

1.0 INTRODUCTION

Air emissions from burning agricultural waste, primarily consisting of fine particles, can be a significant source of air pollution on a short-term and intermittent basis. These emissions can impact visibility in Class I areas located near burns, or those Class I areas located far away through regional transport.

The Western Regional Air Partnership (WRAP) and its Fire Emissions Joint Forum (FEJF) need a thorough assessment of the alternatives to agricultural burning, including their impacts on the environment, economy, health and safety, society, politics, and on the business and productivity of the agricultural industry. The study will begin with an evaluation of the major crop types and amount of residue burned that currently occurs in the 15 western states of Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, North Dakota, New Mexico, Nevada, Oregon, South Dakota, Utah, Washington, and Wyoming. Based on an understanding of current burning practices, alternatives can be compared and contrasted based on their environmental, economic, and other impacts. This thorough analysis will also include an evaluation of barriers to implementation, accountability mechanisms, and an implementation strategy.

1.1 Project Objectives

This work plan was prepared by Eastern Research Group (ERG) and Enviro-Tech Communications. It describes the approach to achieve the following study objectives:

- Identify current crops and the extent to which residue is disposed of through burning for the 15 western states;
- Identify potential alternatives to agricultural burning and characterize their agronomic, environmental, health and safety, social, economic, and political impacts;
- Develop criteria for selecting “reasonable” non-burning alternatives;

- Identify barriers to the use of alternatives, including non-statutory barriers, and make recommendations on how these can be overcome;
- Develop accountability mechanisms for tracking if, and which, non-burning alternatives are used by local, state, tribal, or federal entities; and
- Develop a plan for implementing a non-burning program based on the analysis, findings, and recommendations developed under this project.

1.2 The ERG/Enviro-Tech Communications Team

Eastern Research Group and our consultant Dr. Karlyn Black of Enviro-Tech Communications have recent, relevant experience in assessing impacts from agricultural burning, evaluating non-burning alternatives, and working with the agricultural and regulatory communities in this regard. We will apply our experience to provide the WRAP and the FEJF with a thorough, accurate, and defensible analysis of agricultural burning and its alternatives as applied to the 15 states in the Western U.S

2.0 TASK COMPLETION REQUIREMENTS

ERG/Enviro-Tech has developed a technical approach to achieve the project objectives that is based on intensive collection and dissemination of data on crops and non-burning alternatives, conducting an analysis to determine criteria for selecting reasonable non-burning alternatives, and researching barriers and opportunities for implementation of alternatives. Findings and recommendations will be provided in high-quality reports and deliverables that provide the WRAP and FEJF with defensible results. The approach is presented in detail below.

2.1 **Task 2.1: Identify Crops and Non-Burning Alternatives**

ERG/Enviro-Tech will use a three-tiered research approach to collect information on crops and current and/or potential non-burning alternatives. The first tier would comprise agricultural agencies and information sources anticipated to have the highest data quality, availability, and completeness; the second tier of sources would have readily available data, but it is anticipated to take more time to contact them and/or disseminate their information; and the third tier sources are anticipated to provide additional crop, state, or regionally-specific information. At the conclusion of Task 2.1, the results will be summarized by the ERG/Enviro-Tech Communications team, and presented to the FEJF and other stakeholders at a meeting.

Subtask 2.1.A: Collect Crop Data

It is desirable to collect as much data on crops grown in the 15 western states—as reported by crop, year, season, region, state, county and/or geographical area—as possible. At a minimum, information must be gathered on crop types, acres planted/harvested, residue quantities, amount of residue burned, and time or duration of burning.

To address the collection of crop data, the first level of sources to research or contact are the federal agency sources such as the following agencies of United States Department of Agriculture (USDA):

- Farm Services Agency;
- Economic Research Service; and
- National Agricultural Statistics Service (NASS: 50 state offices) and their various reports, publications and document (e.g., Annual Census of Agriculture, which includes National, State and County Tables of information).

Also, the National Technical Information System (NTIS) will be contacted.

The second tier of resources would include the various state-level agencies as follows:

- Divisions and/or Departments of the U.S Department of Agriculture (available for all 15 western states)
- State Divisions or Departments of Agriculture;
- Selected Land-Grant Universities in the 15 western states;
- Joint agency working groups or task forces such as the FEJF Emissions Assessment Task Force; and
- Other agricultural institutions.

