50 million portfolio of federal (DOE) and State (NDIC) grants and Minnkota investment dollars to support Tundra's development. This unique experience, including commercial project development in ND, deep site-specific knowledge/experience at one of the proposed host sites (MRYS), environmental permitting and NEPA, and managing extremely large and complex projects, will greatly benefit the proposed project. Dr. Laudal holds a B.S. and Ph.D. in Chemical Engineering from UND.

Nolan Theaker, Senior Research Manager – Critical Minerals, will be the overall principal investigator (PI) and serve as UND's technical lead. Mr. Theaker has been the technical driver for UND's technology development and resource characterization efforts related to REE/CM since he joined CEM in 2018. He is widely recognized within the DOE and the research community as a leading expert on REE/CM technologies. Mr. Theaker was the Co-PI/technical lead on UND's bench-scale demonstration (DE-FE0027006), the PI on the ongoing pilot-scale project (DE-FE0031835), and the Co-PI/technical lead on the conceptual design and feasibility study (89243320RFE000032). He is also currently involved as key personnel on two ongoing CORE-CM projects: Williston Basin and Gulf Coast. He has B.S. and M.S. degrees in Chemical Engineering from the University of Louisville, Kentucky.

Other Key Personnel: UND's team will also include business and financial development experts to lead and support Task 7. **Mr. Kevan Rusk**, CEM's Director of Business Development, is a broadly experienced manufacturing and engineering professional with an extensive background in business and relationship development, technical sales, and commercial execution. Our team will leverage Mr. Rusk's 30 years of relevant experience in leading the business planning effort in Task 7. **Mr. Anthony Maher**, Entrepreneur Lead for Startup Growth & Fundraising at UND's Center for Innovation, has spent most of his career working with innovative startup companies in the Silicon Valley. He began his career working in corporate development, conducting market analyses in Munich, Germany, for Siemens, a multinational publicly traded company. He became a founding member of Mustang Ventures based in Silicon Valley, the venture capital arm of the Siemens Communications Networks Group. He later led a global team of financial

analysts at Siemens Venture Capital, the global venture capital arm of Siemens AG. His responsibilities included evaluating and investing in innovative venture capital-backed companies by conducting business due diligence and detailed financial modeling. We will leverage Mr. Maher's extensive financial modeling/planning experience to support Task 7 activities.

Barr Engineering

Barr is a comprehensive engineering and environmental firm, providing consulting services to clients globally. Barr works with clients on large and complex engineering and environmental projects, providing services that range from initial permitting and siting assistance through process and facility design to construction management, operations support, and closure planning. Barr's services and staff have grown to meet client needs for over 50 years, with offices in seven states and Canada. Barr has collaborated with UND on technology development since its inception and was the engineering lead on the team's successful AACE Class 4 pre-FEED study. Key personnel from Barr Engineering are highlighted below.

Dr. Dan Palo, Vice President and Senior Process Engineer, will be Barr's Principal-in-Charge. He is a professional engineer with a Ph.D. in chemical engineering and has 25 years of experience in process design, plant improvement, project management, and research and development for processes that involve minerals, chemicals, fuels, and manufactured products. Dan provides engineering and management services on projects for local, national, and international clients. His technical work includes process design and modeling, plant debottlenecking, new process development, and overall project coordination.

Nick Sosalla, Mineral Processing Engineer, will be Barr's Project Manager. He has over eleven years of experience with various mineral processing and chemical engineering projects, including design, mass and energy balance calculations, process modeling, and capital and operating expense estimates. He has served clients in the mining and mineral processing industries for potash, iron ore, trona/soda ash, and

industrial sands, as well as industrial manufacturing clients. Nick has served as a process engineer and project manager for various mining and engineering projects over the past five years. Nick's work has ranged from process engineering support for studies to project management, coordinating multi-disciplinary teams, and combining field and off-site engineering work. Nick has worked closely with client engineers and project managers throughout these projects to provide efficient and effective projects and deliverables. He recently served as Project Manager for Barr's ongoing work with the UND REE pilot plant.

Ryan Rayda, Senior Structural Engineer, will be Barr's Construction Engineering Lead. He has 20 years of progressive experience in project leadership and structural design at mining facilities, power plants, material handling facilities, refineries, water treatment plants, sanitary and stormwater pumping stations, and many other heavy industrial sites. Ryan has extensive design experience related to industrial structures, structural forensics, heavy lifting operations, and building-type structures.

Ryan Siats, Vice President and Senior Chemical Engineer, will be Barr's Environmental Lead. He has 16 years of experience with environmental review, permitting and compliance, focusing on developing, constructing, and operating new/expanding facilities. He also conducts technical and economic studies for pollution-control equipment and processes and performs site evaluations and investigations. Ryan primarily works on multi-disciplinary projects in the mining and mineral processing industry in the Midwest and Intermountain West, including North Dakota.

McCarl's

McCarl's is a full-service integrated contractor and maintenance leader specializing in complex heavy industrial processes and pipe fabrication for the oil and gas, chemical, power, steel, environmental, heavy industrial, manufacturing, water treatment, and cryogenic processing industries. McCarl's will be a subcontractor to Barr and will support the FEED with constructability review and cost estimating. Their efforts will be led by **Thomas Rauch**, President – Technical Services, who specializes in high-risk project

delivery and has experience with small cap through mega-projects in North America, Africa, and Asia in mining, metals, and chemical industries.

Rare Earth Salts

RES is the technology developer and IP holder for the proposed REE separations and metallization technologies. The company has been addressing the issue of developing an environmentally friendly, cost-effective solution to the rare earth separations issue since 2012. In 2013, they developed the patented aqueous-based electrowinning foundation for their separations process. Their overall separations process has been steadily improved and built upon, including recently developed proprietary processes to decrease both the CapEx and OpEx of their overall separations stream. Many groups with DOE funding have recognized RES' technology as cutting-edge and economically feasible, including Battelle, UND, and Anactis. Key personnel from the RES team are highlighted below.

