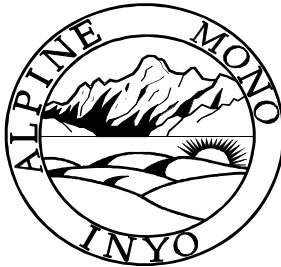# Board Order 080128-01
Attachment C

2008 Owens Lake Dust
Source Identification
Program Protocol

Great Basin Unified Air Pollution Control District

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2008 Owens Lake Dust Source Identification Program Protocol

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Glossary of Terms and Symbols

AIRS	US Environmental Protection Agency's Aerometric Information and Retrieval System
ATV	All-Terrain Vehicle
APCO	Air Pollution Control Officer
BACM	Best Available Control Measure
BACT	Best Available Control Technology
CAAA	Clean Air Act Amendments of 1990
CALMET	A meteorological preprocessor program for CALPUFF.
CALPUFF	An air pollution model
CARB	California Air Resources Board
CSC	Cox Sand Catcher, a passive sand flux measurement device.
DCA	Dust Control Area
DCM	Dust Control Measure
Dust ID Program	Owens Lake Dust Source Identification Program
EIR	Environmental Impact Report
Event-specific K_f	Weighted-average of hourly K-factors for a dust event, weighted by the hourly PM_{10} concentration
Exceedance	Modeled or monitored $PM_{10} > 150$ µg/m^3 at the shoreline
FTEE	Full-time equivalent employee
GBUAPCD	Great Basin Unified Air Pollution Control District
GIS	Geographic Information System
GPS	Global Positioning System
KE	Kinetic energy
K-factor	Proportionality constant for sand flux and PM_{10} emissions, K_f
LADWP	City of Los Angeles Department of Water and Power (also City)
m^3	cubic meter
met	meteorological
mg	milligram
MSM	Most Stringent Measure
NAAQS	National Ambient Air Quality Standards
NEAP	Natural Events Action Plan
OVPA	Owens Valley PM_{10} Planning Area
PC	Particle count
PM_{10}	Particulate matter less than 10 microns aerodynamic diameter
QA	Quality Assurance
RASS	Radio Acoustic Sounding System
RSIP	Great Basin APCD 2003 Owens Valley PM_{10} Planning Area Revised State Implementation Plan

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Sensit	An electronic sand motion detector.
Settlement Agreement	2006 Settlement Agreement between LADWP and GBUAPCD
Storm-average K_f	Arithmetic average of hourly K-factors for a dust event
SCR	Supplemental Control Requirements of the 2003 SIP
SFM	Sand flux monitor
TEOM	Tapered-Element Oscillating Microbalance, measures PM_{10}.
USEPA	United States Environmental Protection Agency
USGS	US Geological Survey
WD	Wind direction
2003 SIP	Great Basin APCD 2003 Owens Valley PM_{10} Planning Area Revised State Implementation Plan
µg	microgram

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2008 Owens Lake Dust Source Identification Program Protocol

1. Program Overview

1.1 Introduction

The objective of the Owens Lake Dust Source Identification (Dust ID) Program is to identify dust source areas at Owens Lake that can cause or contribute to violations of the National Ambient Air Quality Standards (NAAQS) for PM_{10}. The Dust ID Program is a long-term monitoring program that is intended to identify dust source areas for control under the provisions of the Supplemental Control Requirements (SCR) in the 2003 revised Owens Valley PM_{10} State Implementation Plan (RSIP) and the 2006 Owens Lake Settlement Agreement (Settlement Agreement). The text of the Settlement Agreement and SCR provisions is included in the appendices to this document.

The RSIP and Settlement Agreement require the City of Los Angeles Department of Water & Power (City) to control all sources of wind blown dust from the lake bed of Owens Lake that cause or contribute to an exceedance of the PM_{10} NAAQS at the historic shoreline (3,600-foot contour line). Based on dust events that occurred between January 2000 and July 2006, 43 square miles of the lake bed were found to cause or contribute to NAAQS violations. Dust controls are required to be implemented on 29.8 square miles of the lake bed by December 31, 2006, and an additional 13.2 square miles by April 1, 2010.

Provided that these control measures are implemented in accordance with the RSIP and Settlement Agreement, the District will suspend making determinations to control additional dust source areas from December 4, 2006 until May 1, 2010. During this period, all monitoring, modeling and observations will continue as described in this Dust ID Program Protocol. Data and information collected during this period will be used to determine any control requirements for Study Areas as described in the Settlement Agreement, and to advise the City on any monitored dust emissions from the lake bed and surrounding areas. If any new lake bed dust source areas are identified from data collected after April 1, 2010, they will be subject to dust control requirements as provided for in the Settlement Agreement and any future revisions to the Owens Valley PM_{10} State Implementation Plan. SCR determinations shall make reasonable efforts to account for impacts caused by Dust Control Measure (DCM) construction activities.

1.2 Locating Dust Source Areas

A network of sand flux samplers, PM_{10} monitors, meteorological towers and remote camera sites will be used to monitor and locate dust source areas at Owens Lake. Figure 1.1 shows a map of the Dust ID network at Owens Lake. As configured in 2003, the Dust ID network included: sand flux monitors at 136 lake bed sites at 1-km spacing, 7 PM_{10} monitors, 13 met towers, 8 observation sites, and 10 time-lapse cameras at 7 sites. At the discretion of the Air Pollution Control Officer, additional sand flux, PM_{10} and met sites will be added as necessary to collect

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information that can be used to monitor and model the impact from new areas that may become emissive on the lake bed.

The automated monitoring network will be augmented with information from observers who will map dust source locations from off-lake sites when dust events take place during normal work hours. These maps will be used to help document source areas that may be outside the sand flux network or that may be within the network, but missed by the samplers. Field personnel will inspect active source areas and map the source area boundaries using a GPS (Global Positioning System) as conditions allow. Data collected from the sand flux network, visual mapping and GPS surveys will be included in a Geographic Information System (GIS) database for mapping and analysis. Maps generated using these different methods will be compared qualitatively to help delineate source area boundaries.

1.3   Monitored Exceedances

Analysis of hourly PM_{10} concentrations at shoreline and off-lake monitoring sites may show that lake bed source areas cause or contribute to PM_{10} exceedances. Monitoring of PM_{10} concentrations will be done using US EPA-approved monitors. Currently, hourly PM_{10} readings are obtained using TEOM (Tapered-Element Oscillating Microbalance) PM_{10} monitors manufactured by R&P, Inc. If a PM_{10} exceedance is monitored, PM_{10} concentrations will be paired with the local wind direction for each hour of that event to determine if lake bed source areas caused or contributed to the exceedance.

Twenty-four hour average PM_{10} monitor concentrations will be adjusted for winds coming from the direction of the lake to the monitor (from-the-lake) and from directions not from the lake to the monitor (non-lake). PM_{10} concentrations during any hour with winds from a non-lake wind direction will be assumed to have an average background concentration of 20 µg/m^3 and from-the-lake wind directions will be given their hourly value. If the adjusted 24-hour average is greater than 150 µg/m^3, then an exceedance will have been monitored from a lake bed source or sources.

If a lake bed source area causes or contributes to an exceedance, hourly PM_{10} concentrations and wind directions will be reviewed to see if a new source area (or areas) is associated with that exceedance. If sand flux data are available that show erosion activity in the direction of a new source area, this event will also be modeled as described in the air quality modeling protocol. If the PM_{10} monitor data indicate that a new source area caused or contributed to an exceedance, DCMs may be required under the provisions of the Settlement Agreement or current SIP.

1.4   Modeled Exceedances

Air quality modeling will be performed with the CALPUFF modeling system or other United States Environmental Protection Agency (USEPA) approved modeling method. At least once a year, the Dust ID information will be examined and the model will be run to determine if there were any modeled shoreline exceedances since the period covered by the last model run. PM_{10} emissions for the model will be based on hourly sand flux measured at lake bed sites and spatial and temporal factors derived using the empirical relationship between sand motion on the lake

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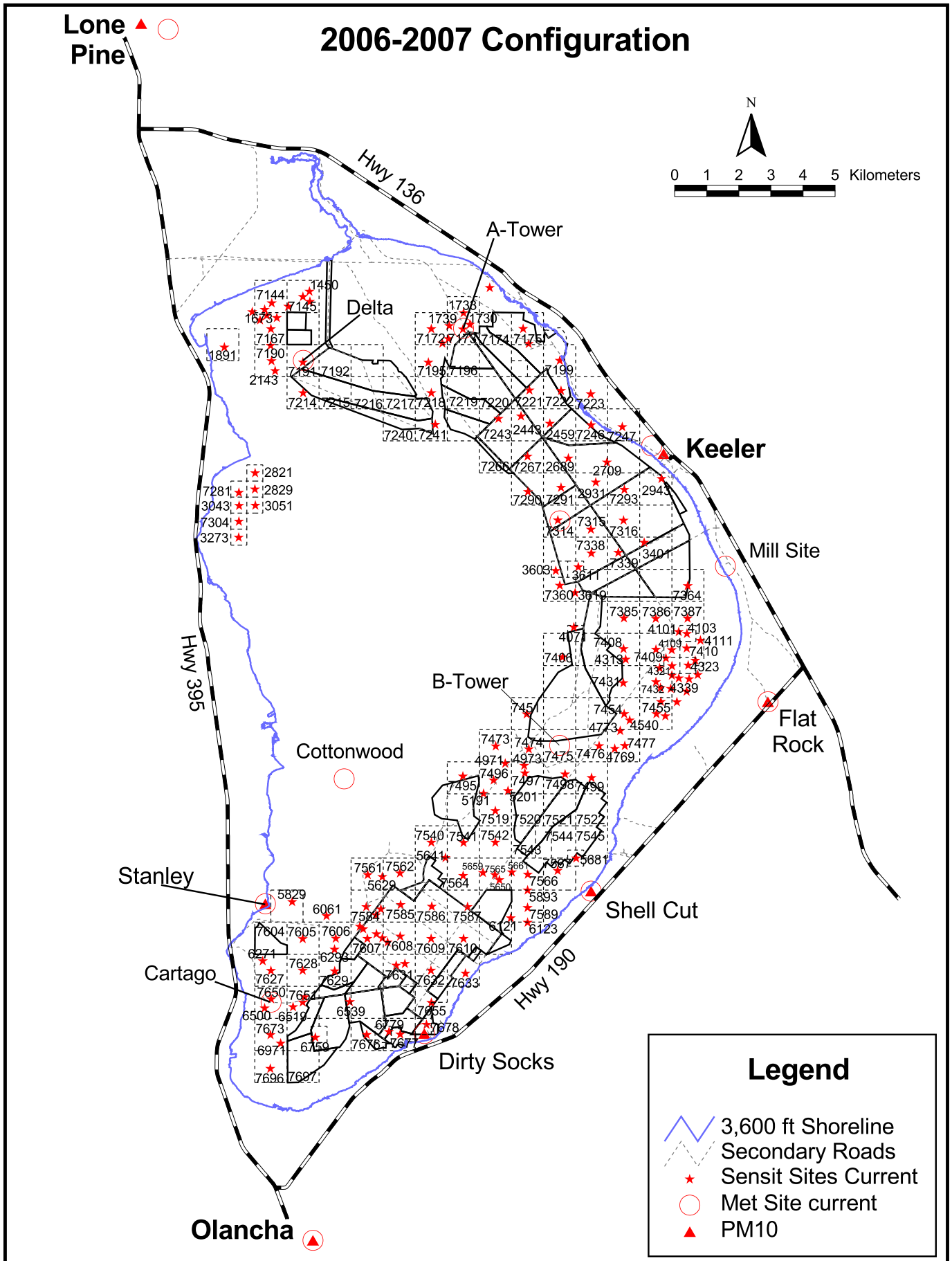
Figure 1.1 - Owens Lake Dust ID monitoring network

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bed and measured PM_{10} values. CALPUFF will be run using the following equation to estimate emissions and to model PM_{10} impacts at the shoreline:

Equation 1.1

$$PM_{10} = K_f \times q$$

where,

q = Sand flux measured at 15 cm above the surface [$g/cm^2/hr$]
K_f = K-factor, empirically-derived ratio of the PM_{10} emission flux to the sand flux at 15 cm.

