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EMISSION ESTIMATION TECHNIQUES FOR UNIQUE SOURCE CATEGORIES IN MEXICALI, MEXICO

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Center on Air Pollution
Centro de Información Sobre Contaminación de Aire
CICA

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U.S.-Mexico Border
Information Center on Air Pollution

CICA

Centro de Información sobre Contaminación de Aire Para la Frontera entre EE. UU. Y México

Sponsored by:

Clean Air Technology Center (CATC)
Information Transfer Group (MD-12)
Information Transfer and Program Integration Division
Office of Air Quality Planning and Standards
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

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Office of Air Quality Planning and Standards
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Research Triangle Park, NC 27711

EPA REVIEW NOTICE

This report has been peer and administratively reviewed by the U.S. Environmental Protection Agency. This review was coordinated by the U.S.-Mexico Information Center on Air Pollution / *Centro de Informacion Sobre Contaminacion de Aire Para la Frontera entre EE.UU. Y México* (*CICA*). In addition, CICA coordinated review of this report with other agencies that participated in the study, including: the County of Imperial Air Pollution Control District; and the *Instituto Nacional de Ecoligía* in Mexico; and the Mexicali district office of the *Secretaría de Medio Ambiente, Recursos Naturales y Pesca*. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

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PREFACE

The U.S.-Mexico Border Information Center on Air Pollution *(Centro de Información sobre Contaminación de Aire Para la Frontera entre EE.UU.-México,* or ***CICA***) was established by the U.S. Environmental Protection Agency (U.S. EPA), Office of Air Quality Planning and Standards (OAQPS) to provide technical support and assistance in evaluating air pollution problems along the U.S.-Mexico Border. These services and products are available at no cost to Federal, State and Local Agencies and universities in Mexico. Others can use these services depending on available resources. *CICA* provides ready access to U.S. EPA information and expertise. It draws on professional staff from the EPA's OAQPS and Office of Research and Development (ORD). Private contractors also are available when appropriate.

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- **INTERNATIONAL TECHNOLOGY TRANSFER CENTER FOR GLOBAL GREENHOUSE GASSES**

Establishing a reliable emissions inventory for all significant sources of air pollutants in the Mexicali, Baja California, Mexico - Imperial Valley, California, U.S.A. area is part of a comprehensive effort to identify air pollution problems and implement measures to improve ambient air quality along the U.S.-Mexico border. The purpose of this project was to identify and evaluate alternative approaches that could be used to determine potential emissions from two unique sources in Mexicali, Mexico; i.e., street vendor cooking devices and wastewater canals.

ACKNOWLEDGMENTS

This report was made possible through the information, cooperation and coordination provided by Mr. Gaspar Torrez, County of Imperial Air Pollution Control District, El Centro, CA and Mr. Octavio Alonzo, Chief, *Departamento de Calidad del Aire, Delegación Federal de la Secretaría de Medio Ambiente, Recursos Naturales y Pesca* (*SEMARNAP*). *CICA* also appreciates the effort of Dr. Victor Hugo Páramo, *Director de Administración del Aire, Instituto Nacional de Ecoligía* (*INE*), and his staff for reviewing and commenting on the draft final report.

CICA also acknowledges and appreciates the efforts of Mr. Gerardo Rios, U.S. EPA Region IX, for proposing and providing initial coordination for this project. We are also very grateful to Mr. Jaime Mendieta, Senior Environmental Employee with *CICA* for his tireless efforts in preparing the Spanish version of the draft final report and Ms. Allyson Siwik, U.S. EPA Region VI Border Liaison Office, for reviewing and commenting on the final report.

TABLE OF CONTENTS

TABLES

LIST OF ACRONYMS

AP-42	U.S. EPA's central document listing all recommended emissions factors
BBS	Bulletin Board System, electronic data management and retrieval system
C##	organic compound or fragment with ## carbon atoms
CATC	Clean Air Technology Center
CHIEF	Clearinghouse for Inventories and Emission Factors
CICA	U.S.-Mexico Border Information Center on Air Pollution / *Centro de Información Sobre Contaminación de Aire Para la Frontera entre EE.UU. y México*
CMB	Chemical Mass Balance
CO	carbon monoxide
EE.UU.	*Estados Unidos*, United States of America
FTIR	Fourier Transform Infrared
HAP	Hazardous Air Pollutants
IBM	International Business Machines, Inc.
INE	*Instituto Nacional de Ecoligía* (National Institute of Ecology; part of *SEMARNAP*; responsible for setting environmental standards in Mexico)
IR	Infrared
kb	kilobytes
NATICH	National Air Toxics Information Clearinghouse
NO_x	oxides of nitrogen
OAQPS	Office of Air Quality Planning and Standards
PAH	Polycyclic Aromatic Hydrocarbons
PC	Personal Computer
PIES	Pollution Prevention Information Exchange System
POTW	publicly owned treatment works
PM_{10}	particulate matter with aerodynamic diameter of 10 microns or less
RAM	random access memory
SAIC	Science Applications International Corporation
SCAQMD	South Coast Air Quality Management District
SEMARNAP	*Secretaría de Medio Ambiente, Recursos Naturales y Pesca* (department of environment, natural resources and fisheries in Mexico; U.S. EPA's counterpart in Mexico)
SIP	State Implementation Plan
TRI	Toxic Release Inventory
TTN	Technology Transfer Network
U.S. EPA	United States Environmental Protection Agency
VOC	volatile organic compounds

ABSTRACT

An initial assessment of two unique air emissions source categories in Mexicali, Mexico was completed. The source categories evaluated in this study are street vendor cooking devices and open sewage impoundments, canals and conveyance systems. The assessment included a preliminary literature review to identify relevant available information that could be used to develop an emissions inventory methodology for those sources. A site visit was made to Mexicali to observe examples of these sources to better understand the potential air emissions contributions of those sources and to help put these sources in context relative to air quality in Mexicali and air pollution transport issues that can ultimately affect air quality problems immediately across the border in the United States. Through continuing discussions with researchers interested in similar and related problems and additional published reports, several options for emissions estimation approaches were identified. A series of criteria were developed to help rank order potential emissions methodologies. Candidate emissions estimation approaches were evaluated against the list of criteria and these approaches were ranked relative to one another. Finally, some ideas for control programs that might be considered for implementation to reduce the overall emission rates from those sources were presented.

INTRODUCTION

BACKGROUND

Establishing a reliable emissions inventory for all significant sources of air pollutants in the Mexicali-Imperial Valley area is part of a comprehensive effort to identify air pollution problems and implement measures to improve ambient air quality along the U.S.-Mexico border. The U.S. Environmental Protection Agency (U.S. EPA), working through the Clean Air Technology Center (CATC), and the U.S.-Mexico Border Information Center on Air Pollution / Centro de Información sobre Contaminación de Aire Para la Frontera entre EE.UU. y México (*CICA*) in coorperation with the *Departamento de Calidad del Aire, Delegación Federal de la Secretaría de Medio Ambiente, Recursos Naturales y Pesca (SEMARNAP)* and the *Administración del Aire, Instituto Nacional de Ecoligía* (*INE*) in Mexico have jointly initiated programs to achieve this goal. The purpose of this project is to investigate specifically two unique source categories in Mexicali, Mexico and develop a list of possible methodologies to estimate air emissions from those sources. The two source categories considered in this effort are street vendor cooking devices and open sewage impoundments, canals, and conveyance systems. The possible methodologies were evaluated relative to a list of criteria, and ranked in order of preference. Finally, the costs to implement those methodologies that appear to be useful have been estimated.

