PHYSICAL MODELING OF PLUME DISPERSION AT ALKALI AND COAL CREEK, NEAR CRESTED BUTTE, COLORADO

by

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FLUID MECHANICS AND
WIND ENGINEERING PROGRAM

COLLEGE OF ENGINEERING

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LIST OF SYMBOLS

Symbol	Definition	Units
A	Hot film calibration constant	(-)
B	Hot film calibration constant	(-)
C_p	Specific heat at constant pressure	$(m^2 s^{-2} {}^oK^{-1})$
CF	Calibration factor	(μv-s/ppm)
d	Diameter of hot film or displacement height	(m)
E	Hot-film voltage	(V)
Ec	Eckert number $\left[u_o^2/(C_{p_o} \Delta T_o)\right]$	(-)
F_L	Lagrangian spectral function	(s)
Fr	Stack Froude number $\left[\frac{u_s}{\sqrt{g\gamma D}}\right]$	(-)
g	Acceleration due to gravity	(ms^{-2})
Gr	Grashof number $\left[\frac{gd^3(T_w-T_g)}{\nu_g^2 T_g}\right]$	(-)
H_r	Reference height (equals 0.32 cm in model)	(m)
h	Height of stack	(m)
i	Longitudinal turbulence intensity	(-)
$i_{x,y,z}$	Turbulence intensity in x, y, or z direction [u'/u, v'/u, w'/u]	(-)
I	Current through wire or integrated value	(varies)
k	Thermal conductivity	$(Wm^{-1} {}^oK^{-1})$
k_s	Uniform sand grain height	(m)
K	Dimensionless concentration $\left[\frac{\chi u_r H_r^2}{\chi_o V}\right]$	(-)
L	Reference length	(m)

Symbol	Definition	Units
M_o	Momentum ratio $\left[\frac{\rho_s u_s^2}{\rho_a u_a^2}\right]$	(-)
n	Power law exponent	(-)
ΔP	Pressure difference	(mb)
P	Pressure	(mb)
Pr	Prandtl number $\left[\frac{\nu_o \rho_o C p_o}{k_o}\right]$	(-)
Re	Reynolds number $\left[\frac{L_o u_o}{\nu_o}\right]$	(-)
R	Resistance	(Ω)
Ri	Richardson number $\left[\frac{\Delta T_o g L_o}{T_o u_o^2}\right]$	(-)
R	Universal gas constant	($m^2/s^2 {}^oK$)
Ro	Rossby number $\left[\frac{L_o \Omega_o}{u_o}\right]$	(-)
$R(\tau)$	Autocorrelation	(-)
t, τ, ξ	Time or time scales	(s)
ΔT	Temperature difference	(^oK)
T, θ	Temperature or potential temperature	(^oK)
To	Surface temperature	(^oK)
t_1	Center of gravity of autocorrelation curve	(s)
t_o	Integral time scale	(s)
u,v,w	Velocities in x, y, or z direction	(m/s)
u_r	Velocity at reference height H_r	(m/s)

Symbol	Definition	Units
u_m	Maximum velocity	(m/s)
u*	Friction velocity	(m/s)
V	Volume flow	(m^3s^{-1})
z_m	Height of maximum velocity	(m)

Subscripts

Symbol	Definition
a	Pertaining to ambient conditions
BG	Pertaining to background data
c	Pertaining to calibration temperature
g	Pertaining to gas
i,j,k	Tensor or summation indices
i	Pertaining to tracer i
m	Model
o	General reference quantity or initial condition
p	Prototype or full-scale
s	Pertaining to stack exit conditions
w	Pertaining to hot wire
∞	Free stream

Superscripts

'	Root-mean-square of quantity
*	Dimensionless parameter

Greek Symbols

Symbol	Definition	Units
δ	Kronecker delta tensor	(-)
ε	Tensor permutation tensor	(-)
χ	Concentration	(ppm)
χ_o	Source Strength	(ppm)
γ	Density ratio $\frac{\rho_a-\rho_s}{\rho_a}$	(-)
Λ	Length scale	(m)
θ	Potential temperature	(^oK)
μ	Dynamic viscosity	($kgm^{-1}s^{-1}$)
ν	Kinematic viscosity	(m^2s^{-1})
Ω	Angular velocity	(s^{-1})
ϕ^*	Dissipation term	(-)
ρ	Density	(gm^{-3})
σ_z,σ_y	Vertical and horizontal standard deviation of concentration distribution	(m)

1.0 INTRODUCTION

The research effort reported on here is a subset of a total program. The purpose of the total program is to evaluate the environmental impact of primary and secondary pollutants due to AMAX, Incorporated mine development in the vicinity of Crested Butte, Colorado. The purpose of the study conducted at Colorado State University is to obtain quantitative and qualitative information about the transport and diffusion processes in the vicinity of the proposed mine site in Coal Creek and the proposed mill site at Alkali Creek through physical modeling. This information, once validated against field observation, will be used to test and refine a numerical model that will ultimately be used to assess the environmental impact of the primary and secondary pollutants.

To meet the objectives of the project, a 1:1920 scale model of the topography for a west wind direction at Coal Creek and a 1:2560 scale model of the topography for a west wind direction at Alkali Creek were constructed. The model testing was divided into two phases: drainage and forced flow. Drainage flow, referred to as "free convection", was simulated by cooling the surface of the terrain model and thereby establishing a density generated flow field. These tests were run outside the wind tunnel in a specially constructed facility that prevented unwanted drafts from affecting the flow field.

The tests referred to as "forced" were conducted in an environmental wind tunnel. In the tunnel, two atmospheric stability categories (neutral and stable) were simulated for each wind direction studied. At Coal Creek, a west-southwest wind direction was tested, whereas at Alkali Creek, both east and west winds were tested. Only the west wind direction was tested for neutral stratification at Alkali Creek.

Once the desired atmospheric condition was set in the tunnel or drainage flow facility, a series of velocity, temperature, concentration, and photographic measurements were obtained. The purpose of this report is to present the results of these measurements, to discuss the similarity criteria for relating the model to the full-scale and to document the experimental procedures employed. A complete set of black and white photographs, color slides, and motion pictures supplement this report. These photographic materials should be viewed to gain a more complete understanding of the complicated flow and dispersion patterns simulated.

2.0 WIND-TUNNEL SIMILARITY REQUIREMENTS

2.1 Basic Equations

The basic equations governing atmospheric and plume motion (conversion of mass, momentum and energy) may be expressed in the following dimensionless form (Cermak, 1974; Snyder, 1979):

$$\frac{\partial \rho^*}{\partial t} + \frac{\partial(\rho^* u_i^*)}{\partial x_i^*} = 0, \tag{2.1}$$

$$\frac{\partial u_i^*}{\partial t^*} + u_j^* \frac{\partial u_i^*}{\partial x_j^*} - \left[\frac{L_o \Omega_o}{u_o}\right] 2\epsilon_{ijk} \Omega_j^* u_k^* =$$

$$- \frac{\partial P^*}{\partial x_i^*} - \left[\frac{\Delta T_o L_o g_o}{T_o u_o^2}\right] \Delta T^* g^* \delta_{i3} \tag{2.2}$$

$$+ \left[\frac{\nu_o}{u_o L_o}\right] \frac{\partial^2 u_i^*}{\partial x_k^* \partial x_k^*} + \frac{\partial}{\partial x_j^*}(-\overline{u'^*_i u'^*_j})$$

and

$$\frac{\partial T^*}{\partial t^*} + u_i^* \frac{\partial T^*}{\partial x_i^*} = \left[\frac{k_o}{\rho_o C_{p_o} \nu_o}\right] \left[\frac{\nu_o}{L_o u_o}\right] \frac{\partial^2 T^*}{\partial x_k^* \partial x_k^*} \tag{2.3}$$

$$+ \frac{\partial}{\partial x_i^*}(-\overline{\theta'^* u_i'^*}) + \left[\frac{\nu_o}{u_o L_o}\right] \left[\frac{u_o^2}{C_{p_o} (\Delta T)_o}\right] \phi^*$$

The dependent and independent variables have been made dimensionless (indicated by an asterisk) by choosing appropriate reference values.

For exact similarity, the bracketed quantities and boundary conditions must be the same in the wind tunnel and in the plume as they are in the corresponding full-scale case. The complete set of requirements for similarity is:

1) Undistorted geometry

2) Equal Rossby number: $Ro = \frac{L_o \Omega_o}{u_o}$

3) Equal Richardson number: $Ri = \frac{\Delta T_o g\ L_o}{T_o u_o^2}$

4) Equal Reynolds numbers: $Re = u_o L_o / \nu_o$

5) Equal Prandtl number: $Pr = (\nu_o \rho_o C_{p_o}) / k_o$

6) Equal Eckert number: $Ec = u_o^2 / [C_{p_o} (\Delta T)_o]$

7) Similar surface-boundary conditions

8) Similar approach-flow characteristics.

For exact similarity, each of the above parameters must be matched in model and prototype for the stack gas flow and ambient flow separately. Naturally, the reference quantities will change depending on which flow is being considered. To insure that the stack gas rise and dispersion are similar relative to the air motion, three additional similarity parameters are required (Snyder, 1979; Petersen et al., 1977):

9) Momentum ratio: $M_o = \frac{\rho_s u_s^2}{\rho_a u_a^2}$

10) Froude number : $Fr = \frac{u_s}{\sqrt{g \gamma D}}$

11) Density ratio : $\gamma = \frac{\rho_a - \rho_s}{\rho_a}$

All of the above requirements cannot be simultaneously satisfied in the model and prototype. However, some of the quantities are not important for the simulation of many flow conditions. The parameters which are equal and those which are not equal in model and prototype will be discussed in the following subsections.

2.2 Non-Equal Scaling Parameters

For this study equal Reynolds number for model and prototype is not possible since the length scaling is 1:1920 or 1:2560 and unreasonably high model velocities would result. However, this inequality is not a serious limitation.

The Reynolds number related to the stack exit is defined by

$$Re_s = \frac{u_s D}{\nu_s} .$$

Hoult and Weil (1972) reported that plumes appear to be fully turbulent for exit Reynolds numbers greater than 300. Their experimental data show that the plume trajectories are similar for Reynolds numbers above this critical value. In fact the trajectories appear similar down to $Re_s = 28$ if only the buoyancy-dominated portion of the plume trajectory is considered. Hoult and Weil's study was in a laminar cross flow (water tank) with low ambient turbulence levels, and hence the rise and dispersion of the plume would be predominantly dominated by the plume's own self-generated turbulence. For this study neutrally buoyant plumes were released horizontally at various altitudes above the ground. Since the plume rise was not being studied, this Reynolds number is not important.

For similarity in the region dominated by ambient turbulence consider Taylor's (1921) relation for diffusion in a stationary homogeneous turbulence

$$\sigma_z^2(t) = 2\overline{w'^2} \int_0^t \int_0^t R(\xi) d\xi dt \tag{2.4}$$

which can be simplified to (see Csanady, 1973)

$$\sigma_z^2(t) \cong \overline{w'^2} t^2 \cong i_z^2 x^2 \tag{2.5}$$

for short travel times; or,

$$\sigma_z^2(t) = 2\overline{w'^2}\, t_o(t-t_1) \; ; \tag{2.6}$$

for long travel times where

$$t_o = \int_o^\infty R(\tau)d\tau \tag{2.7}$$

is an integral time scale and

$$t_1 = \frac{1}{t_o} \int_o^\infty \tau R(\tau)d\tau \tag{2.8}$$

is the center of gravity of the autocorrelation curve. Hence, for geometric similarity at short travel times,

$$\frac{[\sigma_z^2]_m}{[\sigma_z^2]_p} = \frac{[L^2]_m}{[L^2]_p} = \frac{[i_z^2\ x^2]_m}{[i_z^2\ x^2]_p} \quad *$$

or,

$$[i_z]_m = [i_z]_p \; . \tag{2.9}$$

For similarity at long travel times

$$\frac{L_m^2}{L_p^2} = \frac{[\sigma_z^2]_m}{[\sigma_z^2]_p} = \frac{[\overline{w'^2}\ t_o(t-t_1)]_m}{[\overline{w'^2}\ t_o(t-t_1)]_p}$$

$$= \frac{[i_z^2]_m}{[i_z^2]_p}\ \frac{[t_o(t-t_1)/u^2]_m}{[t_o(t-t_1)/u^2]_p} = \frac{[Li_z^2\ \Lambda]_m}{[Li_z^2\ \Lambda]_p} \; ,$$

if it is assumed $t_1 << t$, $t_o/u = \Lambda$ and $t/u = L$. Thus, the turbulence length scales must scale as the ratio of the model to prototype length scaling if $(i_z)_m = (i_z)_p$ or,

$$\frac{L_m}{L_p} = \frac{\Lambda_m}{\Lambda_p} \; . \tag{2.10}$$

---

* m refers to model, and p refers to prototype or full-scale

An alternate way of evaluating the similarity requirement is by putting 2.4 in spectral form or (Snyder, 1972),

$$\sigma_z^2 = \overline{w'^2} t^2 \int_0^\infty F_L(n) \left[\frac{\sin \pi nt}{\pi nt}\right]^2 dn \qquad (2.11)$$

$$= \overline{w'^2} t^2 \; I$$

where

$$I = \int_0^\infty F_L(n) \left[\frac{\sin \pi nt}{\pi nt}\right]^2 dn$$

F_L = Langrangian Spectral function.

The quantity in brackets is a filter function the form of which can be seen in Pasquill (1974). In brief for $n > 1/t$ the filter function is very small and for $n < 1/10t$ virtually unity.

For geometric similarity of the plume the following must be true:

$$\frac{L_m^2}{L_p^2} = \frac{[\sigma_z^2]_m}{[\sigma_z^2]_p} = \frac{[w'^2 t^2 I]_m}{[w'^2 t^2 I]_p} = \frac{[L^2 i_z^2 I]_m}{[L^2 i_z^2 I]_p}$$

or,

$$\frac{[i_z^2 I]_m}{[i_z^2 I]_p} = 1 \qquad (2.12)$$

If $[i_z]_m = [i_z]_p$ the requirement is $I_m = I_p$. For short travel times, the filter function is essentially equal to one; hence, $I_m = I_p = 1$ and the same similarity requirement as previously deduced for short travel times is obtained (Equation 2.9).

For long travel times the larger scales (smaller frequencies) of turbulence progressively dominate the dispersion process. If the spectra in the model and prototype are of a similar shape, then similarity would be achieved. However, for a given turbulent flow a decrease in Reynolds number (hence, wind velocity) decreases the range (or energy) of the high frequency end of the spectrum. Fortunately, due to the nature of the filter function, the high frequency (small wave length) components do not contribute significantly to the dispersion. There would be, however, some critical Reynolds number below which too much of the high frequency turbulence is lost. If a study is run with a Reynolds number in this range, similarity may be impaired.

The ambient flow field also affects the plume trajectories and consequently similarity between model and prototype is required. The mean flow field will become Reynolds number independent if the flow is fully turbulent (Schlichting, 1968; Sutton, 1953). The critical Reynolds number for this criteria to be met is based on the work of Nikuradse as summarized by Schlichting (1968) and is given by

$$(Re)_{k_s} = \frac{k_s u^*}{\nu} > 70.$$

In this relation k_s is a uniform sand grain height. If the scaled down roughness gives a $(Re)_{k_s}$ less than 70, then exaggerated roughness would be required. In the tunnel k_s may be approximated as the average terrain step size of approximately 0.64 cm. With $\nu = 0.15\ cm^2/s$ that means u^* must be greater than 16.41 cm/s or assuming $u^*/u_\infty \sim 0.06$, u_∞ must be greater than 2.7 m/s. All neutral tests were run above this speed. Reynolds number independence for stratified flow has not been systematically studied and consequently the best evaluation tool is to compare full-scale and model results.

The Rossby number, Ro, is a quantity which indicates the effect of the earth's rotation on the flow field and resultant turning of the wind with height (Ekman spiral). In the wind tunnel, equal Rossby numbers between model and prototype cannot be achieved. The effect of the earth's rotation becomes significant if the distance scale is large. Snyder (1979) puts a conservative cutoff point at 5 km for diffusion studies under neutral or stable conditions in relatively flat terrain. Mery (1969) suggests a 15 km limit, Ukejurchi et al. (1967) suggest 40 to 50 km, and Cermak et al. (1966) and Hidy (1967) recommend 150 km. A middle road would be that of Orgill et al. (1971a and 1971b) who suggest that a length scale of 50 km for rugged terrain in high winds is not unreasonable. The distances studied are acceptable, whichever criteria is believed.

When equal Richardson numbers are achieved, equality of the Eckert number between model and prototype cannot be attained. This is not a serious compromise since the Eckert number is equivalent to a Mach number squared. Consequently, the Eckert number is small compared to unity for laboratory and atmospheric flows.

2.3 Equal Scaling Parameters

Since air is the transport medium in the wind tunnel and the atmosphere, near equality of the Prandtl number is assured.

The remaining relevant parameters are the momentum ratio, M_o, buoyancy ratio, B_o, density ratio, γ, and Richardson number, Ri. Since plume rise is not being simulated, M_o, B_o, and γ are of no consequence.

The remaining similarity parameter is the Richardson number, Ri. For the atmosphere Ri is defined:

$$(Ri)_p = \frac{g}{\overline{T}} \frac{\Delta\theta z}{u(z)^2} = \frac{g}{\overline{T}} \frac{(\Delta T + \Gamma z)z}{u(z)^2}$$

where

ΔT = temperature difference between z and surface-- $T(z)-T_o$

Γ = adiabatic lapse rate ($\sim 1^oC/100m$)

$u(z)$ = wind speed at height z

z = height above ground--taken to be 250 m for all forced flow tests and the height of maximum velocity z_m for drainage flow tests

$\overline{T}$ = mean temperature between surface and z

For the wind tunnel Γz is typically less than 0.002°C, whereas ΔT is greater than 1°C. Hence for the wind tunnel, the Richardson number is defined:

$$(Ri)_m = \frac{g}{\overline{T}} \frac{(\Delta T)z}{u(z)^2}$$

Before comparing a laboratory to full-scale case, near equality of the Richardson numbers for the two should first be checked. For the neutral forced flow tests $\Delta T \doteq 0$ in model and $\Delta T + \Gamma z \doteq 0$ in prototype; hence, $(Ri)_m = (Ri)_p = 0$. Thus, any neutral full-scale case (regardless of wind speed) having the same free stream wind direction as studied in the wind tunnel will have similar dispersion and flow patterns.

For the stable and drainage flow tests, the Ri values varied. A $(Ri)_m$ was computed for each forced flow case based on z = 250 m in full-scale ($\frac{250m}{1920}$ or $\frac{250m}{2560}$ in model for Coal Creek and Alkali Creek respectively). For drainage flow z was set equal to the height of maximum velocity z_m. To find corresponding full-scale values for the stable and drainage flow tests, first consider only those cases having the same free stream wind direction. Secondly, the Richardson number in model should be nearly equal to that in the full-scale. If these two conditions are met, the full-scale values in the field will correspond to those in the model. If no field data are present, typical full-scale conditions may be computed using the equation:

$$\left(\frac{\Delta\theta}{\overline{T}u(z)^2}\right)_p = \frac{1}{(g)(z)_p} (Ri)_m$$

In summary, the applicable scaling parameters for the neutral, stable, and drainage flow boundary layer simulation are:

1) $Ri = \frac{(\Delta T)_o g L_o}{T_o u_o^2}$; $(Ri)_m = (Ri)_p$ = 0 for neutral
= + for stable

where the reference quantities are as defined above.

2) Similar geometric dimensions and dimensionless boundary conditions (i.e., velocity and turbulence profiles).

3) Sufficiently high Reynolds number to insure Reynolds number independence.

3.0 EXPERIMENTAL METHODS

3.1 General

A 1:1920 scale model of the topography for a west wind direction at Coal Creek and a 1:2560 scale model for a west wind direction at Alkali Creek were constructed to study the transport and dispersion of effluent under drainage and forced flow conditions. Figure 3-1-1 shows the terrain areas modeled for the various atmospheric conditions.

Each test was conducted in a similar manner. Measurements of wind speed, temperature (for the drainage and stable tests only), and tracer gas concentration were obtained at various locations to document the flow pattern and for later use in developing and validating a numerical model. Concentration measurements were obtained at ground level and in vertical arrays. The release location, release height, volume flow, reference wind speed, and sampling location for each run are given in Table 3-1.

Prior to testing the appropriate free stream velocity (zero for drainage flow) and surface temperature (room temperature for neutral stratification) were set in the wind tunnel or drainage flow test facility. Velocity or concentration measurements did not begin until the surface temperatures reached equilibrium, which was usually less than 15 minutes. Thereafter, all velocity measurements (and if time permitted, concentration measurements) were obtained before shutting the system down. The conditions were set again in the same manner if additional measurements were required.

A complete discussion on every facet of the study will now follow.

3.2 Scale Model and Test Facilities

- Scale Models

Construction of the topographic model entailed a two-step process. The first involved constructing a Styrofoam model out of 0.64 cm thick Styrofoam sheets (corresponds to a 40-ft contour interval) for the Coal Creek model and 0.95 cm thick Styrofoam sheets (corresponds to an 80-ft contour interval) for the Alkali Creek model. United States Geological Survey maps were photographed and the projected image used as patterns from which the Styrofoam was cut. The second phase of construction entailed fabricating a wood ribbed frame as shown in Figure 3-2-1. The frame had wood supports approximately every 30 cm which were cut to conform with the terrain elevation. Next, thin aluminum foil was placed on the Styrofoam model and molded in 30 cm-wide strips to fit the terrain contours. Once a strip was molded it was placed onto the wood frame and fastened. This procedure was repeated until one model section (normally 1.22 x 3.66 m) was complete. A picture of a completed section is shown in Figure 3-2-2. At this stage the model section was ready for installing either thermistors or concentration sampling lines. Thermistors and ground-level sampling taps were installed at various locations on both the Coal Creek and Alkali Creek models. Figures 3-2-3, 3-2-4, and 3-2-5 show the respective locations for each thermistor. A close-up of one thermistor installation is shown in Figure 3-2-6 and a close-up of the concentration sampling tubes is shown in Figure 3-2-7. The concentration sampling locations are given with the data in Appendices A, B, C, D, E, F and G.

The complete model sections were then placed in either the Environmental Wind Tunnel or the Drainage Flow Facility for testing of forced and drainage flows.

• Wind Tunnel

The Environmental Wind Tunnel shown in Figure 3-2-8 was used for testing neutral or stable transport and diffusion over the Coal Creek and Alkali Creek models. The terrain areas that were placed in the tunnel are shown in Figure 3-1-1. Upwind of the modeled topography a set of spires was used to stimulate the boundary layer. The tunnel setup for the neutral Alkali Creek and Coal Creek tests is shown in Figure 3-2-9. A similar setup was used for the stable tests.

• Drainage Flow Facility

To study the natural mountain-valley or slope winds a special enclosed room was constructed. Inside this room a platform was built for positioning the aluminum shell topographic model. Figure 3-2-10 shows the platform in the final stages of construction. Holes were drilled through the top of the frame for mounting fans. Figure 3-2-11 shows a technician mounting these fans inside the frame.

Once the frame was completed the aluminum shell sections were installed on top and the space under the model was then to be used as a cold sink. The cold sink consisted of several short tons of dry ice at approximately -80°C, loaded on carts. Figure 3-2-12 shows a technician loading the ice on one of these carts prior to sliding the cart under the frame. During the loading air packs were used to avoid breathing the high concentrations of CO_2. The loaded test bed with model in place is shown in Figure 3-2-13. After installing the ice the side of the frame and model were sealed with an insulating material.

The forced air circulation system for the cold sink consisted of 120 instrument fans connected to a motor speed controller. The rate of air circulation, as determined by the speed controller, made it possible to adjust the surface temperature conditions or shut the cooling system down entirely between experiments to conserve dry ice.

3.3 Gas Tracer Technique

• Test Procedure

The test procedure consisted of: 1) setting the proper tunnel wind speed and/or surface temperatures, 2) releasing a metered mixture of source gas of the required density (that of air) from the release probe, 3) withdrawing samples of air into a series of syringes at the locations designated, and 4) analyzing the samples with a flame ionization gas

The procedure for analyzing air samples from the tunnel was as follows: 1) a 2 cc sample volume drawn from the wind tunnel is introduced into the flame ionization detector (FID), 2) the output from the electrometer (in microvolts) is sent to the Hewlett-Packard 3380 Integrator (HP 3380), 3) the output signal is analyzed by the HP 3380 to obtain the proportional amount of hydrocarbons present in the sample, 4) the record is integrated and the methane or ethane concentration as appropriate is determined by multiplying the integrated signal (μv-s) times a calibration factor (ppm/μv-s), 5) a summary of the integrator analysis (gas retention time and integrated area (μv-s)) is printed out on the integrator at the wind tunnel, 6) the integrated values and associated run information are tabulated on a form, 7) the integrated values for each tracer are keypunched into a computer along with pertinent run information, and 8) the computer program converts the raw data to a dimensionless concentration (K) and the results are printed out in report format as shown in Appendices A, B, C, E, F and G.

The integrated values are converted as follows:

$$K = \left[\frac{\chi u_r H_r^2}{\chi_o V}\right]_m \tag{3.1}$$

where

K = dimensionless concentration

$(\chi)_m$ = $[(I - I_{BG})CF]_i$

$(\chi_o)_m$ = tracer gas source strength in ppm

I = integrated value of sample for tracer i

I_{BG} = integrated value of background for tracer i

CF_i = calibration factor for tracer i

H_r = reference height in model (m)--equal to 0.32 cm

u_r = model (m) reference wind speed (m/s)

The calibration factor was obtained by introducing a known quantity, χ_s, of tracer i in the HPGC and recording the integrated value, I_s, in μv-s.

The CF_i value is then

$$CF_i = \left[\frac{\chi_s(\text{ppm})}{I_s(\mu\text{v-s})}\right]_i \tag{3.2}$$

Calibrations were obtained at the beginning and end of each measurement period. The tracer gas mixtures were supplied by Scientific Gas Products. To convert the results to $\frac{\chi u}{Q}$ in the full scale the K value must be multiplied by $\left[\frac{1}{(1920)(.0032)}\right]^2$ or $\left[\frac{1}{(2560)(.0032)}\right]^2$.

- Gas Chromatograph

The FID operates on the principle that the electrical conductivity of a gas is directly proportional to the concentration of charged particles within the gas. The ions in this case are formed by the effluent gas being mixed in the FID with hydrogen and then burned in air. The ions and electrons formed enter an electrode gap and decrease the gap resistance. The resulting voltage drop is amplified by an electrometer and fed to the HP 3380 integrator. When no effluent gas is flowing, a carrier gas (nitrogen) flows through the FID. Due to certain impurities in the carrier, some ions and electrons are formed creating a background voltage or zero shift. When the effluent gas enters the FID, the voltage increases above this zero shift in proportion to the degree of ionization or correspondingly the amount of tracer gas present. Since the chromatograph[1] used in this study features a temperature control on the flame and electrometer, there is very low zero drift. In case of any zero drift, the HP 3380 which integrates the effluent peak also subtracts out the zero drift.

The lower limit of measurement is imposed by the instrument sensitivity and the background concentration of tracer within the air in the wind tunnel. Background concentrations were measured and subtracted from all data quoted herein.

- Sampling System

The tracer gas sampling system shown in Figure 3-3-1 consists of a series of fifty 30 cc syringes mounted between two circular aluminum plates. A variable-speed motor raises a third plate which in turn

[1]A Hewlett Packard 5700 gas chromatograph was used in this study (shown in Figure 3-3-1).

raises all 50 syringes simultaneously. A set of check valves and tubing are connected such that airflow from each tunnel sampling point passes over the top of each designated syringe. When the syringe plunger is raised, a sample from the tunnel is drawn into the syringe container. The sampling procedure consists of flushing (taking and expending a sample) the syringe three times after which the test sample is taken. The draw rate is variable and generally set to be approximately 60 s.

The sampler was periodically calibrated to insure proper function of each of the check valve and tubing assemblies. The sampler intake was connected to short sections of tygon tubing which led to a sampling manifold. The manifold, in turn, was connected to a gas cylinder having a known concentration of tracer (100 ppm ethane). The gas was turned on and a valve on the manifold opened to release the pressure produced in the manifold. The manifold was allowed to flush for ~ 1 min. Normal sampling procedures were carried out to insure exactly the same procedure as when taking a sample from the tunnel. Each sample was then analyzed for methane, ethane, propane, and butane. Methane, ethane, and butane were analyzed to insure that the tygon had not absorbed these hydrocarbons and was not "gassing" them off. Percent error was calculated, and any "bad" samples (error > 2 percent) indicated a failure in the check valve assembly, and the check valve was replaced or the bad syringe was not used for sampling from the tunnel. A typical sampler calibration is shown in Figure 3-3-2.

- Averaging Time

To determine the averaging time for the predicted concentrations from wind-tunnel experiments, the dispersion parameters--σ_y and σ_z--

for undisturbed flows in the wind tunnel have been compared to those used for numerical modeling studies (Petersen et al., 1979; 1980) in the atmosphere. The dispersion rates used in the atmosphere are referred to as the Pasquill-Gifford curves and are given in Turner (1970) and modified values are given in Pasquill (1974, 1976). The results of this comparison showed that the σ_y and σ_z values in the wind tunnel compare (when multiplied by the length scaling factor) with those expected for the atmosphere. Hence, the method used for converting numerical model predictions to different averaging times should also be used for converting the wind-tunnel tests.

The EPA guideline series for evaluating new stationary sources (Budney, 1977) conservatively assumes that the Pasquill-Gifford σ_y and σ_z values represent 1-hour average values. To convert to a 3-hour value multiply by 0.9 ± 0.1 and if aerodynamic disturbances are a problem the factor should be as high as 1.

Generally, steady-state average concentrations measured in the wind tunnel are thought to correspond to a 10- or 15-minute average in the atmosphere (Snyder, 1979). This line of reasoning is based on the observed energy spectrum of the wind in the atmosphere. This spectrum shows a null in the frequency range from 1 to 3 cycles per hour. Frequencies below this null represent meandering of the wind, diurnal fluctuations, and passage of weather systems and cannot be simulated in the wind tunnel. The frequencies above this null represent the fluctuations due to roughness, buildings and other local effects and are well simulated in the tunnel. This part of the spectrum will be simulated in the tunnel as long as the wind direction and speed characteristics remain stationary in the atmosphere which is typically 10 to 15 minutes.

At many locations, however, persistent winds of three or more hours may occur. For these cases, the wind tunnel averaging time would correspond to the atmospheric averaging time. For the more typical cases, the wind-tunnel results would have to be corrected for the large-scale motion using power law relations such as given by Hino (1968) or Turner (1970).

3.4 Velocity Profiles

- General

Vertical profiles of mean velocity were obtained for the various tests at the locations indicated in Figures 3-2-3, 3-2-4, and 3-2-5. The measurements were performed to 1) monitor and set flow conditions, 2) document flow conditions, and 3) for use in calculating surface roughness, power law exponent and Reynolds stress.

The velocity measurements for the Coal Creek drainage basin and stable test, as well as the Alkali Creek stable tests, were made using a Gould/Datametrics Model 800-LV temperature compensated linear velocimeter without a probe shroud. The probe shroud was removed to minimize the disturbance to the flow field by the bulk of the probe as it was lowered near the model surface. The velocity measurements for the Alkali Creek drainage basin test were made with a Thermosystems hot-film anemometer system and a method of temperature compensation analysis. The hot film was also used for all neutral stability tests where temperature compensation was not required.

The techniques used to obtain the velocity data will now be discussed in detail.

- Hot-film Anemometry

The transducer for velocity measurement in the Alkali Creek drainage flow and neutral stability tests was a Model 1210-20 hot-film sensor. The sensor consists of a platimun overlay deposited on a cylindrical quartz fiber, the overall diameter of which is 51 microns. The sensor is capable of resolving a velocity component in the plane perpendicular to the length of the element. The probe was positioned during the measurements so that this direction corresponded to the orientation of the flow.

The governing mechanism of operation is defined by the first law of thermodynamics: the heat removed from the probe element and delivered to the surroundings equals the electrical power supplied to the wire (Hinze, 1975). This is represented mathematically as:

$$\pi \ell k_g (T_w - T_g)\ Nu = I^2 R_w \tag{3.3}$$

where

I = electric current through the probe element

R_w = electrical resistance of the probe element at T_w

T_w = effective operating temperature of probe element

T_g = temperature of surroundings

k_g = thermal conductivity of air

ℓ = length of probe element

Nu = Nusselt number $= \frac{hd}{k_g} = f\left[Re, Pr, Gr, Ek, \frac{T_w - T_g}{T_g}, \frac{\ell}{d}, \phi\right]$

h = heat transfer per unit time

ϕ = diameter of probe element

Re = Reynolds number $= \frac{\rho_g u d}{\mu_g}$

Pr = Prandtl number $= \frac{C_p \mu_g}{k_g}$

$$Gr = \text{Grashof number} = \frac{g\rho_g{}^2 d^3 \beta (T_w - T_g)}{\mu_g{}^2}$$

$$Ek = \text{Eckert number} = \frac{u^2}{C_p (T_w - T_g)}$$

ρ_g = mass density of air evaluated at T_g

μ_g = molecular dynamic viscosity of air evaluated at T_g

β = coefficient of thermal expansion of air

g = gravitational acceleration

u = velocity of air

C_p = specific hear of air at constant pressure

Free convection from the wire may be neglected for $Re > 0.5$ when the Rayleigh number satisfies:

$$Ra = GrPr < 10^{-4}$$

Collis and Williams (as reported in Hinze, 1975) concluded from their low Reynolds number experiments in air that buoyancy effects are negligible when:

$$Gr < Re^3$$

In other words, when $Re \simeq 10^{-2}$, Gr should be smaller than 10^{-6}. In air, this corresponds to a film ten times smaller in diameter than that used here and a velocity of 0.4 cm/s.

