**COORDINATING RESEARCH COUNCIL, INC.**
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WWW.CRCAO.ORG

September 30, 2014
In reply, refer to:
CRC Project No. E-113

Dear Prospective Bidder:

The Coordinating Research Council (CRC) invites you to submit a written proposal to provide services for "Validation of Land Use Change" (CRC Project No. E-113). A description of the project is presented in Exhibit A, "Statement of Work."

Please indicate by letter, fax, or email if you or your organization intends to submit a written proposal for this research program. CRC will answer technical questions regarding the Request for Proposal if they are submitted in writing. CRC will then return written answers to all of the bidders, along with a copy of the original questions.

A CRC technical group composed of industry representatives will evaluate your proposal. CRC reserves the right to accept or reject any or all proposals.

The reporting requirements will be monthly progress reports and a summary technical report at the end of the contractual period. The reporting requirements are described in more detail in the attachment entitled "Reports" (Exhibit B).

The proposal must be submitted as two separate documents. The technical approach to the problem will be described in Part One, and a cost breakdown that is priced by task will be described in Part Two. The cost proposal document should include all costs associated with conducting the proposed program. The technical proposal shall not be longer than 10 pages in length.

CRC expects to negotiate a cost-plus fixed fee or cost reimbursement contract for the research program.

Contract language for intellectual property and liability clauses is presented in Exhibit C and in Exhibit D, respectively.

Important selection factors to be taken into account are listed in Exhibit E. CRC evaluation procedures require the technical group to complete a thorough technical evaluation before considering costs. After developing a recommendation based on technical considerations, the costs are revealed and the recommendation is modified as needed.

Electronic copies of the technical and cost proposals should be submitted to:

Dr. Chris Tennant
Coordinating Research Council
5755 North Point Parkway, Suite 265
Alpharetta, GA 30022

Phone: 678-795-0506
Fax: 678-795-0509
E-mail: ctennant@crcao.org

The deadline for receipt of your proposal is November 12, 2014.

Yours truly,

Chris Tennant
Deputy Director

## EXHIBIT A

## Statement of Work

## Validation of Land Use Change Models for Corn Ethanol Fuel Pathway – Scoping Study and Full Validation Study

Garry Gunter and Amit Kapur
Revised September 11, 2014

Background

From the 1940s to the 1970s, very little fuel ethanol was sold in the United States mostly because of the availability of inexpensive gasoline. Several developments resulted in increased blending of ethanol into gasoline starting in the mid-1970s. High gasoline prices caused by the oil embargo of the 1970s resulted in the sale of "gasohol", a gasoline blend containing up to 10% ethanol. High-octane oxygenates including MTBE and ethanol were used to boost gasoline octane number as a replacement for lead upon the phase-out of leaded gasoline starting in the mid-1970s. In the late 1980s and early 1990s, state and federal regulations mandated reformulated gasoline containing oxygenates including ethanol in certain urban areas to reduce carbon monoxide and ozone-forming hydrocarbon emissions. Increased ethanol blending helped meet octane and oxygenate requirements after MTBE was banned from gasoline in the mid-2000s. The Renewable Fuel Standard (RFS and RFS2) of 2005 and 2007 mandated annually-increasing volumes of biofuels from years 2006 until 2022. In addition, the California Low Carbon Fuel Standard (LCFS) mandated increasing use of "low carbon" fuels including ethanol using approved production pathways starting in year 2011. The overall result has been increasing fuel ethanol production for the last 40 years, with a sharp increase after year 2001, as shown in Figure 1. This increase in ethanol production was achieved by an increase in corn acreage grown in the U.S. as shown in Figure 2, as well as an increase in yield per acre in the U.S. as shown in Figure3 [1]. Approximately 45% of the current corn crop is used for fuel ethanol production as shown in Figure 4.