Street vendors cooking devices include a variety of activities in which food is prepared in either portable or fixed structures. The food items prepared in these units include grilled meats for use in tacos, burritos and other typical foods for the region. The units burn mainly charcoal or compressed gas. These units are more or less ubiquitous throughout the city and in some locations during the evening hours they are lined up one after the other down significant lengths of some of the streets. Emissions of concern from these street vendor cooking devices are particulate matter with aerodynamic diameter less than 10 microns (PM_{10}), hazardous air pollutants (HAP), volatile organic compounds (VOC), and oxides of nitrogen (NO_x).

Open sewage impoundments, canals, and conveyance systems refer to a system of ditches or canals that were originally designed to manage run off primarily from agricultural activities on the outskirts of the City of Mexicali. The population of the city is now over 1,000,000 and the city boundaries extend into areas where these run off canals exist. Several industrial plants and residential areas are located in close proximity to these canals. As a result, these ditches collect an assortment of wastes, both liquid and solid. The waste ditches contain waste oils, a variety of industrial wastes, residential sewage, and other materials that wash out of trash, tires and appliances that are disposed in the ditches. Pollutants of interest from the waste ditches include VOC and organic HAP.

The canals drain into the New River, which is the main artery that directs flow north through the Imperial Valley in California and ultimately to the Salton Sea. The Salton Sea is located approximately 75 miles north of the border between the U.S. and Mexico. Its surface is at 229 feet below sea level and it has no outlet. The untreated wastewater generated in Mexicali,

and all of the agricultural runoff from the significant food and grain production in the Imperial Valley ends up in the Salton Sea.

The project design originally included an analysis of a third source, residential burning of waste materials; specifically used tires. Recently, a law has been in effect in Mexicali prohibiting the use of waste materials as a fuel source in residences. The law is enforced and this is no longer thought to be a significant problem. Therefore, work on this source category was stopped. Although discussions with local representatives were initiated in an attempt to specify another source category, as of the time that this report was prepared, no alternate source category had been identified for consideration in this effort.

APPROACH

The project was conducted in four phases. The first was a literature review of known data sources, reports and guidance materials on sources similar in nature to those evaluated in this study. The second phase was a site visit to see the sources and to make a visual assessment of the types of methodologies that could be used to evaluate emissions. In the third phase, options for emissions control opportunities and alternatives for emissions estimation methodologies are discussed. The fourth phase presents a set of criteria for evaluating the proposed emissions estimation methods and ranking those proposed approaches against the criteria. Finally, a recommended approach is presented for each source category. To the extent possible a rough cost estimate is provided for each recommended approach. This draft report was prepared and submitted to officials from the U.S. EPA, the County of Imperial and from Mexico, as well as other interested partners for review and comment. The discussion below describes the activities completed in each of these phases.

Phase 1. Literature Review

The work assignment identified a list of six specific published reports, guidance materials and information summaries and required a review of these materials for any relevant background information and any results of emissions estimation methods or emission factors suitable for the source categories of interest. Those specific information sources are listed below in Table 1. Preliminary efforts to locate applicable information sources revealed several additional sources of information that were considered potentially applicable to this effort. Those information sources were also obtained and reviewed. Table 2 is a summary list of the materials and reports that were reviewed in this phase. The table indicates whether the materials contained information that was thought to be useful in the analysis. Since waste derived fuel-fired residential heating sources were eliminated from the overall analysis under this work assignment, the information sources relevant to that source category that were reviewed in this phase are not included in Table 2.

Phase 2. Site Visit

Science Applications International Corporation (SAIC), U.S. EPA contractor, coordinated with Mr. Gaspar Torrez of the County of Imperial Air Pollution Control District located in El Centro, CA and scheduled a visit to the Mexicali area on June 27, 1996. Mr. Torrez coordinated with the principal contact from Mexico on this project, Mr. Octavio Alonzo, head of the Departamento de Calidad del Aire, Delegación Federal de *SEMARNAP* in Mexicali. A meeting was held on the morning of June 27, 1996 in the local offices of SEMARNAP. We presented the objectives of the project and gave a brief description of the project. Mr. Alonzo indicated his approval for the project and offered to assist in any way possible.

Following the meeting we proceeded by car to tour Mexicali to see examples of the street vendor cooking devices and the uncontrolled open sewer waste canals. The site visit concluded during the afternoon of June 27, 1996.

TABLE 1. LIST OF INFORMATION RESOURCES FOR CONSIDERATION

Title	Author	Sponsor	Date
Implementation Plan for Mexico Emissions Inventory Methodology (Ref. 1)	Radian Corporation	Border XXI Air Work Group, through the Western Governors' Association with assistance from the Binational Advisory Committee	September 1995
Imperial Valley/Mexicali Cross Border PM_{10} Transport Study; Draft Final Report (Ref. 2)	Desert Research Institute, University and Community College System of Nevada	U.S. EPA Region IX	April 21, 1995
Procedures for Estimating and Allocating Area Source Emissions of Air Toxics - Working Draft (Ref. 3)	Versar, Inc.	U.S. EPA; CHIEF BBS on OAQPS TTN	March 1989
Compilation of Air Toxics Emission Inventory Questionnaires EPA 450/4-88-008 (Ref. 4)	Engineering Science, Inc.	U.S. EPA	June 1988
Technical Procedures for Developing AP-42 Emission Factors, EPA 454/B-93-050 (Ref. 5)	NA	U.S. EPA	October 1993
Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone, EPA-450/4/91/016 (Ref. 6)	NA	U.S. EPA	December 1992

TABLE 2. SUMMARY OF REFERENCE MATERIALS

REFERENCE NAME	SPONSORING AGENCY	DATE	APPLICATION	BRIEF DESCRIPTION	USEFUL	
					YES	NO
Ref. 4 - Compilation of Air Toxics Inventory Questionnaires (EPA-450/4-88-008)	U.S. EPA	6/88	Street Vendors; Waste Canals	Guidelines for development and use of questionnaires for collecting information for inventory development and emission factors for hazardous air pollutants	X	
Ref. 7 - Identification and Characterization of Missing or Unaccounted For Area Source Categories (EPA-600-R-92-006)	U.S. EPA	1/92	No Relevant Applications	Establishes some background and information resources for developing emissions estimates for selected nontraditional source categories		X
Ref. 8 - Example Documentation Report for 1990 Base Year Ozone and CO SIP Emission Inventories (EPA-450/4-92-007)	U.S. EPA	3/92	Street Vendors; Waste Canals	Provides examples of how to document the development of emissions inventory data for use in SIP development; Useful for guidance on how to establish credible methods	X	
Ref. 9 - Compiling Air Toxics Emission Inventories 2nd Edition (EPA-450/4-86-010)	U.S. EPA	2/90	Street Vendors; Waste Canals	Provides guidance on building capabilities to identify previously ignored sources of air toxic emissions;	X	
Ref. 10 - Submicrometer Aerosol Mass Distributions of Emissions from Boilers, Fireplaces, Automobiles, Diesel Trucks and Meat-Cooking Operations (Aerosol Sci. & Tech. 14, No. 1, 1991)	Unknown	1991	Street Vendors	Presents data on composition of very fine particle mass emissions from meat cooking operations.	X	

TABLE 2. SUMMARY OF REFERENCE MATERIALS (continued)

