California Environmental Protection Agency

Air Resources Board

Staff Report:

Initial Statement of Reasons for the Proposed Airborne Toxic Control Measure to Reduce Emissions of Toxic Air Contaminants from Outdoor Residential Waste Burning

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State of California
California Environmental Protection Agency
AIR RESOURCES BOARD

STAFF REPORT: INITIAL STATEMENT OF REASONS FOR PROPOSED RULEMAKING

Public Hearing to Consider

ADOPTION OF THE PROPOSED AIRBORNE TOXIC CONTROL MEASURE TO REDUCE EMISSIONS OF TOXIC AIR CONTAMINANTS FROM OUTDOOR RESIDENTIAL WASTE BURNING

To be considered by the Air Resources Board on February 21, 2002, at:

California Environmental Protection Agency
Air Resources Board
Coastal Hearing Room
1001 “I” Street
Sacramento, California

Air Resources Board
P.O. Box 2815
Sacramento, California 95812

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State of California
California Environmental Protection Agency
AIR RESOURCES BOARD

PROPOSED AIRBORNE TOXIC CONTROL MEASURE TO REDUCE EMISSIONS OF TOXIC AIR CONTAMINANTS FROM OUTDOOR RESIDENTIAL WASTE BURNING

Staff Report

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EXECUTIVE SUMMARY

Residential waste burning is the practice of outdoor burning of household wastes associated with one and two family homes.[1] These household wastes include materials such as garbage, paper, cardboard, cloth, and processed wood. Typically, 55 gallon metal drums, known as burn barrels, are used for this burning. The smoke and ash created by these fires contain many harmful pollutants, including polychlorinated dibenzo-p-dioxins and dibenzofurans (collectively referred to as dioxins), polycyclic aromatic hydrocarbons (PAHs), benzene, 1,3-butadiene, and polychlorinated biphenyls (PCBs), as well as particulate matter.

The main focus of the proposed ATCM is to address public exposure to dioxins, although emissions of other toxic air contaminants and particulate matter will also be reduced. The Air Resources Board (ARB) has identified dioxins as the most potent toxic air contaminant identified to date, based on its potential to cause cancer and affect immune systems (ARB, 1986). Concerns about children's exposure to burn barrel emissions is particularly high due to the Office of Environmental Health Hazard Assessment's (OEHHA) recent identification of dioxins and PAHs as two of the initial five toxic air contaminants that may cause children to be especially susceptible to illness (OEHHA 2001d).

Dioxins are formed through the incomplete combustion of materials containing carbon and chlorine. Residential waste materials such as plastics and paper contain both of these substances, and therefore form dioxins when burned. The relatively low temperatures present in the burn barrels during combustion are particularly conducive to dioxin formation. Dioxins can contaminate air, water, food, and soil where they may last in the environment for many years. Dioxins can also accumulate in the fat of fish and animals, and are then passed on to people when contaminated food is eaten. Because dioxins can be passed through mothers milk, children are especially vulnerable. Children may also be more sensitive to dioxin exposure because of their rapid growth and development (U.S. EPA 2001b).

Currently, eight districts prohibit the burning of residential waste other than natural vegetation. Natural vegetation is not included because the amount of dioxins generated is substantially less than household wastes and the form of the dioxins generated is less toxic (OEHHA, 2001e). In the remaining 27 air pollution control districts or air quality management districts (air districts), some form of burning of residential waste other than natural vegetation is allowed in all or part of the air district. Six air districts allow all forms of residential waste to be burned, including household garbage, in all or part of the air district. The remaining 21 air districts prohibit the burning of household garbage, but allow the burning of other materials such as paper or cloth. The portions of these 27 air districts where non-vegetative burning is allowed represent approximately seven percent of the State's population.

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1 Health and Safety Code section 41800 prohibits the use of fire to dispose of waste at other than one or two family dwellings.

In order to reduce the public health impacts of residential waste burning, we are proposing an airborne toxic control measure (ATCM) to regulate both the materials that can be burned and the method of burning. The ATCM would eliminate the burning of residential waste other than natural vegetation, and the use of burn barrels across the State. Exemptions would be granted for some regions of the State based on specified criteria including availability of waste disposal services, distance to approved landfills and transfer stations, and population density. The following sections provide additional information on the development of the proposed regulation and its impacts.

1. What authority does the ARB have to control emissions of toxic air contaminants?

This control measure is developed under the authority of the California Toxic Air Contaminant Identification and Control Program, established under California law by Assembly Bill 1807 and set forth in Health and Safety Code sections 39650 through 39675. The Board identified dioxins as a toxic air contaminant (TAC) and potential human carcinogen at its July 1986 Board hearing (ARB, 1986). The Board determined there was not sufficient scientific evidence available to identify a threshold level of exposure below which no adverse health effects are likely to occur. Other substances that are produced during the burning of residential waste include benzene, 1,3-butadiene, PAHs, and PCBs. The ARB has also formally identified these compounds as TACs (ARB, 1984; ARB, 1992; ARB, 1993a).[2]

Following the formal identification of a substance as a TAC, Health and Safety Code section 39665 requires the ARB, with the participation of the air districts, and in consultation with affected sources and interested parties, to prepare a report on the need and appropriate degree of regulation for that substance. Once the ARB has evaluated the need and appropriate degree of regulation for a TAC, Health and Safety Code section 39666 requires the ARB to adopt ATCMs to reduce emissions of that TAC. When adopting ATCMs, Health and Safety Code section 39666 requires that any control measure for a TAC without a Board-specified threshold level be designed to reduce emissions to the lowest level achievable through the application of best available control technology or a more effective control method if necessary to reduce risk.

A needs assessment for dioxins was conducted between 1988 and 1990 as part of the ARB's development of the ATCM for emissions of dioxins from medical waste incinerators (ARB, 1990).[3] This staff report is a supplement to that original needs assessment for dioxins based on new information about the potential emissions from outdoor residential waste burning. The new information is based on data collected by the United States Environmental Protection Agency (U.S. EPA). The U.S. EPA began a reassessment of dioxins exposure and human health effects (U.S. EPA, 2001b). Based on national inventories for 1987 and 1995, the U.S EPA reported that the burning of residential waste represents one of the largest uncontrolled sources of dioxins in the

2 California Code of Regulations, title 17, sections 93000 and 93001.
3 California Code of Regulations, title 17, section 93104

environment (U.S EPA, 2001a). The U.S. EPA has taken action to reduce emissions of dioxins from medical waste incinerators and municipal waste incinerators under sections 111 and 129 of the federal Clean Air Act.

2. How prevalent is the practice of residential waste burning and what are the emissions of dioxins and other toxic air contaminants?

Due to the potentially overlapping nature of air district rules, local ordinances, and fire agency prohibitions, it is difficult to estimate the true number of households burning their residential waste in California. Information on waste disposal practices is also limited in some areas, and the relationship between availability of service and an individual household's decision to burn any or all of its waste is not always clear cut. For example, even though some households have regular waste pickup for their household garbage, they may still be burning their paper and cardboard. Also, some households that do not have waste pickup service dispose of their household waste by means other than burning. However, based on discussions with air district staff and waste management agencies, we have developed our best estimate of the number of households that could be burning their non-vegetative waste in California.

Approximately 82,000 households are located in the portions of the six air districts that have no prohibitions on the materials that can be burned. In these six air districts, we estimate that about 15,000 households may be burning their residential waste, including household garbage. An additional 641,000 households are located in the remaining 21 air districts where burning of other waste materials is allowed. We further estimate about 93,000 households may be regularly burning materials such as cardboard and paper in these 21 air districts. In general, these estimates are based on our discussions with the affected air districts. In total, approximately 108,000 households may be burning some or all of their residential waste.

The U.S. EPA has developed emission factors for residential waste burning conducted in burn barrels (U.S. EPA, 1997a; Lemieux 2000). Using these factors and an average waste generation rate of 2,137 pounds of waste per household per year (CIWMB, 2000), the average household burning residential waste could generate between 0.005 and 0.15 grams of total dioxins per year. Based upon these emission levels, the U.S. EPA has reported that residential waste burning is one of the largest uncontrolled source of dioxins in the United States (U.S. EPA 2001a). It is also important to recognize that while these numbers appear small, dioxins in even small quantities pose health hazards and there is no threshold below which exposure to dioxins has been deemed safe.

3. What are the potential health impacts associated with exposure to dioxins and other toxic air contaminants from residential waste burning?

Exposure to dioxins may result in both cancer and non-cancer health effects to the individuals conducting the burning, as well as to surrounding residents. Non-cancer effects from exposure to dioxins include headaches, dizziness, rapid heartbeat,

damage to the immune system, and liver and kidney damage. Dioxins are the most carcinogenic air pollutant identified by the ARB (ARB, 1986). Because dioxins can be passed through mothers milk, young children are especially vulnerable. Children may also be more sensitive to dioxin exposure because of their rapid growth and development (U.S. EPA, 2001b).

Health effects of other toxic air contaminants generated during residential burning such as benzene, 1,3-butadiene, PAHs, and PCBs include skin, eye and respiratory irritation, fatigue, neurological and immune system effects, and cancer**.** In addition to these TACs, smoke from residential burning contains particulate matter that can worsen existing disease conditions and can produce respiratory and cardiac effects, especially among sensitive populations such as the elderly and the very young (Pope, 1999; Samet, 2000). Particulate matter is a criteria pollutant with standards set by both the State and federal government. As required by the Children's Environmental Health Protection Act (Senate Bill 25, Escutia, 1999), ARB and the Office of Environmental Health Hazard Assessment (OEHHA) are reviewing the State PM10 standards for their ability to adequately protect public health, including that of infants and children. Recommendations for revised standards will be presented to the Board in the spring of 2002.

The risk assessment conducted to assess the potential health impacts from residential waste burning found potential cancer risks ranging between less than 10 to about 2,300 chances in a million at the near-source location (a near-source location is defined as a minimum modeled distance of 20 meters from the burning activity). The lower end of this range includes the potential cancer risk from inhalation, soil ingestion, skin absorption, and breast milk exposure pathways (OEHHA, 2001c). The upper end of the range estimates potential cancer risks across all included exposure pathways (i.e., the four minimum pathways discussed above plus crop, meat, and milk ingestion).

The dioxins emitted from the burning of residential waste materials can have near-source impacts on individuals in a household conducting the burning and on nearby neighbors. As discussed previously, the impacts on young children are of special concern. In addition, there is also a broader community impact from the dioxins generated from this source. Dioxins are ubiquitous throughout the environment, due to the cumulative emission impacts from many sources, including residential waste burning. Dioxins emitted from a source have a half-life in the atmosphere of several days (Balkanski et al., 1993). Eventually, the dioxins in the air are deposited onto vegetation, waterways, and the soil. Once there, dioxins are highly persistent, with the half-life in the soil surface estimated at 9 to 15 years, and in the soil subsurface at 25 to 100 years (Paustenbach et al., 1992). Dioxins can also accumulate in the fat of fish and animals, and are then passed on to people when contaminated food is eaten. It is estimated that 90 percent of dioxin intake for a typical person comes from dietary intake of animal fats (Gilman & Newhook, 1991).

A more detailed discussion of health impacts is presented in Chapter V.

4. What are the requirements of the proposed ATCM?

The proposed control measure would minimize emissions of dioxins and other toxic air contaminants such as benzene, 1,3-butadiene, PAHs, and PCBs, and the criteria pollutant, particulate matter, from residential waste burning by addressing both the materials which can be burned and the method of burning. The proposed ATCM prohibits the burning of residential waste, other than natural vegetation, anywhere in the State except for areas that qualify for a temporary exemption based upon specified criteria. The use of burn barrels would also be prohibited statewide, except in exempt areas, as a means of ensuring that burn barrels are not used for the burning of prohibited residential waste. The ATCM would require the use of ignition devices approved by the Air Pollution Control Officer of the air district. It would also prohibit the burning of allowable combustibles as defined in the regulation, unless it is a permissive burn day in the air district where the residential burning takes place. The prohibitory provisions of the regulation would be effective on July 1, 2003. During the time before the prohibitions become effective, the ARB will work with air districts to carry out public education and outreach efforts prior to implementation.

With the concurrence of the ARB, air districts may specify geographic areas that will be exempt from the prohibitions in the ATCM if they meet specified criteria including, but not limited to, all of the following:

1) no available waste pickup service, considering reasonable cost and frequency of service; and
2) greater than a reasonable distance from an approved transfer station or disposal facility or a communal or community dumpster, considering road miles or time traveled, road conditions, terrain, weather conditions, reasonable tipping fees, and hours of operation; and
3) low population density per census tract or other appropriate sub-unit of the county area.

Those areas that meet these exemption criteria would be allowed to burn only those materials that are currently allowed under air district rules, and would be allowed to use burn barrels, or other incinerator type devices to dispose of the waste. Requests for Exemptions would be submitted to the ARB by March 1, 2003. These exemptions would be approved by both the Board of the air district and the Executive Officer of the ARB. Exemptions must be justified and renewed every five years.

5. What are the potential economic impacts of the proposed ATCM?

The proposed regulatory action may create some costs to the California Integrated Waste Management Board for addressing potential impacts on waste diversion rates, and the California Department of Forestry and Fire Protection for enforcement. The proposed regulatory action may also result in nonmandatory costs to local agencies responsible for waste management to the extent they choose to provide expanded waste disposal services and to address waste diversion impacts. The proposed

regulation may also result in some small, but unquantifiable, costs to air districts for enforcement and public education and outreach. However, costs for public education and outreach would be addressed through preparation of materials by the ARB. Most air districts have enforcement programs due to existing rules addressing the burning of residential waste. The proposed regulation is not expected to increase the enforcement workload.

In developing this regulatory proposal, we evaluated the potential economic impacts and/or benefits on businesses. The proposed regulatory action will not have a significant adverse economic impact on businesses, including the ability of California businesses to compete with businesses in other states. The proposed regulatory action however, may provide increased business opportunities for waste pickup services, landfill operators, and recycling center operators to provide expanded waste disposal services. Some of these may be small businesses. Additional discussion of potential economic impacts is provided in Chapter VII.

6. Will consumers have to pay more for waste disposal due to the proposed ATCM?

Consumers who are currently burning their residential waste may have to pay more to dispose of these materials. The proposed ATCM will require them to obtain waste management services or to self-haul their waste to landfills or transfer stations. In some areas, new waste service routes may need to be developed. In other areas, new customers may be added to existing routes. The increased cost will vary depending upon the costs of obtaining waste management service in their area.

We estimate that a consumer who did not previously contract for waste service could incur new yearly costs for waste pickup of $96 to $420. These costs would be less for households that already are disposing of a portion of their waste through waste pickup service. Alternatively, some consumers may elect to self-haul their waste to landfills and transfer stations. Staff estimates that a consumer who previously burned all of their waste could incur yearly disposal costs of $78 to $520 for landfill or transfer station tipping fees to self-haul their waste materials. Fuel costs to transport the waste could amount to an additional $78 dollars per year per household. These costs could be reduced in areas where recyclable materials, such as plastics and paper, are separated, and which can often be dropped off for no cost. Consumers who had previously been self hauling only a portion of their waste, and burning the rest, would incur lower additional yearly costs.

7. What are the potential environmental impacts of the proposed ATCM?

The ARB is committed to evaluating community health impacts of proposed regulations, and to addressing environmental justice concerns. Because some communities experience higher exposures to toxic air pollutants due to cumulative impacts and other factors, it is a priority of the ARB to ensure that full protection is afforded to all Californians.

The proposed ATCM is designed to reduce emissions of dioxins and other TACs from residential waste burning, resulting in reduced exposures to these emissions for those communities and individuals currently allowed to burn residential waste, with associated lower potential health risks. The proposed ATCM will also reduce emissions of particulate matter from residential waste burning.

The proposed ATCM was also evaluated in terms of potential impacts on waste diversion rates, landfill capacities, illegal dumping, illegal waste storage, and increased vehicle travel due to expanded waste service or self-hauling. In evaluating impacts, we considered the role of exemptions in the proposed regulation. The goal of the exemptions would be to allow burning in those areas where feasible alternatives to waste disposal do not exist and where population density is low; therefore mitigating the potential for adverse impacts in areas where they would be most likely to occur.

While the waste that is no longer burned will result in increased materials deposited at landfills and have an impact upon waste diversion rates, these impacts can be mitigated through efforts to decrease waste generation and increase recycling and composting, and through a strong public education and outreach campaign regarding the availability of alternative waste disposal options. In addition, some jurisdictions can qualify for rural reduction programs with lower required diversion rates, or can develop new baseline waste generation rates to better reflect the previously burned waste. Based upon the available information, ARB has determined that no significant adverse environmental impacts should occur.

8. What public outreach was conducted in developing the ATCM?

For this assessment we developed an extensive outreach program that involved State and local regulatory agencies, waste management agencies and service providers, fire protection agencies, and other interested parties. These entities participated in the development and review of the necessary surveys and draft reports, conference calls, working group meetings, workshops, and the proposed regulation. Outreach efforts also provided participants a forum in which to address their concerns. As part of this process, ARB outreach activities included:

- conducting six public workshops in December 2001;
- scheduling an additional ten public workshops for January 2002;
- using newspaper advertisements and media advisories for workshops;
- mailing workshop notices to over 4,000 people;
- preparing and distributing two fact sheets;
- developing and maintaining a residential burning web site;
- holding over 20 individual meetings with waste management agencies, fire protection agencies, air districts, and the Regional Council of Rural Counties; and
- convening eleven meetings of the Residential Burning Working Group.

RECOMMENDATION

We recommend that the Board adopt the proposed regulation set forth in Appendix A. The proposed regulation would eliminate residential waste burning, excluding natural vegetation, and burn barrel usage except in some very rural areas of the State. The proposed ATCM is based upon staff's evaluation of the best available control method for dioxin emissions from this source. We considered the emissions and associated health risks of residential waste burning, the availability and cost of alternative methods of disposal, and the economic and environmental impacts of the proposed regulation. As a result of this evaluation, with the incorporation of recommended exemptions, staff considers the proposed ATCM to be environmentally, technically, and economically feasible, resulting in a safe, effective, and less-hazardous alternative to burning.

I. INTRODUCTION

A. Overview

Residential waste burning, for the purpose of this document, is defined as the outdoor burning of wastes, other than natural vegetation, generated by a single or two family residence. The United States Environmental Protection Agency (U.S. EPA) has identified residential waste burning as a major source of polychlorinated dibenzo-*p*-dioxins and dibenzofurans (collectively referred to as dioxins). Dioxins in particular are the most potent carcinogens identified to date by the Air Resources Board (ARB or Board) as toxic air contaminants (TACs). In addition to dioxins, many other toxic air contaminants are generated from residential waste burning, including polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), benzene, and 1,3–butadiene. These toxic air contaminants may result in substantial health impacts, ranging from headaches, dizziness, rapid heartbeat, damage to the immune system, and liver and kidney damage, to cancer. Because dioxins can be passed through mothers milk, children are especially vulnerable.

Particulate matter is also generated from residential waste burning. Most of the particulate matter emitted from residential waste burning is small enough to be inhaled and can be especially harmful to people with existing respiratory illness, the aged, and the very young. Exposure to such particles may worsen existing disease conditions and can produce symptoms ranging from breathing difficulties to increased respiratory infection and even premature death (Pope, 1999; Samet, 2000).

The Board identified dioxins as a TAC and a potential human carcinogen at its July 1986 Board hearing (ARB, 1986). The Board determined that there was not sufficient scientific evidence available to identify a threshold level of exposure below which no adverse health effects are likely to occur. Once dioxins were identified as TACs in 1986, the ARB was required under the Toxic Air Contaminant Identification and Control Program to: 1) prepare a report on the need and appropriate degree of regulation for the compounds, and 2) adopt regulations to reduce emissions of the compounds. These regulations are called airborne toxic control measures (ATCMs) or control measures. In this report, we use the terms regulation, control measure, and ATCM interchangeably. State law requires that such control measures for TACs without a Board-specified threshold exposure level be based on the best available control technology or a more effective control method in consideration of cost and risk.

This Initial Statement of Reasons for the *Proposed Airborne Toxic Control Measure to Reduce Emissions of Toxic Air Contaminants from Outdoor Residential Waste Burning* presents information on the toxic air contaminant identification and control process, the report preparation process, and previous identification and control (regulatory) activities for dioxins. We then present physical characteristics of dioxins and other TACs and information on sources and ambient concentrations. This is followed by a discussion of typical waste burning activities across the State, and information on exposure and health

effects for dioxins and other TACs. Finally, we present the proposed control measure, and its health, economic, and environmental impacts.

B. Purpose

On March 23, 2000, the Board adopted revisions to the State's Smoke Management Guidelines for Agricultural and Prescribed Burning. At that time, the Board also directed staff to assess the impacts of outdoor residential waste burning. We convened a residential burning working group and performed a preliminary analysis of outdoor residential waste burning. Our analysis included: 1) a survey of all the air districts in the State to assess existing regulations and practices regarding residential waste burning and burn barrel use; 2) a preliminary screening risk assessment to quantify health risks associated with dioxins and other toxic compounds emitted from residential waste burning; 3) meetings with the California Integrated Waste Management Board (CIWMB) to assess existing waste management services across the State and the potential for expanding service; and 4) discussions with fire management agencies within the State to identify potential fire safety and resource management issues.

We presented our analysis to the Board at its June 28, 2001, meeting. Based upon the prevalence of burning and the screening risk assessment, we recommended adding residential waste burning to ARB's Clean Air Plan and developing an ATCM. Two witnesses, including the Chair of the California Air Pollution Control Officers Association (CAPCOA), urged ARB to develop an ATCM to ban residential waste burning and the use of burn barrels. As a result, the Board directed staff to proceed with developing an ATCM and report back to the Board in 2002.

Following the June 28, 2001, Board meeting, we continued to refine our waste burning/burn barrel use analysis. We contacted air districts, the CIWMB, and local waste management agencies and service providers statewide to enlist their help with characterizing the potential for and costs to expand waste management services. We also worked with land management and fire safety representatives to address any potential concerns they might have with banning waste burning and the use of burn barrels.

C. Regulatory Authority

The California Toxic Air Contaminant Identification and Control Program (Program), established under California law by Assembly Bill 1807 (Chapter 1047, Statutes of 1983) and set forth in Health and Safety Code sections 39650 through 39675, is designed to protect public health by reducing emissions of TACs. This law mandates the identification and control of air toxics in California and complements the State's criteria air pollutant program. The identification phase of the Program requires the ARB, with the participation of other State agencies, to evaluate the health impacts of, and exposure to, substances and to identify those substances that pose the greatest health threat as TACs. ARB's evaluation is made available to the public and is formally reviewed by the Scientific Review Panel (SRP) established under Health and Safety

Code section 39670. Following ARB's evaluation and the SRP's review, the Board identified dioxins as TACs at its July 1986 Board hearing. The Board determined there was not sufficient scientific evidence available to support the identification of a threshold exposure level (ARB, 1986).

A threshold level can be defined as a level of pollutant exposure below which no adverse health effects are likely to occur. In their evaluations of dioxins, staff from the California Environmental Protection Agency's Office of Environmental Health Hazard Assessment (OEHHA) recommended that dioxins be treated as having no threshold exposure level because: 1) all dioxins are potential human carcinogens, and
2) currently, there is insufficient evidence available to designate an exposure level below which no significant adverse health impacts are anticipated.

Following the identification of a substance as a TAC, HSC section 39665 requires the ARB, with participation of the air districts, and in consultation with affected sources and interested parties, to prepare a report on the need and appropriate degree of regulation for that substance.

A needs assessment for dioxins was conducted between 1988 to 1990 as part of the ARB's development of the Airborne Toxic Control Measure for Emissions of Dioxins from Medical Waste Incinerators (title 17, California Code of Regulations, section 93104) (ARB, 1990). During that assessment, the ARB identified numerous sources of dioxins, including incineration of medical waste, recycled waste oil, hazardous waste, sewage sludge, municipal waste, and woodwaste.

Subsequent to that report, the U.S. EPA also began a reassessment of dioxins exposure and human health effects (U.S. EPA, 2001b). Based on national inventories for dioxins representing 1987 and 1995, the EPA report suggested that the burning of household waste is one of the largest uncontrolled sources of dioxin emissions in the environment.

D. Regulatory Activities

1. Airborne Toxic Control Measures

Once the ARB has evaluated the need and appropriate degree of regulation for a TAC, State law (Health and Safety Code section 39666) requires the ARB to adopt regulations to reduce emissions of the TAC to the maximum extent feasible in consideration of cost, risk, and other factors specified in Health and Safety Code section 39665. To date, the ARB has developed eleven ATCMs for a variety of TACs. In 1990, the ARB adopted a control measure to reduce emissions of dioxins from medical waste incinerators by 99 percent. At that time, medical waste incinerators were one of the largest known sources of dioxins in California. As a result of this regulation, the number of medical waste incinerators in the State dropped sharply from about 150 to less than 15. In 1994, the U.S. EPA adopted a control measure to regulate municipal waste incinerators by the year 2000 (U.S. Federal Register, 1994). In California, there are only three operating municipal waste incinerators. Each of these control measures incorporate the use of

best available control technology. In the case of dioxins, best available control technology to minimize or eliminate the formation of dioxins is achieved through careful control of combustion conditions, including maintaining combustion temperatures at approximately 1000° C for a minimum of one second. This type of controlled combustion is not feasible for small residential burning sources such as backyard burn barrels or piles.

2. National Emission Standards for Hazardous Air Pollutants

In the federal Clean Air Act Amendments of 1990, the U.S. EPA identified dioxins as hazardous air pollutants (HAPs) because they were either known to have or may have adverse effects on human health or the environment. Health and Safety Code section 39658(b) requires the Board to designate federal HAPs as TACs, and the Board did so in 1993 (ARB, 1993a). Therefore, dioxins are TACs both because they have been identified by the Board through the Toxic Air Contaminant Identification and Control Program and because they are HAPs.

3. SB 25 Children's Environmental Health Protection Act Air Toxics Priorities List

The California Children's Environmental Health Protection Act (SB 25, Escutia; chaptered 1999), requires the California Environmental Protection Agency to specifically consider children in developing criteria for evaluating TACs. The law requires OEHHA to evaluate available information on TACs and develop a listing of up to five TACs that "may cause infants and children to be especially susceptible to illness." The initial listing was made final in October 2001. Dioxins and PAHs are two of the top five compounds initially listed. The listing will be updated periodically (OEHHA, 2001d).