Dr. Joseph Brewer, Chief Technology Officer and President, will be the co-lead for RES on the project. Dr. Brewer has been the lead on all funded work with the DOD and DLA-related grants at Rare Earth Salts. Dr. Brewer has spent the past 16 years focused on fundamental rare earth chemistry. He conducted graduate research from 2005-2010 on functional rare earth compounds and developed high-temperature gas phase synthetic routes to produce nanowires or thin films. He obtained numerous patents during his graduate career, which led to the founding of a rare-earth-based solar thin film photovoltaic company. Dr. Brewer began research on the extraction and concentration of rare earth elements from mineral feedstocks to supply materials for the photovoltaic project during the rare earth crisis of 2010-2011. In 2012, he filed a patent on his research and co-founded RES. Dr. Brewer co-led and patented the invention of a novel separations technology from aqueous solutions. He is proficient in quantifying and identifying rare earth compounds and their fundamental chemistry due to his extensive background in rare earth chemistry. He holds a B.S. from Minot State University and an M.S. and Ph.D. from the University of Nebraska-Lincoln.

Dr. Ryan Winburn, Vice President of Research and Development, will be the co-lead for RES on the project. Dr. Winburn has been the lead or co-lead on all of the funded work with the DOE (FE0031529, FE0031835, and 89243320RFE000032). He spent fourteen years prior to joining RES as a faculty member at Minot State University (Minot, ND), where his focus was on inorganic and analytical chemistry projects. His research experience has included electrochemistry, computational chemistry, high-temperature thermal synthesis, and the development of quantitative x-ray diffraction techniques (QXRD), including studies on minimizing associated errors, developing techniques to monitor toxic elements within the environment, and working with NIST to certify standards for QXRD. Dr. Winburn is the co-developer of the patented electrowinning process used by RES. He holds a B.S. from the University of Wisconsin – Eau Claire, an M.S. from the University of North Dakota, and a Ph.D. from North Dakota State University.

Microbeam Technologies, Inc.

MTI is a commercial company with the corporate mission of providing advanced analysis tools and technologies to minimize the impacts of inorganic components in fuels on power system performance. Microbeam has completed more than 1,600 projects since 1992, providing advanced analyses of coal, biomass, petroleum coke, fly ash, slag, ceramics, metals, and other materials, and has performed consulting for researchers, the power industry, boiler manufacturers, coal companies, and the government. Microbeam's primary area of expertise lies in its understanding of fuel and related material behaviors in energy conversion systems. This extensive experience has afforded MTI an understanding of the association of REE/CM in different ranks of coal across the world. Key personnel are highlighted below.

Alex Benson, Senior Project Manager, has a B.S. degree in Mechanical Engineering. He actively leads multiple commercial projects associated with REE/CM resource evaluation, detection, measurement, and extraction in coal and associated waste materials. Mr. Benson has over three years of experience in project management and commercialization in the medical device manufacturing industry, where he led commercialization engineering activities for new product launches and capacity expansion projects. He is

one of the inventors on a US patent application held by MTI for algorithms used with handheld XRF and PGNAA-DGA for REE/CM measurements and one of the inventors of a process for Ge and Ga separation from ash materials and mixed rare earth element concentrates.

Dr. Steve Benson, President, has a Ph.D. in Fuel Science from Pennsylvania State University and over 45 years of experience in fuel analysis, fuel properties, combustion, gasification, ash transformations, and pollution control. Dr. Benson is an inventor on a US patent held by UND for the extraction of REE/CM from lignite and associated materials, one of the inventors on a US patent application held by MTI for algorithms used with handheld XRF and PGNAA-DGA for measuring REE-CM, and one of the inventors of a process for Ge and Ga separation from ash materials and mixed rare earth element concentrates.

WSP Golder

Golder, a member of WSP, is a consulting, design, and construction services firm specializing in the areas of earth, environment, and energy. Golder is experienced in designing, permitting, and constructing Class I injection wells for the management of process waters generated at industrial facilities. The company has unique site-specific knowledge of the two proposed ND host sites, having previously designed and permitted the existing operational Class I injection well at Coal Creek Station and designed and prepared permit applications for the planned Class I injection well at the MRYS as part of Project Tundra. The Golder team will be led by **Todd Stong**, project director, who managed the construction, operations support, and ongoing permitting of Coal Creek Station's Class I well and served as the project director for the design and permitting of a Class I well in NE and three additional Class I wells in ND.

North American Coal Corporation (NACoal)

Falkirk Mining Company, a subsidiary of NACoal, operates the Falkirk Mine near Underwood, ND. NACoal will provide technical, environmental, legal, and business input during Phase 1 to perform the FEED and to evaluate and develop the business/financial opportunity for continuing to Phase 2. **Gerard Goven**, mine

geologist at Falkirk Mine, will be the point of contact for NACoal.

Rainbow Energy Marketing Corporation (REMC)

In May 2022, REMC purchased the Coal Creek Station. REMC will provide technical, environmental, legal, and business input during Phase 1 to perform the FEED and to evaluate and develop the business/financial opportunity for continuing to Phase 2. **Stacy Tschider**, President, will be the point of contact for REMC.

BNI Coal, LTD (BNI)

BNI operates the Center Mine near Center, ND, and provides lignite coal for the adjacent Milton R. Young Station. BNI will provide technical, environmental, legal, and business input during Phase 1 to perform the FEED and to evaluate and develop the business/financial opportunity for continuing to Phase 2. **Mike Heger**, general manager of BNI Energy, will be the point of contact for BNI.

Minnkota Power Cooperative (Minnkota)

Minnkota operates the MRYS and will provide engineering, environmental, legal, and business input during Phase 1 to perform the FEED and to evaluate and develop the business/financial opportunity for continuing to Phase 2. **Craig Bleth**, VP for Project Development, will be the point of contact for Minnkota.

AmeriCarbon

AmeriCarbon is a technology development company and the owner of the proprietary and patented Eco-Pitch™ technology[10] that produces tailored pitch products from domestic coal resources, including all coal types and ranks. AmeriCarbon has demonstrated the ability to tailor its pitches for a wide variety of end-use applications. The Eco-Pitch process results in a >99% GHG emissions reduction compared to the existing coal tar pitch supply. AmeriCarbon owns and operates a pilot scale (10 tpd coal feed) research & manufacturing facility in Morgantown, WV, which is the only known pilot-scale coal liquefaction pitch production unit in the U.S. or world. As described in the attached letters of commitment, AmeriCarbon has expressed an interest in an ownership/investment role in the Phase 2 REE Demonstration Facility and

will work with our team to develop and evaluate this opportunity during Phase 1. AmeriCarbon is led by CEO **Dave Berry**, who previously served as the Associate Director of the Energy Conversion and Engineering Directorate at DOE NETL. Mr. Berry is the technical development driver for AmeriCarbon's technology platform. **Greg Henthorn**, VP for Corporate Development, leads AmeriCarbon's commercial and financial development, including their in-progress effort to install their first commercial pitch production facility in ND using lignite coal as the feedstock.

