.

Oil and Gas Research Program

North Dakota

Industrial Commission

Application

Project Title: Creedence Energy Services EOR Biosurfactant Applications

Applicant: Creedence Energy Services /Locus Bio-Energy

Principal Investigator:

Date of Application: 10/30/2020

Amount of Request: $205,750

Total Amount of Proposed Project:

Duration of Project: 18 months

Point of Contact (POC): Kevin Black

POC Telephone: 701-740-7481

POC E-Mail Address: kevin.black@creedence-energy.com

POC Address:

Creedence Energy Services
Attn: Kevin Black
PO Box 3480
Minot, ND 58702

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ABSTRACT

Objective: To increase production appreciable amounts over the expected production decline of oil producing wells depleting due to formation conditions. Creedence aims to prove suitability of novel biosurfactant chemistry, which, due to its incredibly small micelle size (< 2.0 nm) will be able to contact reservoir surfaces previously unreachable. The biosurfactant has properties which allow adsorption onto rock surface, allowing for long term chemical effect (>6months). Once in contact with formation surface and production fluids, the highly active biosurfactant will water-wet the formation rock (decreasing oil affinity for adhering to rock), reduce the surface tension of fluids (reducing the force needed to lift the fluids to surface), and reduce the interfacial tension of oil and water. Creedence aims to prove this technology in closed hole, legacy assets, as well as early Bakken production wells with limited perforation surface area. Once the adsorption and mechanism of stimulation is proven, Creedence aims to explore open-hole applications and more recent Bakken production wells with increased perforation space. This technology is a low pressure injection stimulation job which should prove less costly than full-scale "re-fracs". This decreased economic impact may help reduce statewide production decline while economic conditions are unfavorable to investment in new wells or full-scale re-fracs. With the return of favorable economic conditions and proof of the biosurfactant suitability, this chemistry may be applied initially in well stimulations to increase initial production of Bakken wells also. Lastly, if enough demand is created, investment in a biosurfactant fermenter may be warranted in the state, which would utilize canola oil and sugar as fuel sources, both of which are abundantly available due to North Dakota's agriculture industry.

Expected Results: Results are highly dependent on the wellbore design of the producing well and the stage of life of its production. Mechanical lift changes, such a change in pump size, can make production increases difficult to distribute across multiple factors. Lastly, this chemistry cannot make up for a complete depletion of reservoir lift, so proper selection of well, relative to life cycle, is needed. If lift methodology is maintained constant and a suitable wellbore situation is selected, a well with depleting production can expect a minimum 25% increase of produced oil, above its projected decline curve. This estimation is a very conservative estimate.

Duration: 6 to 18 months

Total Project Cost: $205,750 Total: $32,000 for lab equipment + $112,500 for 50% cost share of 3 proof of concept trials for 2-mile laterals + $52,500 for 50 % cost share of 3 proof of concept trials for 1-mile laterals + $8,750 for 50 % cost share of 5 proof of concept trials for 5 vertical wells

Participants: Creedence Energy Services and Locus Bio-Energy Solutions

PROJECT DESCRIPTION

Objectives: Recover oil from current production assets left behind by previous technological capabilities. This increased oil recovery will be done through use of 'squeeze' or batch treatment applications of a nano biosurfactant. This increased oil production can be at costs significantly smaller than those associated with full scale restimulations.

Data acquired through this project will help optimize application parameters to maximize oil production and create a payback window for the return on the investment of future jobs under six months. Optimizing applications that 'payback' in that time frame are critical for accounting purposes to stay under capital expenditure classification. Current market environments strongly discourage capital expenses by oil and gas operators.

Proof of concept and subsequent widespread application may create an operating expense categorized option for operators to maintain or increase production. Without an option of this nature, assets and entire fields' production will fall precipitously according to the natural decline curve associated with shale oil production. With enough application across the basin, an appreciable minimization of decreases to oil productions, and thus, revenue to the State of North Dakota from decreased production, may be realized.

Methodology: Prove suitability for application of the stimulation biosurfactant via lab testing and trial applications. Lab testing would measure increased mobility of oil after entraining representative oil in Bakken core samples or drill cuttings via Amott Cell Imbibition Testing. This test would simulate the ability of the biosurfactant to mobilize oil wetted to formation wet. Capillary pressure reduction of produced fluids would be tested and measured. Interfacial tension of produced fluids would be measured. The ability of the biosurfactant to alter Bakken oil's wetting of a surface would be measured as well. This test would simulate the ability of the product to alter the formation face encouraging oil droplet departure from the formation. These lab tests will help determine blending specifications for the biosurfactant blend to ensure it is best suited for various formations in North Dakota, and its representative fluids.

