Exhibit A: Project Description
(Scope of Work, Special Requirements)

Project Title: Advancing Bio-Based Chemicals and Next-Generation Fuels from Montana's Agricultural Crops

Objective 1: Life Cycle Analysis (LCA) and Techno-Economic Assessment of Green Diesel and Bio-jet Fuel (Next-Generation Fuels)

Under this task, the Principal Investigators (P.I.s) will generate cultivation growth models for both green diesel and bio-jet fuel based on Montana climatological data. The modeling framework for both processes will be based on a so-called "cradle-to-gate" scope, incorporating all processes upstream of the delivered energy product (i.e., extraction of raw resources). Life cycle inventory will be provided for each process within the production chain: cultivation, harvesting, oil extraction, conversion, and product distribution. LCA outputs for performance comparison will include energy use and greenhouse gas emissions (GHG). Techno-economic inputs will include both capital costs and annualized operating costs. The following initial capital expenses will be assumed to occur at the beginning of the project: land, infrastructure, irrigation, retrofitting of reactors, and engineering and contingencies.

Expected outcomes:

1. Camelina cultivation growth model applicable to Montana's climatological conditions developed;
2. LCA impacts (i.e. energy use and greenhouse gas emissions) quantified;
3. Energy-return-on-investment (EROI) analyzed;
4. Capital cost and annualized operating cost calculated; and
5. Camelina, green diesel, and bio-jet fuel's selling price determined.

Objective 2: Production of Camelina-Derived Alkylated Aromatics as a Blend Component to Aviation Gasoline (Avgas)

The P.I.s will propose and validate a mechanism for producing alkylated aromatic hydrocarbons derived from camelina that has a minimum anti-knock index of 100 or higher. The anti-knock index is a measure of the fuel's compression ratio or its ability to prevent engine knocking, defined as the average of both research octane number (RON) and motor octane number (MON). The proposed process consists of the following steps: (a) olefin metathesis of camelina oil to cyclohexadiene and (b) dehydrogenation and alkylation of cyclohexadiene to alkylated aromatics (Soriano et al., 2014). The bio-based alkylated aromatic, such as bio-derived ethylbenzene, will then be combined with unleaded avgas to determine the optimum blend ratio that conforms to ASTM D910-15 (Standard Specification for Leaded Aviation Gasoline). Samples will be sent for analysis to aviation fuel testing labs such as the Propulsion and Airpower Engineering and Research (POWER) Lab at FAA William J. Hughes Technical Center in New Jersey.

Expected outcomes:

1. Chemistry of converting camelina to alkylated aromatics understood;
2. Optimum blend ratio of camelina-derived alkylated aromatics and unleaded avgas with desired anti-knock value identified, and;
3. The optimized unleaded avgas blend conformed to ASTM D910-15 specifications.

Objective 3: Development of Heterogeneous Grubbs Catalyst for Biomass Conversion (Heterogeneous Catalyst)

The P.I.s will develop a robust heterogeneous Grubbs catalysts for olefin metathesis of natural oils. Two approaches will be employed: [a] silica-supported Grubbs catalyst and [b] silica-supported polymeric Grubbs catalyst. In the first approach, silica-supported Grubbs catalysts will be synthesized by initially functionalizing a silica and an N-heterocyclic carbene (NHC) ligand using azide and alkyne groups, respectively. The ruthenium complex will then be grafted to the functionalized NHC ligand. Using click chemistry, the functionalized silica and the NHC-grafted ruthenium complex will be covalently bonded together. The second approach consists of synthesizing of silica-supported polymeric Grubbs catalyst. Styrene will be attached to an NHC ligand to generate a monomeric unit. The resulting monomer will be attached to the silica's active site to initiate subsequent polymerization of styrene-NHC monomer. The ruthenium complex will then be grafted to each of the accessible pendant NHC ligand of the silica-supported polymer. The synthesized heterogeneous catalysts derived from both of these approaches will be evaluated for their activity, recyclability and ruthenium leaching rate. If successful, the heterogeneous catalyst will significantly lower the operating cost of avgas production from camelina. As an additional benefit, the catalyst can be applied to lignocellulosic biomass conversion to bio-based chemicals.

Expected outcome:

1. Efficient heterogeneous Grubbs catalyst successfully synthesized.

Objective 4: Design of an Optimum Process Configuration and Economic Analysis for Medium- and Large-Scale Pelletizing Plants for Camelina Meal (Next-Generation Fuels)

The P.I.s will develop a process for fuel pellet production from camelina meal in combination with underutilized biomass sources such as other agricultural byproducts and lawn clippings. Camelina meal is a large side stream from camelina processing that has a value-added disposition to support biorefinery economics. The process will be demonstrated at the 100 ton per year scale (50 lb/hr) at the Montana State University Billings City College campus. Process development will include production of a range of pellet compositions to verify producibility. The products will be used to test potential markets and determine product price including some novel concepts such as a floating fish food for export. Testing of the high-ash products will also be conducted in a range of commercially-available multi-fuel pellet stoves to verify operational adequacy. A study design will be prepared for the refined pelletizing process scaled to medium- and large- capacities in the 40,000 to 500,000 ton per year range with an overall economic analysis including construction, operating, raw material, and transportation costs. The final report will include a book intended to provide useful and accessible information to perspective pellet mill owners and operators including farmers, farm cooperatives, landfill operators, engineers, designers, and financial institutions.

Expected outcomes:

1. An optimized process for fuel pellet production from camelina meal developed;
2. A range of pellet compositions to verify producibility manufactured;
3. Products in a range of commercially-available multi-fuel pellet stoves tested;
4. Potential markets tested and product price including a fish food for export determined; and
5. Study design for 40,000 to 500,000 ton per year pelletizing plants with economic analysis prepared.