The temperature dependence of the electric resistance of the film may be expressed as

$$R_w = R_i \left[1 + b_1 (T_w - T_g) + b_2 (T_w - T_g)^2 + \ldots \right]$$

Under the operating conditions usual for hot-film anemometers, the nonlinear terms may be disregarded. For example, for platinum

$$b_1 = 3.5 \times 10^{-3}\ {}^\circ K^{-1}, \quad b_2 = 5.5 \times 10^{-7}\ {}^\circ K^{-2}$$

for tungsten

$$b_1 = 5.2 \times 10^{-3}\ °K^{-1}, \quad b_2 = 7.0 \times 10^{-7}\ °K^{-2}$$

Ignoring the quadratic and higher order terms in Eq. (3.3), the temperature difference $(T_w - T_g)$ can be represented by the more easily measured quantity $(R_w - R_g)$, where R_g denotes the electrical resistance of the wire at the ambient fluid temperature T_g, or

$$T_w - T_g = \frac{R_w - R_g}{bR_i} \tag{3.4}$$

Substituting into Eq. (3.3) results in

$$I^2R_w = \frac{\pi \ell K_g}{b} \cdot \frac{R_w - R_g}{R_i} Nu \ . \tag{3.5}$$

An empirical formula developed by Collis and Williams (Hinze, 1975) represents the most accurate relation yet obtained for the prediction of Nusselt number in forced flow.

$$Nu \left(\frac{T_f}{T_g}\right)^{-0.17} = A + BRe^n \tag{3.6}$$

where

	$0.2 < Re < 44$	$44 < Re < 140$
n	0.45	0.51
A	0.24	0
B	0.56	0.48

and $\quad T_f = (T_w + T_g)/2$

Substituting from relations (3.5) and (3.6) yields

$$\frac{I^2R_w}{R_w - R_g} = A_T + B_T u^n \tag{3.7}$$

where

$$A_T = A \left(\frac{T_f/T_g}{T_f{}^c/T_g{}^c}\right)^{0.17} \tag{3.8}$$

and

$$B_T = B\left(\frac{T_f/T_g}{T_f^{\,c}/T_g^{\,c}}\right)\left(\frac{\rho_f}{\mu_f}\frac{\mu_f^{\,c}}{\rho_f^{\,c}}\right)^n \tag{3.9}$$

where A and B are the constants obtained at calibration temperature, pressure, and overheat ratio and A_T and B_T are the constants corrected for temperature, viscosity and density variation. The terms with a superscript c are quantities measured at calibration conditions.

Now $$\rho_f = \rho(T_f) = \rho\left(\frac{T_w + T_g}{2}\right)$$

and $$\mu_f = \mu(T_f) = \mu\left(\frac{T_w + T_g}{2}\right)$$

Using the Sutherland equation to represent in analytical form the variation of the molecular viscosity of air with temperature near atmospheric pressure.

$$\mu(T) = \frac{145.8T^{1.5}}{T + 110.4}$$

and the equation of state for ideal gases

$$\rho = \frac{P}{RT}$$

we can make the necessary substitutions into Eq. (3.9) and get

$$B_T = B\left(\frac{T_f/T_g}{T_f^{\,c}/T_g^{\,c}}\right)^{0.17}\left[\frac{P}{P_c}\left(\frac{T_w^{\,c} + T_g^{\,c}}{T_w + T_g}\right)^{2.5}\frac{T_w + T_g + 220.8}{T_w^{\,c} + T_g^{\,c} + 220.8}\right]^n$$

Finally using Ohm's law

$$\frac{E^2}{R_w} = I^2R_w \tag{3.10}$$

and combining (3.7) and (3.9) we get

$$\frac{E^2}{R_w(R_w - R_g)} = A_T + B_Tu^n$$

or,

$$u = \left[\frac{\frac{E^2}{R_w(R_w - R_g)} - A_T}{B_T} \right]^{1/n} . \qquad (3.11)$$

The constants A, B, and n from Eq. (3.8) and (3.9) were obtained from a calibration at room temperature; A_T, B_T and R_g were then determined for the temperature at which measurements were obtained.

- Experimental Technique

For the Alkali Creek drainage flow tests, a system providing a source of reference air speeds was used immediately prior to each experiment to calibrate the velocity measurement apparatus. This system shown in Figure 3-4-1 consists of a discharge nozzle, having established aerodynamic characteristics, constructed at the Colorado State University Engineering Research Center machine shop facilities. This nozzle was supplied with regulated air the quantity of which was monitored on a Union Carbide linear mass flow meter. Regression analysis was used to fit the calibration data to a suitable mathematical expression. The results of the calibration are shown in Figure 3-4-2.

For the neutral stability tests, calibration of the hot film was performed with the Model 1125 TSI calibrator and a type 120 Equibar pressure meter where the following relation applies:

$$u = \sqrt{\frac{2\Delta P_a}{\rho_a}}$$

A calibration was performed at the beginning of each day's measurement. After the wire was calibrated, the desired flow condition was set in the wind tunnel. The free-stream velocity was monitored with the MKS Baratron and pitot tube. Once the desired condition at the reference height was obtained the pressure meter setting was recorded and used to set and monitor the tunnel conditions for all remaining tests. During all subsequent velocity and concentration measurements care was taken to ensure the pressure meter reading remained constant.

The Datametrics Model 800-LV temperature compensated linear velocity meter was used for the Coal Creek drainage flow and all stable flow tests. The principle of operation of this probe is the same as the hot film discussed above with the addition of an unheated element, the resistance of which corresponds to ambient temperature and controls the overheat ratio of the velocity sensing element. In this manner the probe is made insensitive to temperature variations. The probe is normally configured with a shield over the wire with a hole allowing air flow for measurement. Since the shield restricted the closeness with which one could approach the model surface, it was removed. Figure 3-4-3 shows the two sensing elements, the top one being the velocity sensor and the bottom one the temperature sensor. From an experimental standpoint, the Alkali Creek technique is preferred to that used in the Coal Creek test which consisted of the temperature compensated instrument. This is because the spatial temperature gradient near the model surface is of a physical scale comparable to the separation distance within the probe configuration of the velocity and temperature sensing wires as shown in Figure 3-4-3. This distance results in an inability within the instrument to satisfactorily control the overheat ratio as a function of local temperature which results in an error in velocity measurement close to the surface. In a steady flow regime, this difficulty is overcome by combining the functions of velocity and local temperature measurement in the same element as was done for the Alkali Creek tests. The two measurements were made immediately subsequent to one another. The spatial temperature gradient effect is likewise minimized by the smaller physical dimensions of the Thermo Systems hot-film element.

The problem arising in the single element hot-film method lies in analyzing the data with a heat transport model which can be adequately supported by either theoretical argument or experimental evidence. Such a model is available and was discussed above.

• Data Collection and Analysis

The manner of collecting the data was as follows:

1) The hot-film or datametrics probe was attached to a carriage.

2) The bottom height of the profile was set to the desired initial height.

3) A vertical distribution of velocity was obtained using a vertically traversing mechanism which gave a voltage output corresponding to the height of the wire above the ground.

4) The signals from the anemometer and potentiometer device indicating height were fed directly to a Hewlett-Packard Series 1000 Real Time Executive Data Acquisition System.

5) Samples were stored digitally in the computer, and

6) The computer program converted each voltage into a velocity (m/s) using the equation:

$$u = \left[\frac{\frac{E^2}{R_H(R_H - R_g)} - A}{B} \right]^{1/n}$$

or printed out the mean voltage for the Datametrics. For the Alkali Creek drainage flow tests it was found that $A_T \doteq A$ and $B_T \doteq B$ to within 3 percent accuracy. Hence no correction for temperature was applied to A_T

and B_T and the calibration values were used. The wire resistance R_g at local temperatures however was used when computing u.

For the Alkali Creek and Coal Creek neutral flow studies, no temperature compensation was necessary thus $A_T = A$, $B_T = B$ and $R_c = R_g$.

3.5 Temperature Measurement

Temperature measurements at the model surface for the drainage flow and forced advection stable stratification cases and the local air temperature at the air speed probe for the drainage flow, forced advection neutral and stable stratification cases, were made by Yellow Springs Instruments Model 44004 thermistors. The model surface temperature measurement was made by mounting the thermistor on the model terrain so that the lead wires passed beneath the model and the body of the thermistor element was exposed to the air immediately above and adjacent to the model surface material. The location of these probes is seen in Figures 3-2-3, 3-2-4, and 3-2-5 for Coal Creek, Alkali Creek west wind, and Alkali Creek east wind, respectively. Resistance measurements of the thermistors were routed through a switch panel to a Keithley Instruments Model 177 digital multimeter. The resistances were then converted to temperature with a table supplied by Yellow Springs. The air speed probe thermistor was mounted on a hot-wire probe fixture so that the body of the thermistor was positioned lateral to the velocity probe but near it in the flow field and at the same height.

4.0 COAL CREEK-DRAINAGE FLOW RESULTS (Free Convection)

4.1 Velocity and Temperature Measurements

A series of seven velocity and temperature profiles were taken at the following locations: 1) Thermistor 17 (denoted T17), 2) Coal Creek below the proposed mine site (denoted VP), 3) T5, 4) T16, 5) concentration sampling locations 25 (C25), 6) C16, and 7) T13. The location of these measurement positions relative to Crested Butte is shown in Figure 3-2-3. The temperature boundary conditions during testing are shown in Table 4-1. The temperatures along Coal Creek range from -24 to 30°C, depending upon location. At the tops of the mountains the temperatures are between -14 and 6°C. From the results shown in Table 4-1 it was concluded that it would be sufficient to monitor one temperature during testing with less frequent samplings of all thermistor readings. Hence, in all subsequent tests (concentration and visualization) this procedure was followed.

The seven velocity profiles shown in Figures 4-1-1 through 4-1-7 are reported in sequence starting at the location annotated T17 and finishing in Crested Butte at T13. These profiles all show a similar character, namely, a high wind speed at some varying distance above the ground and a zero velocity at an upper altitude. Several of the profiles show a double peak in the velocity profile. The common fact about these double peak profiles is that they were obtained at the lowest valley elevation or in Coal Creek. The two profiles not showing any tendency for a double peak were taken at T16--which is on the bank above Coal Creek--and at T13--which is out of the valley in Crested Butte. This double peaks suggests there is a slope flow following Coal Creek and superimposed upon this, the mountain wind which is also in the same direction--toward Crested Butte.

Another interesting feature about the profiles is the increase in maximum velocity with distance down the valley. For example, at T17 the maximum velocity (u_m) is 18.3 cm/s whereas at T13 in Crested Butte the flow has accelerated sufficiently to attain u_m = 26.9 cm/s. The intermediate values of u_m are 18.4 (at VP), 19.5 (T5), 20.5 (T16), 24.6 (C25), and 27.9 (C16) cm/s. The height above ground of the lower peak velocity ranges from 0.5 to 2.5 cm (9.6 to 48 m full-scale) with the more typical value of 1.5 cm (28.8 m full-scale). The second or only maximum (which is also the highest wind speed for all profiles) occurs from 2.5 to 8.5 cm (48 to 163 m full-scale) above the surface. At T16, which corresponds to the field measurement site, the height of the maximum velocities is 6.5 cm (125 m full-scale) above the ground.

The temperature profiles are also shown in Figures 4-1-1 through 4-1-7. A surface temperature measurement (T_o) was used to calculate the dimensionless temperature $[(T-T_o)/(T_\infty-T_o)]$ using the nearest ground level thermistor reading. The free stream temperature T_∞ was taken to be that at the top of the profile. In general, $T_\infty-T_o$ ranged from 40°C at T17 to 25.7°C at T13. The profiles show that an extremely stable layer was generated in the test chamber.

A Richardson number was computed for each profile as discussed in Section 2.3. The results of the computation are given on each figure.

4.2 Concentration Measurements

The concentration measurements for the drainage flow simulations down Coal Creek are graphically presented in Figures 4-2-1 to 4-2-4. For these tests, the surface temperatures were set to be nearly equal to those set during the velocity measurement tests. The ground level isopleths resulting when a tracer was emitted at T16 from a 6.1 m prototype stack are shown in Figure 4-2-1. The emissions travel down Coal Creek, moving around Gibson

Ridge and pass through Crested Butte. The concentration level diminishes slowly over Coal Creek until the end of the valley where the plume is no longer restricted laterally. In Figure 4-2-2, a cross section of the plume is shown. This cross section was taken 1.35 km (full-scale) downwind of the release point (A, A' in Figure 4-2-1). As is evident, the plume has settled into the valley bottom and vertical mixing is restricted. It appears that the plume is well mixed, however, within this confined layer. Figure 4-2-3 shows another cross section taken 3.65 km downwind of the release point just upwind of Crested Butte (B, B' in Figure 4-2-1). Here the plume has grown laterally with almost no vertical spread. The uniform mixing is even more pronounced at this location.

Figure 4-2-4 shows ground-level isopleths for a 49 m stack. As expected the point of maximum concentration has moved down the valley when compared to Figure 4-2-1 and the evidence of lateral spread upon exiting the valley is still present. The maximum concentration for the elevated release is over a factor of 10 less than that for the short release. In Crested Butte the concentrations are nearly equal for the two releases.

4.3 Visualization and General Flow Patterns

From visually observing the flow patterns established by cooling the surface of the aluminum model some general features of the mountain wind were noticed (Davidson, 1963; Defant, 1951). First the commonly observed down-valley flow with a return flow above was evident. Figure 4-3-1 shows a top view of smoke being released over T16. Crested Butte is at the top of the picture just outside the valley. As can be seen the smoke follows the terrain confluences, changing direction and shape as the valley changes shape or orientation. This down-valley flow generally extended up to 18 cm (350 m full-scale). Above this down-valley flow a 180° reversal in the flow was seen. The documentation on this reversal is best seen by viewing the motion pictures associated with this report. Figure 4-3-2 does show the shape of the reversed flow. The down-valley flow is not evident in the figure. On top of the down- and up-valley flows were slope flows. These flows were very shallow (3 to 5 cm) and were developed along all sloping valley side walls. The downslope winds would flow into the valley center and merge with the down-valley flow. Figure 4-3-3 shows the smoke wand positioned near the ground up the valley side. As can be seen, the flow first goes toward the valley center (Coal Creek) and then turns 90° and heads down the valley. What was observed was the downslope flow coming down the slope and when it converged with the down-valley flow, it would rise up above the ground then turn down valley.

To aid in visually depicting the flow patterns a smoke wire technique was used. Figure 4-3-4 shows the smoke wire positioned at T16 and the shape of the lower profile. In the picture the solid metal rod which supports a thin nichrome wire is visible as is the smoke produced by instantaneously evaporating a thin oil film coated on the wire. Although only a portion of the wire and support is visible in the picture, the wire length was measured to be 5.94 cm in a different picture with the same camera setup. Since the actual wire length is 66 cm, a conversion factor of 5.94/66 was used to estimate model dimensions from the picture. The height of drainage flow in the picture is 2.21 cm which converts to 24.6 cm in the model or 471 m full-scale. This compares reasonably with a drainage flow thickness measured with the velocity probe of 18 cm as seen in Figure 4-1-4. Also from the photograph it can be seen that the ratio of upslope velocity to downslope velocity is approximately 1 to 10. Since the camera was not directed perpendicular to the flow a large error can be expected in this ratio. The thickness of the upslope flow appears to be at least 1.27 cm in the picture or 14 cm in the model (271 m full-scale). This observed depth agrees with that shown in Figure 4-1-2. The measured ratio of upslope to downslope velocity is 1 to 2.5. This latter ratio is more accurate than that obtained from the picture analysis.

In summary, the visualization showed what was expected from a mountain flow. Wind developed on all slopes and these slope winds moved toward the valley center. At the valley center the slope wind merged with the down-valley wind. Above the down-valley wind an up-valley component was observed.

5.0 ALKALI CREEK - DRAINAGE FLOW RESULTS (Free Convection)

5.1 Velocity and Temperature Measurements

For the Alkali Creek drainage flow test velocity and temperature profiles were taken at four locations (designated T4, T6, T11 and V2) and a temperature profile was obtained at T8. These locations are marked on Figure 3-2-4.

The temperature boundary conditions that were set during the velocity measurements are given in Table 5-1. At a given thermistor the temperature during testing did not change by more than 4°C with most of the readings staying within 2°C. The temperatures at the surface ranged from -25°C at T12 to -49°C at T9 and T13. The free air temperature T_∞ was 9°C for all tests.

The velocity and/or temperature profiles are shown in Figures 5-1-1 through 5-1-5. The velocity profile taken at T4, which corresponds to the field and model tracer gas release locations, shows a light wind and irregular profile. Between 0 and 6 cm essentially zero velocity is noted. A zero reading is suspicious since visually smoke was observed to flow over this location. It may be, however, that the speed is 2 to 3 cm/s and due to inherent errors in measurement technique a value of zero is calculated. Regardless, the speed is low--probably 2 to 3 cm/s. Between 7 and 15 cm a zone of higher velocity is noticed with a peak of 6.7 cm/s. The region is probably the spillover from Alkali Creek that is moving in a westerly full-scale direction. From 20 to 30 cm another region of high velocity is observed with a peak of 8.3 cm/s at 28 cm. This region may be a return flow moving easterly or a general circulation developed in the drainage flow zone. Since the velocity probe does not indicate direction and the flow was not noticed during the visualization phase, only speculations can be made.

The temperature profile at T4 shows an extremely stable layer between 0 and 0.5 cm with a temperature difference of approximately 39°C. Between 0.5 and 10 cm the temperature changes 11°C and reaches the free-stream value.

Velocity and temperature measurements at T6 are plotted in Figure 5-1-2. The measurement location is west-southwest of T4 down the slope toward Ohio Creek as shown in Figure 3-2-4. At this location an organized sloped wind with a maximum velocity of 18.3 cm/s at 0.6 cm (15.4 m full-scale) is observed. The profile reaches zero velocity at approximately 8 cm (205 m full-scale). Above 8 cm the irregular flow patterns as observed at T4 are seen. One profile (from 10 to 25 cm) may still be the overflow from Alkali Creek and the other (from 25 to 31 cm) the return flow moving east or a general room circulation. At this location the temperature does not reach a free-stream value until 30 cm where the temperature difference ($T_\infty - T_o$) is 49°C.

On the east side of the saddle between Flat Top and Red Mountain close to where the East River and Alkali Creek merge, a velocity profile was taken at T11. The location is shown in Figure 3-2-4. The velocity profile shown in Figure 5-1-3 has a different character than those on the west side of the saddle. The maximum speed is higher (50.2 cm/s) and the layer of velocity is much deeper (approximately 24 cm). The reason for both is that more energy is available to drive the flow. A large amount of cold air from both Red Mountain and Flat Top feeds into Alkali Creek and enhances the speeds. The change in elevation is also greater on the east side of the saddle. The temperature profile at T11 shows an irregular shape with an extremely stable layer between 0 and 5 cm. Over this layer a 46°C temperature change is noted compared to an overall change from 0 to 31 cm of 55°C.

Visually it was noticed that slope winds off Red Mountain and Flat Top were feeding into Alkali Creek. A velocity and temperature profile was taken at one of these locations. A high-speed slope wind was noticed coming down Red Mountain. Consequently, the profile shown in Figure 5-1-4 was taken at the location marked "V2" in Figure 3-2-4. The maximum velocity at this point is 42.9 cm/s and occurs at 1.3 cm (33.3 m full-scale) above the ground. The region of flow extends to approximately 8 cm (205 m full-scale). The temperature between 0 and 4 cm changes by 74°C, whereas between 0 and 30 cm the change is 50°C.

Due to the complexity of the flow field--that is, wind direction changes with height of 90° at several locations--no more velocity profiles were obtained. One additional temperature profile was obtained at T8 which is located at the origin at Alkali Creek in a basin where the flow was stagnant close to the surface. Above the surface, the wind goes down Alkali Creek while above this a flow off Red Mountain passes over the top at a 90° angle. The profile in Figure 5-5-5 shows a deep stable layer extending up to 14 cm (358 m full-scale). An overall temperature change of 60°C between 0 and 30 cm is noticed at this location. This deep, extremely stable layer is due to the stagnant air close to the surface and the continuous supply of cold air off Red Mountain and Flat Top.

The Richardson number was computed for each profile as discussed in Section 2.3. The values are tabulated on each figure.

5.2 Concentration Measurement Results

The concentration measurements made for the drainage flow simulation near Alkali Creek consist of vertical and horizontal profiles taken at three locations downwind of a 0.32 m release (8.1 m full-scale) and a horizontal and vertical profile at one location downwind of a 2.54 cm release (65.0 m full-scale). This set of profiles is shown in Figures 5-2-1 to 5-2-4. The temperature conditions during the run are given in Table 5-2. As can be noticed the temperatures are warmer than those for the wind velocity tests. This is due to the fact that the ice load was getting low and a lower temperature could not be achieved. Scheduling prohibited another ice load to obtain data at a colder temperature.

The concentration results are presented as a dimensionless concentration $K = \frac{\chi u_m H_r^2}{\chi_o V}$ where u_m was taken to be the measured peak velocity over thermistor 6, H_r was set equal to 0.32 and the remaining parameters are given in Table 3-1. Figures 5-2-1 to 5-2-3 show the horizontal and vertical concentration profiles that were taken at successive positions southwest of T4 for an 0.32 cm release (8.1 m full-scale). In general the plume appears to get lower, wider and less concentrated as it moves further from the release. At the closest profile location (Figure 5-2-1) which is 26 cm from the release, the plume centerline is 1.02 cm (26 m full-scale) above the ground and the plume width is approximately 2.11 cm (54 m full-scale). The reason the plume center is higher than the release height is because the release was on a small knoll (approximately 40 ft high in full-scale) and the terrain falls off quickly in the direction of flow. So in essence the release was higher than 8.1 m above the effective ground level and may have traveled horizontally for some distance due to the initial momentum of the release before going down the slope. The horizontal and vertical profile taken at 59 cm (1.5 km) from the 8.1 m release is shown in Figure 5-2-2. At this distance the plume centerline is 0.78 cm (20 m) above the ground and the width is 4.0 cm (102 m). The maximum concentration has been reduced to half of the value at the 26 cm location. For the profiles taken at 90 cm (2.3 km) the maximum value has reduced again by two from that at 59 cm and the height of the maximum is 0.59 cm (15 m). The plume width at this location is 5 cm (128 m).

The profiles taken 26 cm (0.67 km) from a 2.54 cm (65.0 m) release are shown in Figure 5-2-4. At this location the plume centerline is 8.2 cm (210 m) and its width is 3.1 cm. For this height release the plume must be traveling horizontally and is not becoming trapped in the slope flow. This fact is evident because the terrain has dropped approximately 3 cm (70 m) which means the plume is slightly higher with respect to a horizontal plane than when it was released. Also evident in the figure is a vertical profile with two peaks. This double peak may be attributed to the complex and irregular flow field above the slope wind field.

5.3 Visualization

The flow patterns for the Alkali Creek drainage flow tests were extremely complicated. Consequently, additional movie footage of the flow was taken. To obtain the best description of the flow the movies should be viewed. The general features of the flow will be discussed here.

On the east side of the ridge around the Alkali Creek Basin the flow was quite complicated. Slope winds off Red Mountain were feeding into Alkali Creek moving in a southerly direction. Upon reaching Alkali Creek Basin (at the origin of the creek), a portion of flow turns east and moves down Alkali Creek. In addition a small segment of flow turns west and spills over the ridge and flows downslope toward Ohio Creek. Figure 5-3-1 shows smoke being released near Big Alkali Lake up the slope toward Red Mountain. As can be seen the flow moves downslope in a southerly direction and turns east to move down Alkali Creek. The spilling over the ridge to the west is evident on the right-hand side of the picture. Figure 5-3-2 shows the spillover flow in more detail. This picture shows the flow moving southwesterly toward Ohio Creek. The depth of this spillover is quite shallow and is shown in Figure 5-3-3. In the picture a tape measure is placed on the rim of the ridge around Alkali Creek. The one-foot marker on the tape measure is visible in the picture and the spillover appears to be about 1/9 of a foot or 3.4 cm (87 m full-scale).

Another interesting feature about the flow in the Alkali Creek Basin is two flows--one above the other--going in directions at 90° to each other. The flow off Red Mountain toward the Alkali Creek Basin would drain down toward the basin until it reached the height of the ridge. At this point the flow would level off and flow either east or west as described above. Below this south-moving slope wind a flow down Alkali Creek was noticed moving in an easterly direction. In fact, a part of the flow off Red Mountain would turn west and then turn a circle around the Alkali Creek Ridge and become entrained in the flow moving east down Alkali Creek. Figure 5-3-4 depicts these irregular flows.

6.0 COAL CREEK - NEUTRAL STRATIFICATION RESULTS (Forced Flow)

6.1 Velocity Measurements

Mean velocity and turbulent intensity profiles were taken for the Coal Creek - Neutral Stratification tests at T3, T7, T13, T14, T15, T16 and T17. The locations are marked in Figure 3-2-3. As a review for these tests the aluminum topographic model of the area shown in Figures 3-1-1 and 3-2-3 was placed in the environmental wind tunnel and a free stream velocity, u_∞, of 3 m/s set for all tests. The free stream velocity was set 30.5 cm above T16.

To document the flow patterns the velocity profiles shown in Figures 6-1-1 through 6-1-7 were obtained. The profiles are presented in a general sequence starting at the west end of the valley (T17) and moving east. All of the profiles have a similar appearance except the one taken at T7. This profile was taken about half way up Mt. Emmons and was in the lee of high ground. Hence the profile shows the character of being in a wake. It has reduced velocity and high turbulence within the lower 20 cm (384 m full-scale). The turbulence intensity for this profile reaches a maximum of about 32% whereas the maximum for the other profiles is close to 20%.

Each profile was analyzed to obtain the surface roughness (z_o), friction velocity (u^*), power law exponent (n) and the turbulent Reynolds number $\left(\frac{z_o\, u^*}{\nu}\right)$. The z_o and u^* values were obtained by fitting the data by least squares to the following equation:

$$\frac{u}{u^*} = \frac{1}{k} \ln\left(\frac{z + d}{z_o}\right)$$

and the power law exponent by fitting to the equation

$$\frac{u}{u_\infty} = \left(\frac{z}{z_\infty}\right)^n$$

Table 6-1 gives the results of the analysis. The surface roughness values range from 0.027 cm to 0.445 cm (0.5 to 8.5 m full-scale) with an average (excluding the highest value) of 0.05 cm (1.1 m full-scale). The location showing the highest z_o value was at T7 which was in a wake and a higher z_o is expected. The remaining profiles show relatively little variation in z_o. The turbulent Reynolds number Re_{z_o} ranged from 2.4 to 77.1. All values were close to or exceeded the limit of 2.5 to ensure fully turbulent flow. The power law exponent ranged from 0.12 to 0.31 where the highest value was again at T7. The remaining locations had an average n of 0.21. The value of u^*/u_∞ was 0.061, or less, at all locations except T7 which had a value of 0.081.

In summary the velocity profiles show that a turbulent boundary layer was simulated and that the velocity profile characteristics are those expected for rough topography.

6.2 Concentration Measurements

The concentration measurements results for the Coal Creek Neutral Stability Tests are given in Appendix C and summarized in Figures 6-2-1 to 6-2-6.

The ground-level isopleths shown in Figure 6-2-1 are for a 6.1 m release over T16 and a model free stream velocity of 3 m/s. The plume travels directly down the valley (east) reaching a maximum concentration 1.3 km downwind of the source. One might expect the maximum to occur near the release since it was essentially a surface release. However the release site was on a 25 m bank overlooking Coal Creek and the effective release height was greater. Vertical cross sections of the plume were taken at locations C-C' and D-D' as depicted in Figure 6-2-1. At C-C' (1.3 km downwind of the release) the plume centerline is found effectively on the valley floor as shown in Figure 6-2-2. The plume spread in the horizontal and vertical appears greater than that observed for the drainage flow test. For the cross section taken 3.7 km downwind (D-D') where the valley has opened up, the plume has grown in the horizontal and vertical and the maximum normalized concentration has dropped from 2.1×10^{-3} to 5.5×10^{-4} or a factor of 4.

Ground-level isopleths are shown for a 49 m release height in Figure 6-2-4. No significant change over the 6.1 m release is found in the position or magnitude of maximum concentration. When the release height is increased to 98 m, the point of maximum concentration is moved only slightly downwind as shown in Figure 6-2-5. The increase in release height from 6.1 to 98 m appears to have no appreciable effect on the position or magnitude of the measured maximum ground-level concentration.

For a 6.1 m release 1.2 km upwind of T16 the position of maximum concentration is moved upwind at least a kilometer as shown in Figure 6-2-6. The lack of data points closer to the release excludes the possibility of determining the position and magnitude of the maximum concentration.

7.0 ALKALI CREEK - NEUTRAL STRATIFICATION RESULTS (Forced Flow)

7.1 Velocity Measurements

Mean velocity and turbulence intensity profiles were obtained at five locations for the Alkali Creek Neutral Flow Tests. These locations are annotated in Figure 3-2-4. All profiles were taken at a free stream velocity of 3 m/s and the results are shown in Figure 7-1-1 through 7-1-5.

The velocity profile at Location A in Figure 7-1-1 was taken 61 cm (1.56 km full-scale) upwind of T4. The profile shown in Figure 7-1-2 was taken at the release site - Location B in Figure 3-2-4. The two profiles show how the velocity and turbulence profiles develop when moving up a slope. An increase in velocity, accompanied by a decrease in turbulence, is noticed at Location B, in comparison to the values for those same qualities recorded at Location A. Location C, like Location B, is also on rising terrain and the greater velocity and lesser turbulence intensity close to the surface are, again, observed. Locations D and E are each in the lee of a hill and a slowdown in the velocity and increase in turbulence are evident near the surface as expected.

Each of the profiles was analyzed to obtain z_o, u* and n, as discussed in Section 6.1. The results are given in Table 7-1. The surface roughness factor at locations (A, B, C) where the terrain is rising in the direction of flow, range from 0.0001 to 0.00227 cm (0.03 cm to 5.2 cm full-scale). At locations (D and E) in the lee of terrain, the z_o values are 0.057 and 0.082 cm (1.5 to 2.1 m full-scale). The power law exponent and $u*/u_\infty$ values show the same trend. The n values are low at A, B and C (0.08, 0.17 and 0.09, respectively) and high at D and E (0.21 and 0.23). The u^*/u_∞ values are 0.025, 0.039 and 0.035 at A, B and C and 0.062 and 0.064 at D and E.

The turbulent Reynolds number values at A, B and C were below the critical value of 2.5 to insure fully turbulent flow; whereas, the Re_{z_o} values at D and E are well above the minimum. These results suggest the flow is not Reynolds number independent. However, it should be stressed that the criteria $Re_{z_o} > 2.5$ was developed for horizontally homogeneous flow. For the case of flow over a hill the criteria is not valid. In addition the computation of z_o values for such a flow can have large errors.

In summary the results show what one would expect for flow over a hill--a speed-up in velocity on rising terrain and a decrease in wakes and larger z_o, u^* and n values in wakes than on flat or rising terrain.

7.2 Concentration Measurements

The results of the concentration measurements for the Alkali Creek Neutral Stability Tests are presented in Figure 7-2-1 to 7-2-6. All runs were made with a 3 m/s free stream wind velocity.

Figure 7-2-1 shows the observed isopleths at ground-level when the release height was 6.1 m. The maximum concentration is found 600 m downwind of the release. The effective release height is higher than 6.1 m since the release was situated on a 20 m hill. The isopleths show that the plume is diverted around Flat Top and does not follow a straight trajectory. Figure 7-2-2 is a cross section taken 1.0 km east of the release point (E-E' in Figure 7-2-1). The plume contour line is near the ground and has maintained a high degree of symmetry. In Figure 7-2-3 a cross section 3.0 km east of the release point is shown (F-F' in Figure 7-2-1). Again the symmetry is present but the plume has spread over a larger region. The maximum concentration has decreased by a factor of four between 1 and 3 km.

Figures 7-2-4 and 7-2-5 show the effect of increasing the stack height with ground-level isopleths plotted for a 65 and 130 m release respectively. For the 65 m release the maximum concentration has moved out to 1 km and has decreased by a factor of 5 over the 6.1 m release. Also the plume appears to be diverted less as it goes over Flat Top. For the 130 m release, shown in Figure 7-2-5, the maximum concentration has moved to 3 km downwind and has decreased by a factor of 20 as compared to the 65 m release. For this release the plume is diverted to the east as it moves over Flat Top.

Figure 7-2-6 shows the ground-level isopleths of normalized concentration (K) for an 8.1 m release height that is 2.1 km upwind of the field release site (T4 in the model). The maximum value was not measured because it occurred in front of the sampling grid. The plume still appears to be diverted around Flat Top for this case.

8.0 COAL CREEK - STABLE STRATIFICATION RESULTS (Forced Flow)

8.1 Velocity and Temperature Measurement

For the Coal Creek Stable Flow Tests, velocity and temperature profiles were taken at the following six locations annotated in Figure 3-2-3: T17, VP, T5, T16, T15, and T13. The surface temperature boundary conditions that were set during the measurements are given in Table 8-1. For all thermistors, the surface temperature during testing did not change by more than 6^{o} C, and for most locations it did not change by more than 1^{o} C. The minimum temperature was 23.6^{o} C at T15, and the maximum was 13.3^{o} C at T4. The free stream temperature was approximately 20^{o} C for all tests, and the free stream velocity was approximately 64 cm/s.

The velocity and temperature profiles are shown in Figures 8-1-1 through 8-1-6. The profiles are arranged in a sequence starting toward the origin of the valley (T17) and ending at the mouth (T13). The common feature about all the velocity profiles is the speed-up near the ground. This speed-up is attributed to the drainage flow which is superimposed upon the forced flow. The height of peak velocity for the low level drainage flow ranges from 2 to 5 cm. This corresponds closely to the height observed when no free stream velocity was present (see Section 4.1)

To give an indication of the stability simulated, a Richardson number (Ri) for each case was computed--(Ri) is defined:

$$(Ri) = \frac{g[T(z) - T_o]z}{\overline{T} \quad u(z)^2}$$

where z = 13 cm.

The Ri values for each profile are 0.5 (T17), 1.7, 2.1, 1.1, 1.4, and 1.0. If we assume that a full-scale case has a u(z) of 5 m/s, then for Ri = 1.0 $T_\infty - T_o$ will equal 2.9^{o} C assuming $\overline{T} = 283^{o}$ C and z = 250 m. When comparing these results against full scale values, the full scale (Ri) should first be computed. The wind tunnel tests should then be compared with full scale cases having a similar (Ri) and wind direction.

8.2 Concentration Measurement Results

A series of ground level and aerial concentration measurements were obtained for the condition described in Section 8.1. To insure a similar condition was set, the ambient temperature (T_a) and temperature at T15 were monitored during all concentration measurements. Table 8-2 gives the values of T_a and T_{T15} for each test.

The measured concentrations and location of measurement are given in Appendix E. Figures 8-2-1 through 8-2-4 summarize these results in the form of isopleths of $\log_{10}$ K. Figure 8-2-1 shows the ground level isopleths of $\log_{10}$ K for a 0.32 cm (6.1 m full scale) release height. The highest observed K value is 2.8×10^{-2} and occurs 0.4 km downwind of the release site. In Crested Butte (3.7 km downwind of release) the highest K value is 1.1×10^{-3}.

The effect of increasing the release height to 2.54 cm (49 m full scale) can be seen by referring to Figure 8-2-2. At 0.4 km the K value is now 1.9×10^{-4} and Crested Butte 1.0×10^{-4}.