The ratio of PM_{10} to sand flux (K_f) is referred to as the K-factor. The initial Dust ID program results showed that K-factors could be derived empirically by comparing model predictions to monitored PM_{10} concentrations. Initial studies also showed that average K-factors can vary spatially and seasonally at Owens Lake. Default K-factors will be used with Equation 1.1 to estimate hourly PM_{10} emissions unless new K-factors are generated from future dust events following the modeling procedures in this program protocol. If the CALPUFF model results indicate that a new lake bed source area caused or contributed to an exceedance at a shoreline location, dust controls may be required under the provisions of the 2006 Settlement Agreement or the current SIP.

1.5 Sand Flux Measurements

Sand flux is measured using a combination of Cox Sand Catchers (CSC) and Sensits. CSCs are sand collection devices that provide a mass collection amount for a certain time period (about 1 to 3 months), and Sensits are electronic sand motion detectors used to time-resolve the collected mass to estimate hourly sand flux rates. The sand flux rate is applied to the area represented by the sand flux sampling site, which may vary in size and shape depending on the source area delineated by field observations.

1.6 Dust ID Program Protocol Content

Section 2 of the Dust ID Program Protocol describes the methods and instrumentation that will be used to monitor sand flux with Sensits and CSCs on the lake bed. Section 3 provides a brief description of the PM_{10} and meteorological monitoring network that will be used to monitor PM_{10} exceedances, develop K-factors and to call public health advisories. Section 4 describes methods that will be used by visual observers and field personnel to map lake bed dust source areas and delineate boundaries using GPS. Section 5 explains the procedures for developing K-factors using air quality modeling and monitoring data. Section 6 provides the protocol for dispersion modeling.

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2. Protocol for Measuring Sand Flux Rates and Operation of the Sensit and Cox Sand Catcher Network

2.1   Objective

Sand flux measurements will be used as a surrogate to estimate PM_{10} emissions coming off the lake bed. The objective of the sand flux measurements is to provide an hourly emissions estimate for all active source areas on the lake bed.

2.2   Methods and Instrumentation

Sand flux will be measured with Sensits and Cox Sand Catchers (CSCs). Collocated Sensits and CSCs are used to measure hourly sand flux rates at different locations on the lake bed. The 2006-2007 Sensit/CSC network locations are shown in Figure 1.1. The instruments are placed with their sensors or inlets positioned 15 cm above the surface. Sensits are electronic sensors that measure the kinetic energy or the particle counts of sand-sized particles as they saltate, or bounce, across the surface. Sensits are used to time-resolve the CSC mass to provide hourly sand flux rates.

Figure 2.1 shows a Sensit suspended above the ground on the right, and a CSC in the ground to the left. The photo was taken at a site that was used to test the accuracy of Sensits and CSCs before the Dust ID Program began. The battery powered Sensits are augmented with a solar charging system. A datalogger records 5-minute Sensit data during active saltation periods. Data collection is triggered by particle count activity and continues until particle counts are zero for an hourly period. Each datalogger has a radio transmitter that sends Sensit data to the District's Keeler field office once a day to provide updates on erosion activity at each site. These daily updates are used to alert field personnel to active source areas for possible Global Positioning System (GPS) mapping and inspection. Daily transmission of the data may be temporarily suspended if the solar battery power is low due to extended days of cloud cover.

CSCs are passive collection instruments that capture windblown, sand-sized particles. These instruments were designed and built by the District as a reliable instrument that could withstand the harsh conditions at Owens Lake. CSCs have no moving parts and can collect sand for a month or more at Owens Lake without overloading the collectors. Field personnel visit CSC sites to measure the mass of the collected sand catch. A diagram of the CSC is shown in Figure 2.2. Not shown in the diagram is an internal sampling tube that can be seen in the photo in Figure 2.3. The internal sampling tube is removed from the PVC casing to measure the sand catch sample. The lengths of the sampling tubes and casings are adjusted during construction to accommodate the amount of sand flux in each area and to avoid overloading the CSC. The CSC length ranges from about one to three feet. Because the PVC casing is buried in the ground, an adjustment sleeve is used to keep the inlet height at 15 cm to compensate for surface erosion and deposition. Field techs use a standardized measuring device to check or adjust the sampling inlets to 15 cm after collecting each sample.

Figure 2.4 shows an example of the linear relationship between the CSC collected sand mass and the kinetic energy measured with a co-located Sensit. Sensits measure saltation in terms of

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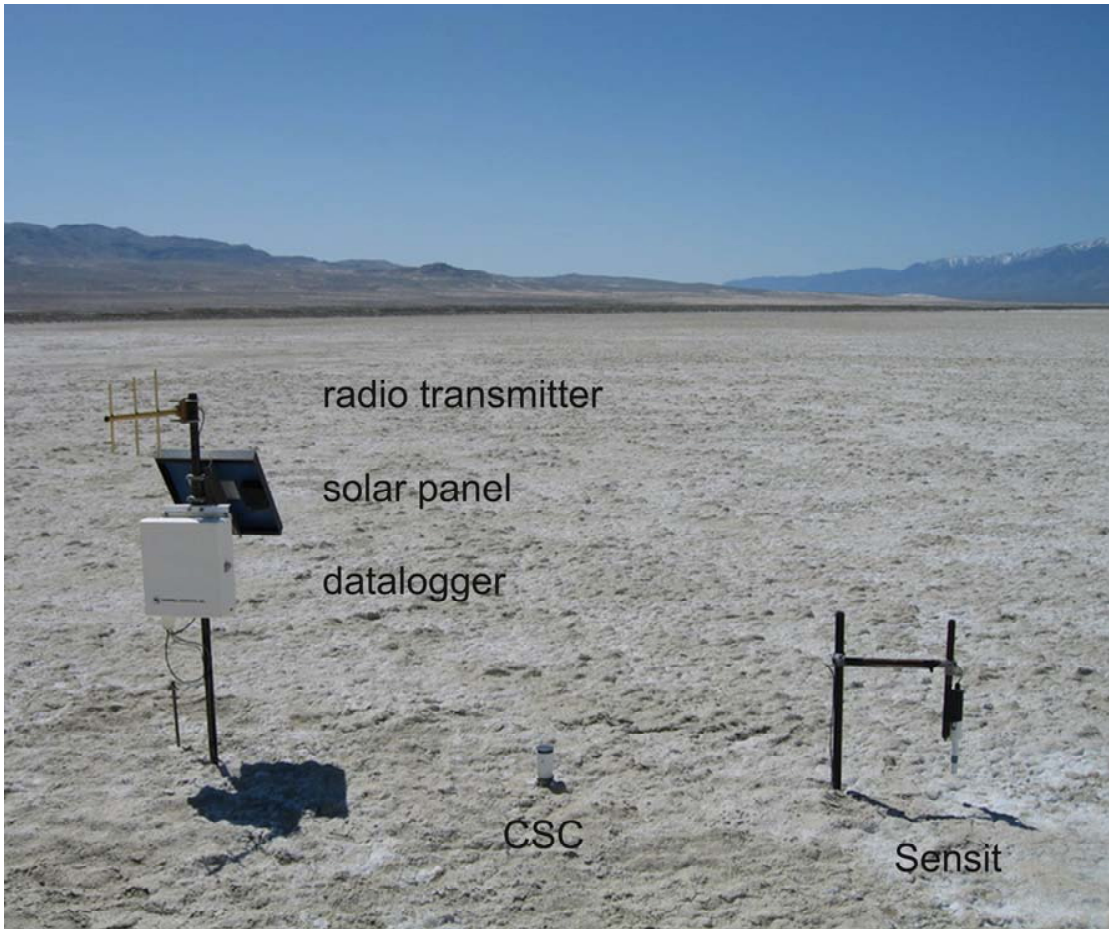
Figure 2.1 - Dust ID sand flux monitor sites measure wind erosion activity using CSCs to collect sand-sized particles and Sensits that electronically detect moving particles. Sensit data are recorded on dataloggers and transmitted by radio from each site to the District's office in Keeler.

Figure 2.2 - Diagram of the Cox Sand Catcher (CSC) used to measure sand flux at Owens Lake.
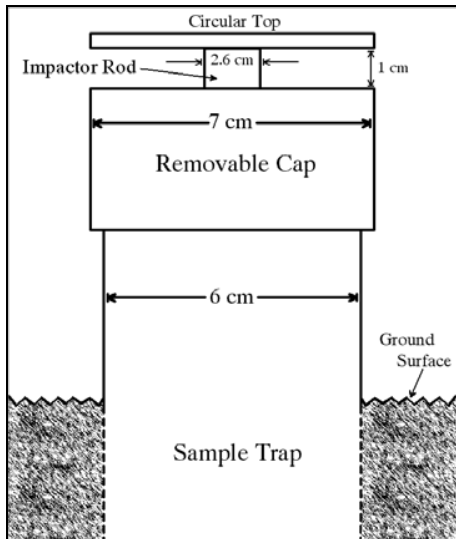
Figure 2.3 - Example of a Cox Sand Catcher (CSC) with the inner sampling collection tube removed.

$$y = 0.33x - 0.01$$
$$R^2 = 0.91$$
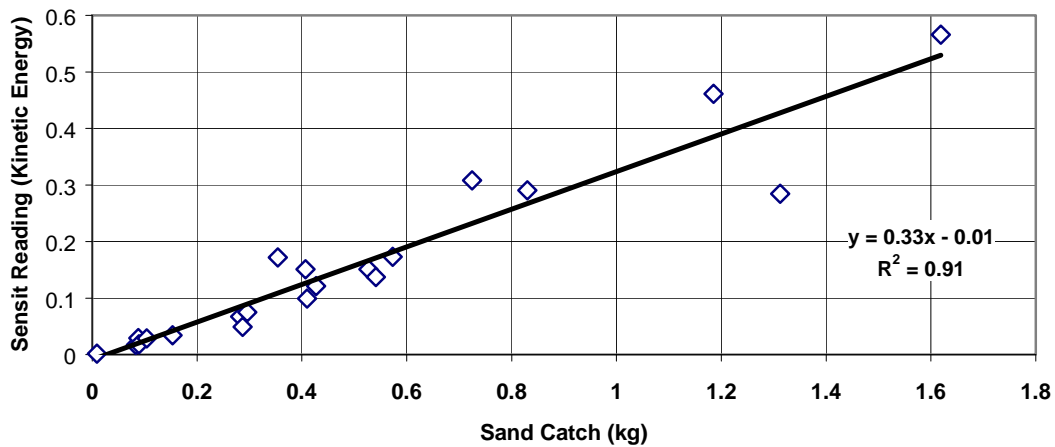
Figure 2.4 - Example of the linearity between CSC mass and a Sensit reading using kinetic energy reading (Sensit No. 7291).

kinetic energy (KE) and particle count (PC). The District uses the output (KE or PC) that provides the best precision and accuracy for the range of saltation activity expected at each site.