II. PUBLIC OUTREACH AND REPORT PREPARATION

A. Outreach Efforts

Outreach and public participation are important components of ARB's needs assessment and report preparation process. For this assessment we developed an extensive outreach program that involved State and local regulatory agencies, waste management agencies and service providers, fire protection agencies, and other interested parties. These entities participated in the development and review of the necessary surveys and draft reports, conference calls, working group meetings, workshops, and the proposed regulation. Outreach efforts also provided participants a forum in which to address their concerns. ARB outreach activities included:

- establishing a Residential Burning working group which held 11 meetings and conference calls between October 2000 and December 2001. The working group consists of over 50 people;

- conducting six public workshops in December 2001 at the following locations and times:

    - Sacramento, Sacramento County – December 4, 2001
    - Yreka, Siskiyou County – December 5, 2001
    - Alturas, Modoc County – December 6 2001
    - Susanville, Lassen County – December 7, 2001
    - Hollister, San Benito County – December 10, 2001
    - Alpine, San Diego County – December 17, 2001

- scheduled ten public workshops for January 2002 at the following locations:

    - Nevada City, Nevada County – January 7, 2002
    - Auburn, Placer County – January 7, 2002
    - Jamestown, Tuolumne County – January 9, 2002
    - Willows, Glenn County – January 10, 2002
    - Oroville, Butte County – January 15, 2002
    - Mariposa, Mariposa County – January 16, 2002
    - Placerville, El Dorado County – January 17, 2002
    - Eureka, Humboldt County – January 22, 2002
    - Redding, Shasta County – January 23, 2002
    - Yuba City, Yuba County – January 23, 2002

- mailing or faxing working group agendas, minutes, draft surveys, survey analyses, draft and final reports to over 50 people;

- making newspaper display ads available for all workshop locations, as well as providing local media advisories in advance of all workshops;

- developing and distributing two fact sheets;
- mailing workshop notices to over 4,000 people;
- meeting with waste management agencies and service providers on: 1) the existing waste collection and disposal services available in those districts; 2) the ability to expand service; and 3) associated costs for expanded service;
- meetings with California fire protection organizations, including the Sacramento Valley Fire Marshals Association, California Office of the State Fire Marshal, the Placer County Residential Burning Committee, and the California Department of Forestry and Fire Protection (CDF) to discuss fire safety issues;
- meetings with the Regional Council of Rural Counties on issues related to waste disposal and environmental and economic impacts; and
- making information available through a residential burning web site.

1. Public Involvement

As described below, we worked with affected stakeholders and organizations interested in minimizing exposure to dioxins and other toxic air pollutants emitted from residential waste burning. These groups included the Regional Council of Rural Counties and the County Supervisors Association of California, as well as the general public. To increase the general public's participation in this assessment, we have made information available via the ARB's Internet web site:

http://www.arb.ca.gov/smp/resburn/resburn.htm

The web site provides background information on the ATCM development process, including fact sheets, workshop dates and locations, and electronic links on residential waste burning air toxic emissions and health effects.

2. Industry Involvement

Waste management agencies and service providers were consulted in the development of this report and in evaluating the availability of alternative waste disposal options. Comments and suggestions were provided by these groups from across the State during the development of surveys and subsequent analysis. Industry involvement in the process has also included:

- approximately 200 telephone conversations and email exchanges;
- meetings with local waste management agencies in five of the six air districts that currently allow the burning of household garbage; and

- completion of a waste management questionnaire on current and future availability and cost of waste management services for the six air districts in California that currently allow the burning of household garbage.

3. Government Agency Involvement

Other local, State, and federal agencies with an interest in dioxins emissions associated with residential waste burning and use of burn barrels have been involved in the assessment process to promote statewide consistency in addressing public health concerns and providing a multi-media perspective. These agencies include: air districts, the California Environmental Protection Agency's (Cal/EPA's) CIWMB and OEHHA, CDF, the State Fire Marshal, and the U.S. EPA.

We have apprised the air districts of our activities through CAPCOA meetings, and have also worked with them to gather information on how the air districts regulate residential waste burning and burn barrel use. This work has included informational surveys and telephone calls to the air districts, and participation by many air districts in the Residential Burning Working Group.

B. Data Collection Tools to Assist in Report Preparation

Between October 2000 and October 2001, ARB staff conducted three surveys to gather information associated with residential waste burning and the use of burn barrels to support development of the ATCM. The three surveys were: 1) the Air District Rules Survey (Rules Survey); 2) the ATCM Concept Survey (ATCM Survey); and 3) the Burn Barrel Use Survey (Burn Barrel Survey). A fourth data collection tool utilized in September 2001 was the Waste Management Services Questionnaire (Waste Management Questionnaire).

1. Rules Survey

The Rules Survey was conducted in October 2000. This survey was sent to all air districts in the State to assess air district rules and practices associated with residential waste burning. The survey requested information on current rules regulating residential burning, complaints and workload associated with residential burning, and suggestions for State and local efforts to improve management of residential burning. All 35 air districts in the State responded to the survey. The survey highlighted the variability in how residential waste burning is regulated throughout the State. Many air districts also reported that addressing complaints from residential waste burning represented a significant workload.

2. ATCM Survey

The ATCM Survey was sent to members of the Residential Burning Working Group in September 2001, with further input from CAPCOA in November 2001. The working group is made up of representatives from the 27 air districts around the State that allow

some residential waste burning other than natural vegetation. The ATCM survey gathered information about the air district's perspectives regarding how the ATCM should be structured and implemented. Issues that were addressed included the types of materials that should be included, the need for and the form of any exemptions, and the implementation schedule. All 27 of the air districts responded to the survey and provided input.

3. Burn Barrel Survey

The Burn Barrel Survey was sent to 21 air districts in the State that allow residential waste burning but not residential garbage burning. It requested information on the estimated number of burn barrels in each of the 21 air districts and the percentage of barrels in each air district estimated to have illegal materials burned in them. Responses were received from all 21 of the air districts surveyed.

4. Waste Management Questionnaire

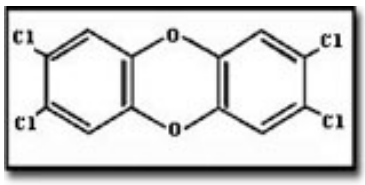
The Waste Management Questionnaire was sent to agencies responsible for waste management in the six air districts that allow the burning of household garbage in September 2001. It gathered information on the availability of service in each area, costs for service, and any obstacles that might be encountered to address the additional waste that could no longer be burned under the proposed ATCM. Written or verbal information was obtained from waste management agencies in all six air districts.

III. PHYSICAL CHARACTERISTICS, SOURCES, AND AMBIENT CONCENTRATIONS OF DIOXINS AND OTHER TOXIC AIR CONTAMINANTS

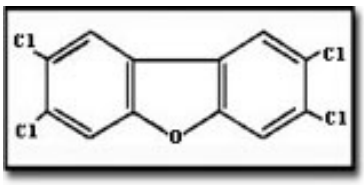
A. Dioxins

1. Background

"Dioxins" is a generic term used to denote any of a family of compounds that are derived from dibenzo-p-dioxin, or a mixture of such compounds. The basic structure of all dioxins consists of two benzene rings joined to each other by two oxygen atoms (see Diagram below). A closely related family of compounds are the dibenzofurans. They have structures and properties similar to dioxins and are often found in association with them. These compounds are collectively referred to as dioxins. Dioxins are classified into groups termed homologues on the basis of the number of chlorine atoms in the molecule. Thus, tetrachloro-dibenzo-p-dioxins and dibenzofurans contain four chlorine atoms, pentachloro-dibenzo-p-dioxins and dibenzofurans contain five chlorine atoms, and so on. Within each homologue, individual isomers are characterized by the location of the chlorine atoms on the rings.



2,3,7,8 Tetrachlorodibenzo-p-dioxin



2,3,7,8 Tetrachlorodibenzo furan

CHLORINATED DIOXINS/DIBENZOFURANS OF CONCERN

	Dioxins	**Dibenzofurans**
Tetrachloro	2,3,7,8	2,3,7,8
Pentachloro	1,2,3,7,8	1,2,3,7,8 2,3,4,7,8
Hexachloro	1,2,3,4,7,8 1,2,3,6,7,8 1,2,3,7,8,9	1,2,3,4,7,8 1,2,3,6,7,8 1,2,3,7,8,9 2,3,4,6,7,8
Heptachloro	1,2,3,4,6,7,8	1,2,3,4,6,7,8 1,2,3,4,7,8,9

NOTE: The numbers indicate the position of chlorine atoms on the dioxin or dibenzofuran molecule.

There are 75 different polychlorinated dibenzo-p-dioxins and 135 polychlorinated dibenzofurans, differing from each other by the number and location of chlorine atoms on the molecule.

2. Physical Characteristics

The mixture of dioxins emitted from combustion sources are in both the gaseous and particulate phase. The persistence of these substances may be a function of the phase into which they are emitted. The gas/solid phase partition factor is influenced by flow rate, temperature, and dimensions of the sampling. These substances do not appear to degrade when sorbed to solids (ARB, 1986). It is believed that the hexa through hepta chlorinated congeners are sorbed to particulates, whereas, the tetra and penta congeners partition to the vapor phase (Bidleman, 1988).

Dioxins are highly persistent under normal environmental conditions, particularly when adsorbed on soils or other substrates. The half-life of 2,3,7,8 Tetrachlorodibenzo-p-dioxin has been reported to be approximately 25 to 100 years in subsurface soil and 9 to 15 years at the soil surface (Paustenbach et al., 1992). Several researchers have reported global transport of dioxins in the atmosphere (Denison, 2000; Commoner et al., 2000). Dioxins are degraded by sunlight in solution under laboratory conditions, but the extent to which dioxins are degraded by sunlight in the atmosphere is unknown (ARB, 1986). Gas-phase dioxins may be degraded by reaction with hydroxyl (OH) radicals and direct photolysis. Particulate-associated dioxins are removed from air by wet and dry deposition. The average half-life for particles in the lower atmosphere is several days, whether particle-associated or gaseous (Balkanski et al., 1993).

3. Sources and Emissions

Dioxins are formed as products of incomplete combustion when chlorine and complex mixtures containing carbon are present. Conditions which have been associated with formation of dioxins during combustion include: 1) poor gas-phase mixing; 2) low combustion temperatures; 3) oxygen-starved conditions; 4) high particulate matter loading; 5) particulate matter-bound copper; 6) presence of hydrogen chloride and/or chlorine; and 7) significant gas-phase residence time in the 250-700°C temperature range. Dioxins are emitted from incinerators that burn residential waste, medical waste, municipal solid waste, hazardous waste sewage sludge, tires, and metal smelting operations when the feedstock contains dioxin precursors (Bumb et al., 1980; U.S EPA, 1997a; U.S. EPA, 1997b; U.S. EPA, 2001a; U.S EPA, 2001b; ARB, 1990).

Dioxins are also formed in small quantities as unwanted combustion byproducts in certain industrial processes associated with the manufacture of polychlorinated biphenyls (PCBs). Other possible sources of dioxins are sawmills, wire and scrap metal reclamation incinerators, black liquor boilers, cement kilns, cofiring wastes, transformer fires, wood stoves/fireplaces, and agricultural burning. Dioxins can form in wood through chlorination of phenolic compounds present in wood, paper pulp, or through the

combustion breakdown of pentachlorophenol, a pesticide used to inhibit mold growth in lumber. 2,3,7,8-Tetrachlorodibenzo-p-dioxin is produced as an unwanted contaminant during the manufacture of pesticides, such as chlorophenols, and their derivatives such as 2,4,5-trichlorophenoxyacetic acid (ARB, 1997). Dioxins have also been detected in fly ash and stack gas of various combustion processes (Tiernan, 1983).

Dioxins adsorbed on airborne particulate or in industrial effluent are deposited on the soil and eventually bind to other organic substances and bottom sediment in lakes and rivers. Although dioxins are encountered in both the vapor and particulate phases, it has been suggested that ingestion results in 90 percent of human exposure (Gilman & Newhook, 1991). Atmospheric dioxins deposit on vegetation which farm animals consume. Humans then ingest crops, fish, meat, and dairy products and thus accrue a body burden of dioxin. Subsistence fisherman can have unusually high levels of dioxin (U.S. EPA, 1989a; Hites, 1991). Secondary exposure, due to such soil and water pollution, may be as significant as atmospheric exposure and could substantially increase total risk (ARB 1986). Dioxins in very small concentrations are ubiquitous in the environment and it is likely that some of the primary sources are not yet known. Dioxins have been found worldwide, even in remote areas (ARB, 1986).

The U.S. EPA 's national emissions inventory for dioxins in 1987 and 1995 is shown in Table III-1 (U.S. EPA, 2001a). U.S. EPA’s best estimate of releases of dioxins to air, water and land from reasonably quantifiable sources suggests an approximate 77 percent decrease between 1987 and 1995, due primarily to reductions in air emissions from municipal and medical waste incinerators. In 1990, the ARB adopted a control measure to reduce emissions of dioxins from medical waste incinerators by 99 percent. At that time, medical waste incinerators were one of the largest known sources of dioxins in California. As a result of this regulation, the number of medical waste incinerators in the State dropped sharply from about 150 to less than 15. In 1994, the U.S. EPA adopted a control measure to regulate municipal waste incinerators by the year 2000 (Federal Register, 1994). Based upon the most recent source emissions data, U.S. EPA estimates that uncontrolled combustion, such as burning of residential waste, is expected to become the largest quantified source of dioxin emissions to the environment in the United States (U.S. EPA, 2001b).

Table III-1. Inventory of Environmental Releases (grams/year TEQ*) of Dioxins From Known Sources in the United States for 1987 and 1995

Inventory of Sources of Dioxin-Like Compounds in the United States-1987 and 1995	1987 Emissions (g TEQdf-WHO98/yr)	1995 Emissions (g TEQdf-WHO98/yr)	*Percent Reduction 1987 - 1995*
Municipal Solid Waste Incineration, air	8877.0	1250.0	86%
Backyard Refuse Barrel Burning, air	604.0	628.0	-4%
Medical Waste Incineration, air	2590.0	488.0	81%
Secondary Copper Smelting, air	983.0	271.0	72%
Cement Kilns (hazardous waste burning), air	117.8	156.1	-33%
Sewage Sludge/land applied, land	76.6	76.6	0%
Residential Wood Burning, air	89.6	62.8	30%
Coal-fired Utilities, air	50.8	60.1	-18%
Diesel Trucks, air	27.8	35.5	-28%
Secondary Aluminum Smelting, air	16.3	29.1	-79%
2,4-D, land	33.4	28.9	13%
Iron Ore Sintering, air	32.7	28.0	14%
Industrial Wood Burning, air	26.4	27.6	-5%
Bleached Pulp and Paper Mills, water	356.0	19.5	95%
Cement Kilns (non-hazardous waste burning)	13.7	17.8	-30%
Sewage Sludge Incineration, air	6.1	14.8	-143%
EDC/Vinyl chloride, air	NA	11.2	NA
Oil-fired Utilities, air	17.8	10.7	40%
Crematoria, air	5.5	9.1	-65%
Unleaded Gasoline, air	3.6	5.6	-56%
Hazardous Waste Incineration, air	5.0	5.8	-16%
Lightweight ag kilns, haz waste,air	2.4	3.3	-38%
Commercially Marketed Sewage Sludge,land	2.6	2.6	0%
Kraft Black Liquor Boilers, air	2.0	2.3	-15%
Petrol Refine Catalyst Reg., air	2.24	2.21	1%
Leaded Gasoline, air	37.5	2.0	95%
Secondary Lead Smelting, air	1.29	1.72	-33%
Paper Mill Sludge, land	14.1	1.4	90%
Cigarette Smoke, air	1.0	0.8	20%
EDC/Vinyl chloride, land	NA	0.73	NA
Primary Copper, air	0.5	0.5	0%
EDC/Vinyl chloride, water	NA	0.43	NA
Boilers/industrial furnaces	0.78	0.39	50%
Tire Combustion, air	0.11	0.11	0%
Drum Reclamation, air	0.1	0.1	0%
Carbon Reactivation Furnace, air	0.08	0.06	25%
TOTALS	13,998	3,255	77%
Percent Reduction from 1987 to 1995		77%	

NA = Not Available; (+) = reduction from 1987 to 1995; (-) = increase from 1987 to 1995; (0) = no change from 1987 to 1995.

(U.S. EPA, 2001a)

* **Toxic Equivalent – a quantitative measure of the combined toxicity of a mixture of dioxin-like chemicals**

4. Ambient Concentrations

Limited data are currently available to characterize ambient concentrations of dioxins in California. The ARB commissioned a study to assess the ambient concentrations of dioxins in the South Coast Air Basin (Hunt et al. 1990). 2,3,7,8-Tetrachlorodibenzo-p-dioxin levels were non-measurable at some sites and 0.0086 pg/m^3 at West Long Beach (monitor near a petroleum refinery) and 0.034 pg/m^3 at the CalTrans site (monitor near a highway intersection) (U.S. EPA, 1993a).

A study to assess ambient concentrations of dioxins was also conducted in Fresno, California in 1991. The majority of the atmospheric burdens of dioxins are represented by non 2,3,7,8-substituted species which are not of toxicological importance. However, the reported range for 2,3,7,8-Tetrachlorodibenzo-p-dioxins was 0.012 to 0.027 pg/m^3 and for 2,3,7,8-Tetrachlorodibenzo-p-furans was 0.041 to 0.134 pg/m^3. It is thought that combustion sources (including wood stoves as shown by high retene concentrations) are responsible for these concentrations (ARB, 1993b).

The ARB is currently developing an air quality monitoring and testing program to collect ambient data for dioxins, furans, and dioxin-like PCBs in California known as the California Ambient Dioxin Air Monitoring Program (CADAMP). The CADAMP monitoring will take place at a total of nine locations in the State (five in the San Francisco Bay Area and four in the South Coast Air Basin). Monitoring will begin in January 2002 and will continue for two years.

B. Benzene

Benzene is a clear, colorless, volatile, highly flammable liquid with a characteristic sickly, sweet odor. It is chemically characterized by six carbon atoms linked in a planar symmetrical hexagon (equal C-C bond lengths) with each carbon atom attached to a hydrogen atom. The electronic structure of that geometry makes benzene unusually stable. It does react with other compounds mainly by the substitution of a hydrogen atom (U.S. EPA, 1993b). Benzene is soluble in water and miscible with alcohol, chloroform, ether, carbon disulfide, carbon tetrachloride, glacial acetic acid, acetone, and oils (Merck, 1989).

The predominant sources of total benzene emissions in the atmosphere are gasoline fugitive emissions and gasoline motor vehicle exhaust. Mobile sources contribute 85 percent and industry related stationary sources 15 percent of the emissions. Approximately 70 percent of mobile source benzene emissions can be attributed to on-road motor vehicles, with the remainder attributed to non-road mobile sources (U.S. EPA, 1993b).

Although benzene is not present in household products except in small amounts in some automotive and cleaning products, it is a widely used industrial chemical. In 1985, it was the 16th highest-volume chemical produced in the United States. It is used in the manufacture of medicinal chemicals, shoes, dyes, detergents, explosives,

linoleum, oil cloth, and artificial leather. Benzene is a solvent for waxes, fats, resins, paints, plastics, and fast drying inks. Other uses are as a raw material in the synthesis of organic compounds such as cyclohexane, styrene, phenol, and rubber. Tobacco smoke also contains benzene (ARB, 1997). Benzene emissions occur from residential burning, agricultural burning, forest management burning, and wildfires. These emissions can vary significantly from year to year (ARB, 1984). The primary stationary sources that have reported emissions of benzene in California are crude petroleum and natural gas mining, petroleum refining, and electric service (ARB, 1997).

C. 1,3-Butadiene

1,3-Butadiene is a flammable, colorless gas with a pungent, aromatic, gasoline-like odor. It is insoluble in water, slightly soluble in methanol and ethanol, and soluble in organic solvents such as benzene and ether (U.S. EPA, 1989b). 1,3-Butadiene is a gas at most environmental temperatures and is very volatile even at lower temperatures (ARB, 1997).

In California, the majority of 1,3-butadiene emissions are from incomplete combustion of gasoline and diesel fuels. Mobile sources account for approximately 96 percent of the total annual emissions statewide for quantified sources. Vehicles that are not equipped with functioning exhaust catalysts emit greater amounts of 1,3-butadiene than vehicles with functioning catalysts (ARB, 1992).

Other sources of 1,3-butadiene include petroleum refining, styrene-butadiene copolymer production, and biomass burning, including residential wood combustion, agricultural burning, and managed forest fires. The largest use of 1,3-butadiene in the United States is in the production of synthetic elastomers, which include: styrene-butadiene copolymer, acrylonitrile butadiene-styrene resin, polybutadiene, neoprene, and nitrile rubber. Products commonly made from the styrene-butadiene copolymers include tires, mechanical rubber goods, and latex. Latex is commonly used in foam products, paints, carpet and textile backing, paper coatings, and adhesives. The second major national use of 1,3-butadiene is in the production of adiponitrile, the raw material used in nylon 6,6 production (ARB, 1992). The primary stationary sources that have reported emissions of 1,3-butadiene are petroleum refining, manufacturing of synthetics and man-made materials, and oil and gas extraction (ARB, 1997).

D. Polycyclic Aromatic Hydrocarbons

Polycyclic organic matter (POM) consists of over 100 compounds and is defined by the Federal Clean Air Act as organic compounds with more than one benzene ring that have a boiling point greater than or equal to 100° C.

POM can be divided into the subgroups of polycyclic aromatic hydrocarbons (PAHs) and PAH-derivatives. PAHs are organic compounds that include only carbon and hydrogen with a fused ring structure containing at least two benzene (six-sided) rings. PAHs may also contain additional fused rings that are not six-sided. PAH-derivatives

also have at least two benzene rings and may contain additional fused rings that are not six-sided rings. However, PAH-derivatives contain other elements in addition to carbon and hydrogen (CAPCOA, 1993).

In general, POM exists as a gas when its molecular weight is below 230 grams per mole, and is a particle above this molecular weight. This means that compounds with two rings (e.g., naphthalene) exist as a gas. Compounds with three to four rings (e.g., pyrene) exist either as a gas or particle depending on the temperature and pressure. Compounds with five rings (e.g., dibenzo[a,h]anthracene, benzo[a]pyrene) exist as particles in the atmosphere (ARB, 1997).

PAHs are primarily planar, nonpolar compounds that melt well above room temperature (U.S. EPA, 1987). Generally, PAHs exist as colorless, white, or pale yellow-green solids that are attached to particulate matter. PAHs may also exist as solids in soil or sediment. Benzo[a]pyrene is a PAH and is soluble in benzene, toluene, and xylene, but practically insoluble in water (ARB 1997). PAH-derivatives include nitro-PAHs, amino-PAHs, and oxygenated PAHs (phenols, quinones, and heterocyclic aromatic compounds containing sulfur and oxygen (Finlayson-Pitts and Pitts, Jr., 1986).

POM is produced by the incomplete combustion of fossil fuels and vegetable matter. PAHs have been detected in motor vehicle exhaust, smoke from residential wood combustion, and fly ash from coal-fired electric generating plants (Finlayson-Pitts and Pitts, Jr., 1986). The primary stationary sources that have reported emissions of benzo[a]pyrene in California are petroleum refineries, industrial machinery manufacturers, and the wholesale trade in petroleum and petroleum products. The primary stationary sources that have reported emissions of PAHs in California are paper mills, manufacturers of miscellaneous wood products, and petroleum refining (ARB, 1997).

E. Polychlorinated Biphenyls

There are 209 possible polychlorinated biphenyl (PCBs) isomers. PCBs vary in appearance from mobile, oily liquids to white, crystalline solids to hard, non-crystalline resins. They are thermally stable, resistant to oxidation, acids, bases, and other chemical agents, and have excellent dielectric properties. PCBs are colorless crystals in the pure form. The melting point is depressed when PCBs are mixed. PCBs are practically insoluble in water, and soluble in oils and organic solvents. When heated to decomposition, they emit toxic fumes of hydrochloric acid and other chlorinated compounds (NTP, 1991).

Since 1974, all uses of PCBs in the United States have been confined to closed systems such as electrical capacitors, electrical transformers, vacuum pumps, and gas-transmission turbines. PCBs are no longer produced in the United States except for limited research and development applications (NTP, 1991). Sources of PCBs are landfills containing PCB waste materials and products, destruction of manufactured articles containing PCBs in municipal and industrial waste disposal burners, and gradual wear and weathering of PCB-containing products (ARB, 1997).

Other sources in California that have reported emissions of PCBs are adhesives and sealants, fabricated rubber products, commercial prints and lithographs, and ground or treated mineral facilities, electric services, and refuse systems. The primary stationary sources that have reported emissions of PCBs in California are crude oil pipelines, wholesale trade in miscellaneous durable goods, and hydraulic cement manufacturers (ARB, 1997).

IV. SUMMARY OF RESIDENTIAL WASTE BURNING PRACTICES AND EMISSIONS

During the control measure development process, the practice of residential waste burning, the use of burn barrels, and associated toxic air emissions were examined for California. This chapter presents these findings, based on information collected from the literature, surveys of air districts, waste management agencies, fire protection agencies, and ARB analysis.

A. Residential Waste Burning Practices

The types of materials that can be burned based on current air district rules are shown in Table IV-1. Table IV-1 also lists prohibitions on the use of burn barrels. Eight air districts restrict the materials that can be burned to natural vegetation. These eight air districts represent approximately 79% of the statewide population. Current rules in 27 air districts allow the burning of some form of household wastes other than natural vegetation in all or part of the air district. Non-vegetative waste materials may include, but are not limited to, household garbage, plastics, paper, cardboard, cloth, and treated wood products.

Roughly 2.2 million people (722,400 households), about 7% of California's population, live in the portions of the 27 air districts that allow the burning of such wastes. The remaining 14% of the population live in the portions of these 27 air districts where only the burning of vegetation is allowed. Six of the 27 air districts allow the burning of all materials, including household garbage, in all or part of the district. The remaining 21 air districts prohibit the burning of household garbage, but may allow the burning of various materials such as paper, cardboard, cloth, and wood products. However, further restrictions on allowable materials may occur due to local ordinances within cities in some of these air districts. These additional prohibitions could be imposed by city ordinance, through local fire agency regulations, or through adoption of certain portions of the Uniform Fire Code which address the use of incinerators and allowable materials. In addition, six of the 21 air districts prohibit the use of burn barrels in all or part of the air district. These local restrictions would further reduce the number of households that are allowed to burn certain materials.

Due to the potentially overlapping nature of air district rules, local ordinances, and fire agency prohibitions, it is difficult to estimate the true number of households burning their residential waste in California. Information on waste disposal practices is also limited in some areas, and the relationship between availability of service and an individual household's decision to burn any or all of its waste is not always clear cut. For example, even though some households have regular waste pickup for their household garbage, they may still be burning their paper and cardboard in order to reduce waste disposal costs. Also, some households that do not have waste pickup service dispose of their waste by means other than burning. However, based on discussions with air district staff and waste management agencies, we have developed our best estimate of the number of households that could be burning their non-vegetative waste in California.

Table IV-1. Air District Rules on Residential Burning

Air District	Garbage Burned	Materials Allowed to be Burned*	Burn Barrels Allowed
Great Basin	ENTIRE AIR DISTRICT	G V P C	Yes
Modoc County	ENTIRE AIR DISTRICT	G V P C	Yes
Monterey Bay Unified	PART OF AIR DISTRICT	G V P C	Yes
Kern County	PART OF AIR DISTRICT	G V P C	Yes
Sacramento Metro	PART OF AIR DISTRICT	G V P C	Yes
San Diego County	PART OF AIR DISTRICT	G V P C	Yes
Calaveras County	NO	V P C	Yes
Mariposa County	NO	V P C	Yes
Northern Sierra	NO	V P C	Yes
Lassen County	NO	V P C	Yes
Siskiyou County	NO	V P C	Yes
Colusa County	NO	V P C	Yes
Feather River	NO	V P C	Yes
Tehama County	NO	V P C	Yes
Imperial County	NO	V P C	Yes
Lake County	NO	V P	No
El Dorado County	NO	V P	Yes
Amador County	NO	V P	Yes
Tuolumne County	NO	V P	Yes
North Coast Unified	NO	V P	Yes
Mendocino County	NO	V P	Yes
Northern Sonoma County	NO	V P	Yes
Placer County	NO	V P	Yes
San Luis Obispo County	NO	V P	Portions Only
Butte County	NO	V P	Yes
Glenn County	NO	V P	Yes
Shasta County	NO	V P	Yes
Bay Area	NO	V	Yes
Antelope Valley	NO	V	No
Mojave Desert	NO	V	No
San Joaquin Valley	NO	V	No
Santa Barbara County	NO	V	No
South Coast	NO	V	Yes
Ventura County	NO	V	Yes
Yolo-Solano	NO	V	Yes

* Materials Burned: G = Household Solid Waste (Garbage/Rubbish)
V = Any kind of Vegetation
P = Paper and Cardboard
C = Cloth

Approximately 82,000 households are located in the portions of the six air districts that have no prohibitions on the materials that can be burned. In these six air districts, we collected information on the availability of waste service, the prevalence of self-hauling practices, as well as air district estimates of likely burners. Based on this information, we estimate that about 15,000 households may be burning their residential waste, including household garbage. This is shown in the third column of Table IV-2. However, as discussed above, even some of the households with waste pickup service, or those that self-haul, may still be burning some of their waste materials, such as paper and cardboard.