Trial jobs will help prove the concept of the biosurfactant applications in this Basin. In addition to establishing credibility, various parameters of the jobs will be able to tweak and tested to determine best practices for maximum return. There parameters include job size per perforation cluster/lateral foot, concentration of active biosurfactant in jobs, overflush volumes, and pill/overflush fluid makeup. Optimization of these parameters will maximize return on investment by reducing the initial expenditure. That optimization, along with the proof of concept, should encourage move application, mobilizing more oil in the state without full scale restimulation costs.

Anticipated Results: Conservatively, a minimum increase of 25% in daily oil production over the course of a year. This increase is expected to be greater upon initial return to production following the job. The initial spike is then expected to fall off incrementally throughout the designed lifetime of the application (usually 1 year) until it returns to the pre-job production rate. These are safe estimates.

Success stories from other basins include a well producing 2.1 barrels of oil per day (BOPD) which received an 80-barrel treatment. The production on this well spiked to 12.8 BOPD following the biosurfactant application. This production increase leveled off to 2.3 BOPD after **554 days**. This application resulted in 1,316 barrels of incremental oil from its decline trajectory. Economically, the incremental oil from the first 48 days paid for the cost of the job, with the remaining 506 days of incremental production being enjoyed by the operator at no additional expense. This well was producing from a sandstone reservoir.

This chemistry has been applied in shale applications. A 2019 application in the Wolfcamp Shale resulted in a well, producing 21 BOPD, to increase its average oil production to 32 BOPD over a 12-month period.

Facilities: Laboratory testing would be conducted in Williston, North Dakota at the Creedence Energy Services Laboratory. Additional testing and support would be conducted in the Woodlands, Texas.

Applications would not have an applicable facility to denote.

Resources: Initial evaluation will require lab testing to ensure reduction of interfacial tension (IFT), capillary pressure, water-wetting of representative fluids to representative core/drill cuttings, and increased oil mobility. Acquisition of this lab equipment, so that this equipment may be tested in North Dakota, in a timely and responsive fashion, to be $15,000. Technical time, which may be significant, will also be required.

Each job will require a time investment from a qualified reservoir engineer, or professionally trained engineer/scientist, to determine suitability based upon well schematics, trending oil productions, and expected return on investment. Subsequent time will be required to then create an appropriately sized application by the same individual.

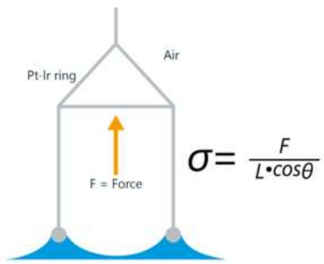
Each biosurfactant application will require a few main components. An amount of biosurfactant concentrate, determined by the surface area of perforation in the well to be treated, is calculated. This concentrate is diluted 10 to 20x in freshwater, which will also need to be required. This freshwater will often require heating. A pumping unit, or the investment of the time associated with a pumping unit, will also be required. The pumping unit may be an acid truck, treater truck, or hot oil truck for smaller sized jobs (for vertical wells). Larger jobs treating 1-mile laterals or longer will require a frac unit pump, to pump the volume in a reasonable amount of time. The operator will have to shut production in for 24 to 48 hours to allow for the chemistry to chemisorb/physisorb onto the formation surface to ensure a long-term effect from the treatment. This results in delayed production. Resources may be required to compensate the time associated for required personnel on location during the application.

Ongoing monitoring of the application will require time associated with sampling production fluid from the treated asset, along with the costs associated with laboratory testing to determine remaining chemical amount (and thus application life). This testing equipment is included previously, plus associated consumables and technician time.

Techniques to Be Used, Their Availability and Capability:

To ensure maximum field performance a series of laboratory tests are conducted using samples of field fluids (oil and water) plus core or cuttings that accurately reflect the mineralogy of the reservoir to be treated. Lab determinations of surface tension and interfacial tension and oil release rates can predict the volume of additional oil that will be mobilized by the biosurfactant treatment. Surface tension and interfacial tensions are measured using the industry standard Du Noüy ring method.

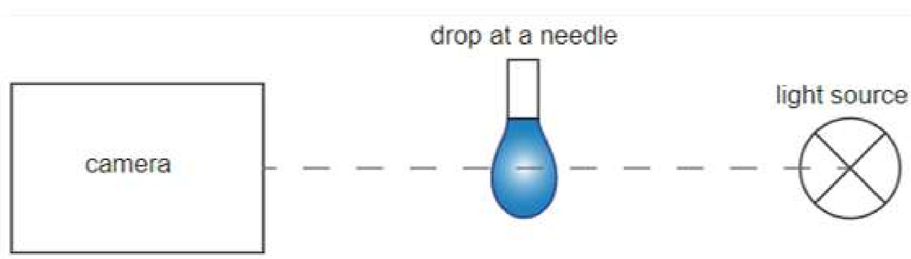
Du Noüy ring method:



This method measures the surface tension of a liquid and the interfacial tension between two liquids. The force referred to the wetted length acting on a ring as a result of the tension of the withdrawn liquid lamella when moving the ring from one phase to another is measured in this method.

