1. INTRODUCTION

The Office of Air Quality Planning and Standards (OAQPS) of the U.S. Environmental Protection Agency (EPA, or the Agency) has the responsibility for the hazardous and criteria air pollutant programs described by sections 112 and 108 of the Clean Air Act (CAA). Several aspects of these programs require evaluation of the health risks and environmental effects associated with exposure to these pollutants.[1] In response to these risk-related mandates of the CAA, and the scientific recommendations of the National Academy of Sciences (NAS) (NRC 1994), the Presidential/Congressional Commission on Risk Assessment and Risk Management (CRARM) (CRARM 1997), as well as EPA guidelines and policies, OAQPS recognized the need for improved fate and transport, exposure, and risk modeling tools that:

- Have multimedia assessment capabilities;
- Have human health and ecological exposure and risk assessment capabilities;
- Can perform multiple pollutant assessments (*e.g.*, ability to assess mixtures of pollutants, ability to track chemical transformations);
- Can explicitly address uncertainty and variability;
- Have the ability to easily perform analyses iteratively, moving from the use of simpler assumptions and scenarios to more detailed assessments; and
- Are readily available and user-friendly, so that they can be used by EPA, as well as by a variety of Agency stakeholders.

In 1996, OAQPS embarked on a multi-year effort to develop the Total Risk Integrated Methodology (TRIM), a time series modeling system with multimedia capabilities for assessing human health and ecological risks from hazardous and criteria air pollutants.

The main purpose of the TRIM Status Report (U.S. EPA 1999c) is to summarize the work performed during the second developmental phase of TRIM. The first phase, which included the conceptualization of TRIM and implementation of the TRIM conceptual approach through development of a prototype of the first TRIM module, TRIM.FaTE (U.S. EPA 1998a), was reviewed by EPA's Science Advisory Board (SAB) in May 1998 (U.S. EPA 1998b). The second developmental phase has included refining TRIM.FaTE and developing a model evaluation plan, initiating development of the second module (TRIM.Expo), and conceptualizing the third module (TRIM.Risk). In addition, progress has been made on developing overarching aspects, such as the computer framework and an approach to uncertainty and variability. Consistent with the integral role of peer review in the TRIM development plan, the current Status Report and

[1] Hazardous air pollutants (HAPs) include any air pollutant listed under CAA section 112(b); currently, there are 188 air pollutants designated as HAPs. Criteria air pollutants are air pollutants for which national ambient air quality standards (NAAQS) have been established under the CAA; at present, the six criteria air pollutants are particulate matter, ozone, carbon monoxide, nitrogen oxides, sulfur dioxide, and lead.

Technical Support Documents (TSDs) were subjected to review by representatives from the major program offices at EPA and an EPA Models 2000[2] review team prior to this SAB advisory.

This TSD describes the development of TRIM.Expo, detailing the work completed to date toward developing the first TRIM.Expo prototypes. More specifically, the report addresses the following areas:

- OAQPS' modeling needs and the intended goals for TRIM;
- Design of the TRIM modeling system;
- TRIM.Expo's relation to the TRIM modeling system;
- Purpose and ongoing development of TRIM.Expo;
- Conceptual framework of TRIM.Expo, in the context of the general approach to exposure assessment and modeling;
- Approach used in TRIM.Expo for calculating inhalation and ingestion exposures;
- Comparative overview of existing exposure models and modeling approaches, addressing the strengths and limitations of some of the more commonly used exposure models;
- Plans for developing and evaluating the TRIM.Expo prototypes;
- Glossary of terms and definitions; and
- Listing of examples of input parameters for TRIM.Expo.

1.1 GOALS AND OBJECTIVES FOR TRIM

The TRIM modeling system is intended to represent the next generation of human and environmental exposure and risk models for OAQPS. For example, TRIM is expected to be a useful tool for performing exposure and/or risk assessments for the following CAA programs: the Residual Risk Program (CAA section 112[f]); the Integrated Urban Air Toxics Strategy (CAA section 112[k]); studies of deposition to water bodies and mercury emissions from utilities (CAA

[2] Following the report of the Agency Task Force on Environmental Regulatory Modeling (U.S. EPA 1994a), the Agency conducted the Models 2000 Conference in December 1997. This conference has led to renewed emphasis on Agency-wide coordination of model development and the proposal for the implementation of a Council on Regulatory Environmental Modeling (CREM) to facilitate and promote scientifically-based, defensible regulatory computer models. The charter for CREM has been reviewed by SAB and is being updated for implementation by the Agency.

sections 112[m] and 112[n]); petitions to delist individual HAPs and/or source categories (CAA sections 112[b][3] and 112[c][9]); review and setting of the national ambient air quality standards (NAAQS) (CAA section 109); and regulatory impact analyses (RIA).