To assess the vertical distribution of pollutants within the valley, plume cross-sections were obtained at A - A' and B - B' as annotated in Figure 8-2-1. Figure 8-2-3 shows the isopleths in the vertical of $\log_{10}$ K at a downwind distance of 1.3 km. The distribution appears to be well mixed in the vertical as compared to the drainage flow profile at the same location (Figure 4-2-3). The horizontal mixing appears similar to that observed in the drainage flow simulation. Also the maximum concentration is greater ($K = 3.2 \times 10^{-3}$) for the stable case than for the drainage case ($K = 5.5 \times 10^{-3}$).

Figure 8-2-4 shows the isopleths in the vertical of $\log_{10}$ K at 3.7 km from the source for a 0.32 cm release (6.1 m full scale). The vertical mixing for this case is again greater than the drainage flow case (Figure 4-2-3) whereas the horizontal dispersion appears less than the drainage case. The maximum concentration for the stable case is 1.6×10^{-3} and the drainage case 1.0×10^{-3}. At this distance the stable case has a higher concentration than the drainage case.

9.0 ALKALI CREEK WEST WIND - STABLE FLOW RESULTS (Forced Flow)

9.1 Velocity and Temperature Results

For the Alkali Creek West Wind - Stable Flow Tests velocity and temperature profiles were obtained at the following locations: T6, T4, T8, T9 and T10. The locations are annotated in Figure 4-2-4. The temperature boundary conditions that were set during testing are given in Table 9-1. In general the surface temperature at a fixed point remained within 1° C for all velocity profiles. The lowest temperature was -61° C at T8 and the highest was 1° C at T7. The free stream temperature T_{∞} for all tests was approximately 17° C and free stream velocity was set to be 43 cm/s.

The velocity and temperature profiles are presented in Figures 9-1-1 through 9-1-5. Figure 9-1-1 shows the velocity/temperature profiles taken at T6 which is west of Alkali Creek on a slope heading toward Ohio Creek. The slope is angled such that a drainage flow is generated in an opposite direction to the free stream. The magnitude of the peak velocity in the low level drainage flow shown in Figure 9-1-1 is approximately 14 cm/s. For the drainage flow tests without an upper level flow the magnitude of the low level flow was 19 cm/s (see Figure 5-1-2). The depth of the stable layer extends to 5 cm at this location.

The velocity and temperature profiles at T4, which corresponds to the field release location,are shown in Figure 9-1-2. At this location no reverse flow toward Ohio Creek is noticed since the site is at the top of the slope. The downslope velocity at this point was essentially zero even when no free stream velocity was superimposed as discussed in Section 5.1 (see Figure 5-1-1).

The next three profiles were taken along Alkali Creek at locations T8, T9 and T10. The first profile at T8 is shown in Figure 9-1-3. T8 is located near the origin of the Creek in a basin. As is evident from the velocity profile, a drainage flow is superimposed upon the forced flow. A speed-up in the velocity profile near the ground is noticed with a peak velocity of 20 cm/s occurring at 4 cm above the ground. The stable layer extends up to 10 cm in the basin and exhibits the largest temperature differential (~ 78^{o} C). As we move down Alkali Creek, the magnitude of this low level maximum in the velocity profiles increases to 30 cm/s at T9 (Figure 9-1-4) and 56 cm/s at T10 (Figure 9-1-5). In fact, at T10 the low level drainage flow velocity is higher than the free stream velocity of 46.2 cm/s. The depth of the stable layer remains approximately 10 cm at T9 and T10; however, the temperature differential ($T_{\infty} - T_{o}$) becomes greater: 47^{o} C at T9 and 49^{o} C at T10.

Overall, this case was more stable than the Coal Creek simulation discussed in Section 8. For comparative purposes, the Richardson numbers (Ri) for these profiles are 14.2 at T6, 6.9 at T4, 13.5 at T8, 7.4 at T9, and 3.0 at T10.

9.2 Concentration Measurement Results

Vertical concentration distributions were obtained at four distances downwind of a 0.32 cm (8.1 m full scale) and 2.54 cm (65 m full scale) horizontal release situated at T4. The location of the release point and downwind measurement locations are shown in Figure 9-2-1. The conditions set in the tunnel were those described in Section 9.1. The surface and ambient temperature recorded during the concentration measurements are given in Tables 9-2 and 9-3. The concentration results and measurement locations are given in Appendix F.

Figures 9-2-2 through 9-2-5 show vertical plume cross-sections taken at respective locations A-A', B-B', C-C', and D-D' for a 0.32 cm (6.1 m full-scale) release. As is evident from the figures the plume did not travel in a straight path. Instead the plume was deflected around Flat Top and moved down into Alkali Creek. This occurred at the closest measurement location (A-A'). Once in Alkali Creek the plume became caught in the low level drainage flow and followed the creek as shown in Figures 9-2-3 through 9-2-5. The maximum observed K values are 2.0×10^{-3} at A-A' (1.56 km downwind), 1.6×10^{-3} at B-B' (3.1 km downwind), 6.3×10^{-4} at C-C' (4.7 km downwind) and 6.3×10^{-4} at D-D' (6.2 km downwind). At all distances the plume is skewed toward Flat Top which is toward the south.

For the 2.54 cm (65 m full-scale) release a completely different result was obtained as shown in Figures 9-2-6 through 9-2-9. At A-A' (Figure 9-2-6) the plume has moved in nearly a straight trajectory and has not been deflected toward Alkali Creek. The maximum concentration at this point (1.56 km downwind) is 1.3×10^{-3} which is less than that observed for the 0.32 cm release. This is due to the fact that the plume is in a less stable layer and more mixing is allowed. At B-B' (Figure 9-2-7) the plume is deflected toward Alkali Creek by the slope flows off Flat Top. The maximum K value at this location is 7.9×10^{-4}, again less than that observed for the 0.32 cm release. Moving to C-C' and D-D' the plume travels in a straight trajectory and is spread horizontally by the slope flows. The maximum K values at C-C' and D-D' are 4×10^{-4} and 5×10^{-4} respectively.

The results of this section show how the combined drainage and forced flow can distort the plume shape and trajectory and that the amount of distortion is a function of release height.

10.0 ALKALI CREEK EAST WIND - STABLE FLOW RESULTS (Forced Flow)

10.1 Velocity and Temperature Measurements

Six velocity and temperature profiles were obtained for a stable east wind simulation at Alkali Creek. The profiles were obtained at locations A, B, C, D, E and F as annotated in Figure 3-2-5. The surface temperature conditions that were set during the profile measurements are given in Table 10-1. The maximum temperature was 6.9^{o}C at T12 and the minimum was -54^{o}C at T8. The free stream air temperature was approximately 20^{o}C and the free stream velocity was 72 cm/s.

Figures 10-1-1 through 10-1-6 show the velocity and temperature profiles at locations A, B, C, D, E and F. The profile at A corresponds to the field release site location and exhibits a speed-up in velocity close to the ground. This is because the measurement site is on a small hill. The velocity profile at B has a similar shape as the one at A. The temperature profile at B however shows a deeper stable layer. Location C is in the Ohio Creek Valley and consequently shows reduced velocities below 10 cm. This location also shows the most stable layer having a temperature difference of 71^{o}C between the surface and 15 cm. The profiles at D, E and F were taken at progressively higher altitudes moving from Ohio Creek toward the West Elk Wilderness Area. At D and E reduced velocities are noticed below 15 cm. This is due to the opposing gravity force as the fluid moves up the slope. Location F is at the top of the slope on a peak near the West Elk Wilderness Area and speed-up near the ground is noticed.

All profiles show that an extremely stable layer was generated. The Richardson numbers for the profiles are 0.24 at A, 0.21 at B, 0.77 at C, 0.30 at D, 0.16 at E and 0.12 at F.

10.2 Concentration Measurement Results

Ground-level and aerial concentration distributions were measured for the conditions described in Section 10.1. Figure 10-2-1 shows the ground-level measurement locations and the locations where vertical plume cross sections were obtained (A-A' and B-B'). The surface temperatures were monitored during testing and are given in Table 10-2. The free stream velocity was 72 cm/s above T4. The concentration data are tabulated in Appendix G.

Figures 10-2-2 and 10-2-3 show the respective ground-level values of $\log_{10}$ K for a 0.32 cm (8.1 m full-scale) and 2.54 cm (65 m full-scale) release above T4. The figures show a blow-up of that portion of the map in Figure 10-2-1 that has the ground-level measurement locations. No isopleths were plotted for these results since no uniform pattern could be discerned. The ground-level concentrations appear to be almost uniform. The highest K value for the 0.32 cm release was 1.78×10^{-4} at location 53 and for the 2.54 cm release, 2.13×10^{-4} at location 72. The uniform mixing was also evident from the visualization of the motion. Portions of the plume would stagnate in the Ohio Creek Valley and gradually mix. In fact a visualization at a lower wind tunnel speed (higher Richardson number) showed that the plume would not move over the high terrain west of Ohio Creek. Instead it would stagnate in the valley. This case would not occur in nature since the valley is not blocked at one end as it is in the tunnel. The visual results do suggest that at some critical Richardson number a plume released from T4 would not travel over the terrain toward the West Elk Wilderness Area but instead would turn and flow down Ohio Creek toward Gunnison.

Vertical plume cross sections taken 110.5 cm (2.8 km full-scale) and 335 cm (8.6 km full-scale) downwind of T4 are shown in Figures 10-2-4 and 10-2-5. At 335 cm (Figure 10-2-4) the plume has a well-defined shape and shows that the mixing is not uniform at this distance. At 335 cm (Figure 10-2-5) the plume is uniformly mixed over a large region. This location is on the west side of Ohio Creek.

The results of this section show that a plume moving toward the West Elk Wilderness Area under stable conditions would be diverted down Ohio Creek for a critical Richardson number. If the flow was forced over the terrain toward the West Elk Wilderness Area the concentration would be approximately uniformly mixed.

11.0 SUMMARY

Physical modeling experiments were conducted simulating forced flow (stable and neutral stratification) and free convection (drainage flow). The simulations were made over east-west oriented scale models of the topography in the vicinity of Coal Creek and Alkali Creek near Crested Butte, Colorado. Vertical profiles of temperature and velocity were obtained as well as ground level and aerial concentration distributions. The model tracer gas releases were at locations where full-scale field releases were made. The purpose of this phase of the overall program, directed and managed by Camp Dresser & McKee (CDM), is to provide information for developing and validating a numerical model as well as for assessing pollutant impact. The results of the study can be summarized as follows:

- Coal Creek--Drainage Flow (Free Convection)

The velocity and temperature profiles showed a pattern characteristic of a mountain - valley wind. An increase in the maximum velocity with distance down the valley was noticed. Also, the depth of the mountain - valley wind system was proportional to ridge height. Above the down valley flow, a referse flow moving up-valley was observed.

The tracer gas released at a location similar to that in the field showed that the effluent followed the valley confines. Upon exiting the valley, the effluent flowed over Crested Butte. Vertical mixing appeared restricted while horizontal mixing was enhanced as the plume exited the valley.

• <u>Alkali Creek--Drainage Flow (Free Convection)</u>

The flow measurements indicated that a complicated flow pattern had developed in the Alkali Creek Basin. Wind direction changes with height of 90^{o} were evident. Shallow (~ 80 m) slope flows were evident on exposed slopes, whereas deeper slope flows developed along Alkali Creek. The deeper flows in Alkali Creek were the result of the converging slope winds off Red Mountain and Flat Top. The flow in Alkali Creek was also high in magnitude relative to other locations.

The tracer gas released at the field release site was transported westerly toward Ohio Creek. The plume was caught in the shallow slope flow, and the plume center remained at about the same altitude above ground level. As the release height was increased, portions of the plume escaped the slope flow and diffused into the still air above.

• Coal Creek and Alkali Creek--Neutral Stratification (Forced Flow)

The velocity profiles for these cases are more regular in shape than the stable and drainage cases. A speed-up in the velocity was noticed near the ground on hill or mountain tops, whereas a slow-down was noticed in hill or mountain wakes. Turbulence intensity also increased in hill or mountain wakes. The surface roughness was computed to be greater for the Alkali Creek model as compared to the Coal Creek model.

The concentration measurements showed the plume being transported in the direction of the upper level flow. However, there was a slight tendency for the plume to be diverted around Flat Top for the Alkali Creek tests. The horizontal and vertical dispersion appeared greater for these tests in comparison to the drainage flow cases or the stable forced flow cases.

- Coal Creek--Stable Stratification (Forced Flow)

A deep stable layer (~ 400 m) was observed for these tests as well as irregularly shaped velocity profiles. In the lower 200 m, profiles similar to the drainage velocity profiles were observed, while above this layer the velocity rapidly increased to the free-stream value.

The plume released from the field release location was transported along Coal Creek. The horizontal and vertical dispersion appeared less than the neutral case, but greater than the drainage case except at the valley exit. The horizontal dispersion at the valley exit was enhanced for the drainage case to such an extent as to be greater than the neutral or stable cases.

- Alkali Creek West Wind--Stable Stratification (Forced Flow)

A shallow stable layer (~ 100 m) was developed over the surface of this model, except in Alkali Creek where the layer extended to approximately 250 m. On the lower 100 m, a drainage flow profile was evident at all locations while above this layer the velocity quickly approached the free-stream value. On windward slopes, a slope flow in a direction opposite the upper level flow was observed. In general, the wind direction near the surface was in the direction of lower elevation.

The plume transport for this case was a function of release height. For the low release height case (8.1 m full-scale), the plume was caught in the slope flow and was transported into Alkali Creek Basin; thereafter it was transported down Alkali Creek. For the high release (65 m full-scale), the plume first was transported in a straight trajectory, after-which it turned around Flat Top, became caught in the slope flow, and eventually was transported down Alkali Creek.

Alkali Creek East Wind--Stable Stratification (Forced Flow)

For these tests, the wind was toward the West Elk Wilderness Area. The velocity and temperature profiles were similar to the Alkali Creek West Wind--Stable Case. Visual experiments showed that at a critical stability the flow would stagnate in Ohio Creek and a plume released at 8 or 65 m would not be transported toward the West Elk Wilderness Area. For a case less stable than the critical stability, the plume could be forced over the mountains near the Wilderness Area. Since in the wind tunnel the ends of Ohio Creek Valley were blocked, the valley could not be ventilated, hence stagnation occurred. In the full-scale, it is expected that the plume released at the field release site would not reach the West Elk Wilderness Area except under near neutral conditions. For stable conditions, the slope and valley winds would divert the plume down the Ohio Creek Valley.

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TABLES

Table 3-1. Test Parameters for Forced and Drainage Flow Experiments

Run Number	Site	Wind/Stability	Release Location	Release Height (cm)	Volume Flow (cm^3/s)	Reference Velocity (m/s)	Sampling Distance Downwind of Release Points (cm)
CCC 1	Coal Creek	drainage flow/stable	T16	0.318	2.44	0.2[1)]	ground-level points
8-10				0.318	2.44	0.2	68 1.3 km
3-7				0.318	2.44	0.2	196 3.7 km
2				2.54	2.44	0.2	ground-level points
ACC 1A	Alkali Creek	drainage flow/stable	T4	0.318	2.38	0.18[2)]	27
2A				0.318	2.38	0.18	59
3A				0.318	2.38	0.18	90
4A				5.08	2.38	0.18	27
CCC 1A	Coal Creek	west/neutral	T16	0.318	23.5	3.0[3)]	ground-level points
5A-5AS				0.318	23.5	3.0	68
6A-6AS				0.318	23.5	3.0	196
2A				2.54	23.5	3.0	ground-level points
3A				5.08	23.5	3.0	ground-level points
4A			*	2.54	23.5	3.0	ground-level points
ACC 1	Alkali Creek	west/neutral	T4	0.318	23.5	3.0[3)]	ground-level points
5N-5				0.318	23.5	3.0	39.66
6N-6SS				0.318	23.5	3.0	117.1
2				2.54	23.5	3.0	ground-level points
3				5.08	23.5	3.0	ground-level points
4			**	2.54	23.5	3.0	ground-level points
CBC 1	Coal Creek	west/stable	T16	0.318	1.205	0.183[4)]	ground-level points
2				2.540	1.205	0.296	ground-level points
3				0.318	1.205	0.183	65.5
4				0.318	1.205	0.183	192.5
5				0.318	1.205	0.183	192.5
6				0.318	1.205	0.183	192.5
7				0.318	1.205	0.183	65.5
8				0.318	1.205	0.183	65.5
CBA 1	Alkali Creek	west/stable	T4	0.318	1.205	0.129[5)]	244
2				0.318	1.205	0.129	244
3				0.318	1.205	0.129	183
4				0.318	1.205	0.129	122
5				0.318	1.205	0.129	61
6				0.318	1.205	0.129	61
7				0.318	1.205	0.129	122
8				2.54	1.205	0.155	244
9				2.54	1.205	0.155	244
10				2.54	1.205	0.155	183
11				2.54	1.205	0.155	183
12				2.54	1.205	0.155	122
13				2.54	1.205	0.155	61
14				2.54	1.205	0.155	61
15				2.54	1.205	0.155	122
16				2.54	1.205	0.155	122
17				2.54	1.205	0.155	244
CBM 1	Alkali Creek	east/stable	T4	0.318	1.205	0.487[5)]	ground-level points
2				2.54	1.205	0.542	ground-level points
3				0.318	1.205	0.487	110.5
4				0.318	1.205	0.487	110.5
5				0.318	1.205	0.487	335
6				0.318	1.205	0.487	335
7				0.318	1.205	0.487	335

1) At location T16, maximum velocity
2) At location T6, maximum velocity
3) The free stream velocity
4) At location T16, velocity at release height
5) At location T4, velocity at release height

*release 60 cm upwind of #16
**release 78 cm upwind of #14

Table 4-1. Crested Butte Drainage Flow Surface Temperatures Recorded on 18 October 1979 during Velocity Measurements

Thermistor	Time of Day									
	10:08A	10:25A	10:40A	10:50A	11:00A	11:10A	11:20A	11:30A	11:40A	11:50A
1	-15	-16	-16	-16	-15	-15	-15	-15	-15	-15
2	-19	-20	-20	-20	-20	-20	-20	-20	-20	-19
3	-22	-22	-23	-22	-23	-23	-23	-23	-22	-22
4	-24	-24	-25	-25	-25	-25	-24	-24	-24	-24
5	-22	-23	-24	-24	-24	-24	-24	-24	-21	-23
6	-18	-18	-18	-18	-17	-18	-17	-17	-13	-17
7	-14	-14	-14	-14	-14	-14	-14	-13	-13	-13
8	-11	-11	-11	-11	-10	-10	-10	-10	-10	-10
9	- 9	-10	-10	-10	- 9	-10	-10	-10	-19	- 9
10	- 3	- 3	- 4	- 3	- 3	- 3	- 3	- 3	- 3	- 3
11	+ 1	0	0	0	0	0	+ 1	+ 1	+ 1	+ 1
12	+ 6	+ 6	+ 6	+ 6	+ 6	+ 6	+ 7	+ 7	+ 7	+ 7
13	-15	-15	-15	-16	-15	-16	-16	-16	-16	-15
14	-30	-30	-30	-30	-29	-29	-29	-28	-28	-28
15	-24	-24	-24	-24	-24	-24	-24	-24	-24	-24
16	off scale	→	→	→	→	→	→	→	→	→
17	-24	-28	-30	-30	-30	-30	-30	-29	-29	-28
18	-24	-24	-24	-24	-24	-24	-24	-24	-24	-24
19	-24	-24	-24	-24	-24	-23	-24	-23	-23	-23
20	-	-	-	-	-	-	-	-	-	-
21	-19	-19	-19	-19	-19	-19	-19	-19	-19	-19
22	-14	-14	-14	-14	-14	-14	-14	-14	-14	-14
23	- 3	- 4	- 5	- 5	- 5	- 5	- 5	- 5	- 5	- 5
24	-20	-20	-21	-20	-20	-20	-20	-20	-20	-20
	10:20A	10:40A	10:50A	11:00A	11:10A	11:20A	11:30A	11:40A	11:50A	12:00N

Table 4-1 (continued)

Thermistor	Time of Day						
	2:10PM	2:20PM	2:30PM	2:40PM	2:50PM	3:03PM	3:15PM
1	-16	-15	-15	-16	-15.7	-15.0	-14.9
2	-17	-18	-18	-19	-18.9	-18.5	-18.5
3	-22	-21	-21	-22	-21.5	-21.0	-20.7
4	-24	-24	-24	-24	-23.6	-23.4	-23.0
5	-24	-22	-22	-22	-22.0	-22.0	-22.0
6	-17	-17	-17	-17	-17.0	-17.0	-16.8
7	-12	-12	-12	-13	-12.4	-12.2	-12.0
8	- 8	- 9	- 9	- 9	- 9.1	- 9.1	- 8.3
9	- 9	- 9	- 9	- 8.9	- 9.1	- 8.9	- 9.4
10	- 2	- 2	- 2	- 2	- 2.2	- 2.1	- 2.5
11	+ 1	+ 1	0	0	- 0.8	- 0.9	+ 0.1
12	+ 7	+ 7	+ 6	+ 5.8	+ 5.8	+ 5.8	+ 6.1
13	-16	-15	-15	-15	-15.7	-15.6	-15.6
14	-28	-27	-27	-27	-26.2	-26.3	-26.2
15	-24	-24	-24	-24	-23.8	-23.5	-23.2
16	off scale	→	→	→	→	→	→
17	-26	-26	-26	-26	-26.0	-25.7	-25.7
18	-23	-23	-23	-23	-23.0	-23.0	-22.8
19	-22	-22	-22	-22	-22.1	-22.2	-22.0
20	-	-	-	-	-	-	-
21	-18	-18	-18	-18	-17.8	-17.5	-17.4
22	-14	-13	-14	-14	-14.1	-13.9	-13.7
23	- 3	- 4	- 4	- 4	- 4.9	- 4.0	- 4.2
24	-19	-18	-19	-19	-19.0	-18.7	-18.3
	2:20PM	2:30PM	2:40PM	2:50PM	3:03PM	3:15PM	

Table 5-1. Surface Temperature Conditions during Velocity/Temperature Measurements for Alkali Creek on 18 October 1979

Thermistor \ Time	Temperatures (°C)		
	11:25 p.m.	1:45 a.m.	2:32 a.m.
1	-47	-44	-43
2	-45	-42	-41
3	-43	-40	-39
4	-44	-41	-40
5	-42	-39	-38
6	-42	-39	-39
7	-41	-38	-38
8	-41	-38	-38
9	-49	-46	-45
10	-39	-36	-35
11	-48	-44	-44
12	-28	-25	-25
13	-49	-46	-45
P_a (in Hg)	24.487	24.502	24.526
T_∞ (°C)	9	9	9

Table 5-2. Alkali Creek Drainage Flow Surface Temperatures during the Concentration Measurement Tests

Thermistor Number	Run #1		Run #2		Run #3	Run #4	
1	--	--	-31.10	-30.21	-28.97	-25.54	-25.23
2	-26.3	-25.25	-20.84	-22.89	-20.05	-19.49	-18.96
3	+ 3.13	+ 3.09	+ 5.83	+ 4.14	+ 4.72	+ 4.62	+ 4.76
4	-24.61	-25.58	-22.99	-21.63	-20.71	-23.16	-22.73
5	-23.54	-23.04	-20.39	-21.57	-17.07	-15.40	-14.72
6	- 9.08	- 9.28	- 7.32	-10.11	- 5.34	- 5.77	- 5.15
7	-27.37	-28.39	-24.97	-25.97	-23.48	-20.37	-19.80
8	-26.30	-26.67	-23.86	-24.29	-22.17	-20.05	-19.59
9	-35.81	-36.00	-33.59	-33.24	-31.55	-28.02	-27.54
10	-26.70	-26.77	-24.14	-24.15	-21.93	-19.93	-19.59
11	-36.04	-36.20	-34.13	-33.54	-31.93	-28.36	-27.89
12	-16.85	-16.90	-16.07	-15.95	-14.91	-12.86	-12.48
13	+ 4.55	+ 3.74	+ 6.32	+ 4.28	+ 6.28	+ 5.54	+ 5.69

$T_\infty = 20°C$

Table 6-1. Summary of Coal Creek Neutral Stratification Velocity Profile Analysis for u_∞ = 3.21 m/s.

Location	z_o(cm)	u*(cm/s)	Re_{zo}	n	$u*/u_\infty$
T16	0.02707	16.660	3.007	0.1808	0.052
T15	0.06649	19.525	8.655	0.2470	0.061
T14	0.07305	19.488	9.491	0.2280	0.061
T13	0.02337	15.322	2.387	0.1759	0.048
T17	0.08248	19.476	10.709	0.2012	0.061
T3	0.06674	19.495	8.674	0.1975	0.061
T7	0.44548	25.956	77.086	0.3050	0.081

Table 7-1. Summary of Velocity Profile Analysis for the Alkali Creek Neutral Stability Tests and $u_\infty = 3.0$ m/s.

Location*	z_o(cm)	u*(cm/s)	d(cm)	Re_{z_o}	n	$u*/u_\infty$
A	0.00001	7.478	0.275	3.507×10^{-4}	0.0792	0.025
B	0.00227	11.754	0.450	0.1776	0.1661	0.039
C	0.00022	10.448	0.000	1.550×10^{-2}	0.0946	0.035
D	0.05694	18.669	0.000	7.087	0.2069	0.062
E	0.08220	19.219	0.000	10.532	0.2323	0.064

*See Figure 3-2-4 for map location.

Table 8-1. Surface Temperature Boundary Conditions during Velocity/Temperature Profile Measurements for Coal Creek Stable Flow Tests. Profiles Taken from 1840 on 6 February 1980 to 0120 on 7 February 1980

SURFACE THERMISTOR NUMBER	Velocity/Temperature Profile Location					
	T16	VP	T17	T5	T15	T13
4	13.4°	13.3°	13.0°	12.9°	12.9°	12.7°
7	4.8°	4.6°	4.2°	4.0°	3.8°	3.7°
8	8.6°	8.6°	8.6°	8.6°	8.5°	8.4°
9	8.3°	7.9°	7.7°	7.6°	7.5°	7.3°
10	10.3°	10.4°	10.3°	10.1°	10.1°	9.8°
11	11.3°	11.3°	10.9°	10.9°	10.8°	10.5°
12	-8.9°	-10.9°	-11.2°	-13.4°	-13.3°	-13.2°
13	-11.7°	-13.4°	-14.4°	-14.4°	-14.4°	-17.3°
14	-16.4°	-17.2°	-17.4°	-17.2°	-17.5°	-17.5°
15	-20.0°	-21.2°	-21.7°	-21.7°	-23.6°	-
18	-3.7°	-5.0°	-7.4°	-8.1°	-8.8°	-9.4°
19	-3.9°	-4.7°	-5.5°	-5.9°	-6.3°	-6.5°
21	3.3°	4.2°	3.4°	3.1°	2.7°	2.3°
24	3.5°	3.5°	2.9°	2.9°	2.8°	3.0°

Table 8-2. Surface and Ambient Temperatures Recorded from 0903 to 1900 on 6 February 1980 during Concentration Measurements for the Coal Creek Stable Flow Tests

SURFACE THERMISTOR NUMBER	Concentration Run Number							
	CBC1	CBC2	CBC3	CBC4	CBC5	CBC6	CBC7	CBC8
T15	-24.4	-24.0	-21.9	-22.0	-21.6	-21.4	-21.7	-22.3
T_a	+20	+20	+20	+20	+20	+20	+20	+20

Table 9-1. Surface Temperatures Recorded from 1724 to 2154 on 12 February 1980 while taking Data for Velocity and Temperature Profiles along Alkali Creek with Stable Flow and Westerly Wind Conditions

SURFACE THERMISTOR NUMBER	Velocity/Temperature Profile Location					
	T4	T6	T8	T9	T10	T11
1	-55.4	-56.1	-55.4	-55.4	-55.6	-55.8
2	-30.7	-29.6	-30.1	-30.5	-30.8	-31.9
3	-8.5	-8.5	-8.5	-8.2	-8.2	-8.2
4	-53.9	-54.4	-53.4	-53.2	-53.0	-53.1
5	-49.0	-50.0	-48.7	-48.9	-49.2	-49.3
6	-32.0	-33.2	-31.7	-32.0	-32.5	-32.5
7	+0.1	+0.3	+0.4	+1.0	+1.2	+1.0
8	-61.0	-61.0	-61.1	-60.5	-61.0	-61.2
9	-30.5	-30.1	-29.5	-29.6	-29.8	-30.0
10	-33.2	-33.5	-32.9	-32.4	-32.9	-32.9
11	-47.7	-48.5	-49.0	-48.9	-49.6	-49.1
12	+6.7	+6.4	+6.5	+6.5	+6.4	+6.2
13	-56.9	-57.0	-56.5	-56.7	-56.8	-56.8

Table 9-2. Surface Temperatures Recorded from 1100 to 2013 on 13 February 1980 while taking Concentration Samples along Alkali Creek with Stable Flow (West Wind) Conditions and a 0.318 cm Release Height

SURFACE THERMISTOR NUMBER	CONCENTRATION RUN NUMBER						
	CBA 1	CBA 2	CBA 3	CBA 4	CBA 5	CBA 6	CBA 7
1	-54.3	-52.2	-52.5	-53.0	-53.2	-51.7	-48.7
2	-30.2	-28.2	-27.0	-23.9	-25.1	-25.6	-22.9
3	-9.0	-7.2	-6.6	-6.3	-6.5	-6.3	-5.7
5	-50.9	-49.7	-49.1	-49.6	-49.1	-47.8	-44.4
6	-34.6	-32.7	-32.3	-32.9	-32.5	-31.4	-26.0
7	+0.1	+1.0	+1.0	+1.5	+0.7	+0.7	+1.8
8	-56.8	-56.6	-56.5	-56.4	-56.8	-56.0	-56.7
10	-37.2	-36.3	-37.8	-36.4	-34.4	-33.9	-29.3
11	-53.1	-51.4	-53.1	-50.7	-49.3	-48.9	-44.3
12	+6.9	+6.5	+6.9	+6.9	+7.3	+7.3	+7.7
13	-55.9	-54.6	-53.8	-53.6	-53.6	-52.9	-50.2
T_a	+18	+18	+18	+18	+18	+18	+19

Table 9-3. Surface Temperatures Recorded from 2122 on 13 February 1980 to 1710 on 14 February 1980 while taking Concentration Samples along Alkali Creek with Stable Flow (West Wind) Conditions and a 2.54 cm Release Height

SURFACE THERMISTOR NUMBER	CONCENTRATION RUN NUMBER									
	CBA 8	CBA 9	CBA 10	CBA 11	CBA 12	CBA 13	CBA 14	CBA 15	CBA 16	CBA 17
1	-51.6	-50.3	-50.8	-51.1	-50.1	-50.2	-48.0	-49.0	-49.4	-48.0
2	-22.7	-23.0	-23.3	-24.4	-23.6	-23.6	-23.3	-24.4	-25.1	-23.0
3	-4.5	-4.3	-4.5	-4.7	-4.9	-5.7	-5.5	-6.1	-6.1	-5.9
5	-45.3	-45.1	-46.0	-46.4	-44.9	-45.5	-45.5	-45.9	-46.1	-46.1
6	-27.8	-28.0	-28.5	-28.8	-29.2	-30.1	-30.3	-30.0	-29.8	-29.3
7	+3.4	+3.7	+3.1	+2.7	+2.4	+1.3	+1.3	+1.8	+1.3	+1.8
8	-56.4	-56.5	-56.8	-56.7	-55.7	-56.8	-56.2	-56.5	-56.4	-56.2
10	-29.5	-29.9	-29.9	-27.6	-30.3	-31.6	-30.0	-37.1	-30.9	-30.0
11	-44.4	-44.9	-45.7	-44.5	-45.5	-46.0	-45.7	-46.2	-45.8	-43.5
12	+9.9	+9.9	+9.9	+9.5	+9.5	+9.5	+9.0	+9.0	+9.0	+9.0
13	-	-50.2	-50.5	-50.5	-49.9	-51.0	-50.9	-51.2	-51.3	-50.8
T_a	+18	+18	+19	+18	+18	+18	+18	+18	+18	+18

Table 10-1. Surface Temperatures (^oC) Recorded from 1614 to 2249 on 19 February 1980 while taking Data for Velocity and Temperature Profiles along Alkali Creek with Stable Flow and East Wind Conditions

THERMISTOR	VELOCITY PROFILE LOCATION					
	A	B	C	D	E	F
1	-19.3	-19.8	-18.8	-18.8	-19.0	-19.5
2	-15.1	-17.5	-16.7	-17.0	-17.1	-17.4
5	-41.0	-40.2	-40.1	-39.9	-40.4	-40.6
7	-37.9	-34.2	-28.2	-32.1	-21.7	-26.3
8	-53.7	-53.1	-54.0	-53.6	-53.2	-53.1
10	-30.4	-31.1	-29.6	-30.2	-30.5	-30.5
11	-24.7	-32.0	-25.1	-26.7	-26.9	-31.2
12	+6.9	+6.5	+6.7	+6.9	+6.9	+6.5
13	-46.5	-40.8	-41.5	-44.8	-45.6	-45.3

Table 10-2. Surface Temperatures (^oC) Recorded from 0758 to 1732 on 20 February 1980 during Concentration Sampling for the Alkali Creek Stable Flow and East Wind Conditions

THERMISTOR	CONCENTRATION RUN NUMBER						
	CBM 1	CBM 2	CBM 3	CBM 4	CBM 5	CBM 6	CBM 7
1	-19.6	-	-17.2	-19.1	-18.6	-19.4	-18.5
2	-17.7	-	-16.5	-18.6	-18.5	-18.3	-17.8
5	-43.7	-	-44.1	-46.9	-47.4	-47.8	-47.7
7	-48.7	-	-50.2	-52.6	-52.9	-52.7	-52.9
8	-52.7	-53.1	-52.3	-52.9	-53.4	-53.2	-52.6
10	-29.6	-	-39.5	-44.5	-44.5	-43.1	-42.9
11	-40.3	-	-33.1	-40.2	-35.5	-32.2	-30.8
12	+7.7	-	+7.3	+6.9	+6.5	+6.9	+6.9
13	-20.7	-	-21.5	-25.5	-26.7	-26.6	-25.1
T_a	+20	+20	+20	+20	+20	+20	+20