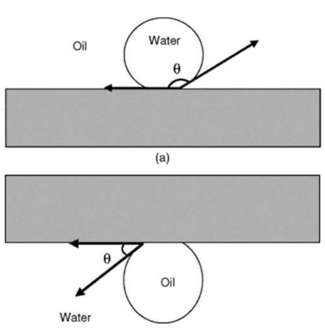
Contact Angle Measurement: Pendant Drop Method

The surface tension of a liquid and the interfacial tension between two liquids can be determined with an



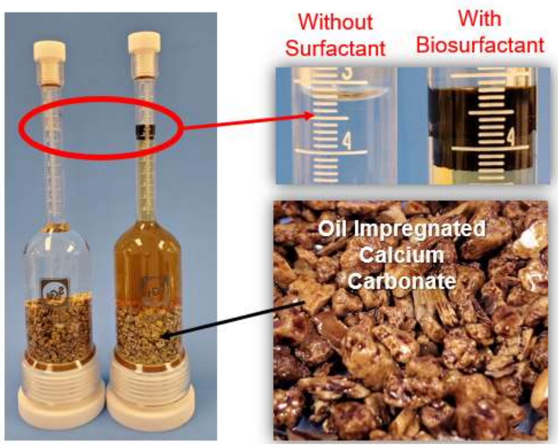
optical contact angle measuring and contour analysis called the "Pendant Drop Method".

A high speed camera is used to capture an image of a liquid oil drop that hangs on a dosing needle. The analysis of the drop shape is based on the Young-Laplace equation. This equation describes the pressure difference (Laplace pressure) between the areas inside and outside of a curved liquid surface/interface. This pressure difference is influenced by the addition of surface active chemicals such as biosurfactants. The faster the separation of the drop from the end of the needle, the more effective the surface active chemical is at mobilizing oil from a reservoir. These tests are conducted using field oil and water samples and the results have a strong correlation to actual field results obtained. The pendant drop method is an effective method to fine tune the exact dosage required for a specific application.



This method can also be modified to determine the **"Contact Angle"** of (a) a water droplet in an oil phase (water-in-oil) and (b) an oil droplet in a water phase (oil-in-water). A droplet (3µl) of the treatment fluid at different concentrations is placed onto a glass slide while a high speed camera records pictures. After 30 seconds the contact angle (θ) is taken in respect to the water phase to determine the contact angle. These measurements relate to the change in wettability of a reservoir rock.

Amott Cell Imbibition Test



The spontaneous imbibition Amott test consists of placing oil-saturated core cuttings in a brine filled Amott cell. An adequate time between brine filling and sample immersion is necessary to ensure a constant, homogeneous temperature profile in the brine. The volume of oil expelled can accurately be measured by reading the graduation on the cell. The apparatus is comprised of a sealed glass container and a graduation tube located above it. The volume of additional oil compared to the blank (untreated) brine expelled can accurately be measured by reading the graduation on the cell.

If this Grant Application is accepted by the NDIC, part of the funds requested will be used to install the above equipment in Creedence Energy Services' laboratory in Williston to allow the required screening tests to be conducted in the North Dakota area vs shipping samples out of state for analyses.

The field application would use established industry techniques. A pumping unit, sized upon the total freshwater to be injected in the application, will connect to the annular space or production tubing, determined by the presence of absence of a packer. After require safety procedures to ensure proper connection and pressure ratings, the pump unit operator will begin to pump the job appropriately. Some jobs may require an initial pretreatment to clean up anticipated near well bore damage due to paraffin/wax accumulation or scale precipitation. The main 'pill' of the job will then be pumped below fracturing pressures and at a rate below that likely to cause migration of existing proppant in the well. Pressures and rate limits may also be limited by the operating company. Following treatment of the 'pill', which contains the biosurfactant, placement into the producing zone of the well will be ensured by pumping an 'overflush'. This overflush will be a volume of water equal to that of the annular or tubular space required to displace any remaining pill into the perforated zones.

Environmental and Economic Impacts while Project is Underway

Environmental and economic impacts to production assets and operators are below an order of magnitude lower than associated costs of full scale restimulations.