REFERENCE NAME	SPONSORING AGENCY	DATE	APPLICATION	BRIEF DESCRIPTION	USEFUL	
					YES	NO
Ref. 15 - Air Emissions Models for Waste and Wastewater (EPA-453/R-94-080A)	U.S. EPA	11/94	Waste Canals	Reviews available models for calculating air emissions from wastewater handling systems. Description of WATER8 with examples of its use	X	
Ref. 16 - NATICH Data Base Report on State, Local and EPA Air Toxics Activities, (EPA-450/3-89-29)	U.S. EPA	7/89	No Relevant Applications	Summaries activities completed to develop emissions estimates for some sources of air toxics; does not include information on the target source categories		X
Ref. 17 - Methods Evaluation for Mexico Emissions Inventory Methodology	Border XXI Air Work Group through the Western Governors' Assoc. with assistance of Binational Advisory Committee	4/95	Not Specific for target source categories	Presents an general overview of emissions inventory preparation methods; does not give information for specific source categories		X
Ref. 1 - Implementation Plan for Mexico Emissions Inventory Methodology	Border XXI Air Work Group through the Western Governors' Assoc. with assistance of Binational Advisory Committee	3/96	Not Specific for target source categories	Presents general approaches for a long term project to develop emissions inventories for Mexico		X
Ref. 18 - The New River Workshop	National Water Research Institute	5/95	Not Specific for Target Source Categories	Reviews current scientific understanding of the problems facing the New River and assesses future needs to advance improvements in New River Water Quality		X

TABLE 2. SUMMARY OF REFERENCE MATERIALS (continued)

REFERENCE NAME	SPONSORING AGENCY	DATE	APPLICATION	BRIEF DESCRIPTION	USEFUL	
					YES	NO
Ref. 20 - Protocol - Rule 1174 Ignition Method Compliance Certification Protocol	South Coast Air Quality Management District	2/91	Street Vendors	Presents the compliance testing protocol for charcoal grill starter fluids	X	
Ref. 21 - Quantitative Characterization of Urban Sources of Organic Aerosol by High Resolution Gas Chromatograph (Env. Sci. Tech., 25, No. 7, 1991)	Unknown	1991	Street Vendors	Provides measurement information on the chemical composition of fine particle mass emissions from meat grilling operations	X	
Ref. 22 - Sources of Fine Organic Aerosol 1. Charbroilers and Meat Cooking Operations (Env. Sci. Tech., 25, No. 6, 1991)	Unknown	1991	Street Vendors	Provides detailed analysis of chemical composition of emissions from meat (hamburger) grilling and frying operations	X	
Ref. 23 - Study to Develop Background Information for Direct Meat Firing Industry (GCA-TR-77-36-G)	U.S. EPA	1/78	Street Vendors	Discusses processes, test methods and emissions characteristics for direct meat (hamburger) grilling operation in U.S. fast food setting; discusses emissions control technology	X	
Ref. 24 - Particulate Emissions Test Summary	*Hardee's Food Systems*	1974	Street Vendors	Provides test results for example grilling operations in typical U.S. fast food industry	X	

During the site visit several examples of the street vendor cooking devices and waste canals were observed. The visit was conducted in the late morning and early afternoon. Most of the activity involving the street vendor cooking begins later in the afternoon and reaches its peak between approximately 5 PM and 11 PM in the evening. Therefore, it was not possible to observe the peak of the activity on this visit, but Mr. Torrez pointed out the streets where significant activity is normally observed during the evening hours and it was possible to understand the magnitude of the problem. The street vendor devices range from small units that are towed or pushed to a location along many of the streets in Mexicali, to larger permanent sites with enclosures and tables. Cooking is done mainly with either charcoal or compressed gas fuels. During the visit most of the operating units observed were fired with charcoal. Emissions from the gas burners are thought to be inherently lower than those for the charcoal burners although the most significant emissions probably result from the drippings from grilled meats onto the hot coals or elements of the gas burners. Therefore, both types of units are of primary interest in this study. During the site visit it was not possible to observe flame characteristics or other operational conditions to estimate combustion efficiency that might be relevant to NO_x emissions from the gas burners.

The waste canals are trenches that range from about 6 meters to 10 meters wide and about 3 meters or less deep. Flow was observed in these trenches verifying the presence of sources upstream of the locations observed. There was a considerable amount of trash and debris along the sloped banks of the trenches and in the water. Although odors were present they were not excessive or readily distinguishable, indicating that at the points of observation there is probably not a significant amount of volatilization of organic materials.

Phase 3. Emissions Estimation Methods and Control Options

Emissions Estimation Methods

Street Vendor Cooking Devices

These sources are small fossil fuel-fired combustion sources, that are emissions sources for selected VOCs and potentially other more complex organics, NO_x, and particulate matter. Although these sources are individually small, the large number of them that are routinely in operation in Mexicali creates a source category that could be significant. The fact that these sources emit both ozone precursors and particulate matter further increases their importance as contributors to two significant air quality problems. Recently, there has also been a significant amount of interest in the possibilities that charbroiling red meats can create benzo(a)pyrene an organic carcinogen and other polycyclic aromatic hydrocarbons (PAH), some of which may become airborne (Rogge, et. al., 1991).

There are two basic fuel types used in these devices; charcoal and a mixture of compressed propane and butane gas. VOC emissions resulting from starter fluids used on the charcoal, and leaks in the compressed gas storage, transfer, and delivery systems at the cooking

units may be significant sources of additional VOC. The use of these fuels also leads to additional concerns for emissions and environmental problems. Exploration of these additional issues is outside the scope of the current work but it should be recognized in any event. Emissions may also result from the transport and handling of bulk compressed gas fuel and in the manufacture and handling of the charcoal fuel. Of most concern is potential leaks from the main bulk storage devices which are located in an area of the city where there is significant commercial activity and population density. Not only is there a possibility of gas leaks from the transfer of fuel from these bulk storage facilities to intermediate transport devices or directly to users but there is also a risk of explosion. If the manufacturing process for the charcoal are located in or near Mexicali there will be emissions of VOC from that process, and possible particulate emissions resulting from storage and handling of the charcoal. Further cooperation and coordination with Mexican authorities is recommended to determine the relative importance of these possible concerns.

The U.S. EPA has a vast amount of data describing emissions processes and emission factors for various fossil fuel-fired combustion sources (U.S. EPA *AP-42*, 1995). Most of this information is specific for large utility and industrial external combustion sources. While these types of sources are similar in nature to the small cooking devices, specific differences in combustion chamber design, air/fuel mixtures, temperatures and pressures between these two source types make direct application of the emissions factors and estimation procedures for the large source inapplicable to the smaller sources of interest in this study. EPA has also completed a significant amount of research related to emissions from fireplaces and wood stoves, to support specific PM-10 nonattainment areas, where wood stoves and fireplaces are used in large numbers for heating (Houck, et. al., 1989; Chow, et. al., 1993). These studies have not explored the possible emissions of VOC from such sources in any detail.

The South Coast Air Quality Management District (SCAQMD), the local air quality agency in the Los Angeles air basin, has developed emission characteristics for backyard barbeques using charcoal briquets and commercially available starter fluids. Those studies were only concerned with emissions of VOC caused by the application and burning of the starter fluids. The SCAQMD developed a rule (Rule 1174) based on these studies that regulates the characteristics of starter fluids that are allowed for sale, purchase and use in the air basin. In that work, however, a testing protocol for measurement of the emissions characteristics of charcoal grills was developed (SCAQMD, 1991). Although the procedure adopted by SCAQMD was specific for the measurement of total nonmethane hydrocarbon emissions, that same approach could be used to obtain samples for analysis of particulate matter and speciated VOC for application to this project.