FIGURES

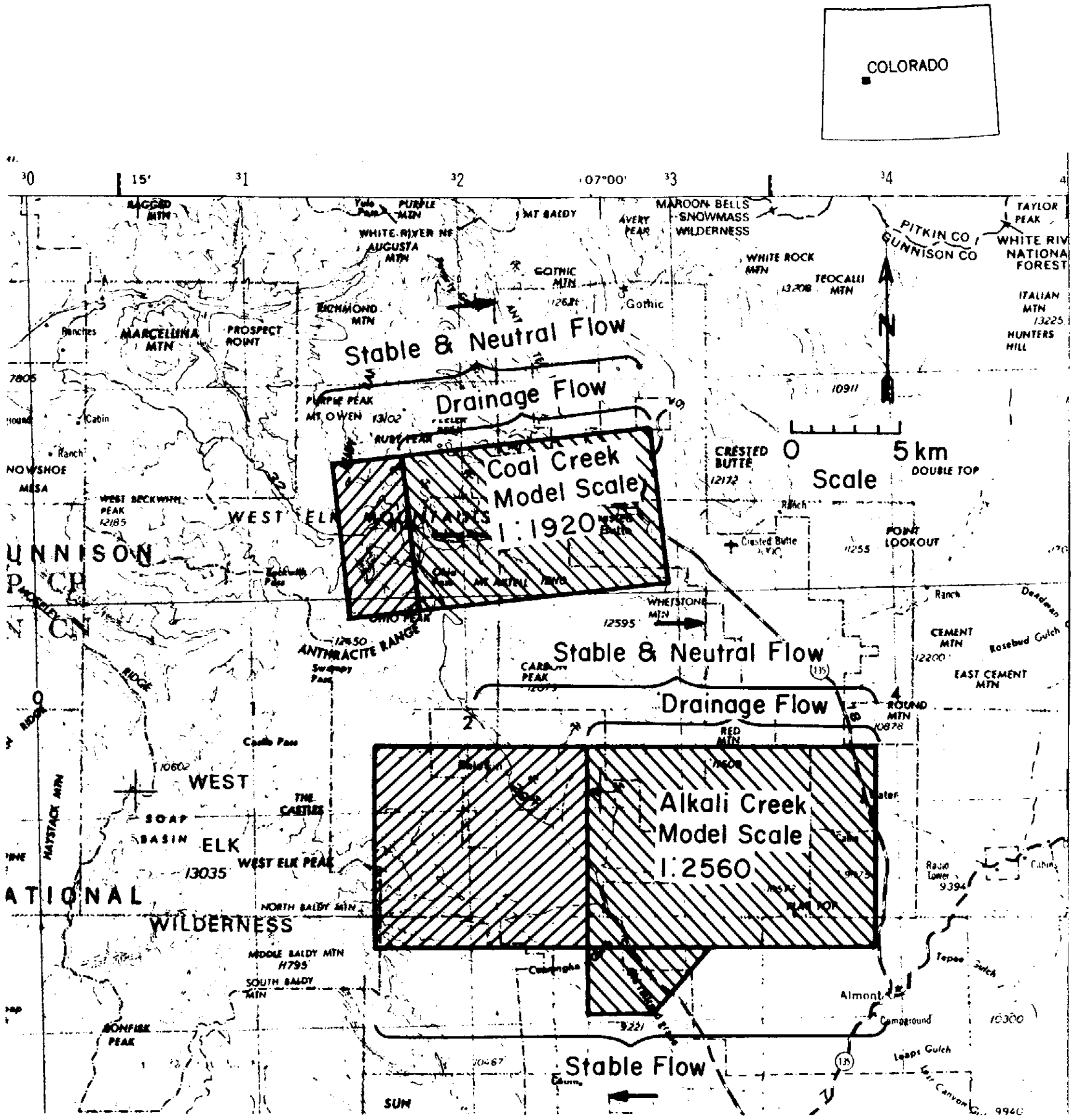


Figure 3-1-1. Map Showing the Topographic Areas Modeled for the Various Physical Simulations

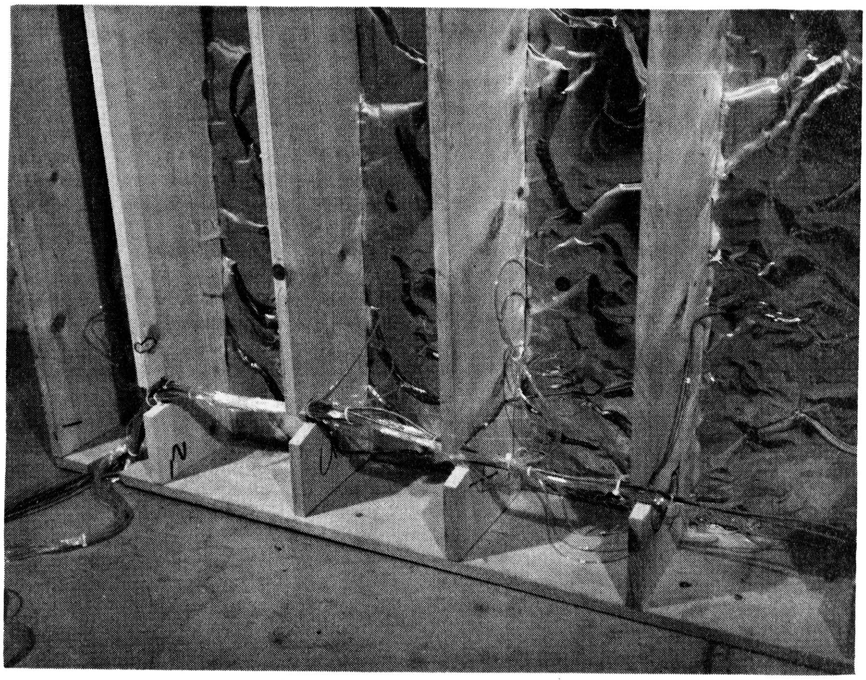


Figure 3-2-1. Picture of a Portion of Wood Frame Used to Support Aluminum Surface Representing Model Topography (Also Pictured is the Tubing Used for Tracer Gas Sampling at Ground Level)

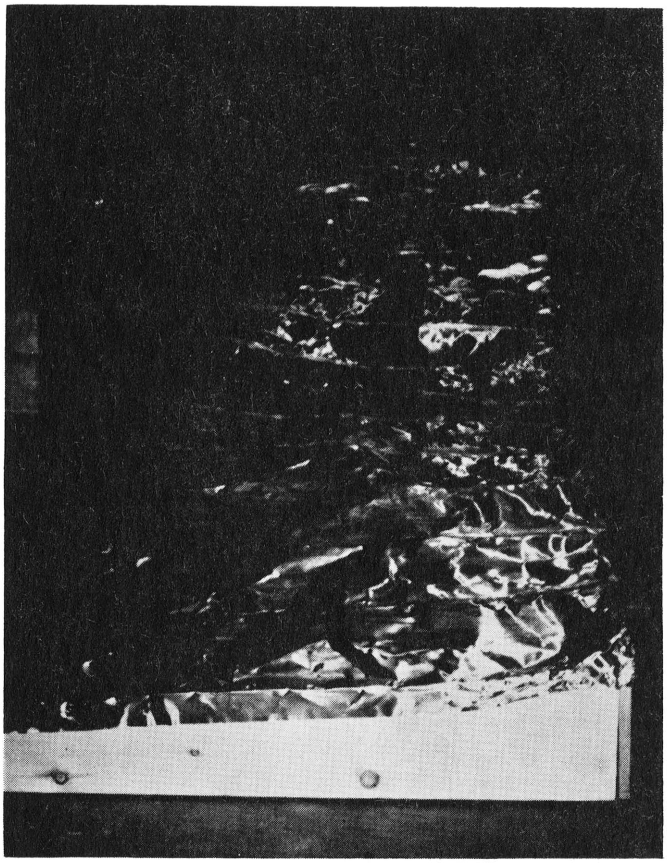


Figure 3-2-2. Picture of One Complete Section of Alkali Creek Model

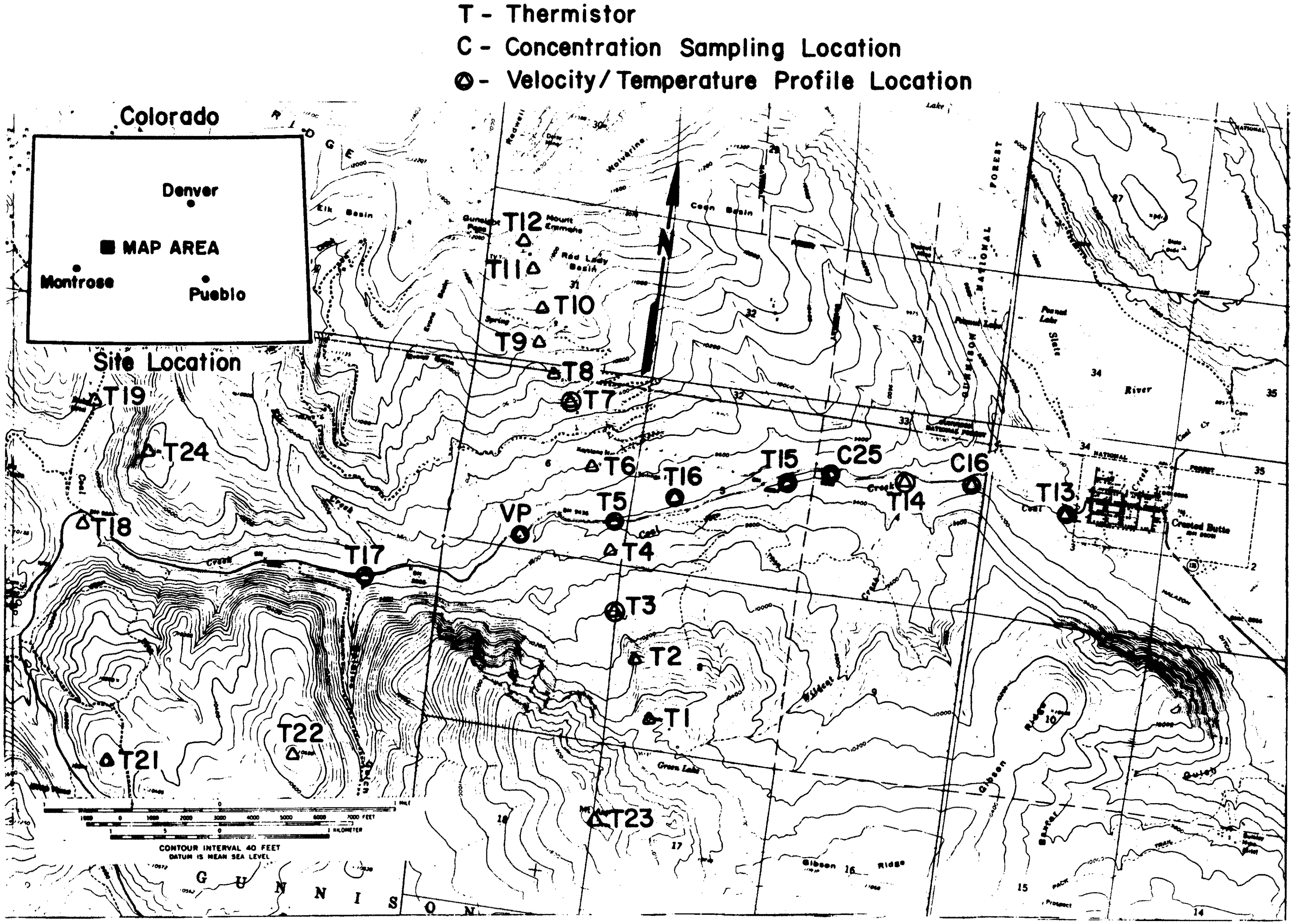


Figure 3-2-3. Map Showing Thermistor and Velocity/Temperature Profile Locations for Coal Creek Tests

T - Thermistor
Velocity/Temperature Profile Location

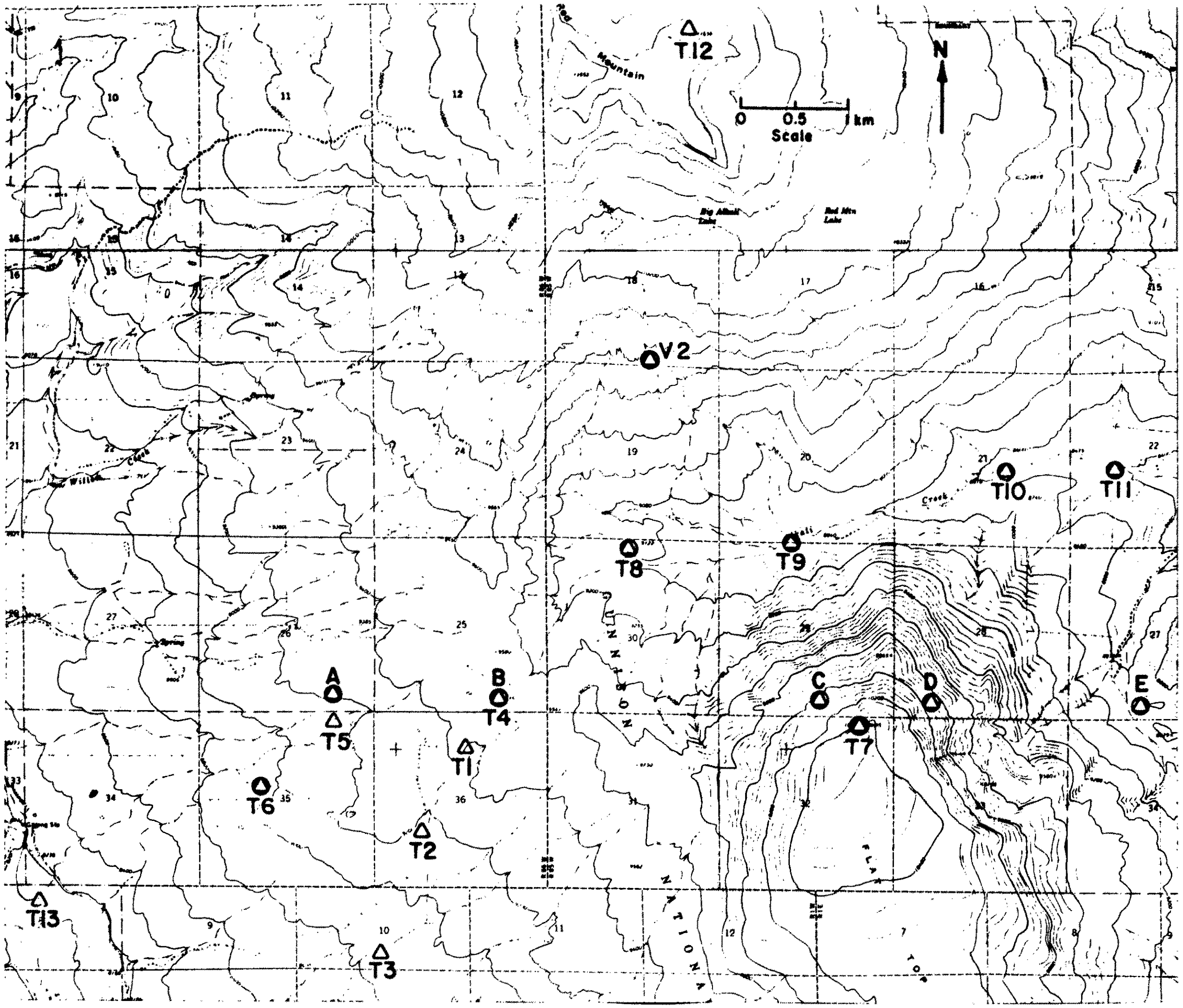


Figure 3-2-4. Map Showing Location of Thermistors and Velocity-Temperature Sampling Points for Alkali Creek (West Flow) Tests

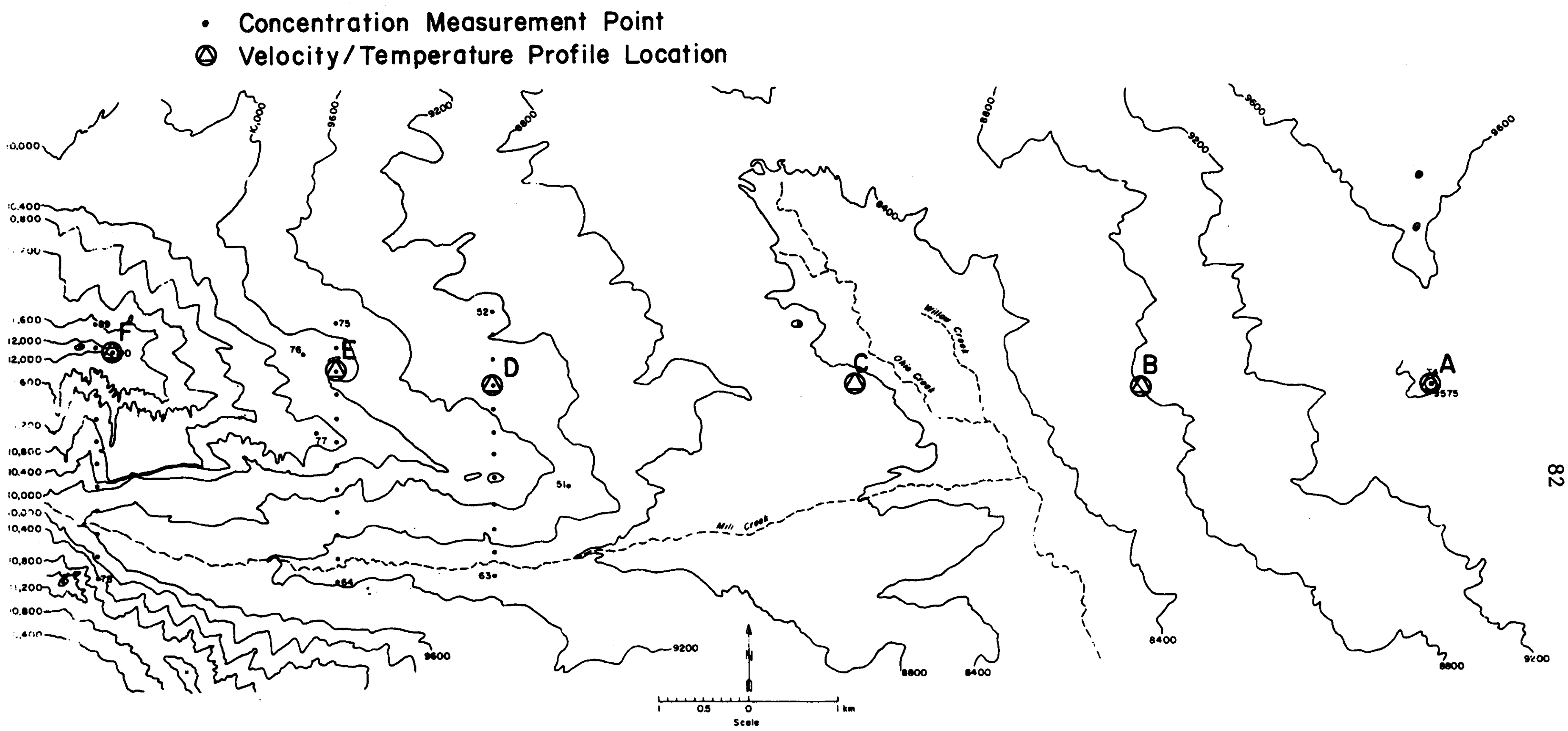


Figure 3-2-5. Map Showing Velocity/Temperature Profile Locations for Alkali Creek (East Wind) Tests

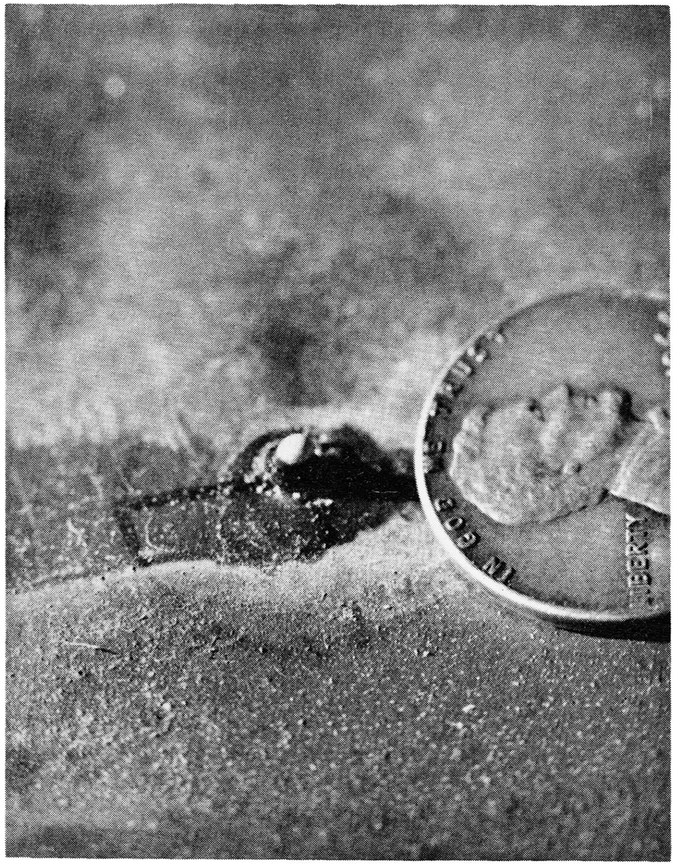


Figure 3-2-6. Close-up of Surface Mounted Thermistor

Figure 3-2-7. Close-up of Ground-level Sampling Point Number 11 at Alkali Creek

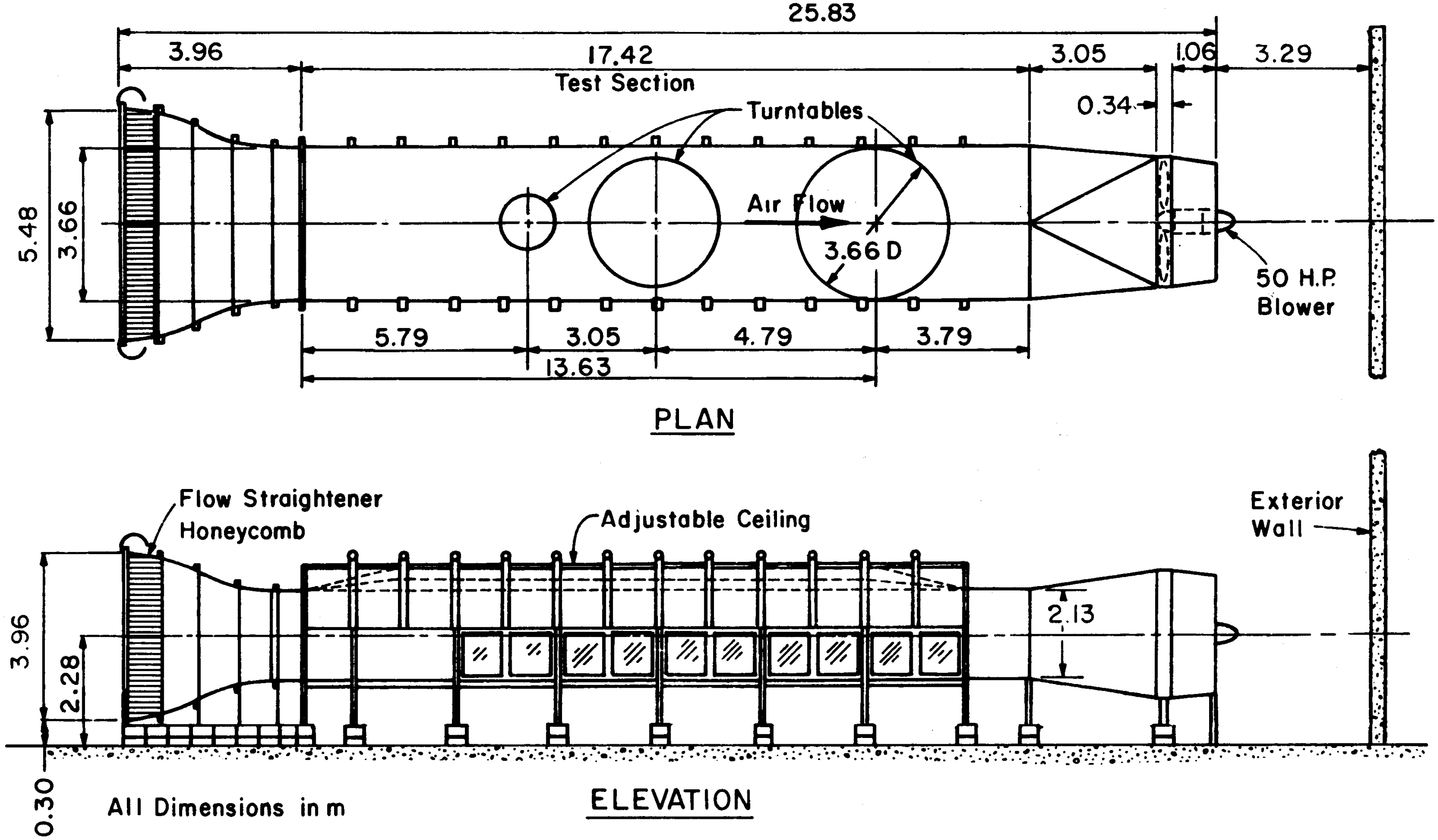
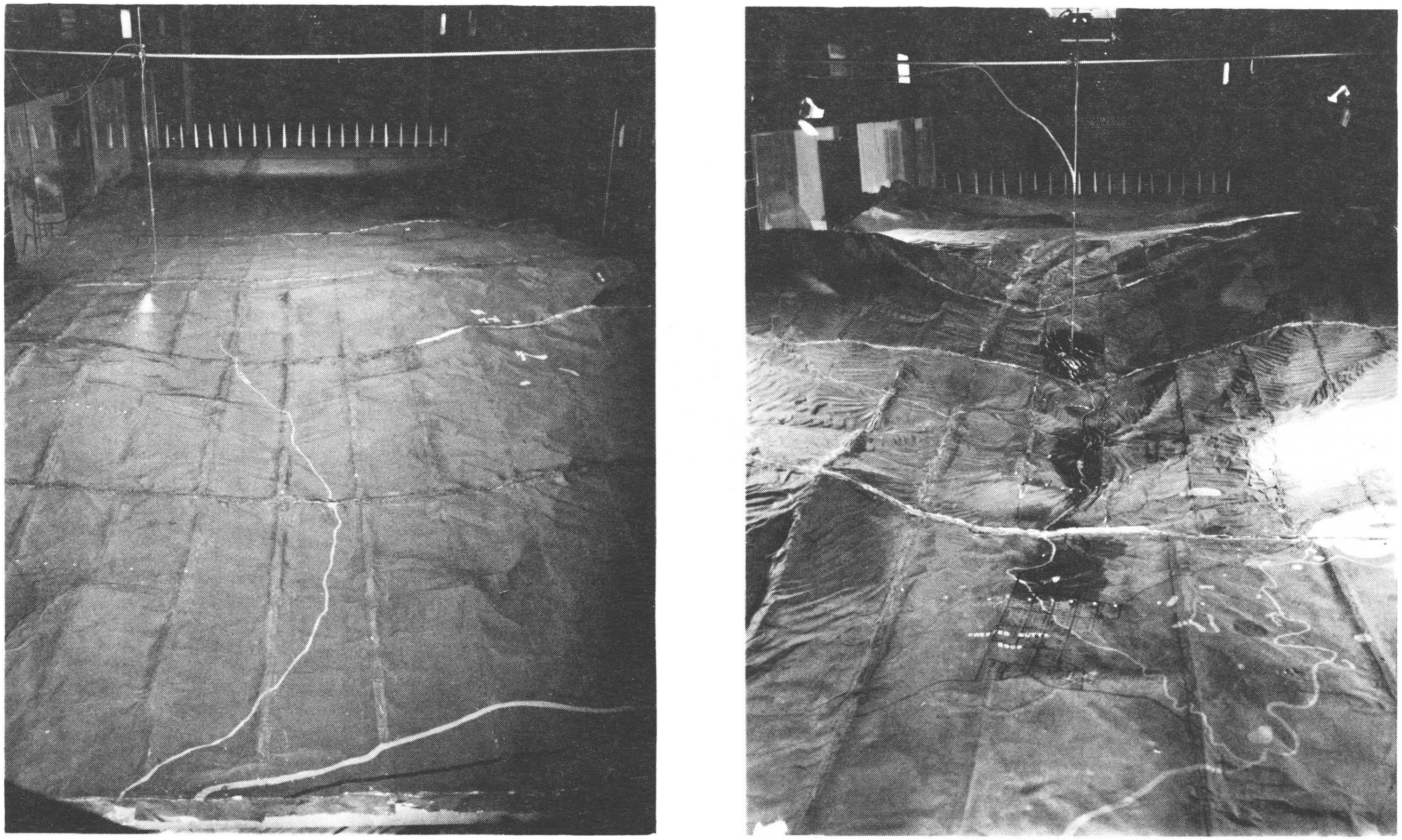


Figure 3-2-8. Environmental Wind Tunnel



(a) (b)

Figure 3-2-9. Alkali Creek (a) and Coal Creek (b) Model Setup in the Environmental Wind Tunnel

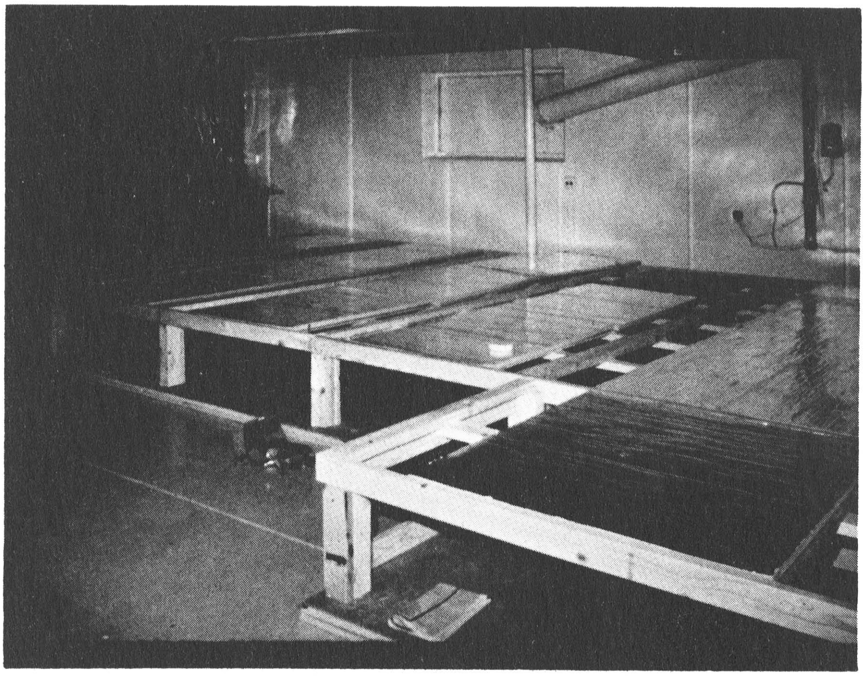


Figure 3-2-10. Platform Used as a Support for Hollow Aluminum Model

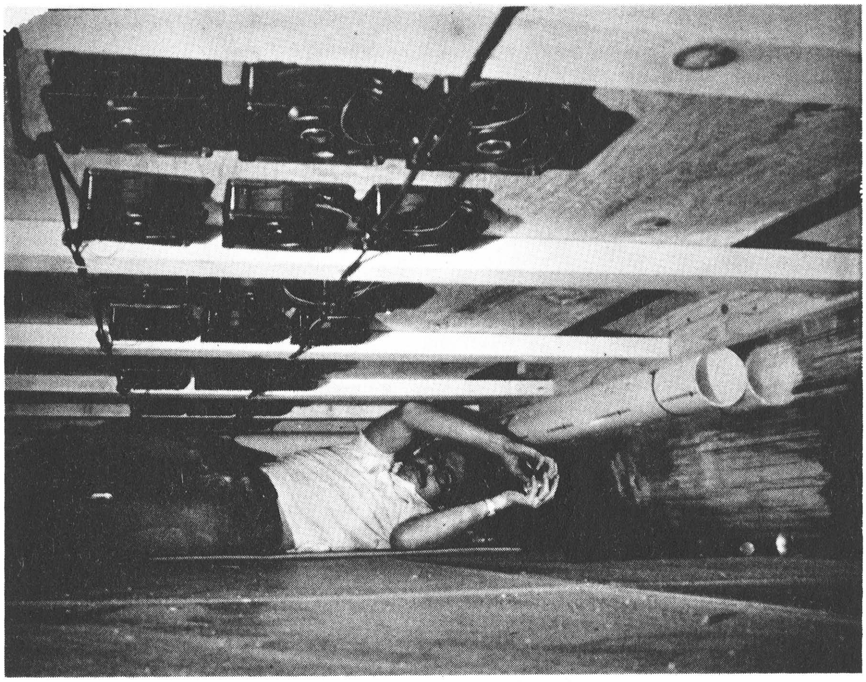


Figure 3-2-11. Fans Installed under Frame to Circulate Cold CO_2 Vapors

Figure 3-2-12. Technician Loading Dry Ice Blocks on Carts that are Positioned under Aluminum Shell Model