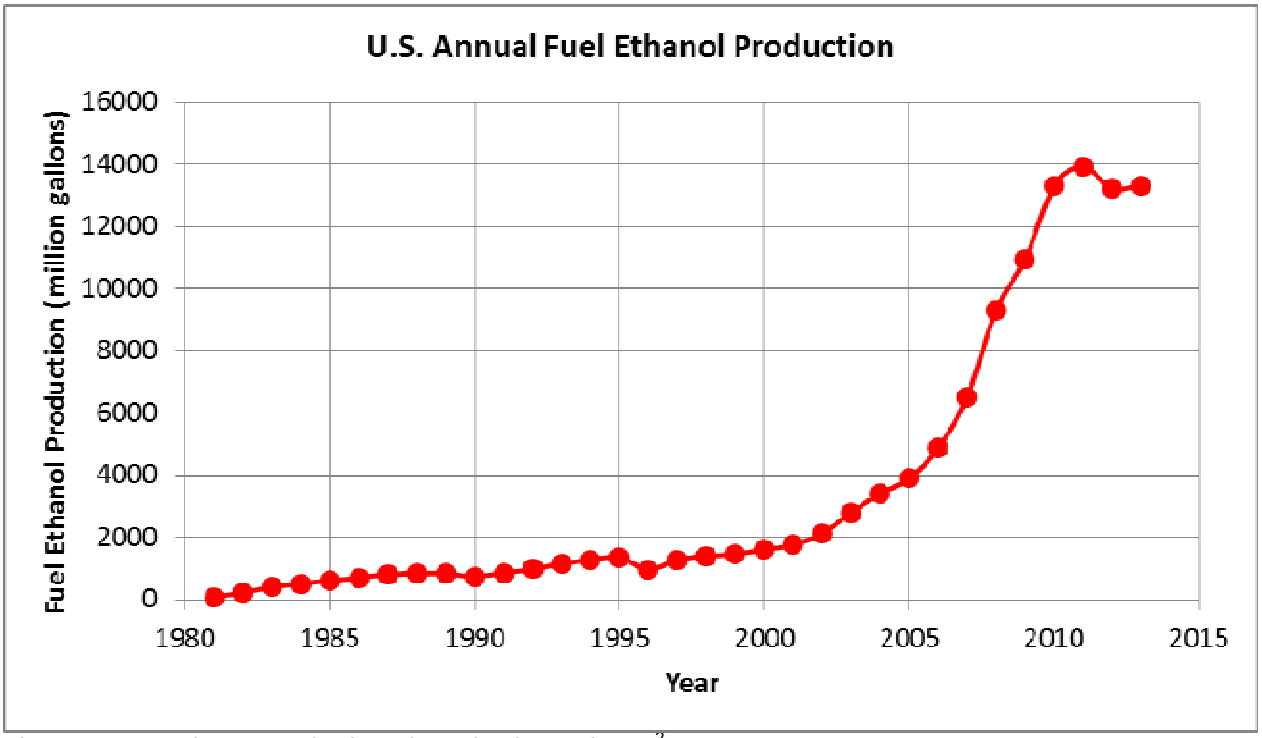


Figure 1. Annual U.S. Fuel Ethanol Production Volume [2]

