PURSER

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Appendix 11.2

Meteorological Data – AERMET

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Appendix 11.2 Meteorological Data – AERMET

AERMOD incorporates a meteorological pre-processor AERMET (version 16216) (USEPA, 2018). AERMET allows AERMOD to account for changes in the plume behaviour with height. AERMET calculates hourly boundary layer parameters for use by AERMOD, including friction velocity, Monin-Obukhov length, convective velocity scale, convective (CBL) and stable boundary layer (SBL) height and surface heat flux. AERMOD uses this information to calculate concentrations in a manner that accounts for changes in dispersion rate with height, allows for a non-Gaussian plume in convective conditions, and accounts for a dispersion rate that is a continuous function of meteorology.

The AERMET meteorological preprocessor requires the input of surface characteristics, including surface roughness (z_0), Bowen Ratio and albedo by sector and season, as well as hourly observations of wind speed, wind direction, cloud cover, and temperature. A morning sounding from a representative upper air station, latitude, longitude, time zone, and wind speed threshold are also required.

Two files are produced by AERMET for input to the AERMOD dispersion model. The surface file contains observed and calculated surface variables, one record per hour. The profile file contains the observations made at each level of a meteorological tower, if available, or the one-level observations taken from other representative data, one record level per hour.

From the surface characteristics (i.e. surface roughness, albedo and amount of moisture available (Bowen Ratio)) AERMET calculates several boundary layer parameters that are important in the evolution of the boundary layer, which, in turn, influences the dispersion of pollutants. These parameters include the surface friction velocity, which is a measure of the vertical transport of horizontal momentum; the sensible heat flux, which is the vertical transport of heat to/from the surface; the Monin-Obukhov length which is a stability parameter relating the surface friction velocity to the sensible heat flux; the daytime mixed layer height; the nocturnal surface layer height and the convective velocity scale which combines the daytime mixed layer height and the sensible heat flux. These parameters all depend on the underlying surface.

The values of albedo, Bowen Ratio and surface roughness depend on land-use type (e.g., urban, cultivated land etc) and vary with seasons and wind direction. The assessment of appropriate land-use types was carried out in line with USEPA recommendations (USEPA, 2005) and using the detailed methodology outlined by the Alaska Department of Environmental Conservation (ADEC, 2008). AERMET has also been updated to allow for an adjustment of the surface friction velocity (u*) for low wind speed stable conditions based on the work of Qian and Venkatram. Previously, the model had a tendency to over-predict concentrations produced by near-ground sources in stable conditions.

Surface roughness

Surface roughness length is the height above the ground at which the wind speed goes to zero. Surface roughness length is defined by the individual elements on the landscape such as trees and buildings. In order to determine surface roughness length, the USEPA recommends that a representative length be defined for each sector, based on geometric mean of the inverse distance area-weighted land use within the sector, by using the eight land use categories outlined by the USEPA. The area-weighted surface roughness length derived from the land use classification within a radius of 1 km from Oak Park is shown in **Table 11.2.1**.

Sector	Area Weighted Land Use Classification	Spring	Summer	Autumn	Winter[Note 1]
0-60	100% Grassland	0.05	0.1	0.01	0.01
60-330	100% Cultivated Land	0.03	0.2	0.05	0.05
330-360	100% Deciduous Forest	1	1.3	0.8	0.8

Table 11.2.2: Surface Roughness based on an inverse distance area-weighted average of the land use within a 1 km radius of Oak Park.

[Note 1] Winter defined as periods when surfaces covered permanently by snow whereas autumn is defined as periods when freezing conditions are common, deciduous trees are leafless and no snow is present. Thus for the current location autumn more accurately defines "winter" conditions at the facility.

Albedo

Noon-time Albedo is the fraction of the incoming solar radiation that is reflected from the ground when the sun is directly overhead. Albedo is used in calculating the hourly net heat balance at the surface for calculating hourly values of Monin-Obuklov length. The area-weighted arithmetic mean albedo derived from the land use classification over a 10 km x 10 km area centred on Oak Park is shown in **Table 11.2.2**.

Area Weighted Land Use Classification	Spring	Summer	Autumn	Winter[Note 1]
48% Grassland, 19% Urban, 25% Cultivated Land, 5% Deciduous Forest, 3% Water	0.16	0.18	0.19	0.19

Table 11.2.2: Albedo based on an area-weighted arithmetic mean of the land use over a 10 km x 10 km area centred on Oak Park.

[Note 1] For the current location autumn more accurately defines "winter" conditions at the facility.

Bowen Ratio

The Bowen ratio is a measure of the amount of moisture at the surface of the earth. The presence of moisture affects the heat balance resulting from evaporative cooling which, in turn, affects the Monin-Obukhov length which is used in the formulation of the boundary layer. The area-weighted geometric mean Bowen ratio derived from the land use classification over a 10 km x 10 km area centred on Oak Park is shown in **Table 11.2.3**.

Area Weighted Land Use Classification	Spring	Summer	Autumn	Winter[Note 1]
48% Grassland, 19% Urban, 25% Cultivated Land, 5% Deciduous Forest, 3% Water	0.50	0.91	1.09	1.09

Table 11.2.3: Bowen Ratio based on an area-weighted geometric mean of the land use over a 10 km x 10 km area centred on Oak Park.

[Note 1] For the current location autumn more accurately defines "winter" conditions at the facility.