An additional 641,000 households are present in the remaining portions of the 21 air districts where burning of other waste materials is allowed. Because these households are already required to dispose of their household garbage through non-burning alternatives, we assumed that all of these households must either have waste pickup service, or are self-hauling. Therefore, the decision to burn is based more on the additional cost to dispose of additional materials such as paper and cardboard, as well as the practical ease of doing so, rather than alternative disposal methods.

The estimate of the number of households actually burning residential waste in these 21 air districts (in third column) is based upon estimates provided by the air districts, CDF, and local jurisdictions. Each agency may have used different methods to develop its estimate. Some air districts used information on waste service availability and judgement based on compliance inspections. In other air districts, the estimated number of households burning is based upon the number of permits issued for residential burning by CDF and other local fire agencies. In some cases, this may represent an underestimate because not all households obtain permits outside of the summer controlled burn season, and because a number of different agencies issue permits, making tracking difficult. However, based upon the information provided by these agencies, we estimate approximately 93,000 households may be burning materials such as cardboard and paper in these 21 air districts.

In total, approximately 108,000 households may be actually burning some or all of their residential waste in the 27 air districts. A breakdown by county of the number of households allowed to burn under air districts rules, as well as our best estimate of the number of households actually burning is provided in Table IV-2. The first six air districts in the table are allowed to burn all forms of waste in all or part of the air district. The remaining 21 air districts do not allow the burning of household garbage, but do allow the burning of other residential waste materials. The first column in the table gives the total population in each of the 27 air districts, including areas prohibited from burning. The second column shows the number of households that are allowed to burn residential waste. The third column shows the number of households estimated to be actually burning residential waste.

However, many air districts also experience varying degrees of illegal garbage burning. Illegal garbage burning represents a substantial percentage of air quality complaints from the public for many air districts (ARB, 2001). Some air districts report that as many

as 100 percent of burn barrels inspected have illegal materials in them. It is difficult for air districts to observe and cite illegal burning because they cannot see the materials in the burn barrels from a distance.

Table IV-2. Estimate of Households Burning by Air District

Air District	Total Population in Air District (2000 census)	ARB Estimate of Number of Households Allowed to Burn Waste	Local estimate of Number of Households Actually Burning Waste Outdoors
Great Basin	32,006	10,700	2,000
Kern County (east)	120,000	6,000	250
Modoc County	9,449	3,200	3,000
Monterey Bay Unified	710,598	39,000	3,600
Sacramento Metro	1,223,499	7,600	5,000
San Diego County	2,813,833	15,300	1,500
Amador County	35,100	11,700	1,800
Butte County	203,171	67,700	1,300
Calaveras County	40,554	13,500	2,500
Colusa County	18,804	6,300	2,000
El Dorado County	156,299	52,100	5,000
Feather River	139,149	46,400	3,600
Glenn County	26,453	8,800	2,800
Imperial County	142,361	47,500	5,000
Lake County	58,309	19,400	250
Lassen County	33,828	11,300	2,500
Mariposa County	17,130	5,700	2,000
Mendocino County	86,265	28,800	13,000
North Coast Unified	167,047	55,700	23,600
Northern Sierra	116,412	38,800	4,000
Northern Sonoma County	65,400	21,800	500
Placer County	248,399	82,800	2,000
San Luis Obispo County	246,681	16,200	500
Shasta County	163,256	54,400	2,000
Siskiyou County	44,301	14,800	6,500
Tehama County	56,039	18,700	6,000
Tuolumne County	54,501	18,200	6,000
TOTAL	7,028,844	722,400	108,200

B. Amount of Residential Waste Generated in California

On average, the typical household in California is comprised of approximately three people and generates between 3 and 11 pounds of garbage per day. The range takes into account factors such as the number of residents living in a household, physical household size, family income, location within the State, recycling characteristics, and

time of year. The best estimate of residential waste generation is 5.9 pounds per day per household, based on the average waste disposal rates for each California county and assuming three people per household. This amounts to 41 pounds per household per week, and 2,137 pounds (970 kg) per household per year (CIWMB, 2000). Typical California residential waste constituents and estimates of their relative proportions are listed in Table IV-3 below. New York residential waste composition, the basis of the U.S. EPA tests described below, is also shown for comparison.

Table IV-3. Typical California Residential Waste Constituents

Material Type	California Percentage*	New York Percentage
Paper	44%	63%
Glass	7%	9%
Metals	8%	9%
Plastics	14%	12%
Food Waste	11%	7%
Other Materials (Wood, textiles, paint, etc.)	16%	0%

* Adjusted for removal of leaves, grass, and other organic materials

C. Emission Estimates for Residential Waste Burning

In order to assess the magnitude of emissions from residential waste burning, the U.S. EPA conducted a number of tests to characterize the emissions of dioxins and other TACs generated during the burning of household waste in burn barrels (EPA, 1997a). In an initial series of tests, four test burns were conducted to simulate the typical waste generated by a recycling and non-recycling household. The waste materials burned represented the typical percentages of materials disposed of by residents in New York State. Waste materials included paper, plastics, food waste, textiles, glass and ceramics, and metal and aluminum cans. A comparison of the percentages of waste materials in the New York tests to California waste materials is provided in Table IV-3. The California and New York waste compositions compare well, with slightly more paper in the New York waste, and more plastics and other materials such as wood and paint in the California mix. The materials were burned in a standard 55 gallon metal drum (sandblasted free of paint), with a series of air holes punched near the bottom for ventilation. The tests took place in a burn hut that included instrumentation to measure temperature and emissions.

These initial results showed significant emissions of dioxins and other TACs. However, there was also significant variability in the dioxin emissions between tests. Therefore, eighteen further tests were conducted to examine the factors influencing the emissions of dioxins from residential waste burning in burn barrels (Lemieux, 2000). These further

test results indicated that dioxin emissions from burn barrels were likely dependent upon variations in the distribution of the waste materials which were actually burning at a given time within the burn barrel, even when an identical waste mix was burned each time. However, dioxin emissions were significant, across the range of measured values.

We used these test results to estimate the yearly emissions of dioxins and other TACs from residential garbage burning for a single household using a burn barrel. The emission factors developed by U.S. EPA were combined with residential waste generation rates and waste composition described above. Due to the variability in emission rates, composite emission factors for dioxins were developed representing each set of tests. The emission factors for the other pollutants are based on the original tests. The residential waste combustion rate was 10.4 pounds per hour, and the burn duration was 78 minutes, in accordance with the U.S. EPA test protocol.

The emission factors, and calculated emissions are provided in Table IV-4 for both series of tests. The emission factors are reported in terms of milligrams of pollutant per kilogram of trash burned, as well as grams per second, while emissions are reported in terms of grams per household per year. The emissions represent total mass. In the case of dioxins, the individual isomers of dioxins and furans were measured and summed to the total.

Table IV-4. Toxic and PM10 Emissions from Residential Waste Burning

Pollutant	Average Emissions Factor (mg/kg burned)	Average Emissions (grams/second)	Average Emissions (grams/ household/year)
Dioxins (Series 1 1997 Testing)	0.16	2.06E-07	0.15
Dioxins (Series 2 2000 Testing)	0.005	6.10E-09	0.005
1,3-Butadiene	141.2	1.85E-05	137.0
Benzene	979.7	1.28E-03	950.0
PAHs	45.0	5.89E-05	43.5
PCBs	0.13	1.65E-07	0.12
PM10	1.23E+04	1.60E-02	1.12E+04

As shown in the table, the average household burning residential waste could generate between 0.005 and 0.15 grams of dioxins per year. These emissions are based on a household that burned a complete mix of waste materials and likely represents the high end of expected emissions. While these numbers appear small, it is important to recognize that even small amounts of TACs can be hazardous to health. In addition, there is no threshold below which exposure to dioxins has been deemed safe. In addition, unlike medical and municipal waste incinerators, the temperatures at which residential burning takes place (typically between 50° C and 600° C) do not achieve the temperatures needed to minimize or eliminate the production of dioxins.

V. POTENTIAL HEALTH IMPACTS OF DIOXINS AND OTHER TOXIC AIR CONTAMINANTS FROM RESIDENTIAL WASTE BURNING

A. An Overview of Health Risk Assessment

A health risk assessment (HRA) is an evaluation or report that describes the potential a person or population may have of developing adverse health effects from exposure to an emission source. Some health effects that are evaluated could include cancer, developmental effects, or respiratory illness. The exposure pathways that can be included in an HRA depend on the toxic air pollutants that a person (receptor) may be exposed to, and can include breathing, the ingestion of soil, water, crops, fish, meat, cow's milk, and eggs, and dermal exposure. The consumption of mother's milk can be evaluated for an infant receptor. When multiple exposure pathways are considered in an HRA, the evaluation is called a multi-pathway assessment.

For this HRA, we evaluated the potential multi-pathway health impacts for polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans (collectively referred to as dioxins), benzene, 1,3-butadiene, PAHs, and PCBs. Multi-pathway assessments are traditionally conducted when lipophilic (fat-loving), semi-volatile, or low volatility compounds such as dioxins, PAHs, and PCBs are emitted.

To develop this HRA, we followed a four-step process. The four steps are Hazard Identification, Dose-Response Assessment, Exposure Assessment, and Risk Characterization.

1. Hazard Identification

In the first step, we identified the pollutant(s) of concern and the type of effect, such as cancer or respiratory effects.

For this assessment, the pollutants of concern have been formally identified under the AB 1807 Program as TACs. The ARB formally identified dioxins, benzene, 1,3-butadiene, PAHs, and PCBs as TACs under California's Toxic Air Contaminant Identification and Control Program (ARB, 1986; ARB, 1984; ARB, 1992; ARB, 1993a). This identification was done through an open public process as specified under Health and Safety Code sections 39650 through 39662. In addition, dioxins, benzene, 1,3-butadiene, PAHs, and PCBs are listed as hazardous air pollutants under the Federal Clean Air Act (42 U.S.C. 7412).

The HRA was limited to these five substances (or groups of substances) after we performed a screening HRA on over 260 substances that were detected in U.S. EPA-sponsored source tests on the emissions from residential waste burning (U.S. EPA, 1997a). Of these 260 substances or groups of substances, the Air Resources Board lists approximately fifty percent as TACs. We refined this HRA to focus on these five substances or groups of substances because they were the main risk drivers in a screening HRA performed by the ARB. These five substances or

groups constituted approximately seventy-three percent of the potential cancer risk through breathing and approximately ninety-nine percent of the potential cancer risk through ingestion routes (e.g., crop exposure). Other substances that were measured that have also been identified as TACs included cadmium, chromium, and mercury.

2. Dose-Response Assessment

In this step of risk assessment, we characterized the relationship between a person's exposure to a pollutant and the incidence or occurrence of an adverse health effect.

OEHHA performs this step of the HRA for the ARB. OEHHA supplies these dose-response relationships in the form of cancer potency factors or unit risk factors (URFs) for carcinogenic effects and reference exposure levels (RELs) for non-carcinogenic effects. The URFs and RELs that are used in California for the substances evaluated in this HRA can be found in the following references:

(1) U.S. Environmental Protection Agency Integrated Risk Information System (IRIS), 1996 (OEHHA, 1999c);

(2) The California Air Pollution Control Officer's Association Air Toxics "Hot Spots" Program, Revised 1992, Risk Assessment Guidelines, October 1993;

(3) The Office of Environmental Health and Hazard Assessment Air Toxics "Hot Spots" Program Risk Assessment Guidelines, Part I, The Determination of Acute RELs for Airborne Toxicants, March 1999;

(4) The Office of Environmental Health and Hazard Assessment Air Toxics "Hot Spots" Program Risk Assessment Guidelines, Part II, Technical Support Document for Describing Available Cancer Potency Factors, April 1999;

(5) The Office of Environmental Health and Hazard Assessment Air Toxics "Hot Spots" Program Risk Assessment Guidelines, Part III, Technical Support Document for the Determination of Noncancer Chronic Reference Exposure Levels, April 2000; and

(6) The Office of Environmental Health and Hazard Assessment Air Toxics "Hot Spots" Program Risk Assessment Guidelines, Part IV, Technical Support Document for Exposure Assessment and Stochastic Analysis, September 2000.

3. Exposure Assessment

In this step of the risk assessment, we estimated the extent of public exposure by looking at who is likely to be exposed, how exposure will occur (e.g., inhalation and ingestion), and the magnitude of exposure.

Residential waste burning activities emit substances that can impact receptors (residents) both in the near field and on a larger, regional scale. Avoiding the plume of

smoke is not necessarily sufficient to eliminate the potential health impacts. Waste burning activities can still impact people who do not burn. Substances that are emitted through incineration can travel long distances, depositing onto crops, soil, and water. Residents can be exposed to these substances when breathing or they can ingest the substances in their diet or daily activities. Ingestion pathways can include soil ingestion, breast milk ingestion, ingestion of crops, meat (e.g., chicken and cows), and cow's milk. Meat and milk products can be impacted because animals ingest the pollutants and then these substances can be passed to people when animal products are ingested.

For this HRA, the receptors are assumed to be residents living near a single waste burning emissions point (burn barrel). We used a multipathway assessment that considers potential exposures through breathing, dermal absorption, and the ingestion of soil, backyard garden crops, meat, eggs, cows milk, and breast milk.

For this HRA, we used emissions from the U.S. EPA source tests which were conducted in 1997 and 2000 (U.S. EPA, 1997a; Lemieux, 2000). Emissions from the 2000 source tests were used for dioxins and PCBs because, according to U.S. EPA, these emissions are more representative than the 1997 emissions. The emissions from the 1997 source tests were used for benzene, 1,3-butadiene, and PAHs because these compounds were not quantified in the 2000 tests. Note however, that the 1997 tests showed higher dioxin and PCB emissions when compared to the 2000 tests.

Computer air dispersion modeling was used to provide downwind ground-level concentrations of the TACs at near-source locations (20 to 1,000 meters). The dispersion modeling used both default meteorological conditions from SCREEN3 and site-specific meteorological data from four locations across California (Alturas, Bishop, San Benito, and Escondido). These locations were selected to represent a range of meteorological conditions throughout the State where the burning of residential waste is allowed.

4. Risk Characterization

This is the final step of risk assessment. In this step, we combined information derived from the previous steps. Modeled concentrations, which are determined through exposure assessment, are combined with the URFs (for cancer risk) and RELs (for non-cancer effects) determined under the dose-response assessment. This step integrates this information to quantify the potential cancer risk and non-cancer health impacts.

B. The Tools Used For This Risk Assessment

The tools and information that are used to estimate the potential health impacts from a source include an air dispersion model and pollutant-specific health risk values. Combining the output from the source tests, air dispersion model, and the pollutant-specific health risk values provides an estimate of the potential cancer and non-cancer health impacts from the emissions of a toxic air contaminant. A description

of the air dispersion modeling and pollutant-specific health effect values is provided below.

1. Air Dispersion Modeling

Air dispersion models are used to estimate the downwind, ground-level concentrations of a pollutant after it is emitted from a source. The downwind concentration is a function of the quantity of emissions, release parameters at the source, and appropriate meteorological conditions. We used the ISCST3 model for this assessment. The U.S. EPA recommends the ISCST3 model for refined air dispersion modeling (U.S. EPA, 1995a,b). This model is currently used by the ARB, air districts, and other states. The dispersion modeling used both default meteorological conditions from SCREEN3 and site-specific meteorological data from four locations across California (Alturas, Bishop, San Benito, and Escondido). A detailed discussion of the air dispersion modeling is presented in Appendix C.

2. Pollutant-Specific Health Effects Values

Dose-response or pollutant-specific health effects values are developed to characterize the relationship between a person's exposure to a pollutant and the incidence or occurrence of an adverse health effect. A unit risk factor (URF), also known as a cancer potency factor, with units of (micrograms per cubic meter)$^{-1}$ or ($\mu g/m^3$)$^{-1}$, is used when estimating potential cancer risks. A URF is defined as the estimated upper-confidence limit (usually 95%) probability of a person contracting cancer as a result of constant exposure to a concentration of one $\mu g/m^3$ of a pollutant over a 70-year lifetime.

Reference exposure levels (RELs) are used as an indicator to assess potential non-cancer health impacts. A REL is defined as a concentration level at or below which no adverse health effects are anticipated. RELs are designed to protect most of the sensitive individuals in the population by including safety factors in their development and can be created for both acute and chronic exposures. An acute exposure is defined as one or a series of short-term exposures generally lasting less than 24 hours. Chronic exposure is defined as repeated exposure usually lasting from one year to a lifetime.

Exposure to dioxins, benzene, 1,3-butadiene, PAHs, and PCBs may result in both cancer and non-cancer health effects. Table V-I presents the current health effects values that were used in the HRA and the toxicological endpoints (organs or body systems) that these substances may affect.

Table V-1. Pollutant-Specific Health Effects Values Used For Determining Potential Health Impacts

Compound	Cancer Unit Risk Factors		Non-Cancer Reference Exposure Levels			Non-Cancer Toxicological Endpoints	
	Inhalation[1] $(ug/m^3)^{-1}$	Oral [1,2] $(mg/kg\text{-}d)^{-1}$	Acute [3] (inhalation) (ug/m^3)	Chronic [4] (Inhalation) (ug/m^3)	Chronic [2,4] (Oral) (mg/kg/d)	Acute [3]	Chronic [4]
Benzene	2.9E-05		1.3E+03	6.0E+01		Developmental Hematologic, Immune, Reproductive	Developmental hematologic; nervous
1,3-Butadiene [5]	1.7E-04			2.0E+01			Reproductive
Polychlorinated Dibenzo-*p*-dioxins [6]							Alimentary; developmental; endocrine; hematologic; reproductive; respiratory
2,3,7,8-TCDD	3.8E+01	1.3E+05		4.0E-05	1.0E-08		
1,2,3,7,8-PeCDD	1.9E+01	6.5E+04		8.0E-05	2.0E-08		
1,2,3,4,7,8-HxCDD	3.8E+00	1.3E+04		4.0E-04	1.0E-07		
1,2,3,6,7,8-HxCDD	3.8E+00	1.3E+04		4.0E-04	1.0E-07		
1,2,3,7,8,9-HxCDD	3.8E+00	1.3E+04		4.0E-04	1.0E-07		
1,2,3,4,6,7,8-HpCDD	3.8E-01	1.3E+03		4.0E-03	1.0E-06		
1,2,3,4,6,7,8,9-OCDD	3.8E-02	1.3E+02		4.0E-02	1.0E-05		
Polychlorinated Dibenzofurans [7]							
2,3,7,8-TCDF	3.8E+00	1.3E+04		4.0E-04	1.0E-07		
1,2,3,7,8-PeCDF	1.9E+00	6.5E+03		8.0E-04	2.0E-07		
2,3,4,7,8-PeCDF	1.9E+01	6.5E+04		8.0E-05	2.0E-08		
1,2,3,4,7,8-HxCDF	3.8E+00	1.3E+04		4.0E-04	1.0E-07		
1,2,3,6,7,8-HxCDF	3.8E+00	1.3E+04		4.0E-04	1.0E-07		
1,2,3,7,8,9-HxCDF	3.8E+00	1.3E+04		4.0E-04	1.0E-07		
2,3,4,6,7,8-HxCDF	3.8E+00	1.3E+04		4.0E-04	1.0E-07		
1,2,3,4,6,7,8-HpCDF	3.8E-01	1.3E+03		4.0E-03	1.0E-06		
1,2,3,4,7,8,9-HpCDF	3.8E-01	1.3E+03		4.0E-03	1.0E-06		
1,2,3,4,6,7,8,9-OCDF	3.8E-02	1.3E+02		4.0E-02	1.0E-05		

Table V-1 (continued). Pollutant-Specific Health Effects Values Used For Determining Potential Health Impacts

Compound	Cancer Unit Risk Factors		Non-Cancer Reference Exposure Levels			Non-Cancer Toxicological Endpoints	
	Inhalation[1] $(ug/m^3)^{-1}$	Oral [1,2] $(mg/kg\text{-}d)^{-1}$	Acute [3] (inhalation) (ug/m^3)	Chronic [4] (Inhalation) (ug/m^3)	Chronic [2,4] (Oral) (mg/kg/d)	Acute [3]	Chronic [4]
Polycyclic Aromatic Hydrocarbons [8]							
Benzo[a]pyrene	1.1E-03	1.2E+01					
Benz[a]anthracene	1.1E-04	1.2E+00					
Benzo[b]fluoranthene	1.1E-04	1.2E+00					
Benzo[k]floranthene	1.1E-04	1.2E+00					
Chrysene	1.1E-05	1.2E-01					
Dibenz[a,h]anthracene	1.2E-03	4.1E+00					
Indeno[1,2,3-c,d]pyrene	1.1E-04	1.2E+00					
Naphthalene				9.0E+00			Respiratory
Polychlorinated Biphenyls	5.7E-04	2.0E+00		1.2E+00 [9]	2.5E-05 [10]		Alimentary, developmental, immune, reproductive

1. Office of Environmental Health Hazard Assessment, Air Toxics "Hot Spots" Program Risk Assessment Guidelines, Part II, Technical Support Document for Describing Available Cancer Potency Factors, April 1999.
2. Office of Environmental Health Hazard Assessment, Air Toxics "Hot Spots" Program Risk Assessment Guidelines, Part IV, Technical Support Document for Exposure Assessment and Stochastic Analysis, September 2000.
3. Office of Environmental Health Hazard Assessment, Air Toxics "Hot Spots" Program Risk Assessment Guidelines, Part I, The Determination of Acute Reference Exposure Levels for Airborne Toxicants. Benzene has an REL based on a 6-hour averaging period.
4. Office of Environmental Health Hazard Assessment, Air Toxics "Hot Spots" Program Risk Assessment Guidelines, Part III, Technical Support Document for the Determination of Noncancer Chronic Reference Exposure Levels, April 2000.
5. Office of Environmental Health Hazard Assessment, Adoption of Chronic Reference Exposure Levels For Airborne Toxicants, Memorandum, January 2001.
6. Polychlorinated dibenzo-*p*-dioxin is listed here as a group heading. Individual congeners are listed below this heading with their respective health factors.
7. Polychlorinated dibenzofuran is listed here as a group heading. Individual congeners are listed below this heading with their respective health factors.
8. Polycyclic aromatic hydrocarbons (PAHs) are listed here as a group heading. Individual PAHs (and naphthalene) used in the HRA are listed below this heading with their respective health factors.
9. California Air Pollution Control Officer's Association, Air Toxics Hot Spots Program, Revised 1992 Risk Assessment Guidelines, October 1993.
10. United States Environmental Protection Agency, Integrated Risk Information System, 1996 (OEHHA, 1999c).

C. Potential Health Effects of Dioxins, Benzene, 1,3-Butadiene, PAHs, and PCBs

This section summarizes the cancer and non-cancer impacts that can result from exposure to dioxins, benzene, 1,3-butadiene, PAHs, and PCBs. The information comes from ARB's 1997 reference report, *Toxic Air Contaminant Identification List – Summaries* unless otherwise noted (ARB, 1997).

1. Dioxins

Exposure to dioxins may result in both cancer and non-cancer health effects. The probable route of human exposure to dioxins is inhalation, ingestion, and dermal absorption (ARB 1986). In addition, dioxins can be passed down to children through mother's milk. Once dioxin enters the human body, a small amount is metabolized and eliminated, while the rest bioaccumulates in body fat. As fat is metabolized, stored dioxins is released and excreted primarily in feces. The body's concentration is dependent on the rates of ingestion, elimination, and storage capacity of dioxins. The approximate half-life of dioxins in humans was estimated to range from 6 to 10 years (ARB, 1997).

a. Cancer

The OEHHA staff has performed an extensive assessment of the potential health effects of dioxins, reviewing available carcinogenicity data. OEHHA concluded that dioxins are a potential human carcinogen with no identifiable threshold below which no carcinogenic effects are likely to occur. The Board formally identified dibenzo-*p*-dioxins and dibenzofurans (chlorinated in the 2,3,7 and 8 positions and containing 4,5,6, or 7 chlorine atoms) as a TAC in July 1986 (ARB, 1986). The State of California under Proposition 65 listed polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans, and 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin as carcinogens in April 1988 and January 1988, respectively (OEHHA, 2001b).

In 1990, the U.S. EPA listed 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin as a Hazardous Air Pollutant (HAP) pursuant to subsection (b) of Section 112 of the Federal Clean Air Act (42. U.S.C. 7412). The U.S. EPA is preparing a final Dioxin and Related Compounds risk assessment document. The International Agency for Research on Cancer (IARC) classified 2,3,7,8-tetrachlorodibenzo-*p*-dioxin as Group 1: Human carcinogen, based on sufficient evidence in humans (ARB, 1997).

Human studies that have reported cancer increases are inconclusive because of inadequate data. There is adequate evidence to support a conclusion that 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin is carcinogenic in rodents and should be considered a potential carcinogen to humans. Ingestion studies in rodents have shown increases in tumors of the liver, lung, squamous cell, nasal turbinates, and hard palate (ARB, 1997).

b. Non-cancer

Short-term (acute) and long-term (chronic) exposure to dioxins may also result in non-cancer health effects. Acute exposure of humans to dioxins has caused chloracne, liver toxicity, skin rashes, nausea, vomiting, and muscular aches and pains. A severe weight loss in animals has been observed following acute exposure to dioxin as have hyperkeratosis, facial alopecia, inflammation of the eyelids, and loss of fingernails and eyelashes. The immune system appears to be very sensitive to dioxin toxicity. Thymic atrophy is a prominent finding in exposed animals and has been observed in all laboratory species examined. Other lymphoid tissues such as the spleen, lymph nodes, and bone marrow are also affected. Symptoms of chronic exposure to dioxins include splenic and testicular atrophy, elevated gamma-glutamyl transpeptidase levels, elevated cholesterol levels, and abnormal neurological findings. Other effects may include risk of enzyme induction, diabetes, and endocrine changes (ARB, 1997).

Human studies on the adverse reproductive and developmental effects of dioxins have proven inconclusive. Animal studies have shown 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin to be both teratogenic and fetotoxic. Reproductive and teratogenic effects observed in animals are cleft palate, kidney abnormalities, decreased fetal weight, and survival, hydrocephalus, open eye, edema, resorptions, petechiae, and infertility (ARB, 1997). The State of California under Proposition 65 listed 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin as a chemical known to the State to cause developmental toxicity in April 1991 (OEHHA, 2001b).

2. Benzene

Exposure to benzene may result in both cancer and non-cancer health effects. The probable routes of human exposure to benzene are inhalation and ingestion of drinking water (ARB, 1997).

a. Cancer

The OEHHA staff has performed an extensive assessment of the potential health effects of benzene, reviewing available carcinogenicity data. The OEHHA staff agrees with U.S. EPA and IARC that benzene is a human carcinogen with no identifiable threshold below which no carcinogenic effects are likely to occur. The Board formally identified benzene as a TAC in January 1985 (ARB, 1984). The State of California under Proposition 65 listed benzene as a carcinogen in February 1987 (OEHHA 2001b).

