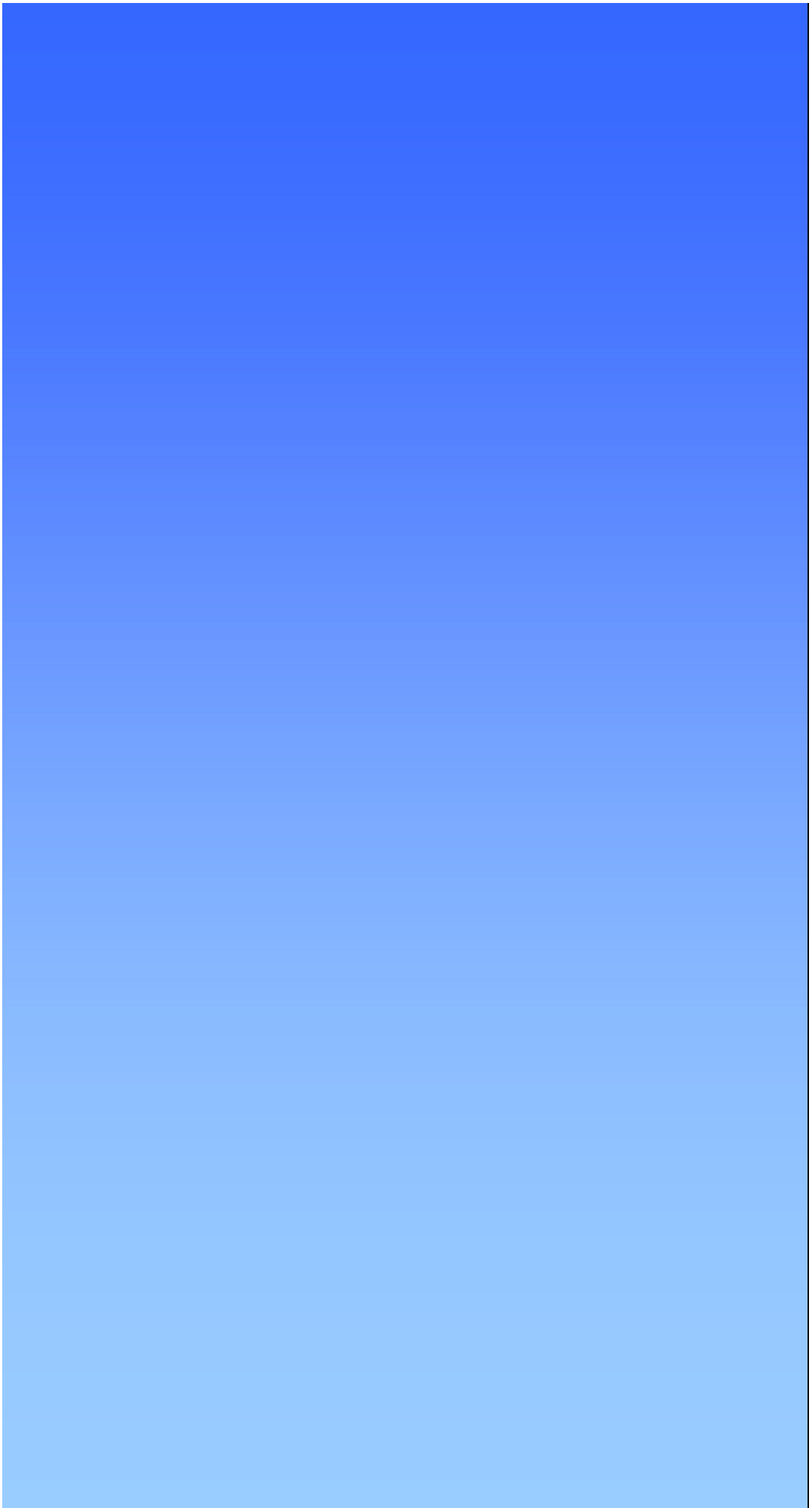


AIR SCIENCES INC.

DENVER • PORTLAND

FINAL

Development of a Commodity-based Fire Emissions Tracking System

WORK PLAN

PREPARED FOR:

WESTERN GOVERNORS' ASSOCIATION
WESTERN REGIONAL AIR PARTNERSHIP
FIRE EMISSIONS JOINT FORUM

PROJECT 230-1
MAY, 2007

CONTENTS

Page

Tables

Figures

SECTION 1

INTRODUCTION

The Western Regional Air Partnership (WRAP) Policy / Fire Tracking System Executive Summary states that the WRAP is charged with developing technical and policy tools to assist states and tribes with implementing the Regional Haze Rule. The WRAP policy on Fire Tracking Systems (FTS) was developed through a stakeholder-based consensus process to assist the WRAP region states and tribes in addressing emissions from fire sources. It is the position of the WRAP FTS Policy that it is necessary to track fire activity information in the WRAP region using a fire tracking system, which will also provide the information essential to create a fire emissions inventory.

The Fire Tracking System Task Team (Task Team) was charged with evaluating existing fire tracking systems to determine if an existing system, with few or minor modifications, would satisfy the WRAP's requirements. After careful review of seven existing FTS, The Task Team, its contractors, and the WRAP have agreed that a commodity-based Fire Emissions Tracking System (FETS) approach would be the most timely, efficient, cost-effective method to build an operable, stable, and user-friendly FTS. This FETS will be accessible to any of the WRAP states and Tribes and its design is intended to efficiently accommodate data exchanges from state / tribal FTS currently in operation.

In the preparation of this Work Plan and throughout the development of the FETS, the project team of Air Sciences, Wingate Designs, and the Cooperative Institute for Research in the Atmosphere (Project Team) will reference the WRAP Policy – Fire Tracking System (April 2, 2003), the "Needs Assessment for Evaluating and Design of an Emission Data Reporting, Management, and Tracking System" (July 25, 2003 – in particular those sections pertaining to fire tracking), The Evaluation of Existing Fire Tracking Systems Final Report (March 2007), and the Fire Emissions Tracking System White Paper (July 31, 2006).

A critical objective of the Project Team is to develop a fire tracking system that meets the WRAP's minimum needs and is flexible enough to allow for modifications to accommodate evolving needs of data providers and users and expansions to augment the FETS with additional features. The intent is not to create a "brilliant, new design" but to draw on commodity products and existing systems as appropriate. The primary emphases of this project are:

- Efficient data acquisition;
- Stable data storage and availability;
- Real-time data import and export capabilities;
- An interface to allow for enhanced coordination of planned and unplanned events among regional smoke managers; and

- A system that accommodate cost effective development of fire emission inventories.

SECTION 2

PROJECT GOALS AND DELIVERABLES

The stated goal of this project is to build a Fire Emissions Tracking System (FETS) that will provide the following:

- A web-based interface for manual and automatic entry of planned fire events
- Coordination with existing fire tracking databases through automated or manual data assimilation.
- A central coordinating database of all planned and unplanned fire events.
- Options for viewing and reporting fire events from the central database, including but not limited to the following:
    - A mapping tool capable of displaying and querying chosen events.
    - Download of chosen data into model-ready formats, such as SMOKE, BlueSky, and emissions inventory formats such as NEI.
    - Download of chosen data into CSV or DBF format for manipulation by users.

In addition to the above mechanical features, the FETS will be developed according to specific guiding principles:

- Data acquisition will be accomplished by a number of methods in order to accommodate differing data provider and user needs.
- Data acquisition methods will be developed to minimize the burden of additional reporting requirements on data providers.
- To the point that it is practical and feasible, existing software, scripts, designs, and formats from other systems will be used, with the intent of minimizing system and software development costs.
- The FETS will be designed so that it is not dependent on, or wedded to, one single platform, software package, or host, especially when it involves costly proprietary licensing.
- The FETS will be designed to limit extensive, high-frequency maintenance and attention by a Database Administrator.