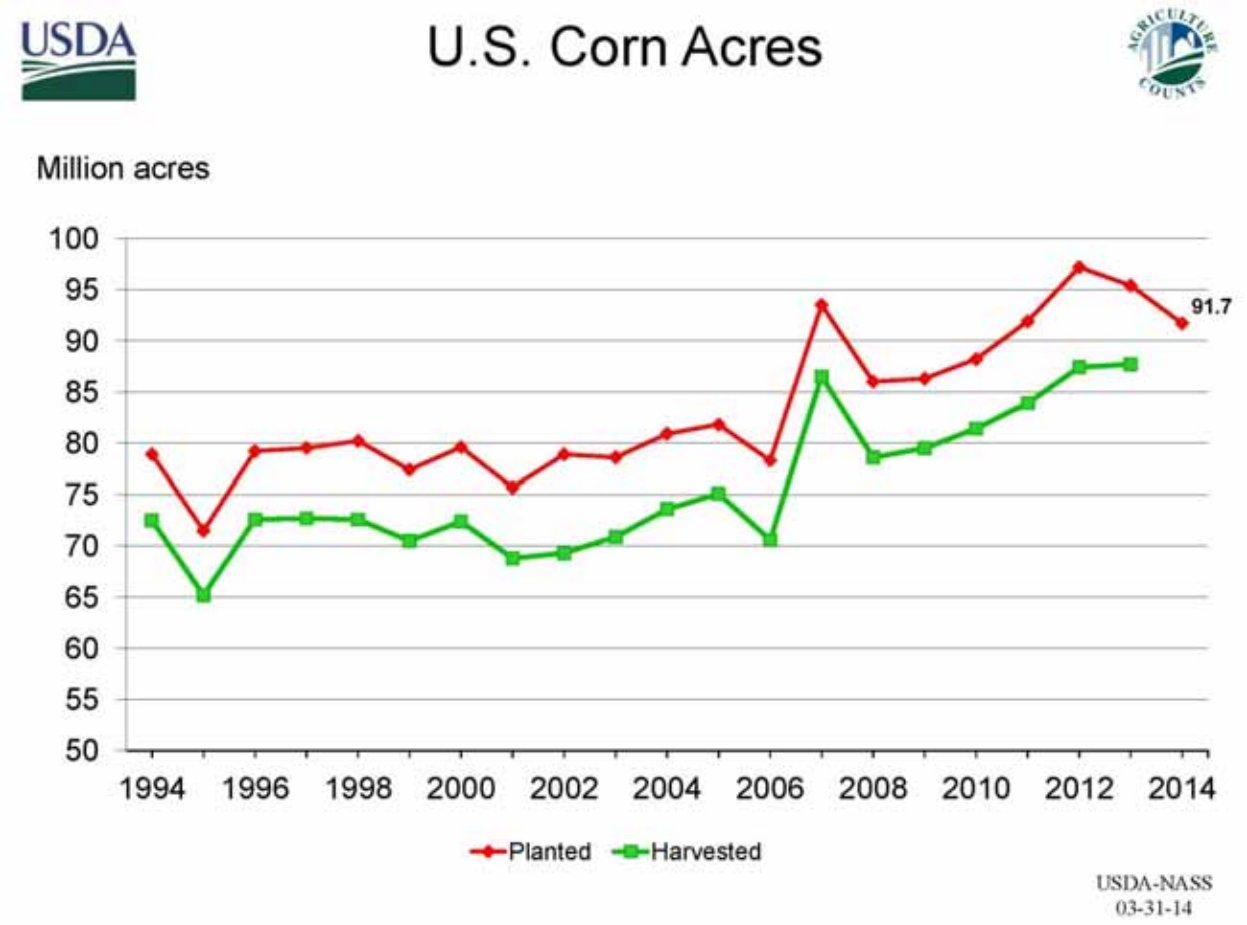


Figure 2. Annual U.S. Corn Acreage [3]