Measurements of particulate matter emissions characteristics of representative charcoal grilling operations in Mexicali were made as part of the Imperial Valley/Mexicali Cross Border PM_{10} Transport Study (Chow and Watson, 1995). In that study, emissions from two of the permanent restaurant style operations were made to develop the source emissions profile necessary to run the Chemical Mass Balance (CMB) model and other receptor modeling approaches. Data were collected through dilution sampling from a point approximately 0.3

meters above the edge of the roof vent from these structures. Unfortunately, the raw data collected in that study are insufficient to quantify the mass emissions rate of either particulate or organic compounds.

Appropriate modifications to this general approach can be implemented to estimate source specific emissions contributions in a region of the city. The technique can also be very effective to routinely evaluate changes in the contributions of specific source categories to the overall particulate loadings in the area. These data can be used to infer an emissions rate and changes in emissions rates after controls are implemented. These approaches require a strong knowledge of and experience with receptor modeling approaches and further discussions with experienced researchers in receptor modeling approaches are recommended if further work related to this approach is contemplated.

Various measurements programs specific to emissions from meat grilling operations in the U.S. fast food industry were completed in the mid to late 1970s (Commonwealth Lab. Inc. 1974; GCA Technologies, 1978). Although these data are specific for the grilling of ground beef in hamburger patties, the results are useful in the current analysis. The data in both studies show a large amount of fine particulate to be emitted from these processes. Over 90 percent of the particulate mass is in the less than 1 micron size range. These emissions combined with oily fumes also emitted from meat grilling could result in significant particulate emissions. Additional research is continuing in the United States to explore the possible emissions of cholesterol and other fatty compounds, organic acids, and organic carcinogens to the air from meat grilling operations.

In most U.S. restaurant operations grease traps are required to be installed in the exhaust flues from these types of operations. These units can significantly reduce the air emissions of fatty organic compounds. The fine particulate is not reduced significantly in the grease traps and rather sophisticated filters would be needed to capture the bulk of the particulate in the less than 1 micron size range. Such filters are employed at selected fast food restaurants in the United States. Details on the design and operation of these filters are readily available.

More recent studies conducted at the California Institute of Technology (Hildemann, et. al., 1991), reviewed meat grilling as one component of an analysis of the source contributions to total organic aerosol in the Los Angeles area. These studies show that meat grilling contributes a large percentage of organic acids that elute from the gas chromatograph between C20 and C25, with a strong peak at C21 and C22. These results are useful for planning any receptor type analyses because the components in this range will provide fingerprint elements specific for this source that are distinguishable from other sources of organic aerosol.

Emissions estimation approaches for this category are limited to two possibilities. One is a source measurements based approach, and the other is an inferential approach based on ambient measurements. The source measurements based approach would require the selection of a group of routine operations that would provide a composite representation of all of the street vendor

activity in Mexicali. These units would then be subjected to monitoring of mass emissions rates following some agreed standard method over the range of typical operations. Quantities of fuel consumed, meat products grilled, and/or square meters of grill area in operation should be collected during the emissions tests for use in the development of an emission factor or series of emission factors that could be used to describe the average rate of mass emissions from these operations. In the inferential approach more detailed source composition profiles could be generated and emissions rates in selected areas of the city could be inferred through analysis of a series of ambient monitoring tests in a method that is similar to more accepted receptor modeling approaches.

Both of these approaches would require some method of estimating the overall activity rate expressed in a representative form for that source category. This could be accomplished through a mandatory reporting mechanism or through a survey approach. In the reporting approach either the fuel distributors, or the vendors would be required to report total fuel sales or fuel consumption in specified reporting periods, or the vendors would be required to report the total amount of meat product grilled or sold during specified reporting periods. In a survey approach a group of staff would be selected and trained to periodically observe operations at a large percentage of the units operating in Mexicali to estimate a unit of activity that would be representative of the operations in selected areas of the city. These estimates of activity rate could then be compared to the overall inferred emissions under the base scenarios to estimate emissions over time.

Careful planning of the initial data collection methods would ensure that either method would be source and pollutant specific. It is assumed that sufficient data is not currently available to support either of the proposed approaches. This represents a significant weakness and detailed discussions with Mexican officials and U.S. representatives in the border area would be needed to establish the most cost-effective methods to obtain and maintain the data needed to use the methods. In both cases, small investments of resources could be committed to train appropriate staff from Mexico to complete the initial data collection and estimations and to maintain that process over time. Again through a careful planning process either approach could be developed in a way to support the continued update of estimates to track the usefulness of any control programs, and to provide data suitable for planning purposes both in Mexico and as needed to support cooperative bilateral programs.

Each of these approaches would be fairly expensive. Initial costs associated with source monitoring or ambient data collection to support the receptor analysis approach would be similar. Depending on the amount of support and facilities that could be provided by the Mexican authorities, it is estimated that an initial investment of $50,000 to $150,000 U.S. would be needed to collect the initial data to make a baseline estimate. Once the most appropriate source markers were identified it would likely be less expensive over the long term to establish the approach based on ambient data collection rather than on source monitoring. The main uncertainty relative to cost would be the cost associated with developing and maintaining the activity data use rates and number of units that employ various control systems. The basic approach to collect and

maintain these data is straightforward, however, the overall effect of these additional reporting mechanisms to both the street vendors and the central authority is difficult to estimate. Clearly, additional discussions and negotiations with the Mexican authorities is critical to understanding the burdens and impacts of those burdens on vendors and the public.

Open Sewage Impoundments, Canals and Conveyance Systems

These sources are slow flowing waste canals that meander through the industrial areas of the city and through some residential areas. These canals accept a variety of liquid and soluble wastes and these wastes ultimately empty into the New River. Discussions with Mr. Torrez and other people in Mexicali indicate that these canals frequently contain oils such as used motor oil, chemical wastes from some of the industrial sites and untreated human sewage, and other household wastewater. The canals also receive a variety of trash and used appliances, etc., that litter the sides and bottom of the canals. It is likely that some of these items dumped into the canals also contribute some contaminants.

There has been a significant amount of research conducted to describe emissions processes and to calculate potential VOC emissions resulting from wastewater collection, conveyance and treatment. One good alternative for this work is the WATER8 computer system. WATER8 includes a series of mass transfer calculations that allow an estimate of emissions resulting from wastewater handling and treatment processes. Of interest in this application are the capabilities of the model to simulate unit specific emissions from open trenches, equalization ponds, and lagoons. The system is available on diskette and can be operated on nearly any IBM-compatible PC with at least 520 kb of random access memory (RAM). The user must specify physical parameters on the type of unit, and chemical parameters on the specific compounds that are of interest. The user must specify the chemical constituents that are to be modeled. There are accompanying computer systems that identify the required chemical parameters for over 900 specific VOC species that can be handled by the WATER8 program. If it is necessary to calculate emissions for compounds not included in the prepared lists, the chemical property data for those compounds can be entered by the user.

Bilateral discussions since the early 1980s have focused on the continuing problem of contamination of the New River from industrial and residential sources in Mexicali (International Boundary and Water Commission, 1980, 1987, 1992). Although these discussions and agreements have sought a comprehensive solution to pollution problems of the New River, continued residential growth and industrial expansion in the Mexicali area have exceeded the capacity of solutions implemented to date. In addition, these efforts have focused on affecting improvements to the water quality of the New River and have not concerned controls or elimination of the causes of that pollution or the effects on potential air emissions resulting from industrial contaminants that are routinely discharged to the waste canals feeding the New River. In fact, several of the proposed solutions to this problems advocated the construction of new or upgrading of existing aeration lagoons to pretreat industrial contaminants in the wastewater discharges.