Details of the mechanical features and steps to meet the guiding principles are outlined in Section 3 of this document. Significant deviations from the above guidelines must be justified to the Task Team and the WRAP and documented. Enhancements to the mechanical features outlined above will be considered based on need, requests of the Task Team or the WRAP, suggestion of the Project Team, and budgetary constraints. Coincident with the development of the FETS, the Project Team will develop supporting documentation, including this Work Plan, a Technical Support Document, and a Users Guide.

SECTION 3

HARDWARE AND SOFTWARE REQUIREMENTS

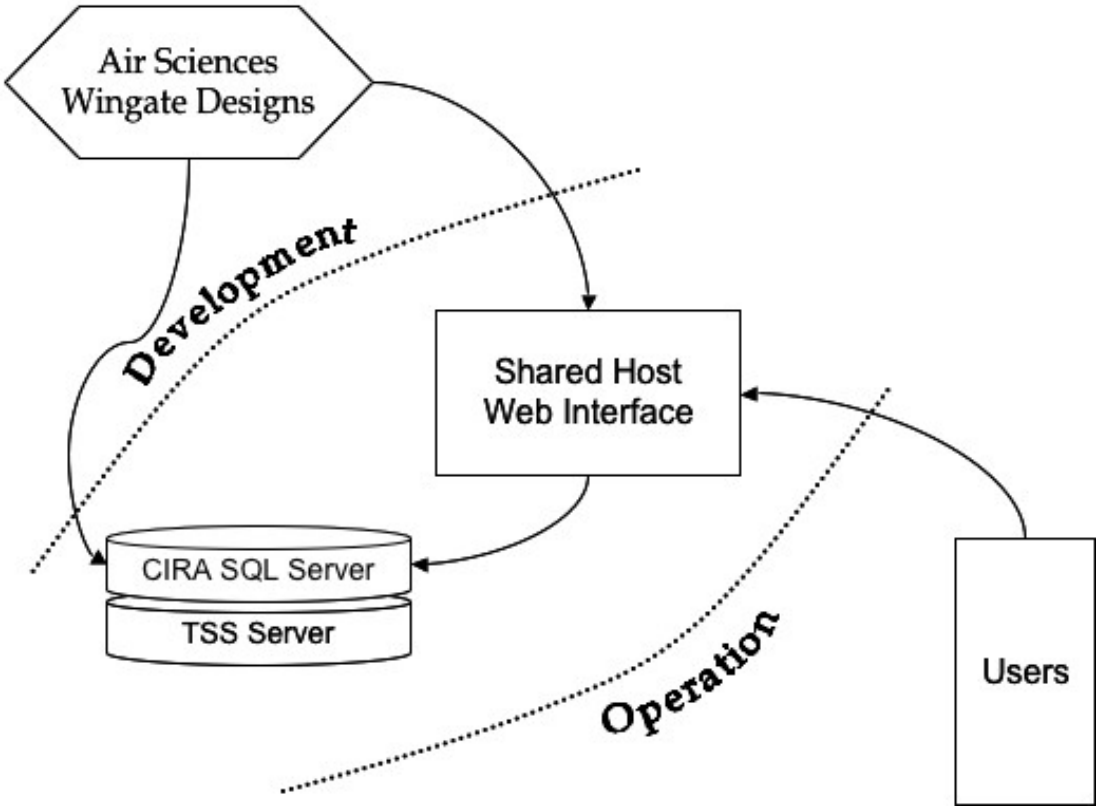
The deliverables for the FETS project include several hardware and software needs. One of the stated goals of this project is to maximize use of existing tools, software, and hardware to serve the FETS. With this in mind, the hardware and software requirements include:

- A reliable, secure web-hosting server to act as the gateway for all FETS users,
- Server storage space sufficient for database record storage and archiving well into the future, on the order of 100 GB,
- A secure, easy-to-implement database software package and development environment,
- Simple, efficient programming language software packages to communicate with the database, control data mining, and provide an effective, fully-functional web interface.

Two primary options for a web-hosting server, storage, and database environment were explored. Third-party hosting services (such as Yahoo! or GoDaddy.com) offer storage, a database environment and software packages for a nominal monthly subscription ($10-$40). Conversations with developers of the WRAP Technical Support System at CIRA—the eventual home of the FETS—revealed the existence and accessibility at CIRA of more than adequate storage space and MS SQL server software, but web-hosting at CIRA would require buying a dedicated server ($4000) and programming software is limited.

Both options offer distinct advantages, and it was decided to utilize portions of both. A shared SQL Server space has been set up on the CIRA system for the FETS, offering the Project Team full administrative rights to build a database. The web-hosting server will be developed on a third-party host and the CIRA database will be accessed remotely (illustrated in Figure 1). This allows the FETS development to proceed without the need to buy a dedicated server, while also taking advantage of superior web-development tools and database communication software offered by the third-party host. While this provides the FETS some degree of autonomy and flexibility, utilizing the server at CIRA will make future integration to the TSS a more efficient process and ultimately creates a more powerful suite of tools for the WRAP.

Figure 1: Diagram of system configuration and development strategy.



SECTION 4

PROJECT TASKS AND METHODOLOGY

Task 1: Project Work Plan, Meetings, and Information Gathering

Task 1a: Work Plan

This Work Plan presents the methods and deliverables for the project to develop a fire tracking system. This work is being managed by the Fire Tracking System Task Team (Task Team) of the Fire Emissions Joint Forum (FEJF) under contract to the Western Regional Air Partnership (WRAP) of the Western Governors' Association (WGA). The draft Work Plan will be reviewed by the Task Team and revised as necessary to prepare the final Work Plan. The final Work Plan will be submitted to the Task Team and the WRAP (Technical Coordinator) for approval prior to implementation.

The Work Plan defines the technical scope of work and deliverables in as many areas as possible. Some aspects of the Work Plan may be presented in a way that maintains more flexibility for the FEJF / WRAP to investigate technical aspects of the work and provide input to final methodologies and products. The Work Plan is prepared with sufficient detail for the Air Sciences – Wingate - CIRA Project Team to meet the Task Team's, FEJF's, and WRAP's expectations for the technical deliverables, the project schedule, and budget estimate.

Task 1b: Participation in Conference Calls and Meetings

The successful development and implementation of the FETS will require the Project Team's active involvement with a number of conference calls and meetings. Below are brief descriptions of the calls and meetings that have taken place. Also included are brief descriptions of planned meetings and calls.

Past Meetings / Calls:

- A Task Team Conference Call, February 13, 2007 at 2:30 MST, was conducted to present a draft outline of the scope of work and technical aspects of the FETS. Feedback and necessary discussion items for presentation to the FEJF meeting were provided to the Project Team.
- A FEJF meeting, February 22-23, 2007 in San Diego, CA. The Project Team presented a detailed outline, timeline for completion, and update of the FETS project.

Planned Meetings / Calls:

- The WRAP Technical Support System Workshop, scheduled June 19-20 in Denver, CO. The Project Team will presented a working prototype of the FETS and provide training sessions for users.A WRAP "Lesson Learned" Emissions Inventory meeting, scheduled tentatively for mid-September, 2007. The Project Team will present the final working version of the FETS

and demonstrate tools that have been developed to integrate the data of the FETS into the WRAP's Technical Support System (TSS).