Economically, full scale restimulations costs associated with 2-mile lateral wells in the Williston Basin could cost up to $3-4 million in early 2020. Costs of such jobs since the market downturn associated with the COVID-19 pandemic have not been available, likely to the scarce number of jobs performed. Recent estimation from ongoing viability research calculated a likely required investment between $80,000 and $100,000. This job design was a premium job application and smaller application sizes may prove effective after reviewing data acquired from this project.

The biosurfactant treatment uses significantly less resources than a full-scale restimulation, including less freshwater and pumping horsepower to complete the jobs. Jobs are generally pumped at low pressure with rates between 5-15 barrels per minute which minimizes impact and resources required on the well location.

The proposed biosurfactant treatment is water based. Chemically the biosurfactant is a fermentation product of glucose and corn or rape seed oil derived fatty acids methyl esters. The biosurfactant is produced by nonpathogenic microbes, generally recognized as safe (GRAS). This biosurfactant combines green chemistry and a lower carbon footprint without the undesirable side products or environmental downsides associated with many market reference surfactants. The product is fully biodegradable and to has a low acute toxicity. Independent Studies demonstrate that the biosurfactant does not affect Daphnia reproduction, and that the chronic toxicity is an order of magnitude lower than that of reference surfactants, with a no-observed-effect concentration (NOEC) of 11.3 mg/L as compared to approximately 1 mg/L.

This project will reduce the environmental impact and required investment to recover more of the original oil in place compared to currently available techniques. It will recover oil that is available from previous drilling. These reduced impacts should encourage greater activity in enhanced oil recovery effects, creating previously unavailable oil production in the state.

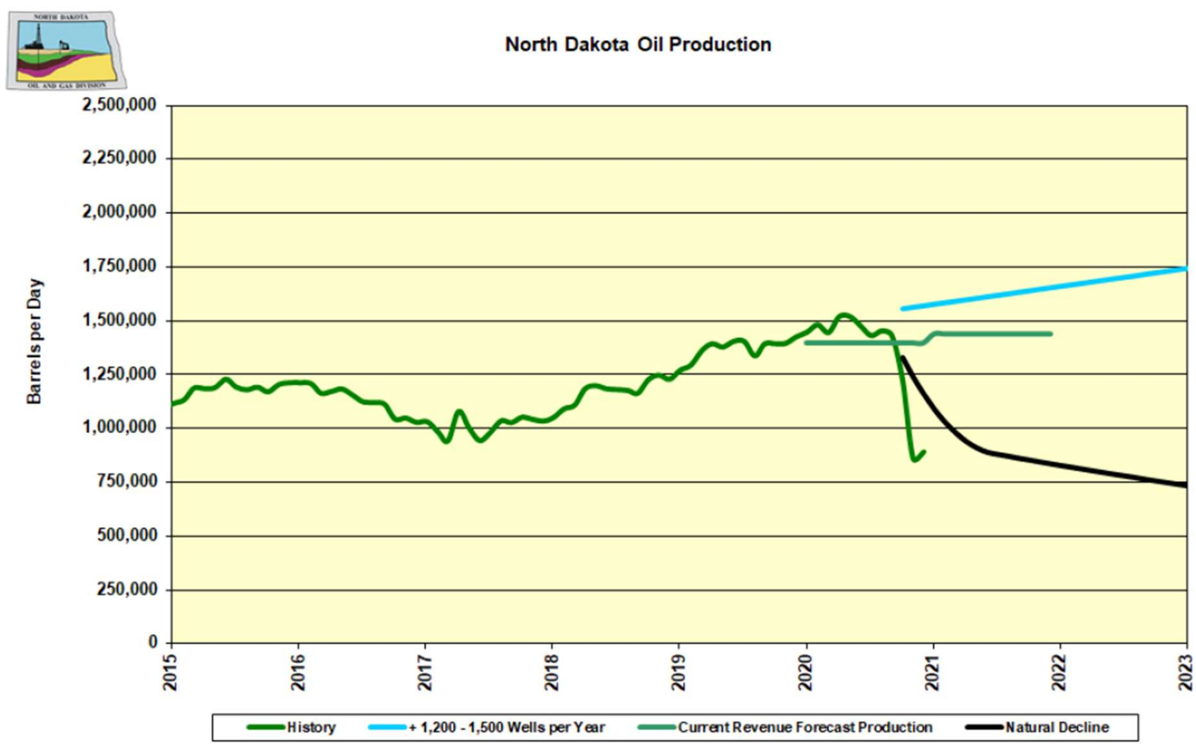
Ultimate Technological and Economic Impacts:

Field wide application may result in serious incremental production for operators in the basin that would not have been previously available without the application. Additionally, it may provide an option as an operating expense job as opposed to being funded by inaccessible capital expenditure funding. These jobs will reach oil that has already been drilled to and large capital expenses have been incurred to reach. Mobilizing this inaccessible hydrocarbon, across enough assets, may help operators reach economic goals, stabilizing their investment in the Williston Basin, along with its workforce.