In 1990, the U.S. EPA listed benzene as a HAP pursuant to subsection (b) of Section 112 of the Federal Clean Air Act (42. U.S.C. 7412). The U.S. EPA has classified benzene in Group A: Human carcinogen based on sufficient epidemiological evidence. The IARC classified benzene in Group 1: Human carcinogen based on sufficient evidence in humans (ARB, 1997). Increased incidences of leukemias, especially acute myelogenous leukemia and its variants including erythroleukemia and myelomonocytic

leukemia, have been observed in humans occupationally exposed to benzene. A retrospective mortality study in China in 1989 has provided supporting evidence that benzene exposure is associated with cancers in humans. Animal cancer bioassays show benzene causes leukemia and a variety of other cancers including cancers of the lymphoid system, skin, ovary, oral cavity, lip, tongue, lung, mammary gland, and two secretory organs unique to rodents, the Zymbal and preputial glands (ARB, 1997).

b. Non-cancer

Short-term (acute) and long-term (chronic) exposure to benzene may result in non-cancer health effects. Brief inhalation exposure to high concentrations of benzene can cause central nervous system depression. Acute effects include central nervous system symptoms of nausea, tremors, drowsiness, dizziness, headache, intoxication, and unconsciousness. Benzene vapors are mildly irritating to the eyes and respiratory tract. Benzene can sensitize the myocardium to the arrythmogenic effects of epinephrine. Chronic human inhalation exposure can cause hematopoietic system decreases in erythrocytes, leukocytes, or platelets with progression to leukopenia, thrombocytopenia, pancytopenia, and/or aplastic anemia. Occupational exposures to low concentrations have been observed to have an initial stimulant effect on the bone marrow, followed by aplasia and fatty degeneration. Workers chronically exposed to benzene have shown alterations in serum levels of immunoglobulins (ARB, 1997).

Results from several studies conducted in rats and mice have indicated depressed cellular proliferation in the bone marrow from short-term exposures to benzene. In humans, there have been reports of menstrual disorders and possibly reduced fertility associated with benzene exposure, but these reports are limited by factors such as simultaneous exposure to several chemicals, or poor or no controls. In mice and rats, following inhalation of benzene during pregnancy, reduced fetal weight and other indications of growth retardation have been observed. Exposure of pregnant mice resulted in alterations of hematopoiesis in the fetus or offspring, but no effects on red or white blood cell count or hemoglobin analysis. The significance of the hematopoietic alterations is unclear (ARB, 1997). The State of California under Proposition 65 listed benzene as a chemical known to the State to cause developmental toxicity and male toxicity in December 1997 (OEHHA, 2001b).

3. 1,3-Butadiene

Exposure to 1,3-butadiene may result in both cancer and non-cancer health effects. The probable route of human exposure to 1,3-butadiene is through inhalation (ARB, 1997).

a. Cancer

The OEHHA staff has performed an extensive assessment of the potential health effects of 1,3-butadiene, reviewing available carcinogenicity data. The OEHHA staff agrees with U.S. EPA and IARC that 1,3-butadiene is a probable human carcinogen

with no identifiable threshold below which no carcinogenic effects are likely to occur. The Board formally identified 1,3-butadiene as a TAC in July 1992 (ARB, 1992). The State of California under Proposition 65 listed 1,3-butatiene as a carcinogen in April 1988 (OEHHA, 2001b).

In 1990, the U.S. EPA listed 1,3-butadiene as a HAP pursuant to subsection (b) of Section 112 of the Federal Clean Air Act (42. U.S.C. 7412). The U.S. EPA has classified 1,3-butadiene in Group B2: Probable human carcinogen. The International Agency for Research on Cancer has classified 1,3-butadiene in Group 2A: Probable human carcinogen based on limited evidence in humans and sufficient evidence in animals. The United States Occupational Safety and Health Administration has proposed that exposure to 1,3-butadiene is associated with an increased risk of death from cancer of the lymphohematopoietic system, and has classified 1,3-butadiene as a potential occupational carcinogen (ARB, 1997).

Epidemiological studies of production workers exposed to 1,3-butadiene provide limited evidence of an increased risk of death from hematologic neoplasms, especially leukemia and other lymphomas. Studies of mice exposed to concentrations of 1,3-butadiene indicate that 1,3-butadiene is taken up rapidly by the body and distributed with metabolites to all tissues. This distribution can result in cancer in multiple sites, including the heart, lung, mammary gland, ovaries, forestomach, liver, pancreas, thyroid, testes, and hematopoietic system. Exposure to 1,3-butadiene at higher concentrations is associated with tumors in the rat. It is important to note that 1,3-butadiene is 1 of only 2 chemicals (the other being the fungicide Captafol) known to induce cancer in the heart of laboratory animals (ARB, 1997).

b. Non-cancer

Short-term (acute) and long-term (chronic) exposure to 1,3-butadiene may result in non-cancer health effects. 1,3-butadiene vapors are mildly irritating to the eyes and mucous membranes and cause neurological effects such as blurred vision, fatigue, headache, and vertigo at very high levels. Epidemiological studies of workers in the rubber industry have shown an increase in cardiovascular diseases such as rheumatic and arteriosclerotic heart diseases and blood effects. Animal studies have shown respiratory effects, blood effects and hyperplastic changes to the heart from prolonged inhalation exposure to 1,3-butadiene.

No information is available on adverse reproductive or developmental effects of exposure to 1,3-butadiene in humans. There is evidence of reproductive toxicity in animal studies. Female mice exhibited ovarian atrophy from exposure to 1,3-butadiene at 6.25 parts per million. In developmental toxicity studies, 1,3-butadiene has been shown to be fetotoxic in the absence of producing maternal toxicity. At 40 parts per million in mice, 1,3-butadiene resulted in reduced fetal weight of males, and at 200 parts per million, reduced ossification was reported in fetuses (ARB, 1997).

4. Polycyclic Aromatic Hydrocarbons

Polycyclic aromatic hydrocarbons (PAHs) is within the group of chemicals known as particulate polycyclic organic matter (POM). POM was identified by the Board as a TAC in April 1993 when it formally adopted the federal HAPs as TACs as required by AB 2728 legislation (ARB, 1993a). Benzo[a]pyrene is in the PAH class of compounds. In April 1994, an exposure and health assessment for benzo[a]pyrene was prepared by ARB and OEHHA and reviewed by the ARB's Scientific Review Panel on TACs (ARB, 1994).

Exposure to polycyclic aromatic hydrocarbons (PAHs) may result in cancer health effects. The probable routes of human exposure to PAHs occurs through inhalation, ingestion and dermal contact (ARB, 1997).

a. Cancer

The OEHHA staff has performed an extensive assessment of the potential health effects of benzo[a]pyrene, reviewing available carcinogenicity data. The OEHHA staff agrees with U.S. EPA and IARC that benzo[a]pyrene is a probable human carcinogen with no identifiable threshold below which no carcinogenic effects are likely to occur (ARB, 1994). The State of California under Proposition 65 listed 25 PAH compounds (including benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, and indeno[1,2,3-cd]pyrene) as carcinogens between the years 1987 and 1990 (OEHHA, 2001b).

In 1990, the U.S. EPA listed POM as a HAP pursuant to subsection (b) of Section 112 of the Federal Clean Air Act (42. U.S.C. 7412). The U.S. EPA has classified benzo[a]pyrene in Group B2: Probable human carcinogen. The International Agency for Research on Cancer (IARC) has classified benzo[a]pyrene in Group 2A: Probable human carcinogen based on sufficient evidence in animals and limited evidence in humans.

Results from epidemiologic studies have indicated an increase in lung cancer occurs in humans exposed to coke oven emissions, roofing tar emissions, and cigarette smoke. Each of these mixtures contains a number of PAHs. Respiratory tract tumors have been reported in animals exposed via inhalation to benzo[a]pyrene and forestomach tumors, leukemia, esophageal and laryngeal tumors from oral exposure (ARB, 1997).

b. Non-cancer

No information is available on the acute effects of POM in humans. Enzyme alterations in the mucosa of the gastrointestinal tract and increased liver weights have been reported in animals exposed orally to several PAHs. Chronic exposure to benzo[a]pyrene in humans has resulted in dermatitis, photosensitization in sunlight, eye irritation and cataracts. Animal studies have reported effects on the blood and liver

from oral exposure to benzo[a]pyrene and effects on the immune system from dermal exposure to benzo[a]pyrene (ARB, 1997)

No information is available on adverse reproductive or developmental effects of POM in humans. Oral exposure to benzo[a]pyrene in animals has been reported to result in adverse reproductive effects, including reduced incidence of pregnancy and decreased fertility, and developmental effects such as reduced viability of litters and reduced mean pup weight, and decreased fertility in offspring. Benzo[a]pyrene has been demonstrated to cause transplacental carcinogenesis in animals (ARB, 1997).

5. Polychlorinated Biphenyls

Exposure to PCBs may result in both cancer and non-cancer health effects. The probable routes of human exposure to PCBs occurs through inhalation, ingestion, and dermal contact (ARB, 1997).

a. Cancer

The OEHHA staff has performed an extensive assessment of the potential health effects of PCBs, reviewing available carcinogenicity data. The OEHHA staff agrees with U.S. EPA and IARC that PCBs are a probable human carcinogen (OEHHA, 1999b). The Board identified polychlorinated biphenyls (PCBs) as a TAC in April 1993 when it formally adopted the federal HAPs as TACs as required by AB 2728 legislation (ARB 1993a). The State of California under Proposition 65 listed polychlorinated biphenyls and polychlorinated biphenyls (containing 60 or more percent chlorine by molecular weight) as carcinogens in October 1989 and January 1988 respectively (OEHHA, 2001b).

In 1990, the U.S. EPA listed PCBs as a HAP pursuant to subsection (b) of Section 112 of the Federal Clean Air Act (42. U.S.C. 7412). The U.S. EPA has classified PCBs as Group B2: Probable human carcinogen. The IARC has classified PCBs as Group 2A: Probable human carcinogen (ARB, 1997).

Human studies were inconclusive but suggest an association between exposure to PCBs and liver cancer. In studies in which rats and mice were orally exposed to some PCB formulations, an increased incidence of liver tumors was observed (ARB, 1997).

b. Non-cancer

Short-term (acute) and long-term (chronic) exposure to PCBs may result in non-cancer health effects. Exposure to PCBs may cause skin, eyes, nose, throat, and respiratory tract irritation. Chronically overexposed workers may suffer from chloracne and mild liver injury. Infrequently reported symptoms include anorexia, gastrointestinal upset, and peripheral neuropathies. In animal studies, oral exposure to PCBs was reported to cause possible liver, kidney, and central nervous system effects (ARB, 1997).

Mothers exposed to PCBs through fish consumption have given birth to infants with adverse developmental effects including motor deficits, impaired psychomotor index, impaired visual recognition memory, and deficits in short-term memory. Decreased birth weights and lower gestational age at birth are reported among women occupationally exposed to high levels of PCBs as compared to lower levels of PCBs. Animal studies have reported learning deficits, impaired immune function, cellular alterations of the thyroid, and reproductive effects such as decreased fertility, decreased conception, and disrupted ovarian cyclicity (ARB, 1997). The State of California under Proposition 65 listed polychlorinated biphenyls as a chemical known to the State to cause developmental toxicity in January 1991 (OEHHA, 2001b).

D. Summary of the Potential Health Impacts from Residential Waste Burning

This section presents the potential health impacts from the analysis that was performed for residential waste burning. Potential health impacts are discussed both in terms of individual risk, as well as community exposure.

1. Individual Health Impacts

Both carcinogenic and non-carcinogenic individual health risk impacts were estimated at a variety of locations ranging from 20 to 1,000 meters downwind from a single burn barrel. Depending upon property size, these distances could reflect impacts on both an individual household, as well as neighboring households.

Table V-2 provides an overview of the potential multipathway health impacts at 20 meters using both default meteorological conditions from SCREEN3 and site-specific meteorological data from four locations across California (Alturas, Bishop, San Benito, and Escondido). The purpose of presenting this data at a near-source location of 20 meters is to illustrate what the potential health impacts may be if a resident is located in close proximity to a burn barrel. ARB staff observed burn barrels well within the 20 meter distance during tours provided by local air district personnel of residential locations with burn barrels.

The table also provides estimates of potential cancer risk for each exposure pathway. Since an individual’s potential cancer risk will vary depending upon the routes they are exposed to, the exposure pathways are presented separately to provide a feel for how each pathway contributes to the total potential cancer risk. An individual's total

potential cancer risk can be determined by adding together the potential cancer risk for each exposure route. The four basic pathways of inhalation, soil ingestion, skin absorption, and mother's (breast) milk are considered minimum pathways for this assessment of residential waste burning (OEHHA, 2001c). However, the other pathways (homegrown crops, meat, and cow's milk) can be included or not, depending upon individual lifestyles. For example, an individual who does not consume meat from their own animals would not include the potential risk numbers from that exposure route in their estimate of total potential cancer risk. If they have no homegrown crops, then the crop pathway would not be included.

For more detailed information, tables B-1 to B-5 in Appendix B present the potential multipathway health impacts at 20, 50, 100, 200, 500, and 1,000 meter distances for each meteorological condition or site-specific meteorological data set.

Table V-2 shows a range of near-source potential multipathway cancer risk across all meteorological conditions or data sets at approximately 6 to 2,300 chances per million. The lower end of this range includes the potential cancer risk from inhalation, soil ingestion, dermal absorption, and breast milk pathways (OEHHA 2001c). The upper end of the range estimates potential cancer risks across all included exposure pathways (i.e., the four minimum pathways plus crop, meat, and milk ingestion).

The highest non-cancer acute inhalation hazard index is 0.02. The highest non-cancer chronic hazard index for the minimum the exposure pathways (inhalation, soil, dermal) is 0.08 and the highest non-cancer chronic hazard index across all pathways is 2.0. Generally, hazard Indices less than 1.0 are not considered to be a concern to public health. Hazard indices greater than 1.0 could be an indicator for potential non-cancer health impacts. However for this assessment, hazard indices greater than 1.0 are only present when all exposure pathways are included. As discussed above, if an individual's lifestyle does not include all exposure pathways then their potential health risk would be reduced.

Table V-2. Overview of the Potential Health Impacts from Residential Waste Burning at 20 Meters [1,2]

Exposure Pathways [3, 4]	Meteorological Data				
	SCREEN3	Alturas	Bishop	San Benito	Escondido
	Cancer Risk (chances per million)				
Inhalation	44	3.3	4.6	6.4	8.2
Soil Ingestion	16	1.2	1.6	2.2	2.9
Skin Exposure	14	1.0	1.4	2.0	2.6
Mothers Milk [5]	8.9	0.7	1.0	1.3	1.7
Backyard Garden	56	4.2	5.8	8	10
Meat and Eggs	1010	75	105	145	187
Milk (cow)	1160	86	120	166	215
Total Cancer Risk	2309	172	239	331	428
	Non-Cancer Hazard Indices				
Acute Inhalation[6]	0.02	0.01	0.02	0.02	0.02
Chronic Multipathway [7]	0.08 – 2.0	0.15	0.2	0.3	0.4

1. All results are rounded. Potential health impacts are calculated from air dispersion modeling results and risk at 20 meters. Emissions for dioxins and PCBs are from the U.S. EPA 2000 source tests. Emissions for benzene, 1,3-butadiene, and PAHs are from the U.S. EPA 1997 source tests.
2. All risk assessment results are based on a 70-year exposure for all pathways except the mother's (breast) milk pathway (44-year). Results are based on the CAPCOA Risk Assessment Guidelines methodology, HRA 2.0e, and the updated OEHHA cancer potencies and reference exposure levels as of January 2001.
3. All pathways of exposure are assumed to occur at the same distance (location) from the source.
4. Emissions are assumed to be uncontrolled (0.05 factor). Multipathway route assumptions include: 15% of produce in the receptor's diet is homegrown; 100% of dietary meat (beef, pork, and chicken), eggs, and cow's milk is impacted; 50% of cattle's diet is from impacted grassland and other feed is not contaminated; Farm animal drinking water is from a 300 gallon trough, measuring one square meter, and is consumed every 3.75 days byr one lactating cow.
5. PCB contribution calculated by ratio of PCB to PCDD body half-life (0.7) multiplied by the PCDD & PCDF mother's milk to inhalation ratio.
6. Benzene impacts were assessed using 6-hour average concentrations. Primary endpoints are cardiovascular or blood, reproductive system, and immune system.
7. Dioxins, PAHs, and PCBs were assessed for chronic impacts. Includes both inhalation and non-inhalation exposure pathways. Primary endpoints are reproductive system, cardiovascular or blood, and nervous system. The lower end of the range includes inhalation, soil, and dermal exposure pathways. The upper end of the range includes all exposure pathways, except mother's milk.

The potential cancer risk for the four minimum pathways at the near-source (20 meters) residential receptor ranges from 6.2 chances per million at Alturas to approximately 83 chances per million under SCREEN3 meteorological conditions. Benzene, 1,3-butadiene, and dioxins are the primary contributors to the potential health impacts through inhalation exposure. Dioxins, PAHs, and PCBs are the primary contributors to the potential cancer risk through ingestion pathways. Depending upon the environmental setting of the emission's source, additional pathways such as consumption of produce from backyard gardens, home-raised meat, and cow's milk could be considered. If these additional pathways are considered, the range of total potential cancer risk increases to approximately 170 chances in a million at Alturas and approximately 2,300 chances per million under SCREEN3 meteorological conditions. These risk estimates assume that burning occurs twice per week for two hours throughout the year. In some years, CDF may impose a ban on burning during the summer fire season. Depending upon meteorological conditions, a reduction in the

period of burning would result in no reduction in potential health impacts up to a 20 percent reduction.

2. Community Health Impacts

Dioxins are emitted from the burning of residential waste materials which can have near source impacts on individuals in the household conducting the burning and on nearby neighbors. However, there is also a broader community impact from the dioxins generated from this source. Dioxins are widespread throughout the environment, representing the cumulative emission impacts from many sources, including residential waste burning. Although dioxins are formed from almost all combustion sources, the most toxic forms are generated by burning manmade substances. The most toxic forms existed only in trace amounts in the environment prior to the 1930's.

Dioxins emitted from a source can travel long distances because they exist partially in the vapor form and partially in the particulate form. They have a half-life in the atmosphere of several days. Eventually, the dioxins in the air are deposited onto vegetation, waterways and the soil.

Once deposited, dioxins are highly persistent, with the half-life in the soil surface estimated at 9 to 15 years, and in the soil subsurface at 25 to 100 years. Dioxins can also accumulate in the fat of fish and animals and are concentrated up the food chain. It is estimated that up to 90% of dioxin intake for a typical person comes from dietary intake of animal fats (Gilman & Newhook, 1991). These various environmental sources lead to widespread, low-level exposure of the general population to dioxins. Because dioxins can be passed through mothers milk, young children are especially vulnerable. Children may also be more sensitive to dioxin exposure because of their rapid growth and development (U.S. EPA, 2001a).

Reducing emissions from the sources that emit dioxin into the atmosphere can therefore reduce community exposure to dioxins. The typical person continues to accumulate dioxins over a lifetime. Current average body burdens are close to levels at which effects on the immune system occur. In addition, current average body burdens pose an unacceptable cancer risk. Countries around the world, including the United States have recognized the public health threat posed by dioxin emissions. They have been taking steps to reduce dioxin emissions with measurable success. Further reductions are dependent upon eliminating sources such as residential burning.

VI. THE PROPOSED CONTROL MEASURE AND ALTERNATIVES

In the previous two chapters we assessed emissions and potential risk from residential waste burning. This chapter contains a summary of the proposed control measure and provides the basis for selecting the provisions being proposed and alternatives we considered in developing this proposal. The proposed ATCM is set forth in Appendix A.

A. Summary of the Proposed Control Measure

1. General Provisions

The proposed control measure would minimize emissions of dioxins, as well as other toxic air contaminants such as benzene, 1,3-butadiene, PAHs, and PCBs, and the criteria pollutant, particulate matter, from residential waste burning by addressing both the materials which can be burned, and the method of burning. The proposed ATCM prohibits the burning of residential waste, other than natural vegetation, anywhere in the State except for areas that qualify for a temporary exemption based upon specified criteria. The use of burn barrels would also be prohibited statewide, except in the exempt areas, as a means of ensuring that such barrels are not used for the burning of prohibited residential waste.

The ATCM would require the use of an ignition device approved by the Air Pollution Control Officer. A variety of devices or materials can be used to ignite residential waste fires, ranging from propane to diesel fuel. This provision will require the use of ignition devices that ensure a fire that ignites quickly and that minimizes the production of smoke, as appropriate to the conditions and materials burned in each air district.

It would also prohibit the burning of allowable combustibles, including natural vegetation, as defined in the regulation, unless it is a permissive burn day in the air district where the residential burning takes place. This requirement aligns the burning of residential waste with the requirements for agricultural and prescribed burning. Burning only on permissive burn days will ensure optimal conditions for smoke dispersion and minimize nuisance and health impacts.

2. Applicability

The proposed ATCM applies to persons conducting outdoor burning of combustible or flammable waste generated from inside residences, and from outdoor activities associated with a residence, for the purpose of disposing of the waste. The proposed ATCM also applies to persons lighting fires that burn combustible or flammable waste in enclosed or partially enclosed vessels, such as incinerators or burn barrels, or in an open outdoor fire, such as in pits or in piles on the ground.

3. Exemptions

With the concurrence of the ARB, air districts may specify geographic areas that will be exempt from the prohibitions in the ATCM if they meet criteria including, but not limited to, all of the following:

1) no available waste pickup service, considering reasonable cost and frequency of service; and
2) greater than a reasonable distance from an approved transfer station or disposal facility or a communal or community dumpster, considering road miles or time traveled, road conditions, terrain, weather conditions, reasonable tipping fees, and hours of operation; and
3) low population density per census tract or other appropriate sub-unit of the county area.

Exemptions would only apply to residential waste materials that are allowed under air district or local jurisdiction rules in effect as of the date of hearing notice for the Board meeting to consider the proposed ATCM. The use of burn barrels would also be allowed in these exemption areas.

In order to be considered for exemptions, air districts must submit documentation to the ARB, which has been approved by the air district Board at a public hearing, by March 1, 2003. The air district must provide mapped excluded geographic areas with a detailed, written justification for the mapping based on the criteria listed above. The justification must also include a demonstration that waste disposal alternatives are not likely to become available within the next five years.

ARB would have 60 days to review the documentation and approve or disapprove the request. If the request is disapproved, the air district must resubmit the request within 30 days. However, it is ARB's intention to work with the air districts requesting exemptions in advance of request submittals in order to provide guidance on exemption criteria and to facilitate the approval process. A determination of allowable exemption areas would be revisited every five years. At that time, air districts must demonstrate to the ARB that the criteria for the exemptions are still met, and that waste disposal services for these areas were not expected within the next five-year time frame. Table VI-1 summarizes the requirements of the proposed ATCM. A further discussion of the exemption criteria is provided in section B.3.

4. Schedule

The provisions of the regulation would be effective on July 1, 2003. As discussed above, Requests for Exemptions would need to be submitted by March 1, 2003 to allow time for ARB review and approval prior to the effective date of the regulation.

Table VI-1. Requirements of the Proposed ATCM

Applicability	Exemptions	Requirements
Applies to all areas of the State.	Allowed based upon air district documentation of areas which meet the criteria, and with ARB concurrence: 1) availability and cost of waste service, 2) distance from and accessibility of an approved transfer station or landfilll, and 3) low population density	**Effective March 1, 2003:** By this date, air districts must submit Requests for Exemption with appropriate documentation and justification. **Effective July 1, 2003:** The provisions of the ATCM become effective. **Effective Every Five Years after July 1, 2003:** Air districts may request continuing exemptions. Air districts must submit documentation that the criteria for the exemptions still exist.

B. Basis For The Proposed Regulation

California Health and Safety Code section 39665(b) requires the Board to address the technological feasibility of proposed ATCMs. Health and Safety Code section 39665(b) also requires the Board to address the "availability, suitability and relative efficacy" of substitute products of a less hazardous nature when proposing an ATCM. In addition to the issues to be addressed under Health and Safety Code section 39665(b), Health and Safety Code section 39666 requires that any control measure for a TAC without a Board-specified threshold level be designed to reduce emissions to the lowest level achievable through the application of best available control technology (BACT) or a more effective control method.

To evaluate these factors, we reviewed existing literature on emissions from residential waste burning, assessed control programs in other states, and held numerous discussions with waste management agencies, waste service providers, the CIWMB, fire protection agencies, and air districts about enforcement and the feasibility, cost, and environmental impacts of alternative methods for disposing of prohibited residential waste materials. We also reviewed existing air district rules governing residential waste burning.

1. Best Available Control Technology

Dioxins are a by-product of the combustion of residential waste materials containing carbon and chlorine during low temperature, poor oxygen conditions. While the burning of natural vegetation does produce some dioxins, the emissions are much lower than the emissions from the burning of manmade materials. In addition, the burning of

natural vegetation produce dioxin isomers which are less toxic. Dioxins are optimally formed when combustion temperatures are within a window of 250° C and 700° C. The formation of dioxins can be minimized or eliminated through careful control of combustion conditions, including maintaining combustion temperatures at approximately 1000°C for a minimum of 1 second. For major sources such as municipal and hospital waste incinerators, combustion conditions can be carefully controlled, and the required high temperature and residence time can be achieved. However, this type of controlled combustion is not feasible for small residential burning sources such as backyard burn barrels or piles. No external control technologies, or changes in burning practices, are available or achievable to reduce or eliminate dioxin emissions from residential burning.

Testing performed by the U.S. EPA (U.S. EPA, 1997a; Lemieux, 2000) on a mixture of residential waste materials including household food waste, plastics, glass, metal cans, and paper demonstrated that dioxins are emitted during the burning of these materials. As discussed in Chapter III, the burning of waste in burn barrels provides optimal conditions for the formation of dioxins, including low combustion temperatures and low oxygen availability. Typical combustion temperatures in burn barrels measured during the U.S. EPA tests ranged from 50° C to 600° C, with temperatures within the optimal 250° C to 700° C window for a significant portion of the test duration (U.S. EPA, 1997a).

Individual tests are not available to quantify the dioxin emissions from separate material types such as paper and cardboard. While the burning of plastics produces the greatest amount of dioxins, both carbon and chlorine are present in all residential waste materials, including paper and cardboard. Most paper and cardboard also contains inks and dyes that can also release other toxic air contaminants when burned. Additionally, many modern paper products contain small amounts of plastics or have plastic linings. Therefore, staff determined that best available control technology for residential waste burning would be a prohibition on burning of all types of residential waste materials other than natural vegetation. As noted in previous chapters, seven air districts already prohibit the burning of non-vegetative materials, and six air districts already prohibit the use of burn barrels.

2. Effectiveness

The proposed control measure would prohibit the burning of all residential waste materials with the exception of natural vegetation except in areas with limited exemptions. We estimate that approximately 108,000 households are burning some form of non-vegetative waste and would be affected by the proposed regulation. In the non-exempt areas, the proposed control measure would result in a complete elimination of dioxins and other TACs generated from the burning of the prohibited residential waste materials, although the potential for illegal burning of prohibited materials could still exist. We recognize that in some areas, alternatives to burning residential waste materials are not available at a reasonable cost. Therefore, the proposed ATCM allows for limited exemption areas. However, exempted areas would need to meet stringent criteria, with documentation provided by the air district, and with concurrence from the

ARB. We estimated the number of households that might be exempt under the criteria specified in the proposed regulation by assuming that only those households living outside an incorporated community would be likely to meet the exemption criteria. Based upon the distribution of population in incorporated versus unincorporated areas in the portion of each air district that allows burning of residential waste, we estimate that up to 67,000 households could be exempt. This is approximately 62 percent of the 108,000 households that are estimated to be currently burning some form of residential waste.