Task 1c: Information Gathering and Evaluation of Available Commodity products

The Project Team has initiated and will continue to investigate available commodity products to use in building the FETS. There are several components to the FETS that will require development, including the data management structure, web-based user interface, mapping tools, data reporting tools, and technical tools to perform emissions calculations and incorporate the use of Emission Reduction Techniques (ERT). Possible products include, but are not limited to, those used by existing FTS, open-source database architecture and web-interface / data management software, and available mapping tools such as Google Earth. Products will be chosen based upon their compatibility with other required components, ease of use (both for the end-user and the developers), cost (if any) of licensing and maintenance, likely time required to integrate the product into the FETS, and the expertise of the Project Team members. Given these criteria, the products chosen, and any additional software created by the Project Team, are meant to meet the following FETS performance goals:

- Robust - The FETS will be modular in design so it can be easily extended to include new applications or adapted to different and more complex applications by extension of the FTS rather than modification to the existing structure.
- Flexible - The FETS can handle a variety of different import and export data structures with a modular design that can be extended without major modification of the base system.
- Consistent - The components that make up the FETS are designed around explicit conventions for style, structure, and format. The data usage routines and emission calculation methods are intended to present fire emissions across the WRAP region in a systematic and consistent way.
- Ease of Use - Users of the FETS are not required to memorize complex structures or coding systems associated with data input, editing, output, querying, reporting, archiving, restoring archived data, etc.
- Universal Acceptance - All users understand and accept the FETS, including the regulated community, federal land managers, tribal and regulatory agencies.
- Complete and Explicit - There is nothing implied about any of the information and data contained in the application or transmitted between parties.
- Compatibility - The conversion / integration of data from existing system(s) is / are not unnecessarily complex.
- Rigorous - Definitions and principles upon which the FETS is designed must be adhered to and well defined.

Task 2: FETS Software Development

Task 2a: Database Architecture

The WRAP FTS policy lists seven minimum elements required for storing and tracking fire events. These elements include,

- Date of Burn
- Location of Burn (Lat / Lon)
- Size of Burn (acres)
- Fuel Type
- Fuel Loading (pre-burn and actual)
- Type of burn (wildfire, prescribed, WFU) [broadcast / piled]
- Natural / Anthropogenic[1]

Additional elements, not listed as essential in the FTS Policy but considered by WRAP, state, and tribes to be important as fire-related elements of Regional Haze SIPs are developed and implemented and are planned to be integrated into the FETS:

- Emissions Calculations
- Annual Emissions Goals
- Projections
- Emission Reduction Techniques

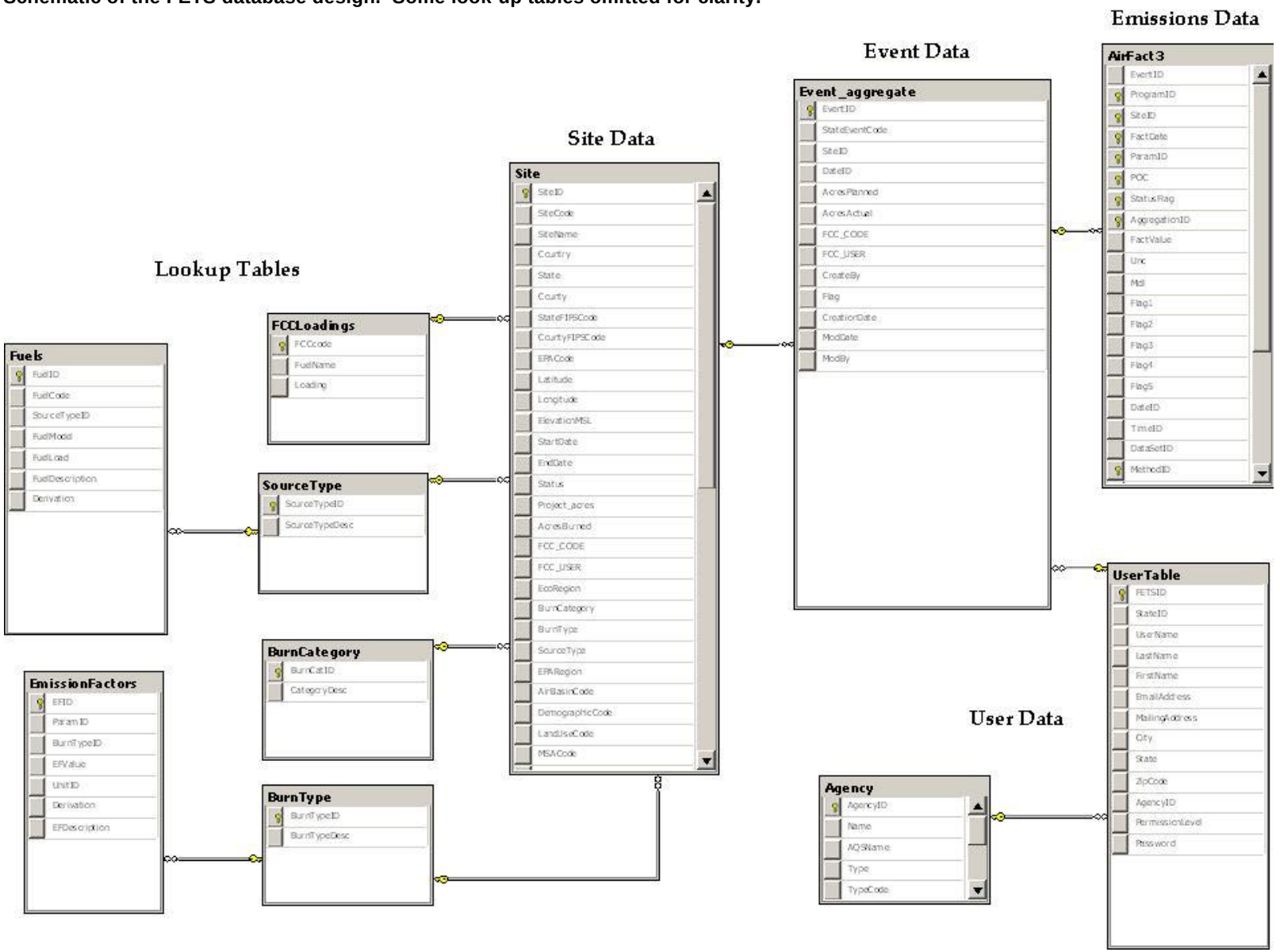
The Project Team has gone through several iterations of the database design, starting with a simple collection of flat (non-relational) tables. While a simple design may be adequate for the FETS initially, eventual integration to the TSS or enhancement of FETS capabilities requires a more efficient database structure. Therefore, the structure of the FETS will mirror the database developed for the TSS.

The basic structure of the database is shown in Figure 2. The table at the top of the hierarchy, the AirFact3 Table, is organized such that each record contains a quantity of emissions of a single pollutant for a single day of a single burn event (whether wildfire, prescribed, or WFU). All other information about the fire, collectively referred to as the "metadata" (including identifying information for burn, the inputs to the emissions calculation, etc.) is linked by unique integer keys to tables contained in the second row in Figure 2 (Program, Site, Parameter, and Flag). These are linked to several lookup tables containing all fixed parameters related to each fire, including pollutant information, unit information (such as tons / acre), State, County, and Tribal FIPS codes, etc. Field definitions for the two primary input tables, AirFact3 and Site, are included in Appendix A (Table A-

[1] Consistent with "Policy For Categorizing Fire Emissions," Fire Emissions Joint Forum, November 15, 2001. Prescribed fire, Agricultrual burning and Wildland Fire For Use (WFU) are considered "Anthropogenic"; Wildfire and Tribal burning are considered "Natrual".