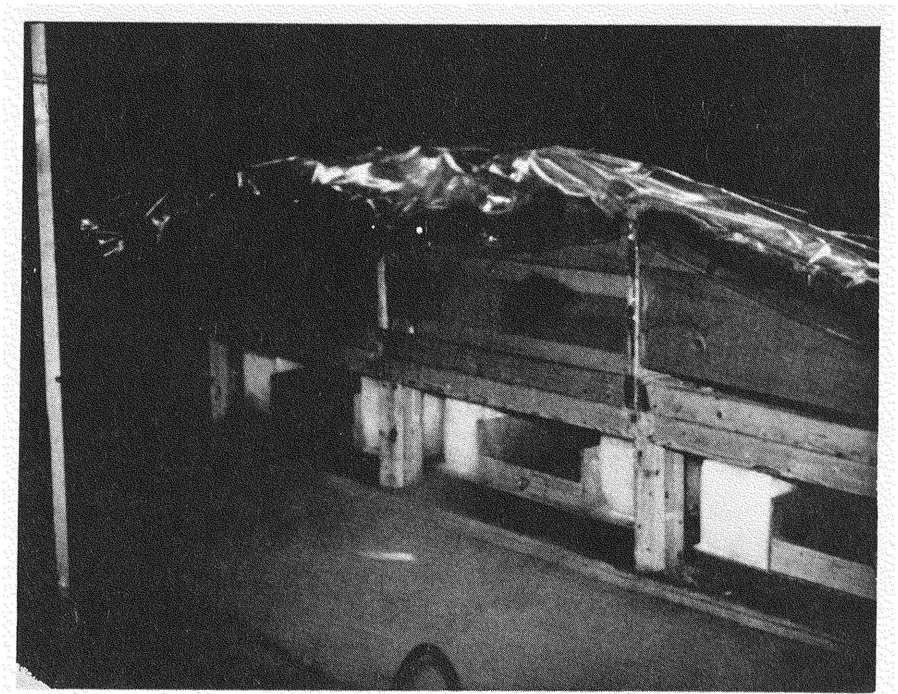
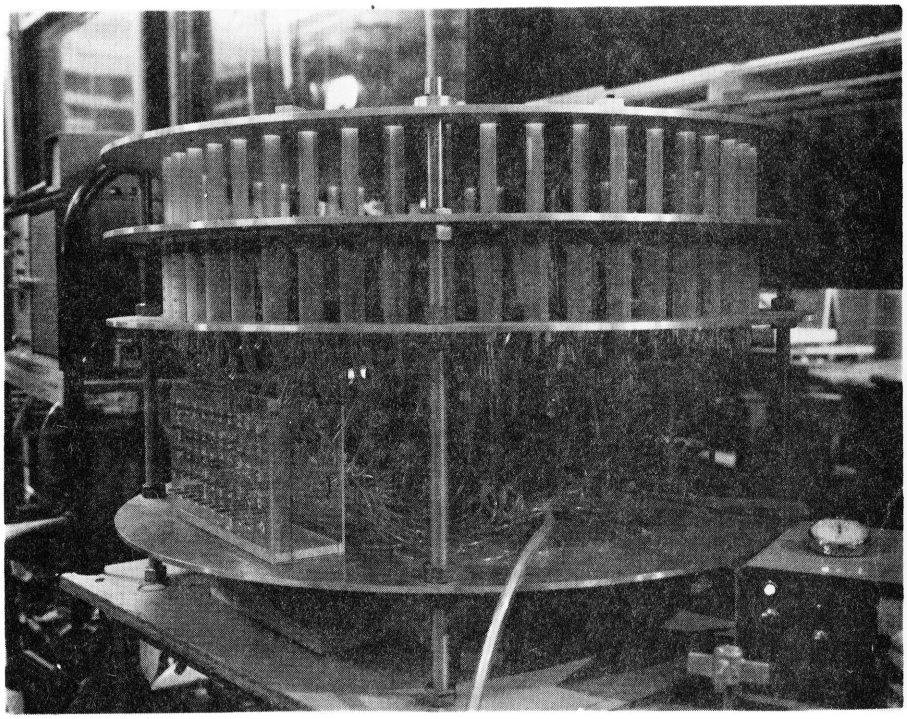
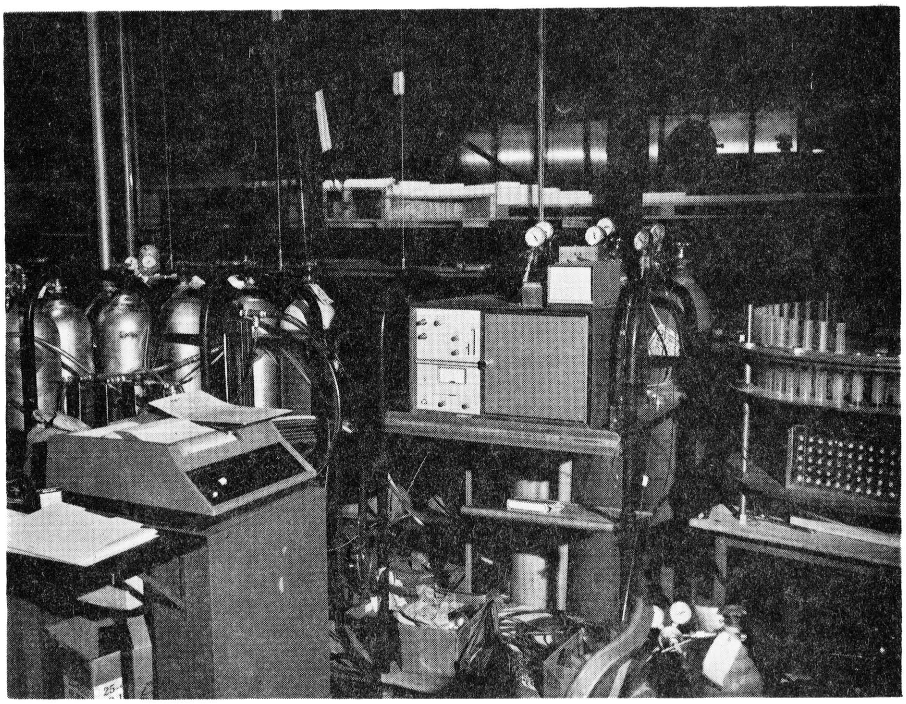


Figure 3-2-13. A Picture of a Complete Dry Ice Load



(a)



(b)

Figure 3-3-1. Photographs of (a) the Gas Sampling System, and (b) the HP Gas Chromatograph and Integrator

Syringe #	Integrated Value (μv-s)
1	205694
2	203629
3	202588
4	204305
5	204430
6	203817
7	204636
8	204425
9	204820
10	202794
11	202874
12	203496
13	197171
14	203790
15	202432
16	202426
17	202317
18	200461
19	200372
20	201950
21	201829
22	201817
23	199365
24	201459
25	200297
26	200940
27	200012
28	200622
29	------
30	199445
31	199914
32	198845
33	198725
34	198899
35	198898
36	195163
37	198945
38	197443
39	197502
40	196235
41	196938
42	196890
43	147606
44	196634
45	196964
46	197027
47	195721
48	196414
49	196934
50	196582
Calibration Gas	197778

Figure 3-3-2. Typical Sampling System Calibration Showing the Integrated FIGC Response After Injecting a Known Concentration from Each Syringe

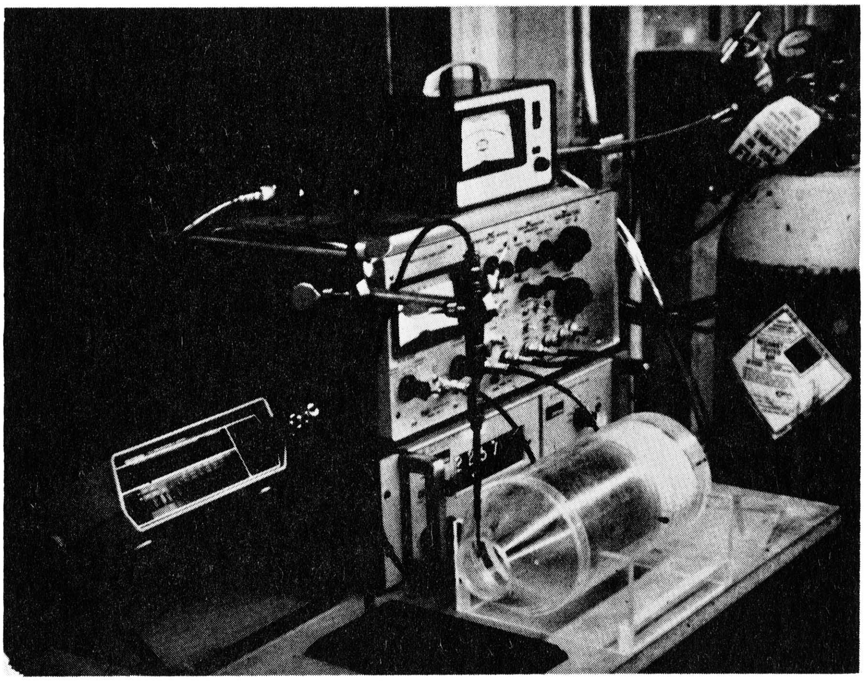


Figure 3-4-1. Equipment Used for Calibrating Hot-film Anemometer at Low Speeds

Measured Velocity--u (cm/s)	Voltage--E	Calculated Velocity--u (cm/s)	% Error
7.175	2.880	7.186	.15
11.038	2.905	10.977	-.56
14.794	2.930	14.924	.88
18.522	2.952	18.507	-.08
22.126	2.973	22.012	-.52
25.725	2.994	25.592	-.52
29.406	3.017	29.595	.64
33.024	3.037	33.141	.35
36.687	3.056	36.563	-.34

Calibration is: $A = .24326$

$B = .00155$

$n = .9111$

where:

$$\frac{E^2}{R_H(R_H - R_c)} = A + Bu^n$$

$$\frac{T_F^c}{T_g^c} = 1.4278$$

$$\frac{A}{B} = 156.942$$

$$R_H = 9.925\Omega$$

$$E_o = 2.852V$$

$$T_a = 288.72°K; \; P_a = 24.3''Hg$$

$$R_c = 6.615\Omega$$

Figure 3-4-2. Hot-film Calibration Results for Alkali Creek Test--Drainage Flow

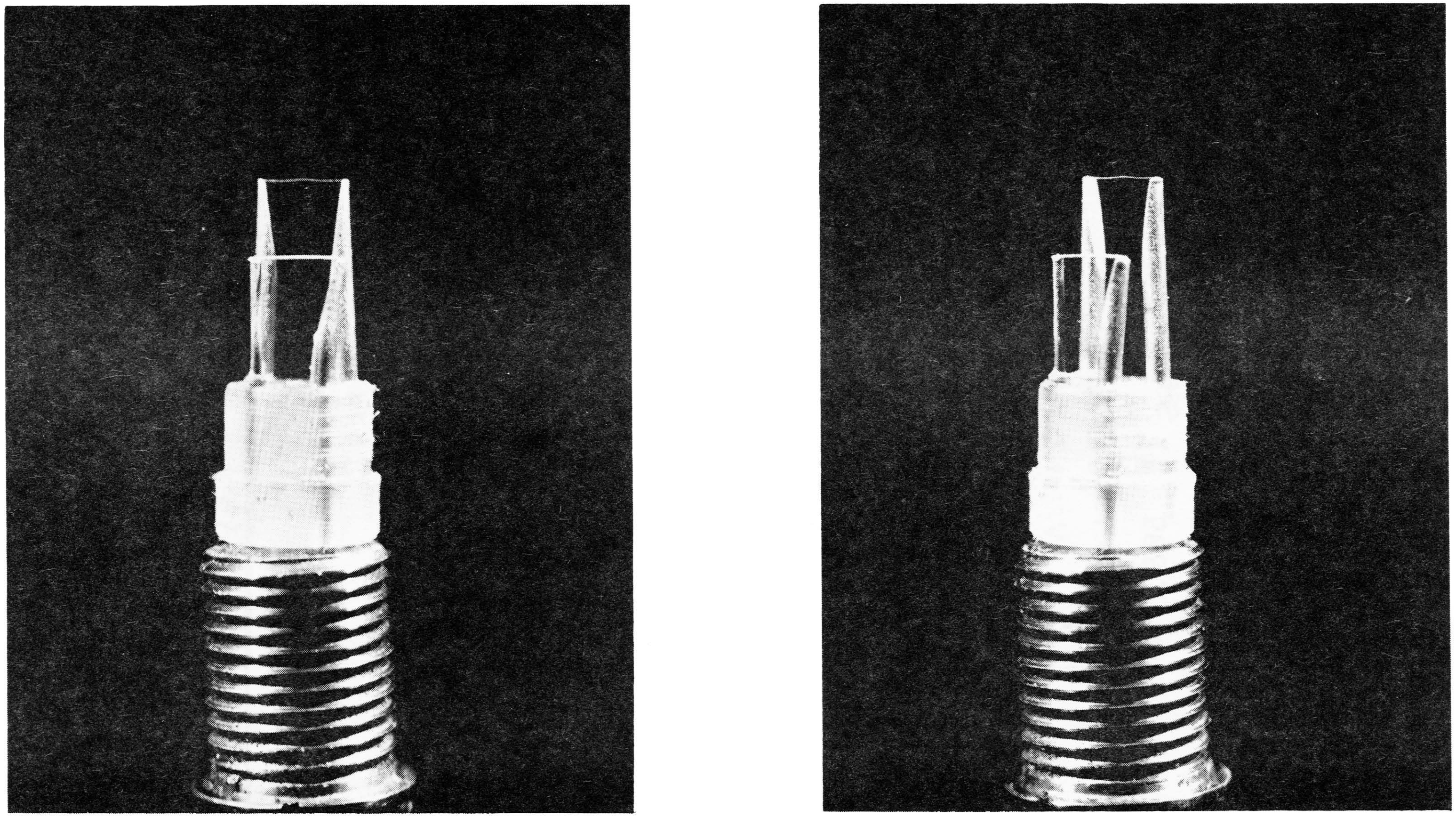


Figure 3-4-3. Photographs at Two Angles of Datametrics Probe with Shield Removed (Top Sensor for Velocity and Bottom for Temperature)(Spacing is Approximately 0.5 mm)

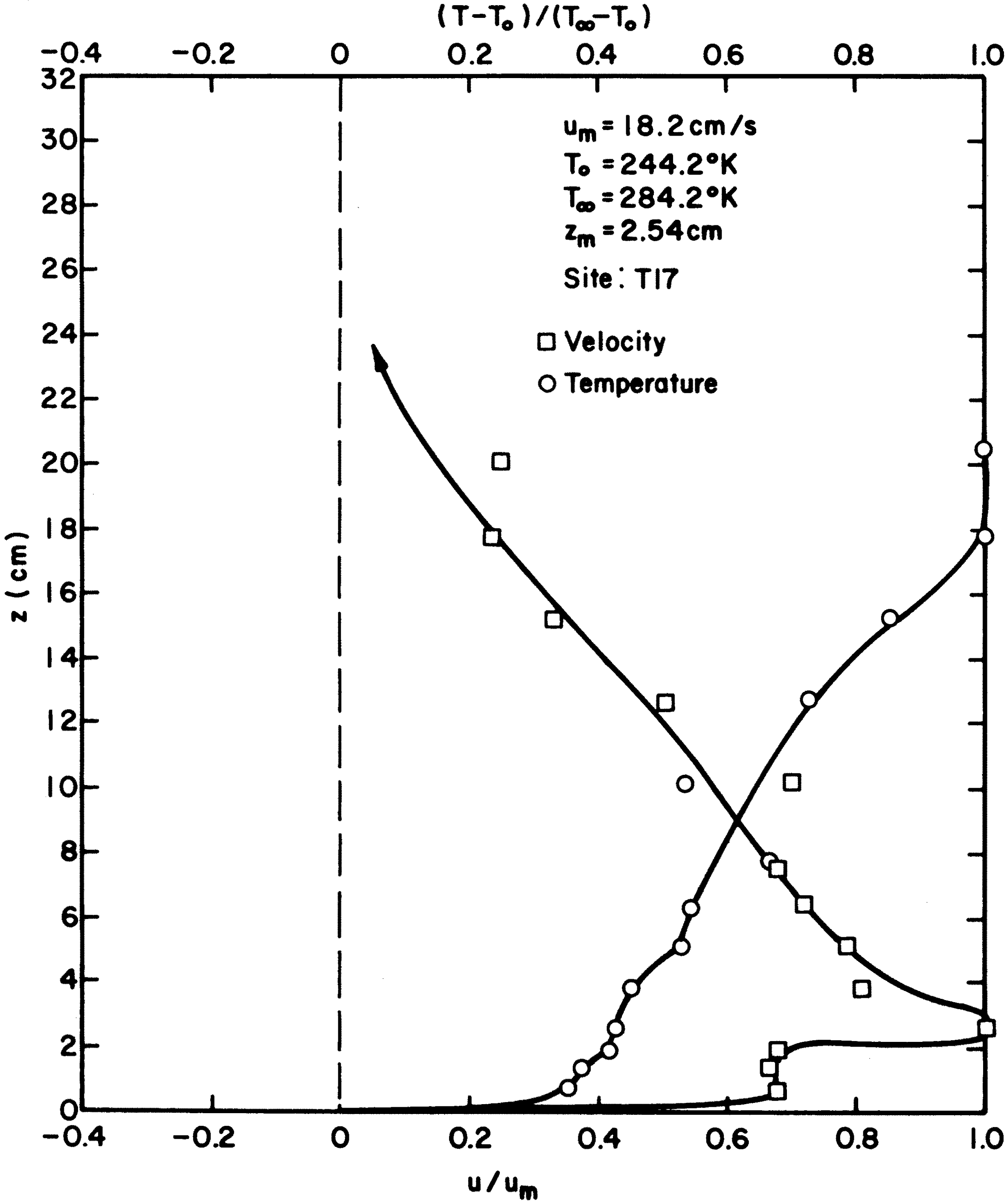


Figure 4-1-1. Velocity and Temperature Profiles Taken at T17 for the Coal Creek Drainage Flow Tests. (Ri = 0.50)

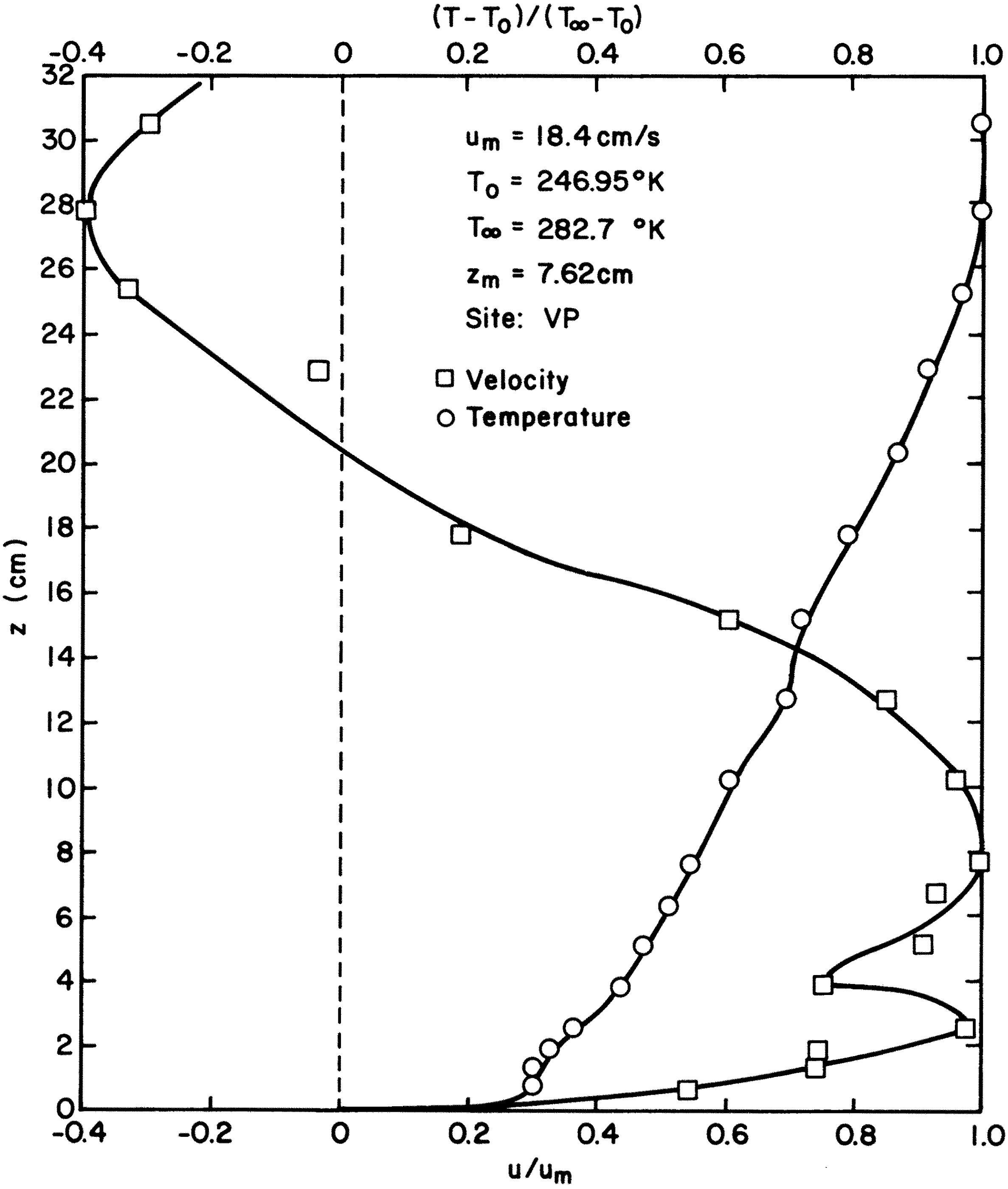


Figure 4-1-2. Velocity and Temperature Profiles Taken at VP Site for the Coal Creek Drainage Flow Tests. (Ri = 1.69)

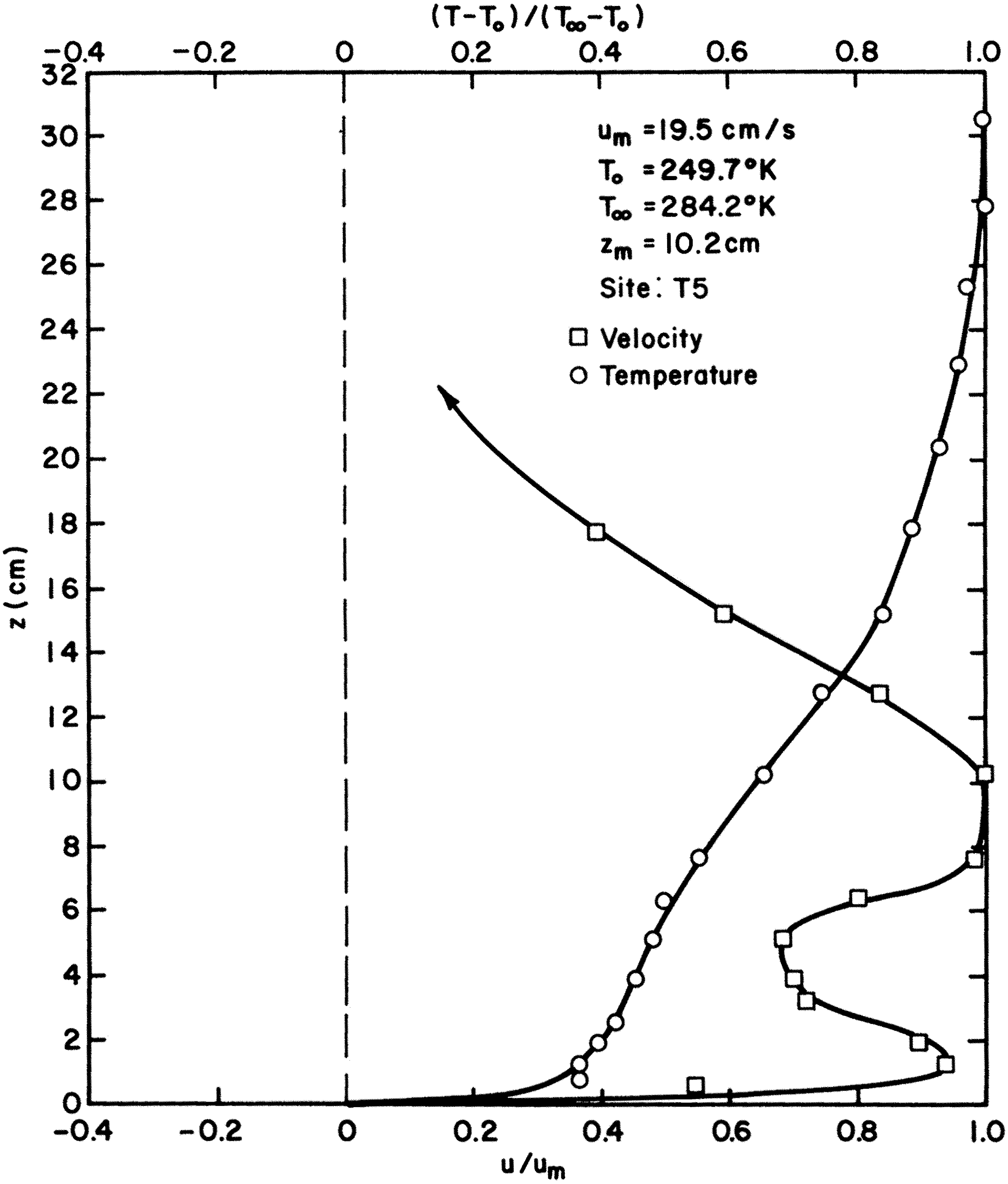


Figure 4-1-3. Velocity and Temperature Profiles Taken at T5 for the Coal Creek Drainage Flow Tests. (Ri = 2.20)

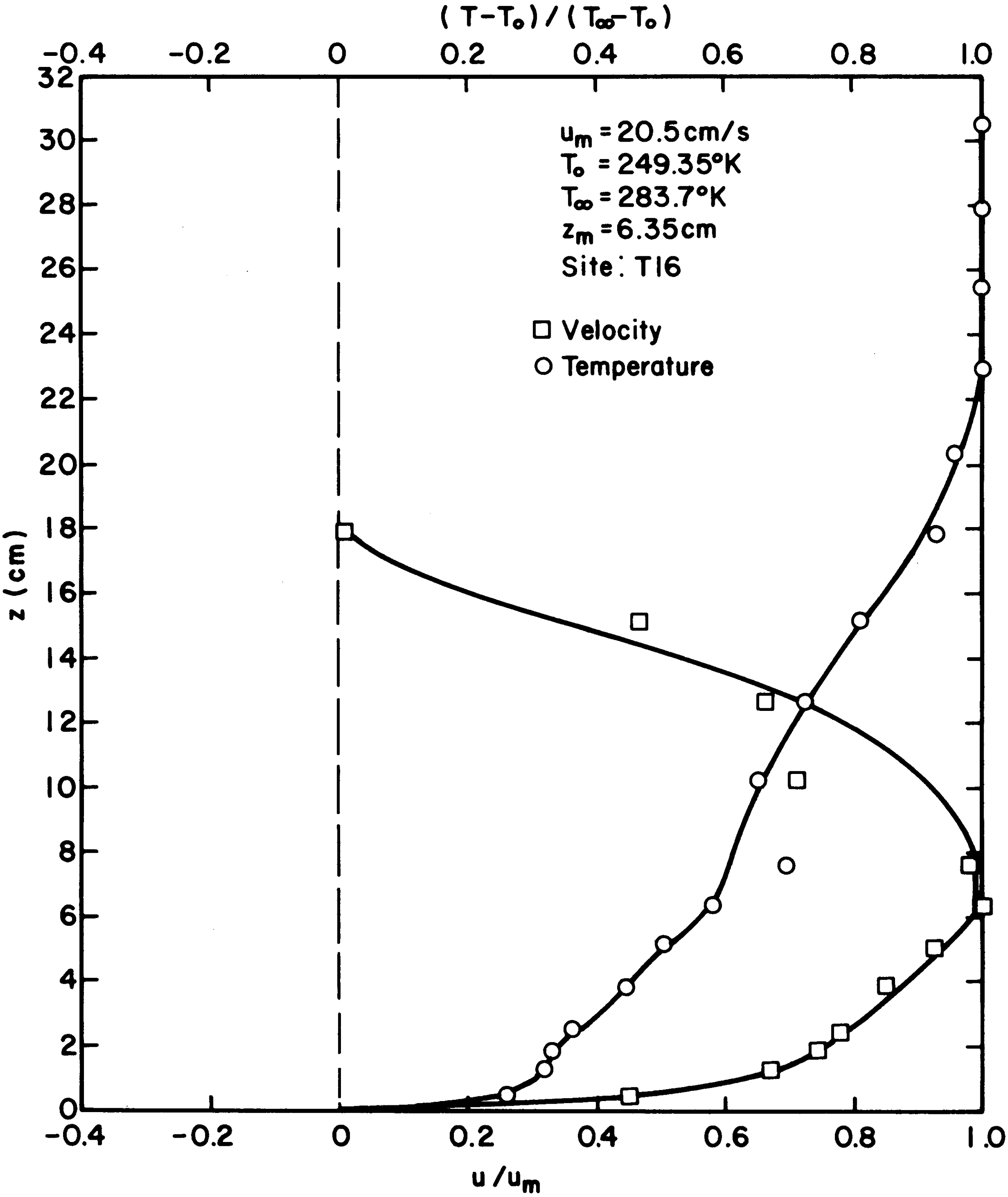


Figure 4-1-4. Velocity and Temperature Profiles Taken at T16 for the Coal Creek Drainage Flow Tests. (Ri = 1.14)

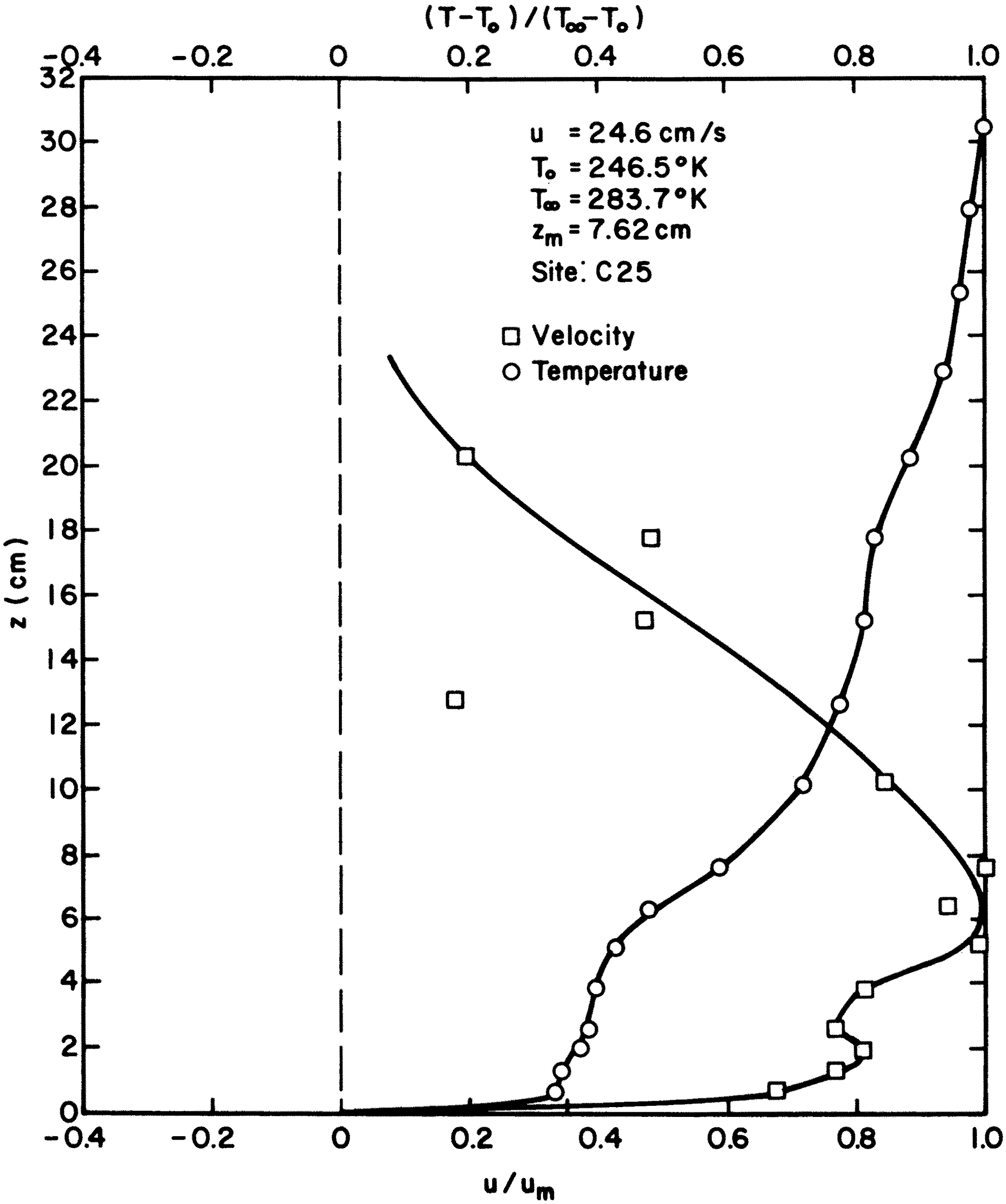


Figure 4-1-5. Velocity and Temperature Profiles Taken at Concentration Sampling Tap 25 (C25) for the Coal Creek Drainage Flow Tests. (Ri = 1.09)

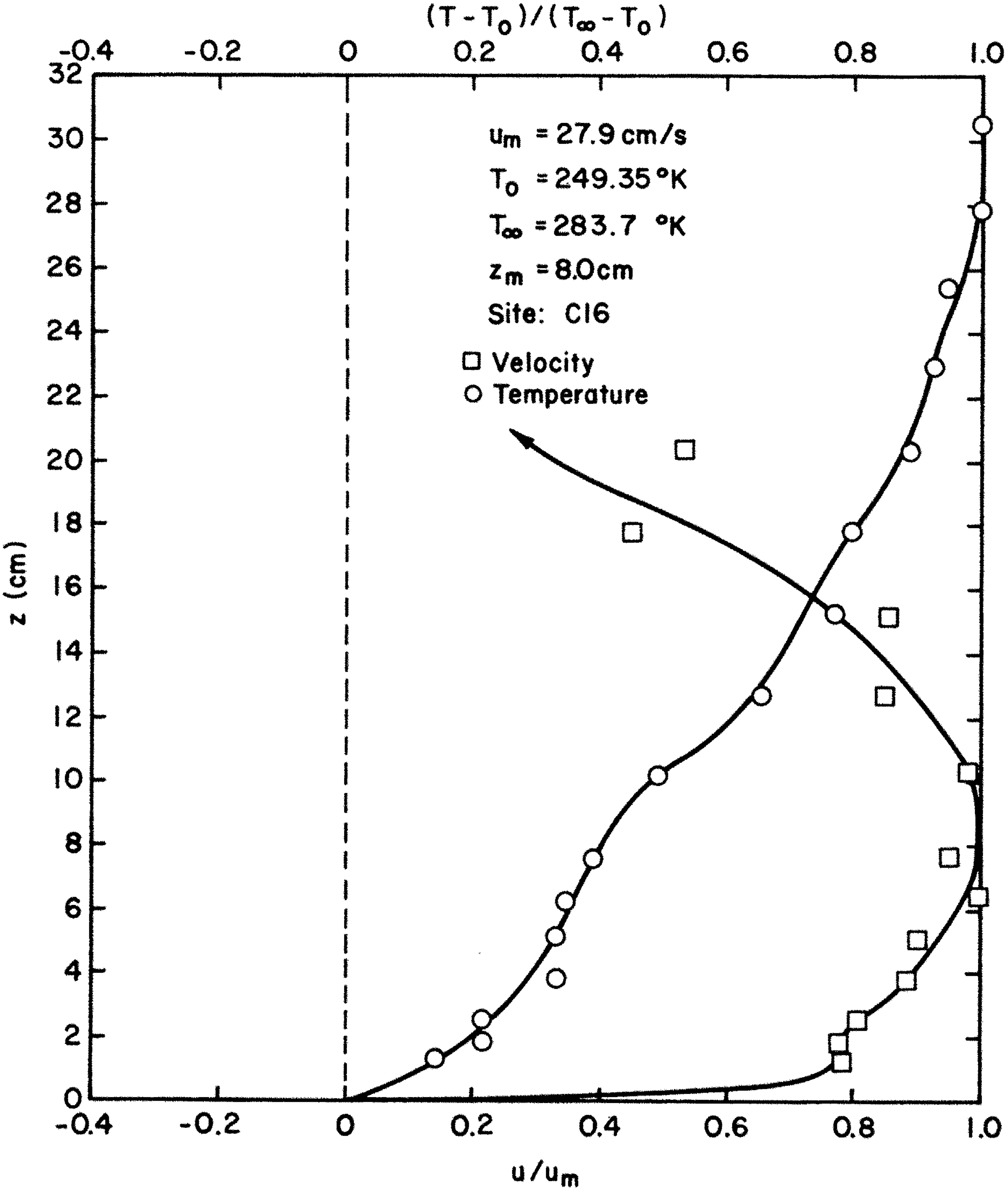


Figure 4-1-6. Velocity and Temperature Profiles Taken at Concentration Sampling Tap 16 (C16) for the Coal Creek Drainage Flow Tests. (Ri = 0.54)