Because the electronic Sensit response to the saltation flux can vary, Sensits were used in combination with CSCs to determine hourly sand flux rates. This combination takes advantage of the good precision and accuracy of the CSC sand catch data, and the ability of Sensits to time-resolve the sand flux for each hour of the CSC sampling period. In this way, the sum of the hourly sand catches always matches the CSC sand catch for each sampling period, and it minimizes the error in the hourly sand flux.

Changes to the sand flux monitoring network are made as necessary to improve the characterization of dust source areas on the lake bed. Sand flux sampler sites are added to the network to monitor new source areas or to improve the sand flux estimates for known dust source areas. Although the sand flux network was originally designed in a fixed grid pattern with 1 km site spacing, the current practice is to place the samplers at sites that represent smaller source areas. Some sites may be less than 250 m apart, and their locations may be off the regular grid pattern to better represent sand flux activity in the dust source area. In addition, many of the original sampling sites that are now in flooded portions of the shallow flood DCM were removed, since PM_{10} emissions from the flooded sites can be assumed to be zero in the Dust ID model.

2.3   Operating Procedures

Sand captured in the CSCs will be weighed in the Keeler lab to the nearest tenth of a gram. A field technician will visit each site every one to three months to collect the sample tubes. The following procedures will be used when collecting the CSC samples and downloading Sensit data:

1) Park field vehicle 10 meters or more east of the site and walk the remaining distance to the sampling site. Field personnel will access all Sensit and CSC sites from an easterly approach to minimize upwind surface impacts near the sampling sites.
2) Measure and record the inlet height above the surface to the middle of the inlet.
3) Remove the sample collection tube from the CSC.
4) Verify collection tube number corresponds to site number on the field form.
5) Weigh and record the gross weight of the collection tube and sample to the nearest 1 gram using a field scale.
6) If any soil material is visible in the tube, seal the collection tube and place it in the tube rack for transport to the lab. If no soil material is visible, note this on the collection form and reuse the collection tube for the next sampling period.
7) Place a clean collection tube in the CSC and record the collection tube number.
8) Replace the CSC inlet and adjust the height to 15 cm ($\pm$1 cm).
9) Download Sensit data from the datalogger to a storage module.
10) Measure and record the Sensit sensor height above the surface to the center of the sensor using the Height Adjustment Tool, and adjust if necessary to 15 cm. See Figure 2.5.
11) Inspect the sensor and radio transmitter wiring and clean or repair, if needed.

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12) A field operational response test on the Sensit will be completed during each visit and the Sensit will be replaced, if it fails the test.

13) CSC samples will be removed from the sample collection tubes and weighed on a calibrated bench-top scale in the Keeler lab to the nearest 0.1 gram.

14) Wet samples will be removed from the collection tubes and oven dried before weighing in the lab.

2.4 Data Collection

A field form will be used to document the information for the CSC and Sensit (see example in Figure 2.6). The form will have the site number, date and time of measurement (Pacific Standard Time), "as is" CSC inlet and Sensit sensor height ($\pm$ 1 cm), tube tare weight prior to sand catch ($\pm$ 0.001 kg), total sand catch weight ($\pm$ 0.001 kg), and post-catch tube weight ($\pm$ 0.001 kg), Sensit response test (particle counts or kinetic energy), operator's initials, and a comments section where the condition of the sampler and any other relevant factors, such as surface condition will be documented. The Data Processing Department will calculate the net sand catch weight from the CSC during data analysis. CSC lab weights, measured to the nearest 0.1 g will be recorded on the Lab Form shown in Figure 2.7. After completion of the forms, the field technician will make a copy of the completed forms and file the copies at the Keeler office. The original forms will be sent to Data Processing in the Bishop office. Data Processing will enter the data into an electronic file. The original hard copy forms will be filed in the Bishop office.

Each day, dataloggers for all Sensit sites will be downloaded by radio transmission to the Keeler Field office. Data from the storage modules will be downloaded to the computer at the Keeler office by the field technician at the end of a collection period. The radio transmitted Sensit data will be used as the data of record. Storage module data will be collected at least quarterly and will serve as a back-up file.

Technicians will keep a log of all the repairs, maintenance, or replacement of Sensits or CSCs, radio transmitters, and datalogger equipment. This log will be kept in a field notebook and the field forms sent to Data Processing as they are completed. It is the technician's or operator's responsibility to review the data and notify the Air Monitoring Specialist and Data Processing who will decide whether any data should be edited or deleted and why.

2.5 Chain of Custody

Each field form will be initialed and dated by the field technician during each site visit. The form will be signed and dated by the person receiving the data when delivered to the Bishop office. If no person is available to sign the form in the Bishop office, the delivery person will sign and date the form and place it in the Data Processor's box.

2.6 Quality Assurance

All field and lab scales will be checked at least every two months using Class F weights. Field scales will also be checked with a 100-gram weight at each sample site before weighing the sand catch and the weight recorded on the field form. The bench-top scale in the Keeler office will be

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Figure 2.5   - A Height Adjustment Tool is used to measure the
height of Sensits and CSCs and to adjust the sensor and inlet
height to 15 cm above the soil surface.

CSC Field Form.xls

Technician: _____   Date (mm/dd/yyyy): _____ / _____ / _____

Site #	Time PST	Pre-Sensit Height, cm	Sensit Response	Final Sensit Height, cm	Pre-CSC Inlet Height, cm	Field Cal Weight, kg	CSC Full, kg	CSC Tare, kg	Final CSC Height, cm	No VP
	:					.	.	.		
	:					.	.	.		
	:					.	.	.		
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	:					.	.	.		

Marble Rankings: 0=No Crust 1=Complete Damage 2=Indent or Surface Damage 3=No Damage 4=Wet

Site #	Rank	Surface Description	Comments and Maintenance

Delivered By:	Date:
Received By:	Date:

Figure 2.6 - Example of a CSC and Sensit Field Documentation Form

CSC Lab Form.xls

| Lab Technician: | Tare Date (mm/dd/yyyy): | / | / |
| Lab Technician: | Post Date (mm/dd/yyyy): | / | / |

Site Tube #	Tube Tare, g	Tube/Catch Weight, g	Catch Weight, g	Comments
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Figure 2.7 - Example of a CSC laboratory documentation form

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checked with the Class F weights before each set of sand catches are weighed. The test weights will be recorded on the scale log sheet in the laboratory. Both scales will be calibrated and certified at least once every year. Ten percent of the CSC sand catch samples will be stored for at least one year from the date of collection before discarding.

2.7   Calculating Hourly Sand Flux

For modeling purposes discussed in Section 6, hourly sand flux is calculated for each Sensit/CSC site using the sand catch to Sensit reading ratio for each collection period and apportioning the sand catch to the hourly Sensit reading. The hourly sand flux is divided by 1.2 cm^2, which is the equivalent inlet opening size of the CSC for flux calculation purposes.

For Sensits using kinetic energy,

> *Equation 2.1*
> $$q_{n,t} = \left(S_{n,t} - S_{n,bg}\right) \times \frac{CSC_{n,p}}{\sum\limits_{t=1}^{N}\left(S_{n,t} - S_{n,bg}\right)} \times \frac{1}{1.2} \quad [\text{g/cm}^2/\text{hr}]$$

Where,
$q_{n,t}$ = hourly sand flux at site n, for hour t [g/cm^2/hr]
$CSC_{n,p}$ = CSC mass for site n, for collection period p [g]
$S_{n,t}$ = Sensit total KE reading for site n, for hour t [non-dimensional]
$S_{n,bg}$ = Sensit KE background reading for site n, [non-dimensional]
N = Total number of hours in CSC collection period p.

For Sensits using particle count,

> *Equation 2.2*
> $$q_{n,t} = S'_{n,t} \times \frac{CSC_{n,p}}{\sum\limits_{t=1}^{N} S'_{n,t}} \times \frac{1}{1.2} \quad [\text{g/cm}^2/\text{hr}]$$

Where,
$S'_{n,t}$ = Sensit total PC reading for site n, for hour t [non-dimensional]

2.8   Sensit Calibration and Data Analysis

2.8.1   Sensit Calibration Check

Data Processing will track Sensits by their serial number. After each sample collection period, Sensit and CSC data will be added to data from other sample collections. Data Processing will determine the average sand catch to Sensit ratio for each Sensit. Sensit readings will be collected

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for particle counts and kinetic energy for each Sensit. Due to differences in individual Sensit responses, some Sensits have a more consistent sand flux to Sensit reading ratio using particle count rather than kinetic energy. This normally depends on the manufacturer's electronic design. At high sand flux sites, kinetic energy provides a more linear response for most Sensits. If KE is used, a background KE is subtracted from the reading if it is not zero. A background KE is determined from the KE reading when the PC reading is zero.

The ratio of the Sensit response to the collected mass will be compared for each collection period to previous ratios for the same instrument to ensure that the Sensit is responding consistently. As seen in Figure 2.4 this ratio can vary, especially at low collection masses, so large deviations in the ratio should only be used as an indicator for a possible problem. Sensits will be replaced if they show no readings with significant sand associated CSC collection, have significant readings during calm wind periods, have an erratic response as compared to previous collection periods, or if they fail the field operational response test.

2.8.2 Replacing Missing Sand Catch Data

Sand catch data can be lost if the CSC collector tube is full, or damaged, or if the sample is spilled during weighing. The lost sand catch data will be estimated using Sensit data. A cumulative sand catch to Sensit ratio is calculated by adding all of the valid sand catches and all of the corresponding Sensit data for that particular Sensit/CSC pair, and then dividing them to obtain the total ratio. The cumulative ratio is applied to the Sensit data to estimate the hourly sand flux. If there was a Sensit change, only data generated after the Sensit change is used to calculate the cumulative sand catch to Sensit ratio.