The third tier of sources would include various private consortiums, which may include growers, producers and distributors, professional agricultural organizations and information clearing houses such as the Agricultural Network Information Center (AgNIC) which provides quality info on the internet as selected by the National Agricultural Library. As other sources are identified during the research process they will be included as appropriate.

The Contractor will prepare a written report (draft and final) addressing the following items:

- A list of alternatives to burning by crop or fuel type, along with
- Recommended methods for characterizing potential environmental, health and safety, and agronomic/ecosystem impacts from use of alternatives compared with fire (including the agronomic efficacy of alternatives v. fire).

- Recommend methods to characterize agronomic, environmental, economic, social, and political impacts from use of alternatives.
- Include preliminary estimates of potential impacts of non-burning alternatives for the two items listed immediately above.

Subtask 2.1.B: Characterize Non-Burning Alternatives

The identification of existing and potential as yet unproven, or still in the developmental stages, non-burning alternatives, will take a considerable amount of effort. Also, gathering and interpreting data on the characteristics of the alternatives will be intensive because of the breadth of types of data that are needed (e.g., economic, environmental, health and safety, agronomic, ecologic, etc.). Any additional analyses that may be necessary to use these data (e.g., calculating air emissions from burning and the alternatives) would be conducted under Task 2.2 (see below) based on the top 10 crops from each State, or some other system of prioritization.

The same three-tiered research approach will be employed for this effort as was described above under Task 2.1.A; however, it is expected that this information will be highly disbursed among the three tiers of sources. The first tier of sources to research include the following:

- U.S. Department of Agriculture, its National offices and its Divisions or Departments in the 15 Western States;
- Federal Agricultural Research Centers;
- National Agricultural Statistics Services (NASS) Research Division; and
- U.S Department of Natural Resources Conservation Services (NRCS) and its Technical Assistance Centers.

The NRCS has an extensive hands-on farming practices outreach program that also provides a detailed printed handbook of recommended “Best Practices”. This will be an excellent resource for the identification of existing non-burning practices as well as a possible resource for non-burning alternatives program implementation in the future.

The second tier of sources include various state-level groups such as the following:

- Universities and Land Grant Institutions in the 15 western states;
- Agricultural Research Centers;
- University Agricultural Extension Services;
- Agricultural Statistic Services;
- Divisions or Departments of Pesticide Management; and
- Working groups or task forces such as the California Advisory Committee on Alternatives to Rice Straw Burning, which comprises representatives from the rice growing community, the California Department of Food and Agriculture and the California Air Resources Board.

The third tier of sources may be more difficult to identify but are expected to include various private consortiums, such as growers, producers or distributors, professional agricultural organizations and information clearing houses. As other sources are identified during the research process they will be included as appropriate.

Subtask 2.1.C: GIS Application

The contractor will develop a GIS application with the objective of storing, reporting, and mapping crop and burn data at the state level and the county level (based on availability of data). The GIS will be developed using ArcView GIS software. The contractor will purchase two copies of the ArcView GIS program for the WRAP FEJF and deliver the software packages, along with the GIS database and 20 hard-copy maps to the FEJF. Initial estimates of the maps to be generated include:

- 1 Map: 15 states in WRAP region showing crops with greatest acres harvested;
- 15 Maps: Individual state maps showing top crop(s) by county; and
- 4 Maps: 15 states in WRAP region showing total number of acres burned by state by season.

2.2 Task 2.2: Establish Criteria for Use of Reasonable Non-Burning Alternatives

In this task ERG/Enviro-Tech will develop procedures for assessing the reasonableness of the non-burning alternatives identified in Task 2.1. For each type of impact characterized in Task 2.1 (environmental, social, health and safety, etc.) ERG/Enviro-Tech will develop criteria to establish a “go/no-go” determination for the various alternatives. In addition, control cost curves will be developed using available data and expert opinion for each major crop/fuel type and each reasonable alternative. Finally, ERG/Enviro-Tech will illustrate the criteria evaluation process for two to three crop/fuel types with significant emission reduction potentials ERG/Enviro-Tech will complete this task by providing a final report which summarizes the results.