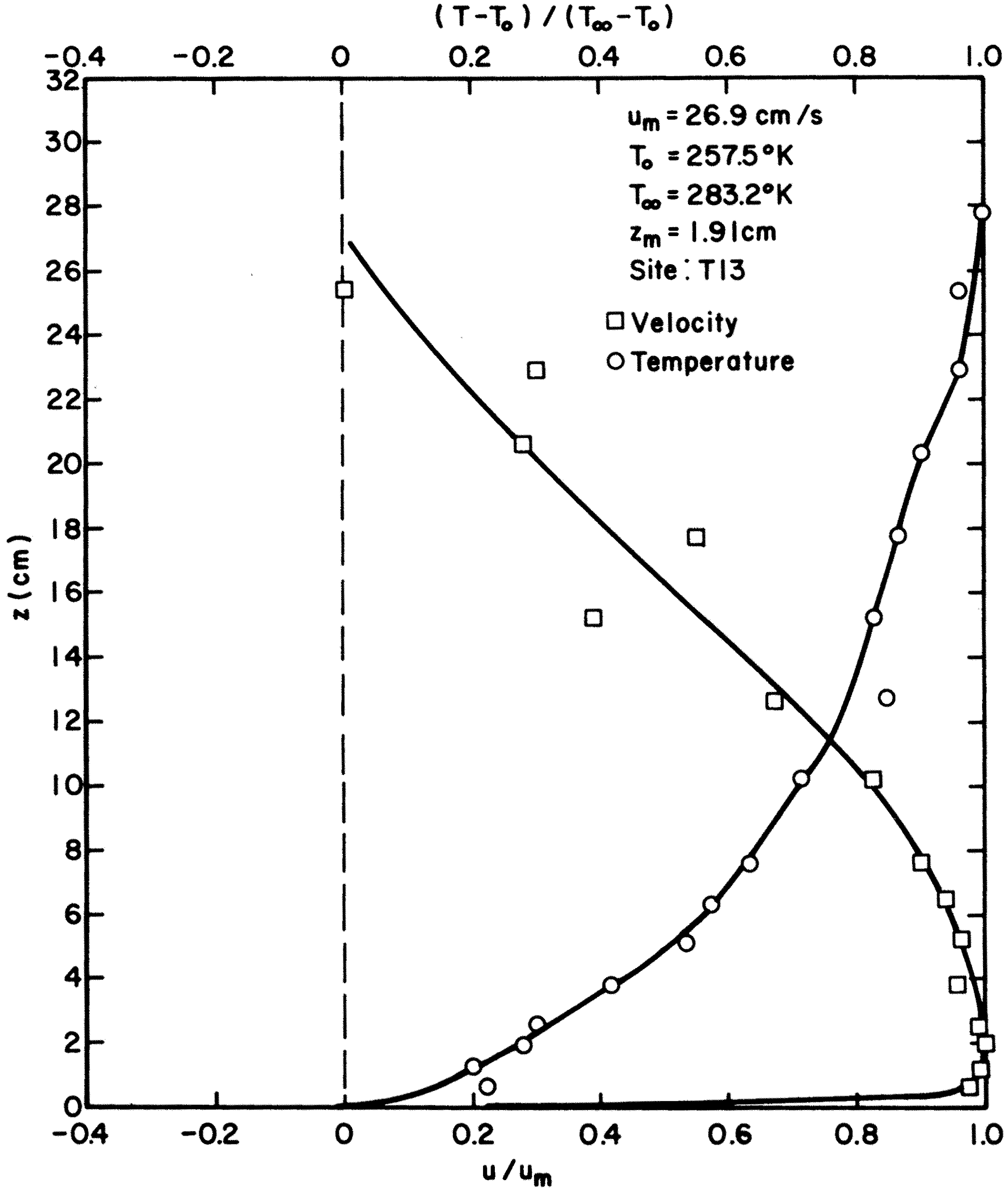


Figure 4-1-7. Velocity and Temperature Profiles Taken at T13 for the Coal Creek Drainage Flow Tests. (Ri = 0.07)

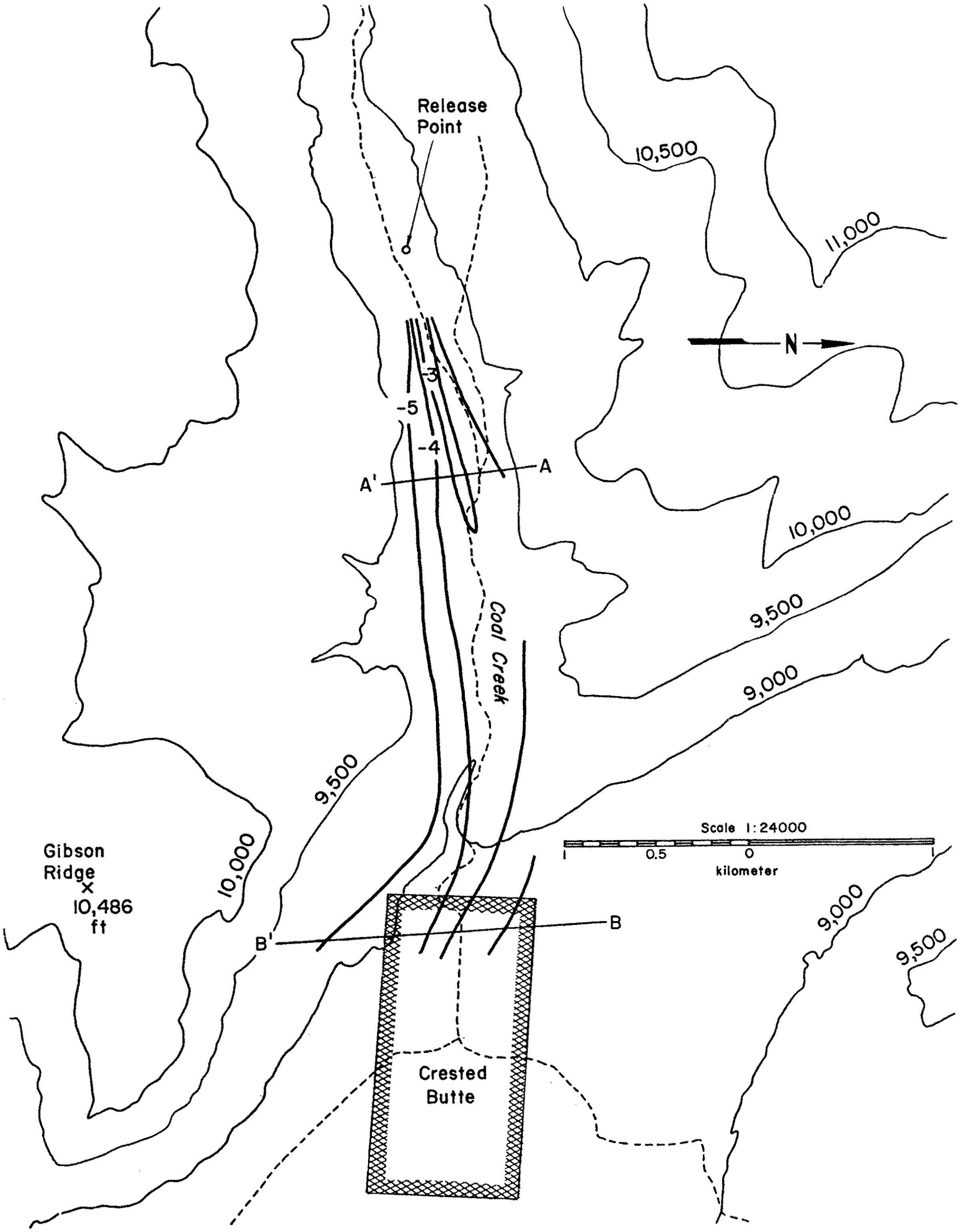


Figure 4-2-1. Isopleths of Ground-level Normalized Concentration (K) for Drainage Flow at Coal Creek with a 0.318 cm (6.1 m) Release (Numbers are the Logarithm of the Normalized Concentration).

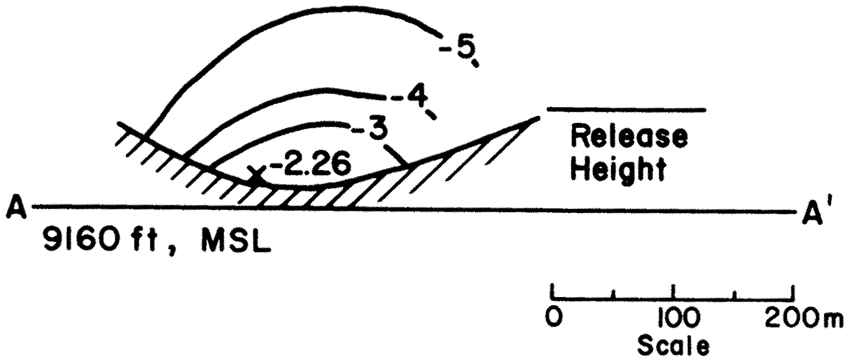


Figure 4-2-2. Isopleths in the Vertical of the Normalized Concentration (K) for the Coal Creek Drainage Flow Test Taken 68 cm (1.3 km) Downwind of a 0.318 cm (6.1 m) Release (Numbers are the Logarithm of the Normalized Concentration)

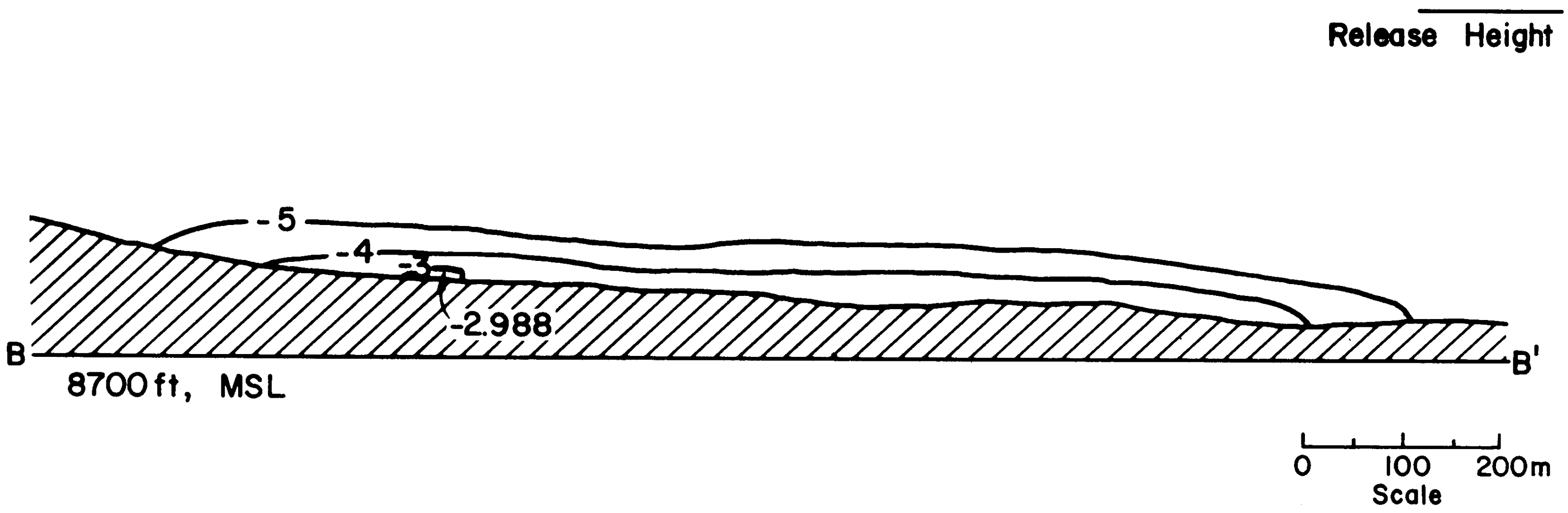


Figure 4-2-3. Isopleths in the Vertical of the Normalized Concentration (K) for the Coal Creek Drainage Flow Test Taken 196 cm (3.7 km) Downwind of a 0.318 cm (6.1 m) Release (Numbers are the Logarithm of the Normalized Concentration)

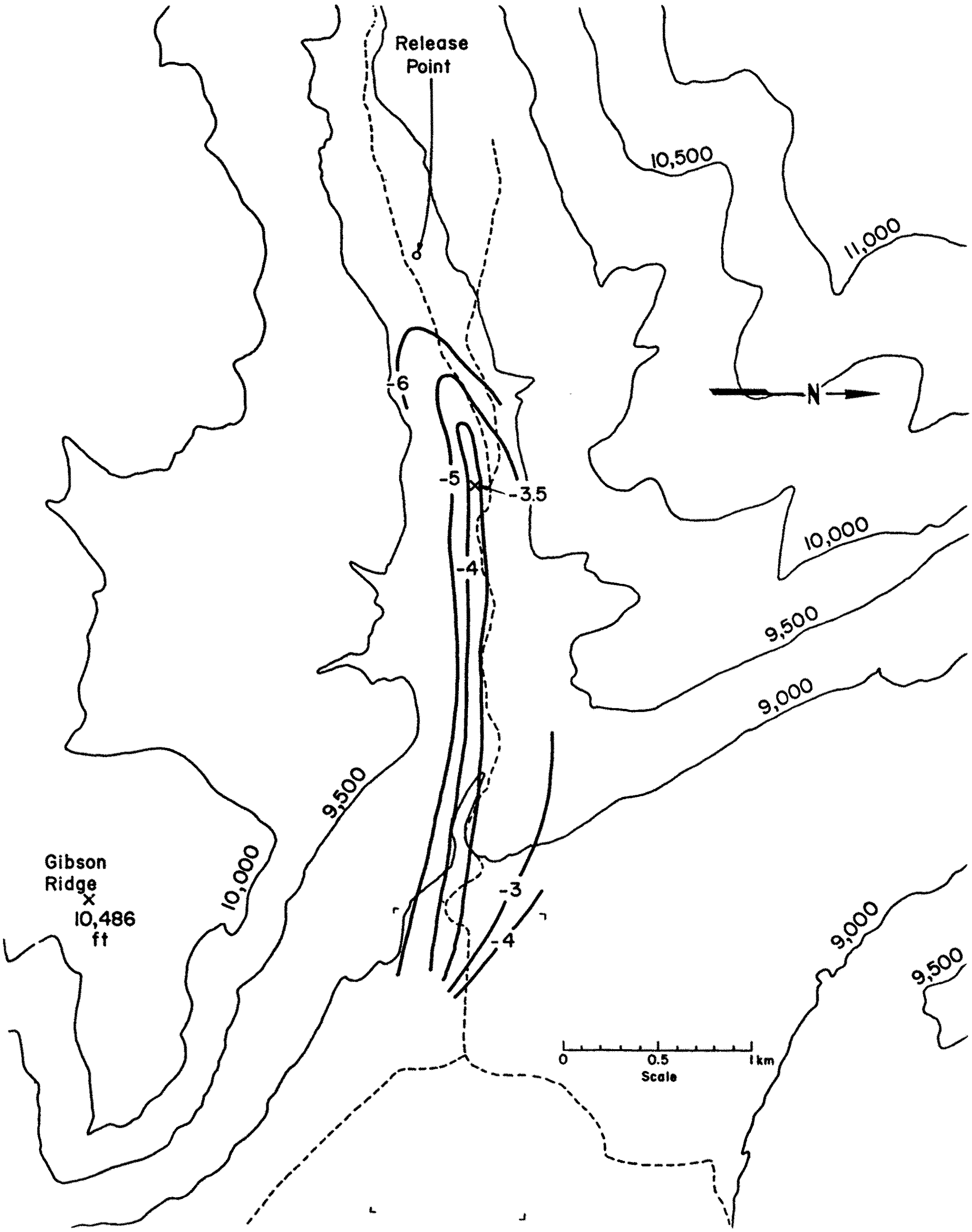


Figure 4-2-4. Isopleths of Ground-level Normalized Concentration (K) for Drainage Flow at Coal Creek with a 2.54 cm (49 m) Release (Numbers are the Logarithm of the Normalized Concentration)

Figure 4-3-1. Picture Taken above Coal Creek Model of Smoke Released at T16. Crested Butte is at Top Center of Picture

Figure 4-3-2. Picture Taken from Mt. Emmons Side of Model at Up-valley Return Flow (Slains Gulch Shows in Lower Left)

Figure 4-3-3. Picture Taken from Top of Smoke Released up the North Side of Valley Showing the Slope Flow Merging with the Down-valley Flow. Crested Butte is at Top Center of Picture

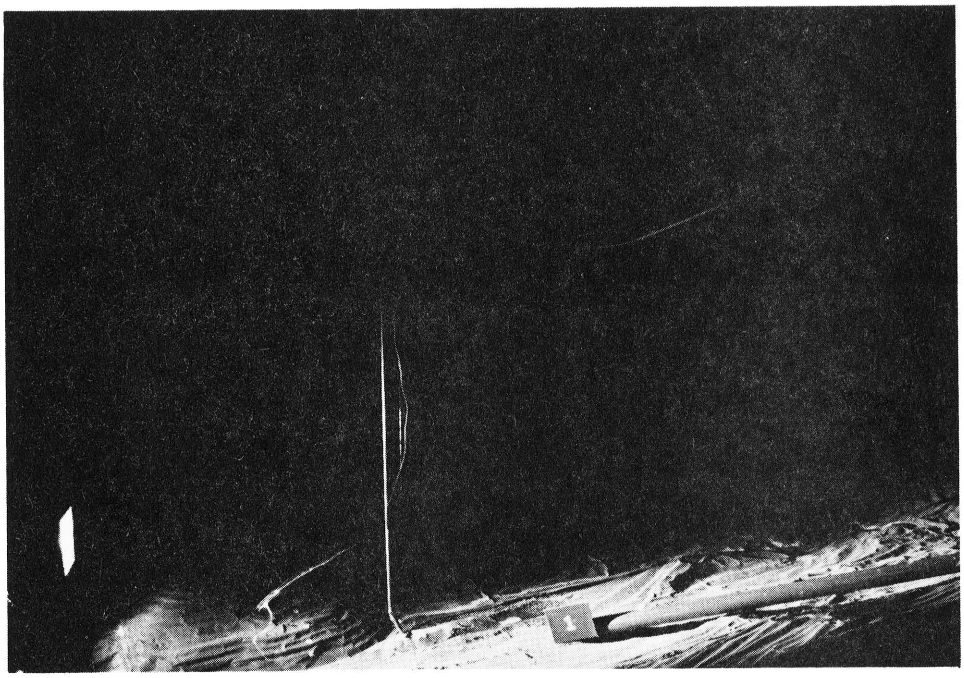


Figure 4-3-4. Photograph of Velocity Profile over T16 as Produced by the Smoke Wire (the Down-valley Component has the Largest Magnitude)

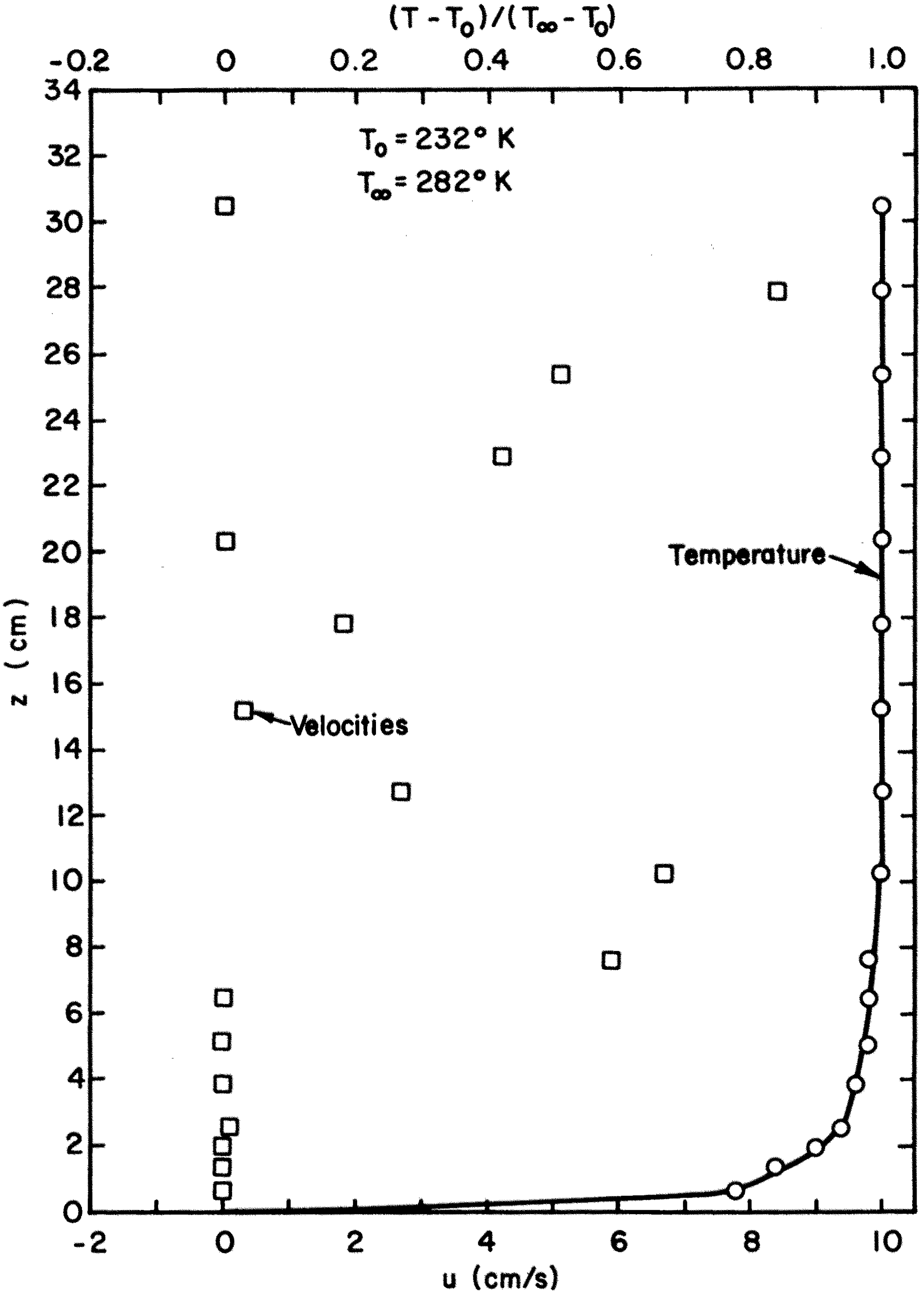


Figure 5-1-1. Velocity and Temperature Profile at T4 for the Alkali Creek Drainage Flow Test

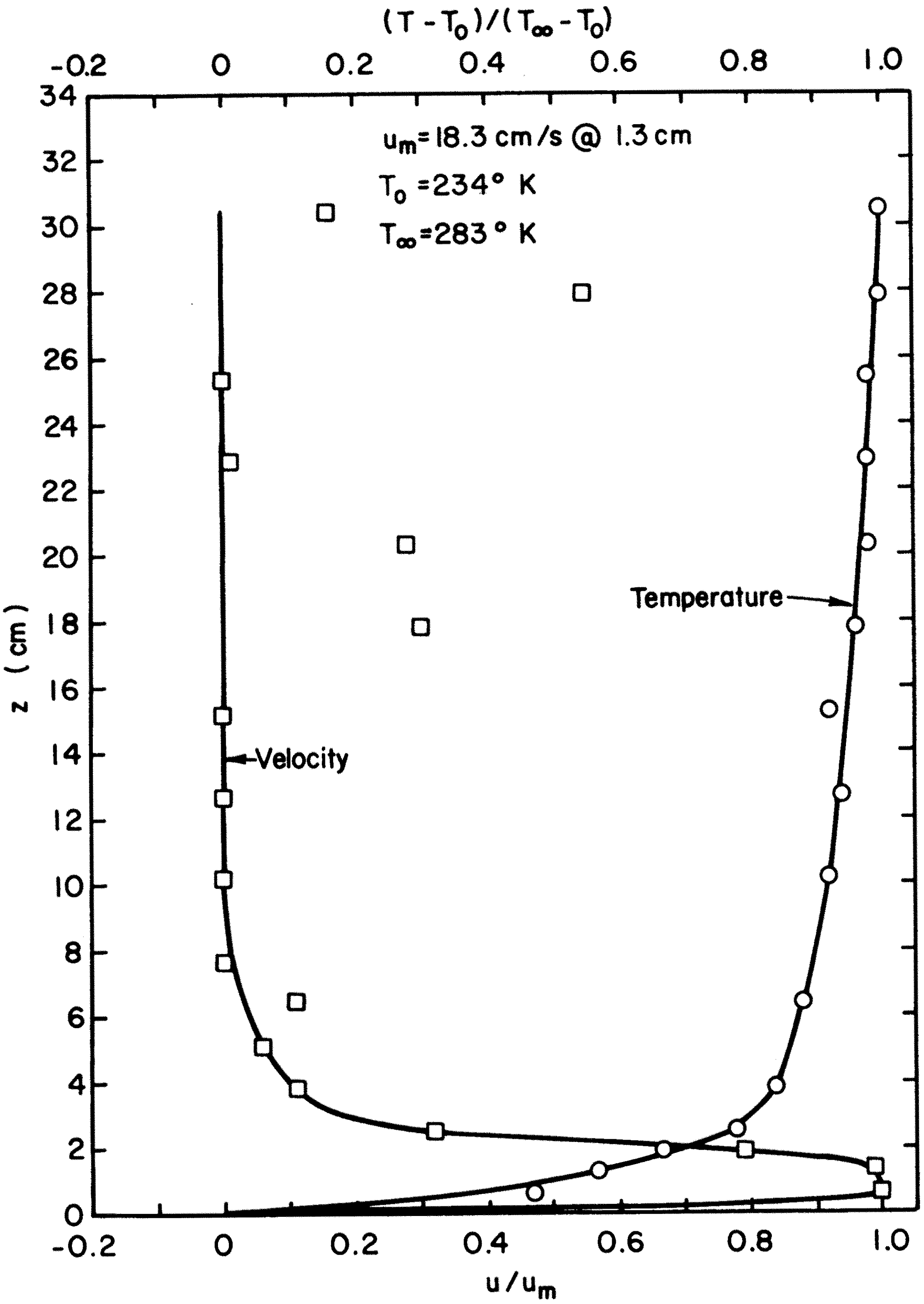


Figure 5-1-2. Velocity and Temperature Profile at T6 for the Alkali Creek Drainage Flow Test (Ri = 0.38)

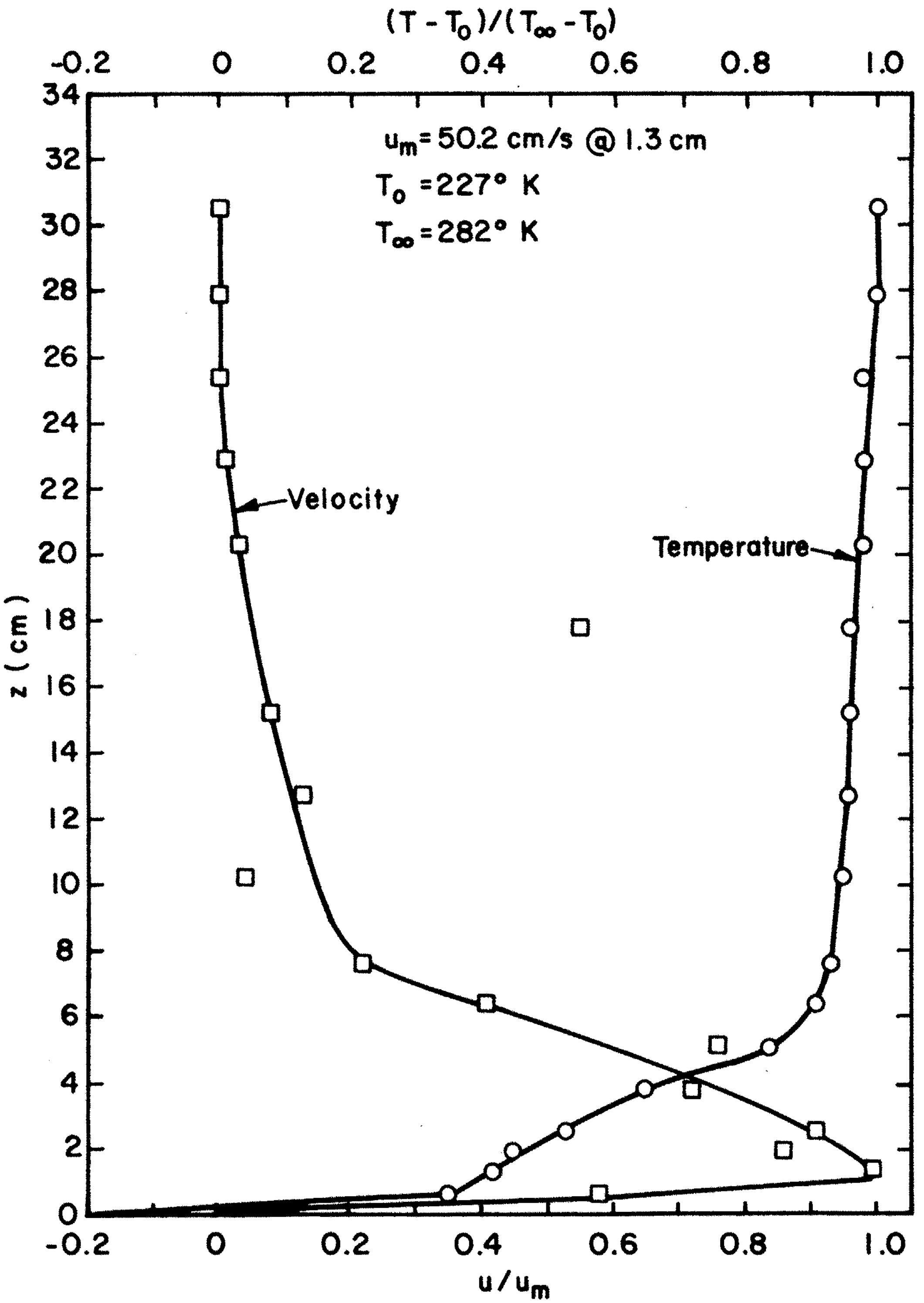


Figure 5-1-3. Velocity and Temperature Profile at T11 for the Alkali Creek Drainage Flow Test (Ri = 0.05)

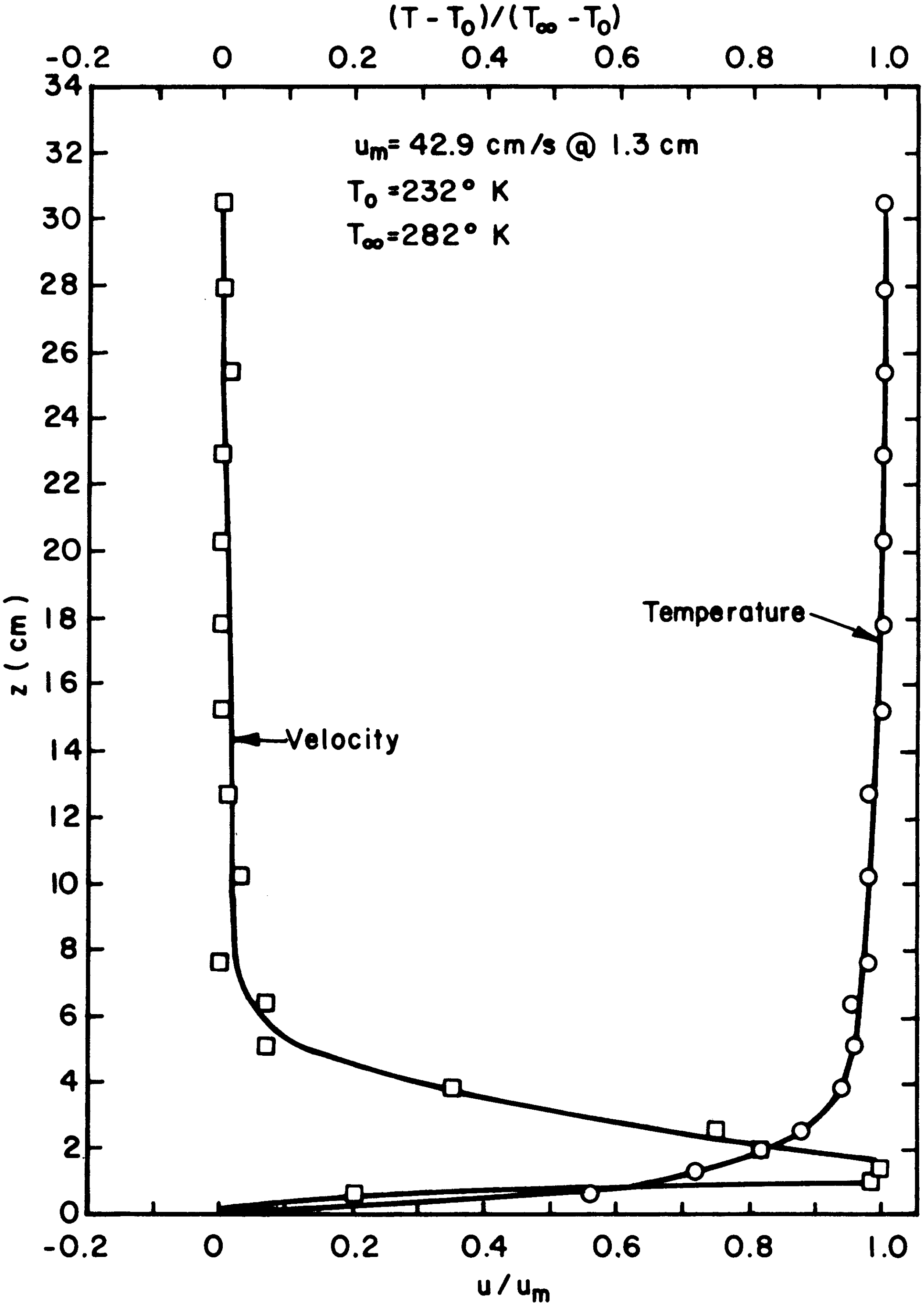


Figure 5-1-4. Velocity and Temperature Profile at the Red Mountain Set Location for the Alkali Creek Drainage Flow Test (Ri = 0.10)