CSC collection tubes will be weighed and reset at the same time as any Sensit change at a site in order to maintain the time correlation between the two devices.

2.8.3 Replacing Missing Sensit Data

Sensit data can be lost when the datalogger or Sensit fails. In such cases, the sand catch data will be time resolved using a neighboring site. The historical hourly sand flux data are compared to determine which neighboring site behaves most similarly to the site with the lost data. The correlation coefficients between the data sets will be used to determine which site behaves most similarly. If no adjacent sites were active during the period of lost Sensit data, then the nearest active sites will be used for comparison.

3. Protocol for Measuring Ambient PM$_{10}$ and Meteorological Conditions

3.1 Objective

Ambient PM$_{10}$ monitors will be placed at locations generally around the shoreline of Owens Lake and in local communities to monitor the ambient air for exceedances of the PM$_{10}$ NAAQS and to develop K-factors for modeling PM$_{10}$ emissions from lake bed sources. PM$_{10}$ monitors may be placed on the lake bed for short-term special-purpose monitoring studies.

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3.2 Methods and Instrumentation for PM$_{10}$ and Meteorological Data

PM$_{10}$ monitoring will be performed using USEPA-approved reference or equivalent method monitors. The current monitoring network shown in Figure 1.1 includes seven PM$_{10}$ monitor sites – Keeler, Lone Pine, Olancha, Dirty Socks, Shell Cut, Bill Stanley and Flat Rock. Each PM$_{10}$ site is equipped with a Tapered Element Oscillating Microbalance (TEOM) PM$_{10}$ monitor. TEOM monitors are capable of measuring hourly PM$_{10}$ concentrations. The Dust ID Program will rely on the TEOM to determine if an exceedance is caused by a lake bed source, since the data can be correlated with hourly wind directions to determine dust source directions. TEOM data will also be used to generate K-factors to model the PM$_{10}$ emissions from lake bed sources.

Ten-meter meteorological towers will be located near each PM$_{10}$ monitor site and at other locations around the lakeshore and on the lake bed. The current met sites are shown in Figure 1.1. The met data are used to create wind fields with the CALMET model that are used with CALPUFF to model air quality impacts. All met towers include instrumentation to measure wind speed and wind direction. Two lake bed met sites (A & B Towers) measure wind speed at different heights (0.5, 1, 2, 5 and 10 m) to determine surface roughness and vertical wind speed profiles. Some met sites also measure temperature, relative humidity, barometric pressure, and/or precipitation.

3.3 Operating Procedures, Instrument Calibration and Quality Assurance

PM$_{10}$ monitoring will be performed in accordance with USEPA monitoring guidelines found in 40 CFR, Part 58 and meteorological monitoring will be performed in accordance with USEPA Quality Assurance Handbook for Air Pollution Measurement Systems, Volumes I, II, and IV.

3.4 Data Handling and Data Access via Modem

TEOM PM$_{10}$ data will be delivered to Data Processing on a routine monthly schedule. After the data pass the proper data review and QA checks they will be submitted to the USEPA's AIRS database. PM$_{10}$ data from special-purpose monitors that may be located on the lake bed will not be submitted to the AIRS database.

All the PM$_{10}$ sites and some met sites are equipped with modem links that allow for access to the hourly concentrations. These data are useful for alerting field personnel to possible new sources of PM$_{10}$, and for alerting the public in case of high concentrations. For hourly concentrations above 400 µg/m^3 the District will issue public health advisories when the communities of Keeler, Lone Pine or Olancha are affected. The public can view real-time wind speed, direction and PM$_{10}$ data from the Dust ID monitoring network on the District's website at www.gbuapcd.org/data.

4. Protocol for Observing and Mapping Source Areas and Dust Plume Paths

    4.1   Objective

The objective for source area mapping is to use the best available information from visual observations, GPS mapping, and sand flux measurements to delineate the boundaries of dust source areas for as many events as possible. This information will be used to help delineate the control area boundaries for new sources.

    4.2   Methods and Instrumentation

The Dust ID Program includes four methods to help locate dust source areas and to delineate the source area boundaries. The methods are: 1) visual mapping by trained observers, 2) time-lapse cameras, 3) surface inspections with GPS mapping, and 4) sand flux activity (as measured with Sensits and CSCs).

        4.2.1   Mapping Dust Source Areas from Off-Lake Observation Sites

One or more trained observers will complete observations from viewpoints to best observe the active dust source areas. For instance, two observers may be at viewpoints on the east side of the dust plume in the Inyo and Coso Mountains and a third may be on the west side in the Sierra. The observers will create hourly maps of the visible boundaries of any dust source areas, their plume direction and note if the visible plume crosses the shoreline. To the extent practicable, all lake bed and off-lake dust sources will be included in the observations. Figure 4.1 shows an example of sand flux measurements and the cumulative information that can be collected by observers mapping the dust plumes from different locations.

        4.2.2   Video Cameras

Remote time-lapse video cameras will record dust events during daylight hours. This information will be reviewed to help identify source areas that may have been missed by observers, or to help confirm source area activity detected by PM_{10} monitors or the sand flux network. Remote time-lapse video can also be used to help verify modeled impacts that were not monitored by the PM_{10} network, to check compliance of dust control areas, and to identify off-lake sources not measured by any of the other methods.

        4.2.3   Mapping Using GPS

            4.2.3.1   "Trigger" Levels for Initiating Field Inspections and GPS Surveys

Dust observations, Sensit activity, elevated PM_{10} concentrations and video will be used as "trigger data" to determine the time and location for a Dust Source Area Survey (survey). Sensit and PM_{10} data will be automatically collected via radio transmission every workday. A technician will summarize and review the data each workday. The summary will list all Sensit activity greater than background output levels, and hourly TEOM PM_{10} concentrations over
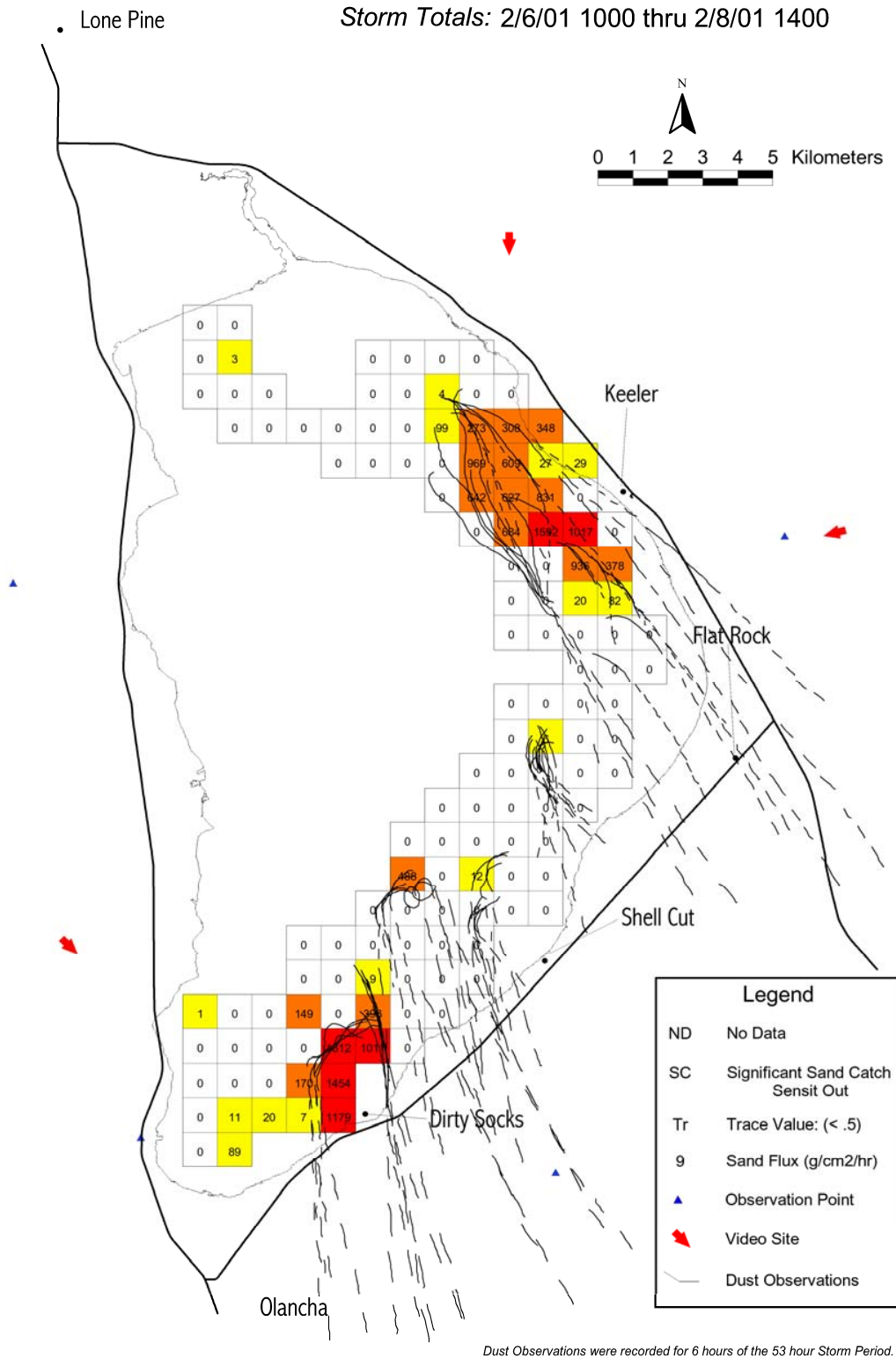
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Figure 4.1 - Example of dust plume maps drawn by observers during daylight hours and total sand flux for a dust event on February 6-8, 2001.

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50 µg/m^3 with corresponding wind speed and direction data. If dust observations are available from a recent dust storm, they will be used to confirm the location of the dust source(s) that correspond with the Sensit activity and elevated PM$_{10}$ concentration. Video will be used to identify a source or sources that were not identified by observations, Sensit data or PM$_{10}$ information. Wind speed and wind direction data will be used to help determine if a lake bed dust source could have caused elevated PM$_{10}$ concentrations. All of the trigger information will be used to identify any lake bed dust source area to initiate a dust source survey and/or surface inspection. The survey should be completed the same day if weather conditions are favorable. For larger areas, surveying may continue for several days or until precipitation obscures the boundaries of the source area.

In addition to the above process, general field inspections will be completed after dust storms to verify lake bed emission activity and the need for a survey. A survey will be completed if the trigger data and /or field inspections indicate emissive conditions in an area that has not been previously surveyed during the current dust period (Section 4.3) or in an area that has been previously surveyed but has increased in size since its last survey. The priorities for completing a survey are:

1) new lake bed source areas outside the instrumented Sensit network;
2) new lake bed source areas that have not been surveyed within the instrumented Sensit network; and
3) lake bed source areas that have previously been surveyed.