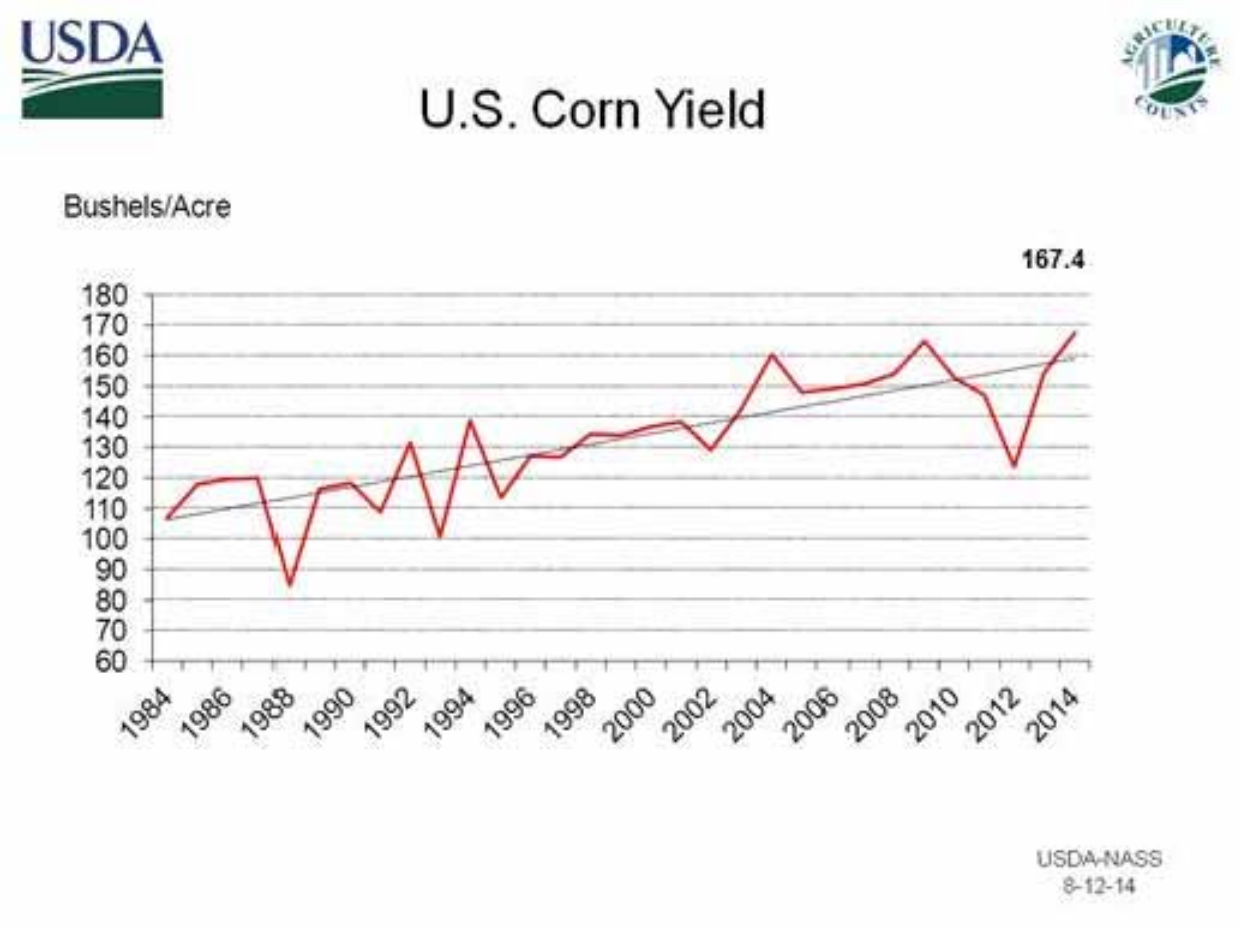


Figure 3. Annual U.S. Corn Yield [4]