1). All editable records contain audit fields that trace the creation date and user name and separately trace the most recent modification date and user name.

Figure 2: Schematic of the FETS database design. Some look-up tables omitted for clarity.



An important consideration with the database design is the potential conflict between one user entering data into the database and another simultaneously querying data (to view on a map, for example). While this is rarely a problem, day-to-day coordination during peak fire season may result in "high-traffic" periods. Therefore, it is prudent to maintain two instances of the database side-by-side: one database will serve as the repository for all real-time data entry, and the other as a "data warehouse" that will be used solely for retrieving queried data. The frequency with which the database copies itself has not been determined, but it is recognized that the copying technique and frequency with which database copies are made need to be accomplished in a way that maximizes user access to the data in the FETS.

The TSS database currently does not include fire data and therefore is potentially missing appropriate fields and tables. Some of the data (such as acres) will be integrated into existing tables as additional fields or records; other data will need to be incorporated as additional tables, including the following:

- A table of stored User information. User information for data coming in from external sources may not be available, but will still carry a user ID. User IDs coming in from external sources will have the two-letter state name concatenated to the ID to avoid any duplication across states.
- A table of Emission Reduction Techniques (ERT) suites. Unique by season, vegetation type, and region. An alternative approach includes a matrix of Emission Reduction Factors (ERF) for individual ERT. See Appendix B for more discussion.
- A table of emission factors that includes broadcast and pile burning consistent with WRAP emissions calculation methods.
- A table of WRAP-modified fuel loadings for emissions calculation.

The Project Team has initiated and will conduct a full analysis of the necessary modifications to the TSS database structure. This is not anticipated to take more time than developing a new, independent database. Identified benefits to this approach include developing a robust database that can utilize the full power of SQL Server platform. A ancillary benefit is that FETS developers will communicate database modifications for the FETS to TSS developers who will consider the merits of these modifications for the TSS.

Task 2b: Web-based User Interface

The key to an effective user interface for the FETS is maintaining a minimalist approach while ensuring powerful, flexible, and useful querying ability for the user. In addition, because data will potentially be entered by (at most) hundreds of users, the interface should maintain the ability to create, retrieve, update, and delete entered records to avoid the proliferation of excess erroneous records.

The interface will consist of the following basic pages:

- **User login page.** Entry boxes for username/password. Button linked to Create New User page.
    - New User Creation page. Includes entry boxes for user information. As a way of helping avoid data duplication, a warning will be issued if the user is a SMP with an existing FTS and the data are already uploaded/mined automatically. New users requesting read-only access to the database will be automatically approved. Users requesting write access will require manual approval.
- **Manual data entry page.** Entry boxes for information outlined in Task 2a will be displayed.
    - For information such as State, County, and Agency, use of ERT, fuel class, and vegetation type, drop-down menus will be in place.
    - The user will be able to review input before final submittal.
    - Error checking on the data (potentially including showing fire locations on a simple map) will be performed prior to writing to database, and on-screen highlights of any errors will be shown.
    - Much incoming data for planned events will be organized by unit/site with one or more burn events/proposals. Manual entry page(s) will reflect this organization: a burn unit/site must be created before events/proposals may be created.
- **Batch file data upload page**. A browse menu will enable the user to choose a file for upload. Error checking on the file will be performed. Errors in the file will be displayed back on the upload page. If there are errors, none of the data in the file will be assimilated. An unresolved aspect of batch file uploads is whether to allow batch uploads through the web-interface or through a dedicated FTP site. The former option has greater potential on both sides for automation of data assimilation, but makes it more difficult for users to identify or be aware of errors in submitted data. Regardless of method, *all batch-loaded files must follow the same ASCII delimited text format*.
- **Data query page**, linked to three further options:
    - **Edit/delete existing records.** A list of editable record will be available. The list will be restricted to data linked to the user and within an allowable time window (current calendar year). The user may select one or more burns from the list to edit. Record(s) will appear on screen in table format, with editable fields (not established) as entry boxes populated with existing data. A reset button will be available to cancel any changes. Error checks similar to those for new records will QC edited data.
    - **Data mapping tool.** Described in more detail in Task 2c
    - **Data download in various formats.** At a minimum, the FETS will process burn emissions into SMOKE/CMAQ and BlueSky model formats, as well as an emissions

inventory format (e.g. NEI) and simple tabular formats (CSV, DBF, and/or XML). Planned and unplanned events will be available for download. There will be no restrictions on which data the user wishes to download. A query page will assist the user in choosing precisely the data needed.

Pages will be created in XHTML format, with Cold Fusion acting as a communicator with the database. In addition, JavaScript will be used as appropriate (see Task 2c, Mapping Tools).

Task 2c: Emissions Calculations

Calculating emissions for fire data stored in the FETS is identified in the Fire Tracking System (FTS) Policy as a necessary capability, and is considered within the scope of work of the FETS Project. Appendix B of the Draft FETS Work Plan (distributed on 3/23/07) identified several unresolved issues related to emissions calculations:

- Provide a rough, initial estimate of emissions calculated by WRAP method for day-to-day coordination purposes (these emission estimates may or may not be stored permanently in the FETS).
- Have several emissions estimates, all stored, at different levels of confidence – the last or final estimate is used for emission inventory purposes.
- Use of a fuel-loading classification scheme, such as National Fire Danger Rating System (NFDRS), Fuel Characteristics Classification System (FCCS), and Canadian Forest Fire Danger Rating System (CFFDRS) for Alaska.
- Allow user-defined emissions.
- Have a link to an emissions calculator on the website.
- Provide a consistent method of calculating emissions that may be used for specific applications (e.g., regional dispersion modeling).

This section presents the approaches for several steps to execute emissions calculations and store fire emissions data in the Fire Emissions Tracking System (FETS). The following section was provided as a Strawman to the FETS Task Team to solicit feedback on the methodology; those comments have been integrated into this section.

1) Review & Selection of Fire Emissions Calculation Method(s)

Five emissions calculations methods, commonly used by the fire community and/or by the WRAP for emissions inventory purposes, have been reviewed by Air Sciences. Several criteria were evaluated, including:

- Ease of incorporation into the FETS.
- Feasibility of using a calculation method in its current form.
- Accuracy gained (or lost) when using a particular method.

Table 1 identifies the basic data input requirements for the emission calculations reviewed. Generic inputs used to calculate emissions are listed in the left of the table. Requirements specific to each method are listed in the "Minimum" columns. Not all inputs are required for each method, and in those cases the field has been shaded out. "Difficulty ratings," indicating Air Sciences' assessment of the ease of implementing each emission calculation method into the FETS, are listed in the last row (a lower score implies easier implementation).

The basic emission equation/calculation methods (i.e., the WRAP-modified method used in the 2002 WRAP Emissions Inventory, and the seasonal method used in the 2002 Inter-RPO Wildfire Emissions Inventory) have the lowest scores due to the need only for a series of look-up tables in the FETS database and relatively few inputs. The other three methods represent stand-alone programs, all with a Graphical User Interface (GUI), making incorporation into the FETS a more involved undertaking.

Of the three stand-alone programs, CONSUME 3.0 is the only calculator with a command-line executable capable of accepting a batch file of any number of fire events at one time. This feature simplifies the task of implementing CONSUME 3.0 into the FETS. FOFEM is integrated with the MT/ID fire tracking system, and is capable of providing emissions calculations directly from the web interface. However, the code for accomplishing is not readily available for use by the FETS Project Team (personal communication with Lee Macholz on 4/10/07) and FOFEM does not accept data in batches. FEPS is exclusively a stand-along program with a GUI interface and, therefore, would require substantial programming to implement into the FETS. Based on this review, CONSUME 3.0 is considered the best choice among stand-alone emissions calculators.[2]

[2] CONSUME 3.0 has many input requirements and options for establishing universal defaults (e.g. pile dimensions, number of piles per acre, slope, etc). Air Sciences will need to resolve these input-data as we expect that such detailed data will not be provided for the majority of fires entered into the FETS.

