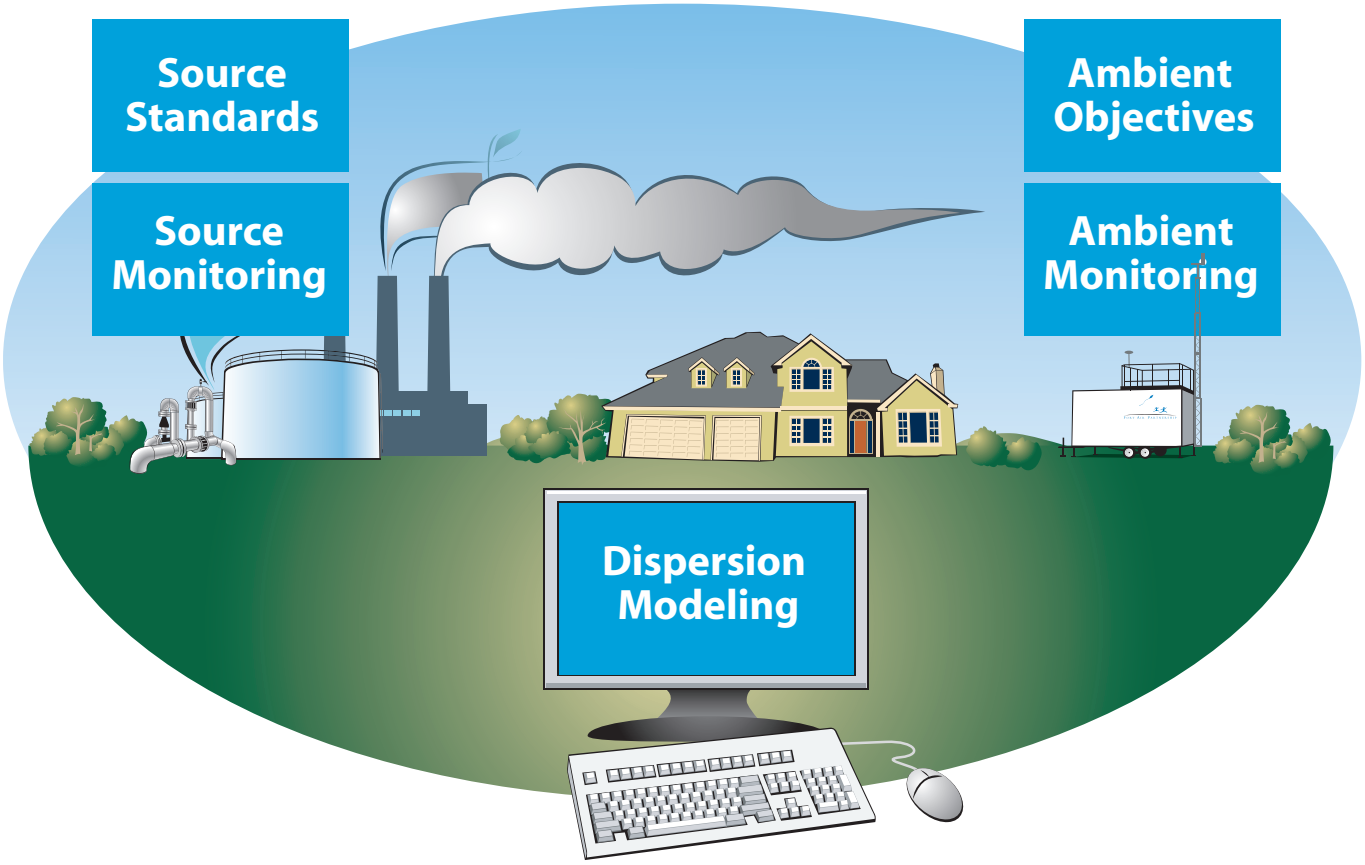
AIR QUALITY DISPERSION MODELS

FORT AIR PARTNERSHIP
We Monitor the Air You Breathe

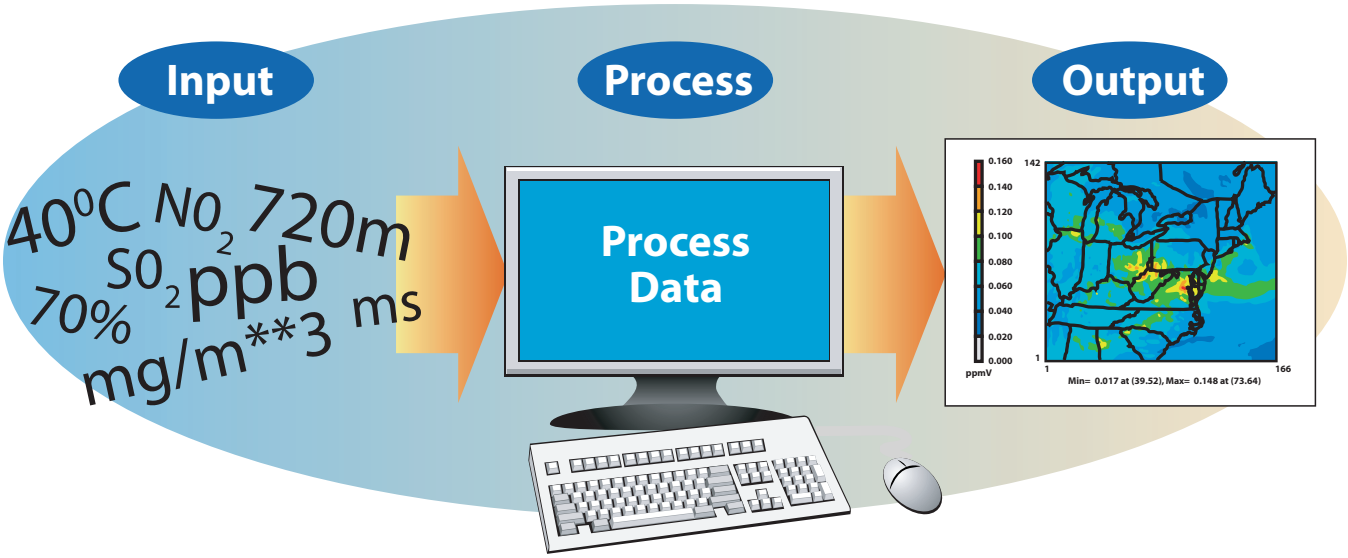
The Government of Alberta is committed to protecting the province's air, which includes assessing the environmental impact of new and existing facilities. These assessments include the use of air quality dispersion models to predict the ambient concentration of substances that may be present over an area. Air quality dispersion models are computer programs that simulate and describe how gases and particles will behave when they are released into the air.



Dispersion models use a set of scientific equations to describe and simulate the dispersion, transformation and deposition of substances emitted into the atmosphere. In addition to the quantity and type of substances released into the air, factors such as topography, atmospheric conditions and the source location of the substances have a significant effect on air quality. While dispersion modelling can greatly assist in air quality management, representing the real world using computer models is a challenging task.

Information Required to Model Air Quality

Dispersion models estimate the ambient concentrations of substances at various distances and heights from the source. To do this, information such as atmospheric conditions, predicted or measured emissions, study area characteristics and dimensions of any nearby manmade structures are required. These inputs can influence the dispersion, transformation and/or deposition of airborne substances.



ATMOSPHERIC CONDITIONS

The movement, mixing and dispersion of substances are greatly influenced by meteorological conditions. Wind speed and direction, vertical mixing height and temperature are used to describe atmospheric conditions in air quality dispersion models.

EMISSIONS AND EMISSION TECHNOLOGY

Dispersion modelling can involve measuring or calculating the amount of airborne substance released during a specified time. Rates are determined from samples taken from an emission point, such as a stack in an industrial facility. Calculated rates are determined using emission factors like the temperature and velocity of the emitted gas, as well as the stack height and diameter.

An air emissions inventory is an accounting of air substance emissions for a given area. It is a database that contains information on sources and substances. These inventories are used for air quality modelling and evaluations.