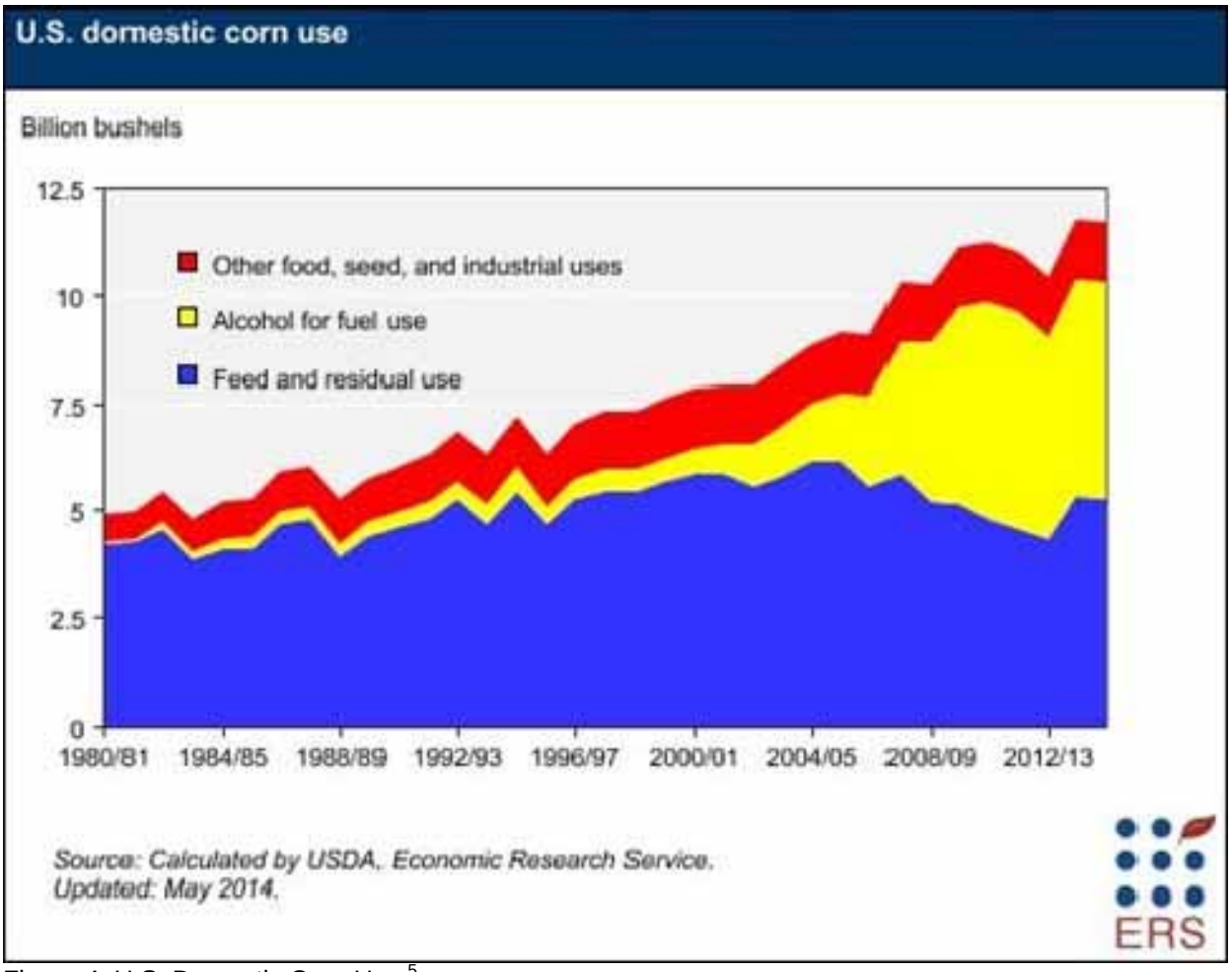

Figure 4. U.S. Domestic Corn Use [5]

Land use change (LUC) can contribute significantly to the overall greenhouse gas emission profile of biofuels. Life cycle assessment (LCA) models rely on agro-economic models (such as GTAP, FASOM, and FPRI) and emission factor databases (such as Woods Hole, Winrock/MODIS) to estimate the land use impacts. The increased demand for biofuel production can lead to direct and indirect land use change. Direct land use change occurs when existing cropland or non-cropland is converted to produce biofuel feed stocks. As a result, land used for food and feed production is displaced. In order to meet the global demand for food and feed, additional land is converted (either domestically or internationally). This is called indirect land use change.

The Coordinating Research Council (CRC) conducted several studies evaluating and comparing input data, assumptions, methodology, and variation of results for commonly-used Life Cycle Analysis (LCA) models as well as agro-economic models for LUC impacts [6 7 8 9]. However, few validation studies have been performed in which LUC predictions have been compared to actual land use change. The authors are aware of a recent study attempting to validate LUC impacts of fuel ethanol production on deforestation in South America [10].

For many biofuel pathways, it is not possible to validate model predictions because the biofuels are not produced in significant commercial quantities using these pathways. Corn ethanol, however, has been developed for widespread commercial use, and therefore it may be possible to validate LUC model predictions for this pathway.

**Objective**

The objective of this study is to validate economic LUC models by comparing model predictions of the location and types of land converted to crop production with actual land use change that can be attributed to production of corn ethanol for fuel use in the United States. This study will attempt to quantify differences between observed and modeled predictions of land use change. If the differences are determined to be significant, then the study will explain why they exist and recommend strategies (model or method modification, change assumptions, or data collection) to reduce them.