Table 1: Diagram of Strawman to help determine the most feasible emissions calculator.

	CONSUME			FEPS			FOFEM			Inter-RPO			WRAP		
	Minimum	Exists	Needed	Minimum	Exists	Needed	Minimum	Exists	Needed	Minimum	Exists	Needed	Minimum	Exists	Needed
Burn Type	Nonpiled / Piled	X		Five types combine		X	Nat / slash / pile	X		Bdcst / piled	X		Bdcst / piled	X	
Source Type	Rx, WFU, WF	X		source / burn						WF / Rx	X		WF / Rx	X	
Fuel Class	FCCS number		X	FCCS or NFDRS		X	FCCS / SAF / SRM / NVCS		X	NFDRS		X	NFDRS		X
Eco-Region	Equation type		X												
Fire Shape	Piles only		X	Oval or linear		X									
Dates	Burn Date	X		Start / End	X		Season	X		Month	X				
Location	Lat / Lon	X		Lat / Lon	X		Lat / Lon	X		Lat / Lon	X		Lat / Lon	X	
Acres	Fuelbed Size	X		Acres	X					Acres	X		Acres	X	
Moisture	10hr / 1000hr / Duff		X	6 classes, Very dry to Very wet		X	Vdry, dry, mod, wet		X	6 classes, Very dry to Very wet		X			
Batch / command line	command-line batch mode	X		None		X	Possibly		X						
Additional needs	%crown consumed; Shrubland % Blackened; Slope; Days Since Rain; Number of piles		X												
Difficulty:	**4**			**6**			**4**			**2**			**1**		

Key:

Minimum:

Bare minimum of inputs required

Exists: Data already incoming to tracking system / Capability exists

Needed: Requires addition of one or more look-up tables to the database, or need to establish defaults

Not applicable to calculation method

2) Hierarchy of Emission Estimates

The WRAP-modified method of emissions calculation can be readily implemented with no additional software or hardware requirements and will be implemented as the default option for calculating emissions in the FETS. The Project Team recognizes the benefit to moving toward a more resolved and widely-accepted emissions calculator. CONSUME 3.0 in its current form is the most feasible choice for incorporation into the FETS, and the Project Team will move toward a goal of implementing this as part of the full integration of the FETS with the TSS by September 2007. At this time, the WRAP-modified method of emissions calculation will continue to be used for estimating $PM_{2.5}$ emissions on a regional coordination level as a rough day-by-day guide. CONSUME 3.0 will be used to estimate emissions as accomplished acres and other post-burning reporting becomes available.

3) Pollutants and User-provided Emission Estimates

CONSUME 3.0 calculates emissions for PM, $PM_{2.5}$, PM_{10}, CO, CO_2, non-methane hydrocarbons (NMHC), and methane (CH_4). Additional pollutants calculated in past WRAP emissions inventories include elemental carbon (EC), organic carbon (OC), SO_2, NO_x, ammonia (NH_3) and coarse PM. A complete suite of pollutants for each fire event will be developed by combining CONSUME 3.0 values and WRAP-method values and / or by scaling CONSUME 3.0 emissions by scalars published in EPA / OAQPS reference documents.

In addition to performing emissions calculations within the database, the FETS will accept user-provided emissions values. (In most cases, "users" will be state and tribal Smoke Management Programs). User-provided emission estimates are likely to not include all pollutants in the complete suite of pollutants. A complete suite of pollutants for each fire event will be developed by populating pollutant data fields according to a pollutant data hierarchy. An example of the pollutant data hierarchy is illustrated in Figure 3.

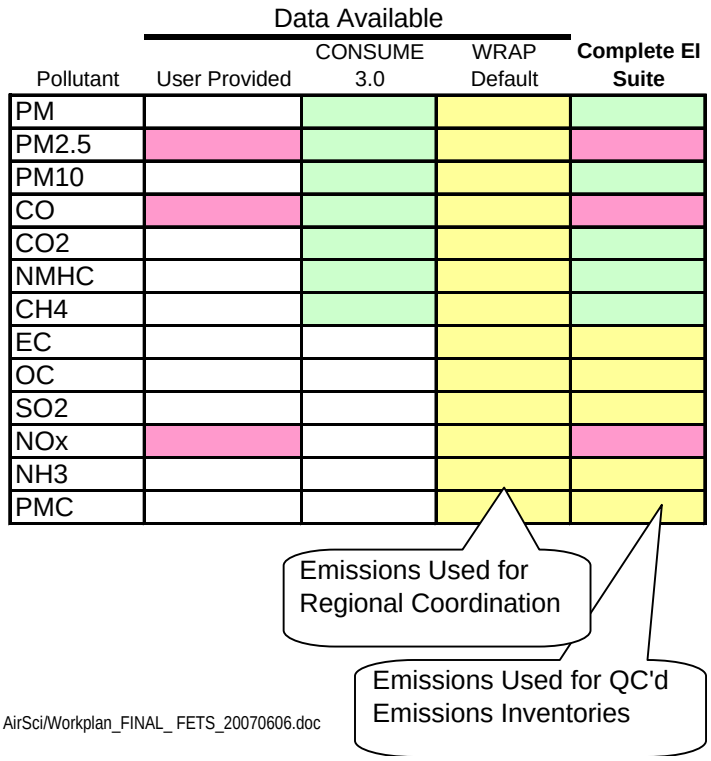


Figure 3: Pollutant Data Hierarchy. This is an example of how pollutant-specific data from several emission calculation methods for a single fire event may be combined to develop a complete suite of emission estimates.

4) Special Purpose Emission Estimates ("final" level of QA/QC for the FETS)

Not all end-user applications of FETS have been foreseen. For some unforeseen applications, the suite of emissions data in the FETS may be insufficient or incomplete. For examples:

- A modeling analysis for a specific ozone non-attainment issue may require speciation of VOCs beyond those stored in the FETS.
- A state air quality agency may be interested in the emissions inventory for mercury (there are no mercury emission estimates in FETS).
- Certain applications may benefit from fire emission calculations using perimeter / remotely sensed data or plume characteristics.

The FETS is designed to initially provide emissions data equal in quality and integrity to existing inventory methods. However, this focused capability will not preclude the FETS from providing flexibility to applications with additional requirements.

The FETS database is designed such that additional pollutants or calculation methods may be appended without a wholesale revision of the database architecture. Emission calculation methods are integrated into the FETS in a modular fashion such that each method operates on a unique set of records in the database. Adding a new calculation method will generate a new set of records for all or a specified subset of fire events stored in the FETS while the existing metadata and emissions calculations remain intact. Similarly, emissions for each pollutant are stored as unique records. This architecture allows new pollutants to be added and efficiently accessed.

5) Fuel Layer Node.

A common feature between all emissions calculation methods is the need for information pertaining to vegetative cover / fuel classification and estimates of fuel loading and fuel consumption. For users entering data via the web interface of the FETS, users will be able to select fuel class directly from a pull down data. The most likely candidate sources of information for fuel class are the Fuel Characteristic Classification System (FCCS) (continental United States) and the Canadian Forest Fire Danger Rating System (CFFDRS) (Alaska). For fire emissions data that are "mined" by the FETS or provided in batch mode by data providers, fuel class information may be missing. Therefore, the Project Team has committed to implementing a "fuel layer node" in the FETS. This node will consist of an automated routine that pulls fire events from the database (with a spatial location), drops the data onto a fuel layer map, and inserts the resulting fuel class information back into the database for each fire event. At this time, a single fuel classification will correspond to a given set of fire event coordinates—fire perimeter information will not be incorporated.