3. Criteria for Exemptions

Pursuant to State law, control measures for TACs without a Board-specified threshold exposure level such as dioxins must be based on best available control technology in consideration of cost and risk. We developed a three-tiered exemption criteria approach that is designed to minimize public health risk in consideration of cost and feasibility in implementing best available control technology. These exemption criteria were developed recognizing that there are some areas in the State where feasible and cost-effective alternatives to burning of residential waste are not available. However, exemptions must also address the need to minimize public exposure to dioxins and other TACs generated from residential waste burning.

In order request an exemption, an area must meet all three criteria: 1) no available waste pickup service, considering reasonable cost and frequency of service; 2) greater than a reasonable distance from an approved transfer station or disposal facility or a communal or community dumpster, considering road miles or time traveled, road conditions, terrain, weather conditions, reasonable tipping fees, and hours of operation; and 3) low population density per census tract or other appropriate sub-unit of the county area.

Based upon discussions with air districts and waste management agencies, staff determined that these exemption criteria must be flexible enough to address the unique variability in waste disposal options and topography in each air district, while maintaining an appropriate level of health protection. Thus "one-size-fits all" exemption criteria were not appropriate. The following sections discuss the various factors that influence how these exemption criteria may be met.

a. Availability of Waste Service

A number of different forms of curbside waste service exist throughout the State. Many jurisdictions require mandatory garbage service. Mandatory service is defined as service by a franchised waste provider where the household is required to pay for and use the service. Voluntary service is defined as households that are served by a franchised waste service provider, but where the household may elect to use or not use the service. Finally, discretionary service represents households which are not served by a selected franchise waste service, but which may contract for waste services on their own.

Under the exemption criteria, areas with mandatory or voluntary waste service would be considered to have available waste service. However, areas with discretionary service may meet the first exemption criteria. In these areas, waste providers may not be willing to serve all households due to access problems, or the cost of service may be many times higher than contracted rates for the mandatory and voluntary service areas. For example, in San Benito County, mandatory or voluntary service is provided to all households in the northern portion of the county. However, households in the more remote southern portions of the county have discretionary service only. In areas with discretionary service, the feasibility and cost of the service will be considered in determining whether an area meets this exemption criteria. Cost for service that exceeds twice the median cost for currently served mandatory and voluntary areas in the air district would be considered high.

b. Distance to Approved Disposal Facility

Many households that do not contract for regular curbside pickup elect to self-haul their residential waste to approved landfills, transfer stations, or recycling facilities. The number and location of these facilities in relation to the locations of households varies throughout the State. Many counties have no landfills, and provide only transfer stations. The waste from these transfer stations is then sent to landfills in other counties or out of State. The distance an individual household would have to travel to dispose of their waste therefore varies in each air district. In addition, reasonable travel distances can vary depending upon road conditions, posted speed limits, terrain, and weather conditions. A reasonable travel distance in a county with flat terrain, may be unreasonable in another county with mountainous terrain and poor roads. For example, current rules in the Kern County air district specify that households within 15 miles of an approved landfill or transfer station may not burn their residential waste. However, this criteria may not be appropriate in a more mountainous region. In general, a half-hour travel time, or approximately 15 miles would be considered a reasonable distance.

The operating hours and tipping fees for a disposal facility may also be considered. For example, in Modoc County, many of the transfer stations are only open a few days a week, with limited operating hours. Therefore, the location of landfills and transfer stations, their operating schedule, and reasonable travel distances in relation to the locations of households all need to be considered in determining whether a specific area would meet the second exemption criteria.

c. Population Density

The population density exemption criteria were developed to ensure that any allowable burning would minimize public exposure to dioxins and other TACs. In addition, it is recognized that it is more difficult to establish regular waste pickup service at a reasonable cost in sparsely populated areas than in more densely populated areas. Due to differences in topography and meteorological dispersion conditions that affect exposure levels, staff determined that specifying a single population density value in the proposed regulation was not appropriate. In addition, the distribution of the population in a given area must be considered. For example, a more densely populated area may exist within a broader region of very low population density. In this situation, the average population density could be very low, however, protection of public health would not be achieved by allowing burning in the more densely populated sub-area. Therefore, the criteria specify that population density exemptions must be made on a sub-county basis such as a census tract or other unit of zoning.

4. Enforceability

Primary responsibility for enforcement of the proposed control measure, as with all ATCMs, would be with the air districts. However, the ARB is also authorized to enforce ATCMs (Health and Safety Code section 39669). Prohibitions on the burning of all residential waste materials other than natural vegetation facilitates enforcement efforts by creating a clear distinction between the types of materials which can and cannot be burned. In addition, the enforceability of the proposed control measure is enhanced through the elimination of burn barrels. Air districts report that many households burn prohibited materials in burn barrels.

In July 1997, the Lake County Air Quality Management District conducted a survey of burn barrel contents from burn barrels randomly selected throughout the county. Inspectors found that greater than 90% of the 52 burn barrels evaluated had illegal materials in them. Burn barrel contents included batteries, diapers, flashlights, children's toys, electronic devices, and other illegal materials (Lake County AQMD, 2001a, Lake County AQMD, 2001b).

In September 2001, ARB surveyed the 21 air districts in California which allow residential waste burning, but not garbage burning. The purpose of the survey was to determine how many burn barrels there are in each of those air districts and what percentage are found to contain illegal materials in them. All 21 air districts surveyed responded. The initial survey found that there were about 113,000 burn barrels burning residential waste. Some numbers were subsequently revised based on further conversations with the air districts, resulting in our best estimate of 93,000 households burning residential waste. Fifteen of the 21 air districts that responded to the survey reported that greater than 50% of burn barrels in their air district have illegal materials burned in them (ARB, 2001).

It is often difficult for air district enforcement staff to determine whether prohibited materials have been burned in burn barrels. The use of open piles on the ground for the burning of natural vegetation will therefore facilitate improved air district enforcement efforts. A strong public education and outreach campaign to alert the public to the health impacts of residential waste burning and the availability of alternative waste disposal options will also assist with compliance efforts and minimize the incidence of illegal burning.

5. Cost and Resource Requirements

The proposed control measure would have a limited fiscal impact on the State and air districts, primarily in terms of enhanced public education and outreach, and enforcement. It would also have a limited economic impact on consumers and local waste management agencies where new service is established. These economic impacts are discussed in Chapter VII.

6. Environmental Effects

The proposed control measure was evaluated for potential impacts on waste diversion rates, landfill capacities, illegal dumping, illegal waste storage, increased vehicle traffic due to expanded waste pickup service, and fire safety. Based on available information, the ARB has determined that no significant adverse environmental impacts should occur. Environmental impacts are discussed in Chapter VIII.

7. Alternative Waste Disposal Methods

The proposed control measure will require some households to use waste disposal methods other than burning for some or all of the residential waste. The greatest impact will be seen in the six air districts where there are no restrictions on the materials that can be burned, and where some households therefore may not be using any other alternative disposal mechanisms. Some of these waste materials, such as food waste and other organic materials, can be composted, and probably already are in many rural households. The remaining waste will need to be disposed of at a landfill, transfer station, or recycling center, either through self-hauling or contracting for curbside pickup. In areas where these disposal options are not available, considering cost and feasibility, limited exemptions will allow for the continued burning of residential waste. It should be noted however, that in some years, the CDF invokes a ban on all residential burning during fire season, typically between July and October. During these months, households may already be using some of the alternative disposal methods discussed above.

In the remaining 21 air districts which already prohibit the burning of household garbage, households are already disposing of a portion of their waste through non-burning methods, presumably through curbside pickup or self-hauling. The proposed control measure will require these households to dispose of additional materials, primarily paper and cardboard, through the same non-burning disposal methods.

Other options to dispose of residential waste materials include the purchasing of products that minimize the use of packaging and re-using materials, as well as shredding and compacting of waste to reduce bulk.

8. Health Impacts

The proposed ATCM would result in a substantial reduction of dioxins and other TACs from residential waste burning. As discussed in Chapter V, dioxins from residential waste burning impact not only individuals located near the source of the burning, but also the broader population due to their transport and deposition onto soil, water, and vegetation. Dioxins can accumulate in the fatty tissues of animals that ingest the water and vegetation. Further bioaccumulation occurs when the meat, milk, and eggs from these animals are ingested by humans. Dioxin emissions from residential waste burning contribute to this global accumulation of dioxins in the environment. Emissions of dioxins from other large sources such as municipal and medical waste incinerators have been controlled. The U.S. EPA estimates that emissions from residential waste burning are one of the largest remaining sources of uncontrolled emissions of dioxins (U.S. EPA, 2001b). Therefore, reductions in the emissions from residential waste burning will reduce the environmental loading of dioxins and further reduce public exposure to dioxins and resultant health impacts.

C. Alternatives to the Proposed Control Measure

Staff identified two alternatives to the proposed control measure. This section discusses each of the two alternatives, and provides the reasons they were considered to be less effective than the proposed regulation. The first alternative was to take no action, to allow the continued burning of residential waste, and the use of burn barrels. The second alternative was to prohibit only the burning of household garbage. We determined that these alternatives would not be as effective at reducing emissions of and exposure to dioxins and other TACs from residential waste burning activities as the proposed control measure. Furthermore, the two alternatives did not meet the HSC section 39666 criterion to reduce emissions to the lowest level achievable through the application of best available control technology, or a more effective control method, in consideration of cost, risk, and environmental impacts.

1. Alternative One - No Action

The “no action” alternative would not address the potential risk posed by residential waste burning activities. As evidenced by the potential health impacts discussed in Chapter V, this alternative would not be protective of public health.

2. Alternative Two – Prohibition Only on Burning of Household Garbage

This alternative would prohibit only the burning of household garbage. Under this alternative, households would still be allowed to burn their non-garbage wastes, such

as paper, cardboard, wood products, and cloth. This would affect only six air districts, or approximately 15,000 households that are likely to be burning residential waste in these areas. However, this option would be less protective of public health and would not promote the development and expansion of alternatives to burning in as many areas. In addition, the alternative would do little to minimize the illegal burning of garbage in burn barrels, or the burning of materials such as paper in more densely populated areas.

D. Recommendation

As a result of the evaluation, with incorporation of recommended exemptions, we consider the proposed ATCM to be environmentally, technically, and economically feasible, resulting in a safe, effective, and less-hazardous alternative to burning. Based on this evaluation, we believe that it is appropriate prohibit residential burning of all materials with the exception of natural vegetation, as well as to eliminate the use of burn barrels.

VII. ECONOMIC IMPACTS OF THE PROPOSED AIRBORNE TOXIC CONTROL MEASURE

This chapter discusses the impacts that the proposed ATCM may have on consumers as well as costs to businesses and local, State, and federal agencies.

A. Economic Impacts Analysis on California Businesses as Required by the California Administrative Procedure Act (APA) and other State Law

1. Legal Requirements

Section 11346.3 of the Government Code requires State agencies to assess the potential for adverse economic impacts on California business enterprises and individuals when proposing to adopt or amend any administrative regulation. The assessment shall include a consideration of the impact of the proposed regulation on California jobs, business expansion, elimination or creation, and the ability of California business to compete with businesses in other states.

Also, State agencies are required to estimate the costs or savings to any State or local agency and school district in accordance with instructions adopted by the Department of Finance. The estimate shall include any nondiscretionary costs or savings to local agencies and the costs or savings in federal funding to the State.

Health and Safety Code section 57005 requires the ARB to perform an economic impact analysis of submitted alternatives to a proposed regulation before adopting any major regulation. A major regulation is defined as a regulation that will have a potential cost to California business enterprises in an amount exceeding ten million dollars in any single year. The proposed ATCM is not a major regulation.

2. Affected Businesses

Waste service providers in the 27 air districts that currently allow some form of residential waste other than natural vegetation to be burned could be affected by the proposed control measure. We estimate that there are more than 100 waste service providers that serve these air districts. Private recycling centers and waste disposal facilities could also be affected.

3. Potential Impact on Consumers

Consumers who are currently burning their residential waste may have to pay more to dispose of these materials. The proposed ATCM would require them to obtain waste disposal services or to self-haul their waste to landfills or transfer stations. In some areas, new waste service routes may need to be developed. In other areas, new customers may be added to existing routes. The increased cost will vary depending upon the costs associated with increasing waste management service in their area.

We surveyed a number of local waste management agencies to determine the costs and availability of service. Based upon surveys conducted by ARB staff, and information from the CIWMB, we identified several forms of service and cost structures for service. Many jurisdictions require mandatory garbage service. Mandatory service is defined as households that are served by a franchised waste provider selected by the jurisdiction where the household is required to pay for and use the service. Voluntary service is defined as households that are served by a franchised waste service provider selected by the jurisdiction, but where the household may elect to use or not use the service. Finally, discretionary service represents households which are not served by a selected franchise waste service, but which may contract for waste services on their own.

Within these forms of service, there are also a number of cost structures. In many jurisdictions, a standard monthly fee covers the cost of pickup of one 32 gallon trash container per week. Incremental fees often apply for additional or larger containers. In other jurisdictions, the monthly fee is fixed regardless of the number or size of container. Not all areas require the separation of natural vegetation (also known as green waste) and recyclable materials in the waste containers. However, where this is done, some include separate green waste and recyclable containers as part of the overall monthly fee, while other jurisdictions may charge a small additional fee.

A number of different fee structures also exist for landfills and transfer stations. In most jurisdictions, consumers pay what is known as a tipping fee. This tipping fee is based upon the amount of material dropped off, and is often assessed by weight or volume. However, there are some jurisdictions, such as eastern Kern County, where all households are assessed a flat annual fee for landfill services. This fee entitles each household to drop off their waste materials at county landfills, and no "per use" tipping fee is assessed. While some landfills and transfer stations do not separate the materials that enter the landfill, many establish separate areas for recyclable materials. Generally recyclable materials can be dropped off for no cost.

Based on surveys, we found that consumer costs for monthly curbside waste pickup generally range from $8 to $25. This is typically 1 pickup per week for one or two 32 gallon containers. In some jurisdictions, additional fees are charged for additional cans, and/or for containers for recyclable materials. These additional fees can range from $3 to $10 per month. We estimate that a consumer who did not previously contract for waste service could therefore incur new yearly costs for waste pickup of $96 to $420. This would apply primarily to consumers in the six air districts where there are no restrictions on the materials that can be burned. In these air districts there may be households where waste disposal options other than burning have not previously been used. In the remaining 21 air districts where the burning of household garbage has already been prohibited, it can be assumed that consumers are already using some form of alternative waste disposal, whether it is curbside pickup or self-hauling. These consumers however may have some additional waste that was previously burned. Assuming that these consumers live in jurisdictions where additional fees would apply

for extra cans or recycling containers, they could incur additional yearly costs of $36 to $120.

It is also possible that the expansion of existing routes could result in enhanced economies of scale and some incremental reduction in costs to all consumers already receiving service. Establishing service for a remote area not previously served however, could necessitate service fees which are two to three times higher than the typical fees described above. In this instance, the cost of service could be a consideration in requesting an exemption for the specified area.

Alternatively, some consumers may elect to self-haul their waste to landfills and transfer stations. Typical tipping fees for landfills and transfer stations generally range from $25 to $85 per ton of compacted waste disposed or $3 to $20 per cubic yard of uncompacted waste. Some landfills also charge on a per vehicle basis, regardless of the amount of waste. However, as discussed above, some landfills and transfer stations have established sorting areas for recyclable materials, and consumers are not charged for the portion of their waste which is recyclable.

Assuming that a household would make one trip per week to a landfill or transfer station, with one half a cubic yard of waste in each trip, staff estimates that a consumer who previously burned all of their waste could incur yearly costs of $78 to $520 to self-haul their waste materials. These costs could be reduced in areas where recyclable materials are separated. Consumers who had previously been self-hauling only a portion of their waste, and burning the rest, would incur lower additional yearly costs. Again, these costs could be reduced if the additional waste, which is often paper and cardboard, was brought to a recycling facility. Households that self-haul could also incur additional fuel costs to transport the material to the landfill or transfer station. Assuming a round trip distance to the landfill or transfer station of 20 miles, a fuel cost of $1.50 per gallon, and a fuel efficiency of 20 miles per gallon, a household that previously burned all their waste could incur additional costs of $1.50 per trip. At 52 trips per year, that additional fuel related costs would amount to $78 per year. This cost would be less for households that previously transported some of their waste materials, and only increase the frequency of trips as a result of the proposed regulation.

4. Potential Impact on Employment, Business Creation, Elimination or Expansion

The proposed ATCM is not expected to have a noticeable impact on the status of California businesses. The primary businesses affected would be waste service providers as well as operators of private recycling centers and waste disposal facilities. The proposed ATCM may actually create some business opportunities and employment for California waste service providers in areas where either additional households opt into service where service had been voluntary, or where service areas are expanded. New or expanded opportunities could also be created for recycling facilities.

5. Potential Impact on Business Competitiveness

The proposed ATCM would have no impact on the ability of California waste service providers to compete with similar businesses in other states. Waste service contracts are determined on a local jurisdictional basis. The requirements of the proposed ATCM would affect all waste service providers competing for a contract, regardless of where they originate from.

B. Analysis of Potential Impacts to California State or Local Agencies

1. Costs to Air Districts

Although there are no specific mandates, the proposed ATCM could have some small, but unquantifiable, economic impacts on the air districts. Health and Safety Code section 39666 requires that after the adoption of the proposed ATCM by the Board, the air districts must enforce the ATCM or adopt and enforce an equal or more stringent regulation. Beginning in July 2003, the air districts, during their normal course of business, will be responsible for enforcement activities and responding to complaints. The proposed regulation does not contain any specific requirements for enforcement or inspection. In addition, because most air districts already have rules and regulations in place that necessitate enforcement for currently prohibited materials, the enforcement efforts required for the proposed regulation would build upon these existing efforts. Air districts are also provided with State funding through the subvention process. Air districts have discretion in using this funding for enforcement purposes, and can apportion the funding based upon program needs.

The air districts may also need to carry out a public education and outreach campaign to enhance compliance with the ATCM and to alert the public to available options for waste disposal. However, ARB will develop public education and outreach materials that can be provided to the air districts. Some air districts may also require resources to determine exemption areas. We estimate that 1 to 2 person months would be needed for this effort initially, with one half to one person month needed every five years to renew exemptions. The ARB will provide technical assistance to the air districts in preparing exemption requests. It should be noted that eight air districts already have programs at least as stringent as the proposed ATCM and therefore would incur no additional burden from the requirements of the regulation.

2. Costs to Local Waste Management Agencies

The proposed ATCM could result in non-mandatory costs to local agencies responsible for waste management services to the extent they choose to provide expanded waste disposal services and to address waste diversion impacts. In many jurisdictions, waste service is already available throughout the area, although in many cases it is not mandatory. Additional households who might opt into service due to the proposed ATCM would not have an impact on the local agency. The expansion of waste service to areas which were previously unserved however, could result in increased costs to

local agencies to develop new waste hauling contracts and for continued management and oversight. However, the costs of additional waste service could be recovered through waste collection service fees.

Local agencies could experience increased costs if they decide to expand the hours of operation at a landfill or transfer station to meet consumer demand or need. Additional costs could also be incurred if a waste agency needed to go through a permit amendment process to expand the allowable capacity of a landfill. It is also possible that a local jurisdiction could elect to build new transfer stations to address increased demand or better serve outlying residents. Infrastructure costs to establish a small, unattended transfer station are approximately $10,000. Additional costs of approximately $20,000 would be incurred for permitting, and costs would be higher for larger, attended facilities. However, discussions with several waste management agencies indicate that many factors would influence the decision to establish additional transfer stations, therefore the potential for this impact cannot be quantified.

Finally, local waste management agencies could develop new baseline waste disposal levels to better address the addition of materials that were previously burned to the waste stream and more accurately calculate diversion rates. Development of a new baseline could cost approximately $50,000 for surveys at selected waste disposal facilities. However, not all local waste management agencies may choose to develop new baseline years.

3. Costs to State and Federal Land Management Agencies

Although there are no specific mandates, the proposed ATCM could have limited economic impacts on State and federal land management agencies. The main impact would be on public education, issuance or permits, and enforcement of complaints that could arise from burning that occurred on State and federal responsibility area lands. As discussed above, ARB will provided the needed public education and outreach materials. The number of permits is not expected to increase as a result of the proposed regulation, and may decrease due to the decrease in the number of households allowed to burn residential waste materials. In terms of enforcement, while these fire agencies have primary responsibility for fire safety, they often are the first ones to respond to complaints about burning, which often are not about fire safety, but the burning of prohibited materials. Some jurisdictions have addressed this problem through a memorandum of understanding between the local fire protection agencies and the air district to allow the fire protection agency to recoup its costs for enforcement through a pass-through of fines assessed by the air district. This has worked especially well in Placer County. Similar efforts in other jurisdictions could minimize the economic impact of enforcement efforts for these State and federal land management agencies.

VIII. ENVIRONMENTAL IMPACTS OF THE PROPOSED AIRBORNE TOXIC CONTROL MEASURE

The intent of the proposed ATCM is to improve air quality and protect the public health by reducing the public's exposure to potentially harmful emissions of dioxins, other TACs, and particulate matter produced during the burning of residential waste materials. An additional consideration is the impact that the proposed ATCM may have on other areas of the environment. This chapter describes the potential impacts that the proposed ATCM may have on waste diversion rates, landfill capacities, illegal dumping, illegal waste storage, increased vehicle miles traveled due to expanded waste pickup service, and fire safety. In evaluating the potential impacts, we considered the role of exemptions in the proposed regulation. The goal of the exemptions would be to allow burning to continue in those areas where feasible alternatives for waste disposal do not exist, and where population density is low. These exemptions are expected to mitigate the potential for adverse impacts in areas where they would be the most likely to occur. Therefore, based on available information, the ARB has determined that no significant adverse environmental impacts should occur.

A. Legal Requirements Applicable to the Analysis

The California Environmental Quality Act (CEQA) and ARB policy require an analysis to determine the potential adverse environmental impacts of proposed regulations.[4] Since the ARB's program involving the adoption of regulations has been certified by the Secretary of Resources (see Public Resources Code section 21080.5), the CEQA environmental analysis is included in the Initial Statement of Reasons for a rulemaking in lieu of preparing an environmental impact report or negative declaration. In addition, prior to adopting the regulation, the ARB will respond in writing to all significant environmental issues raised by the public during the public review period or at the Board hearing. These responses will be contained in the Final Statement of Reasons for the ATCM.

B. Waste Diversion Rates

The proposed ATCM will result in some increases in residential waste sent to municipal waste disposal facilities. The increases would be greatest in the six air districts that currently allow all types of materials to be burned. In the remaining 21 air districts, an increase primarily in paper and cardboard could be seen at these facilities. This additional waste would impact the 50 percent waste diversion requirements established in State law by AB 939 (PRC 41780-41786). The goal of AB 939 is to decrease the amount of materials disposed of at landfills through the development of source reduction, recycling, and composting programs. The legislation established a requirement of 25 percent diversion from landfills for all jurisdictions by January 1, 1995, with a 50 percent diversion requirement by January 1, 2000.

4 California Code of Regulations, title 17, sections 60005 through 60007.

Diversion rates are determined by measuring the amount of solid waste disposed of at a permitted disposal and comparing that with the amount of estimated amount of waste generated by that jurisdiction. Disposal is determined for the current year. Generation is estimated for the current year by adjusting estimates for a base year (generally 1990) based on changes in population, employment, and taxable sales corrected for inflation. These base year generation rates however, would not have included waste that was burned.

Each local jurisdiction is responsible for developing local recycling and waste reduction programs to meet the diversion requirements. Jurisdictions which cannot meet the 50 percent diversion requirement may request an extension, upon demonstration that the jurisdiction is making a good faith effort to implement source reduction, recycling, and composting programs, and that these programs represent the greatest diversion amount that may reasonably and feasibly be achieved.

The CIWMB is currently evaluating reports submitted by local jurisdictions to determine whether they met the diversion requirements. Because the waste that is currently burned was not included in the baseline generation values, the addition of this material to landfills will impact waste diversion rates. However, efforts to promote recycling, particularly for paper could help mitigate this impact. Jurisdictions may also elect to develop new baseline levels to account for the waste that had previously been burned. In addition, as discussed above, CIWMB has a process to work with jurisdictions that have not met the diversion requirements providing the jurisdiction is making a good faith effort to meet the diversion goals.

C. Landfill Capacity

The addition of materials that were previously burned to existing landfills could cause some landfills to reach capacity sooner than originally anticipated. Staff estimates that the additional waste will not exceed 100,000 tons per year, which is less than one percent of the existing waste disposed in California. This percentage may vary by air district however, depending upon the amount of waste previously burned. As with the waste diversion issue discussed above, efforts to promote recycling of materials can help alleviate this potential impact.

D. Illegal Dumping

The proposed ATCM could result in some increases in illegal dumping near roadsides and/or in remote wildland areas by households that refuse to either pay for curbside service, or self-haul their waste to a transfer station or landfill. While illegal dumping is a continuing concern for waste management officials, the proposed ATCM is not expected to result in a significant increase in the small percent of the population that contributes to this illegal activity. A strong public education and outreach campaign that emphasizes the options that are available to consumers for disposing of their waste legally can help mitigate this impact. In addition, the proposed regulation provides for

exemptions for those households that may not have alternative waste disposal options other than burning. This should therefore minimize the possibility of illegal dumping.

E. Waste Storage

The proposed ATCM could result in some increases in illegal storage of residential waste where inclement weather impacts residents' ability to utilize available disposal services, or where residents choose not to utilize available disposal services. This could cause a public health impact associated with increases in disease transmitted by vermin, as well as odor and nuisance problems. Again, a targeted public education and outreach campaign can provide consumers with information about appropriate means of disposing of their residential waste. In addition, as discussed above, the proposed regulation provides for exemptions for those households that would have the greatest difficulty in routinely disposing of their waste through non-burning alternatives, and would therefore minimize the occurrence of extended waste storage.

F. Potential Air Pollution Impacts

The proposed ATCM is designed to reduce the public health risks associated with exposure to the emissions of dioxins and other toxic air contaminants. In addition, the proposed ATCM will reduce the emissions of particulate matter. The proposed ATCM will also result in reductions in oxides of nitrogen (NOx) and volatile organic compounds (VOC). Oxides of nitrogen and volatile organic compounds contribute to the formation of ozone, a key component of smog, and to particulate matter.

The proposed ATCM could result in some increases in vehicle miles traveled (VMT) associated with increased garbage collection service and increased trips associated with taking garbage to landfills and collection sites. As discussed in previous chapters, as many as 108,000 households could be affected by the proposed ATCM. Many of these households could potentially start receiving new curbside service, or start self hauling their residential waste to a landfill of transfer station who were not previously doing so.