4.2.3.2   GPS Mapping Procedures

After a dust source is identified by dust observation, Sensit data, sand catch data, video, PM$_{10}$ concentration or inspection of the lake bed surface, District staff will map the exterior boundary of as many of the source areas identified as possible during daylight hours, as weather conditions allow. The mapping will begin as soon as possible after a dust storm and continue until all the identified areas are mapped or precipitation occurs. The boundary of the emissive area(s) will be mapped using a Global Positioning System (GPS). Surveyors conducting the mapping will ride an ATV or walk around the outer boundary of the wind-damaged surface surveying a line with the GPS. A wind-damaged surface is defined as a soil surface with wind erosion evidence and/or aeolian deposition that has not been modified to an unrecognizable point by precipitation since the last identified dust storm.

GPS line data should be collected at an interval of one record every 10 seconds or less. Data should be collected in NAD83 UTM Zone 11 coordinates. Only GPS units capable of continuously recording line data will be used. Data should be processed and corrected using base station data (either from a commercial correction service or using data from the District's Keeler base station) to ensure positional accuracy.

Before beginning a survey, the edge of the source area is determined by a visual review of the surface conditions within a representative one square meter area along the edge of the source area. An undamaged surface is evident if there is no visible evidence of a disturbed lake bed surface due to wind damage. As an aid to calibrate the level of disturbed surface, a surveyor will

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begin each survey by estimating the percentage of surface that is undamaged by the wind. The surveyor visually determines where a surface with 70 to 80 percent of undisturbed surface is located. The surveyor completes the survey by following a line of travel that closely represents the initial one-meter calibration. The following defined list, Boundary Conditions and Survey Procedures (see below), can be used to determine how to map the source boundary under differing surface boundary conditions.

Boundary Conditions and Survey Procedures:

Distinct Boundary: A visibly sharp transition, 25 feet or less in width, between a wind-damaged lake bed surface and an undamaged lake bed surface. The surveyor should travel directly along this distinct outside edge, if possible, and may deviate 25 feet to the inside or outside on occasion. Small (25-foot wide or less) channels, boundary indentations, roads, mounds, and other obstacles may be directly crossed if the continuation of the main source boundary is clearly visible on the opposite side.

Diffuse Boundary: A visibly distinct transition, 25 to 100 feet in width, between a wind-damaged lake bed surface and an undamaged lake bed surface. Every effort should be made to travel along the outermost edge of the visible distinction.

Indistinct Boundary: A boundary that is not obvious to the surveyor where the edge of the source is located. Mapping would be stopped at this point until a Distinct or Diffuse Boundary can be located.

Generally the surveyor will maintain a constant course of travel following the Distinct Boundary of the wind-damaged area. As the boundary becomes less distinct, it is recommended to move the course of travel further into or outside the source to maintain recognition of surface damage. It is acceptable to travel within approximately 50 feet of the outer or inner edge of the larger more noticeable active area if the boundary is Diffuse. When encountering an Indistinct Boundary condition, the surveyor should note if the boundary can be found or if the boundary cannot be mapped during the existing survey and why. If the boundary cannot be mapped, the survey shall end at that point leaving an unclosed source area polygon.

It is possible for the surveyor to find himself or herself greater than 50 feet within or outside of the source area boundary. When this happens, the surveyor should turn perpendicular to the direction they were traveling and travel in the direction where the distinct edge should be located. For example, if the surveyor were inside the source area, they would turn in the direction where erosion evidence was not observed earlier along their path. If the surveyor were outside the source area, they would turn toward the side where they previously observed the source. Boundary loss may occur because of an Indistinct Boundary or unfavorable lighting conditions. The time and coordinates should always be noted when it is necessary to relocate the boundary during a survey.

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Another alternative for relocating a source area edge is to pause the GPS unit from recording data until the boundary is located and then resume with data collection. This allows the surveyor to travel in any direction until the edge is relocated or end the survey if an edge cannot be located. The line produced between the point where the GPS unit was paused and then restarted would be deleted and considered un-surveyed during post processing.

The presence of Indistinct Boundaries or conditions that cause the ending of a survey must be annotated on the GPS data or explained in the field notes, including point coordinates. Examples would include dust storm, precipitation, lightning, mud, and channel with flowing water, pond, and time constraint or equipment malfunction.

4.2.4   Using Sand Flux Monitors to Map Source Area Boundaries

Dust source area boundaries can be delineated or refined using default cell boundaries represented by active sand flux monitors. The area represented by the active SFM site may be shaped to exclude known non-emissive areas, such as; DCM areas, wetlands, or areas with different soil texture where there is evidence that it is non-emissive.

4.3   Composite Dust Source Map Development

Data Processing will compile the cumulative mapping information from the visual observers and field inspections using the GPS into a GIS database for two periods each year, December through June and July through November. A new composite map will be developed for each period containing only those data collected during that period. Hand drawn observation maps will be scanned and translated into the GIS database. Observation maps will be compared with source area locations from other methods through the GIS generated layers. Overlays of the maps generated from sand flux monitors, video cameras, visual observers and GPS'd source areas will be compared qualitatively, considering the information may have been collected at different times.

5. Protocol for Determining K-factors and PM$_{10}$ Emission Rates from Sand Flux Data

5.1   Objective

The objective of this portion of the Dust ID Program is to estimate the PM$_{10}$ emission flux for each cell or source area using the relationship *PM$_{10}$ emission flux = sand flux x K-factor*. PM$_{10}$ emissions for each area will be used with the CALPUFF modeling system or other USEPA approved model to determine if the PM$_{10}$ emissions will cause or contribute to a NAAQS violation at the shoreline.

5.2   Method for Determining PM$_{10}$ Emissions and New K-factors

5.2.1   PM$_{10}$ Emission Flux = Sand Flux x K-factor

PM$_{10}$ emissions will be estimated using the sand flux for each area represented by a Sensit and CSC and an appropriate K-factor for the area and period. The sand flux values will come from

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the Sensit and CSC data as discussed in Section 2. New K-factors for each area and period will be developed as discussed in this section, and default K-factors will be used to model dust events unless newer K-factors are determined.

5.2.2   Default Temporal and Spatial Storm-average K-factors

PM_{10} emissions may be estimated from default K-factors that were developed from previous dust events that occurred in the same area and the same range of calendar months in previous years.

The areas for K-factor groupings are shown in Figure 1.1: North Area, Central Area, Keeler dunes, and the South Area. Any new source area within the depicted boundaries will be associated with that area for the spatial grouping of new K-factor values. If a new source area and K-factor is developed for an area outside these boundaries, the area and default K-factor will be associated with the K-factor for an existing area with the most similar surface soil texture. The determination of the most similar existing area will be made by the Air Pollution Control Officer.

5.2.3   Method to Determine Sand Flux from Areas with Implemented Dust Control Measures (DCM)

Sand flux will be measured at sites within the shallow flood and managed vegetation DCM areas. Sensits and CSCs will be sited on dry areas within the shallow flood DCM to represent dry areas near the site. DCM areas covered with standing water will be assumed to have zero sand flux. For the Managed Vegetation DCM, sand flux sites will be placed in spatially representative areas and in areas within the DCM where wind blown dust may have been previously observed.

5.2.4   New K-factors Seasonal Cut-points

The APCO will review the K-factor data and propose seasonal cut-points to the LADWP. LADWP will respond to the proposed cut-points within 30 days. If no agreement can be reached within 60 days, the default periods will be used.

The two default periods to be used are: the winter/spring period that includes the months of December, January, February, March and April, and the summer/fall period that includes May through November. These same calendar months will be used to generate new temporal K-factors for each area and to generate new 75-percentile hourly K-factor values for modeling PM_{10} emissions.

5.2.5   Using CALPUFF Modeling System to Generate New K-factors

New hourly K-factors can be inferred from the CALPUFF model by using hourly sand flux as a surrogate for PM_{10} emissions. Modeled PM_{10} predictions can then be compared to monitored concentrations at PM_{10} monitor sites to determine the K-factor that would correctly predict the monitored concentration for each hour. More information on the modeling procedures is included in Section 6.

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A K-factor of 5 x 10^{-5} will be used initially to run the CALPUFF model and to generate concentration values that are close to the monitored concentrations. Hourly K-factor values will then be adjusted in a post-processing step to determine the K-factor value that would make the modeled concentration match the monitored concentration at the PM$_{10}$ monitor site. The initial K-factor will then be adjusted using Equation 5.2.

Equation 5.2

$$K_f = K_i \left(\frac{C_{obs.} - C_{bac.}}{C_{mod.}} \right)$$

Where,

K_i = Initial K-factor (5 x 10^{-5})
$C_{obs.}$ = Observed hourly PM$_{10}$ concentration. [$\mu g/m^3$]
$C_{bac.}$ = Background PM$_{10}$ concentration
$C_{mod.}$ = Model-predicted hourly PM$_{10}$ concentration. [$\mu g/m^3$]

5.2.6 Screening Hourly K-factors

K-factors will be calculated for every hour that has active sand flux in cells upwind from a PM$_{10}$ monitor. These hourly K-factors will be screened to remove hours that did not have strong source-receptor relationships between the active source area (target area) and the downwind PM$_{10}$ monitor. For example, the screening criteria will exclude hours when a PM$_{10}$ monitor site is located on the edge of a dust plume. Because the edge of a dust plume has a very high concentration gradient, a few degrees error in the plume direction could greatly affect the calculated K-factor.

The following criteria will be used to screen the hourly K-factors:

Initial K-factor Screen

1) Wind speed is greater than 5 m/s at 10 m height at any network site.

2) Hourly modeled and monitored PM$_{10}$ concentrations were both greater than 150 $\mu g/m^3$ at the same monitor-receptor site.

3) Hourly wind direction as listed in Table 5.1 for each monitor site.

4) The mean sand flux for all sites with non-zero sand flux is greater than 0.5 g/cm^2/hr.

Final K-factor Screen

5) At least one sand flux site located within the target area and within a 30-degree upwind cone has sand flux greater than 2 g/cm^2/hr.

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6) All sources are within a distance of 15 km of the receptor.

7) More than 65 percent of the PM_{10} contribution at a monitor site came from the target source area (North Area, South Area, Central Area or Keeler dunes).

8) Eliminate hours when sand flux data are missing from one or more cells that are located within a 30-degree upwind cone and within 10 km of the shoreline monitor. For Olancha and Lone Pine, which are both located 5 to 10 km from the lake bed, the distance limitation is changed to 10 km upwind of the shoreline.