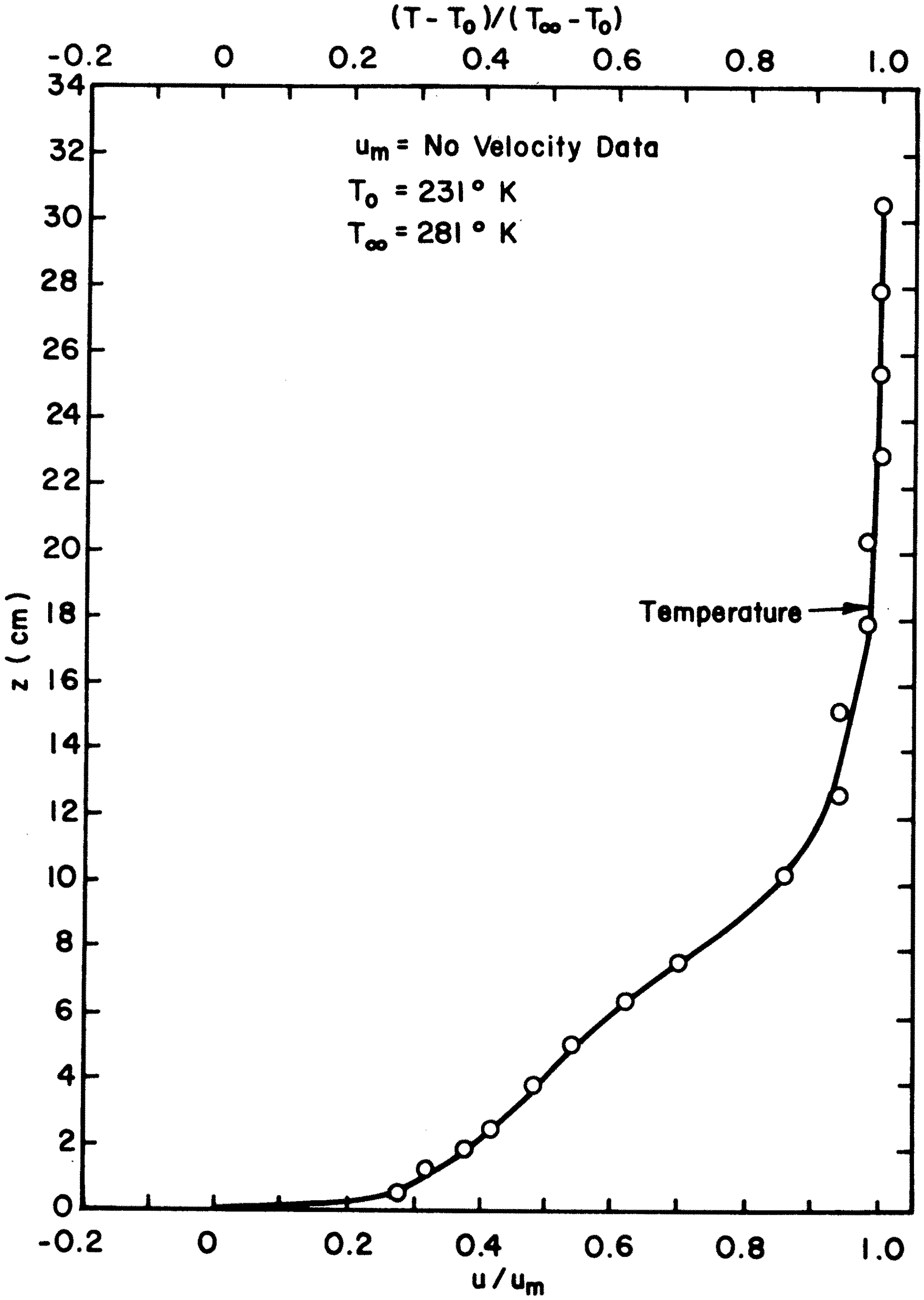


Figure 5-1-5. Temperature Profile at T8 for the Alkali Creek Drainage Flow Test

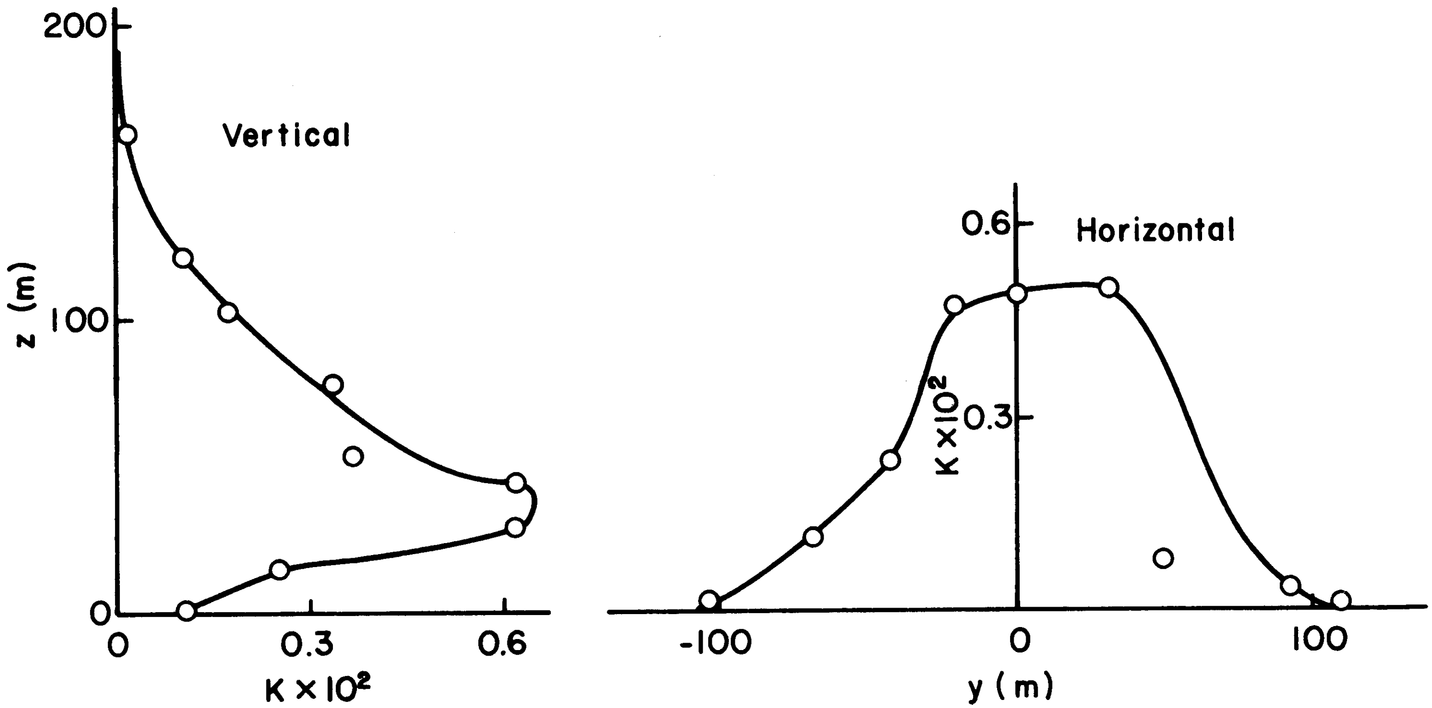


Figure 5-2-1. Vertical and Horizontal Profiles of the Normalized Concentration (K) for the Drainage Flow Test at Alkali Creek Taken 27 cm (0.67 km) Downwind of the 0.318 cm (8.1 m) Release

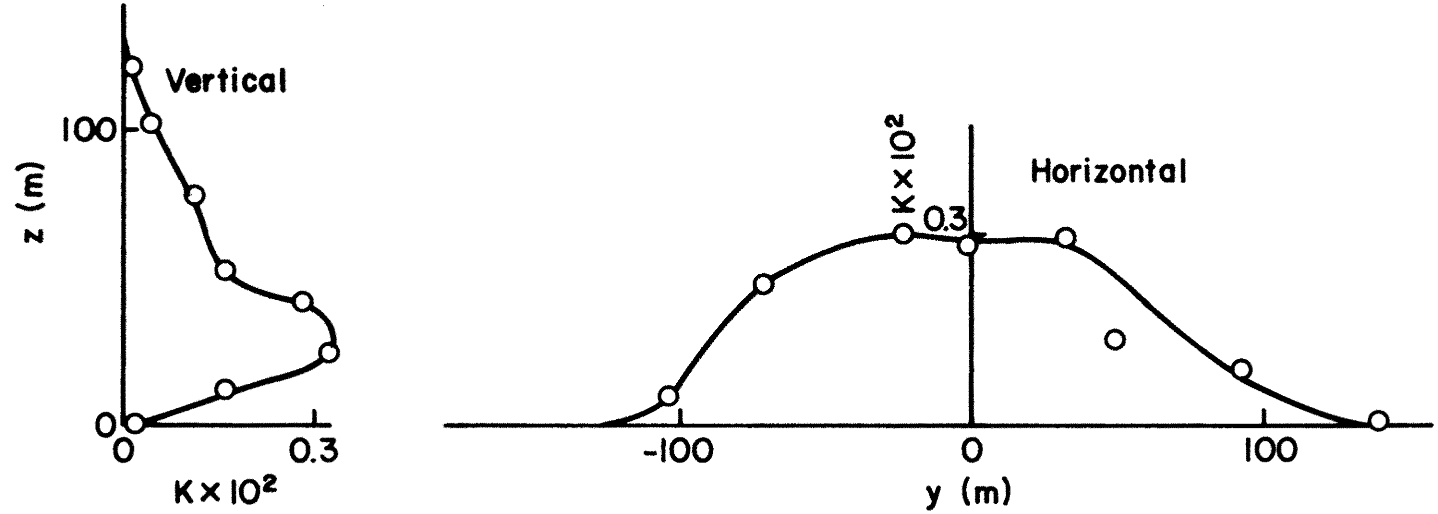


Figure 5-2-2. Vertical and Horizontal Profiles of the Normalized Concentration (K) for the Drainage Flow Test at Alkali Creek Taken 59 cm (1.5 km) Downwind of the 0.318 cm (8.1 m) Release

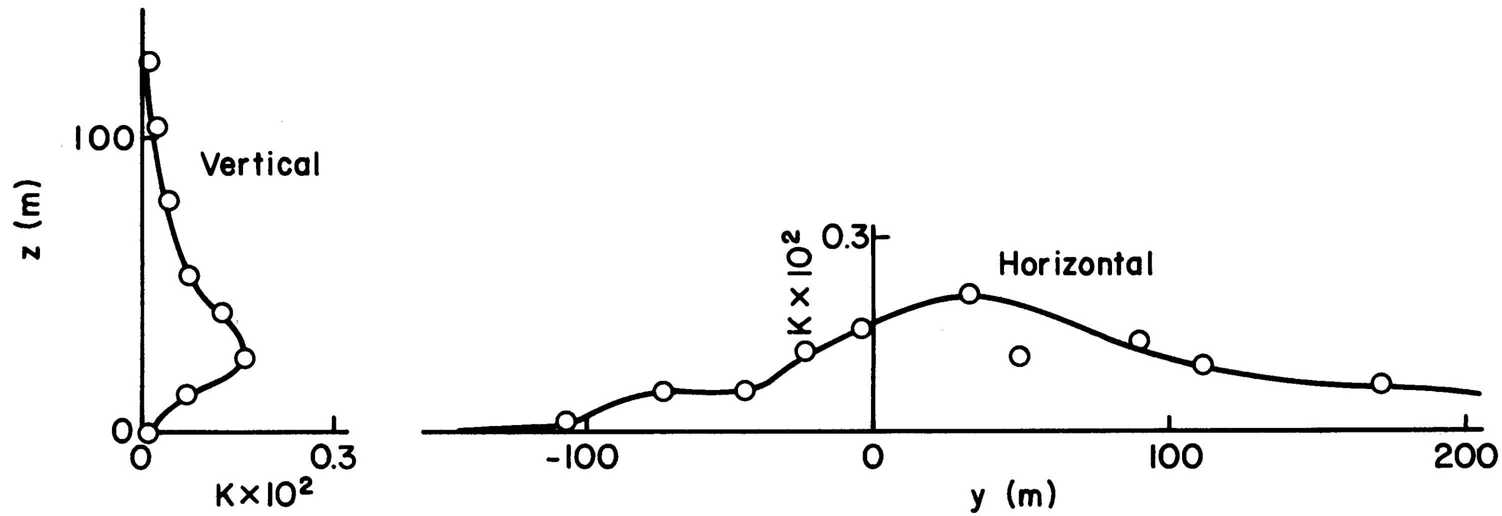


Figure 5-2-3. Vertical and Horizontal Profiles of the Normalized Concentration (K) for the Drainage Flow Test at Alkali Creek Taken 90 cm (2.3 km) Downwind of the 0.318 cm (8.1 m) Release

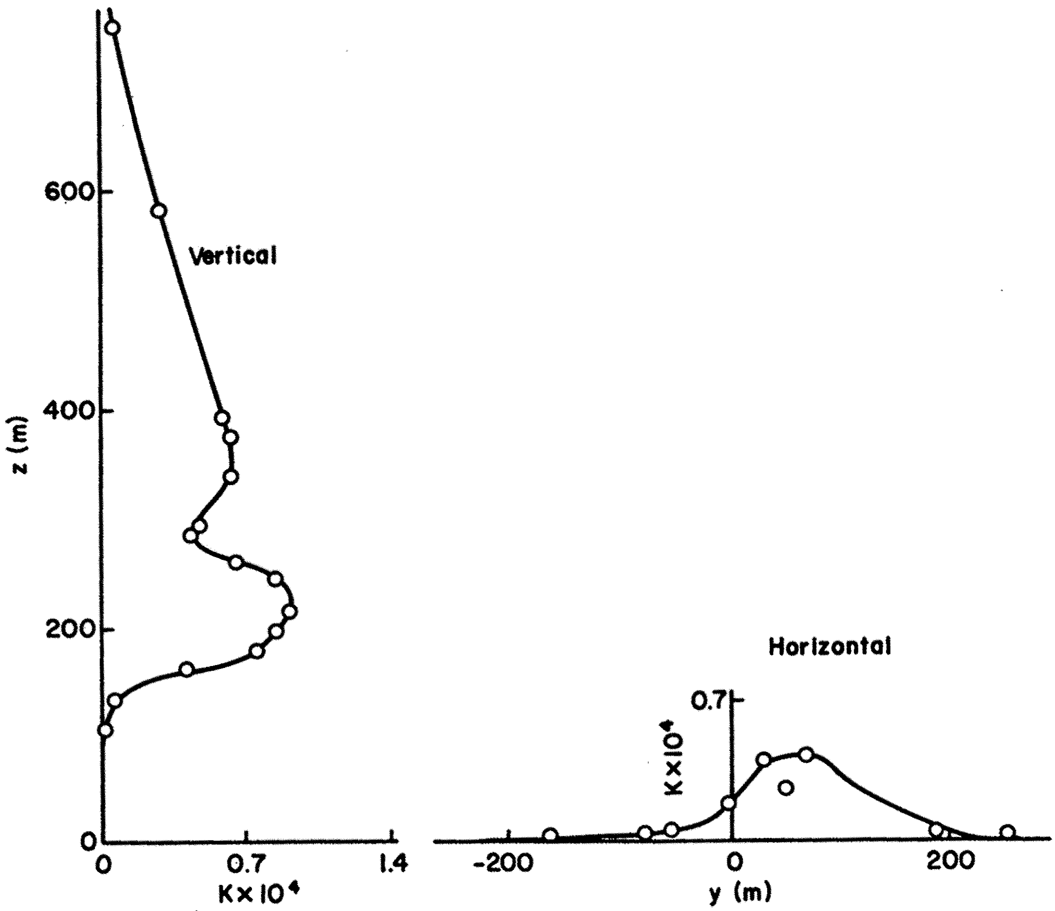


Figure 5-2-4. Vertical and Horizontal Profiles of the Normalized Concentration (K) for the Drainage Flow Test at Alkali Creek Taken 27 cm (0.67 km) Downwind of the 2.54 cm (65 m) Release

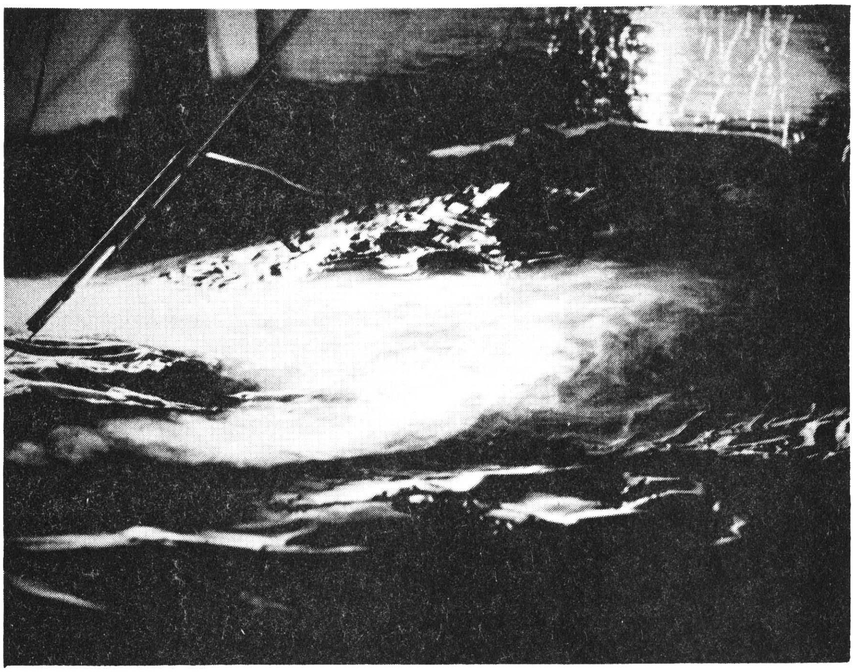


Figure 5-3-1. Visualization of Southerly Flow off Red Mountain Turning East and Southwest with a Stagnant Zone over the Alkali Creek Basin

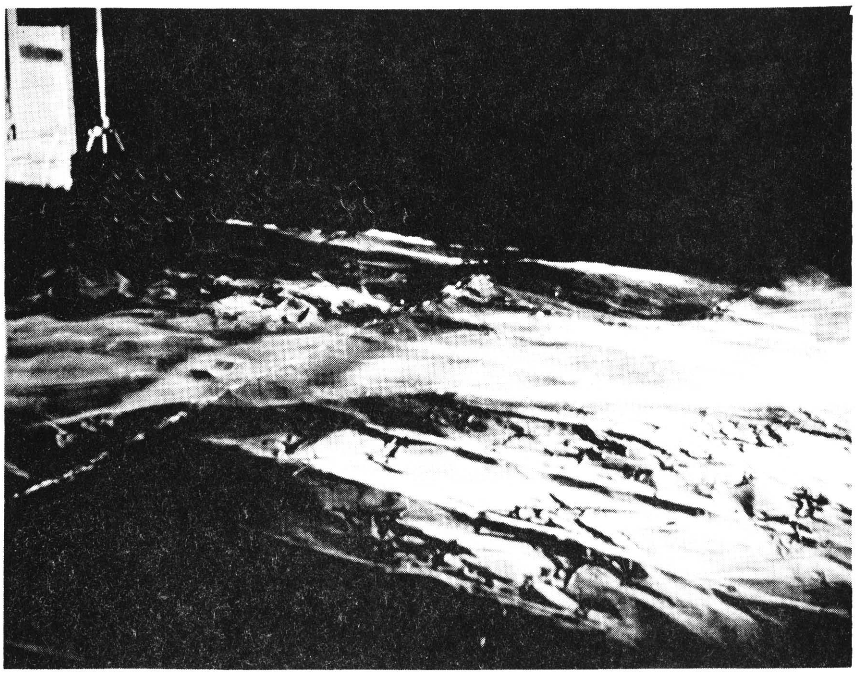


Figure 5-3-2. Picture of the Spillover Flow Moving Southwest toward Ohio Creek (Right Side of Picture)

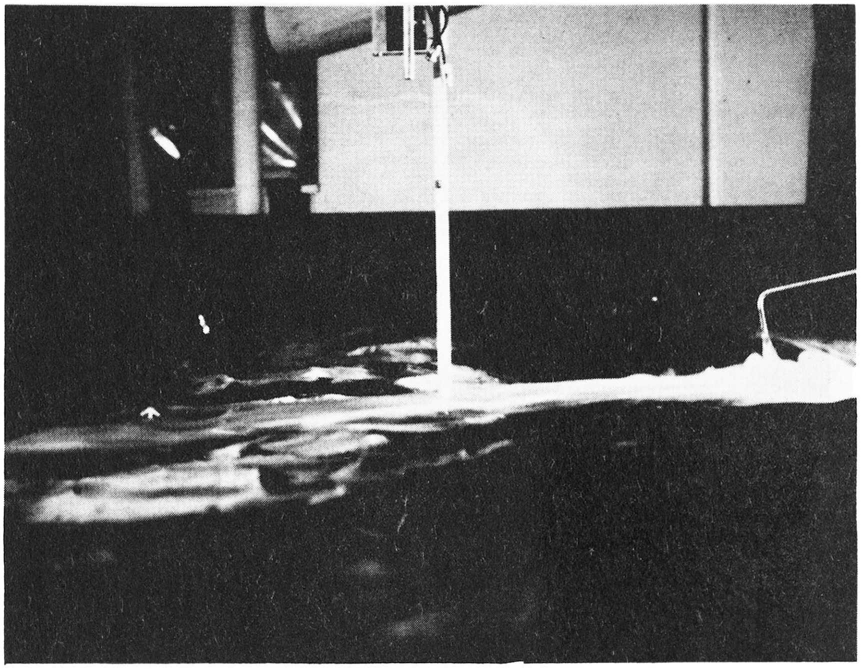


Figure 5-3-3. Picture of Spillover Flow Moving Southwest toward Ohio Creek (toward Left in Picture) The Depth of the Flow is Evident in the Picture

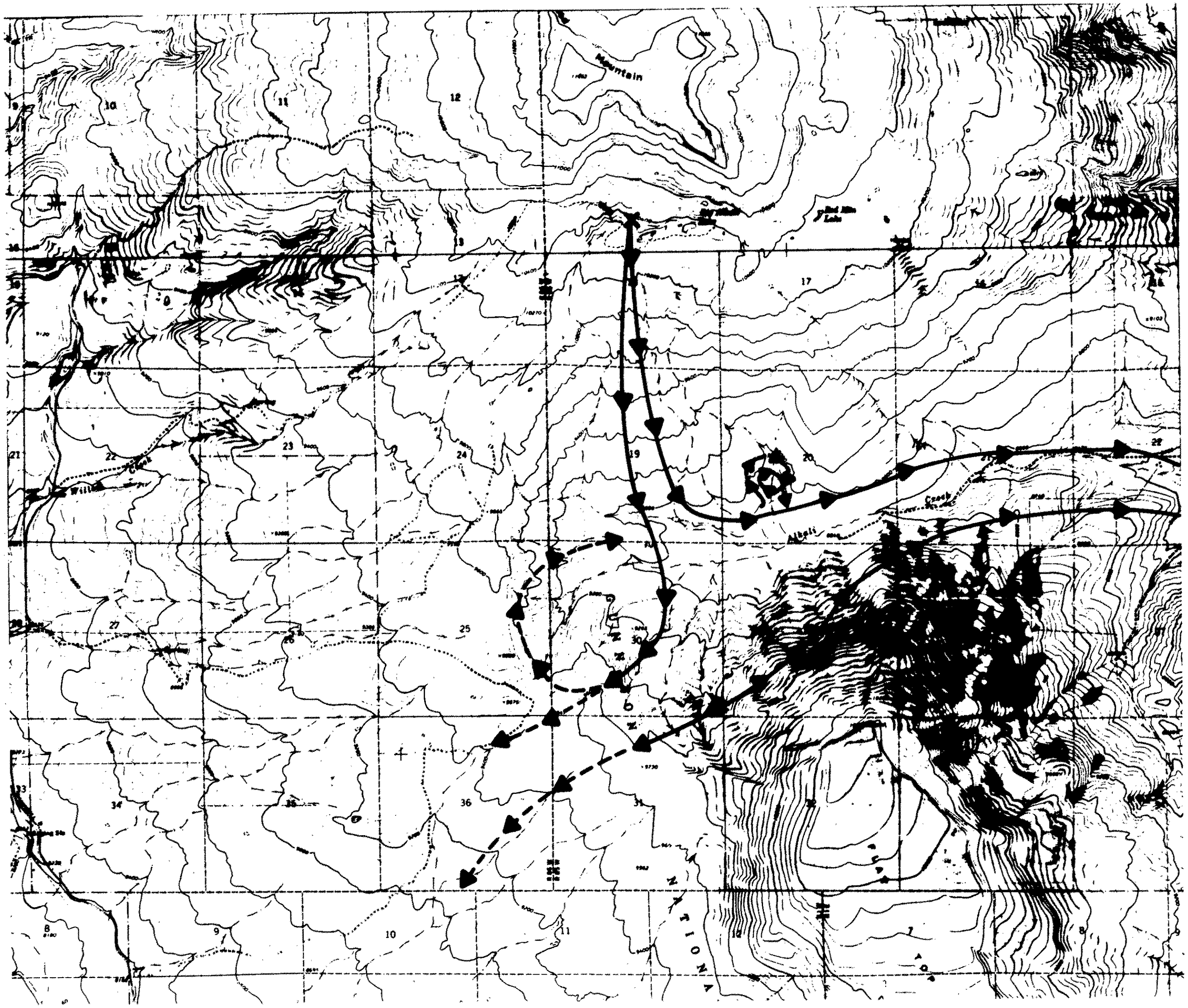


Figure 5-3-4. Depiction of Flow Patterns in the Vicinity of Alkali Creek for Drainage Conditions

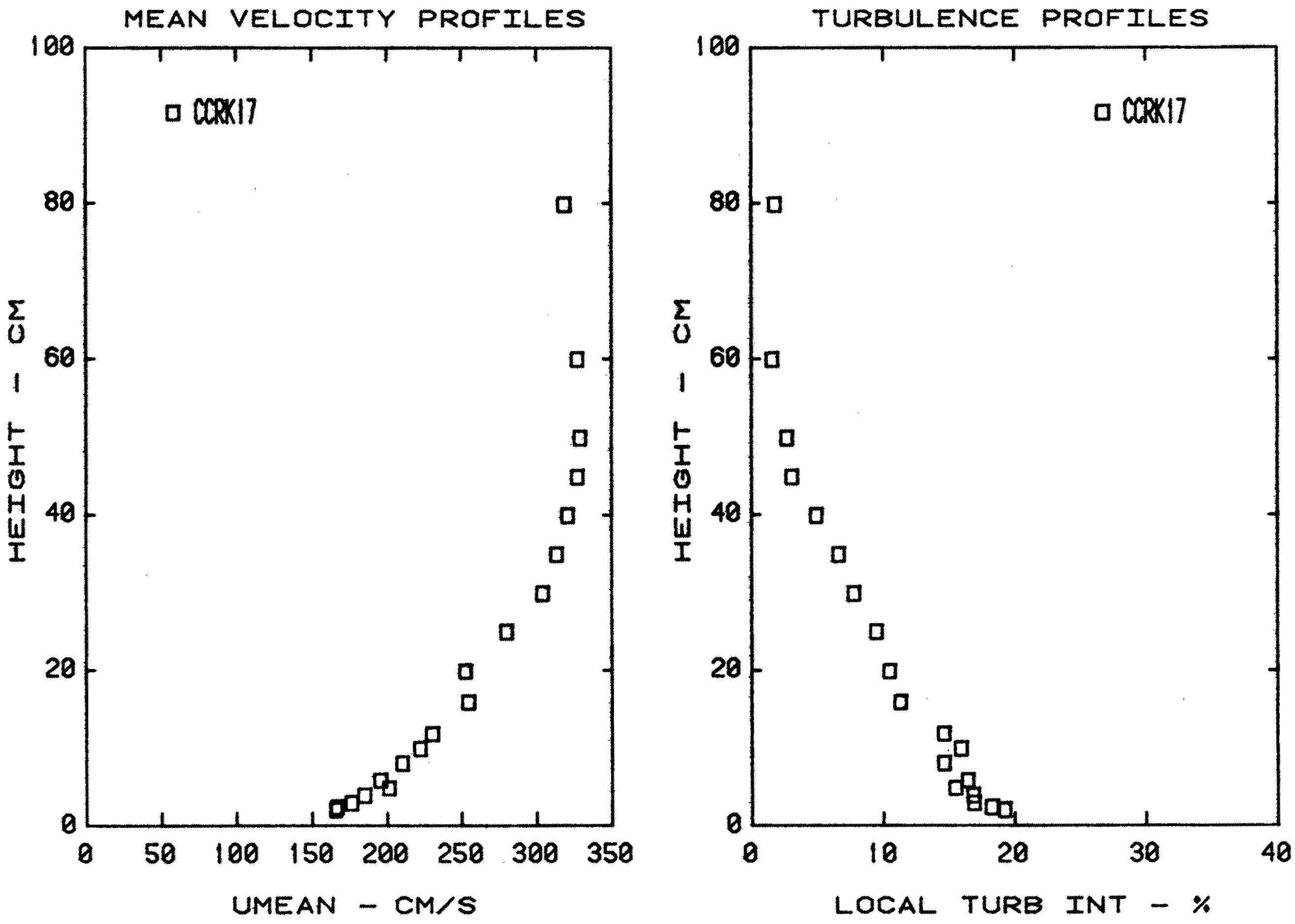


Figure 6-1-1. Mean Velocity and Turbulence Intensity Profiles Taken at T17 for the Coal Creek Neutral Stability Tests.

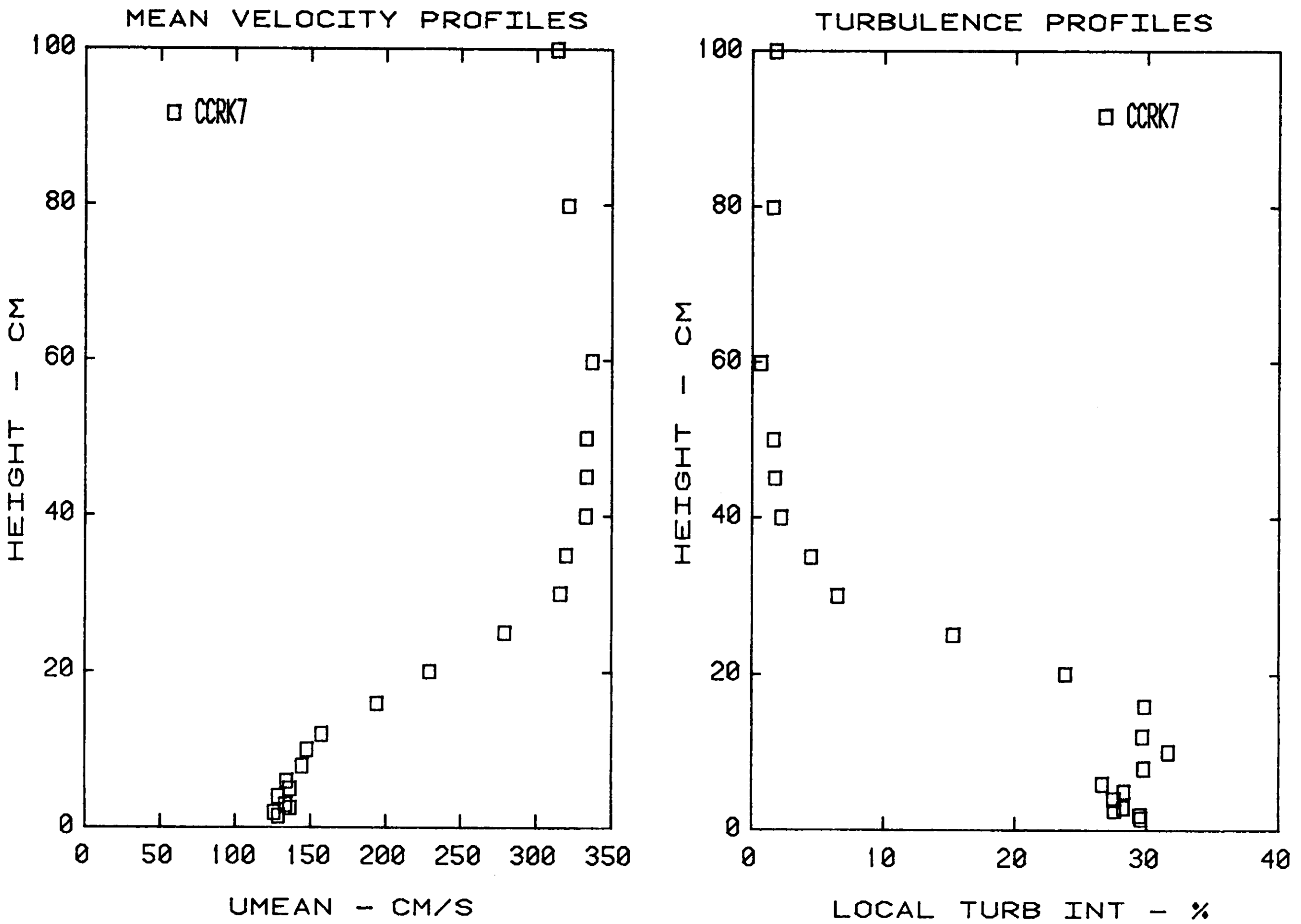


Figure 6-1-2. Mean Velocity and Turbulence Intensity Profiles Taken at T7 for the Coal Creek Neutral Stability Tests.