For many of these households where waste service has been voluntary, there are existing waste service routes which already serve their neighborhood. In this situation, the VMT from garbage trucks would not increase. However, in some cases, the proposed ATCM could result in additional VMT for new waste service routes. Additional VMT may also arise from increased trips by garbage trucks transporting additional waste from transfer stations to a central landfill. Assuming that a garbage truck traveled an additional 100 miles per week, or 5,200 miles per year, transporting additional waste, and using ARB emission factors for refuse trucks in 2004, an additional 29 pounds of PM10, 641 pounds of NOx, and 102 pounds of VOC per year would be generated. For comparison purposes, the additional PM10 emissions from the garbage truck hauling waste for this scenario would nearly equal the PM10 emissions from one burn barrel (approximately 25 pounds per year). The ARB also has an active program to reduce particulate emissions from diesel vehicles through the diesel risk reduction

program. A comparison of NOx and VOCs cannot be made because these pollutants were not measured in the U.S. EPA burn barrel tests.

Many households may also be self hauling a portion of their waste to the landfill. In some cases, they may only increase the amount of material transported, but not the frequency. However, in other cases, some households may increase the frequency with which they transport their waste materials to the landfill or transfer station. Assuming two extra trips per month, at a distance of 20 miles per round trip, the extra VMT would equal 520 miles per year. For a household that previously burned all of their waste, and would therefore begin self-hauling their residential waste once per week, the extra VMT would equal 1,040 miles per year. Using ARB emission factors for light duty trucks (pick-ups) for 2004 of 0.021, 1.171, and 0.846 grams per mile respectively for PM10, NOx, and VOC, the additional emissions would amount to approximately 0.05 pounds of PM10, 2.7 pounds of NOx, and 2.0 pounds of ROG per household per year. For comparison purposes, the additional PM10 emissions from vehicle travel for one household is approximately 500 times smaller than the PM10 emissions from one burn barrel.

G. Fire Safety Issues

The proposed ATCM was evaluated to determine whether there could be any adverse impacts on fire safety. Burn barrels are sometimes recommended by fire safety officials for the burning of residential materials in order to provide a contained area for the fire. However, burn barrels are not typically used for the burning of vegetative material. Rather this material, because of its bulk, is typically burned in piles on the ground. In areas that are not exempt under the proposed regulation, the burning of natural vegetation will be the only material that can be burned under the proposed ATCM. However, areas that receive an exemption will be allowed to use burn barrels to burn allowable waste materials. Therefore, the ATCM should not substantially impact fire safety.

H. Combustion of Waste Materials Indoors

We received several comments that the proposed ATCM would result in the inappropriate burning of residential waste material indoors, either through wood stoves or fireplaces. We recognize that there is a possibility that some people might try this alternative. As part of the public outreach materials that the ARB will prepare, we will make it clear that this is an inappropriate activity and potentially extremely risky because the pollutants can build up indoors.

I. Environmental Justice

The ARB is committed to evaluating community impacts of proposed regulations, including environmental justice concerns. Because some communities experience higher exposures to toxic air pollutants, it is a priority of the ARB to ensure that full protection is afforded to all Californians. The proposed ATCM is designed to reduce

emissions of dioxins and other TACs from residential waste burning, resulting in reduced exposures to these emissions for all communities throughout the State, with associated lower potential health risks.

J. Reasonably Foreseeable Alternatives to the ATCM

We have evaluated two alternatives to the proposed control measure: 1) no action, and 2) prohibition only on the burning of household garbage. Alternatives to the ATCM are discussed in Chapter VI.

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APPENDIX A

Proposed Regulation Order:
Airborne Toxic Control Measure to Reduce Emissions of Toxic Air Contaminants from Outdoor Residential Waste Burning

Proposed Regulation Order

Airborne Toxic Control Measure to Reduce Emissions of Toxic Air Contaminants from Outdoor Residential Waste Burning

Adopt new section 93113, title 17, California Code of Regulations, to read as follows:

93113 Airborne Toxic Control Measure to Reduce Emissions of Toxic Air Contaminants from Outdoor Residential Waste Burning.

(a) Applicability.

(1) Notwithstanding section 41806(a) of the Health and Safety Code, this regulation shall apply to persons conducting outdoor burning of combustible or flammable waste generated from inside residences and from outdoor activities associated with a residence, for the purpose of disposing of the waste.

(2) This regulation shall apply to persons lighting fires that burn combustible or flammable waste, as defined, outdoors in enclosed or partially enclosed vessels, such as incinerators or burn barrels, or in an open outdoor fire, such as in pits or in piles on the ground. This regulation shall not apply to persons lighting fires at the direction of a public officer in an emergency situation for public health or fire safety reasons, in accordance with section 41801 of the Health and Safety Code or other provisions of law.

(3) Except as provided in (a)(1) and (a)(2) above, nothing in this regulation shall affect the applicability of the provisions of article 2 and article 3, respectively, of chapter 3 of part 4 of division 26 of the Health and Safety Code.

(b) Definitions.

Terms used shall have the same definitions as in Health and Safety Code section 39010 et. seq., unless otherwise indicated. For purposes of this regulation, the following additional definitions shall apply:

(1) “Air Pollution Control District” (APCD), “Air Quality Management District” (AQMD), “air district,” or “district” means the Governing Board of an air pollution control district or an air quality management district created or continued in existence pursuant to Health and Safety Code section 40000 et seq.

(2) "APCO" means the Air Pollution Control Officer or the chief executive officer of the respective local air pollution control district or local air quality management district where the property is located, or a designated representative.

(3) "ARB" means the State of California Air Resources Board.

(4) "Air Toxic" means toxic air contaminants as defined in section 39655 (a) of the Health and Safety Code.

(5) "Allowable Combustibles" means dry natural vegetation waste originating on the premises and reasonably free of dirt, soil and visible surface moisture.

(6) "Approved transfer station or disposal facility" means a transfer station, landfill, or municipal waste incinerator with a valid operating permit from the solid waste authority with jurisdiction over its operation.

(7) "Approved ignition device" means an instrument or material that will ignite open fires without the production of black smoke by the ignition device, as approved by the APCO.

(8) "Available regular waste pickup service" means the availability of mandatory or voluntary regular waste collection service, through a licensed waste hauler, by virtue of the residence's location within an area franchised by the local jurisdiction with authority to delineate and to franchise geographic service areas, or through regular waste collection service provided directly by the local jurisdiction.

(9) "Burn Barrel" means a metal container used to hold combustible or flammable waste materials so that they can be ignited outdoors for the purpose of disposal.

(10) "Combustible" means any substance capable of burning or any substance that will readily burn.

(11) "Communal or Community Dumpster" means a dumpster or bin at a fixed location and used by more than one household, under contract with a licensed waste hauler, for disposal of residential waste.

(12) "Disallowed Combustibles" means any waste or manufactured material, including but not limited to petroleum products and petroleum wastes; construction and demolition debris; coated wire; putrescible wastes; tires; tar; tarpaper; non-natural wood waste; processed or treated wood and wood products; metals; motor vehicle bodies and parts; rubber; synthetics; plastics, including plastic film, twine and pipe; fiberglass;

styrofoam; garbage; trash; refuse; rubbish; disposable diapers; ashes; glass; industrial wastes; manufactured products; equipment; instruments; utensils; appliances; furniture; cloth; rags; paper or paper products; cardboard; boxes; crates; excelsior; offal; swill; carcass of a dead animal; manure; human or animal parts or wastes, including blood; and fecal- and food-contaminated material. For purposes of this regulation, dry, natural vegetation waste from yard maintenance is not a disallowed combustible, if reasonably free of dirt, soil and surface moisture.

(13) "Flammable" means capable of catching fire easily, or combustible.

(14) "Incinerator" means any device constructed of nonflammable materials, including containers commonly known as burn barrels, for the purpose of burning therein trash, debris, and other flammable materials for volume reduction or destruction.

(15) "Mandatory regular waste pickup service" means regular waste collection provided to residences by a local agency or an approved waste hauler, where the local waste authority has designated a franchise or a permit, and where each household is required to pay for and use the pickup service.

(16) "Natural vegetation" means all plants, including but not limited to grasses, forbs, trees, shrubs, flowers, or vines that grow in the wild or under cultivation. Natural vegetation excludes vegetative materials that have been processed, treated or preserved with chemicals for subsequent human or animal use, including but not limited to chemically-treated lumber, wood products or paper products.

(17) "Open outdoor fire" means the combustion of combustible material of any type outdoors in the open, not in any enclosure, where the products of combustion are not directed through a flue.

(18) "Permissive burn day" or "burn day" means any day on which agricultural burning, including prescribed burning, is not prohibited by the ARB and agricultural and prescribed burning is authorized by the air district consistent with the Smoke Management Guidelines for Agricultural and Prescribed Burning, set forth in sections 80100-80330 of title 17 of the California Code of Regulations.

(19) "Processed or treated wood and wood products" means wood that has been chemically treated to retard rot or decay or wood that has been modified with glues, laminates, stains, finishes, paints or glosses for use in furniture or for construction purposes, including but not limited to plywood, particle board, fencing or railroad ties. For the purposes of this regulation, dimensional lumber that has been air-dried or kiln-dried, with

no preservatives or finishes added, is not considered processed or treated wood.

(20) "Residence" means a single- or two-family dwelling unit and the land and ancillary structures surrounding it.

(21) “Residential waste burning” means the disposal of the combustible or flammable waste from a single- or two-family dwelling unit or residence by burning outdoors. Residential waste burning is not agricultural, including prescribed, burning.

(22) "Voluntary regular waste pickup service" means regular waste collection offered to residences by a local agency or an approved waste hauler, where the local waste authority has designated a franchise or a permit, but where each household has the option of not paying for and receiving the pickup service that is available.

(23) "Waste" means all discarded putrescible and non-putrescible solid, semisolid, and liquid materials, including but not limited to petroleum products and petroleum wastes; construction and demolition debris; coated wire; tires; tar; tarpaper; wood waste; processed or treated wood and wood products; metals; motor vehicle bodies and parts; rubber; synthetics; plastics, including plastic film, twine and pipe; fiberglass; styrofoam; garbage; trash; refuse; rubbish; disposable diapers; ashes; glass; industrial wastes; manufactured products; equipment; instruments; utensils; appliances; furniture; cloth; rags; paper or paper products; cardboard; boxes; crates; excelsior; offal; swill; carcass of a dead animal; manure; human or animal parts or wastes, including blood; fecal- and food-contaminated material; felled trees; tree stumps; brush; plant cuttings and prunings; branches; garden waste; weeds; grass clippings, pine needles, leaves and other natural vegetation waste.

(c) Prohibitions.

(1) No person shall burn disallowed combustibles from any property for the purpose of disposing of waste material outdoors at a residence, except as provided under subsection (e), “Exemptions”, below.

(2) No person shall dispose of allowable combustibles from any property by burning them in a burn barrel or incinerator outdoors, except as provided under subsection (e), “Exemptions”, below.

(3) No person shall ignite, or allow to become ignited, allowable combustibles unless using an approved ignition device.

(4) No person shall ignite, or allow to become ignited, allowable combustibles unless it is a permissive burn day in the air district where the residential waste burning is to take place.

(d) Compliance Schedule.

(1) For the purposes of Section 39666(d) of the Health and Safety Code, the date of adoption of this regulation shall be _____ [insert the date of filing with the Secretary of State].

(2) Unless an air district adopts an earlier effective date under section 39666(d) of the Health and Safety Code, or applies for exemptions under subsection (e), below, the prohibitions set forth in subsection (c), above, shall become effective on July 1, 2003.

(e) Exemptions.

(1) The prohibitions described in subsections (c)(1) and (c)(2), above, of this regulation shall not apply to any exempted geographic area described under subsection (e)(5), below.

(2) Any air district seeking an exemption from subsections (c)(1) and (c)(2), above, shall file a Request for Exemption in writing to ARB before March 1, 2003. The requirements for a Request for Exemption are described in subsection (e)(4), below.

(3) No air district shall file a Request for Exemption to allow the burning of any disallowed combustible prohibited by air district rules in effect on January 4, 2002. An air district shall not apply for an exemption for a geographic area with a more stringent local ordinance, in effect on January 4, 2002, prohibiting the burning of a disallowed combustible, otherwise allowed by the air district.

(4) A Request for Exemption shall include:
- (A) a resolution from the air district's Governing Board adopted at a public hearing approving the Request for Exemption; and
- (B) a map of the exempted geographic areas within their jurisdiction, which meet the criteria listed in subsection (e)(5), below, and
- (C) a detailed, written justification for the mapping, including a demonstration that alternatives for waste disposal, other than residential waste burning, are not likely to become available within the five-year exemption period, and
- (D) an analysis showing that local ordinances existing on January 4, 2002 do not prohibit the outdoor burning of the materials requested

for exemption, in any part of the exempted geographic area.

(5) The exempted geographic areas must meet criteria including, but not limited to, all of the following:
   (A) no mandatory or voluntary regular waste pickup service, considering reasonable cost and frequency of service; and
   (B) greater than a reasonable distance from an approved transfer station or disposal facility or a communal or community dumpster, considering road miles or time travelled, road conditions, terrain, weather conditions, reasonable tipping fees, and hours of operation; and
   (C) low population density per census tract or other appropriate subunit of the county area, including but not limited to zoning designation or parcel size.

(6) ARB shall review the air district's Request for Exemption and approve or disapprove the Request for Exemption, in writing, within 60 days after submittal. The approval shall state the exempted geographic areas in the air district where the prohibitions of subsections (c)(1) and (c)(2), above, apply.

(7) If the initial Request for Exemption is disapproved, the ARB shall return the Request for Exemption to the air district for amendment. The disapproval shall include reasons for the denial and the air district shall be afforded an additional 30 days from the date of denial to submit a revised Request for Exemption.

(8) Within 30 days of receipt of the revised Request for Exemption, the ARB shall approve or reject the revised Request for Exemption, and shall designate the geographic areas where the prohibitions of (c)(1) and (c)(2) do not apply.

(9) Every five years after ARB has approved an air district’s Request for Exemption, the air district, with the concurrence of ARB, shall determine whether to renew the exemption for an additional five years and whether the mapped exempted geographic area(s) should be modified. In renewing the exemption or in modifying the exempted geographic area(s), the Governing Board of the air district shall make a finding at a public hearing that the exemption criteria in (e)(5) are still applicable to the renewed or modified exempted geographic area.

(10) Consultation with, and concurrence from, the ARB on the renewal and/or modification of the exempted geographic areas shall continue every five years thereafter until the exemption criteria are no longer met, at which time the exemptions shall terminate.

NOTE: Authority cited: Sections 39600, 39601, 39659 and 39666, Health and Safety Code. Reference: Sections 39020, 39044, 39650 through 39669, 39701, 41700 and 41806, Health and Safety Code.

APPENDIX B

Risk Assessment Results Using SCEEN3 Meteorological Conditions And Site-specific Meteorological Data

This appendix includes five tables that summarize the potential health impacts for residential waste burning using default meteorological conditions from SCREEN3 and site-specific meteorological data from four locations across California (Alturas, Bishop, San Benito, and Escondido). Both carcinogenic and non-carcinogenic individual health impacts are presented at locations ranging from 20 meters to 1,000 meters downwind from a single burn barrel. The tables also provide estimates of potential cancer risk for each exposure pathway.

Table B-1. Overview of the Potential Health Impacts from Residential Waste Burning Using the Meteorological Conditions from SCREEN3. [1,2]

Exposure Pathways [3, 4]	Distance (meters)					
	20	50	100	200	500	1000
	Cancer Risk (chances per million)					
Inhalation	44	17	6.4	2.0	0.4	0.1
Soil Ingestion	16	6.1	2.2	0.7	0.2	0.05
Skin Exposure	14	5.5	2.0	0.6	0.1	0.04
Mothers Milk [5]	8.9	3.5	1.3	0.4	0.09	0.03
Backyard Garden	56	22	8.1	2.6	0.5	0.2
Meat and Eggs	1010	397	146	46	9.7	3.0
Milk (cow)	1160	456	168	53	11	3.4
Total Cancer Risk	2309	907	334	106	22	6.7
	Non-Cancer Hazard Indices					
Acute Inhalation [6]	0.02	0.008	0.003	0.0009	0.0002	0.00006
Chronic Multipathway [7]	0.08 - 2.0	0.03 - 0.78	0.01 - 0.29	0.004 - 0.091	0.0008 - 0.019	0.0002 - 0.0058

1. All results are rounded. Potential health impacts listed at 50, 100, 200, 500, and 1,000 meters are extrapolated from air dispersion modeling results and risk at 20 meters. Emissions for dioxins and PCBs are from the U.S. EPA 2000 source tests. Emissions for benzene, 1,3-butadiene, and PAHs are from the U.S. EPA 1997 source tests.
2. All risk assessment results are based on a 70-year exposure for all pathways except the mother's (breast) milk pathway (44-year). Results are based on the CAPCOA Risk Assessment Guidelines methodology, HRA 2.0e, and the updated OEHHA cancer potencies and reference exposure levels as of January 2001.
3. All pathways of exposure are assumed to occur at the same distance (location) from the source.
4. Emissions are assumed to be uncontrolled (0.05 factor). Multipathway route assumptions include: 15% of produce in the receptor's diet is homegrown; 100% of dietary meat (beef, pork, and chicken), eggs, and cow's milk is impacted; 50% of cattle's diet is from impacted grassland and other feed is not contaminated; Farm animal drinking water is from a 300 gallon trough, measuring one square meter, and is consumed every 3.75 days by one lactating cow.
5. PCB contribution calculated by ratio of PCB to PCDD body half-life (0.7) multiplied by the PCDD & PCDF mother's milk to inhalation ratio.
6. Benzene impacts were assessed using 6-hour average concentrations. Primary endpoints are cardiovascular or blood, reproductive system, and immune system.
7. Dioxins, PAHs, and PCBs were assessed for chronic impacts. Includes both inhalation and non-inhalation exposure pathways. Primary endpoints are reproductive system, cardiovascular or blood, and nervous system. The lower end of the range includes inhalation, soil, and dermal exposure pathways. The upper end of the range includes all exposure pathways, except mother's milk.

Table B-2. Overview of the Potential Health Impacts from Residential Waste Burning Using the Alturas Meteorological Data [1,2]

Exposure Pathways [3, 4]	Distance (meters)					
	20	50	100	200	500	1000
	Cancer Risk (chances per million)					
Inhalation	3.3	0.9	0.3	0.07	0.01	0.003
Soil Ingestion	1.2	0.3	0.1	0.03	0.004	0.001
Skin Exposure	1.0	0.3	0.1	0.02	0.004	0.001
Mothers Milk [5]	0.7	0.2	0.06	0.02	0.003	0.0007
Backyard Garden	4.2	1.1	0.3	0.09	0.02	0.004
Meat and Eggs	75	20	6.1	1.7	0.3	0.08
Milk (cow)	86	23	6.9	1.9	0.3	0.09
Total Cancer Risk	172	46	14	3.9	0.7	0.2
	Non-Cancer Hazard Indices					
Acute Inhalation [6]	0.01	0.005	0.002	0.001	0.0002	0.00008
Chronic Multipathway [7]	0.15	0.04	0.01	0.003	0.0006	0.0001

1. All results are rounded. Potential health impacts listed at 50, 100, 200, 500, and 1,000 meters are extrapolated from air dispersion modeling results and risk at 20 meters. Emissions for dioxins and PCBs are from the U.S. EPA 2000 source tests. Emissions for benzene, 1,3-butadiene, and PAHs are from the U.S. EPA 1997 source tests.
2. All risk assessment results are based on a 70-year exposure for all pathways except the mother's (breast) milk pathway (44-year). Results are based on the CAPCOA Risk Assessment Guidelines methodology, HRA 2.0e, and the updated OEHHA cancer potencies and reference exposure levels as of January 2001.
3. All pathways of exposure are assumed to occur at the same distance (location) from the source.
4. Emissions are assumed to be uncontrolled (0.05 factor). Multipathway route assumptions include: 15% of produce in the receptor's diet is homegrown; 100% of dietary meat (beef, pork, and chicken), eggs, and cow's milk is impacted; 50% of cattle's diet is from impacted grassland and other feed is not contaminated; Farm animal drinking water is from a 300 gallon trough, measuring one square meter, and is consumed every 3.75 days by one lactating cow.
5. PCB contribution calculated by ratio of PCB to PCDD body half-life (0.7) multiplied by the PCDD & PCDF mother's milk to inhalation ratio.
6. Benzene impacts were assessed using 6-hour average concentrations. Primary endpoints are cardiovascular or blood, reproductive system, and immune system.
7. Dioxins, PAHs, and PCBs were assessed for chronic impacts. Includes both inhalation and non-inhalation exposure pathways. Primary endpoints are reproductive system, cardiovascular or blood, and nervous system.

Table B-3. Overview of the Potential Health Impacts from Residential Waste Burning Using the Bishop Meteorological Data [1,2]

Exposure Pathways [3, 4]	Distance (meters)					
	20	50	100	200	500	1000
	Cancer Risk (chances per million)					
Inhalation	4.6	1.2	0.4	0.1	0.02	0.005
Soil Ingestion	1.6	0.4	0.1	0.04	0.007	0.002
Skin Exposure	1.4	0.4	0.1	0.03	0.006	0.002
Mothers Milk [5]	1.0	0.3	0.08	0.02	0.004	0.001
Backyard Garden	5.8	1.5	0.5	0.1	0.02	0.007
Meat and Eggs	105	28	8.4	2.4	0.4	0.1
Milk (cow)	120	32	9.6	2.8	0.5	0.1
Total Cancer Risk	239	63	19	5.5	1.0	0.3
	Non-Cancer Hazard Indices					
Acute Inhalation [6]	0.02	0.008	0.003	0.001	0.0002	0.00007
Chronic Multipathway [7]	0.2	0.05	0.02	0.005	0.0009	0.0002

1. All results are rounded. Potential health impacts listed at 50, 100, 200, 500, and 1,000 meters are extrapolated from air dispersion modeling results and risk at 20 meters. Emissions for dioxins and PCBs are from the U.S. EPA 2000 source tests. Emissions for benzene, 1,3-butadiene, and PAHs are from the U.S. EPA 1997 source tests.
2. All risk assessment results are based on a 70-year exposure for all pathways except the mother's (breast) milk pathway (44-year). Results are based on the CAPCOA Risk Assessment Guidelines methodology, HRA 2.0e, and the updated OEHHA cancer potencies and reference exposure levels as of January 2001.
3. All pathways of exposure are assumed to occur at the same distance (location) from the source.
4. Emissions are assumed to be uncontrolled (0.05 factor). Multipathway route assumptions include: 15% of produce in the receptor's diet is homegrown; 100% of dietary meat (beef, pork, and chicken), eggs, and cow's milk is impacted; 50% of cattle's diet is from impacted grassland and other feed is not contaminated; Farm animal drinking water is from a 300 gallon trough, measuring one square meter, and is consumed every 3.75 days by one lactating cow.
5. PCB contribution calculated by ratio of PCB to PCDD body half-life (0.7) multiplied by the PCDD & PCDF mother's milk to inhalation ratio.
6. Benzene impacts were assessed using 6-hour average concentrations. Primary endpoints are cardiovascular or blood, reproductive system, and immune system.
7. Dioxins, PAHs, and PCBs were assessed for chronic impacts. Includes both inhalation and non-inhalation exposure pathways. Primary endpoints are reproductive system, cardiovascular or blood, and nervous system.

Table B-4. Overview of the Potential Health Impacts from Residential Waste Burning Using the San Benito Meteorological Data [1,2]

Exposure Pathways [3, 4]	Distance (meters)					
	20	50	100	200	500	1000
	Cancer Risk (chances per million)					
Inhalation	6.4	1.7	0.5	0.1	0.02	0.006
Soil Ingestion	2.2	0.6	0.2	0.05	0.008	0.002
Skin Exposure	2.0	0.5	0.2	0.04	0.008	0.002
Mothers Milk [5]	1.3	0.3	0.1	0.03	0.005	0.001
Backyard Garden	8	2.1	0.6	0.2	0.03	0.008
Meat and Eggs	145	38	12	3.2	0.6	0.1
Milk (cow)	166	44	13	3.7	0.6	0.2
Total Cancer Risk	331	88	26	7.3	1.3	0.3
	Non-Cancer Hazard Indices					
Acute Inhalation [6]	0.02	0.008	0.003	0.001	0.0002	0.00008
Chronic Multipathway [7]	0.3	0.08	0.02	0.006	0.001	0.0003

1. All results are rounded. Potential health impacts listed at 50, 100, 200, 500, and 1,000 meters are extrapolated from air dispersion modeling results and risk at 20 meters. Emissions for dioxins and PCBs are from the U.S. EPA 2000 source tests. Emissions for benzene, 1,3-butadiene, and PAHs are from the U.S. EPA 1997 source tests.
2. All risk assessment results are based on a 70-year exposure for all pathways except the mother's (breast) milk pathway (44-year). Results are based on the CAPCOA Risk Assessment Guidelines methodology, HRA 2.0e, and the updated OEHHA cancer potencies and reference exposure levels as of January 2001.
3. All pathways of exposure are assumed to occur at the same distance (location) from the source.
4. Emissions are assumed to be uncontrolled (0.05 factor). Multipathway route assumptions include: 15% of produce in the receptor's diet is homegrown; 100% of dietary meat (beef, pork, and chicken), eggs, and cow's milk is impacted; 50% of cattle's diet is from impacted grassland and other feed is not contaminated; Farm animal drinking water is from a 300 gallon trough, measuring one square meter, and is consumed every 3.75 days by one lactating cow.
5. PCB contribution calculated by ratio of PCB to PCDD body half-life (0.7) multiplied by the PCDD & PCDF mother's milk to inhalation ratio.
6. Benzene impacts were assessed using 6-hour average concentrations. Primary endpoints are cardiovascular or blood, reproductive system, and immune system.
7. Dioxins, PAHs, and PCBs were assessed for chronic impacts. Includes both inhalation and non-inhalation exposure pathways. Primary endpoints are reproductive system, cardiovascular or blood, and nervous system.

Table B-5. Overview of the Potential Health Impacts from Residential Waste Burning Using the Escondido Meteorological Data [1,2]

Exposure Pathways [3, 4]	Distance (meters)					
	20	50	100	200	500	1000
	Cancer Risk (chances per million)					
Inhalation	8.2	2.2	0.7	0.2	0.03	0.009
Soil Ingestion	2.9	0.8	0.2	0.07	0.01	0.003
Skin Exposure	2.6	0.7	0.2	0.06	0.01	0.003
Mothers Milk [5]	1.7	0.5	0.1	0.04	0.007	0.002
Backyard Garden	10	2.8	0.9	0.2	0.04	0.01
Meat and Eggs	187	51	15	4.3	0.8	0.2
Milk (cow)	215	58	18	4.9	0.9	0.2
Total Cancer Risk	428	116	35	9.8	1.7	0.5
	Non-Cancer Hazard Indices					
Acute Inhalation [6]	0.02	0.008	0.003	0.0009	0.0002	0.00005
Chronic Multipathway [7]	0.4	0.1	0.03	0.008	0.001	0.0004

1. All results are rounded. Potential health impacts listed at 50, 100, 200, 500, and 1,000 meters are extrapolated from air dispersion modeling results and risk at 20 meters. Emissions for dioxins and PCBs are from the U.S. EPA 2000 source tests. Emissions for benzene, 1,3-butadiene, and PAHs are from the U.S. EPA 1997 source tests.
2. All risk assessment results are based on a 70-year exposure for all pathways except the mother's (breast) milk pathway (44-year). Results are based on the CAPCOA Risk Assessment Guidelines methodology, HRA 2.0e, and the updated OEHHA cancer potencies and reference exposure levels as of January 2001.
3. All pathways of exposure are assumed to occur at the same distance (location) from the source.
4. Emissions are assumed to be uncontrolled (0.05 factor). Multipathway route assumptions include: 15% of produce in the receptor's diet is homegrown; 100% of dietary meat (beef, pork, and chicken), eggs, and cow's milk is impacted; 50% of cattle's diet is from impacted grassland and other feed is not contaminated; Farm animal drinking water is from a 300 gallon trough, measuring one square meter, and is consumed every 3.75 days by one lactating cow.
5. PCB contribution calculated by ratio of PCB to PCDD body half-life (0.7) multiplied by the PCDD & PCDF mother's milk to inhalation ratio.
6. Benzene impacts were assessed using 6-hour average concentrations. Primary endpoints are cardiovascular or blood, reproductive system, and immune system.
7. Dioxins, PAHs, and PCBs were assessed for chronic impacts. Includes both inhalation and non-inhalation exposure pathways. Primary endpoints are reproductive system, cardiovascular or blood, and nervous system.