Table 5.1 – Wind Directions for the Initial K-factor Screen

PM_{10} Monitor Site	From-the-Lake Wind Dir. (Deg.)	Met Tower
Lone Pine	$110 \leq WD \leq 190$	Lone Pine
Keeler	$130 \leq WD \leq 330$	Keeler
Flat Rock	$210 \leq WD \leq 360$	Flat Rock
Shell Cut	$WD \geq 210$ or $WD \leq 50$	Shell Cut
Dirty Socks	$WD \geq 220$ or $WD \leq 65$	Dirty Socks
Olancha	$WD \geq 320$ or $WD \leq 55$	Olancha
Bill Stanley	$50 \leq WD \leq 190$	Bill Stanley
New Sites	TBD	TBD

The from-the-lake wind directions for the initial K-factor screening criterion 3) are shown in Table 5.1. From-the-lake wind directions for any new PM_{10} sites will be determined by the APCO as needed for the initial K-factor screen. Note that 'From-the-Lake' wind directions for assessing the lake bed impacts at PM_{10} monitor sites (see 2008 SIP) are different from these K-factor screening wind directions.

Hourly K-factors that pass through the screening criteria will be used to develop new event-specific spatial K-factors, and new 75-percentile hourly average temporal and spatial K-factors, if enough K-factors are available.

5.3   Temporal and Spatial Event-specific K-factors

5.3.1   Event-Specific K-factors

Screened hourly K-factors will be used to generate event-specific K-factors for the active source areas. The event-specific K-factor will be calculated as the arithmetic average using all the hours when the hourly K-factor passes the screening criteria for the target area.

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5.3.2   Temporal & Spatial 75-Percentile K-factors

The statistical 75-percentile value will be determined from the distribution of the hourly K-factors that pass the screening criteria for that area and period, whenever there are nine or more hourly K-factors. The 75th percentile will be calculated using the Microsoft Excel PERCENTILE function. The Microsoft Excel PERCENTILE function works by sorting values from lowest to highest, then assigns the 0th percentile is the lowest value, the 100th percentile is the largest value, and the values in between as (k-1)/(n-1) where n is the number of data values in the list and k is index of the kth lowest value in the list. Thus, each value is placed 1/(n-1) apart. If a requested percentile does not lie on a 1/(n-1) step, then the PERCENTILE function linearly interpolates between the neighboring values.

5.3.3   Default K-factors

Table 5.2 shows the default K-factors for each of the K-factor areas and periods. These K-factors are derived for the temporal and spatial 75-percentile values from the screened hourly K-factors for the 30-month Dust ID period used for the RSIP. Each of the two temporal periods combines hourly K-factors from the same calendar periods for 2 or 3 years.

Table 5.2 - Default Spatial and Temporal K-factors for the Dust ID Model

AREA	K-factor Jan.– Apr. & Dec.	K-factor May-Nov.
Keeler Dunes	7.4×10^{-5}	6.0×10^{-5}
North Area	3.9×10^{-5}	1.5×10^{-5}
Central Area	$12. \times 10^{-5}$	6.9×10^{-5}
South Area	4.0×10^{-5}	1.9×10^{-5}

6.   Protocol For Dispersion Modeling

This section of the *Protocol* discusses the dispersion model methods planned for the simulation of wind blown dust at Owens Lake using data from the Dust ID Program. The modeling procedures follow the methods used in the RSIP, with refinements based on experience and modifications to support the provisions of the SCR. The modeling techniques will be used both diagnostically to infer emission rates for source areas and prognostically to predict PM_{10} concentrations at the historic shoreline. Following an overview of the modeling approach, the remainder of this section discusses construction of the meteorological data set, dispersion model options, background concentrations and source area characterization.

6.1   Overview of Modeling Procedures and Rationale for Model Selection

The CALPUFF modeling system was used in the RSIP and has been selected for continuing studies in the Dust ID Program. CALPUFF is the USEPA recommended modeling approach for long-range transport studies and USEPA has proposed CALPUFF as a *Guideline Model* to be

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included in the *Guideline on Air Quality Models* (40 CFR Part 51, Appendix W). Recently the modeling system is also being applied to near-field dispersion problems where the three-dimensional qualities of the wind field are important and for stagnation episodes when pollutants remain within the modeling domain over periods of several hours or more. Dust events on Owen Lake are sometimes influenced by complex wind patterns, with plumes from the North Sand Sheet traveling in different directions than plumes from the South Sand Sheet.

The proposed model domain shown in Figure 6.1 includes a 34 km-by-48 km area centered on Owens Lake. The meteorological and computational grid will use a one-kilometer horizontal mesh size with ten vertical levels extending from the surface to four kilometers aloft. The extent of the model domain was selected to include the "data rich" Dust ID Program study area, terrain features that act to channel winds, and receptor areas of interest. This same model domain and mesh size were used in the simulations supporting the RSIP.

6.2 Meteorological Data Set Construction

Three-dimensional wind fields for CALPUFF will be constructed from surface and upper air observations using the CALMET meteorological preprocessor program and the procedures employed in the RSIP. CALMET combines surface observations, upper air observations, terrain elevations, and land use data into the format required by CALPUFF. Winds are adjusted objectively using combinations of both surface and upper air observations according to options specified by the user. In addition to specifying the three-dimensional wind field, CALMET also estimates the boundary layer parameters used to characterize diffusion and deposition by the CALPUFF dispersion model.

6.3 CALPUFF Options and Application

Surface Observations. The necessary surface meteorological data will come from the District's network of ten-meter towers shown in Figure 1.1. The District may also install additional stations to better characterize winds near suspect source areas not currently near an existing site. Very few periods of missing data are typically contained in the District's database. Periods of missing data will be flagged and CALMET will construct the wind fields using the data from the remaining stations. In addition to the District's network, surface data from other field programs at Owens Lake will be used when available.

Cloud Cover Data. The current version of CALMET also requires cloud cover and ceiling height observations. Cloud cover is a variable used by CALMET to estimate the surface energy fluxes and, along with ceiling height, is used to calculate the Pasquill stability class. Hourly cloud cover and ceiling height observations are being collected from the surrounding surface airways observations at China Lake and Bishop Airport. During dust event conditions, the sensitivity of the CALPUFF modeling system to these variables is reduced, as the stability class becomes neutral under moderate to high winds. Algorithms within the modeling system that depend on the surface energy fluxes are dominated by the momentum flux and tend to be insensitive to cloud cover under high winds. For these reasons, the absence of local cloud cover and ceiling height measurements are not expected to significantly affect the results of the modeling study.
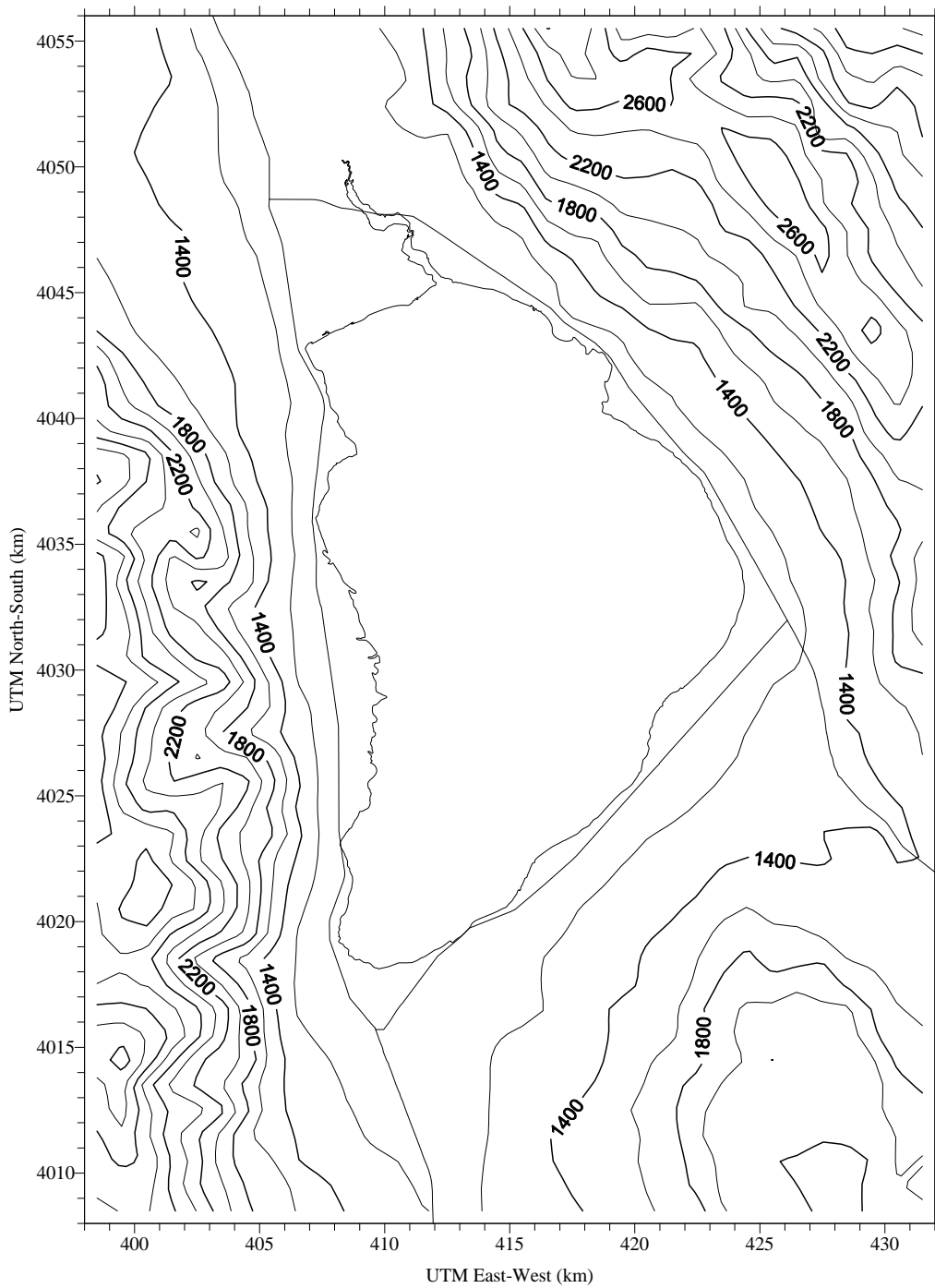
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Figure 6.1 - Model Domain, elevation contours and UTM coordinates for the Dust ID Model

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Surface Characteristics and Terrain. The CALPUFF modeling system requires land use and terrain data. These data are used by CALMET to adjust the wind field and affect the calculations performed by the CALPUFF dispersion model. CALPUFF considers spatial changes in land use, including the surface roughness, and the input data are specified on a horizontal grid. The terrain data influence the constructed wind fields and plume trajectories in regions of sparse observations. Land use and terrain data have been obtained from the U.S. Geological Survey (USGS) data sets on the Internet. The resolution of these land use and terrain data sets are 200 m and about 30 m, respectively. The District has prepared these data sets using the pre-processing software provided with the CALPUFF modeling system. The resulting grids have been plotted and checked against data from the District's GIS database where the modeling domain overlaps the District's data. The 1-km mesh size terrain used by CALMET and CALPUFF is shown in Figure 6.1.