The following summarizes the primary considerations and methodologies to be used for determining the reasonableness of non-burning alternatives.

Subtask 2.2.A: Establish Reasonableness Criteria

The goal of this subtask is to develop a global methodology that can be used to assess the reasonableness of non-burning alternatives, minimizing the need for region and crop-specific assessments when possible. Such a method will be easy to apply to additional alternatives and regions in the future, without requiring substantial new data gathering.

The reasonableness of each crop/alternative combination has several different dimensions. The 1996 Grand Canyon Visibility Transport Commission (GCVTC) report provides a preliminary list of the dimensions to be evaluated:

1. Impact on visibility
2. Agronomic effects
3. Environmental effects (other than visibility)
4. Economic impacts
5. Social and equity impacts
6. Administrative ease and effectiveness.

At a minimum, this subtask will establish reasonableness criteria for the first five of the above categories, plus an analysis of health and safety issues. (Administrative ease and effectiveness will be addressed separately under Task 2.4, Identify Non-Statutory Administrative Barriers). We will also consult with appropriate stakeholders involved with establishing these criteria to obtain background information and their recommendations for revision/refinement of the original list. In addition, we will conduct research and perform a literature review to obtain guidance regarding both qualitative and quantitative analyses for these (and possibly other) categories. Potential sources of such information include:

- USDA;
- State University Agricultural Extension Services;
- State and Federal Agricultural Research Centers;
- State Agricultural Statistic Services;
- Economic Research Service;
- Economics and Statistics System; and
- NASS Research Division.

The ERG/Enviro-Tech team will also evaluate additional concerns that could impact any of the above criteria. For example, social and equity concerns may be dominated by completely different considerations on tribal lands. Other considerations could include the appropriate time horizon for the analysis (e.g., if costs or benefits are expected to vary over time), and any potential economic barriers to implementation (e.g., high start-up capital costs effectively barring small farmer participation). In consultation with FEJF members we will develop a strategy to account for these factors in our criteria assessments.

After identifying the main areas for evaluation, we will develop general guidelines for determining reasonableness criteria for each area. In each case, assessments should first distinguish between alternatives that are universally applicable, versus those only appropriate for specific regions/crops. In some instances these criteria will be quantitative (e.g., maximum dollar per ton of pollutant mitigated), in some cases qualitative (e.g., significance of socio-political impacts). Only those alternatives deemed reasonable for each evaluation criteria will be considered acceptable for further evaluation.

The following briefly discusses the major issues associated with determining reasonableness for each evaluation area.

Visibility Impacts -- Given the large number of potential crop/alternative combinations and counties involved, it is not possible to perform dispersion modeling to directly assess visibility impacts for this project. Therefore we will assume that changes in PM2.5 emissions will have a one-to-one impact on visibility from a given burning source. Under these assumptions the criteria for consideration with respect to visibility is simple – any alternative producing a measurable reduction in PM2.5 (and possibly aerosol) emissions will be considered reasonable. However, reductions must be net of any increased PM2.5/aerosol emissions. For example, accounting for increased particulate from diesel exhaust and/or re-entrained dust if additional heavy equipment is employed for material handling.

Agronomic and Other Environmental Effects -- Potential negative impacts include soil nutrient level reductions, as ash is no longer applied to the land. Lowered nutrient levels could entail the need for chemical fertilizers (or increased use thereof), and their associated cost. In turn runoff could become a concern for newly fertilized fields. Variations in long-term yield should also be considered.

As mentioned above, use of diesel equipment for waste clearing will increase soot and other emissions, as well as contributing to possible problems with soil compaction and erosion (in addition to the added capital costs). Also, wildlife impacts may be considerable, depending on site-specific conditions. These are just a few of the potential agronomic/environmental effects that may merit consideration.

The agronomic and other environmental impacts of alternatives will be diverse and highly variable from site to site. Therefore the criteria for establishing reasonable effects for this category will necessarily be qualitative. In general, some small amount of negative impact could be deemed reasonable, although precise determination of “de minimus” impacts will require policy judgements. Therefore the ERG team will work with the members of the FEJF for guidance in this regard.