**Tasks**

1. Perform a literature review documenting: (a) validation studies of LUC effects of fuel ethanol and co-products, (b) data sources relevant for use in a fuel ethanol LUC study, and (c) knowledge gaps that must be addressed in order to perform a fuel ethanol validation study. Deliverable: Literature review document summarizing available literature findings and a list of relevant literature.
2. Perform a scoping study documenting methods and data sources recommended for use in a more in-depth validation study. Evaluate any data gaps and make recommendations for addressing these gaps. Recommend a study time period which captures a significant change in corn ethanol demand and where sufficient historical data are available to compare observational data with model predictions (for example, year 2000 to 2011). Make recommendations on how to address the Specific Questions of Interest presented in the section below. Deliverable: Final report documenting recommended validation methods, data sources, data study time period, and data gaps.
3. Perform a validation study of LUC predicted by the agro-economic models (FASOM, FAPRI, GTAP, GEMIS, etc.) underlying the four LCA models (BioGrace, EPA RFS2, GREET, and GHGenius) evaluated in the CRC E-102 project [9]. The current study should compare model predictions with actual land use change over a specified study time period and quantify differences. Validate model predictions of agricultural production (both domestic and exports), as necessary to determine accuracy of LUC models. For example, validate agricultural production of corn and wheat compared to model predictions as described in a 2008 paper by Searchinger [11]. If significant differences are found between observations and model predictions, determine the reasons or factors causing these differences and recommend ways (model or method modification, change assumptions, data collection, etc.) to reduce these differences. Address the Specific Questions of Interest presented in the section below. Deliverable: Final report documenting validation methods, data sources, data study time period, data gaps, quantification of differences between model predictions and observed data, and recommendations for improvement of models, methods, assumptions, and data.

**Specific Questions of Interest**

How to decouple effects of competing drivers or factors including:

- Food use
- Population growth
- Weather effects on environment (droughts, etc.)
- Land development for industrial or residential use
- Impact of livestock industry
- Economic growth
- Non-fuel government policy (agricultural policies and incentives, zoning restrictions, urban-sprawl restrictions, wildlife and wilderness preservation, water use restrictions, etc.)
- Non-fuel industrial use of bio-based feed stocks (forestry, “green products”, etc.)
- Consumer-driven agricultural trends (organic or health foods, etc.)
- Agricultural method improvements (equipment, disease-resistant high-yield crops, fertilizer, pesticides, herbicides, tillage practices, etc.)
- Developments in agricultural processing / supply / distribution

Although the vast majority of fuel ethanol used in the U.S. is grown and produced in the U.S., we expect any shortfall to be met by imports from other countries. This study may also evaluate the indirect LUC associated with these imports.

Over the past 20 years, Brazil has significantly increased its production and use of fuel ethanol produced mostly from sugarcane, some of which is sold in the U.S. This study should address whether CRC should consider the effect of Brazilian ethanol production on worldwide LUC.

**Discussion**

- This task will likely require expertise in agricultural economics. Access to and expertise in use of agro-economic models (FASOM, FAPRI, GTAP, GEMIS, etc.) and the underlying databases is required. We desire input into which researchers are likely to possess such expertise.
- We are not sure of either (a) how much data are available for this study or (b) the elapsed time period before sufficient data becomes available, thus the flexibility in study time period. Obviously a recent study time period would be more useful.
- We are not sure how difficult this task will be, so we structured the project in three tasks. If the committee thinks the task will be difficult, the project may be performed with Tasks 1 and 2 as a scoping study and Task 3 as a follow-on study.
- We are not sure how interdependent international effects are, so we listed these as specific questions of interest.

[1] T. Wallington, J. Anderson, S. Mueller, E. Kolinski Morris, S. Winkler, J. Ginder, O. Nielsen, Environ. Sci. and Technol., 46, 6379-6384, 2012
[2] Fuel Ethanol Overview, Monthly Energy Review, Total Energy, Energy Information Agency (EIA), Mar. 2014
[3] U.S. Corn Acres, United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS), Mar. 31, 2014
[4] U.S. Corn Yield, United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS), Aug. 12, 2014
[5] U.S. Domestic Corn Use, United States Department of Agriculture (USDA) Economic Research Service (ERS), May 2014
[6] S. Unnasch et. al., Review of Transportation Fuel Life Cycle Analysis, Coordinating Research Council (CRC) report no. E-88, Feb. 2011
[7] A. Broch et. al., Transportation Fuel Life Cycle Analysis: A Review of Indirect Land Use Change and Agricultural $N_2O$ Emissions, Coordinating Research Council (CRC) report no. E-88-2, Jan. 2012
[8] T. Darlington et. al., Study of Transportation Fuel Life Cycle Analysis: Review of Economic Models Used to Assess Land Use Effects, Coordinating Research Council (CRC) report no. E-88-3, Jan. 2014 (draft report)
[9] Transportation Fuel Life Cycle Assessment: Validation and Uncertainty of Well-To-Wheel Greenhouse Gas Estimates, prepared by $(S\&T)^2$ Consultants Inc. for Coordinating Research Council (CRC) report no. E-102, Nov. 2013
[10] J. Lane, ILUC and the Renewable Fuel Standard: Hard Data appears for the First Time, Biofuels Digest, Feb. 23, 2014.
[11] T. Searchinger et. al., Use of U.S. Croplands for Biofuels Increases Greenhouse Gases through Emissions from Land-Use Change, Science 2008, 319, 1238-1240