Dennis James Consulting (DJC)

Dennis James, president of DJC, is a globally recognized expert in the mining industry, with over 40 years of experience, including geology, geochemical modeling, coal and mineral exploration, and developing mine plans and budgeting for coal and mineral mining operations. Mr. James recently retired from North American Coal as Director of New Technology. Mr. James engaged with UND on our REE technology development from the start of our development in his prior capacity with NACoal. In his role at DJC, Mr. James will provide consulting to the project team related to developing and optimizing the mining plans associated with providing REE-rich feedstock at the lowest possible mining cost.

MLJ Consulting

Dr. Mike Jones, principal of MLJ Consulting, is the former VP for R&D at the Lignite Energy Council (LEC) in North Dakota and was a long-time researcher and project manager at UND's Energy & Environmental Research Center. Dr. Jones has consulted on UND's technology development for the last few years, focusing on commercialization and business planning. He has extensive knowledge and connections in the lignite industry that we will leverage to develop the Phase 2 business and financing plans.

Odney

Odney is a Bismarck, ND-based advertising and public relations consulting firm with a long history of engagement with ND's lignite and energy industries. Odney, under the leadership of CEO **Shane Goettle**,

will support the project team in developing, updating and implementing the Community Benefits Plan, with a specific focus on the Community, Labor, and Stakeholder Engagement Plan.

VALUE TO NORTH DAKOTA

The key value to North Dakota is the creation of new markets for lignite coal, with the ultimate potential of a dramatic economic and industrial development opportunity previously described in **Figure 10**. This Phase 1, and desired Phase 2 project, would enable the more rapid deployment of a REE/CM industry into both North Dakota, as well as the nation. With a FEED study completed, remaining risks for construction, commissioning, and operation would be minimized or known, and would increase the likelihood of success of the establishment of a ND-focused REE/CM industry. As noted in the previous pre-FEED study, the total jobs expected to be created from this demonstration facility are over 100, not including the significant number of mining jobs that could have more stability through the creation of new markets for lignite coal. Preliminary resource estimates suggest ND could be a sole source of Ge, and possibly Ga for the entire US, with the logical follow-on of establishing major refining and semiconductor industries in the region around this production. Additionally, the introduction of federal capital in Phase 2 both to construct, commission, and operate the REE Demonstration Facility for a number of years significantly buys down the risk both to the state, as well as private entities.

MANAGEMENT

The project organization chart is provided in **Figure 11**. Dr. Laudal (PD) will lead **Task 1** and be the administrative lead and point of contact for all project sponsors. He will be responsible for project reporting, complying with the project schedule and budget, and arranging regular meetings between the project team members. Dr. Laudal will also serve as a technical advisor to the project team. Mr. Theaker (PI) will be the task lead for **Tasks 2 and 6** and provide direction for **Tasks 3-5**. He is UND's process technology expert and will ensure continuity from the previous technology development work. Barr

Engineering will lead **Tasks 3-5** in close coordination with the UND team. **Task 6** has multiple subtasks, each led by one of the team member organizations and their task leads. Mr. Theaker will work closely with each of the **Task 6** leads to efficiently execute this effort. Mr. Kevan Rusk from UND will lead the efforts in **Task 7** in collaboration with all project team members and key personnel.

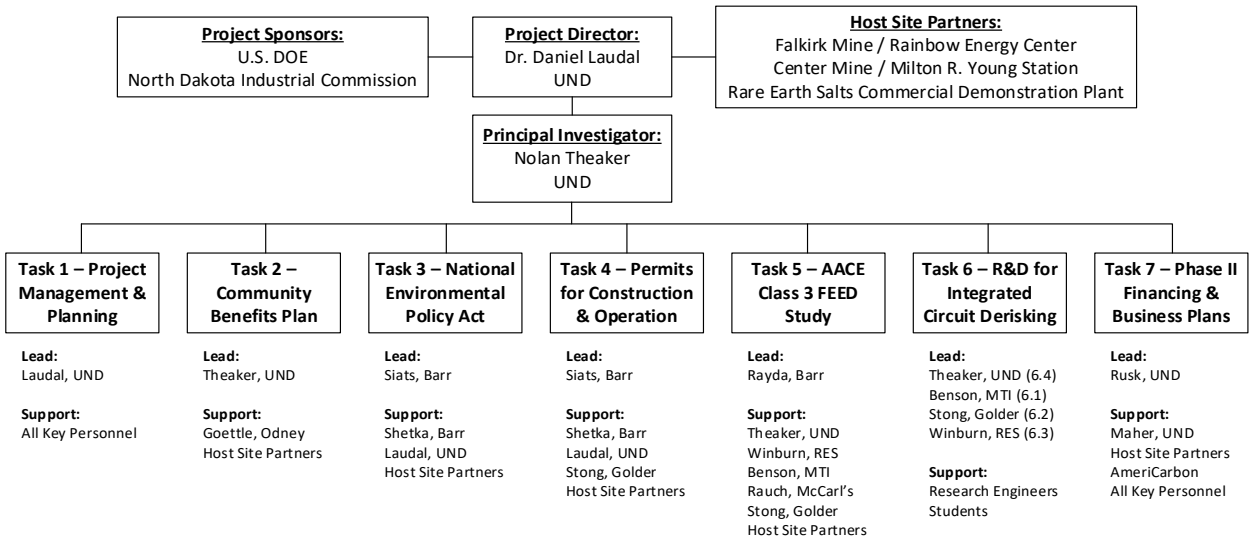

Figure 11. Project organization chart, identifying task leads and supporters.

We have identified project risks, their potential impacts and mitigation strategies, as shown in **Table 2**. This risk table will be continuously monitored and updated, as needed, during project execution.