The goal in developing TRIM is to create a modeling system, and the components of that system, for use in characterizing human health and ecological exposure and risk in support of hazardous and criteria air pollutant programs under the CAA. The goal in designing TRIM is to develop a modeling system that is: (1) scientifically defensible, (2) flexible, and (3) user-friendly.

(1) Characteristics of the TRIM components important to their scientific defensibility include the following.

- **Conservation of pollutant mass.** The modeled pollutant(s)' mass will be conserved within the system being assessed, wherever appropriate and feasible, including during intermedia transfers. For pollutants where transformation is modeled, the mass of the core substance (*e.g.*, mercury for methylmercury as well as divalent mercury) within the modeling simulation will be preserved.

- **Ability to characterize parameter uncertainty and variability.** For critical parameters, the impacts of parameter uncertainty and variability on model outputs will be tracked and, where feasible, differentiated.

- **Capability for multiple pollutant, multiple media, multiple exposure pathway assessment.** The TRIM modeling system is being designed to facilitate assessment of risks posed by aggregate exposures to single or multiple chemicals from multiple sources and via multiple exposure pathways.

(2) To ensure flexibility, the features of TRIM include the following.

- **Modular design.** Major components of TRIM will be independent and can be used individually, with outside information or models, or in combination. Only those model components necessary for evaluating the particular pollutants, pathways, and/or effect endpoints of interest need be employed in an assessment.

- **Flexibility in temporal and spatial scale.** Exposure and risk assessments will be possible for a wide range of temporal and spatial scales, including hourly to daily or yearly time steps, and from local (10 kilometers (km) or less) to greater spatial scales (depending on the module).

- **Ability to assess human and ecological endpoints.** Impacts to humans and/or biota can be assessed.

(3) To ensure that TRIM will be user-friendly for a variety of groups, including EPA, state and local agencies, and other stakeholders, TRIM will have the following characteristics.

- **Easily accessible.** The TRIM modeling system will be accessible for use with a personal computer (PC). The system may be available for download from the Internet and accessible through an Agency model system framework (*e.g.*, Models-3 (U.S. EPA 1999d)).

- **Well-documented.** Guidance materials for use of the TRIM modeling system will be provided through a user's guide, with a focus on the modular aspects of the modeling system, limitations of the modeling system, and appropriate uses, user responsibilities, and user options.

- **Clear and transparent.** The graphical user interface of the TRIM computer framework will provide transparency and clarity in the functioning of the TRIM modules, and output from the risk characterization module will document modeling assumptions, limitations, and uncertainties.