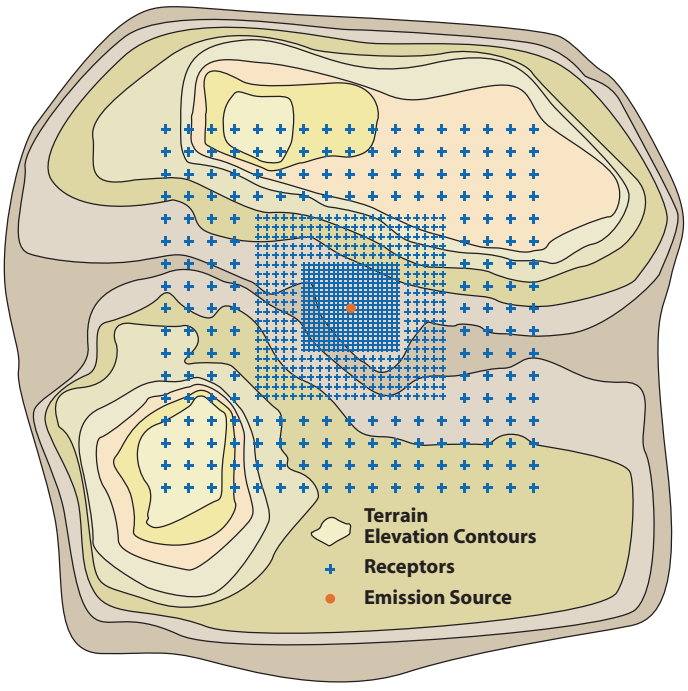
STUDY AREA CHARACTERISTICS

The characteristics of the area being studied can also be part of the information provided for an air quality dispersion model. This information can include the topography of the surrounding land (elevation), nearby manmade structures, and how the land is being used (i.e. it is forested, farmed, urbanized or industrial?)

MODELLING DOMAIN AND RECEPTOR GRID

In developing an air quality model, the study area (modelling domain) must be defined as well as the specific locations (receptors) where the model is to calculate ambient air concentrations. When selecting the boundaries of a study area, it is important the area of interest is identified adequately (i.e. is the domain large enough?) The maximum predicted concentration is identified by having the appropriate number of receptors located in the right locations.

The Government of Alberta provides guidelines for receptor grid spacing to be used in air quality dispersion modelling. The greatest density of receptor spacing is closest to the source or areas where the maximum substance concentrations are expected. Sensitive areas and areas of special interest may be addressed by using denser receptor grid spacing or the specific placement of receptors.



Types of Air Quality Dispersion Models

There are a wide range of models available, and it is important to select the model that meets the requirements of the task. No single model can handle all situations and range of applications.

Models differ in the size of area they can model and the number of situations they can address. The Government of Alberta provides guidelines for determining which type of model is appropriate for a specific project or applications. A model may be designed to handle only a single source (e.g. well test flare); multiple sources (e.g. facility that has flare stacks); or combined sources (e.g. more than one facility and emissions source).