## EXHIBIT B

## REPORTS

### MONTHLY TECHNICAL PROGRESS REPORTS

The contractor shall submit a monthly technical progress report covering work accomplished during each calendar month of the contract performance. An electronic Microsoft® Word compatible file (<1 MB) of the monthly technical progress report shall be distributed by the contractor within ten (10) calendar days after the end of each reporting period. The report shall contain a description of overall progress, plus a separate description for each task or other logical segment of work on which effort was expended during the reporting period.

### FINAL REPORT

The contractor shall submit to or distribute for CRC an electronic pdf-compatible copy transmittable via email) of a rough draft of a final report within thirty (30) days after completion of the technical effort specified in the contract. The report shall document, in detail, the test program and all of the work performed under the contract. The report shall include tables, graphs, diagrams, curves, sketches, photographs and drawings in sufficient detail to comprehensively explain the test program and results achieved under the contract. The report shall be complete in itself and contain no reference, directly or indirectly, to the monthly report(s).

Within thirty (30) days after receipt of the approved draft copy of the final report, the contractor shall make the requested changes and deliver to CRC thirty (30) hardcopies including a reproducible master copy of the final report. The final report shall also be submitted as an electronic copy in a pdf or pdf-convertible file format. The final report may be prepared using the contractor's standard format, acknowledging author and sponsors. An outside CRC cover page will be provided by CRC. The electronic copy will be made available for posting on the CRC website.

## EXHIBIT C

## INTELLECTUAL PROPERTY RIGHTS

Title to all inventions, improvements, and data, hereinafter, collectively referred to as ("Inventions"), whether or not patentable, resulting from the performance of work under this Agreement shall be assigned to CRC. Contractor X shall promptly disclose to CRC any Invention which is made or conceived by Contractor X, its employees, agents, or representatives, either alone or jointly with others, during the term of this agreement, which result from the performance of work under this agreement, or are a result of confidential information provided to Contractor X by CRC or its Participants. Contractor X agrees to assign to CRC the entire right, title, and interest in and to any and all such Inventions, and to execute and cause its employees or representatives to execute such documents as may be required to file applications and to obtain patents covering such Inventions in CRC's name or in the name of CRC's Participants or nominees. At CRC's expense, Contractor X shall provide reasonable assistance to CRC or its designee in obtaining patents on such Inventions.

To the extent that a CRC member makes available any of its intellectual property (including but not limited to patents, patent applications, copyrighted material, trade secrets, or trademarks) to Contractor X, Contractor X shall have only a limited license to such intellectual property for the sole purpose of performing work pursuant to this Agreement and shall have no other right or license, express or implied, or by estoppel. To the extent a CRC member contributes materials, tangible items, or information for use in the project, Contractor X acknowledges that it obtains only the right to use the materials, items, or information supplied for the purposes of performing the work provided for in this Agreement, and obtains no rights to copy, distribute, disclose, make, use, sell or offer to sell such materials or items outside of the performance of this Agreement.

## EXHIBIT D

## LIABILITY

It is agreed and understood that _____ is acting as an independent contractor in the performance of any and all work hereunder and, as such, has control over the performance of such work. _____ agrees to indemnify and defend CRC from and against any and all liabilities, claims, and expenses incident thereto (including, for example, reasonable attorneys' fees) which CRC may hereafter incur, become responsible for or pay out as a result of death or bodily injury to any person or destruction or damage to any property, caused, in whole or in part, by _____'s performance of, or failure to perform, the work hereunder or any other act of omission of Contractor in connection therewith.

## EXHIBIT E

## PROPOSAL EVALUATION CRITERIA

1) Merits of proposed technical approach.
2) Previous performance on related research studies.
3) Personnel available for proposed study – related experience.
4) Timeliness of study completion.