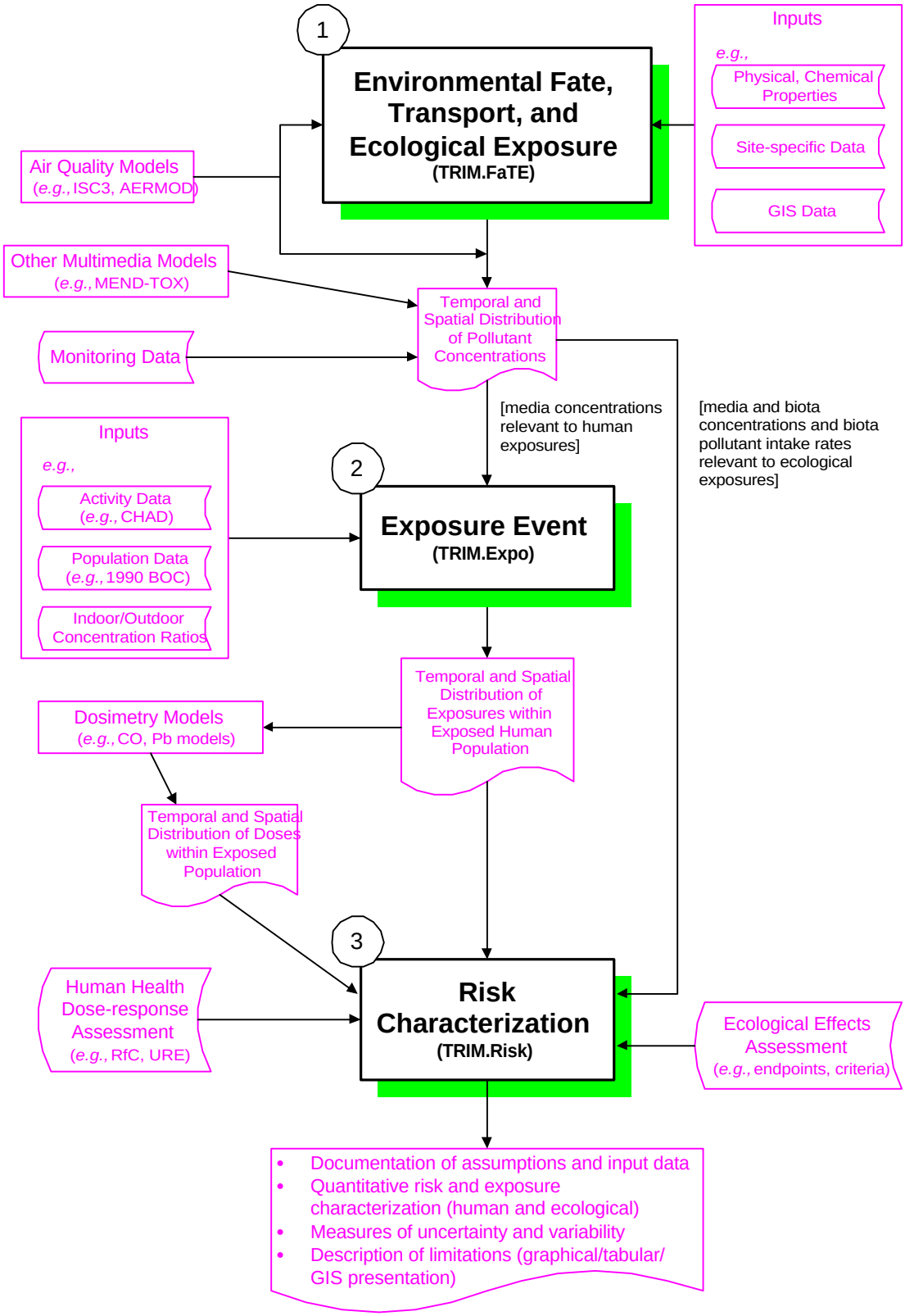
1.2 TRIM DESIGN

The current TRIM design (Figure 1-1) includes three individual modules. The Environmental Fate, Transport, and Ecological Exposure module, **TRIM.FaTE,** accounts for movement of a chemical through a comprehensive system of discrete compartments (*e.g.*, media, biota) that represent possible locations of the chemical in the physical and biological environments of the modeled ecosystem and provides an inventory, over time, of a chemical throughout the entire system. In addition to providing exposure estimates relevant to ecological risk assessment, TRIM.FaTE generates media concentrations relevant to human pollutant exposures that can be used as input to the Exposure-Event module, **TRIM.Expo.** In TRIM.Expo, human exposures are evaluated by tracking population groups referred to as "cohorts" and their inhalation and ingestion through time and space. In the Risk Characterization module, **TRIM.Risk**, estimates of human exposures or doses are characterized with regard to potential risk using the corresponding exposure- or dose-response relationships. The TRIM.Risk module is also being designed to characterize ecological risks from multimedia exposures. The output from TRIM.Risk will include documentation of the input data, assumptions in the analysis, and measures of uncertainty, as well as the results of risk calculations and exposure analysis.

An overarching feature of the TRIM design is the analysis of uncertainty and variability. A two-stage approach for providing this feature to the user is being developed[3]. The first stage includes sensitivity analyses that are useful in identifying critical parameters, while more detailed uncertainty and variability analyses using Monte Carlo methods (*e.g.*, for refined assessment of the impact of the critical parameters) are available in the second stage. The uncertainty and variability feature augments the TRIM capability for performing iterative analyses. For example, the user may perform assessments varying from simple deterministic screening analyses using conservative default parameters to refined and complex risk assessments where the impacts of parameter uncertainty and variability are assessed for critical parameters.

[3] This approach is being developed for the overall TRIM system. However, it has only been implemented to date for the TRIM.FaTE module.