Health and Safety -- The reasonableness criteria for this category, although qualitative, is ultimately simple – alternatives must not significantly increase health or safety risks, relative to current burning practices. ERG will review the literature and consult with local experts to assess the health and safety issues associated with current burning practices as well as the major alternatives (see Task 2.1). Determination of “significantly increased risk” will be made on a case by case basis.

Economic Impacts -- Determination of reasonable economic expenditures for a given alternative will be based on the option’s relative cost-effectiveness (i.e., \$/ton of PM2.5 reduced). ERG will review the literature and consult with state and local officials to identify the cost-effectiveness of other control measures specifically adopted for visibility improvement. Such controls may include major point source Prevention of Significant Deterioration (PSD) rules, and measures for re-entrained dust control, among others. To the extent that an alternative has similar or better cost-effectiveness than other previously adopted measures, that alternative can be deemed reasonable.

This approach implicitly assumes that costly measures are not necessarily unreasonable, as long as the visibility impacts are great enough. However, high absolute costs can be unacceptable, especially to smaller farmers without recourse to subsidies. Such considerations are evaluated below, under Equity Impacts.

Indirect economic impacts such as potential shifts in employment and changes in commodity supply and demand may be addressed in a more qualitative fashion, on a case by case basis.

Social and Equity Impacts -- As mentioned above, there may be certain burning practices or non-burning alternatives that have implications unique to certain groups, such as small farmers or residents of tribal lands. If it is determined in that non-burning alternatives on tribal lands have significant potential for visibility impacts, and are deemed reasonable with respect to the other criteria, then the ERG Team will consult with the FEJF to make additional reasonableness determinations, possibly on a case by case basis.

ERG will also identify those capital-intensive alternatives that could encounter significant credit constraints, especially for small farmers. If adequate subsidies, in the form of low-interest loans, grants, etc., are not considered feasible in these instances, the option will be deemed unreasonable.

Subtask 2.2.B: Develop Abatement Cost Curves

In this subtask we will review the available literature and survey experts in the field to estimate the cost of the alternatives by crop, relative to current burning practices, as a function of the amount of crop left unburned, as well as the level of PM2.5 reduced. Costs will be estimated in annualized terms for those alternatives with constant costs and benefits over time. For those options with variable cost profiles (e.g., alternative results in declining yields over time, or growing demand in recycling markets changes cash flows), we will develop a discounted cash flow to determine a net present value. The period of analysis will be based on the useful life of related equipment, or similarly appropriate metric. This value will then be annualized for purposes of comparison with other options. In both types of analyses, traditionally unquantified labor and management costs will be valued and incorporated in the calculations.

For a given level of control we will develop a range of costs, where data allow. Potential factors influencing costs include:

- Geographic and temporal variability in crop prices
- Geographic and seasonal variation in fuel/other operational costs
- Access to material recycling markets (if applicable)
- Long-term influence of alternative on crop yields
- Appropriate time period for analysis

As appropriate, and depending on the availability of data, we will attempt to account for these different factors in developing the cost estimates for the different alternatives.

We will then combine the data for the different alternatives over the range of potential emission reductions to generate cost curves for each crop type.

Subtask 2.2.C: Prepare Examples of the Use of Criteria and Cost Curves

Based on the results of Task 2.1, we will select two or three crops to apply the evaluation criteria discussed above. These crops will be selected based on overall visibility impact. For each crop ERG will apply each of the decision criteria to determine reasonableness. In addition, we will develop detailed cost curves for the full range of reasonable options. We will also discuss those regional factors that could significantly alter the findings of the general assessment. Finally, we will provide recommendations for applying this process at the regional level.

2.3 Task 2.3: Develop Accountability Mechanisms for Use of Alternatives

Accountability mechanisms may vary by state but they should all have several common elements. These include an accounting of the alternative(s) considered and whether they were employed or not. If they were considered but not used, then a rationale for why it was not used should be provided. If an alternative is employed, the extent to which it was used, the emissions reductions that resulted from the use of the non-burning alternative(s) and the relative success of the same should be noted.