Dr. Laudal and Mr. Theaker will work closely to ensure effective communication within the project team. The task lead structure, identified in the organization chart, provides a clear line of responsibility for each project task. The respective leads will work closely with the UND leads to execute the work and achieve the task goals. Project team meetings will be held weekly or bi-weekly to communicate progress and address any challenges or issues that arise. Individual task meetings may also be held as needed. The proposed core technical team has been collaborating on related efforts for the last several years and can comfortably execute a project of this complexity. This collaboration history provides a strong foundation for decision-making and communications.

Table 2. Project Risk Table

Perceived Risk	Risk Rating			Mitigation/Response Strategy
	Probability	Impact	Overall	
	(Low, Med, High)			
Financial Risks:				
Securing cost share	Low	Med	Low	UND has been selected for award by the DOE and expects to have a contract in place by Aug. 1 2023. The DOE award will provide 80% of the total project cost. Alternative cost-share sources, including our host-site partners and UND internal funding, can be evaluated.
A crucial activity unexpectedly requires substantial additional funds	Low	High	Low	Project and task managers will determine if any modifications can reduce costs and still meet project objectives. Additional funding will be sought if necessary.
Personnel availability	Low	High	Med	Develop a cross-functional team with strong communication capabilities and solid documentation for others to resume activities. Utilize the project team members' deep bench of engineers for support, if necessary. All key personnel are available and committed at the proposed levels.
Cost/Schedule Risks:				
Task costs are overrun	Med	Med	Low	Budgets for each participant will be developed before work begins. Costs will be monitored, and adjustments will be made to stay within the overall project budget if necessary.
Task schedules not met	Med	Med	Med	Schedules for each participant will be developed before work begins. Regular internal review meetings will be held to maintain timelines. Additional personnel resources can be allocated to tasks that are behind schedule.
Technical/Scope Risks:				
Host-site information	Low	High	Low	Host-site partners are committed to the project. See Appendix 3.
Pilot/testing data availability	Low	High	Med	UND, RES, and MTI are currently (at proposal submission) completing testing that will be needed upon Phase 1 start. Inclusion of some limited de-risking R&D.
Management, Planning, and Oversight Risks:				
Communication	Low	High	Low	Coordinate and schedule meetings and strictly follow communications plan.
Cost tracking	Low	High	Low	A resource manager will be assigned to the project to assist the PD with tracking costs.
Meeting milestones	Low	High	Low	The project schedule is organized around key milestones and the critical path. A sufficient buffer is available in the event certain tasks are delayed. Regular progress updates will be made to ensure schedule adherence.

ES&H Risks:				
Project emissions	Low	Med	Low	Testing during Task 6 will be performed at relatively small scales, and all emissions will be vented/ treated according to project team member policies.
Staff injuries	Low	High	Low	Safety training according to UND and team member policies. Operational review meeting prior to each test. A culture of safety will be implemented.
External Factor Risks:				
Unforeseen risks, e.g., natural disasters, social, legal or technical changes, project economics, or changes in political climate	Low	High	Low	Regular updates with the DOE and project partners to solve issues as they arise.

The time commitment of key personnel and total budgeted labor hours for each team member organization are listed in the tables below.

Key Personnel (organization)	**Time Commitment (FTE over 15 months)**
Nolan Theaker (UND)	0.75
Daniel Laudal (UND)	0.50
Kevan Rusk (UND)	0.30
Anthony Maher (UND)	0.35
Nick Sosalla (Barr)	0.36
Dan Palo (Barr)	0.34
Ryan Rayda (Barr)	0.17
Ryan Siats (Barr)	0.28
Thomas Rauch (McCarl's)	0.20
Steve Benson (MTI)	0.13
Alex Benson (MTI)	0.25
Ryan Winburn (RES)	1.0
Joseph Brewer (RES)	0.77

Organization	**Total Budgeted Labor Hours (15 months)**
UND	26,856
Barr/McCarl's	21,875 / 6,390
Golder	4,630
RES	9,800
MTI	7,280
NACoal	1,200 *
Rainbow Energy	500 *
BNI Coal	380 *
Minnkota	880 *
AmeriCarbon	526 *
Envergex	1,034
Dennis James Consulting	300
MLJ Consulting	285
Odney	1,090

*** Budgeted – any additional effort as in-kind cost share.**

Task 5, the AACE Class 3 FEED Study, will require substantial coordination between the team members. We have created a division of responsibility for the various activities in that Task, as provided in **Table 3**.

Table 3. Division of responsibility for the AACE Class 3 FEED study

TPT = Technology Provider Team consisting of UND, RES & MTI

Deliverable / Description	Responsible	Support
PROCESS ENGINEERING		
Project Scope Description - DEFINED	UND	
Facility Production / Capacity - DEFINED	UND	
Circuit/Facility Location(s) - SPECIFIC	UND	
Complete Block Flow Diagrams	UND	
Draft Plant Flowsheets	McCarl's	Barr
Process Design Criteria	TPT	Barr
Draft Utility Flow Diagrams	Barr	
Plant Mass and Energy Balances	TPT / McC	McCarl's
Plant Water Balance	Barr	McCarl's
Piping & Instrumentation Diagrams - Assuming 25-30	McCarl's	Barr
Line Lists & Valve Lists	McCarl's	Barr
Process & Utility Equipment List	Barr	McCarl's
Equipment Specifications / Vendor Info	Barr	McCarl's
Control Philosophy	Barr	
Complete Steady State Emissions Data	Barr	
MECHANICAL ENGINEERING		
2D Sheets for Tanks & Equipment, General Plant Arrangements	McCarl's	Barr
(3) Filter Press, (2) Belt Filters, (5) Scrubber Systems, Crusher Layout, (2) Resin Column Systems, (2) Elec Cells, REE Salt System (?), Metallization System(?)	McCarl's	Barr
Tank Modeling/Layouts (35), Pump modeling (25)	McCarl's	Barr
Building 3D Layout	McCarl's	Barr
Preliminary Pipe Routings	McCarl's	Barr
ELECTRICAL ENGINEERING		
E&I Engineering Design Criteria	Barr	
Single Line Diagrams	Barr	
Electrical Equipment List	Barr	
Motor List, Load List	Barr	
Motor Wiring Diagrams	Barr	
Instrument List	Barr	
Instrument Data Sheets	Barr	
MCC's Conceptual Arrangements & Drawings	Barr	McCarl's
Layouts - 3D Modeling	Barr	McCarl's
Input / Output Count	Barr	
CIVIL/STRUCTURAL		
Concrete Drawings (Details, Specifications)	Barr	
Preliminary/Top of Concrete in 3D Model	McCarl's	Barr
Structural Drawings - Details, Specifications (platforms, building, etc.)	Barr	
Preliminary Structure (beams/columns, grating/platforms, etc.) in 3D Model	McCarl's	Barr
PROJECT MANAGEMENT & PROJECT CONTROLS		
Document Control - Drawing List and Transmittal	McCarl's	Barr
Defined Integrated Project Plan / PEP	McCarl's	Barr
Defined Project Master Schedule	McCarl's	Barr
Defined Escalation Strategy	McCarl's	Barr