Figure 1-1
Conceptual Design of TRIM



Additionally, the modular design of TRIM allows for flexibility in both its development and application. Modules can be developed in a phased approach, with refinements being made as scientific information and tools become available. Furthermore, the user may select any one or more of these modules for an assessment depending on the user's needs. For example, when performing a human health risk assessment for an air pollutant for which multimedia distribution is not significant, TRIM.Expo may be applied using ambient concentration data or the output from an air quality model external to TRIM; the output from TRIM.Expo may then be used as input to TRIM.Risk to perform the desired risk analyses. In the case of a multimedia air pollutant, such as mercury, the user may choose to run all three TRIM modules to assess both human and ecological risks posed by multipathway exposures from multiple media.

Overview descriptions of the TRIM modules are provided in Sections 1.2.1 through 1.2.3, the status and plans for development are presented in Section 1.3, and plans for application appear in Section 1.4. A summary of the previous SAB comments and OAQPS responses is presented in Chapter 2 of the TRIM Status Report. The approach for handling uncertainty and variability in TRIM is described in Chapter 3 of the TRIM Status Report. Certain aspects of the TRIM.FaTE module are addressed in greater detail in Chapters 4 through 7, and additional details on TRIM.Expo and TRIM.Risk are provided in Chapters 8 and 9, respectively, of the TRIM Status Report. Chapter 10 of the TRIM Status Report discusses the computer framework that is being implemented for the TRIM system. In addition, the TRIM.FaTE TSD (U.S. EPA 1999a,b) provides more detail on TRIM.FaTE.

1.2.1 DESCRIPTION OF TRIM.FaTE

The first TRIM module to be developed, TRIM.FaTE, is a spatial compartmental mass balance model that describes the movement and transformation of pollutants over time, through a user-defined, bounded system that includes both biotic and abiotic components (compartments). The TRIM.FaTE module predicts pollutant concentrations in multiple environmental media and in biota and pollutant intakes for biota, all of which provide both temporal and spatial exposure estimates for ecological receptors (*i.e.*, plants and animals). The output concentrations from TRIM.FaTE also can be used as inputs to a human exposure model, such as TRIM.Expo, to estimate human exposures.

Significant features of TRIM.FaTE include: (1) the implementation of a truly coupled multimedia model; (2) the flexibility to define a variety of scenarios, in terms of the links among compartments as well as the number and types of compartments, as appropriate for the desired spatial and temporal scale of assessment; (3) the use of a transparent approach to chemical mass transfer and transformation based on an algorithm library that allows the user to change how environmental processes are modeled; (4) an accounting for all of the pollutant as it moves among the environmental compartments; (5) an embedded procedure to characterize uncertainty and variability; and (6) the capability to provide exposure estimates for ecological receptors. The TRIM.FaTE module is the most fully developed of the TRIM modules at this time, and this development has produced a library of algorithms that account for transfer of chemical mass throughout an environmental system, a database of the information needed to initialize these algorithms for a test site, and a working computer model.

1.2.2 DESCRIPTION OF TRIM.Expo

The TRIM.Expo module, similar to most human exposure assessment models, provides an analysis of the relationships between various chemical concentrations in the environment and exposure levels of humans. Because multiple sources of environmental contamination can lead to multiple contaminated media, including air, water, soil, food, and indoor air, it is useful to focus on the contaminated environmental media with which a human population will come into contact. These media typically include the envelope of air surrounding an individual, the water and food ingested by an individual, and the layer of soil and/or water that contacts the surface of an individual. The magnitude and relative contribution of each exposure pathway must be considered to assess total exposure to a particular chemical. Currently, the focus of TRIM.Expo development is on inhalation and ingestion exposure; however, dermal exposure will be added later.

The exposure analysis process consists of relating chemical concentrations in environmental media (*e.g.*, air, surface soil, root zone soil, surface water) to chemical concentrations in the exposure media with which a human or population has contact (*e.g.*, air, tap water, foods, household dusts, and soils). The initial prototype for TRIM.Expo will predict exposure by tracking the movement of a population cohort through locations where chemical exposure can occur according to a specific activity pattern. In a typical application, TRIM.FaTE could be used to provide an inventory of chemical concentrations across the ecosystem at selected time intervals (*e.g.*, days, hours). For chemicals that are not persistent and/or bioaccumulative, processed air monitoring data or air dispersion modeling results can be substituted for TRIM.FaTE output data. The TRIM.Expo module would then use these chemical concentration data, combined with the activity patterns of the cohorts, to estimate exposures. The movements are defined as an exposure-event sequence that can be related to time periods for which exposure media concentrations are available (*e.g.*, from TRIM.FaTE, ambient data, and/or dispersion modeling results). Each exposure event places the population cohort in contact with one or more environmental media within a specified microenvironment (*e.g.*, inside a home, along a road, inside a vehicle) in an exposure district for a specified time interval. In addition to the location assignments, the

TRIM.Expo KEY TERMS

Cohort - A group of people within a population with the same demographic variables who are assumed to have similar exposures.