We will conduct a thorough investigation of the current mechanisms for documenting and approving agricultural burning in each of the 15 western states which should provide relevant information upon which to build accountability mechanisms. Existing agricultural burn permitting programs and federal or state grant money distribution and accountability mechanisms offer a place to start. “On-line” technology such as the Prescribed Fires Incident Reporting System (PFIRS) could be modeled or even modified to accommodate non-burning alternative reporting. Also, the FEJF Emissions Tracking System will be evaluated as a potential accountability mechanism. Whatever mechanisms are employed they should not be

difficult for agricultural community members use or be onerous in their reporting requirements or use of technology.

Under this task we will prepare a draft and final report of our findings including any existing and all feasible potential procedures followed by governmental entities for making decisions related to implementation of non-burning alternatives.

2.4 Task 2.4: Identify Non-Statutory Administrative Barriers

In practice, non-statutory administrative barriers often limit new program development and implementation to a greater extent than do statutory barriers. Because of this, it important to identify potential barriers as early in the process as possible so that information regarding potential barriers can be obtained routinely as alternatives are identified and considered. Non-statutory administrative barriers may also play a larger role as factors to consider in establishing the criteria for determining reasonable use of non-burning alternatives as well as in assessing the potential effectiveness of any implementation strategies that are developed. For example, administrative barriers include “administrative ease and effectiveness,” an important criteria to be considered under this study.

Under this task we will prepare a draft and final report of our findings including identification, categorization, and characterization of barriers. Also, we will make recommendations on ways to eliminate the barriers.

Subtask 2.4.A: Identify Barriers

Non-statutory administrative barriers will be identified, and later characterized, from contacts made within the agricultural community during the process of identifying and characterizing available non-burning alternatives (Task 1). The U.S. Department of Agriculture has several agencies that may be particularly helpful in identifying non-statutory administrative barriers. These include, for example, the Natural Resource Conservation Service and the Farm

Services Agency, which are groups that work directly with farmers, growers, communities, etc. to address the planning and implementation of agricultural programs.

Some non-statutory administrative barriers that may apply to effective implementation of alternatives to burning on agricultural land include the following:

- *Public acceptance* of a practice or program result, which may be closely tied to aesthetics;
- *Aesthetics* such as visual or olfactory and possibly auditory, but also possibly nuisance factors such as plant debris or dust infiltration or deposition in or near homes and businesses;
- *Economic challenges*, such as labor costs, increased liability and/or disposal, storage, packaging or transport costs, capitol for investing in new technologies, availability of investors, market return, crop yield, crop quality, and production rates;
- *Practical application* such as supply and demand of essential materials like seed or seedlings, storage facilities, machinery for planting, harvesting, delivery mechanisms, reporting mechanisms and timing;
- *Geographic limits* due to climate or topography; and
- *Political, cultural or religious* practices.

Other non-statutory administrative barriers will likely be identified as this question is further researched.

Subtask 2.4.B: Characterize Barriers

Non-statutory administrative barriers typically fall into several categories. These categories include “practical,” “social,” “political,” “economic,” “cultural,” and “religious”. The later two, cultural and religious, are often included within the “social” category but may need to be called out separately under some circumstances. These will likely vary by location within states and between states based on location and crop type. We will characterize these barriers in order to identify their relative importance on inhibiting non-burning alternatives, and recommend ways that barriers can be removed or dealt with in such a way as to minimize their impact.

2.5 Task 2.5: Development of Implementation Plan

The purpose of the implementation plan is to give the WRAP and FEJF a course of action for implementing the recommendations developed under the project. Prior to developing the draft plan, an outline will be prepared and submitted to the FEJF for review and comment. Based on comments received, the outline will be modified and used for developing the draft implementation plan.

The contents of the implementation plan will include, at a minimum, the following:

- Introduction—Discussion of the background of the study and its objectives.
- Summary of Results and Recommendations—Summary of the results and recommendations resulting from the work conducted under Tasks 2.1 through 2.4. For details on the various results the reader will be directed to the reports prepared under Tasks 2.1-2.4.
- Agency Responsibilities and Implementation—Recommendations for assigning responsibilities to agencies, and within agencies, for implementing a non-burning management plan and incorporating the plan into existing operating procedures.
- Stakeholder Involvement—Recommended methods for disseminating information to private landowners and others who will ultimately be responsible for implementing non-burning strategies.

After review of the draft implementation plan by the WRAP, FEJF, and other interested parties, the plan will be finalized and distributed as directed by the FEJF.