SCREENING MODELS

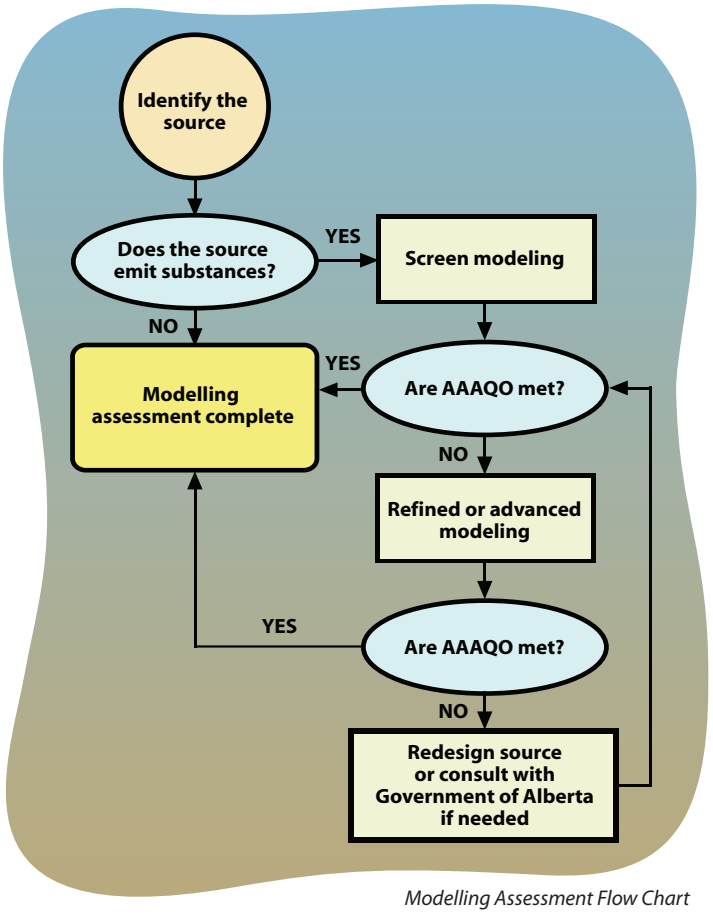
Screening models are basic models that provide a quick way to calculate the highest concentrations that are likely to occur. These concentrations are then compared to the Alberta Ambient Air Quality Objectives (AAAQO). If concentrations are higher than the AAAQO, or the screening model will not adequately address the situation being modelled, then a refined model is used to carry out more detailed modelling.

REFINED MODELS

Refined models are more complex than screening models, and are used to address the impacts of single or multiple sources. They require more detailed and precise input data, and use more complex calculations to provide more accurate estimates of the concentration of substances. Refined models may be used in an area that has many emissions sources, such as an industrial park, or where the area is environmentally sensitive.

ADVANCED MODELS

In some cases, advanced models are required. For example, where the area is large (e.g. province-wide), or a special situation exists that could not be addressed by a refined model. Advanced models require considerable expertise and computer resources to set up, run and interpret the results. Government of Alberta approval is required to do an advanced air quality modelling study for the purpose of obtaining/renewing an industrial operating licence.



Modelling Assessment Flow Chart

Limitations of Air Quality Dispersion Models

Although concerted efforts are made to represent the real world as part of air quality modelling, this has been met with varying success. Every model event with correct underlying assumptions has basic limitations since the results are only as good as the collected data. In addition, each model is designed for a specific application and cannot be used for other applications.

The screening model, for example, is limited in its ability to evaluate the cumulative effects of multiple sources and does not consider the effect of terrain on the dispersion of substances. A different model might be more appropriate if these are important factors. In any modelling, there is inherent uncertainty in the data used to represent the atmosphere. When air quality modelling results are compared to actual ambient air measurements, the modelling predictions tend to be higher. It is much more difficult to understand the impact of non-point sources but they can have a large impact on air quality within a region.

Models are more reliable for estimating concentrations over a long period of time than for short-term concentrations occurring at specific locations. In general, models are reasonably reliable for estimating the highest concentrations that are likely to occur at some specific time or location.

Definitions

Ambient concentration – concentration of airborne substances measured outside buildings, houses and other structures. It can also mean concentrations measured beyond the fence line of an industrial facility.

Deposition – a process by which a substance emitted into the air leaves the air and is deposited on surfaces such as land, vegetation and water bodies.

Dispersion – the process of substances emitted from sources such as industrial plants and vehicle traffic dispersing in the ambient atmosphere.

Emission factor – a value used to estimate an emission rate for an activity. It relates the typical quantity of a substance released with an associated activity.

Topography – the structure and orientation of terrain features such as trees, hills and valleys. These will often influence and even control air motion (wind speed and direction) and mechanical turbulence in the lower atmosphere.

Transformation – the chemical change in an emitted substance as a result of a process that occurs in the atmosphere.

Vertical mixing height – the height in the atmosphere where the released emission is relatively well mixed due to atmospheric turbulence. The height varies depending on atmospheric conditions, and directly impacts the ambient concentration of substances. For example, the mixing height can be low during the winter or at night.

FORT AIR PARTNERSHIP
We Monitor the Air You Breathe

This is one of a series of fact sheets on air quality developed by Fort Air Partnership in cooperation with the Government of Alberta. The rest of the series is available at **fortair.org**.