Activity pattern - A series of discrete events of varying time intervals describing information about an individual's lifestyle and routine. The information contained in an activity pattern typically includes the locations that the individual visited (usually described in terms of microenvironments), the amount of time spent in those locations, and a description of what the individual was doing in each location (*e.g.*, sleeping, eating, exercising).

Microenvironment - A defined space in which human contact with an environmental pollutant takes place and which can be treated as a well- characterized, relatively homogeneous location with respect to pollutant concentrations for a specified time period.

Exposure district - A geographic location within a defined physical or political region where there is potential contact between an organism and a pollutant and for which environmental media concentrations have been estimated either through modeling or measurement.

exposure event would provide information relating to the potential for pollutant uptake, such as respiration rate and quantity of water consumed. The TRIM.Expo module is intended to contribute to a number of health-related assessments, including risk assessments and status and trends analyses.

1.2.3 DESCRIPTION OF TRIM.Risk

Risk characterization is the final step in risk assessment and is primarily used to integrate the information from the other three key steps (*i.e.*, hazard identification, dose-response assessment, exposure assessment). Within the TRIM framework, TRIM.Risk, the risk characterization module, will be used to integrate the information on exposure (human or ecological receptor) with that on dose-response or hazard and for providing quantitative descriptions of risk and some of the attendant uncertainties. The TRIM.Risk module will provide decision makers and the public with information for use in developing, evaluating, and selecting appropriate air quality standards and risk management strategies. The purpose of TRIM.Risk is to integrate information from other TRIM modules and to facilitate the preparation of a risk characterization. The TRIM.Risk module will, therefore, be able to summarize or highlight the major points from each of the analyses conducted in the other TRIM modules. Where possible, the TRIM.Risk module will do so in an automated manner. In general, TRIM.Risk will (1) document assumptions and input data, (2) conduct risk calculations and data analysis, and (3) present results and supporting information.

Current and proposed EPA guidance on risk characterization will guide the development of TRIM.Risk. The TRIM.Risk module will be developed in a phased approach similar to other TRIM modules. Ideally, TRIM.Risk will provide all of the information required to prepare a full risk characterization. However, the type and variability of information needed for this purpose are vast. Therefore, the type of information generated by TRIM.Risk will evolve over time as the Agency gains experience and has the resources to implement more flexibility. For example, early versions of TRIM.Risk will be limited to preparing summaries of input data and results, without supporting text. However, as the Agency gains experience, it may be possible to incorporate generic language to more fully describe the information required for a full risk characterization. Many EPA risk assessments will be expected to address or provide descriptions of (1) individual risk,[4] including the central tendency and high-end portions of the risk distribution, (2) population risk, and (3) risk to important subgroups of the population such as highly exposed or highly susceptible groups or individuals, if known. Some form of these three types of descriptors will be developed within TRIM.Risk and presented to support risk characterization. Because people process information differently, it is appropriate to provide more than one format for presenting the same information. Therefore, TRIM.Risk will be designed so that the output can be presented in various ways in an automated manner (*e.g.*, Chart Wizard in Microsoft® Excel), allowing the user to select a preferred format.

[4] The phrase individual risk as used here does not refer to a risk estimate developed specifically for a single member of a population. Rather, it refers to the estimate of risk for a subgroup of a population that is presented as an estimate of the risk faced by a person rather than by the population as a whole.

1.3 TRIM DEVELOPMENT

In the development of TRIM, existing models and tools are being relied upon where possible. Adopting or incorporating existing models or model components into a tool that meets OAQPS' needs is preferable as it is usually the most cost-effective approach. Consequently, review of existing models and consideration of other current modeling efforts is an important part of TRIM development activities. Reviews of relevant models existing at the initiation of development activities for each module are described in this document and in the TRIM.FaTE TSD. Additionally, OAQPS is closely following several current activities as they relate to TRIM.