There is a fairly complete historical monitoring database of selected water quality parameters from the U.S. side of the New River. In general, these monitoring efforts have focused on nutrient loadings, specific ions, and bacteriological parameters. There may also be a limited amount of data on the chemical composition of the waste canals, although it was not possible to locate these data during the completion of this study. It is likely that it will be necessary to obtain these data directly through Mexican authorities. Recently, the U.S. EPA has required industrial facilities in Mexicali with U.S. parent organizations to report on the quantity of waste streams from their facilities. This action followed closely the U.S. voluntary reporting program known as the Toxic Release Inventory (TRI) system, that is implemented under the Community Right-to-Know legislation, although the data from Mexicali are not included directly in the TRI database (U.S. EPA, 1995).

In this study a total of 117 letters were sent to U.S. parent companies suspected of operating Maquiladora facilities in the Mexicali area requesting information on their contributions to discharges of chemicals on the TRI priority list to all media. U.S. EPA received 8 responses to that letter, 4 companies were removed from the list because they received the letter as a duplicate through another related company, and 13 letters could not be delivered. Of the 8 responses, 7 companies indicated that they operated a Maquiladora in the Mexicali area.

Following that request, U.S. EPA sent administrative subpoenas to 95 U.S. parent companies suspected of operating Maquiladoras in Mexicali. Twenty of the companies that received subpoenas were removed from consideration because the subpoena could not be delivered, the companies were subject under a different company name, the company was out of business, the company had responded to the original letter, or the company was not the parent company of the Maquiladora. Of the 75 responses 57 companies indicated that they were a parent company of a Maquiladora operating in the Mexicali area. The breakdown of industry types represented in the 64 responses for operating U.S. owned Maquiladoras is listed below:

- 9 in Electrical Equipment and Components
- 14 in Fabricated Metal Products
- 7 in Fabric or Apparel Finishing
- 4 in Transportation Equipment
- 3 in Food Products
- 3 in Medical and Optical Goods, and
- 14 Other (2, Repair Parts; 2, Rubber and Plastics; 2, Furniture Manufacturing; 2, Industrial Equipment; 2, Miscellaneous Assembly; and 1 each in Sports Equipment, Glass, and Printing)

The request for information followed the TRI data collection effort which only requires reporting if the company manufactures, processes or otherwise uses for than 10,000 lbs./year of any of the priority chemicals. The bulk of the responses indicated use rates of the priority chemicals that were below the 10,000 lbs./year use rate and therefore they did report their discharges. The total amount of the chemicals reported to be discharged by companies that use

the chemicals at above or below the threshold limit was 49, 510 lbs. Of that total almost all of it was reported to be released directly to the air. Several of the companies report discharging over 800,000 lbs. to wastewater treatment plants, or exporting chemicals back to the U.S., to other Maquiladoras, or to a off-site treatment facility.

This study is not a complete assessment of the potential contribution of the industrial activities in Mexicali to contamination of the waste canals. Many facilities that indicated that their discharges were below the threshold limit may collectively contribute a large amount of discharges. In addition, further information on the number and type of facilities operating in Mexicali that were not subject to this information collection was not available for this review. There are many known facilities either owned by Mexican companies or parent companies outside the United States, that are also likely contributors of discharges to the waste canals.

A review and assessment of all data that are available on the industrial sources of wastewater entering the canals, concentration data on waste streams, water samples taken from the canals and monitoring data from samples collected in the New River itself should be completed. The results of that review should be analyzed relative to the discharge information available through the subpoena program. Following that review an assessment can be made as to the overall importance of these canals as an air emissions source. If the source is still thought to be significant, the data gaps and future needs to fill those data gaps can be identified. It is likely that additional sampling efforts would be required to clearly characterize the major industrial releases. Specific data on the chemical components of waste streams will significantly improve the emissions predictive capabilities of a system such as WATER8 significantly. More importantly, however, specific data on the location, quantity, chemical composition, and release schedules of industrial wastewater that are added to these canals will be essential to identify appropriate control options, and to track the effectiveness of those control options.

Based on insights gained through the site visit and information previously collected on the types and concentrations of various organic constituents in these waste canals, we have concluded that there is insufficient information available to execute WATER8 at this time with any degree of confidence. The preferred alternative to locate information to fill the data gaps is to work directly with the Mexican authorities in Mexicali to obtain and summarize all existing information and to set up a reporting mechanism on operations and releases of industrial wastes to these canals. Sufficient information could be obtained if all of the major industrial sources of wastes to these canals voluntarily submitted the required information. If this preferred approach can not be implemented an alternate approach is to inspect these canals by walking them to identify any permanent industrial out falls. In all cases, when it is possible the inspector should note the source of the wastewater and make an estimate of the volume flow to the canals. These significant out falls will then be mapped. It is suspected that any such contributions to these canals may be either continuous or intermittent and therefore a single view of these canals may not provide sufficient information on the volume of flow to these canals. It is also possible that the specific industrial sources of these out falls will not be obvious during this inspection. It will

be possible, however, to identify the most likely origination points of wastewater when the map is reviewed in combination with known existing industrial facilities.

If it is possible to get the voluntary cooperation of the facilities, they should be contacted to determine what contribution they make to the total flow in these canals and the specific chemical constituents of the wastewater. These data can then be compared to the existing sampling and analysis results to estimate the reach and potential contributions of these specific sources to the overall flow and overall potential VOC emissions. If it is not possible to get voluntary cooperation from the facilities it might be necessary to collect and analyze samples directly from these out falls to ensure complete coverage and to improve the precision of analyses. That information can then be input to WATER8 or any other similar emissions estimation program to make an emissions estimate.

The methodology for developing periodic updates to that activity data is not known at this time. Therefore, the availability of activity data required to track the trend in emissions over time and to quantify the effects of any control measures put in place remains a data gap at this time. It is suggested that any program considered to maintain a periodic update of the quantity and content of the waste streams to these canals over time be developed and implemented by Mexican authorities. The data base resulting from this effort would fill all of the needs of the program including the assessment of any proposed control measures and tracking the effects of implemented control measures over time.

It is difficult to evaluate the cost component for the collection and maintenance of the activity data over time, because the options for collecting these periodic activity updates are not known at this time. All other components of this method, however, would be relatively inexpensive. Depending on the form and format of the data file structures used to collect and maintain the periodic activity data it would be possible to create an automated update of the WATER8 results at periodic intervals at very low cost. This would require a small investment in computer programming early in the program.

One experimental measurement approach using Open-Path Fourier Transform Infrared (FTIR) Spectroscopy, was also considered. Open-Path FTIR technology employs an infrared (IR) energy emitter separated by several hundred meters to perhaps a kilometer from a telescope and receiving optics. Individual chemical compounds in the line-of-sight path between the IR source and the telescope selectively absorb IR radiation in specific wavelength bands. The average concentration of each target compound in the line-of-sight path can be estimated through electronic processing of the IR signal. In some applications, this technology is very powerful because it can measure many diverse compounds simultaneously in time periods of minutes. FTIR technology is probably not applicable to this problem, since it is unlikely that the concentrations of specific compounds will be high enough to provide accurate and repeatable measurements. The technique would also be relatively expensive to implement and the costs involved would complicate continuing periodic updates to track the effectiveness of any implemented control programs.

Emissions Control Options

Street Vendor Cooking Devices

This source category includes a variety of specific activities. The cooking grills included in this category range from small units operated by individuals to larger facilities that use multiple grills and a small staff of perhaps 6 to 8 people. The smaller units are mainly mobile and are towed, pushed or cycled to a specific location. These units can be set up a different locations on any specific day. The larger units are permanent facilities and some are equipped with vents the direct smoke and other emissions from the cooking process to roof vents. There are also the two principle types of fuels, and it is likely that some units use wood, or perhaps even other fuel types. Because of these differences in operations, it is not possible to specify a single universal control method.