APPENDIX C

Air Dispersion Modeling of Emissions from Burn Barrels

Air Dispersion Modeling of Emissions from Burning Barrels

Summary

The air dispersion of emissions from burning trash in domestic burning barrels is evaluated to estimate downwind impacts. This analysis is based on an emission rate of 1 g/s input into the U.S. EPA air dispersion models, Industrial Source Complex – Short Term 3 (ISCST3) and SCREEN3. As a result, the estimated short-term and long-term average air concentrations may be directly scaled by the actual emission rate to estimate downwind concentrations of actual pollutants. A summary of the results is shown in Table C-1 below. A detailed description of the analysis with sensitivity studies follow.

As an example, shown in Table C-1 below, the maximum annual average χ/q for emissions from a burning barrel, based on meteorological data collected in Escondido, is 1920 ($\mu g/m^3$)/(g/s) at the nearest receptor, 20 meters from the source. This is based

Table C-1
Maximum Annual Average Concentration (χ/q)
Above Ambient Conditions - Burning Barrel Emissions

Met. County	Modoc	Inyo	San Benito	San Diego	
Met. City	**Alturas**	**Bishop**	**San Benito**	**Escondido**	***SCREENING***
Notes	(a)	(a)	(a)	(a)	*(b)*
D (m)	**($\mu g/m^3$)/(g/s)**	**($\mu g/m^3$)/(g/s)**	**($\mu g/m^3$)/(g/s)**	**($\mu g/m^3$)/(g/s)**	***($\mu g/m^3$)/(g/s)***
20	773.	1070.	1490.	1920.	*590.*
50	206.	284.	395.	521.	*232.*
100	62.1	85.6	119.	158.	*85.4*
200	17.3	24.6	33.0	43.9	*27.1*
500	3.01	4.48	5.66	7.71	*5.65*
1000	0.78	1.22	1.47	2.03	*1.73*

Notes: (a) Annual χ/q for site specific meteorological data is based on 3,654 hours of emissions at 1 g/s.
(b) Annual χ/q for Screening analysis is based on 208 hours of emissions at 1 g/s.
(c) χ/q is the concentration in $\mu g/m^3$ based on an hourly emission rate of 1 g/s.
(d) Results are valid for two significant digits. Three significant digits are reported to reduce round off error in subsequent calculations.
(e) Burning is permitted 12 months per year.

on uniformly distributing the emissions from burning over an assumed 3,654 daylight hours in a year. Further description on how these values are derived is provided below.

Analysis

This analysis estimates the downwind concentration of emissions from burn barrels for annual averages and six-hour averages. The following parameters are established for the operating conditions of a domestic burning barrel based on discussions with various air districts and at the committee meetings.

Burn Barrel Parameters

- Burning will occur during daylight hours.
- One family may burn twice per week.
- Each burn may last for two hours.
- Each burn can be at any time during a day.
- The final plume height is from 2 meters close to the barrel to a maximum of 4 meters further away from the barrel. Since maximum concentrations are located close to the barrel, the final plume rise will be fixed at 2 meters.
- Perform a sensitivity study for periods for when burn bans are in effect (i.e., June 15 to October 15 burn restrictions).
- Evaluate meteorological conditions for the following meteorological climates.
  - Screening (Worst-Case Maximum)
  - Modoc County
  - Great Basin Air District Counties
  - Monterey / San Benito Counties
  - Eastern San Diego County

Based on the above parameters, we decided to simulate the release of emissions from a burning barrel as a volume source in the ISCST3 and SCREEN3 air dispersion models. The initial dispersion of the plume and the final plume rise of the plume will be static regardless of atmospheric conditions. In this way, the calculations are consistent with air district and committee recommendations on burn barrel plume conditions. The following initial conditions are calculated for the above list of parameters.

Initial Conditions for Model Input

- $\sigma_{yo} = \sigma_{zo} = L/4.3 = 1m / 4.3 = 0.23$ meters
- **$H_{final\text{-}plume\text{-}rise}$ = 2 meters**
- $H_{flagpole\text{-}receptor\text{-}height}$ = 1 meter
- Minimum receptor distance to source = 20 meters
- Daylight hours defined as the following.

Winter	9am to 5pm (8 hours)
Spring	8am to 6pm (10 hours)
Summer	7am to 7pm (12 hours)
Fall	8am to 6pm (10 hours)

- Rural Dispersion Coefficients

Meteorological data are obtained from various California Irrigation Management Information System (CIMIS) stations to represent the locations indicated above. CIMIS stations are managed by the California Department of Water Resources. CIMIS data are collected on two meter towers which is consistent with the plume height estimates for the burn barrels. The atmospheric stability classes are based on the heat flux method as described in U.S. EPA 8/95 and Pasquill 1983.

The nearby city for the CIMIS stations to represent the various county regions are Alturas (Modoc County), Bishop (Great Basin District Counties), San Benito (San Benito County), and Escondido (San Diego County). In all cases, we attempted to obtain the latest consecutive five years of meteorological data as recommended by U.S. EPA Guidelines. The data collected at Alturas, Bishop, and San Benito meets these requirements for data from 1996 through 2000. The station located at Escondido began collecting data in 1999. Therefore only the latest complete year, 2000, was available for processing. Attachment B shows CIMIS information for the location of each station in our analysis.

Annual Average Concentration

The annual average concentration is assessed in a screening mode to estimate an upper bound calculation as well as a refined mode to estimate a site specific calculation. The refined modeling assessment is based on inputting meteorological data from the four CIMIS stations, separately, into the ISCST3 air dispersion model. In addition, the refined modeling assessment for estimating annual average concentrations is based on uniformly distributing the emissions over all possible operating hours on a daily basis. That is 8 hours, 10 hours, 12 hours, and 10 hours for each of the fours seasons, respectively. As a result, the emissions are distributed over 3,654 hours in a year. This is critical for the health risk assessment which is based on the annual average concentration. The emission rate on a gram per second basis for estimating annual average concentrations from the refined χ/q the emissions should be prorated over 3,654 hours.

The SCREEN3 air dispersion model is used to estimate the upper bound annual average concentration. Initially, the SCREEN3 air dispersion model is used to estimate the maximum one-hour concentration. The results from the SCREEN3 model show that the maximum 1-hour concentration (χ/q) is 81,560 $\mu g/m^3$ at 20 meters for F stability and 1 m/s wind speed. F stability is a stable condition that only occurs at night.

Since one of the assumptions for the burn barrels is that emissions are for daylight hours, the SCREEN3 model is used again for the next incremental stability class which is a daytime neutral condition, D stability. The results from the SCREEN3 model show the maximum 1-hour concentration (χ/q) is 49,550 $\mu g/m^3$ at 20 meters for D stability.

The standard procedure for estimating long-term (annual) averages from maximum 1-hour averages is to apply the U.S. EPA scaling factor of 0.08. The screening factor of 0.08 is ideally used when the emissions are continuous over all hours of the year (8760 hours/year). However, in the case for the burning barrels, it is assumed emissions are for two hours per burn and two burns per week (208 hours/year).

Although not explicitly indicated in the U.S. EPA Guidance, the U.S. EPA screening factor of 0.08 to estimate the annual average concentration from maximum 1-hour concentration inevitably includes the effects of varying conditions of wind speed, wind direction, and atmospheric stability over a year period.

Intermittent emissions, such as those from the burning barrels, could have the effect of eliminating some of the annual variability of meteorological conditions. For example, emissions only during the daytime could eliminate the variability of a drainage flow pattern in mountainous terrain. Guidance for estimating long term averages for a screening approach and intermittent emissions is not available. In the interim, we recommend the following approach to estimate long term averages from a source with a burning barrel schedule. Equation Box 1 shows an example that is described below.

Estimate the maximum one-hour concentration based on the SCREEN3 model approach for possible meteorological conditions consistent with operating conditions. In this case, the conditions are restricted to daytime neutral or unstable atmospheric conditions. Estimate the concentration for the averaging period consistent with the

Equation Box 1

$$\chi_{8-hr} = (\chi_{1-hr})(0.5)\left(\frac{2hrs_{burning}}{8hrs_{period}}\right) = \left(49{,}550\frac{\mu g}{m^3}\right)(0.5)(0.25) = 6{,}194\frac{\mu g}{m^3}$$

$$\chi_{annual} = \frac{(\chi_{8-hr})\left(8\frac{hrs}{period}\right)\left(2\frac{periods}{week}\right)\left(52\frac{weeks}{year}\right) + (0)\left(7928\frac{non-burn-period-hours}{year}\right)}{8760hrs/yr}$$

$$\chi_{annual} = \left(6{,}194\frac{\mu g}{m^3}\right)\left(\frac{(8)(2)(52)}{8760}\right) = 590\frac{\mu g}{m^3}$$

$$q_{annual}\left(\frac{g}{s}\right) = Q\left(\frac{lbs}{yr}\right)\left(\frac{453.6g}{lb}\right)\left(\frac{day}{2hrs}\right)\left(\frac{wk}{2days}\right)\left(\frac{yr}{52wk}\right)\left(\frac{hr}{3600s}\right) = Q\left(\frac{lbs}{yr}\right)\frac{453.6}{748{,}800}\left(\frac{g-yr}{lb-s}\right)$$

$$Concentration = (\chi_{annual})(q_{annual})$$

operating conditions. In this case, emissions could occur during the daylight, an 8-hour window during the winter and a 12-hour window during the summer. Therefore, estimate the 8-hour concentration. Use the U.S. EPA screening factor of 0.7 ± 0.2 to estimate the maximum 8-hour concentration. In addition, the emissions are prorated over the 8 hours (i.e., 2hrs/8hrs).

The U.S. EPA Screening Guidance allows for deviation from the suggested conversion factor on a case-by-case basis. We recommend the lower end of the conversion factor (i.e., 0.5) because variability associated with seasonal differences in wind speed, wind direction, and atmospheric stability would not be accounted for otherwise.

The worst-case annual average screening concentration can be estimated by assuming the worst-case 8-hour concentration occurs during each burn and no emissions occur during all other hours in a year. Estimating the worst-case annual average concentration is a matter of prorating the 8-hour concentration over an annual average, as shown in the Equation Box 1.

The emission rate on a gram per second basis for estimating annual average concentrations from the above χ/q now needs to be calculated based on the prorated year (208 hours) instead of the full year (8760 hours). An example is shown in Equation Box 1. This step is necessary for estimating risk with the Health Risk Assessment Program.

Other Results

Table 1, above, shows the maximum annual average concentration (χ/q) for the burning barrel emissions. Table 2, below, shows the maximum 6-hour average concentration (χ/q) for the burning barrel emissions.

The six-hour average is based on the maximum two-hour average concentration because of the assumption that the burns last for only two hours. The example calculation in Equation Box 2 shows the method used to estimate the maximum six-hour concentration for Alturas. A similar method is used to estimate the six-hour average in a screening mode from the maximum 1-hr concentration.

Equation Box 2
Example calculation for Alturas maximum 6-hour average at 20 meters from the source.

$$(\chi)_{2-HR} = 48{,}871\left(\frac{\mu g}{m^3}\right), (from\_ISCST3\_output)$$

$$(\chi)_{6-HR} = \frac{(\chi)_{2-HR}(2hrs) + (0)(4hrs)}{(6hrs)} = \frac{(48{,}871)(2)}{6}\left(\frac{\mu g}{m^3}\right) = 16{,}290\left(\frac{\mu g}{m^3}\right)$$

Table C-2
Maximum 6-hour Average Concentration (χ/q)
Above Ambient Conditions – Burning Barrel Emissions

Met. County	Modoc	Inyo	San Benito	San Diego	
Met. City	**Alturas**	**Bishop**	**San Benito**	**Escondido**	**SCREENING**
Notes	(a)	(a),(b)	(a),(b)	(a)	*(a)*
D (m)	**($\mu g/m^3$)/(g/s)**	**($\mu g/m^3$)/(g/s)**	**($\mu g/m^3$)/(g/s)**	**($\mu g/m^3$)/(g/s)**	***($\mu g/m^3$)/(g/s)***
20	16,300	17,800	18,800	15,400	*16,500*
50	7,170	7,370	7,880	5,940	*6,490*
100	3,570	2,860	3,120	2,160	*2,390*
200	1,400	945	1,040	678	*758*
500	334	202	227	139	*158*
1,000	110	63	71	42	*48*

Notes: (a) Six-hour maximum χ/q is based on 2 hours of emissions at 1 g/s and 4 hours of zero emissions.

(b) χ/q for Inyo and San Benito is higher than for screening analysis. This is a result of slightly stable conditions (E Stability) used for one of the two hours of emissions. This is a direct result of the method used to distribute emissions over the seasons. The screening analysis assumes emissions are for daytime (neutral or unstable) conditions.

(c) χ/q is the concentration in $\mu g/m^3$ based on an hourly emission rate of 1 g/s.

(d) Results are valid for two significant digits. Three significant digits are reported to reduce round off error in subsequent calculations.

Attachment A shows sensitivity study results for evaluating the differences when estimating concentrations in the non-predominant wind direction, as well as evaluating the scenario of a burn ban for four months per year.

References for Appendix C

Marks' Standard Handbook for Mechanical Engineers, 1987, McGraw-Hill, Inc.

Pasquill, Atmospheric Diffusion, 3rd Ed., 1983, Figure 6.10.

U.S. EPA, Evaluation of Emissions From the Open Burning of Household Waste in Barrels, Volume 1. Technical Report, November 1997, EPA-600/R-97-134a

U.S. EPA, Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised, October 1992, EPA-454/R-92-019

U.S. EPA, User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, September 1995, EPA-454/B-95-003a

U.S. EPA, Appendix W to Part 51 - Guideline on Air Quality Models, 2001

U.S. EPA, On-Site Meteorological Program Guidance For Regulatory Modeling Applications, 8/95.

Attachment A

Sensitivity Study

Tables A-1 through A-6 show the results from sensitivity studies of various aspects of the burning barrel evaluation. The primary focus of the sensitivity study are the effects of burning restrictions during fire hazard seasons on downwind impacts. We note that under certain years of high fire hazard, restrictions on burning may restrict the use of burning barrels. In this sensitivity analysis, we assumed that a burning restriction is in place from June 15 to October 15. Table CA-2 (w/burn restrictions) can be compared to Table C-1 of the main text (w/o burn restrictions) to evaluate the differences caused by the burn restrictions on the annual average concentration.

Another sensitivity study evaluates the maximum and minimum concentrations through the evaluation of the predominant and non-predominant wind direction. Tables C-1 and CA-1, C-2 and CA-4, and CA-2 & CA-3 show the minimum concentration in the non-predominant wind direction for various averaging periods.

The final sensitivity study is to report the maximum two hour average concentration in Tables A-5 and A-6 for both the predominant and non-predominant wind directions. The two hour concentrations are used to construct the six hour average concentrations shown in Tables C-2 and CA-4.

The following list gives a brief description of each table.

<u>Annual Average Concentrations Above Ambient Conditions</u>

Table CA-1
Annual Average Concentration (χ/q)
Non-Predominant Wind Direction

Table CA-2
Maximum Annual Average Concentration (χ/q)
Predominant Wind Direction
(Burning is Restricted from 6/15 – 10/15)

Table CA-3
Annual Average Concentration (χ/q)
Non-Predominant Wind Direction
(Burning is Restricted from 6/15 – 10/15)

Six Hour Average Concentrations Above Ambient Conditions

Table CA-4
Six-Hour Average Concentration (χ/q)
Non-Predominant Wind Direction

Two Hour Average Concentration Above Ambient Conditions

Table CA-5
Two-Hour Maximum Average Concentration (χ/q)
Predominant Wind Direction

Table CA-6
Two-Hour Average Concentration (χ/q)
Non-Predominant Wind Direction

Table CA-1
Annual Average Concentration (χ/q)
Non-Predominant Wind Direction
Above Ambient Conditions - Burning Barrel Emissions

Met. City	**Alturas**	**Bishop**	**San Benito**	**Escondido**
D (m)	**($\mu g/m^3$)/(g/s)**	**($\mu g/m^3$)/(g/s)**	**($\mu g/m^3$)/(g/s)**	**($\mu g/m^3$)/(g/s)**
20	145.	162.	70.9	41.0
50	42.5	39.2	21.6	11.0
100	13.5	11.2	6.96	3.28
200	3.85	2.99	2.00	0.88
500	0.69	0.47	0.36	0.15
1,000	0.19	0.11	0.10	0.04

Notes: (a) χ/q for site specific meteorological data is based on 3,654 hours of emissions at 1 g/s.
(b) Results are valid for two significant digits. Three significant digits are reported to reduce round off error in subsequent calculations.
(c) Burning is permitted 12 months per year.

Table CA-2
Maximum Annual Average Concentration (χ/q)
Above Ambient Conditions - Burning Barrel Emissions
(Burning is Restricted from 6/15 – 10/15)

Met. City	**Alturas**	**Bishop**	**San Benito**	**Escondido**	***SCREENING***
Notes	(a)	(a)	(a)	(a)	*(b)*
D (m)	**(μg/m^3)/(g/s)**	**(μg/m^3)/(g/s)**	**(μg/m^3)/(g/s)**	**(μg/m^3)/(g/s)**	**(μg/m^3)/(g/s)**
20	571.	812.	1330.	1860.	*393.*
50	162.	277.	353.	514.	*154.*
100	50.3	88.3	106.	157.	*56.9*
200	14.5	25.4	29.4	44.4	*18.1*
500	2.72	4.61	5.05	7.83	*3.76*
1,000	0.77	1.26	1.30	2.06	*1.15*

Notes: (a) χ/q for site specific meteorological data is based on 2,280 hours of emissions at 1 g/s.
(b) χ/q for Screening analysis is based on 139 hours of emissions at 1 g/s.
(c) χ/q is the concentration in μg/m^3 based on an hourly emission rate of 1 g/s.
(d) Results are valid for two significant digits. Three significant digits are reported to reduce round off error in subsequent calculations.

Table CA-3
Annual Average Concentration (χ/q)
Non-Predominant Wind Direction
Above Ambient Conditions – Burning Barrel Emissions
(Burning is Restricted from 6/15 – 10/15)

Met. City	**Alturas**	**Bishop**	**San Benito**	**Escondido**
D (m)	**(μg/m^3)/(g/s)**	**(μg/m^3)/(g/s)**	**(μg/m^3)/(g/s)**	**(μg/m^3)/(g/s)**
20	157.	246.	87.1	40.8
50	45.4	35.4	27.5	10.6
100	14.4	10.2	8.79	3.16
200	4.12	2.72	2.51	0.86
500	0.74	0.44	0.46	0.14
1,000	0.20	0.10	0.12	0.04

Notes:(a) χ/q for site specific meteorological data is based on 2,280 hours of emissions at 1 g/s.
(b) χ/q is the concentration in μg/m^3 based on an hourly emission rate of 1 g/s.
(c) Results are valid for two significant digits. Three significant digits are reported to reduce round off error in subsequent calculations.

Table CA-4
Six-Hour Average Concentration (χ/q)
Non-Predominant Wind Direction
Above Ambient Conditions – Burning Barrel Emissions

Met. City	**Alturas**	**Bishop**	**San Benito**	**Escondido**
D (m)	**($\mu g/m^3$)/(g/s)**	**($\mu g/m^3$)/(g/s)**	**($\mu g/m^3$)/(g/s)**	**($\mu g/m^3$)/(g/s)**
20	10,244	7,940	8,224	5,674
50	3,629	2,982	3,228	1,753
100	1,283	1,086	1,190	591
200	393	340	377	171
500	79	70	78	31
1,000	24	21	24	8

Notes: (a) χ/q for site specific meteorological data is based on 2 hours of burning and 4 hours of no burning with emissions at 1 g/s.

(b) χ/q is the concentration in $\mu g/m^3$ based on an hourly emission rate of 1 g/s.

(c) Results are valid for two significant digits. Three significant digits are reported to reduce round off error in subsequent calculations.

Table CA-5
Two Hour Maximum Acute Average Concentration (χ/q)
Above Ambient Conditions – Burning Barrel Emissions

Met. City	**Alturas**	**Bishop**	**San Benito**	**Escondido**	***SCREENING***
Avg.	Two HR	Two HR	Two HR	Two HR	One HR
D (m)	**($\mu g/m^3$)/(g/s)**	**($\mu g/m^3$)/(g/s)**	**($\mu g/m^3$)/(g/s)**	**($\mu g/m^3$)/(g/s)**	**($\mu g/m^3$)/(g/s)**
20	43,200	53,300	56,500	46,200	49,600
50	21,500	22,000	23,600	17,800	19,500
100	10,700	8,590	9,370	6,490	7,170
200	4,210	2,840	3,130	2,030	2,280
500	1,000	607	681	416	474
1,000	330	188	214	125	145

Notes: (a) χ/q is the concentration in $\mu g/m^3$ based on an hourly emission rate of 1 g/s.

(b) Results are valid for two significant digits. Three significant digits are reported to reduce round off error in subsequent calculations.

Table CA-6
Two-Hour Average Concentration (χ/q)
Non-Predominant Wind Direction
Above Ambient Conditions – Burning Barrel Emissions

Met. City	**Alturas**	**Bishop**	**San Benito**	**Escondido**
D (m)	**($\mu g/m^3$)/(g/s)**	**($\mu g/m^3$)/(g/s)**	**($\mu g/m^3$)/(g/s)**	**($\mu g/m^3$)/(g/s)**
20	30,700	23,800	24,700	17,000
50	10,900	8,940	9,690	5,260
100	3,850	3,260	3,570	1,770
200	1,180	1,020	1,130	512
500	236	209	235	93
1,000	72	63	72	25

Notes: (a) χ/q is the concentration in $\mu g/m^3$ based on an hourly emission rate of 1 g/s for two hours.

(b) Results are valid for two significant digits. Three significant digits are reported to reduce round off error in subsequent calculations.

Attachment B

CIMIS Details for Meteorological Stations

STATION NO.	**= 90**	**MAINT. BY**	**= M-DWR**
STATION NAME	= Alturas	ELEVATION	= 4405 ft.
COUNTY	= Modoc	LATITUDE	= 41D26'18"N (41.4383)
REGION	= Northeast Plateau	LONGITUDE	= 120D28'45"W (120.4792)
NEARBY CITY	= Alturas	START DATE	= 4/23/89
OWNER	= University of California	END DATE	= ACTIVE
MAINT. PERSON	= Northern District		

STATION NO.	= 126	MAINT. BY	= M-OWN
STATION NAME	= San Benito	ELEVATION	= 340 ft.
COUNTY	= San Benito	LATITUDE	= 36D51'15"N
REGION	= Monterey Bay	LONGITUDE	= 121D21'42"W
NEARBY CITY	= Hollister	START DATE	= 6/ 9/94
OWNER	= San Benito County Water Dist	END DATE	= ACTIVE
MAINT. PERSON	= San Joaquin District		

STATION NO.	= 143	MAINT. BY	=
STATION NAME	= San Juan Valley	ELEVATION	= 245 ft.
COUNTY	= San Benito	LATITUDE	= 36D49'23"
REGION	= Monterey Bay	LONGITUDE	= 121D28'03"
NEARBY CITY	= Hollister	START DATE	= 1/ 1/98
OWNER	= Lisa Kemmer/San Benito WD	END DATE	= ACTIVE
MAINT. PERSON	=		

STATION NO.	= 35	MAINT. BY	= M-DWR
STATION NAME	= Bishop	ELEVATION	= 4170 ft.
COUNTY	= Inyo	LATITUDE	= 37D21'29"N
REGION	= Bishop	LONGITUDE	= 118D24'14"W
NEARBY CITY	= Bishop	START DATE	= 2/ 4/83
OWNER	= DWR	END DATE	= ACTIVE
MAINT. PERSON	= Southern District		

STATION NO.	= 153	MAINT. BY	=
STATION NAME	= Escondido SPV	ELEVATION	= 390 ft.
COUNTY	= San Diego	LATITUDE	= 33D04'52"
REGION	= South Coast/Valley	LONGITUDE	= 116D58'33"
NEARBY CITY	= Escondido	START DATE	= 2/ 1/99
OWNER	=	END DATE	= ACTIVE
MAINT. PERSON	=		

Attachment C

SCREEN3 Model Results

```
11/13/01
                                                                    15:11:28
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***
Burn Barrel
SIMPLE TERRAIN INPUTS:
   SOURCE TYPE              =       VOLUME
   EMISSION RATE (G/S)      =      1.00000
   SOURCE HEIGHT (M)        =       2.0000
   INIT. LATERAL DIMEN (M)  =        .2300
   INIT. VERTICAL DIMEN (M) =        .2300
   RECEPTOR HEIGHT (M)      =       1.0000
   URBAN/RURAL OPTION       =        RURAL

THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.


BUOY. FLUX =     .000 M**4/S**3;  MOM. FLUX =     .000 M**4/S**2.

*** STABILITY CLASS  4 ONLY ***

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC             U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
    20.   .4955E+05    4     1.0    1.0   320.0    2.00    2.01    1.30    NO
    50.   .1946E+05    4     1.0    1.0   320.0    2.00    4.47    2.68    NO
   100.   7173.        4     1.0    1.0   320.0    2.00    8.36    4.78    NO
   200.   2275.        4     1.0    1.0   320.0    2.00   15.71    8.62    NO
   500.   474.2        4     1.0    1.0   320.0    2.00   36.28   18.36    NO
  1000.   144.9        4     1.0    1.0   320.0    2.00   68.25   32.10    NO

 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB
     ***************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
     ***************************************

 CALCULATION        MAX CONC    DIST TO   TERRAIN
  PROCEDURE        (UG/M**3)    MAX (M)    HT (M)
--------------    -----------   -------   -------
SIMPLE TERRAIN      .4955E+05       20.        0.
****************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
****************************************************
```

Attachment D

Example ISCST3 Input File / Output File

(Note: In the interest of brevity, only those pages deemed most prevalent from the ISCST3 output have been reproduced here. The entire input/output files are available on request.)

```
CO STARTING
   TITLEONE  Burning Barrel Analysis
   TITLETWO  Modoc County, Alturas Met. Data
   MODELOPT  DFAULT RURAL CONC
   AVERTIME  1 2 6 PERIOD
   POLLUTID  OTHER
   FLAGPOLE  1.0
   RUNORNOT  RUN
   ERRORFIL  ERRORS.OUT
CO FINISHED

SO STARTING
** LOCATION  Srcid   Srctyp   Xs   Ys    (Zs)
   LOCATION  VOL1    VOLUME   0.   0.     0.

** Volume Source     QS     HS   Syo   Szo
** Parameters:      ----    ----  ---  ---
   SRCPARAM  VOL1    1.     2.   0.233 0.233

**                       Winter           Spring
   EMISFACT VOL1 SEASHR  8*0. 8*1. 8*0.   7*0. 10*1. 7*0.
**                       Summer           Fall
   EMISFACT VOL1 SEASHR  6*0. 12*1. 6*0.  7*0. 10*1. 7*0.

   SRCGROUP  ALL

SO FINISHED

RE STARTING
   GRIDPOLR POLAR STA
            POLAR ORIG  0.  0.
            POLAR DIST 20. 50. 100. 200. 500. 1000.
            POLAR GDIR 36 10. 10.
   GRIDPOLR POLAR END
RE FINISHED

ME STARTING
   INPUTFIL  alt96_00.txt
   ANEMHGHT  2 METERS
   SURFDATA  99090  1996  Alturas
   UAIRDATA  99090  1996  Holzworth
**   DAYRANGE  1/1-6/15 10/16-12/31
ME FINISHED

OU STARTING
   RECTABLE  ALLAVE FIRST
   MAXTABLE  ALLAVE 20
   PLOTFILE  PERIOD ALL plotann_alt_12m.dat
   PLOTFILE  6      ALL FIRST plotsix_alt_12m.dat
   PLOTFILE  2      ALL FIRST plottwo_alt_12m.dat
OU FINISHED1
```