Current Agency model development activities relevant to TRIM development include the recently published updated guidance on assessing health risks associated with indirect exposure to combustor emissions (U.S. EPA 1999h). This guidance, previously referred to as the Indirect Exposure Methodology (IEM), is now called the Multiple Pathways of Exposure (MPE) method. In addition, the multimedia model, FRAMES-HWIR, has recently been developed by the Agency to support a specific risk assessment need regarding hazardous chemicals released from land-based waste management units. The FRAMES-HWIR model has been developed as part of a focused fast-track (two-year) effort to support a risk-based regulation regarding disposal of hazardous waste (HWIR99).[5] Another model of interest for multimedia pollutants is the Stochastic Human Exposure and Dose Simulation (SHEDS) model (*e.g.*, Özkaynak et al. 1999). The OAQPS will be carefully considering the various aspects of MPE, FRAMES-HWIR, and SHEDS with regard to OAQPS needs, as well as compatibility with or future improvements or evaluations of TRIM. As TRIM is intended to be a dynamic method, developmental activities will consider and respond as appropriate to newly available methods and scientific information.

A current major Agency research project involves the design and development of a flexible software system to simplify the development and use of air quality models and other environmental decision support tools. This system, called Models-3, is designed for applications ranging from regulatory and policy analysis to understanding the complex interactions of atmospheric chemistry and physics (U.S. EPA 1999d). The June 1999 release of Models-3 contains a Community Multi-Scale Air Quality (CMAQ) modeling system for urban- to regional-scale air quality simulation of tropospheric ozone, acid deposition, visibility, and fine particles. The long-term goal is to extend the system to handle integrated cross-media assessments and serve as a platform for community development of complex environmental models. In recognition of the availability of Models-3 over the longer term, OAQPS has designed and is developing the TRIM computer framework to be compatible with the Models-3 system.

1.3.1 INITIAL DEVELOPMENT ACTIVITIES

The first phase of TRIM development included the conceptualization of TRIM and the implementation of the TRIM conceptual approach through the development of a prototype of the first TRIM module, TRIM.FaTE (U.S. EPA 1998a). The progress on TRIM.FaTE included the development of (1) a conceptual design for the module; (2) a library of algorithms that account

[5] The FRAMES-HWIR documentation is scheduled for public release in fall 1999.

for chemical mass transfer throughout the ecosystem; (3) a database to initialize the algorithms for a test site; and (4) a working prototype in spreadsheet format.

Consistent with Agency peer review policy (U.S. EPA 1998c) and the 1994 Agency Task Force on Environmental Regulatory Modeling (U.S. EPA 1994a), internal and external peer review are an integral part of the TRIM development plan. Following the first phase of TRIM development, OAQPS submitted TRIM to SAB under their advisory method of review (U.S. EPA 1998b). In May 1998 in Washington, DC, the Environmental Models Subcommittee (Subcommittee) of the Executive Committee of SAB reviewed the TRIM project. The SAB Subcommittee was charged with assessing the overall conceptual approach of TRIM and the specific approach of TRIM.FaTE.

The SAB Subcommittee reported that the development of TRIM and the TRIM.FaTE module was conceptually sound and scientifically based (U.S. EPA 1998b). The SAB Subcommittee provided specific recommendations related to six specific charge questions. The SAB recommendations are detailed in Chapter 2 of the TRIM Status Report along with brief responses, and changes to TRIM.FaTE based in part on the SAB recommendations are highlighted in Chapter 4 of the TRIM Status Report.

1.3.2 RECENT ACTIVITIES

During the most recent developmental phase of TRIM, progress has been made in many areas, including a change to the overall modular design of TRIM. As shown in Figure 1-1, the TRIM design now includes three modules: TRIM.FaTE, TRIM.Expo, and TRIM.Risk. The design presented to SAB in May 1998 included three other modules (Pollutant Uptake, Biokinetics, and Dose/Response). In recognition of the flexibility of the TRIM design, which provides an ability to rely on a variety of input data and outside models, OAQPS decided not to include the development of these modules in the TRIM design at this time.