Intuitively, it can be assumed that overall emissions from units that use compressed gas fuels, would be cleaner than those using charcoal, wood or some other biomass fuel. This assumption is dependent on the relative contribution of the fuel compared to the meat grilling to the overall emissions rate. Drippings from the meat grilling process on hot elements in both types of units results in emissions of fine organic aerosol and other heavy organic pollutants. In addition, the combustion of charcoal and biomass fuels will also generate fine particulate dependent on the ash content of the specific fuels being used. The assumption that compressed gas units are inherently cleaner should be tested.

One reasonable approach to control emissions from these devices is to install some sort of air collection device over or along side the grill surface and use an induced air flow to direct the gases and particles into a capture device. Fairly simple and cheap grease traps can be installed to collect grease and other fatty substances from this air flow. The technology for capturing the very small particles is readily available but simple course filters would not be effective because the size distribution of these particles is dominated by the size fraction under 1μ in diameter. The typical filter systems used in some U.S. fast food operations employs a cylindrical tube with several layers of filter material. These units have been used for some time and details on the design and construction of such filters to handle specific air flows is well established.

New or modified stationary establishments could be required to install adequate air collection systems and removal devices prior to starting up operations. All new establishments could also be subject to construction requirements to ensure that the grilling area is protected from exposure to the wind. A program to identify economically feasible retrofits to existing permanent establishments could be considered as well. It might be possible to consider some kind of economic incentive for those establishments that meet minimum improvements on some set schedule.

This type of control device is subject to two limitations for application to the street vendor cooking devices in Mexicali. The first is that the venting system used to capture the gases and particulates over the grill must be located close to the grill and it will require a power source to operate an air mover. The vents could be constructed as overhead hoods, side ducts next to the grill, or lateral vents that surround the grill surface and collect air to a main duct system underneath the grill. While some form of these three options could be implemented in nearly all of the permanent structures, it would be a significant problem to install such a system on the mobile units. They would require their own power source to operate effectively and it is not feasible to consider this as an option for the mobile units. The second problem is that exposure to wind will significant reduce the collection efficiency of these types of units, which further complicates the application of this approach to the mobile units.

It is recommended to explore the specific operating conditions of these small mobile units and evaluate other possible options for reducing emissions. Changes in burner design that would use less fuel, changes in fuel type, or installation of some form of passive air trap are all possibilities that could prove useful in this application. The effectiveness of these options would depend on the relative emissions rate of the charcoal ash to the total emissions. If there is a recognizable contribution to emissions directly from the charcoal fuel then a program requiring one or a combination of these options could be effective. More detail about the magnitude of emissions, the characteristics of the emissions, and the relative magnitude of emissions from the fuel burning compared to the burning of the meat drippings is needed to make recommendations concerning control alternatives.

If no other viable alternatives are found to be effective and cost efficient and the overall magnitude of the small units is found to pose environmental or health risks, another option to control these emissions is to reduce the number of mobile units, and increase the number of stationary units. It is recognized that this option would require a significant change in the culture and would affect a large number of independent operators.

In any event, controlling a large percentage of the emissions from this source category will require a substantial capital investment. One option to encourage operators to make this investment is to implement a registration program and some form of permit or fee. The fee structure could be set up to incorporate a lower net fee, or low/no interest loans funded through fee receipts to help offset the costs of construction and operation of the collection and removal devices. All operating establishments including the small independent mobile vendors would be subject to this fee. The fees for noncomplying establishments could be set at a high enough value to encourage adoption of the recommended control options and/or to encourage independent operators to form cooperatives and group together into a permanent establishment. If this idea proves to be an acceptable approach some examples that could be used as a model for a permitting program could be provided.

Specific cost data for the materials and construction costs to implement such a program are not available at this time, but this approach would not be a low cost option. There is also the

impact on the lifestyle and character of the city that should be considered. There simply are no other viable options for control approaches that have been identified at this time.

Open Sewage Impoundments, Canals and Conveyance Systems

There are two issues relative to controlling the potential of emissions or environmental effects from these canals. The first issue, concerned directly with the purpose and scope of this project, is to control the volume and/or the content of wastewater discharges responsible for air emissions to the canals from industrial sources. The second issue concerns the effects of industrial and other discharges to these canals that do not cause air quality problems, and the effects of these discharges on the New River and the Salton Sea. The more comprehensive ecosystem effects in the New River and the Salton Sea are not the subject of this report, but any efforts that would reduce the amount or toxicity of discharges to these waste canals will have simultaneous benefits related to these ecosystems.

The methodology selected to assess emissions should be capable of quantifying a large percentage of the total organic industrial wastes that are currently discharged to the waste canals. The database developed would be used first to determine if this source category is a significant source of air emissions. If this source category is found to be of concern to air quality problems the data base would be used to identify those specific facilities that are causing the most serious problems. Once the relative magnitude of emissions from each facility is quantified, overall benefits resulting from specific engineering solutions can be assessed within the basic cost benefit scenario. There are two primary methods available to reduce these releases. The first and most attractive method from an economical standpoint is to create an assistance program to support comprehensive environmental audits of the major facilities to identify, evaluate and implement source reduction measures. The other is to require pretreatment to reduce the amount of organic materials in the discharge streams.

Source reduction measures would seek to change operating practices to reduce the volume of total releases, and/or change the types of organic compounds released to species that are less volatile and less damaging to water resources down stream. These activities are commonly referred to as pollution prevention activities. There are many methods to achieve significant benefits through pollution prevention, and the specific examples that are most suitable are dependent on the specific operations in question. Examples of pollution prevention methods are changes in the operations that produce less waste materials, reductions in the amount of raw materials used in the process or process changes that use less harmful raw materials, identification of opportunities to reuse or recycle waste materials, and identification of alternate or additional products that would use some of the waste materials and have some economic value.

There is a significant amount of information on these waste reduction or pollution prevention opportunities that have been categorized for specific industry types. One comprehensive information resource is the Pollution Prevention Information Exchange System (PIES) a publicly accessible EPA bulletin board. The selection of the most efficient approaches,

however, is often facility specific. The principal advantage of waste reduction and pollution prevention approaches is that they often can result in a net economic benefit by reducing raw material costs, increasing operational efficiency, or lowering power or fuel costs. An assessment of the costs and potential cost savings is a critical component of the environmental assessments that are completed to identify the most suitable opportunities.

The clear advantage of such methods are that the often require a lower capital investment than that required to purchase land, and/or structures associated with waste treatment facilities, and they often have the result of reducing the cost of raw materials, operational costs, or have the capacity to generate additional revenue. Studies of pollution prevention systems reveal that they frequently have the effect of increasing revenue relative to the base operating conditions. Implementing pollution prevention activities will require a commitment by regulatory authorities, cooperation from the facilities, and a willingness on the part of the facilities to implement the measures and maintain the pollution prevention practices.

Specific waste treatment techniques collectively known as pretreatment are commonly used to treat industrial wastewater. In typical systems in the United States these pretreated wastes are often directed to publicly owned treatment works (POTWs). Although this approach has additional benefits related to water quality of the New River and Salton Sea, a complete redirection of wastewater to pretreatment and ultimately to POTWs would be very expensive in terms of initial capital investment, and in operating costs. Pretreatment approaches are commonly used to improve water quality in streams and rivers that accept industrial waste, and are not normally implemented out of air quality related concerns. One common treatment technology used in pretreatment that would not be suitable for this application is aeration. In aeration technologies agitation or sprays are used to strip off volatile species and allow them to evaporate into the air. Other pretreatment options using biological or chemical treatment, however, might be effective to reduce air emissions.