6) Emission Reduction Techniques

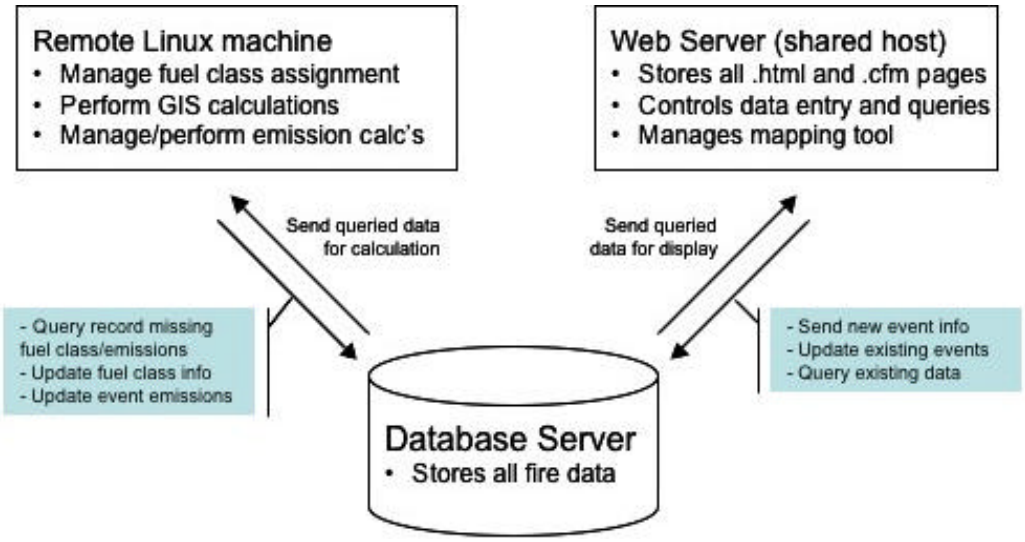
The FETS will accommodate the use of Emission Reduction Techniques (ERT). ERT data will likely come in to the FETS at different times for different states, and in many cases ERT data will not be available until after post-burn reporting has been submitted. The following general approach will be used to handle ERT information:

- For regional coordination purposes, the ERT(s) applied to an event will be noted (if available) but no calculations to reduce emissions for the event will be performed (only uncontrolled PM2.5 emissions will be presented).
- As post-burn reports are submitted and accomplished acres recorded, ERT application will be incorporated into emissions calculations.
- An interface to assist website users with selecting appropriate ERTs will be integrated into the data entry / edit screens.
- Final, quality-controlled emission inventory estimates will include emissions averted due to the use of ERTs.
- The WRAP ERT Technical Package will be available as a reference for users and the WRAP ERT Seasonal Suites will be used as a default for the calculation of emissions averted (for instances for which fire event data indicates that ERTs were applied but no specific information on the ERTs is provided).

7) Server Options for Emissions and Fuel Layer Utilities

An open-source GIS will be employed to implement the Fuel Layer Node. Because the web-server will exist on a shared host (www.godaddy.com) that cannot support individual supporting programs, the Fuel Layer Node (and perhaps the CONSUME 3.0 Utility) will need to reside elsewhere. The server at CIRA (where the FETS SQL database will reside) could be an appropriate location, but this would add a computational burden .in addition to handling user queries and may compromise existing security practices at CIRA. Alternatively, a separate, simple server (e.g. a Linux box) that will perform the necessary functions related to GIS and emissions calculations could be set up and utilized. This will enhance performance for users since calculations may be performed at a much greater frequency, and will allow for the use of open-source GIS software (i.e. GRASS GIS) instead of relying on proprietary software such as ArcView.. Figure 4 outlines the basic architecture of this setup.

Figure 4: Server architecture that includes emissions calculation and fuel layer node.



Task 2d: Interactive Mapping tool

The FETS will have the capability to map planned [and unplanned] events for use in regional and intra-agency coordination. A key feature asked for by many states is the ability to view planned and active fire in neighboring as well as their own airsheds. With this as well as stated FTS policy goals in mind, the mapping tool will have several minimum capabilities.

Planned and active fires for a user-specified window of time (i.e., "current calendar day", "tomorrow", or "Friday-to-Tuesday") will be displayed on the map. Information about each displayed event will be viewable from the map, including:

- Type
- Status (e.g. Approved, Uncontrolled—depends on type)
- Area (acres) —"as-reported" for the planned fire event.
- Fuel type
- Estimate of emissions (if applicable, with calculation method).
- Responsible agency and / or contact name and information.

In addition, unique icons for wildfire, prescribed and WFU burns will be displayed. Other anticipated features of the mapping tool include:

- The ability to Zoom in / out of a desired region and pan to adjacent areas.
- Display / print event information from the map field of view

- Overlay other static data layers (e.g. roads, towns, fuel classification.)

The engine for map creation is the client-side web version of Google Maps API. This freely-available tool consists of an embedded Google Map interface linked to the Google server and includes an array of customizable JavaScript functions for viewing of geo-referenced data and panning and zooming maps. Fire data from the FETS database may be queried and assimilated into the Google map via XML and JavaScript.

A multi-frame web form will exist with a map, several query options, and a data table showing the queried information. The query options frame will consist of several menus where the user establishes which data to query from the FETS database for map display. The query menus will include:

- Time window – current calendar day, tomorrow, Friday-to-Tuesday
- Types of fires—natural / anthropogenic, prescribed, wildfires, all, etc.
- Geographic region—by state(s), counties
- Fire status—approved, controlled, out, etc
- Agency

Based on the choices made, the FETS database will be queried, and a XML file with all eligible fires will be created, carrying the following attribute data:

- Location
- Date
- Acreage—"as-reported" for the planned fire event.
- Emissions (if accomplished)
- Status
- Responsible agency

The queried fires will be displayed on the map. Depending on the scale of the map view, multiple fires in close proximity may be graphically represented as a "fire activity" icon (rather than as individual fire events) to avoid overloading the map tool and slowing down the speed with which maps are created on-the-fly. Appropriate scales and viewing options will be established as the map tool is developed to make the interactive mapping tool effective and illustrative for coordination purposes.

Task 2e: Data Acquisition and Exchange Interface

Development of the FETS will include coordination with existing FTS and other databases containing fire data. The intended result is to capture unplanned events from existing federal data sources and to efficiently receive planned event information already entered into smoke

management databases. The Project Team and the Task Team, will, throughout the FETS development process, continue to target existing fire databases for data acquisition by the FETS. A table of targeted databases will be maintained in Appendix C (Table C-1) as sources of data are identified and specific information about the data is gathered.

Acquiring data for the FETS does not mean a direct link to each individual database. Existing links between databases will be investigated, and coordination to as many systems as necessary to achieve high data coverage will be initiated. A second table in Appendix C (Table C-2) will be maintained that lists the current known and potential data acquisition methods, locations, and frequency.

Coordination with several state fire tracking systems is already underway. Data acquisition from these systems will vary in form, but will likely involve mining of CSV files from one or more ftp locations. An example data crosswalk from three systems is shown in Appendix A (Table A-2). If a state that already tracks fire data wishes to submit data to the FETS for the entire state, the Project Team will work with that state on determining data acquisition and assimilation methods. FETS users who wish to upload data to the FETS through batch-loaded files via the website will be provided a template in order to standardize data formats and integration.