In consideration of SAB comments, TRIM.FaTE was refined, including the development of new and updated capabilities, as well as the development and limited testing of methodologies for model set-up, uncertainty and variability analysis, and evaluation. In addition, OAQPS developed a conceptual plan for TRIM.Expo, initiated work on a prototype of TRIM.Expo (initially focusing on inhalation), and developed a conceptual design for TRIM.Risk. Furthermore, the overall computer framework for TRIM was designed and implemented in a PC-based platform, and substantial progress was made in installing TRIM.FaTE into this framework. Changes and additions to TRIM.FaTE are discussed in more detail in Chapter 4 of the TRIM Status Report. The development of TRIM.Expo is discussed in Chapter 8, and the conceptual plan for TRIM.Risk is described in Chapter 9 of the TRIM Status Report. In addition, the TRIM.FaTE TSD provides more details on TRIM.FaTE.

The current TRIM documentation has gone through internal Agency peer review, which involved reviewers across the Agency, including the major program offices, the Office or Research and Development, and staff involved in the Agency's Models 2000 efforts. The current SAB advisory will be the second on TRIM development activities.

1.3.3 FUTURE ACTIVITIES

Following the 1999 SAB advisory, improvements will be made to the uncertainty and variability approach, TRIM.Expo prototype, and TRIM.Risk conceptual plan. These revisions are scheduled to be completed in 2000. As needed, refinements will be made to the TRIM.FaTE evaluation plan, and completion of the bulk of those activities are also scheduled for 2000. The Agency has planned for a substantial amount of progress on each of the TRIM modules for 2000 and 2001, as described below.

- **TRIM.FaTE.** Future work on TRIM.FaTE will include model evaluation activities and additional development of the module to accommodate additional chemicals. The TRIM.FaTE module is expected to be available for limited external use late in 2000 and to be publicly released in 2001.

- **TRIM.Expo.** Future work on TRIM.Expo in 2000 will include the further development of ingestion algorithms, incorporation of EPA's Air Pollutant Exposure Model (APEX) coding into the TRIM platform followed by adjustments to APEX to include ingestion algorithms, a test case of the inhalation pathway, and a test case of inhalation and ingestion pathways. Over the longer term, addition of the dermal pathway to the module will be initiated.

- **TRIM.Risk.** Development of TRIM.Risk will begin after SAB comments are received on the conceptual design. Module development will include identification of data needs and formatting of data outputs. Programming for a TRIM.Risk prototype is expected to be completed in 2000.

- **TRIM computer framework.** Further development of the TRIM computer framework, including incorporation of the TRIM.Expo (inhalation) module, will take place during 2000. Features to be refined during this time frame include limited geographic information system (GIS) or mapping capabilities. Additionally, long-range comprehensive GIS planning will occur. Development of user guidance materials is planned for 2000 (see text box).

In addition to consulting with Agency scientists during future TRIM development (*i.e.*, peer involvement), in late 2000 or early 2001, OAQPS will seek both internal and external peer review of new aspects following the next phase of TRIM development. In addition to the SAB, which provides the Agency with reviews, advisories, and consultations, other external peer review mechanisms consistent with Agency policy (U.S. EPA 1998c) include the use of a group of independent experts from outside the Agency (*e.g.*, a letter review by outside scientists), an *ad hoc* panel of independent experts, and peer review workshops. The OAQPS intends to seek the peer review mechanism appropriate to the importance, nature, and complexity of the material for review.

USER GUIDANCE

Development of the TRIM user's guide is scheduled to begin in 2000, along with a plan for training activities. The OAQPS recognizes the importance of developing detailed user guidance that will assist users in defining, for a particular modeling application, the spatial and temporal resolution, compartments and linkages, and parameters and initial conditions. For example, the TRIM.FaTE guidance will likely emphasize the value of performing several different preliminary simulations in verifying the adequacy of the parcel and compartment specifications for the desired application. Similarly, detailed user guidance will be developed for TRIM.Expo to assist users in defining cohorts, study areas, exposure districts, and microenvironments, as well as various parameters and exposure factors.

It also will be important for the guidance to note the responsibility of the user in defining the simulation as appropriate to the application. For example, in TRIM.FaTE, default values will likely be made available with the model for a variety of parameters ranging from physiological characteristics of various biota to physical characteristics of abiotic media; the user will need to consider appropriateness of these values or others (*e.g.*, site-specific data) for their application. While the TRIM modules are intended to provide valuable tools for risk assessment, and their documentation and guidance will identify, as feasible, uncertainties and limitations associated with their application, the guidance will emphasize that their appropriate use and the characterization of uncertainties and limitations surrounding the results are the responsibility of the user.