Defined Work Breakdown Structure	McCarl's	Barr
Defined Project Code of Accounts	McCarl's	Barr
Preliminary Contracting Strategy	McCarl's	Barr
Constructability Workshop	McCarl's	Barr
CAPITAL & OPERATING COST ESTIMATE		
Earthworks	McCarl's	Barr
Civil / Structural	McCarl's	Barr
Equipment & Tankage Quotes	Barr / UND	McCarl's
Piping	McCarl's	Barr
Electrical	McCarl's	Barr
Controls & Programming (Equipment and Controls, Inc. quote)	Barr	McCarl's
Indirects	McCarl's	Barr
EPC / EPCM	Barr	McCarl's
Owner's Costs (in conjunction with Client)	McCarl's	Barr
Construction Manpower Estimate	McCarl's	Barr
Capital Cost Reviews	McCarl's	Barr
Operating Cost Estimate	McCarl's	Barr
Cashflow Analysis	Barr/UND	
REPORTING		
Design Basis Report	Barr/TPT	
Performance Results Report	Barr/TPT	
Technology Gap Analysis	Barr/TPT	
Cost Results Report	McCarl's	Barr/UND
Project Execution Plan Presentation	McCarl's	Barr/UND
GHG/LCA Report	Envergex	Barr/UND
Final Report	Barr/UND	

TIMETABLE

The project schedule is provided in **Figure 12**. The milestone log is provided in **Table 4**. Note: the schedule and milestone log shown are the same as provided with the DOE application that assumed a 6/7/2023 start date. The schedule and start date will be updated accordingly once the project officially begins. We have also developed two SMART milestones, presented below.

Year 1. **Specific:** Overall technology and integrated circuits successfully de-risked. **Measurable**: Increase the TRL level of all technology subsystems/circuits to TRL 6 and provide performance data and design criteria for incorporation in the FEED. **Achievable**: The proposed Task 6 lays out our plan to achieve this milestone. **Relevant**: This milestone is necessary to achieve the project objectives. **Timely**: The project

schedule enables engineering activities to commence while Task 6 is being executed. Upon Task 6 completion, results can be input into engineering work.

Year 2. **Specific**: Secure Phase 2 financing. **Measurable**: Firm commitments for the non-federal cost share requirements (at least 50% of total Phase 2 costs). **Achievable**: The FEED study will need to provide a solid business case and the technology must be sufficiently de-risked. **Relevant**: Our ultimate goal is a Phase 2 project. **Timely**: Must be completed by the end of Phase 1.

Table 4. Milestone Log

Task	Milestone Title & Description	Completion	Verification Method
1.0	Project Award	06/07/2023	Cooperative agreement
1.0	Update Project Management Plan	07/07/2023	PMP file
1.2	Update Technology Maturation Plan	09/05/2023	TMP file
2.0	J40 Plan Proposal	09/05/2023	Plan proposal file
2.0	J40 Full Plan	12/04/2023	Full Plan file
2.0	Engagement Plan Development Proposal	09/05/2023	Plan proposal file
2.0	Engagement Plan Development Full Plan	12/04/2023	Full Plan file
2.0	DEIA Plan Update	09/05/2023	DEIA plan file
2.0	Quality Jobs Plan	09/05/2023	Quality Jobs Plan file
2.0	Community Benefits Plan Update	12/04/2023	CBP file
3.0	Environmental Volume Update (pre-NEPA review)	07/07/2023	EV file
3.0	NEPA Review (Environmental Assessment)	09/04/2024	EA documentation
4.0	Finalize all ND permit applications	07/09/2024	Application documents
4.0	Finalize all NE permit applications	01/18/2023	Application documents
5.0	30% FEED completion	10/30/2023	Quarterly reporting
5.0	60% FEED completion	02/01/2024	Quarterly reporting
5.0	90% FEED completion	04/11/2024	Quarterly reporting
5.0	FEED cost estimate	09/04/2024	Quarterly reporting
6.1	Feedstock analysis/sorting performance optimized	09/01/2023	Quarterly reporting
6.2	Confirmation of Class I suitability for wastewater disposal	09/01/2023	Quarterly reporting
6.3	Metallization de-risking FEED data	11/29/2023	Quarterly reporting
6.3	Modification and testing of metallization prototype	05/23/2024	Quarterly reporting
6.4	Site-specific feedstock pilot performance for FEED data	09/01/2023	Quarterly reporting
6.4	Product purity and waste stream compositions determined	11/29/2023	Quarterly reporting
7.1	Secure Phase 2 financing	09/04/2024	Phase 2 application
7.2	Phase 2 business plan	09/04/2024	Phase 2 application
7.2	Securement of off-take agreements	09/04/2024	Phase 2 Application
1.0	Phase 2 Application	09/04/2024	Phase 2 application
1.0	Go/No-Go for Phase 2	03/07/2025	DOE decision

