8. EXECUTIVE SUMMARY

This study evaluated the use of various meteorological data sets in a regulatory-type, near-field air quality modeling application in areas of extreme complex terrain in Southeastern Alaska, using the CALPUFF, AERMOD and ISCST3 dispersion models. A particular focus of the study was whether adequate modeling results could be obtained using only large-scale, regional meteorological data (MM5 data). The study also looked at the use of only remote data obtained from a single National Weather Service (NWS) station, and a combination of MM5 and remote NWS data. In addition to evaluating near-field applications (ambient impacts within areas fairly near the emission sources), the study also compared the far-field (distant) ambient impacts using the CALPUFF modeling system. The following discussion summarizes the reasons for conducting the study, the basic components of the study, and the results.

The study was conducted in an effort to evaluate alternative approaches to modeling emission sources located in areas with no or inadequate local meteorological data. Regulatory modeling applications within Alaska are frequently hampered by the lack of routinely available, adequately representative meteorological data. This is due in part to the limited number of both NWS and other meteorological observation stations within the State. In addition to the limited number of observation sites, Alaska has extensive areas with extremely complex terrain. Therefore, the meteorological data collected at stations located within these complex terrain areas only represent the meteorological conditions within a very limited range. This lack of representative meteorological data has forced New Source Review (NSR) permit applicants to either use conservative screening data in their air quality modeling analysis, or to take the time and expense to collect at least one year of site-specific meteorological data.

Modeling air quality impacts in areas with extensive complex terrain can also provide unrealistic results when using the standard NSR dispersion model, ISCST3. To address this problem, the U.S. Environmental Protection Agency (EPA) has proposed case-by-case use of the more advanced CALPUFF modeling system for modeling near-field impacts in "areas with complex wind flows" (i.e., complex terrain). However, the use of the CALPUFF modeling system may still require the use of local (site-specific) meteorological data. In this case, a network of meteorological towers would be required to provide adequate data for widespread regulatory modeling in Alaska. This need for site-specific data would place a significant resource burden (time and money) either on permit applicants or on the State.

Recent modifications to the CALPUFF modeling system have opened the possibility of using only regional, three-dimensional meteorological fields developed from the fifth generation of the Mesoscale Meteorological Model (MM5) for near-field modeling applications. The CALPUFF modeling system includes a diagnostic meteorological model, CALMET, which could then be used to estimate localized wind-fields from the regional MM5 data, terrain data, and land-use data. The CALPUFF modeling system provides the potential to solely rely on modeled wind-fields instead of site-specific meteorological data for near-field regulatory applications.

This study was conducted to evaluate the adequacy of several potential meteorological data sets that could be produced by CALMET. To provide a worst-case test, the study focused on an area within Southeast Alaska. This area has extremely complex terrain due to numerous mountains and fjords. Southeast Alaska was also selected since an existing MM5 data set with 20 km grid spacing covering this region was available from a previous study conducted on behalf of British Columbia and Alberta. Site-specific and NWS data are also available.

The study centered around Hawk Inlet, which is located on the Chatham Strait side of Admiralty Island. Kennecott Greens Creek Mining Company (KGCMC) operates a loadout facility there and provided data from a meteorological tower located at the inlet. KGCMC also provided meteorological data from their mine/mill site, which is located in a steep, enclosed valley, approximately 8 km from the Hawk Inlet site. Remote NWS surface data was available from the Juneau airport, which is located approximately 30 kilometers from the Hawk Inlet Site. The Juneau airport (NWS site) is located on the continental mainland at the confluence of Gastineau Channel and the Mendenhall Valley.

The study compared the modeled wind-fields using CALMET to the actual observed wind-fields. The study also assumed that two fictitious emission sources were operating at Hawk Inlet. This allowed for a comparison of the dispersion modeling results using the various meteorological data sets. The meteorological data sets included: Hawk Inlet, Juneau NWS and 20 km MM5 data (Scenario 1 - base case); 20 km MM5 data (Scenario 2); 4 km MM5 data (Scenario 3); Juneau NWS data (Scenario 4); and Juneau NWS data and 20 km MM5 data (Scenario 5)

The study found that representative, site-specific meteorological data are needed for the complex terrain situation found in the Juneau area. The use of just 20 km or 4 km MM5 data (Scenarios 2 and 3), remote NWS data (Scenario 4), and remote NWS data along with 20 km MM5 data (Scenario 5) all produced wind characteristics that did not match the observed winds at Hawk Inlet. The same is true when comparing the modeled wind characteristics with the winds observed at the Mill Site. The generality of these conclusions, however are limited to the conditions and grid resolutions tested, as the model performance is highly sensitive to the ability of the grid resolution of the MM5 model to capture the specific terrain features in the application and/or the representativeness of the offsite station in representing the local flow conditions.

A comparison of the magnitude and location of the predicted maximum impacts also shows that the alternative meteorological data sets (Scenarios 2-5) produce significant variability from the base case in the predicted regulatory concentrations. For this study, the base case (Scenario 1) results are used as the reference concentrations when comparing the maximum concentrations obtained with a given dispersion model (i.e., CALPUFF, ISCST3 or AERMOD). Looking at the annual average concentrations obtained when modeling with CALPUFF, all of the maximum impacts for the alternative scenarios are less than 70% of the base case maximum. The location of these impacts ranged from 500 to 1500 meters from the location of the base case maximum. Most of the short-term impacts also have significant differences with the base case, although some of the maximum 3-hour and 1-hour impacts using CALPUFF overpredict rather than underpredict the base case maximum.

This study does not excluded the possibility in the general case of using prognostic model data in observation-sparse areas or remote offsite data to initialize the diagnostic model. It does indicate the need for a detailed examination of the representativeness of the available datasets to characterize the specific features of the flow field considered important in the local area of interest. Further study should concentrate on finer scale MM5 simulations (grid spacing of 1-2 km) in a small area around sources (with 50 km), better characterization of the land surface characteristics (e.g., glaciers in the Juneau area) and on the improvement of drainage flow at high latitudes in CALMET. Also, a more representative offsite station, even in the absence of fine-scale MM5 data, is likely to improve the initial guess field, and the final wind fields.