Task 2f: Database Quality Assurance / Quality Control

QA / QC will focus on several aspects of data entry and storage in the FETS. Every data field in the master table and any other table that populated by user data will carry basic constraints, including

- Data type
- Length (if text)
- Minimum and Maximum (if numeric and applicable)

For data fields with a limited set of possible choices (such as State), pull down menus (created directly from lookup tables in the database) will be put in place of keyboard entry. Error messages will accompany user entry mistakes, both for manual entry and batch upload. Data mined from external sources are likely to have undergone QC procedures specific to that source. Nevertheless, basic automated QC checks on incoming data will be performed.

An important QC issue is gap-filling daily burn data for both planned and unplanned events. This issue is discussed in more detail in Appendix B.

Task 3: Technical Integration to the WRAP Technical Support System

Linking the FETS to WRAP's Technical Support System (TSS) will provide states and Tribes ongoing regional technical support, as well as data access and visualization tools for their

regional haze planning. The FETS will be supported by TSS, thus placing software and hardware maintenance issues in a known and tested environment.

Fire emissions inventory work will be integrated into the TSS by definition – providing the opportunity for ESMPs to integrate the fire data into the rest of the regional haze emissions, monitoring, and modeling data. Integrating the FETS into the TSS will support the development of regional haze SIPs, including:

- Support of essential technical SIP documentation pertaining to fire emissions; and
- Technical tools in the TSS that produce technical demonstrations of Regional Haze Section 309 states' efforts to fulfill Annual Emission Goals requirements.

Short-term integration to the TSS (by mid-2007) involves providing a direct link from the TSS website to the FETS. The long-term goal in the next year is to merge with the TSS so that all states and tribes can share fire activity / emissions data and use the data in TSS analytical and regional planning tools for regional haze SIP planning and preparation. The Project Team has decided to prioritize preparing for full integration from the outset. Mirroring the existing TSS database structure, and identifying areas in the TSS system that need to be adapted to fire data will facilitate integration of the two systems. The TSS will import data from the FETS at an undetermined frequency. Storing data in the TSS separately allows the FETS to maintain some degree of autonomy allowing the system flexibility to evolve over time. In addition, no additional burden will be placed on the FETS system as it will not need to serve queries from users of both systems.

Task 4: Documentation

Documentation for this project will be prepared by the Project Team. Specific documentation deliverables will include:

- Work Plan (draft and final forms). Appendix B – Critical Technical Issues is viewed as a "living document" and will be revised throughout the development of the FETS. As issues are deemed resolved by the Task Team and the Project Team they will be elevated from Appendix B to the Work Plan to be accomplished within the current scope of work.
- Technical Support Document (draft and final forms) including: a description of the methods used to evaluate and select any commodity products, methods used to construct the FETS software, assumptions, and limitations. Final version will include specific feedback from beta testers.

- FETS Users Guide (draft and final forms). Complete and explicit. Instructions and protocols on using all aspects of the FETS will be included: manually entering data; batch-loading files (including an example of the correct format); editing and deleting data; using the map tool; and data retrieval.

PROJECT SCHEDULE

Table 2: Timeline for WRAP Project – Develop the WRAP Fire Emissions Tracking System

In this table major deliverables are bolded and ongoing task work is shown in normal text.

Timeline for WRAP Project - Evaluate Existing Fire Tracking Systems

	Number of weeks from FETS Task Team Conference Call week (2/16).																	
	1	2	3	4	5	9	11	13	15	17	19	21	23	25	27	29	31
Deliverable	2/23	3/2	3/9	3/16	3/23	4/20	5/4	5/18	6/1	6/15	6/29	7/13	7/27	8/10	8/24	9/7	9/21
FETS Task Team Conference Call - Outline formulation																	
Evaluate commodity products																	
FEJF Conference, San Diego. Final Detailed Outline																	
Select commodity products																	
Conference Calls with exisitng FTS managers																	
Determine Database architecture																	
Draft Workplan					Mar 19												
Final Workplan																	
FETS Software Development																	
Database design																	
Web Interface tools																	
Mapping tools																	
Data output formats																	
Test Version of FETS Operational										Jun 19							
TSS Workshop																	
Data Exchange interface																	
Debug / Incorporate user feedback																	
Technical Support Document/User's Guide																	
FETS Operational															Aug 13		
WRAP Emission Inventory "Lesson Learned" meeting																	
TSS Fire Tools Developed																	

SECTION 6

PROJECT TEAM MEMBER RESPONSIBILITIES

The Project Team of Air Sciences and EC/R will cooperate on many technical tasks. For some tasks, one Project Team member or the other will take the primary role to complete the task (or complete the task independently). The responsibilities of the Project Team members are as follows:

(ii) Air Sciences

- Work Plan finalization - lead.
- Meetings/presentations.
- Database development – lead.
- Website design and development – support.
- FETS integration with TSS – co-lead.
- Documentation – lead and delivery.
- Technical workshop(s) – lead.

(iii) Wingate Designs

- Work Plan finalization – support.
- Database Development – support.
- Web site design and development – lead.
- Documentation – support.
- Technical workshop(s) – support.

(iv) Cooperative Institute for Research in the Atmosphere

- Initial database access and set up.
- Database development – technical support.
- FETS integration with TSS – co-lead.
- System administration of CIRA servers – on-going.

APPENDIX A

Database architecture and acquisition details

Table A-1: Emission, Event, and Site table definitions.

AirFact3 table definitions

Keys		Column Name	Type	Nullable	Description
PK	FK	ProgramID	int	No	Will likely stay the same for all FETS data
PK	FK	SiteID	int	No	Automatically generated by Site table
PK		FactDate	smalldatetime	No	
PK	FK	ParamID	int	No	Identifies pollutant
PK		POC	char(1)	No	?? [Default is set to 1]
PK	FK	StatusFlag	char(2)	No	Validation status of value. Currently, F0 = 'Valid, obtained by growth allocation' ; F1 = 'Valid, obtained by reported daily acres
PK	FK	AggregationID	int	No	Is value a representation of aggregated data. Default is 1, no aggregation.
		FactValue	float	No	pollutant emissions in tons
	FK	DataSetID	int	No	ID of incoming data set. For now, created new record in Dataset table identifying WRAP PHII data. May be useful for recording batch loads, but maybe not necessary for individual entries.
	FK	MethodID	int	No	Method of calculation of FactValue. Unique ID for WRAP-modified calculation, State-calculated, CONSUME-calculated

Event_aggregate table definitions

Keys		Column Name	Type	Nullable	Description
PK		EventID	int	No	
		StateEventCode	varchar(16)	Yes	Code provided by user or incoming dataset
		SiteID	int	No	
		DatePlanned	smalldatetime	Yes	Proposed burn date
		DateID	smalldatetime	No	Actual burn date
		AcresPlanned	float	Yes	
		AcresActual	float	Yes	
	FK	FCC_CODE	int	Yes	Event-specific FCC code (optional)
		TenHourMoist	int	Yes	
		ThouHourMoist	int	Yes	
		Flag	char(2)	No	
		CreationDate	datetime	Yes	
		ModDate	smalldatetime	Yes	
		ModBy	varchar(50)	Yes	

Table A-1: Emission, Event, and Site table definitions continued.