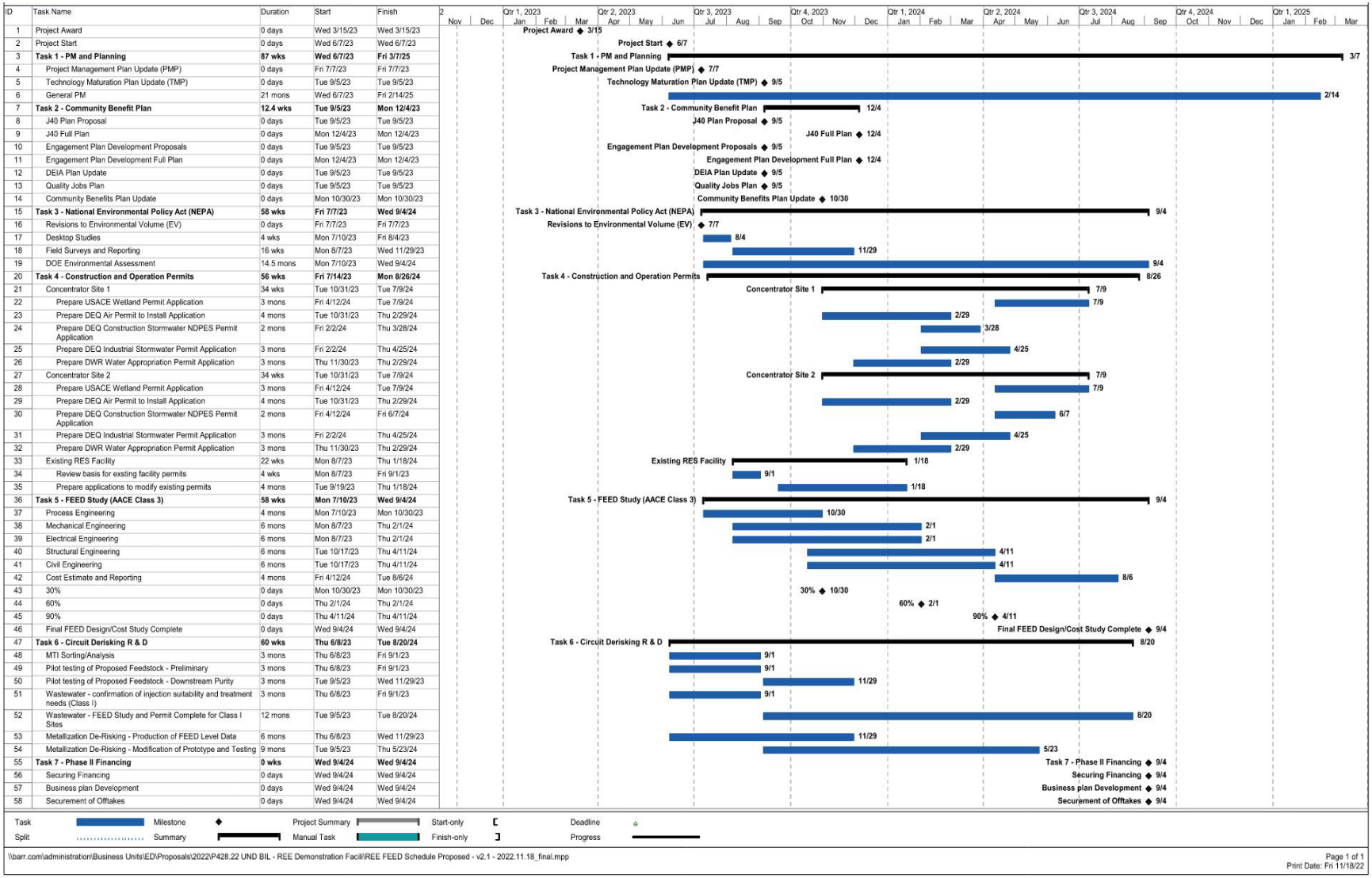

Figure 12. Project schedule

BUDGET

The budget breakdown is provided in **Table 5**. We are requesting $2,000,000 from NDIC, representing 20% of the total budgeted cost. Budget notes are provided in Appendix 1. Letters of commitment for each our subcontractors are provided in Appendix 2.

Table 5. Budget breakdown

Cost Category	DOE Share	NDIC Share	Total Project
Personnel	-	1,061,385	1,061,385
Fringe Benefits	-	336,918	336,918
Travel	10,440	31,710	42,150
Equipment	110,000	-	110,000
Supplies	118,639	4,161	122,800
Barr Engineering	*3,999,660*	-	*3,999,660*
Microbeam Technologies	*748,873*	-	*748,873*
WSP Golder	*736,644*	-	*736,644*
Rare Earth Salts	*645,200*	-	*645,200*
Envergex LLC	*249,900*	-	*249,900*
Odney	*130,800*	-	*130,800*
North American Coal	*95,000*	-	*95,000*
Rainbow Energy Center	*95,000*	-	*95,000*
BNI Coal	*95,000*	-	*95,000*
Minnkota Power Cooperative	*95,000*	-	*95,000*
AmeriCarbon LLC	*50,000*	-	*50,000*
MLJ Consulting	*49,875*	-	*49,875*
Dennis James Consulting	*66,000*	-	*66,000*
Total Contracts	7,056,952	-	7,056,952
Other Direct Costs	428,286	25,000	453,286
Total Direct Costs	9,183,491	-	9,183,491
Indirect Costs	275,682	540,826	816,508
Total Project	**7,999,999**	**2,000,000**	**9,999,999**

MATCHING FUNDS

The Department of Energy will provide $7,999,999 in cash cost share, representing about 80% of the budgeted project cost. The DOE contract is currently being negotiated with DOE and is expected to be in place under award number DE-FE0032295 by August 1, 2023. The DOE award selection notification letter is included as Appendix 4.

As noted in **Table 5** above, our team includes multiple private sector partners in the lignite industry and AmeriCarbon. The proposed budget includes a nominal budget for Minnkota, Rainbow Energy, BNI Coal and North American Coal in the amount of $95,000 and a nominal budget in the amount of $50,000 for AmeriCarbon. However, as noted in each of their respective letters of commitment, any **costs incurred beyond this initial nominal budget will be provided as in-kind cost share.** As we have discussed in this proposal, the key outcome of Phase 1 will be the business and technical information required to move on to Phase 2 construction and operation. As such, ***Phase 1 will be our opportunity to put together the commercial team and financing to pursue the Phase 2 opportunity as a new business***. Each of our lignite industry partners and AmeriCarbon have expressed their interest in evaluating this opportunity. While the in-kind cost share noted above is not contractually obligated, it is our expectation that if a business case exists, one or more of these partners will be interested in being a part of the commercial venture that pursues Phase 2. This would very likely require substantial effort beyond the initial nominal budgets.