Pretreatment methods are also dependent on the specific activities and the character of the waste streams. Any pretreatment facilities that are designed to strip organics through evaporation prior to release to the canals are inappropriate for this application, since the specific goal in this study is to identify options for reducing the air emissions. Such systems would simply move the air emissions from the canals to the pretreatment facility on the facility property. Other methods include biological and chemical treatment, aggregation and phase change to solid forms that can be precipitated, and methods that could isolate and remove organics from the water. Recovered organics can then be used as a fuel to supplement power or heat needs within the facility, or they can be flared or incinerated.

Phase 4. Development of Evaluation Criteria and Ranking of Options

Evaluation Criteria

The following list of criteria are proposed for use in evaluating the usefulness of any specific emissions methodology for application to these sources.

1. Source Specificity Any method developed for this application should be specific to the sources and the source characteristics of these categories. Therefore, studies completed by EPA on large external combustion sources are not useful for application to the street vendor cooking devices. Previous EPA work completed on emissions from fireplaces may offer significant useful information on particle emissions processes, but none of those studies used charcoal as the fuel. These studies used wood that had certain specific moisture characteristics. The results of the SCAQMD studies are very similar, however, the sources in Mexicali appear to use primarily wood charcoal, whereas the SCAQMD studies used charcoal briquets as the primary fuel.

2. Pollutant Specificity An appropriate method should also be specific for the primary pollutants of interest in the work. For the waste canals, VOCs are the primary concern, although many of the sampling and analysis results collected so far on the New River and elsewhere do not provide comprehensive information on volatile species. The techniques developed by SCAQMD for measuring emissions from charcoal ignition may be specific for application to this category, however, the results of those studies do not provide any information on particulate emissions or the individual VOC or more complex organics that are emitted from such devices. The SCAQMD study sampled only for total nonmethane hydrocarbon or total VOC. Information from the EPA fireplace studies and SCAQMD VOC studies does provide a sound background for use in developing a test methodology that could provide the integrated results needed for this study.

3. Availability of Activity Data An ideal method for this application should be based on activity data that is readily available and easily updated. These two conditions allow the method to be implemented with a minimum expenditure and allow the emissions database to be updated on a regular basis to quantify the effects of any emissions reduction strategies that have been put into place. It is often possible to develop more detailed emissions estimates with low degrees of uncertainty using detailed source descriptive databases, however, if these data are difficult to obtain or require an additional investment each time the data is to be updated, they may not be very useful in this particular program.

4. Testing, Analysis and Implementation in Mexicali It is the intent of the project to promote activities that can be completed in Mexicali by technical staff from Mexico. Standard procedures used by both EPA and SCAQMD in their previous testing for emissions from charcoal grills and fireplaces include some specially designed test chambers. Those protocols should be reviewed and discussed with officials from Mexicali to determine if facilities sufficient for completing these tests in Mexicali can be provided. This would allow the testing and analysis

work to be done largely by staff from Mexico. Similarly, analysis and input data for any methodologies for application to the waste canals should also be available in Mexicali. Development of methods that can be completed in Mexico will facilitate routine monitoring of trends and evaluation of the effectiveness of control options.

It is likely that initially assistance will be provided through the U.S. EPA or another U.S. funding agency. While it is desirable to implement a project that can ultimately be operated entirely within Mexico an by Mexican authorities, it is recognized that, depending on the needs for specific testing and laboratory equipment some support from the U.S. or elsewhere may be needed. This criteria is, therefore, considered highly desireable but not critical to the selection of a methodology.

5. Usefulness of the Data Ultimately, the data generated through the approaches recommended here will be used to quantify emissions from these sources relative to more traditional sources in the region, track the trends in emissions from these sources over time, evaluate cost effective control options and to quantify the results of any control options that are implemented. While this criterion is closely linked to the other criteria, it is an important consideration. Emissions estimation methods that are based on data that is directly linked to the most effective control options and can be readily updated, facilitate the task of monitoring improvements and quantifying benefits resulting from any programs implemented. This criteria is of primary interest to the Mexican participants.

6. Cost to Implement and Track Over Time One of the primary reasons for developing an emissions estimation method for these two source categories is to track and quantify the effectiveness of any control options that are implemented over time. Therefore, the cost calculation needs to include costs that would be incurred to complete periodic updates of the emissions estimates to establish the net change in emissions as a function both of changes in the amount of activity and effectiveness of control programs.

Ranking of Emissions Estimation Methods

Based on the information obtained through this preliminary assessment of the two target emissions sources and the list of evaluation criteria presented above the options for emissions estimation methodologies have been ranked relative to one another. Table 3 lists the emissions estimation methodologies discussed in this report and indicates which of those methodologies satisfy the list of evaluation criteria and gives each method a ranking for consideration in future programs. Finally, a recommendation is presented for future activities to support the development of an emissions estimation methodology.

TABLE 3. PROPOSED METHODS LISTED WITH EVALUATION CRITERIA

Emission Estimation Method	Evaluation Criteria						Rank(1)
	Source Specificity	Pollutant Specificity	Availability of Data	Implementation in Mexico	Usefulness of Data	Initial and Continued Cost	
Street Vendor Cooking Devices							
Existing EPA Combustion Source Emission Factors	No	No	No	Yes	No	Yes	4
New Specific Emission Factors Based on Direct Source Testing with Routine Activity Reporting Requirements	Yes	Yes	No(2)	Yes	Yes	--	1 or 2
South Coast Air Quality Management District Rule 1174	No	No	No	Yes	Yes	Yes	3
Inferential by Ambient Monitoring	Yes	Yes	No(3)	Yes	Yes(4)	--	1 or 2
Open Sewage Impoundments, Canals and Conveyance Systems							
Existing EPA Methods for Wastewater Treatment	No	No	No	Yes	No	Yes	2
Use of Computer Program (WATER8)	Yes	Yes	No	Yes	Yes	Yes	1
Open Path Remote Monitoring	Yes	Unknown	Yes	No	Yes	No	3

(1) Ranking is: 1 for best option, through 3 or 4 for least desirable option
(2) Data for specific emission factor is not available; Activity data availability dependent on method mandating data reporting by sources
(3) Activity data availability dependent on method mandating data reporting by sources
(4) Data will be useful for control analysis, but the data collection for inferential method is much less expensive
-- Insufficient information to estimate cost

A rough cost estimate is made for the recommended approaches. Additional issues related to potential control options and emissions needs to support those options are also summarized.

Recommendations

Based on the review of available information presented here there are two candidate methods that would be effective to quantify current emissions from street vendor cooking devices and to monitor improvements as a result of control methods. One of these methods would involve a detailed source monitoring study to develop a representative emission factor or series of emission factors for the different units and fuels included in this source category. The second is the technique based on inferential assessment through ambient monitoring results.

Each of these approaches are listed as number 1 or 2 ranking in Table 3. Further effort is required to develop more specific information and cost details for these two methods. Initially, the highest recommended approach for estimating and tracking these emissions is the inferential approach. This conclusion is based on the assumption that the costs to conduct routine ambient monitoring needed to track emissions over time would be lower than the costs of continued source monitoring and emission factor development that would be required in the other approach. In both of these approaches a substantial investment would be required to perform the initial source monitoring needed to characterize the source contributions, either for emission factor development or to prepare a unique source profile.