Site table definitions				
Keys	Column Name	Type	Allow Null?	Description
PK	SiteID	int	No	Generated by DB; read-only
	SiteCode	varchar(20)	No	ID associated with mined event data, or ID assigned by FMO.
	SiteName	varchar(100)	No	Fire name
FK	Country	varchar(2)	Yes	Linked to Country Table
FK	State	varchar(4)	Yes	Linked to State Table
	County	varchar(5)	Yes	Concatenation of State and County FIPS codes
	StateFIPSCode	varchar(4)	Yes	
	CountyFIPSCode	varchar(3)	Yes	
	Latitude	float	Yes	Decimal degrees
	Longitude	float	Yes	Decimal degrees
	ElevationMSL	float	Yes	Optional input - not cuurently used
	StartDate	datetime	Yes	First burn day at site
	EndDate	datetime	Yes	Last burn day at site
	Status	varchar(3)	Yes	Not in use yet.
	Project_acres	float	Yes	Total acres burned at site
FK	FCC_CODE	int		GIS-derived FCCS class
FK	FCC_USER	int		User-specified FCCS class
	EcoRegion	int		
FK	BurnCategory	int	Yes	Nat / Anth Linked to BurnCategory table
FK	BurnType	char(1)	Yes	Broadcast / Piled. Linked to BurnType Table
FK	SourceType	varchar(3)	Yes	Linked to SourceType table
FK	AgencyID	int	Yes	Not Used
	CreateDate	datetime	No	
	CreateBy	int	No	
	ModDate	datetime	Yes	
	ModBy	int	Yes	

Table A.2: Example data crosswalk from existing FTS. There is some variability in available data.

FETS Fields	Allow Null?	MT/ID	WA	OR/BlueSky
SiteID	*No*			
SiteCode	No	UnitID	BPMT_NO	
SiteName	No	UnitName	BPMT_ID	
Country	*Yes*			
State	Yes			
County	Yes	Location	COUNTY_CD	CNTY
StateFIPSCode	Yes			
CountyFIPSCode	Yes			
Latitude	Yes	Lat	BP_LAT_COORD	LAT
Longitude	Yes	Lon	BP_LON_COORD	LON
ElevationMSL	Yes			
StartDate	Yes		PLN_BURN_INIT_DT	
EndDate	Yes			
Project_acres	Yes	Acres	PLN_BURN_AREA	
FCC_CODE	*Yes*			
FCC_USER	Yes			
BurnCategory	Yes	BurnCategorization		
BurnType	Yes		BURNTY_CD	TYPE
SourceType	Yes			
AgencyID	Yes	Office		OWN
CreateDate	*Yes*			
CreateBy	*Yes*			
ModDate	*Yes*			
ModBy	*Yes*			
EventID	*No*			
StateEventCode	Yes	FireID	BREQ_ID	'ID
SiteID	*No*			
DatePlanned	Yes	ProposedDate	PLN_IGNITION_DT	DATE
DateID	No	DateBurned	ACTL_BURN_DT	
AcresPlanned	Yes	ProposedAcres	PROPS_BURN_AREA	AREA
AcresActual	Yes	AcresBurned	ACTL_BURNED_AREA	AREA**
FCC_CODE	Yes			
FCC_USER	Yes			
TenHourMoist	Yes	10HourMoisture	TEN_HR_MOIST_PC	10HR
ThouHourMoist	Yes		THOUSAND_HR_MOIST_PC	1kHR
Flag	*No*			
CreationDate	*Yes*			
ModDate	*Yes*			
ModBy	*Yes*			

Key:

Optional input	Definition confirmed
Defined internally	Definition not confirmed

**Planned and actual acreage sent to BlueSky in different files

APPENDIX B

Critical technical issues

Listed below are some issues that have arisen during the development of the FETS work plan and in meetings and calls with the Task Team and the Fire Emissions Joint Forum. Appendix B identifies technical issues that require specific input from the Task Team but are considered within the current scope of work. Appendix B is considered a living document. As issues are resolved, items will be removed from Appendix B and elevated to the Work Plan. Based on the complexity of each unresolved issue, the Project Team may solicit input from the Task Team and/or likely FETS users, or may identify the issues and resolutions in more detail for comprehensive discussions among the Task Team and likely FETS users.

Fire Characteristics Issues:

1. Post-burn reporting that is not resolved to a daily level. For example, a wildfire may have daily situation reports in the ICS 209 database during the fire growth period, then a single report weeks later after the fire is out. A method to gap-fill fire days with no daily report must be devised. Options include standardized methods within the database to gap-fill missing daily data such as an "expanding oval" routine or evenly allocated acreage (total acres / # of days).
2. Spotty daily reporting of multiple-day events. May need to derive standard method to estimate daily growth (e.g., "expanding oval;" equally sized daily events).
3. Planned Land Management Projects vs. Requested Burns vs. Accomplished Burns. Issue(s): Planned burns often occur at the same location several times in a year. Land managers and others applying for prescribed burns may submit a permit for a set number of acres, and burn over several non-consecutive days to accomplish all the acres applied for in the original permit. Option(s): Consider whether and how to include "project" level data in the FETS. Daily event data in the FETS for planned burns will carry a project or unit identification as well as a burn identification to distinguish burns at the same location over a period of time. Similarly, unplanned burns will have an event identification as well as a daily identification for a single day of burning. It is recognized not all fires will have data resolved at the daily level. Any burn initially entered into the database as active will continue to show up on maps until flagged otherwise, unless start and end dates are defined. Burns post-reported by event will have a growth allocation calculated for daily emission records, but the method remains an open question.

Integration of FETS into WRAP Technical Support System (TSS)

4. Annual Emission Goals Demonstration Tool.

5. Support Regional Haze SIP Content for fire emissions.

APPENDIX C

Data acquisition tables

Table C-1: Existing Databases Targeted for Data Acquisition by the FETS.

Data Source	Agency	WRAP States	Event records		Daily records		Frequency
			Planned	Unplanned	Planned	Unplanned	
EDMS	WRAP	All	X	X			Annual
USDA	Federal	All					Annual
NRCS	Federal	All					Annual
EPA NEI	Federal	All	X	X			Annual
WFMI	Federal	All					Annual
FACTS	Federal	All					Annual
NIFPORS	Federal	All	X	X	X (?)	X (?)	Semi-Daily?
TEISS	Tribes	All Tribes	X	X			Annual
ICS-209	Federal	All		X		X	Daily
BlueSky	WRAP?	OR,WA, MT/ID, NM,...	X		X		Daily
FCAMMS	State	NM,CO,…	X	X	X	X (?)	Daily
MT/ID Burn Rpt. System	State	MT, ID	X		X		Daily
FASTRACS	State	OR, WA	X		X		Daily
NM Smoke Mgt D'base	State	NM	X	X	X		Daily / Annual

APPENDIX D

Technical issues for future consideration

1. Integrating long-duration, landscape prescribed burns. MT/ID has expressed concern, as they don't fit well into their reporting system. Reporting is spotty for emissions, blackened acres, and consumption. Options include: Rely on post-burn reporting (although this may create problems with the data made available for "real time" coordination.
2. Expanded GIS capabilities
    a. Retroactively integrate fire perimeter data from the Monitoring Trends in Burn Severity (MTBS) project to use, for example, with the mapping tool and to derive weighted-average fuel loadings.
    b. Mine and/or store remotely-sensed data to use with mapping applications or assess the percent acres burned within a fire perimeter.
3. Emissions calculations. The emissions calculation Strawman resolved many issues presented in the draft Work Plan. Some remaining questions include:
    - Have several emissions estimates, all stored, at different levels of confidence – the last or final estimate is used for emission inventory purposes.
    - End-of-year re-calculation for all fires.
    - Separate, consistent method of calculation for emission inventory purposes.
4. Fuel classification.
    - Possibility of using LANDFIRE in the future if a fuel map is available?
    - Incorporate fire perimeter data into GIS fuel classification scheme.
5. Projections
    - Potential to import WRAP's event-based fire emissions projection (2018) inventory data into FETS.