TAX LIABILITY

A copy of UND's Tax Liability Statement is provided in Appendix 6.

CONFIDENTIAL INFORMATION

No confidential information is provided in this application.

APPENDICES

Appendix 1 – UND Budget Notes

Appendix 2 – Subcontractor Letters of Commitment

Appendix 3 – Host Site Commitment Letters

Appendix 4 – DOE Award Selection Letter

Appendix 5 – Letters of Interest (feedstock supply, product offtake, project ownership)

Appendix 6 – UND Tax Liability Statement

Appendix 7 – Resumes of Key Personnel

REFERENCES

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APPENDIX 1 – UND BUDGET NOTES

Explanation of Splitting of Budgetary Items

For the ease of contracting, cost-tracking, and overall project management, cost categories and line items, where possible, have been completely covered under a solitary funding source. For ease of contracting, all subrecipients and subcontractors have been placed directly underneath the DOE award, as well as all equipment purchases (as DOE requires disposition of equipment at the completion of all DOE contracts). As such, only UND-based expenses will be covered underneath the scope of the proposed NDIC effort.

Additionally, all pilot supplies and analysis related expenses have been covered underneath the DOE effort, as well as DOE-mandated travel, leaving the expenses left to be covered to include personnel, fringe benefits, the ASPEN license associated with UND's workscope on the FEED study, and approximately 40% of the total outreach materials costs, with this budget to be used exclusively for ND-based outreach activities. Detailed accounting of these costs is found below, covering the entire 21-month proposed effort.

Personnel

Personnel	Hours Budgeted	Hourly Rate ($)	Total Cost ($)
Project Director	1300	103	$133,900
Principal Investigator	1950	45	$87,750
Director, Business Development	780	103	$80,340
Business & Finance Planner	910	37	$33,670
Research Engineers (5)	13000	38	$494,000
Resource Manager	856	32	$27,405
Graduate Students (3)	5460	28.85	$157,521
Undergraduate Students (4)	2600	18	$46,800

*Hourly rates determined from escalated, actual salary rates for names personnel, and on positional UND salaries for the Research Engineer, Graduate Student, and Undergraduate Student rates.

Explanation of Work

Project Director and Principal Investigator

The PD and PI for this effort will be integrally involved in all tasks, with the PD having a larger role in Task 1 and 7 (Project Management and Planning, and Business and Financing Plan Development), and the PI having a larger role in the technically-focused tasks (Tasks 2-6), although involvement in all tasks by both parties is planned.

Director, Business Development

This role will be most primarily used during the Business and Financing Plan Development Task (Task 7), although will also be utilized during the execution of Task 2 (Community Benefits Plan), in assisting access and involvement throughout the state.

Business and Finance Planner

This role will be solely focused on supporting the project's Task 7, primarily focused on the efforts associated with UND's potential licensure and technical support to interested/involved parties.

Research Engineer

These five positions will be occupied by full-time staff, and will be essential in the completion of Task 5 and 6: FEED-related work (such as mass/energy/water balances, equipment sizing, and other related engineering activities); and the De-risking research associated with the operation of UND's pilot facility. Those employed by this project are planned to be full-time during the scope of UND's work on the represented tasks.

Resource Manager

The resource manager will assist the PD and PI in management and cost-tracking of the project, and as such is only involved in Task 1, Project Management and Planning.

Graduate Students

Three graduate students are planned for full-time work on this project, including for assistance in FEED-related work and modeling, as well as with pilot operations for Tasks 5 and 6.

Undergraduate Students

Four undergraduate students are budgeted for this project, solely focused on pilot-scale research and operations, and are intended to be employed as coop engineers during the period of pilot operation (Fall semester, 2023).

Fringe Benefits

Fringe benefits are estimated based on historic rates within UND, although only the true cost of each dedicated employee on the project will charge their specific rates during project execution. The table below estimates the fringe benefits for each employee category.

Personnel	**Fringe Rate**	**Total Fringe Benefits**
Project Director	35.0%	$46,865
UND Staff Positions*	40.0%	$289,266
Graduate Students	0.50%	$788
Undergraduate Students	0.00%	$0

*This includes the PI, Director of Business Development, Business and Finance Planner, Resource Manager, and Research Engineer positions

Travel

Travel costs for the project, as mentioned above, include all travel costs not associated with mandated DOE-related travel. This includes three trips to various locations in ND for outreach and project meetings, travel to Beatrice, NE for related project meetings and outreach at this site location, and two conference attendances, currently budgeted as Clearwater Clean Energy Conference visits for project dissemination. Current state or federal, where appropriate, GSA rates have been used for these activities. For legibility reasons, the tables below represent the same trips, just separated into two tables to convey all requisite information.

Purpose of Travel	Depart From	Destination	No. of Days	No. of Travelers
Domestic Travel	**Budget Period 1**			
ND host site visit	Grand Forks, ND	Bismarck, ND	3	3
ND host site visit	Grand Forks, ND	Center, ND	3	3
ND host site visit	Grand Forks, ND	Underwood, ND	3	3
NE host site visit	Grand Forks, ND	Beatrice, NE	3	3
NE host site visit	Grand Forks, ND	Beatrice, NE	3	3
Technical Conference (i.e. Clearwater Clean Energy Conf.)	Grand Forks, ND	Clearwater, FL	5	3
Technical Conference (i.e. Clearwater Clean Energy Conf.)	Grand Forks, ND	Clearwater, FL	5	3

Purpose of Travel	Lodging per Traveler	Flight per Traveler	Vehicle per Traveler	Per Diem Per Traveler	Cost per Trip	Basis for Estimating Costs
Domestic Travel	**Budget Period 1**					
ND host site visit	$294	$0	$65	$177	$1,608	Current GSA rates
ND host site visit	$294	$0	$65	$177	$1,608	Current GSA rates
ND host site visit	$294	$0	$65	$177	$1,608	Current GSA rates
NE host site visit	$294	$800	$0	$177	$3,813	Current GSA rates
NE host site visit	$294	$800	$0	$177	$3,813	Current GSA rates
Technical Conference (i.e. Clearwater Clean Energy Conf.)	$865	$1,200	$0	$345	$9,630	Current GSA rates. Includes conference registration
Technical Conference (i.e. Clearwater Clean Energy Conf.)	$865	$1,200	$0	$345	$9,630	Current GSA rates. Includes conference registration

Supplies

A total of $4,161 of supplies is requested for the development, printing, mailing, and dissemination of outreach-related materials for the project.