Upper air data. Upper air data will be collected from a number of different sources for construction of the wind fields and estimation of mixing heights with CALMET. In the RSIP, both local and regional data were collected as follows:

- A 915 MHz Radar Wind Profiler and Radio Acoustic Sounding System (RASS) were used to collect upper level wind and temperature measurements. The Wind Profiler was initially located at Dirty Socks then moved to the Mill Site during the 4th quarter of 2001. The District discontinued measurements with the Wind Profiler on June 30, 2003. The Wind Profiler with RASS samples wind and temperature from 100 m, up to 5000 m with a vertical resolution as low as 60 m depending on the clutter environment, atmospheric scattering conditions, and pulse length. Experience at Owens Lake indicates wind data recovery is sometimes poor above 1000 m due to the dry environment and the RASS data are limited to the lower levels during windy conditions.

- Regional twice-daily upper air soundings from Desert Rock Airport (Mercury, Nevada) and China Lake Naval Air Station.

During high wind events, observations from the Wind Profiler at both the Mill Site and Dirty Socks indicate very little wind speed or wind direction shear with height. Previous CALPUFF simulations suggest concentrations predicted at PM_{10} monitoring sites and at the historical shoreline are not usually influenced by upper level winds because the sources are ground based. The highest impacts occur close to the source areas, and there is very little wind shear during high winds.

Following removal of the Wind Profiler, soundings from China Lake and Desert Rock will be used to construct the data set. The China Lake and Desert Rock sounding will primarily be used for upper level temperature lapse rates. Winds aloft will be based on extrapolation of the surface wind measurements. The default algorithms employed by CALMET based on Similarity Theory often adjust the winds in the wrong direction and predict too much increase in wind speed with height even for very small surface roughness lengths. As an alternative, wind speeds aloft will be adjusted using the empirical results suggested by the previous Wind Profiler measurements. No wind direction turning with height will be assumed except near the Wind Profiler site where the actual data will be used until this program is discontinued.

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CALMET options. The options employed for the application of CALMET to construct the wind fields were provided in the "Modeling Protocol" (MFG, 2001). The majority of the selected model options are based on the defaults incorporated in the code by the model author. Notable model options include:

- Ten vertical levels varying geometrically from the surface to 4000 m. The geometric spacing provides better resolution near the surface and the upper limit is high enough to be above the boundary layer height.

- Vertical extrapolation of surface winds aloft using the results of the Wind Profiler studies.

- Less than default smoothing of wind fields. LADWP contractors Air Sciences and Environ suggested less smoothing of the wind fields by CALMET after review of the *Owens Valley PM$_{10}$ Attainment Demonstration Modeling Protocol*.

Wind fields constructed with CALMET will be randomly checked by plotting the resultant fields and the surface observations on a base map. The CALDESK^{TM} software package will also be used to view the CALMET wind fields.

The application of CALPUFF involves the selection of options controlling dispersion. Although the simulations are primarily driven by the meteorological data, emission fluxes, and source characterization, the dispersion options also affect predicted PM$_{10}$ concentrations. The model options used in the RSIP will continue to be used for the Dust ID Program. In this study, the following options will be used for the simulations:

- Dispersion according to the conventional Pasquill-Gifford dispersion curves. Sensitivity tests were also performed by applying CALPUFF with dispersion routines based on Similarity Theory and estimated surface energy fluxes. These tests did not indicate improved performance over the Pasquill-Gifford based simulations.

- Near-field puffs modeled as Gaussian puffs, not elongated "slugs." CALPUFF contains a computation intensive "slug" algorithm for improved representation of plumes when wind directions vary rapidly in time. This option was tested, but did not significantly influence the CALPUFF predictions.

- Consideration of dry deposition and depletion of mass from the plume. The particle size data used will be based on measurements taken within dust plumes on Owens Lake as discussed below.

Dry deposition and subsequent depletion of mass from the dust plumes depend on the particle size distribution. Several field studies have collected particle size distributions within dust plumes at Owens Lake. Based on results from Niemeyer, *et al.* (1999), the CALPUFF simulations will assume a lognormal distribution with a geometric mean diameter of 3.5 µm and a geometric standard deviation of 2.2.

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6.4 Background PM$_{10}$ Concentrations

The dispersion model simulations include only wind blown emissions from the source areas with sand flux activity measurements. During high wind events other local and regional sources of fugitive dust can contribute to the PM$_{10}$ concentrations observed at the monitoring locations. In the RSIP a constant background concentration of 20 µg/m^3 was added to all predictions to account for background sources. The constant background was calculated from the average of the lowest observed PM$_{10}$ concentrations for each dust event when 24-hour PM$_{10}$ concentrations at any of the sites were above 150 µg/m^3. To avoid including impacts from lake bed dust source areas in the background estimate, the procedures used a simple wind direction filter to exclude hours when the lake bed may have directly influenced observed PM$_{10}$ concentrations. Such hours were removed and daily average background concentrations were recalculated based on the remaining data.

Additional PM$_{10}$ monitors are proposed for installation at Owens Lake. These monitors can be used to measure hourly PM$_{10}$ concentrations upwind from lake bed source areas. Some of these monitors may be representative of regional PM$_{10}$ concentrations and others may be influenced by local sources that may indicate a higher PM$_{10}$ concentration than the regional background level. A method to calculate background concentrations based on upwind monitor concentrations for each modeled-event approved by both the APCO and the General Manager of the LADWP may be developed in the future. Meanwhile, a default background of 20 µg/m^3 will be added to the model prediction for each receptor location.

6.5 Area Source Characterization

CALPUFF simulations at Owens Lake are sensitive to source configuration. Emissions will be varied hourly according to the methods described in Section 6.6 and dust sources represented as rectangular area sources. CALPUFF contains an area source algorithm that provides numerically precise calculations within and near the area source location. The area source configuration used for the Dust ID model run for the period from July 2002 through June 2003 is shown in Figure 6.2. The paired Sensit and CSC measurements were assumed to be representative of the horizontal sand flux for irregularly shaped source areas near the sand flux site. Field observers determined the size and shape of the source areas based on GPS mapping after the storms, observation maps made during the storms, and physical surface characteristics. All source areas were represented by sand flux measured at a single site that was applied to a series of 250 m x 250 m cells that were configured to conform to the general shape of the source area represented by the sand flux site.

The following general rules are used to characterize and map source areas on the lake bed:

- Actual source boundaries will be used when available to delineate emission sources in the simulations. Actual source boundaries will be determined using a weight-of-evidence approach considering visual observations, GPS mapping, and surface erosive characteristics. Erosive characteristics that might be considered when defining a source boundary include properties of the soil, surface crusting, wetlands, and the proximity of the brine pool and existing DCMs.

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- Source boundaries will also be defined based on the DCM locations. For example, sand flux measurements outside the DCM will be assumed to apply up to the boundary of the DCM. Sand flux measurements inside the DCM will be assumed to apply to the area inside the DCM.

- All source areas will be represented by a series of 250 m x 250 m cells that generally conform to the shape of the source area and share the same hourly sand flux rates as the sand flux site representing that source area. Cells small than 250 m x 250 m may be used near the shoreline to better represent source areas where predicted concentrations are expected to be particularly sensitive to the source area configuration. (Figure 6.2)

6.6 Estimation of PM_{10} Emissions

Hourly PM_{10} emissions for each source area will be estimated using Dust ID sand flux data and K-factors following the procedures described in Section 5. See also SCR Section 1.2 and 2.1 regarding the order of priority for using K-factors for modeling.

6.7 Simulation of Shoreline Concentrations

Under the provisions of the SCR in the RSIP, CALPUFF simulations will be used to assess whether lake bed source areas cause or contribute to an exceedance of the PM_{10} NAAQS in areas without PM_{10} monitoring sites. Predictions will be obtained using the RSIP receptor network that contains more than 460 receptor locations placed at the historic shoreline (approximately at the 3600' elevation) of Owens Lake (see Figure 6.2). The receptor spacing along the historic shoreline ranges from 100 to 200 m. Note in several locations along the shoreline, receptors are very close to or even within potential source areas (see Figure 6.3).

7. Owens Lake Safety & Training Program

7.1 Objective

All field personnel that work at Owens Lake are required to complete special training courses to deal with the unique hazards and environmental precautions that must be considered when working on the lake bed. Training includes: first aid and CPR training, proper ATV use, respiratory protection and dust safety, lake bed access reporting, and snowy plover protection.