Ultimately, proof of chemical activity may lead to a next step in chemical application. This could mean inclusion of the nano biosurfactant in initial stimulation jobs on Bakken/Three Forks wells, again increasing the recoverable oil from each asset. This would create the largest potential increase in incremental oil. Older fields being pressurized by water flood may benefit by including the water soluble biosurfactant the injected water to increase production across entire water flood fields. Higher scale applications, such as these, in enough frequency may help reduce declined production from oil and gas producing assets in the State of North Dakota, and subsequently, reduce decreasing revenues.

Creation of enough demand, through the various described applications, could lead to investment in a fermentation plant in the state to serve the need. Biosurfactant production is currently located at our partner company (Locus Bio Energy) plant in Solon Ohio. Their patented, low CAPEX fermentation process is designed to be scaled quickly and built near application sites. Upon successful field validation of this technology it would be our intent to construct a fermentation plant in North Dakota. This local production would significantly reduce product transportation costs and would allow North Dakota grown sugar and corn or canola oil (the two main raw materials required for biosurfactant production) to be utilized making this a 100% locally sourced and manufactured product, creating approximately 20 new jobs in North Dakota.

Why the Project is Needed: Temporary reduction in price for oil due to demand downturns associated with the COVID-19 pandemic have made "capital" investment in drilling and completing new wells unattractive for oil producers. Without increased production new wells, the decline of shale wells is expected to result in a drastic decline of daily oil production in the State of North Dakota, as shown in the figure from the North Dakota Department of Mineral Resources, below.



The decreased oil production directly results in decreased revenue to the State, impacting the overall budget and funding of vital programs.

This economic outlook, combined with the shear amount of oil still entrained in many North Dakota wells create a favorable climate to employ this technology, which will produce incremental energy and capture more revenue for the state, at a lower sized expenditure than full scale restimulation. In 2008, the NDGS estimated that with the existing technology of that time, 2.1 billion barrels of oil was recoverable, out of 16 billion barrels downhole. In 2018, Continental Resources estimated that technological advancements increased recoverable oil in the Bakken to 30 to 40 billion barrels. Wells completed between those time frames recovered drastically different percentages of available oil. It can be easily surmised that wells completed earlier in the Bakken play likely have oil that can be easily mobilized with this lower cost technology, helping to stabilize oil production in the Williston Basin. With proof of concept and application leading to widespread application, it may help ‘flatten the decline curve’ in North Dakota, until economic conditions prove more attractive for capital investment in the Basin.

STANDARDS OF SUCCESS

Standards of Success should include: The measurable deliverables of the project that will determine whether it is a success; The method to be utilized in measuring success; The value to North Dakota; An explanation of what parts of the public and private sector will likely make use of the project's results, and when and in what way; The potential that commercial use will be made of the project's results; How the project will enhance the education, research, development and marketing of North Dakota's oil and natural gas resources; How it will preserve existing jobs and create new ones; How it will otherwise satisfy the purposes established in the mission of the Program; How it will be reporting on the success of the project.

Production volumes from before and after the biosurfactant applications of treated wells will be the key metric in determining success of the project. Determining the reservoir response of applications of different concentrations will help forecast expected production increases. This data will can be used to better design jobs, so that payback of applications is ensured beneath the threshold at which an expense/investment would be categorized as a capital expense (typically payback in 4 or 6 months).

If the data garnered from this project can demonstrate feasibility and create data to optimize Williston Basin application design within the stated payback window, an operating expense option would be created to increase or stabilize oil production (and revenue associated) in the State. This classification as an operating expense job allows for a much greater availability of dollars for operators, which should translate to an increased frequency of enhanced oil recovery (EOR) efforts. Currently operators may not have access to capital expenditure dollars necessary for current EOR methods.

Maintenance or an increase of production levels may aid the financial viability of production fields or assets in the Williston Basin. Many assets are now at-risk for long term shut-in or abandonment. Decisions are being made on how to allocate operating expense dollars, and capital expense dollars are scarce or not available at all. The production increases from these jobs may be able to change the financial viability of particular assets or offset production loss from shut-in or abandoned wells in the same field or route. The stabilization of production, and thus revenue, and the maximization of existing infrastructure with much more available operating expense dollars, may help secure financial justification to maintain, or increase, current workforce numbers.