*** MODEL SETUP OPTIONS SUMMARY ***

- -

```
**Intermediate Terrain Processing is Selected

**Model Is Setup For Calculation of Average CONCentration Values.

  --  SCAVENGING/DEPOSITION LOGIC --
**Model Uses NO DRY DEPLETION.  DDPLETE =  F
**Model Uses NO WET DEPLETION.  WDPLETE =  F
**NO WET SCAVENGING Data Provided.
**NO GAS DRY DEPOSITION Data Provided.
**Model Does NOT Use GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
           1. Final Plume Rise.
           2. Stack-tip Downwash.
           3. Buoyancy-induced Dispersion.
           4. Use Calms Processing Routine.
           5. Not Use Missing Data Processing Routine.
           6. Default Wind Profile Exponents.
           7. Default Vertical Potential Temperature Gradients.
           8. "Upper Bound" Values for Supersquat Buildings.
           9. No Exponential Decay for RURAL Mode

**Model Assumes Receptors on FLAT Terrain.

**Model Accepts FLAGPOLE Receptor Heights.

**Model Calculates  3 Short Term Average(s) of:   1-HR   2-HR   6-HR
    and Calculates PERIOD Averages

**This Run Includes:     1 Source(s);      1 Source Group(s); and     216 Receptor(s)

**The Model Assumes A Pollutant Type of:  OTHER

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
         Model Outputs Tables of PERIOD Averages by Receptor
         Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)
         Model Outputs Tables of Overall Maximum Short Term Values (MAXTABLE Keyword)
         Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)

**NOTE:  The Following Flags May Appear Following CONC Values:  c for Calm Hours
                                                                m for Missing Hours
                                                                b for Both Calm and Missing Hours
```

```
 **Misc. Inputs:  Anem. Hgt. (m) =     2.00 ;    Decay Coef. =    0.000     ;    Rot. Angle =     0.0
                  Emission Units = GRAMS/SEC                                ;  Emission Rate Unit Factor =   0.10000E+07
                  Output Units   = MICROGRAMS/M**3

 **Approximate Storage Requirements of Model =     1.2 MB of RAM.

 **Input Runstream File:          quick_alt.in
 **Output Print File:             quick_alt_12m.out
 **Detailed Error/Message File:   ERRORS.OUT


1 *** ISCST3 - VERSION 00259 ***    ***  Burning Barrel Analysis                                          ***        11/07/01
                                    ***  Modoc County, Alturas Met. Data                                  ***        14:33:20
 **MODELOPTs:                                                                                                        PAGE   2
 CONC                    RURAL FLAT  FLGPOL DFAULT


                                                 *** VOLUME SOURCE DATA ***

             NUMBER EMISSION RATE                    BASE    RELEASE    INIT.    INIT.   EMISSION RATE
   SOURCE     PART.  (GRAMS/SEC)     X        Y      ELEV.   HEIGHT      SY       SZ      SCALAR VARY
     ID       CATS.               (METERS) (METERS) (METERS) (METERS) (METERS) (METERS)        BY
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

   VOL1          0   0.10000E+01       0.0       0.0     0.0     2.00     0.23     0.23   SEASHR
```

CONC RURAL FLAT FLGPOL DEFAULT

* SOURCE EMISSION RATE SCALARS WHICH VARY SEASONALLY AND DIURNALLY (SEASHR) *

SOURCE ID = VOL1 ; SOURCE TYPE = VOLUME :

SEASON = WINTER

HOUR	SCALAR	HOUR	SCALAR	HOUR	SCALAR	HOUR	SCALAR	HOUR	SCALAR	HOUR	SCALAR
1	.00000E+00	2	.00000E+00	3	.00000E+00	4	.00000E+00	5	.00000E+00	6	.00000E+00
7	.00000E+00	8	.00000E+00	9	.10000E+01	10	.10000E+01	11	.10000E+01	12	.10000E+01
13	.10000E+01	14	.10000E+01	15	.10000E+01	16	.10000E+01	17	.00000E+00	18	.00000E+00
19	.00000E+00	20	.00000E+00	21	.00000E+00	22	.00000E+00	23	.00000E+00	24	.00000E+00

SEASON = SPRING

HOUR	SCALAR	HOUR	SCALAR	HOUR	SCALAR	HOUR	SCALAR	HOUR	SCALAR	HOUR	SCALAR
1	.00000E+00	2	.00000E+00	3	.00000E+00	4	.00000E+00	5	.00000E+00	6	.00000E+00
7	.00000E+00	8	.10000E+01	9	.10000E+01	10	.10000E+01	11	.10000E+01	12	.10000E+01
13	.10000E+01	14	.10000E+01	15	.10000E+01	16	.10000E+01	17	.10000E+01	18	.00000E+00
19	.00000E+00	20	.00000E+00	21	.00000E+00	22	.00000E+00	23	.00000E+00	24	.00000E+00

SEASON = SUMMER

HOUR	SCALAR	HOUR	SCALAR	HOUR	SCALAR	HOUR	SCALAR	HOUR	SCALAR	HOUR	SCALAR
1	.00000E+00	2	.00000E+00	3	.00000E+00	4	.00000E+00	5	.00000E+00	6	.00000E+00
7	.10000E+01	8	.10000E+01	9	.10000E+01	10	.10000E+01	11	.10000E+01	12	.10000E+01
13	.10000E+01	14	.10000E+01	15	.10000E+01	16	.10000E+01	17	.10000E+01	18	.10000E+01
19	.00000E+00	20	.00000E+00	21	.00000E+00	22	.00000E+00	23	.00000E+00	24	.00000E+00

SEASON = FALL

HOUR	SCALAR	HOUR	SCALAR	HOUR	SCALAR	HOUR	SCALAR	HOUR	SCALAR	HOUR	SCALAR
1	.00000E+00	2	.00000E+00	3	.00000E+00	4	.00000E+00	5	.00000E+00	6	.00000E+00
7	.00000E+00	8	.10000E+01	9	.10000E+01	10	.10000E+01	11	.10000E+01	12	.10000E+01
13	.10000E+01	14	.10000E+01	15	.10000E+01	16	.10000E+01	17	.10000E+01	18	.00000E+00
19	.00000E+00	20	.00000E+00	21	.00000E+00	22	.00000E+00	23	.00000E+00	24	.00000E+00

**MODELOPTs:
CONC RURAL FLAT FLGPOL DFAULT

*** GRIDDED RECEPTOR NETWORK SUMMARY ***

*** NETWORK ID: POLAR ; NETWORK TYPE: GRIDPOLR ***

*** ORIGIN FOR POLAR NETWORK ***
X-ORIG = 0.00 ; Y-ORIG = 0.00 (METERS)

*** DISTANCE RANGES OF NETWORK ***
(METERS)

20.0, 50.0, 100.0, 200.0, 500.0, 1000.0,

*** DIRECTION RADIALS OF NETWORK ***
(DEGREES)

10.0,	20.0,	30.0,	40.0,	50.0,	60.0,	70.0,	80.0,	90.0,	100.0,
110.0,	120.0,	130.0,	140.0,	150.0,	160.0,	170.0,	180.0,	190.0,	200.0,
210.0,	220.0,	230.0,	240.0,	250.0,	260.0,	270.0,	280.0,	290.0,	300.0,
310.0,	320.0,	330.0,	340.0,	350.0,	360.0,				

CONC RURAL FLAT FLGPOL DFAULT

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: alt96_00.txt
FORMAT: (4I2,2F9.4,F6.1,I2,2F7.1,f9.4,f10.1,f8.4,i4,f7.2)
SURFACE STATION NO.: 99090 UPPER AIR STATION NO.: 99090
NAME: ALTURAS NAME: HOLZWORTH
YEAR: 1996 YEAR: 1996

YR	MN	DY	HR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	MIXING HEIGHT (M) URBAN	USTAR (M/S)	M-O LENGTH (M)	Z-0 (M)	IPCODE	PRATE (mm/HR)
96	01	01	01	299.5	1.03	269.2	6	350.0	350.0	0.0000	0.0	0.0000	0	0.00
96	01	01	02	222.2	1.00	268.8	6	350.0	350.0	0.0000	0.0	0.0000	0	0.00
96	01	01	03	306.2	1.02	268.1	6	350.0	350.0	0.0000	0.0	0.0000	0	0.00
96	01	01	04	214.1	1.00	268.1	6	350.0	350.0	0.0000	0.0	0.0000	0	0.00
96	01	01	05	250.6	1.16	268.4	6	350.0	350.0	0.0000	0.0	0.0000	0	0.00
96	01	01	06	16.5	1.00	267.8	6	350.0	350.0	0.0000	0.0	0.0000	0	0.00
96	01	01	07	310.4	1.00	268.2	6	350.0	350.0	0.0000	0.0	0.0000	0	0.00
96	01	01	08	340.6	1.00	269.6	5	350.0	350.0	0.0000	0.0	0.0000	0	0.00
96	01	01	09	91.9	1.00	271.0	4	175.0	466.7	0.0000	0.0	0.0000	0	0.00
96	01	01	10	96.0	1.02	272.1	4	350.0	583.3	0.0000	0.0	0.0000	0	0.00
96	01	01	11	154.0	1.05	274.2	3	525.0	700.0	0.0000	0.0	0.0000	0	0.00
96	01	01	12	148.4	1.18	276.4	2	700.0	816.7	0.0000	0.0	0.0000	0	0.00
96	01	01	13	352.5	1.11	278.3	2	875.0	933.3	0.0000	0.0	0.0000	0	0.00
96	01	01	14	97.1	1.46	279.3	2	1050.0	1050.0	0.0000	0.0	0.0000	0	0.00
96	01	01	15	195.1	1.00	280.4	2	1050.0	1050.0	0.0000	0.0	0.0000	0	0.00
96	01	01	16	78.9	1.00	280.9	3	1050.0	1050.0	0.0000	0.0	0.0000	0	0.00
96	01	01	17	297.6	1.13	277.2	4	1050.0	1050.0	0.0000	0.0	0.0000	0	0.00
96	01	01	18	286.6	1.05	273.2	5	950.0	950.0	0.0000	0.0	0.0000	0	0.00
96	01	01	19	280.8	1.00	273.1	6	850.0	850.0	0.0000	0.0	0.0000	0	0.00
96	01	01	20	330.1	1.44	273.2	6	750.0	750.0	0.0000	0.0	0.0000	0	0.00
96	01	01	21	183.1	1.19	272.9	6	650.0	650.0	0.0000	0.0	0.0000	0	0.00
96	01	01	22	160.5	1.29	271.9	6	550.0	550.0	0.0000	0.0	0.0000	0	0.00
96	01	01	23	14.1	1.15	270.8	6	450.0	450.0	0.0000	0.0	0.0000	0	0.00
96	01	01	24	298.4	1.36	270.7	6	350.0	350.0	0.0000	0.0	0.0000	0	0.00

*** NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

CONC RURAL FLAT FLGPOL DFAULT

*** THE PERIOD (43848 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): VOL1 ,

*** NETWORK ID: POLAR ; NETWORK TYPE: GRIDPOLR ***

** CONC OF OTHER IN MICROGRAMS/M**3 **

DIRECTION (DEGREES)	DISTANCE (METERS) 20.00	50.00	100.00	200.00	500.00	1000.00
10.00	359.28723	109.09495	35.23533	10.17595	1.86986	0.51552
20.00	322.79550	94.75423	30.04909	8.58382	1.55289	0.42200
30.00	303.82068	87.01556	27.26755	7.73402	1.38359	0.37210
40.00	310.64249	88.56834	27.80078	7.90533	1.41740	0.38177
50.00	343.76212	97.06303	30.28417	8.56304	1.52019	0.40539
60.00	415.36121	118.75463	37.26259	10.58086	1.89030	0.50684
70.00	483.38943	137.87877	43.25087	12.28842	2.19577	0.58894
80.00	551.75903	156.56862	48.91713	13.85778	2.47025	0.66145
90.00	625.56580	175.35014	54.31086	15.28538	2.69682	0.71475
100.00	701.34460	195.15503	60.22597	16.92513	2.97425	0.78414
110.00	743.75629	203.13817	62.05415	17.31683	3.00745	0.78362
120.00	764.23553	204.78236	61.90730	17.15272	2.93798	0.75377
130.00	772.67841	205.59232	62.08289	17.20626	2.93811	0.74987
140.00	745.85541	194.59494	58.10659	15.93469	2.66552	0.66503
150.00	723.08447	188.13655	56.23870	15.42978	2.57930	0.64322
160.00	697.60840	181.07933	54.17500	14.88348	2.49010	0.62121
170.00	675.42920	175.23468	52.36225	14.37422	2.39870	0.59566
180.00	658.65680	174.99783	52.97433	14.69991	2.50293	0.63527
190.00	579.61694	155.84921	47.50737	13.25050	2.28134	0.58686
200.00	437.30966	115.82762	34.90974	9.62612	1.63262	0.41498
210.00	317.55426	84.92886	25.80663	7.16093	1.23060	0.31777
220.00	232.50551	62.56200	19.06682	5.29708	0.91314	0.23672
230.00	186.68686	51.73637	16.08179	4.53995	0.80231	0.21303
240.00	159.59248	45.10520	14.17402	4.02594	0.71774	0.19218
250.00	148.55293	43.20642	13.82930	3.98011	0.72292	0.19682
260.00	151.88326	44.79121	14.40066	4.14873	0.75450	0.20557
270.00	175.13824	55.05038	18.46500	5.49965	1.04397	0.29501
280.00	157.86005	48.11384	15.69142	4.54722	0.83457	0.22946
290.00	154.47588	47.91508	15.80337	4.62305	0.86071	0.23978
300.00	155.87004	48.62551	16.12665	4.74183	0.88769	0.24817
310.00	146.41270	44.58778	14.54168	4.22844	0.78086	0.21581
320.00	144.94771	42.50871	13.51841	3.84975	0.69014	0.18579
330.00	179.44879	54.08427	17.46337	5.04325	0.92535	0.25465
340.00	233.74501	70.48315	22.71098	6.53114	1.19126	0.32634
350.00	324.58835	101.20020	33.15681	9.66215	1.79817	0.50140
360.00	379.02032	118.68980	38.97332	11.38465	2.12648	0.59483

CONC RURAL FLAT FLGPOL DFAULT

*** THE MAXIMUM 20 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): VOL1 ,

** CONC OF OTHER IN MICROGRAMS/M**3 **

RANK	CONC	(YYMMDDHH)	AT	RECEPTOR (XR,YR)	OF TYPE	RANK	CONC	(YYMMDDHH)	AT	RECEPTOR (XR,YR)	OF TYPE
1.	81534.78125	(98111108)	AT (	-20.00, 0.00)	GP	11.	62762.19531	(96111717)	AT (	3.47, 19.70)	GP
2.	77099.78125	(97112708)	AT (	18.79, 6.84)	GP	12.	62494.07812	(98110208)	AT (	-20.00, 0.00)	GP
3.	63778.89062	(96111108)	AT (	-17.32, -10.00)	GP	13.	62494.07422	(98111109)	AT (	-6.84, 18.79)	GP
4.	63717.26953	(97110408)	AT (	-19.70, 3.47)	GP	14.	62407.88281	(96013009)	AT (	0.00, -20.00)	GP
5.	63717.26172	(00112308)	AT (	-20.00, 0.00)	GP	15.	62295.17188	(97120909)	AT (	-18.79, -6.84)	GP
6.	63617.28125	(97112808)	AT (	-15.32, -12.86)	GP	16.	62195.92578	(99011109)	AT (	18.79, -6.84)	GP
7.	63525.13281	(98012209)	AT (	17.32, -10.00)	GP	17.	62195.85938	(00111408)	AT (	-19.70, -3.47)	GP
8.	63206.09766	(00111208)	AT (	0.00, 20.00)	GP	18.	61867.87500	(97120809)	AT (	-3.47, 19.70)	GP
9.	62999.52344	(00012309)	AT (	-20.00, 0.00)	GP	19.	61510.69922	(97122309)	AT (	17.32, 10.00)	GP
10.	62999.52344	(00112608)	AT (	-6.84, 18.79)	GP	20.	61216.41016	(97030608)	AT (	15.32, 12.86)	GP

*** RECEPTOR TYPES: GC = GRIDCART
GP = GRIDPOLR
DC = DISCCART
DP = DISCPOLR
BD = BOUNDARY

CONC RURAL FLAT FLGPOL DFAULT

*** THE MAXIMUM 20 2-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): VOL1 ,

** CONC OF OTHER IN MICROGRAMS/M**3 **

RANK	CONC	(YYMMDDHH)	AT	RECEPTOR (XR,YR)		OF TYPE	RANK	CONC	(YYMMDDHH)	AT	RECEPTOR (XR,YR)		OF TYPE
1.	48871.01172	(98120312)	AT (	20.00,	0.00)	GP	11.	40026.98438	(99012910)	AT (	-20.00,	0.00)	GP
2.	47849.55469	(98011014)	AT (	-6.84,	-18.79)	GP	12.	39146.01562	(97121716)	AT (	17.32,	10.00)	GP
3.	43185.06250	(98111112)	AT (	3.47,	-19.70)	GP	13.	38723.82031	(97012414)	AT (	15.32,	-12.86)	GP
4.	41447.76172	(97122110)	AT (	-17.32,	10.00)	GP	14.	38549.89062	(97112708)	AT (	18.79,	6.84)	GP
5.	41197.90625	(98011510)	AT (	-3.47,	-19.70)	GP	15.	38313.87500	(00021810)	AT (	20.00,	0.00)	GP
6.	40964.49219	(97062708)	AT (	15.32,	-12.86)	GP	16.	38282.94141	(00080108)	AT (	10.00,	-17.32)	GP
7.	40842.83594	(99011810)	AT (	-15.32,	-12.86)	GP	17.	38258.22656	(96080108)	AT (	-3.47,	-19.70)	GP
8.	40767.39062	(98111108)	AT (	-20.00,	0.00)	GP	18.	38173.92188	(00072508)	AT (	12.86,	-15.32)	GP
9.	40444.94141	(96122110)	AT (	3.47,	19.70)	GP	19.	38112.43359	(96080708)	AT (	20.00,	0.00)	GP
10.	40256.50000	(97011510)	AT (	-20.00,	0.00)	GP	20.	37763.02344	(97110210)	AT (	12.86,	-15.32)	GP

*** RECEPTOR TYPES: GC = GRIDCART
GP = GRIDPOLR
DC = DISCCART
DP = DISCPOLR
BD = BOUNDARY

CONC RURAL FLAT FLGPOL DFAULT

*** THE MAXIMUM 20 6-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): VOL1 ,

** CONC OF OTHER IN MICROGRAMS/M**3 **

RANK	CONC	(YYMMDDHH)	AT	RECEPTOR (XR,YR)		OF TYPE	RANK	CONC	(YYMMDDHH)	AT	RECEPTOR (XR,YR)		OF TYPE
1.	23044.16211	(98011012)	AT (	0.00,	-20.00)	GP	11.	16884.92969	(00072512)	AT (	12.86,	-15.32)	GP
2.	19217.70312	(97112712)	AT (	18.79,	6.84)	GP	12.	16869.17578	(97062712)	AT (	15.32,	-12.86)	GP
3.	18968.23242	(98011018)	AT (	-6.84,	-18.79)	GP	13.	16400.34961	(97120512)	AT (	6.84,	-18.79)	GP
4.	18637.32422	(97122112)	AT (	-18.79,	6.84)	GP	14.	16290.33789	(98120312)	AT (	20.00,	0.00)	GP
5.	18598.71094	(98111112)	AT (	3.47,	-19.70)	GP	15.	16217.56641	(00021612)	AT (	19.70,	3.47)	GP
6.	18119.53906	(98012218)	AT (	-6.84,	-18.79)	GP	16.	16210.42773	(97080512)	AT (	12.86,	-15.32)	GP
7.	17679.75000	(00073012)	AT (	10.00,	-17.32)	GP	17.	15785.03711	(97110212)	AT (	12.86,	-15.32)	GP
8.	17354.37891	(00101112)	AT (	-6.84,	18.79)	GP	18.	15478.49512	(97122112)	AT (	-17.32,	10.00)	GP
9.	17291.69336	(98112712)	AT (	-20.00,	0.00)	GP	19.	15428.75195	(98071212)	AT (	19.70,	-3.47)	GP
10.	16999.28516	(96080112)	AT (	-3.47,	-19.70)	GP	20.	15314.57812	(98011512)	AT (	-3.47,	-19.70)	GP

*** RECEPTOR TYPES: GC = GRIDCART
GP = GRIDPOLR
DC = DISCCART
DP = DISCPOLR
BD = BOUNDARY

**MODELOPTs:
CONC RURAL FLAT FLGPOL DFAULT

*** THE SUMMARY OF MAXIMUM PERIOD (43848 HRS) RESULTS ***

** CONC OF OTHER IN MICROGRAMS/M**3 **

GROUP ID		AVERAGE CONC	RECEPTOR (XR, YR, ZELEV, ZFLAG)				OF TYPE	NETWORK GRID-ID
ALL	1ST HIGHEST VALUE IS	772.67841 AT (	15.32,	-12.86,	0.00,	1.00)	GP	POLAR
	2ND HIGHEST VALUE IS	764.23553 AT (	17.32,	-10.00,	0.00,	1.00)	GP	POLAR
	3RD HIGHEST VALUE IS	745.85541 AT (	12.86,	-15.32,	0.00,	1.00)	GP	POLAR
	4TH HIGHEST VALUE IS	743.75629 AT (	18.79,	-6.84,	0.00,	1.00)	GP	POLAR
	5TH HIGHEST VALUE IS	723.08447 AT (	10.00,	-17.32,	0.00,	1.00)	GP	POLAR
	6TH HIGHEST VALUE IS	701.34460 AT (	19.70,	-3.47,	0.00,	1.00)	GP	POLAR
	7TH HIGHEST VALUE IS	697.60840 AT (	6.84,	-18.79,	0.00,	1.00)	GP	POLAR
	8TH HIGHEST VALUE IS	675.42920 AT (	3.47,	-19.70,	0.00,	1.00)	GP	POLAR
	9TH HIGHEST VALUE IS	658.65680 AT (	0.00,	-20.00,	0.00,	1.00)	GP	POLAR
	10TH HIGHEST VALUE IS	625.56580 AT (	20.00,	0.00,	0.00,	1.00)	GP	POLAR

*** RECEPTOR TYPES: GC = GRIDCART
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APPENDIX D

Glossary and Acronyms

Glossary and Acronymns

Glossary

Acute Exposure:	One or a series of short-term exposures generally lasting less than 24 hours.
Air Dispersion Model:	A mathematical model or computer simulation used to estimate the concentration of toxic air pollutants at specific locations as a result of mixing in the atmosphere.
Airborne Toxic Control Measure:	Section 39655 of the Health and Safety Code, defines an "Airborne Toxic Control Measure" means either of the following: 1) Recommended methods, and, where appropriate, a range of methods, that reduce, avoid, or eliminate the emissions of a toxic air contaminant. Airborne toxic control measures include, but are not limited to, emission limitations, control technologies, the use of operational and maintenance conditions, closed system engineering, design equipment, or work practice standards, and the reduction, avoidance, or elimination of emissions through process changes, substitution of materials, or other modifications. 2) Emission standards adopted by the U.S. Environmental Protection Agency pursuant to Section 112 of the federal act (42 U.S.C. Sec. 7412).
Cancer Risk:	The theoretical probability of contracting cancer when exposed for a lifetime to a given concentration of a substance usually calculated as an upper confidence limit. The maximum estimated risk may be presented as the number of chances in a million of contracting cancer.
Chronic Exposure:	Long-term exposure usually lasting from one year to a lifetime.
Hazardous Air Pollutant or HAP:	Means a substance that the U.S. Environmental Protection Agency has listed in, or pursuant to, Section 112 subsection (b) of the federal Clean Air Act Amendments of 1990 (42 U.S. Code, Section 7412(b)).
Hazard Index:	The ratio of the concentration of a toxic pollutant with non-cancer health effects and the reference exposure level for that pollutant.
Health Risk Assessment (HRA):	A comprehensive analysis of the dispersion of hazardous substances in the environment, the potential for human exposure, and a quantitative assessment of both individual and population-wide health impacts associated with the level of exposure.

Near Source Location:	The location closest to an emission's source where concentrations could be estimated through air dispersion modeling.
Non-cancer Risk:	Refers to non-cancer health effects due to acute and/or chronic exposure. This may be illustrated as an estimate of the hazard index or total hazard index (by endpoint) resulting from exposure to toxic air pollutants.
Reference Exposure Level (REL):	These are used as indicators of potential non-cancer adverse health effects. An REL is a concentration level at or below which no adverse health effects are anticipated. RELs are designed to protect most sensitive individuals in the population by including safety factors in their development.
Risk:	The possibility of injury or disease, which may result from exposure to toxic air pollutants.
Scientific Review Panel on Toxic Air Contaminants (SRP):	A nine-member panel appointed to advise the Air Resources Board and the Department of Pesticide Regulation in their evaluation of the adverse health effects toxicity of substances being evaluated as Toxic Air Contaminants.
Toxic Air Contaminant (TAC):	Section 39655 of the Health and Safety Code, defines a TAC as an air pollutant which may cause or contribute to an increase in mortality or an increase in serious illness, or which may pose a present or potential hazard to human health. A substance that is listed as a hazardous air pollutant pursuant to subsection (b) of Section 112 of the federal act (42 U.S.C. Sec. 7412(b)) is a TAC. TACs that are pesticides are regulated in their pesticidal use by the Department of Pesticide Regulation.
Total Hazard Index:	The sum of hazard indices for pollutants with non-cancer health effects that have the same or similar adverse health effects (endpoints).
Unit Risk Factor: (URF):	The estimated upper-confidence limit (usually 95%) probability of a person contracting cancer as a result of a constant exposure to 1 $\mu g/m^3$ of a substance over a 70-year lifetime.

Acronyms

ARB	Air Resources Board
APCD	Air Pollution Control District
AQMD	Air Quality Management District
ATCM	Airborne Toxic Control Measure
Districts	Local Air Pollution Control and Air Quality Management Districts
HAP	Hazardous Air Pollutant
HSC	Health and Safety Code
IARC	International Agency for Research on Cancer
OEHHA	Office of Environmental Health Hazard Assessment
RfD	Reference Dose
REL	Reference Exposure Level
SB	Senate Bill
SRP	Scientific Review Panel on Toxic Air Contaminants
TAC	Toxic Air Contaminant
URF	Unit Risk Factor
U.S. EPA	United States Environmental Protection Agency