In the inferential approach, a more detailed series of source tests is required to differentiate ambient monitoring analyses from other similar source categories in the region. This appears to be possible by specifically targeting higher carbon number complex organics including fatty organic and organic acid constituents. Subsequent routing ambient samples in regions frequented by street vendor devices would also target these same marker organic species to track not only the contribution of these sources to current ambient loadings but to quantify the reductions in the contribution of street vendor cooking devices to these ambient loadings in future sampling efforts. Use of this approach will allow the continuous tracking of progress resulting from control programs to be monitored without a significant interference with the operators of the facilities. The use of this inferential approach is complicated and will require the experience and insights of researchers familiar with similar projects.

The other viable choice for an estimation method is to complete a more detailed source sampling project to quantify total mass emissions from selected representative units in operation in Mexicali. These sampling efforts could focus on total organic contributions to particulate matter and could also quantify the emissions rates of gaseous species. The application of this technique over time, however, would require a routine comprehensive assessment of the number of these units that are operating in the city, and an assessment of the relative amounts of the various fuels employed. This method would require a registration system or some form of reporting or permit system to track the total amount of activity included in the source category over time. Another limitation of this technique is that it would require repeated detailed source

testing of representative establishments as each type of control device is implemented to derive new emissions factors for the controlled establishments. It is likely that the continued and repeated source testing would represent a higher cost than the less invasive ambient monitoring program.

In either case, it is important to carefully plan the initial source measurements program to ensure that the relative contribution of this source category to NO_x, common VOCs and other gaseous emissions is characterized to determine if those emissions are of interest. It is estimated that the cost to establish the source profiles and initial ambient sampling and analysis would be between $50k and $150k U.S. Subsequent ambient analysis to track emissions over time would cost between $25k and $40k per sampling and analysis period and could be higher depending on the specific analytical techniques that would be required to characterize the source. The frequency of these sampling periods would depend on the schedules for implementing control approaches. These costs are preliminary estimates and further detailed planning would be required to establish a reliable cost estimate. These costs are also based on the assumption that the majority of the work would be completed by experienced researchers and laboratory facilities in the United States. Costs might be reduced if the bulk of the analytical work and source monitoring could be done locally in Mexicali.

The recommended approach for estimating emissions from the waste canals is to conduct comprehensive environmental audits of the major facilities or obtain voluntary reports of discharges to the waste canals from the major facilities for use in an air emissions computer model for wastewater processes. If data cannot be obtained through facility cooperation it might be necessary to sample discharge effluents and water in the canals and submit those samples for specific chemical analysis targeting the most likely chemical constituents. One recommended model is WATER8. That model includes emissions estimation capabilities for untreated waste handling systems similar to the waste canals in Mexicali. Existing EPA emission factors for wastewater treatment systems are more suited for use in POTWs and other engineering based treatment systems. Technical methods based on remote sensing were considered but were rejected due to uncertainties about the detection capabilities and the relatively large costs.

Cost estimates for completing this type of program are difficult to make without additional information about the specific industrial categories represented and the types of wastes being handled. A typical industrial audit would cost between $5k and $10k per facility. Execution of the model using data obtained in these audits and analyses to review the overall emissions for all major facilities would cost between $15k and $30k. These cost estimates are preliminary and further planning efforts would be necessary to develop a reliable cost estimate. The costs could rise significantly if input data necessary for execution of the emissions prediction model were not readily available from the facility audits. The cost estimates for this category do not include any additional waste stream sampling and analysis activities or travel costs.

REFERENCES

1. Radian Corporation, “Implementation Plan for Mexico Emissions Inventory Methodology,” Prepared for the Western Governors’ Association and the Binational Advisory Committee, March 19, 1996.

2. Chow, J.C., and J.G. Watson, “Imperial Valley/Mexicali Cross Border PM10 Transport Study,” Prepared by Desert Research Institute for U.S. Environmental Protection Agency Region IX, April 21, 1995.

3. Versar Inc., “Procedures for Estimating and Allocating Area Source Emissions of Air Toxics - Working Draft,” Prepared for the U.S. Environmental Protection Agency, March 1989.

4. Engineering Sciences, Inc., “Compilation of Air Toxics Emission Invenotry Questionnaires,” EPA-450/4-88-008, June 1988.

5. U.S. Environmental Protection Agency, “Technical Procedures for Developing AP-42 Emission Factors,” EPA-454/B-93-050, October 1993.

6. U.S. Environmental Protection Agency, “Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone,” EPA-450/4/91/016, May 1991.

7. Kersteter, S.L., et. al., “Identification and Characterization of Missing or Unaccounted for Area Source Categories,” U.S. Environmental Protection Agency, EPA-600-R-92-006, January 1992.

8. Radian Corporation, “Example Documentation Report for 1990 Base Year Ozone and Carbon Monoxide State Implementation Plan Emission Inventories,” U.S. Environmental Protection Agency, EPA-45-/4-92-007, March 1992.

9. U.S. Environmental Protection Agency, “Compiling Air Toxics Emission Inventories,” EPA-45-/4-86-010, February, 1990.

10. Hildemann, L.M., et. al., “Submicrometer Aerosol Mass Distributions of Emissions for Boilers, Fireplaces, Automobiles, Diesel Trucks, and Meat-Cooking Operations,” Aerosol Science and Technology, Vol. 14, pp 138-152, 1991.

11. International Boundary and Water Commission, “United States of America and Mexico, Minute No. 264,” signed at Ciudad Juarez August 26, 1980.

12. International Boundary and Water Commission, “United States of America and Mexico, Minute No. 274,” signed at Ciudad Juarez April 15, 1987.

13. International Boundary and Water Commission, “United States of America and Mexico, Minute No. 288,” signed at Ciudad Juarez, October 30, 1992.

14. U.S. Environmental Protection Agency, “Summary of Information Collected From U.S. Parent Companies of Maquiladoras Relating to the New River,” December, 1995.

15. U.S. Environmental Protection Agency, “Air Emissions Models for Waste and Wastewater,” EPA-453/R-94-080A, November 1994.

16. Radian Corporation, “National Air Toxics Information Clearinghouse: NATICH Data Base Report on State Local and EPA Air Toxics Activities,” U.S. Environmental Protection Agency, EPA-450/3-89-29, July 1989.

17. Radian Corporation, “Methods Evaluation for Mexico Emissions Inventory Methodology,” Prepared for the Western Governors’ Association and Binational Advisory Committee, April 1995.

18. National Water Research Institute and County of Imperial, “The New RiverWorkshop,” May 19-21, 1995.

20. South Coast Air Quality Management District, “Protocol - Rule 1174 Ignition Method Comliance Certification Protocol,” February 28, 1991.

21. Hildemann, L.M., et. al., “Quantitative Characterization of Urban Sources of Organic Aerosol by High-Resolution Gas Chromatography,” Environmental Science and Technology, Vol 25., No. 7, pp. 1311-1325, 1991.

22. Rogge, W.F., et. al., “Sources of Fine Organic Aerosol. 1. Charbroilers and Meat Cooking Operations,” Environmental Science and Technology, Vol. 25, No. 6, 1991.

23. GCA Technology, Inc., “Study to Develop Background Information for Direct Meat-Firing Industry,” GCA-TR-77-36-G, January 1978.

24. Commonwealth Laboratory, Inc., “Particulate Emissions Test Summary,” Prepared for Hardee’s Food Systems, 1974.

25. U.S. Environmental Protection Agency, “Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Fifth Edition, AP-42,” January 1995.

26. Houck, J.E., et. al., “Determination of Particle Size Distribution and Chemical Composition of Particulate Matter from Selected Sources in California: Volume 1, Final Report,” 1989.

27. Chow, J.C., et. al., “Measurements and Modeling of PM10 in California’s Bay Area, Volume 1, Program Plan,” 1993.