A major contributing portion of the revenue of the State of North Dakota is generated from the oil and gas extraction tax and gross production tax. Adverse market influences on the energy (and agriculture) industries can have disproportionate effects to revenue models on which the State's budget is based. The State has recognized this and been pro-active, as recently as this week, in attempts to maintain or increase production in discouraging market conditions, with the reallocation of $16 million of CARES Act funding to aid/encourage stimulation of roughly 80 wells. Proof of concept and widespread application of the biosurfactant jobs would assist in similar aims to maintain/increase production.

Creation of enough demand for biosurfactant applications could warrant creation of a fermentation plant in the state. This plant would feed off agricultural products in which North Dakota is already prolific in producing, canola oil, corn oil, and sugar beets. This plant would create short-term construction jobs and longer lasting jobs (approximately 20) associated with operation of the plant.

Communication of the standards of success can be communicated to the Oil and Gas Research Council at agreed upon intervals. Additionally, an online platform can be set up for members of the council to view associated data and metrics on-demand.

BACKGROUND/QUALIFICIATIONS

Please provide a summary of prior work related to the project conducted by the applicant and other participants as well as by other organizations. This should also include summary of the experience and qualifications pertinent to the project of the applicant, principal investigator, and other participants in the project.

Locus Bio-Energy Solutions has been providing biosurfactant based products to oil and gas operators commercially for over 4-years. Recently, Locus BioEnergy has partnered with Creedence Energy Services to provide biosurfactant based solutions for paraffin dispersal, enhanced oil recovery, and hydraulic fracturing chemistry.

More than 300 wells have been treated with these products in both the Permian Basin and the Appalachian Basin. These products are suitable for both conventional and unconventional wells. These products provide benefits to oil & gas operators including reduced operating expenses and increased production.

Creedence Energy Services was founded in 2014 by Kevin, Wyatt, and Malachi Black. The business was started utilizing a novel concept for traditional remediation jobs involving acid. They developed a complete closed-loop, self-contained, high-pressure acid pump truck. This engineered solution reduced HSE risk, rig time, required manpower, and resources. The step-change in performing acid jobs efficiently and safely led to growing the fleet to four trucks. Through conversations with customers, this idea evolved to include the prevention of scale formation and deposition.

In 2016, Creedence entered the production chemicals market. Since the inception of the production chemical trials, Creedence has grown to 68 employees and has operations in North Dakota and the Permian Basin. Creedence's production chemical division currently services over 2100 wells in the Williston Basin and is rapidly growing. The treatment philosophy of Creedence is utilizing data and accountability to guide the chemical program to provide solutions.

MANAGEMENT

*A description of **how** the applicant will manage and oversee the project to ensure it is being carried out on schedule and in a manner that best ensures its objectives will be met, **and a description of the evaluation points to be used** during the course of the project.*

The project will be managed jointly by Creedence Energy Services and Locus BioEnergy. CEOs Kevin Black (Creedence) and Jonathan Rogers (Locus BioEnergy) will provide overall guidance and Technical Directors Eric P. Nelson (Creedence) and Marty Shumway (Locus Bio Energy) will provide direct technical support and oversight of the project. Locus BioEnergy's primary focus will be designing the surfactants treatments, manufacturing of the surfactant, and interpretation of post treatment data. Creedence will be responsible for identifying candidate wells, executing the treatments at the well sites, and collecting post-treatment data.

Capturing post-treatment data will be critical to measuring the successfulness of the surfactant treatments. Two Key Performance Indicators (KPIs) will be measured and analyzed on a regular basis: 1) daily oil production (BOPD) and 2) oil phase interfacial tension. Daily oil production data will be provided by the operator on a weekly basis, and Creedence will collect regular oil samples from the wellhead which will be analyzed for interfacial tension at Creedence's Williston, ND, laboratory. All data will be managed by Creedence internal laboratory database and made available via PowerBI or similar data management and reporting platform.

Regular communication between operators, Creedence, and Locus BioEnergy will be necessary. Any changes to the well during the project should be documented and communicated immediately included well failures, artificial designed, offset fracs, or other mechanical changes that could impact production. At a minimum, the following schedule should be adopted to evaluation critical progression points during the project:

Meeting	Timeline	Purpose
Pre-Treatment	Prior to Treatment	Review treatment design and anticipated production increase forecasts
Post-Treatment I	Within 1 Week of Treatment	Review execution of treatment to ensure proper procedures were followed
Post-Treatment II	1 Month After Treatment	Review forecast to actual production data and interfacial tension measurements
Post-Treatment III	3 Months After Treatment	Review forecast to actual production data and interfacial tension measurements
Post Treatment IV	6 Months After Treatment	Review forecast to actual production data and interfacial tension measurements

TIMETABLE

Please provide a project schedule setting forth the starting and completion dates, dates for completing major project activities, and proposed dates upon which the interim reports will be submitted.