Other Direct Costs

$25,000 is requested as an other direct cost to cover the UND commercial ASPEN license required for the project. Due to the non-academic research nature of the project, the commercial license is required, and costs $20,000 per year for UND (an additional $5,000 to cover the total 15-month technical period).

Indirect Costs

UND has two indirect rates, one for on-campus work, and another for off-campus work. All tasks, save the Pilot activity in Task 6 utilize the on-campus rate of 41%, which is applied to all budgeted items (exemptions from UND's indirect rate include tuition waivers, equipment expenditures, and subcontracts expenditures after the first $25,000). The off-campus rate maintains the same exemptions, although is only a rate of 26%. As such, personnel and fringe expenses expected for the project throughout the execution of Task 6 for off-campus related activities use the lower 26% indirect rate.

Location of Work	Indirect Rate	Direct Expenses	Indirect Expenses
On-Campus	41%	$1,076,270	$441,271
Off-Campus	26%	$382,904	$99,555
Total	37%*	$1,459,174	$540,826

*Rate based on a weighted average, and not the planned project charge rate. Indirects associated with actual expenses will be charged at either the 41% or 26% rates, expecting a 37% average rate.

INDUSTRIAL COMMISSION OF NORTH DAKOTA

Doug Burgum
Governor

Drew H. Wrigley
Attorney General

Doug Goehring
Agriculture Commissioner

Memorandum

TO: Doug Burgum, Governor and Chairman
Drew Wrigley, Attorney General
Doug Goehring, Agriculture Commissioner

FR: Reice Haase, Deputy Executive Director

DT: May 25th, 2023

RE: Contract for Transmission Authority Executive Director

The North Dakota Transmission Authority was created in 2005, with the original purpose of serving as a catalyst for developing transmission in North Dakota, offering alternate sources of financing, fostering the development of transmission corridors, and to be a builder of last resort if the private sector was unable to construct needed infrastructure. Since its creation, the role and workload of the Authority has continued to grow.

At its inception, the Industrial Commission contracted with two consultants to assist with the implementation of the legislation. The consultants were hired using Lignite Vision 21 Program grant dollars, which, over time, continued to pay for contracting costs for the Transmission Authority. The Lignite Vision 21 Program later evolved into the Enhance, Preserve and Protect project (EPP), which remains an active project of the Lignite Research Program today.

The Commission appointed its first Transmission Authority Director on October 19, 2006 when it accepted the recommendation of the Lignite Vision 21 Program and the Lignite Energy Council and named Sandi Tabor as acting director. The Commission directed Karlene Fine and Ms. Tabor to conduct a search for a permanent director. Concluding the search, the Commission determined that Ms. Tabor should remain acting director.

Since that time, the Commission had typically appointed a Transmission Authority Director based on the recommendations of Karlene Fine and the Lignite Energy Council. This position was structured as an independent contractor, with a contract executed through the Lignite Energy Council:

- Sandi Tabor as Acting Director from 2006 – 2013 based on Lignite Vision 21 and LEC recommendations
- Curtis Jabs as Acting Director from 2013 – 2014 based on Karlene Fine and Sandi Tabor recommendations
- Andrea Stromberg as Director from 2014 – 2015 based on Karlene Fine and LEC recommendations

- Tyler Hamman as Director from 2015 – 2017 based on Karlene Fine and LEC recommendations
- John Weeda as Director from 2018 – Present based on Karlene Fine and LEC recommendations

During the 68th Legislative Session, the legislature appropriated $300,000 from the General Fund to the Commission to contract directly for the Transmission Authority Director position in the 2023-2025 biennium. The rationale for the appropriation of General Fund dollars instead of continuing to use lignite grant dollars was the evolution of the role of the Authority and its growing workload involving other non-lignite energy sources.

At the April 25th, 2023 Industrial Commission meeting, John Weeda announced his intent to retire from the Transmission Authority Director role. Mr. Weeda recommended the appointment of Mr. Claire Vigesaa, who has been acting as a Deputy to Mr. Weeda.

Two options that the Commission could take to appoint the next Director are as follows:

Option 1: Follow the appointment process that the Commission has traditionally used by appointing the position based on recommendations from the Office of the Industrial Commission and the Lignite Energy Council

Option 2: Develop a new process for appointing the position by directing the Office of the Industrial Commission to solicit applications for the position, with a recommendation to be made to the Commission following an application review process

INDUSTRIAL COMMISSION OF NORTH DAKOTA

Doug Burgum
Governor

Drew H. Wrigley
Attorney General

Doug Goehring
Agriculture Commissioner

Memorandum

TO: Doug Burgum, Governor and Chairman
Drew Wrigley, Attorney General
Doug Goehring, Agriculture Commissioner

FR: John Weeda and Claire Vigesaa

DT: May 25th, 2022

RE: North Dakota Transmission Authority Legislative Update

Direct-current Transmission Line Project:

As the legislature worked through final business, the request from Allete for a $25M contribution in support of rebuilding the DC line from Center to Duluth was not funded. Instead, the legislature included a statement of support for the project and asked them to consider using an existing program for financial support. The program that fits this need is the NDTA authority to make loans in support of Transmission projects.

Since then, NDTA has had a few discussions with Allete and held a meeting including DeAnn Ament to discuss how a loan would be structured and how the bonding would be utilized to raise the funds for the loan. Those discussions are continuing with DeAnn Ament pursuing more details for the questions they have.

Infrastructure Investment and Jobs Act (IIJA) Grid Resilience Grant

Matching funds for the IIJA grid resilience grant program were approved in House Bill 1014. The Department of Energy has not announced the award, but the award is expected soon. NDTA is preparing to move the process forward to solicit project requests soon after the award.