7.2 Safety Requirements

Safety is the first priority while working at Owens Lake. Training requirements are required for every worker at the lake for their own safety. Dust storms can start within minutes exposing workers to dust and sand. Lightning storms often occur in the summer. Winters have sub-freezing temperatures and summers have temperatures well above 100 degrees. Access is usually restricted to ATV's and can change often throughout each year. The objective of all the training requirements is to put safety as the highest priority at all times.
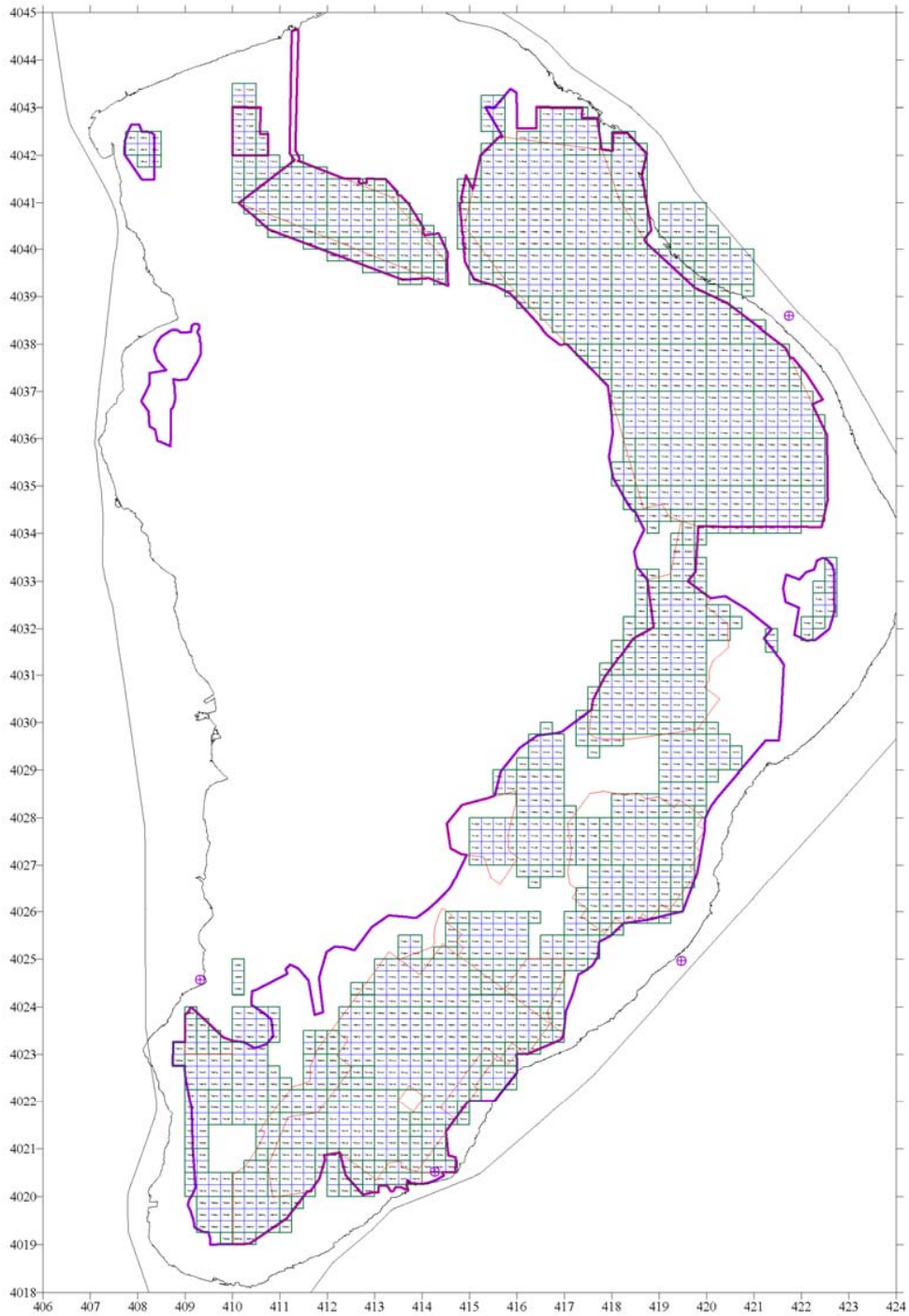
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Figure 6.2 - Area source configuration using 250 m x 250 m cells for July 2002 through June 2003 Dust ID model run. Purple lines represent the control area boundary used with the Settlement Agreement.
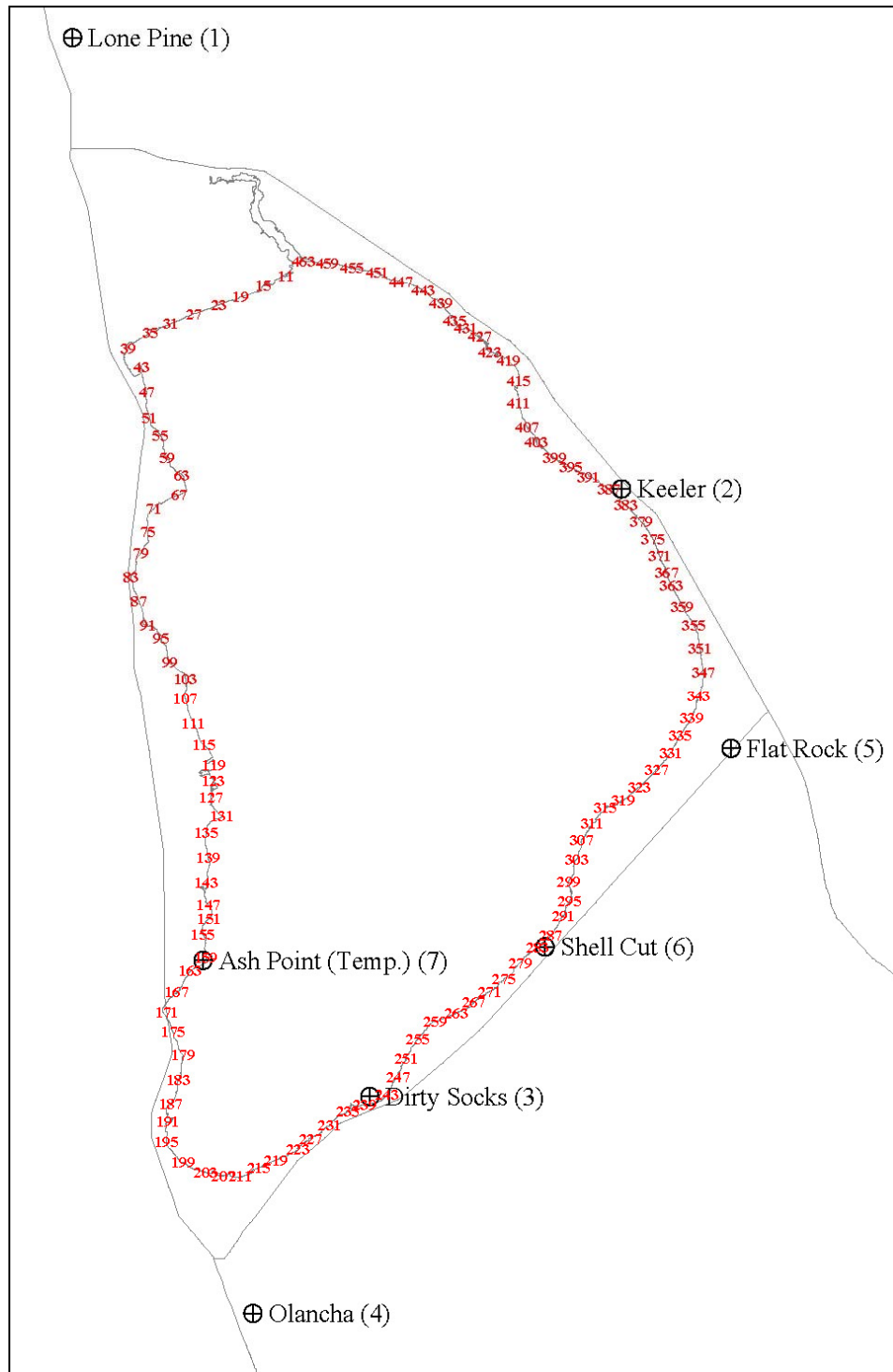
Figure 6.3 -The Dust ID model evaluates PM$_{10}$ impacts at over 460 receptor locations around Owens Lake.

All personnel that are involved with any fieldwork under the Dust ID Program are required to complete all safety training before working on the lake. Everyone must report going onto and leaving the lake. Workers are required to stop work and leave the lake when a dust storm starts. Every field worker will be issued a respirator, goggles for eye protection and earplugs to be used when caught in a dust storm while leaving the lake. Workers are required to leave the Keeler office when the dust impacts Keeler and the TEOM monitor reading exceeds 1000 µg/m^3. Respirator training and face fits will be completed annually. First Aid and CPR training and successful certification is required every three years. Snowy Plover training is required before any new worker can start work on the lake. Other safety issues that all workers will be informed of include the proper use of tools, special weather conditions such as temperature extremes, rain and lightning and training in the operation of ATVs.

7.3 Reporting Procedure for Working on the Lake and Contacts

1. Normal work hours on the Owens Lake are defined as sunrise to 4:45 PM, Monday through Friday. The lake is defined as any area below the 3600 ft. contour.

2. Every person or group must call the Bishop office and leave a message or speak to the Administrative Specialist (AS) to notify that they are working on the lake. They also must inform the AS what area of the lake they will be working. Examples: DIVIT, Dirty Socks sand sheet, "A" Met tower or any commonly used identifiable name of a site or area you will be working.

3. The AS will record the person's name (s) and area of the lake they are working on.

4. Every person or group working on the lake must notify the Bishop office before 4:45 PM on the same day; that they have left the lake OK. This must be done or a person will be sent out to look for you! False alerts will not be appreciated.

5. The AS will call the Director of Technical Services (DTS) in Keeler or one of the back up persons in order on the list below, and report the missing person if not notified before the specified time. An attempt will be first made to contact the missing person by phone and determine their situation. The DTS or an assigned person will begin a search for the missing person if the person cannot be contacted by phone. The search will continue until dark or unsafe conditions at which time the Inyo Sheriff will be notified for assistance.

6. Everyone may work outside normal work hours Monday through Friday <u>at your own risk.</u> However, they must call the Bishop office before the designated time and notify the AS that they will be working past 4:45 PM and call again and leave a message that they left the lake OK before 8:00 AM the next day.

7. The AS will check the messages every morning and record the information. The DTS will be notified if a person that worked after normal hours did not call and leave a message that they left the lake OK. The DTS or an assigned person will follow the procedure for a missing person outlined in step 5.

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8. Nobody may work on the lake after 4:45 PM on Friday, all day Saturday or Sunday unless they receive special permission from their direct supervisor. The supervisor will be responsible for making sure the worker left the lake OK and responding to an emergency or search if necessary. The worker must notify their supervisor when they leave the lake OK during these periods.

Emergency Assistance Reporting Contacts and Phone Numbers (Area Code 760):

Call 911 first if you have an emergency!

Bishop Office AS	872-8211		
Bill Cox (DTS)	876-8103	Cell	937-2886
Earl Wilson	876-8104	Cell	937-1060
Nik Barbieri	876-1803	Cell	937-6696
Grace Holder	872-8211	Cell	937-2887
Guy Davis	876-8115	Cell	937-1766
Dan Johnson	876-4544	Cell	937-1715
Ted Schade	872-8211	Cell	937-3360

7.4 Snowy Plover Training and Other Wildlife Protection Procedures

Field technicians and other District personnel and contractors are required to take precautions to avoid disturbing western snowy plovers during the nesting and brooding season which is from March 15 through August 30 each year. All lake bed personnel must complete snowy plover awareness and avoidance training before venturing onto the lake bed during snowy plover season. A qualified biologist will provide training for all lake bed personnel. In addition to completing snowy plover training, the plover protection program requires the following:

- Report snowy plover sightings to the District's biological resources monitor for dissemination to all lake bed personnel and for scientific data collection purposes. The biological resources monitor will map and mark the sightings in the case of nesting pairs, and will map the last known locations of broods. Lake bed workers will be responsible for checking the latest maps before encroaching onto potential snowy plover use areas.

- If snowy plover nests are found within areas of potential conflict with Dust ID monitoring, they will be marked in the field with green stakes. Within the buffer area demarked by stakes, the maximum allowable time per visit is 10 minutes.

- Field personnel should use established ATV and 4WD vehicle trails to approach and depart monitoring sites. The maximum allowable speed on ATV and off-road 4WD on the lake bed is 15 mph during the snowy plover season.

All existing and new Dust ID monitoring installations will be fitted with raptor perching deterrent (eg., Nixalite) at potential perch sites with a height of greater than 60 inches above the

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playa surface. Maintenance of perching deterrents will be routinely performed. Any new construction that causes new ground disturbance during the snowy plover season will require a pre-construction survey for snowy plover use. A qualified biologist will perform the survey within 1 week prior to the start of construction.

Monitoring will be performed on site in a manner that is least disturbing to wildlife and plant resources as possible. Potentially affected upland resources (those located outside the playa) that could be disturbed during any new ground-disturbing construction activities were identified during District environmental analyses. The animals that use upland areas vary seasonally, with nesting and foraging birds, mammals, reptiles, and invertebrates occurring during the period of dust monitoring. No special training is required to work in upland areas during the dust monitoring season, however pre-construction wildlife and rare plant surveys are required if placement of new facilities at any time of year will cause new ground disturbance.

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