Start dates are dependent on finding operating partner willing to trial the application according to test parameters. Once wells from willing partners are selected, the jobs should be able to be performed in less than one month. In this time frame, the job will be designed to an appropriate according to the individual well characteristics. Initial lab testing will be completed during this time as well, to serve as a baseline comparison for measurements taken after the job.

Following design, approval, and application of the biosurfactant job, production volumes will be communicated and updated weekly. Samples we will be collected and processed in that time frame, as well.

Evaluation of the job will continue until laboratory testing suggests depletion past the minimum effective concentrations of the chemistry. This is expected to be roughly one year. Data collected before the completion of the applications' effectiveness will, however, provide valuable data and insight into reservoir response to the chemistry. The first six months of this data collection will be particularly important. This data will be critical in optimizing job design to meet the economic challenges of enhanced oil recovery in unfavorable market conditions.

BUDGET

Please use the table below to provide an ***itemized list*** *of the project's capital costs; direct operating costs, including salaries; and indirect costs; and an explanation of which of these costs will be supported by the grant and in what amount. The budget should identify all other committed and prospective funding sources and the amount of funding from each source, differentiating between cash, indirect costs, and in-kind services. Justification must be provided for operating costs not directly associated to the costs of the project. Higher priority will be given to those projects that have matching private industry investment equal to at least 50% or more of total cost. (Note ineligible activities or uses are listed under OGRP 2.02)* ***Please feel free to add columns and rows as needed.***

Project Associated Expense	NDIC's Share	Applicant's Share (Cash)	Applicant's Share (In-Kind)	Other Project Sponsor's Share
Amott Cells	$2,000			
Surface Tensiometer	$10,000			
Drop Shape Analysis Instrument	$20,000			
Initial Lab Analysis Time			$61,837.50	
Job Design Time			$17,250	
Sample Collections			$15,300	
Post Job Lab Analysis			$45,900	
50% Cost Share of 3 2-Mile Lateral Jobs	$112,500	$112,500		$45,000
50% Cost Share of 3 1-Mile Lateral Jobs	$52,500	$52,500		$45,000
50% Cost Share of 5 Vertical Jobs	$8,750	$8,750		$12,500

Please use the space below to justify project associated expenses, and discuss if less funding is available that that requested, whether the project's objectives will be unattainable or delayed.

The expenses for the Amott Cells, Surface Tensiometer, and Drop Shape Analysis are for procurement of laboratory equipment to perform the analyses described in the "**Techniques to be used**" section. The costs provided are estimated from Locus procurement of similar/same equipment within the last four years. Creedence is requesting funding to bring this equipment to the state to allow for more responsive and efficient laboratory evaluation of potential well and ongoing applications, as opposed to shipping samples to out-of-state labs. Creedence and Locus are offering an estimated $140,287.50 in-kind contributions to the project. The in-kind contributions are detailed below.

- The following details the commercial prices used to calculate the in-kind contribution figures in the Initial Lab Analysis and Post Jobs Analysis Section. The table describes testing requirements for horizontal wells. These totals are multiplied by the number of jobs requested in this document (six). Five vertical wells are requested, as well. A half rate for these wells is calculated, as frequency will be so reflected for these less prolific assets.

Test	Base Price ($)	Rush Price ($)	Remarks	Pre-Job # of Tests	Pre-Job Costs ($)	Post-Job # of Tests	Post-Job Costs ($)
Surfactant Evaluation							
Surface Tension Measurement (Static)	100	200	per sample/ per dosage	5	500	1	100
Surface Tension Measurement (Dynamic)	100	200	per sample/ per dosage	5	500	8	800
Interfacial Tension Measurement	150	300	per sample/ per dosage	12	1800	8	1200
Contact Angle Measurement (Slide)	75	150	per sample/ per dosage	5	375	4	300
Contact Angle Measurement (Core)	250	500	per sample/ per dosage	3	750	0	0
MicroColumn Recovery Test	300	TBD	per sample/ per dosage	4	1200	0	0
Amott Cell Imbibition Test	500	TBD	per sample/ per dosage	2	1000	0	0
Oil Characterization							
API Gravity	50	100	per sample	1	50	8	400
Carbon Chain By GC-SIMDIS Method	150	300	per sample	1	150	2	300
Wax Appearance Temperature (WAT)	100	200	per sample	1	100	2	200
Wax Dissolution Temperature (WDT)	100	200	per sample	1	100	2	200
Viscosity Measurement	150	300	per sample	1	150	8	1200
Water Analysis							
Complete Analysis	150	300	per sample	1	150	2	300
Conductivity measurement	50	100	per sample	1	50	4	200
Fluid Compatability Testing							
Oil - Water Separation	100	200	per sample	4	400	2	200
TOTAL Lab COSTS					7275		5400