1.4 PHASING TRIM INTO OAQPS' SET OF MODELING TOOLS

As mentioned earlier, TRIM is intended to support assessment activities for both the criteria and hazardous air pollutant programs of OAQPS. As a result of the greater level of effort expended by the Agency on assessment activities for criteria air pollutants, these activities are generally more widely known. To improve the public understanding of the hazardous air pollutant (or air toxics) program, the Agency published an overview of the air toxics program in July 1999 (U.S. EPA 1999e). Air toxics assessment activities (National Air Toxics Assessment,

or NATA) are described as one of the program's key components.[6] The NATA includes both national- and local-scale activities. The TRIM system is intended to provide tools in support of local-scale assessment activities, including multimedia analyses.

EXAMPLES OF TRIM APPLICATIONS

- A human health or ecological assessment of multimedia, multipathway risks associated with mercury emissions from one or several local sources could be performed using all three modules in the TRIM system.
- An assessment of human health risks associated with air emissions of a criteria air pollutant (*e.g.*, ozone) or one or several volatile HAPs in a metropolitan area could be developed using an external air model or ambient concentration data from fixed-site monitors coupled with TRIM.Expo and TRIM.Risk.

One of the Agency's most immediate needs for TRIM comes in the Residual Risk Program, in which there are statutory deadlines within the next two to nine years for risk-based emissions standards decisions. As described in the *Residual Risk Report to Congress* (U.S. EPA 1999f), TRIM is intended to improve upon the Agency's ability to perform multipathway human health risk assessments and ecological risk assessments for HAPs with the potential for multimedia environmental distribution. Another important upcoming use for TRIM is in exposure assessment in support of the review of the ozone NAAQS. The TRIM.Expo and TRIM.Risk modules augmented with external air quality monitoring data and models are intended to support this type of criteria pollutant assessment as well as risk assessments for non-multimedia HAPs.

Consistent with the phased plan of TRIM development, the application of TRIM will also be initiated in a phased approach. With the further development of the TRIM modules in 2000 and 2001, EPA will begin to use the modules to contribute to or support CAA exposure and risk assessments. These initial applications also will contribute to model evaluation. The earliest TRIM activities are expected to include the use of TRIM.FaTE side-by-side (at a comparable level of detail) with the existing multimedia methodology[7] in risk assessments of certain multimedia HAPs (*e.g.*, mercury) under the Residual Risk Program. As TRIM.Expo is developed to accommodate inhalation modeling of HAPs and after it has undergone testing, OAQPS plans to initially run it side-by-side (at a comparable level of detail) with EPA's existing inhalation

[6] Within the air toxics program, these activities are intended to help EPA identify areas of concern (*e.g.*, pollutants, locations, or sources), characterize risks, and track progress toward meeting the Agency's overall air toxics program goals, as well as the risk-based goals of the various activities and initiatives within the program, such as residual risk assessments and the Integrated Urban Air Toxics Strategy. More specifically, NATA activities include expansion of air toxics monitoring, improvements and periodic updates to emissions inventories, national- and local-scale air quality modeling, multimedia and exposure modeling (including modeling that considers stationary and mobile sources), continued research on health effects of and exposures to both ambient and indoor air, and use and improvement of exposure and assessment tools. These activities are intended to provide the Agency with improved characterizations of air toxics risk and of risk reductions resulting from emissions control standards and initiatives for both stationary and mobile source programs.

[7] In support of the *Mercury Report to Congress* (U.S. EPA 1997a) and the *Study of Hazardous Air Pollutant Emissions from Electric Utility Steam Generating Units -- Final Report to Congress* (U.S. EPA 1998d), the Agency relied upon the Indirect Exposure Methodology, which has recently been updated and is now termed the Multiple Pathways of Exposure methodology (U.S. EPA 1999h). This methodology is being used in initial assessment activities for the Residual Risk Program (U.S. EPA 1999f).

exposure model, HEM (Human Exposure Model (U.S. EPA 1986)). When TRIM.Risk has been completed, it will be used, as appropriate, in both criteria and hazardous air pollutant risk assessments.

In later years, OAQPS intends to use TRIM and the TRIM modules in a variety of activities including (1) residual risk assessments using TRIM.FaTE, TRIM.Expo, and TRIM.Risk, in combinations appropriate to the environmental distribution characteristics of the HAPs being assessed; (2) urban scale assessments on case study cities as part of the Integrated Urban Air Toxics Strategy; and (3) exposure and risk assessments of criteria air pollutants (*e.g.*, ozone, carbon monoxide) in support of NAAQS reviews.