- It is estimated to take a Reservoir Engineer 15 hours to design the initial biosurfactant applications while properly accounting for laboratory findings, wellbore considerations, and anticipated production concerns of the well for horizontal wells. That same estimate for the vertical wells is 5 hours. A conservative commercial rate of $150/hour was used for calculation.
- Ongoing sample collection to monitor applications will be required for the first year following treatment. For the first 9 weeks following applications, samples may be required every week. Assuming sample collection is possible within a day, 72 hours is estimated for this period. The sampling frequency is expected to be 50% for the next 9 weeks. Thirty-six hours is allotted to that time period. Monthly samples will be likely be required following that period, until the application date + 1-year. Sixty-four hours of sample collection is calculated for that time period. An hourly rate of $65 is used again, accounting for benefitted field technician time and fuel expenses.
- Chemical cost for 2-mile lateral well jobs is estimated to be $75,000. Creedence is requesting a 50% cost share on 3 trial wells (50% of $225,000) to encourage trials to prove the concept of these applications and increase the rate at which these applications are generally accepted as proven. Expected costs associated with the pumping unit, freshwater, and water heating, are expected to be roughly $15,000, to be assumed by the operating company.

- Chemical cost for 1-mile lateral well jobs is estimated to be $35,000. Creedence is requesting a 50% cost share on 3 trial wells (50% of $105,000) to encourage trials to prove the concept of these applications and increase the rate at which these applications are generally accepted as proven. Expected costs associated with the pumping unit, freshwater, and water heating, are expected to be roughly $15,000, to be assumed by the operating company.
- Chemical cost for vertical well jobs is estimated to be $3,500. Creedence is requesting a 50% cost share on 5 trial wells (50% of $17,500) to encourage trials to prove the concept of these applications and increase the rate at which these applications are generally accepted as proven. Expected costs associated with the pumping unit, freshwater, and water heating, are expected to be roughly $2,500, to be assumed by the operating company.

CONFIDENTIAL INFORMATION

Any information in the application that is entitled to confidentiality and which the applicant wants to be kept confidential should, if possible, be placed in an appendix to allow for administrative ease in protecting the information from public disclosure while allowing public access to the rest of the application. Such information must be clearly labeled as confidential and the applicant must explain why the information is entitled to confidentiality as described in North Dakota Century Code 54-17.6. Oil and gas well data that is a result of financial support of the Council shall be governed by North Dakota Century Code 38-08-04(6). ***If there is no confidential information please note that below.***

Creedence and Locus Bioenergy would like to keep KPI metric data distribution limited to oil and gas producers rather than oilfield service providers. Parameters discovered through this project may provide a competitive advantage in low pressure stimulation work. Creedence and Locus would like to retain ownership of that acquired knowledge in the oilfield service industry. Dissemination of the KPI data, production response and laboratory measurements may be distributed to operators in the Williston Basin. Details regarding the manufacture or composition of the biosurfactant itself would remain confidential, and relevant patents and applications are described in the attached STIM_FLOW_OCT_2020 patent.pdf.

PATENTS/RIGHTS TO TECHNICAL DATA

Any patents or rights that the applicant wishes to reserve must be identified in the application. ***If this does not apply to your proposal, please note that below.***

Patents and rights reserved are listed in the attached document STIM_FLOW_OCT_2020 Patent.pdf.

STATUS OF ONGOING PROJECTS (IF ANY)

If the applicant is a recipient of previous funding from the Commission, a statement must be provided regarding the current status of the project.

No previous or ongoing projects awarded.

APPLICATION CHECKLIST

Use this checklist as a tool to ensure that you have all of the components of the application package. Please note, this checklist is for your use only and does not need to be included in the package.

☐	Application
☐	Transmittal Letter
☐	$100 Application Contribution
☐	Tax Liability Statement
☐	Letters of Support (If Applicable)
☐	Other Appendices (If Applicable)

When the package is completed, send an electronic version to Ms. Karlene Fine at kfine@nd.gov, and 2 hard copies by mail to:

Karlene Fine, Executive Director
North Dakota Industrial Commission
State Capitol – 14th Floor
600 East Boulevard Ave Dept 405
Bismarck, ND 58505-0840

For more information on the application process please visit:
http://www.nd.gov/ndic/ogrp/info/ogrcsubgrant-app.pdf

Questions can be addressed to Ms. Fine at 701-328-3722 or Brent Brannan at 701-425-1237.