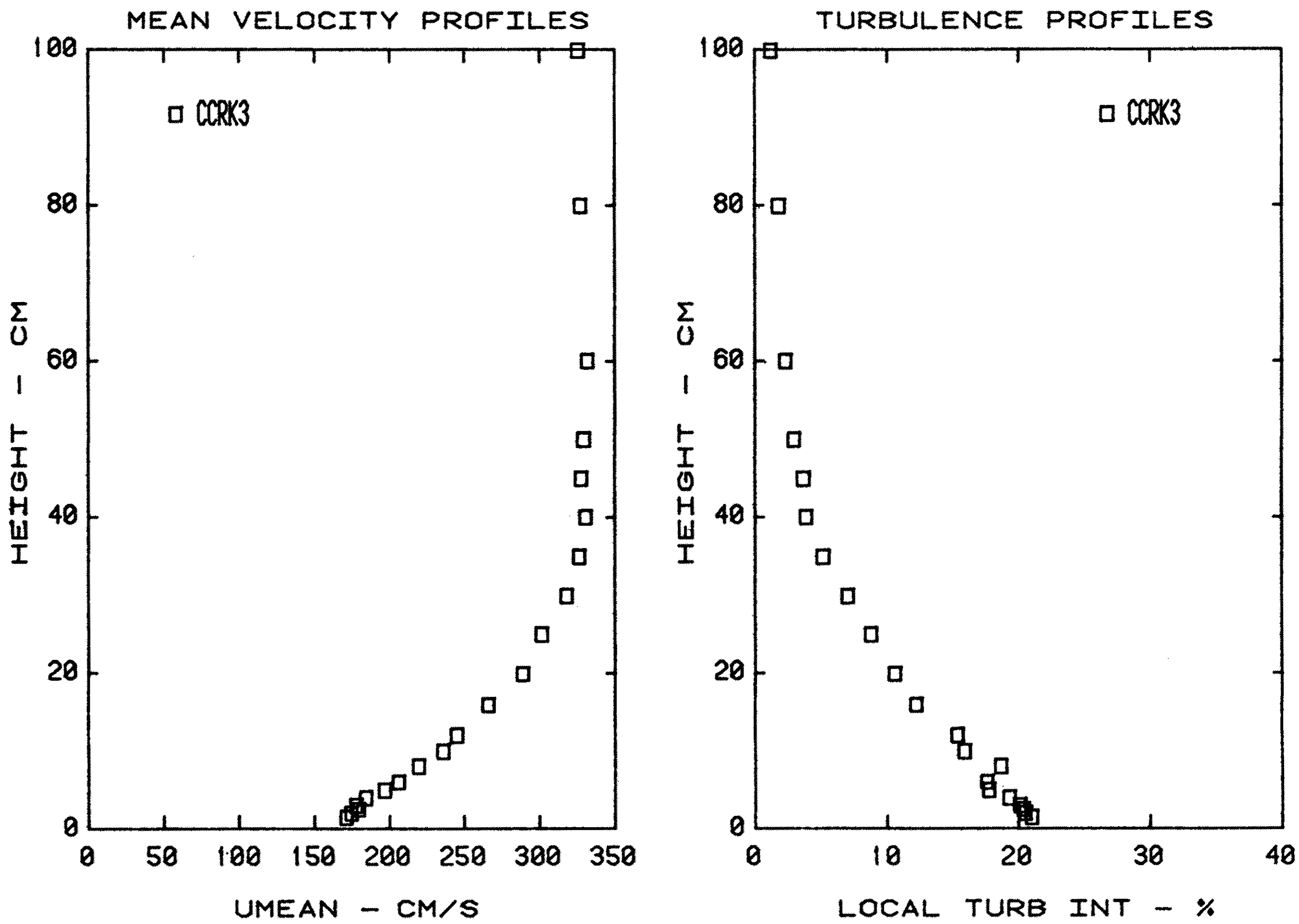


Figure 6-1-3. Mean Velocity and Turbulence Intensity Profiles Taken at T3 for the Coal Creek Neutral Stability Tests.

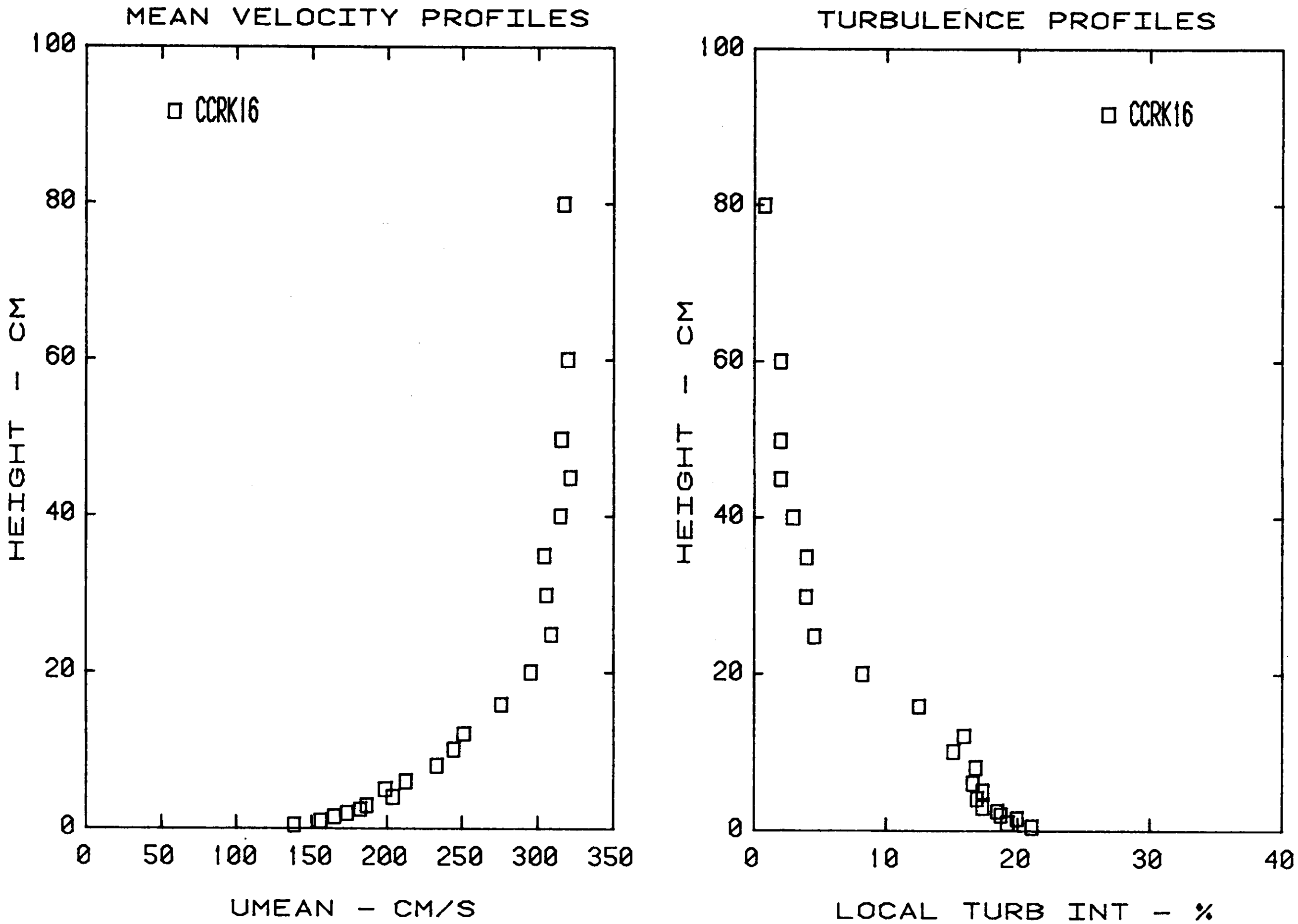


Figure 6-1-4. Mean Velocity and Turbulence Intensity Profiles Taken at T16 for the Coal Creek Neutral Stability Tests.

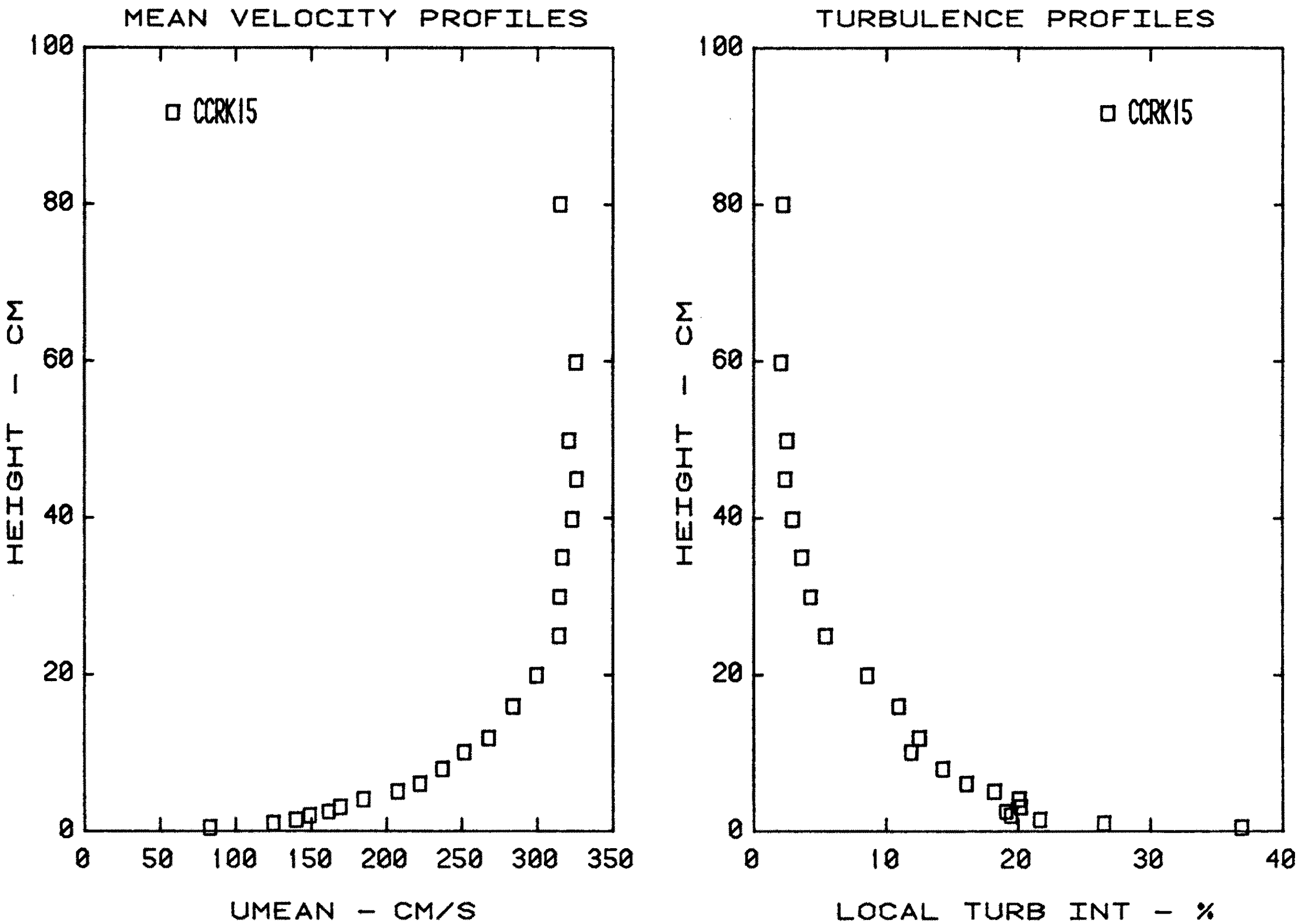


Figure 6-1-5. Mean Velocity and Turbulence Intensity Profiles Taken at T15 for the Coal Creek Neutral Stability Tests.

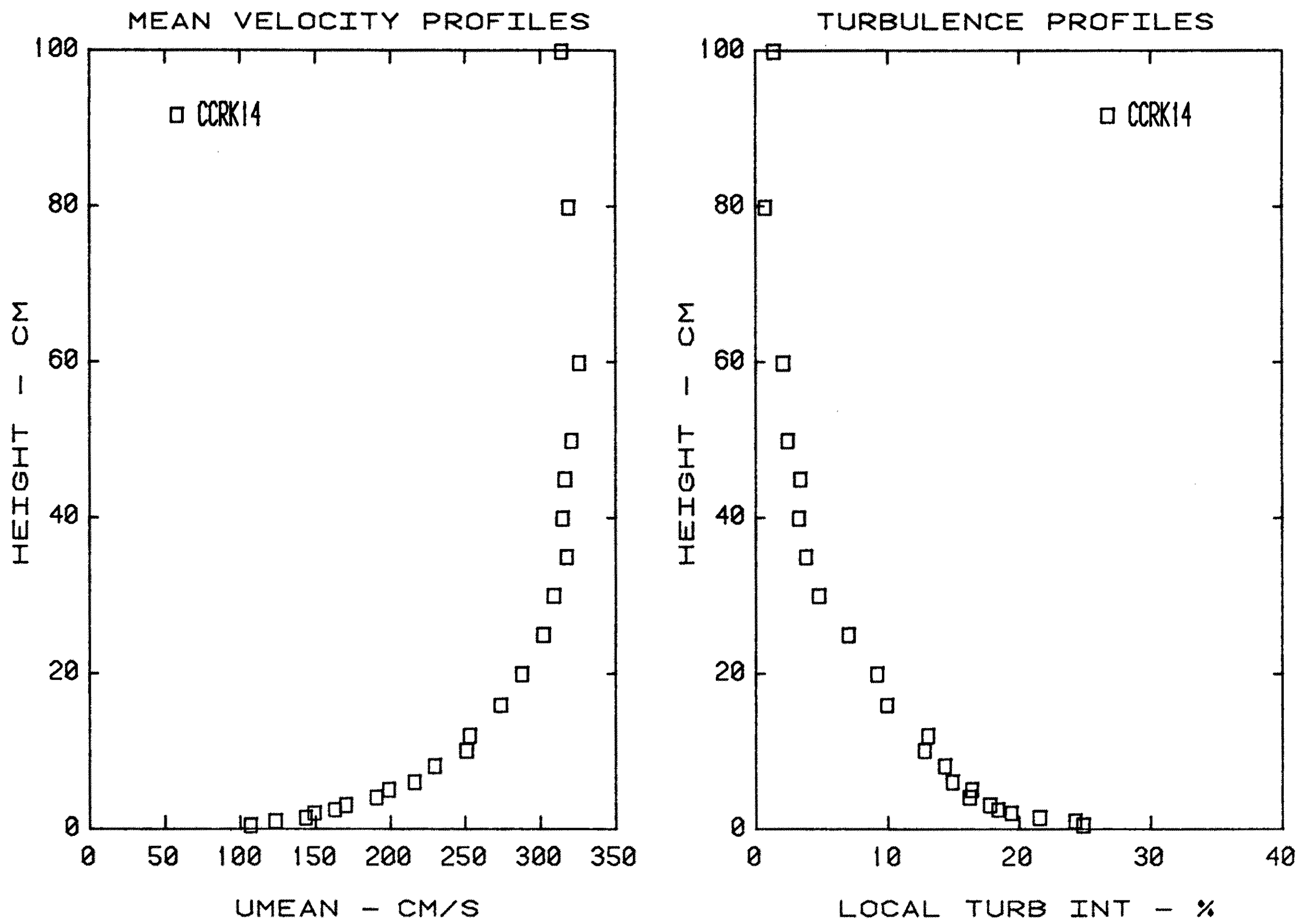


Figure 6-1-6. Mean Velocity and Turbulence Intensity Profiles Taken at T14 for the Coal Creek Neutral Stability Tests.

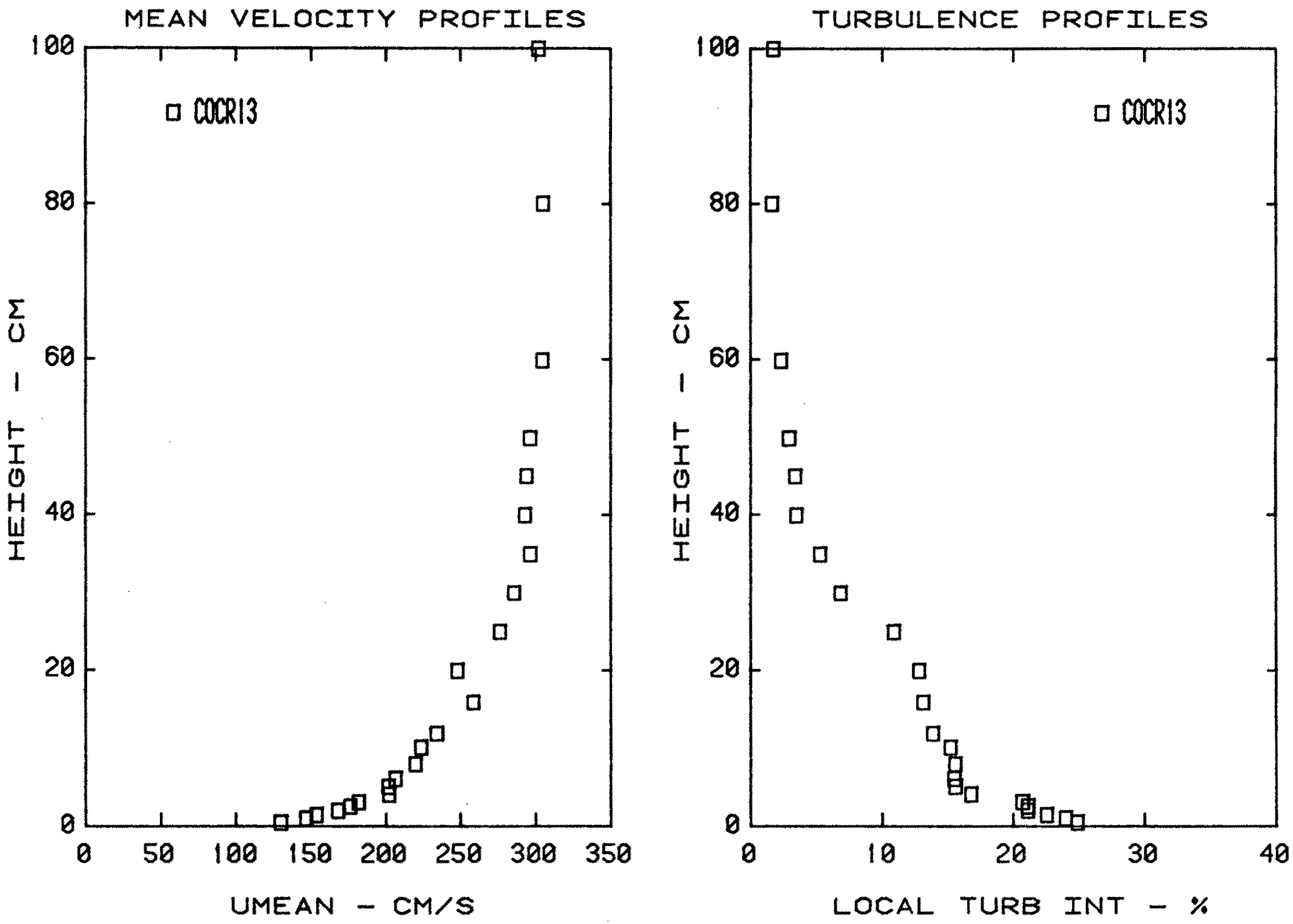


Figure 6-1-7. Mean Velocity and Turbulence Intensity Profiles Taken at T13 for the Coal Creek Neutral Stability Tests.

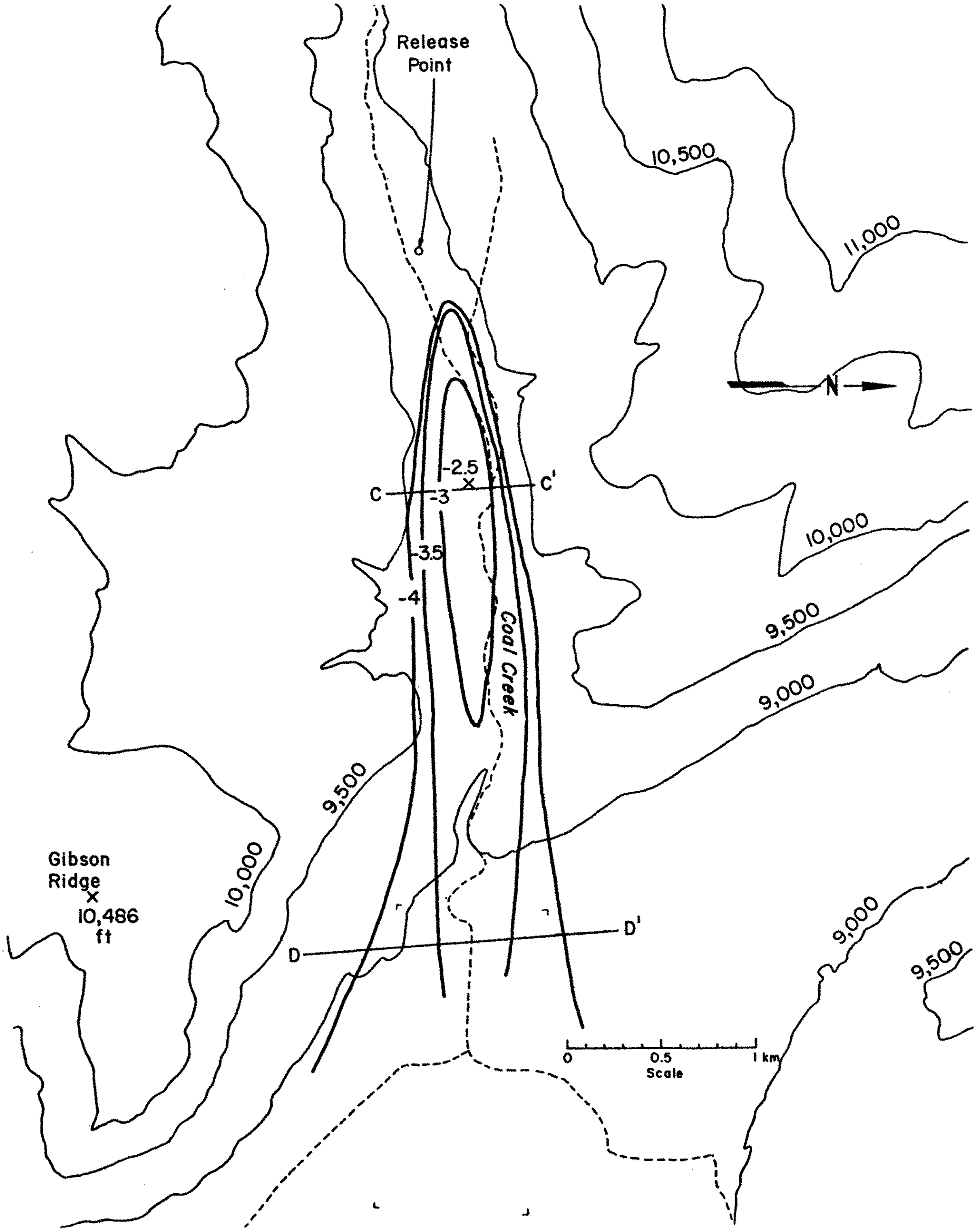


Figure 6-2-1. Isopleths of Ground-level Normalized Concentrations (plotted $\log_{10}$ K) for the Coal Creek Neutral Stability Test with a Free-stream Velocity of 3.0 m/s and a 0.318 cm (6.1 m full-scale) Release

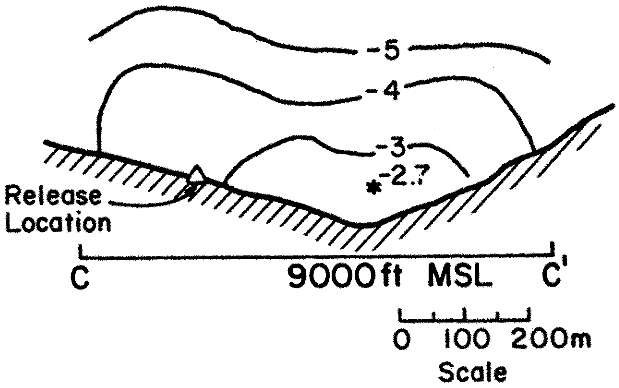


Figure 6-2-2. Isopleths in the Vertical of the Normalized Concentrations (plotted $\log_{10}$ K) for the Coal Creek Neutral Stability Test with a Free-stream Velocity of 3.0 m/s and Measured 68 cm (1.3 km full-scale) Downwind from a 0.318 cm (6.1 m full-scale) Release

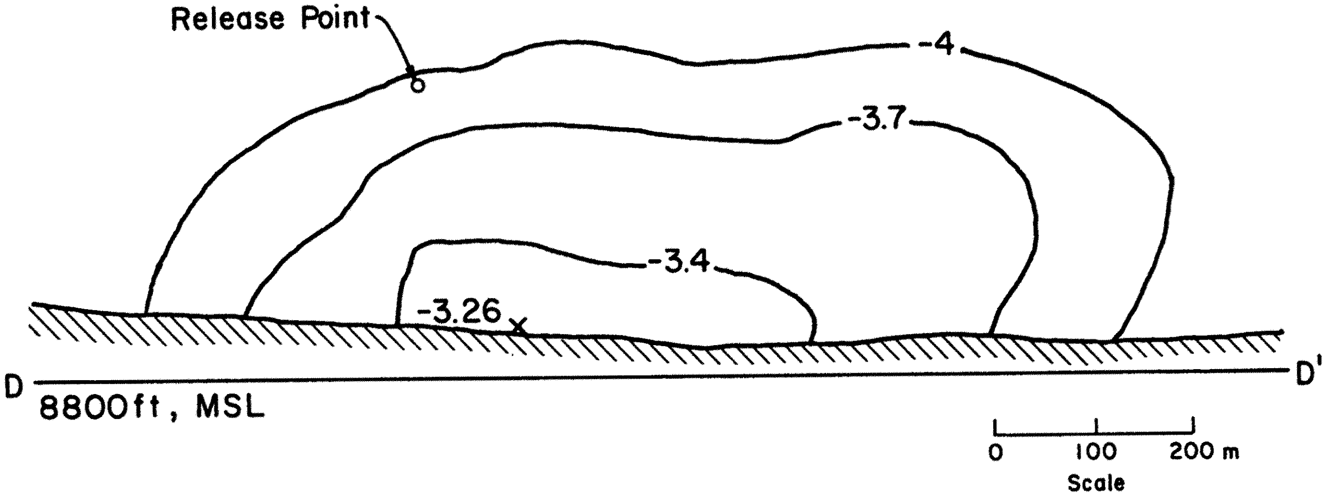


Figure 6-2-3. Isopleths in the Vertical of the Normalized Concentrations (plotted $\log_{10}$ K) for the Coal Creek Neutral Stability Test with a Free-stream Velocity of 3.0 m/s and Measured 196 cm (3.7 km full-scale) Downwind from a 0.318 cm (6.1 m full-scale) Release

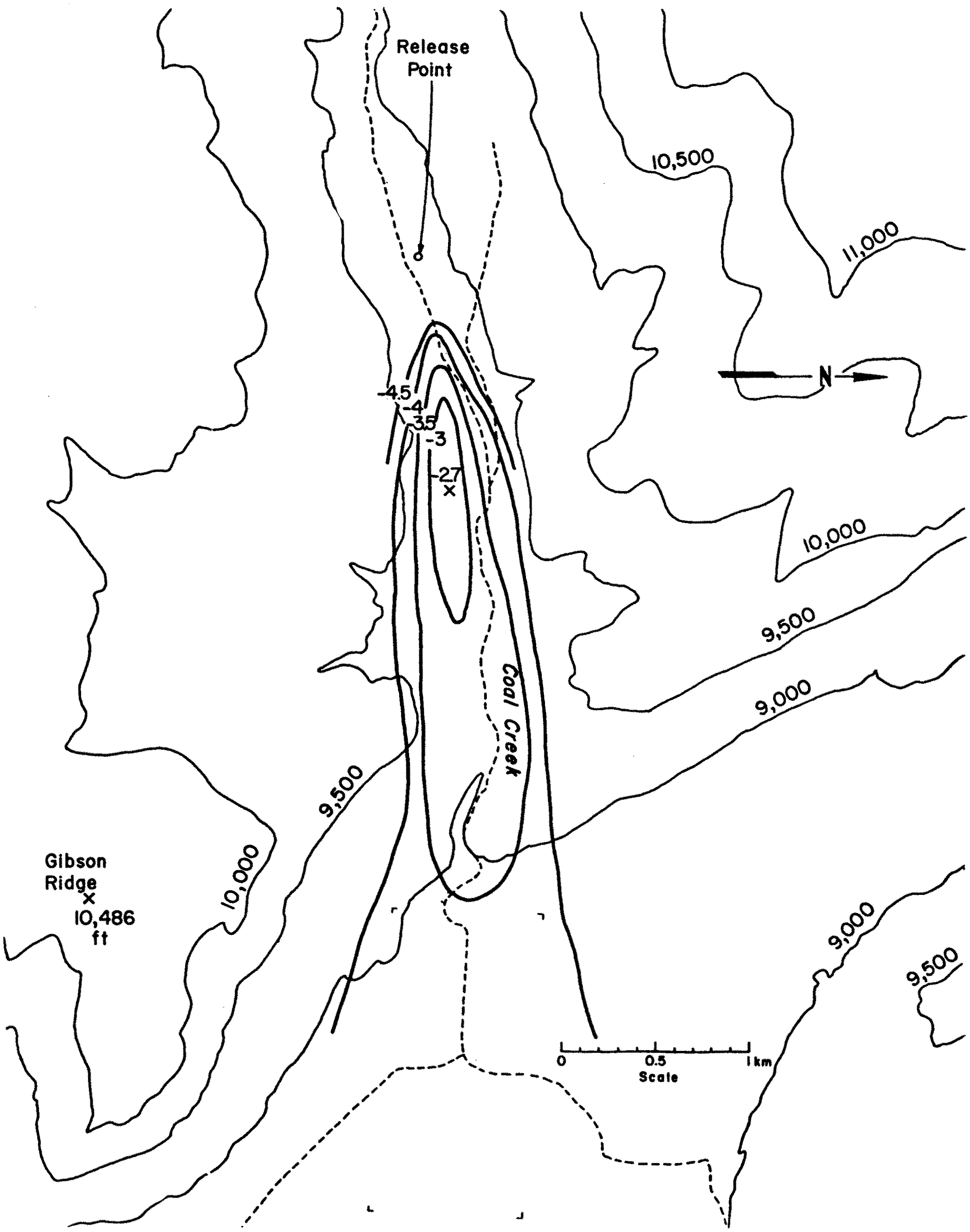


Figure 6-2-4. Isopleths of Ground-level Normalized Concentrations (plotted $\log_{10}$ K) for the Coal Creek Neutral Stability Test with a Free-stream Velocity of 3.0 m/s and a 2.54 cm (49 m full-scale) Release

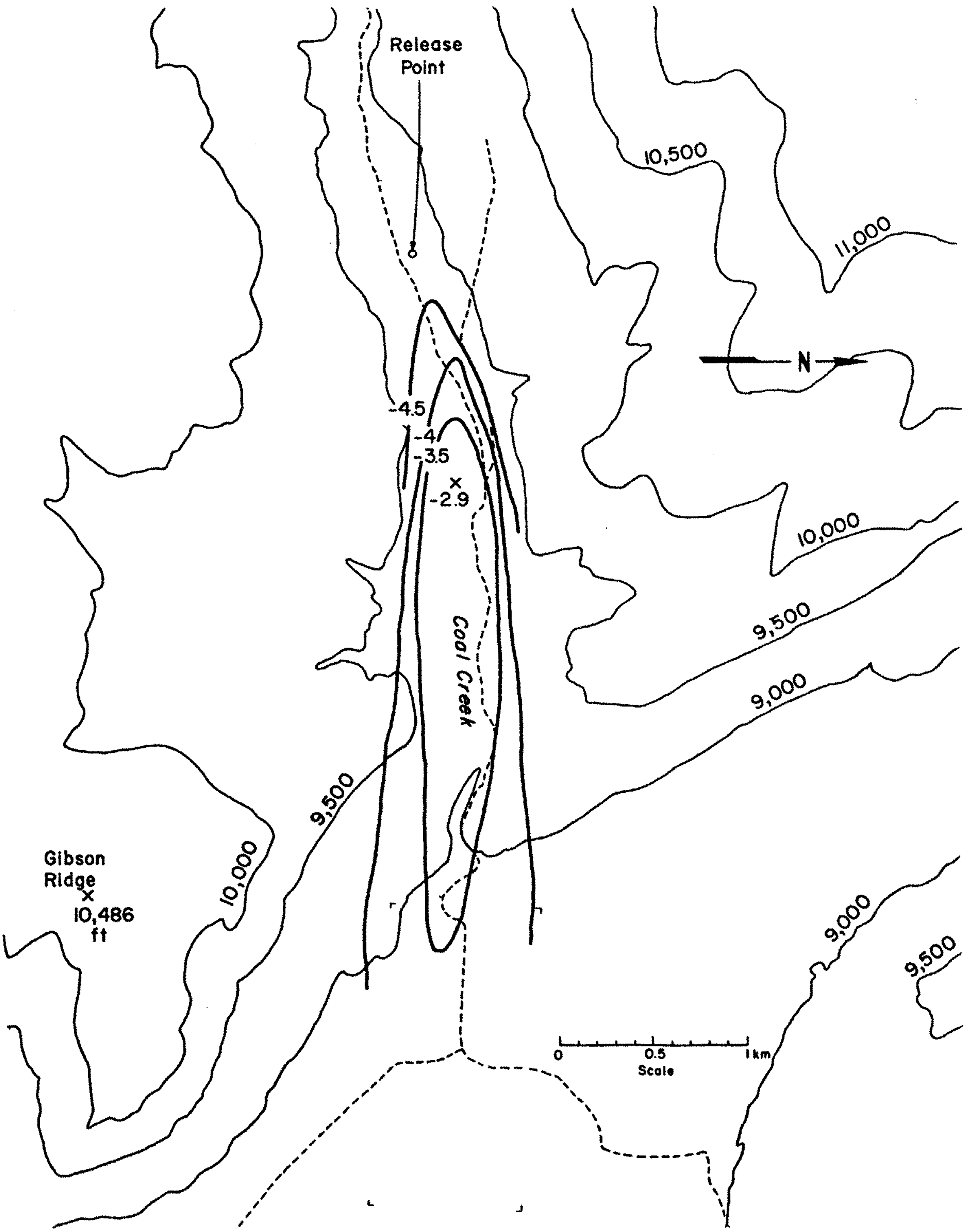


Figure 6-2-5. Isopleths of Ground-level Normalized Concentrations (plotted $\log_{10}$ K) for the Coal Creek Neutral Stability Test with a Free-stream Velocity of 3.0 m/s and a 5.08 cm (98 m full-scale) Release

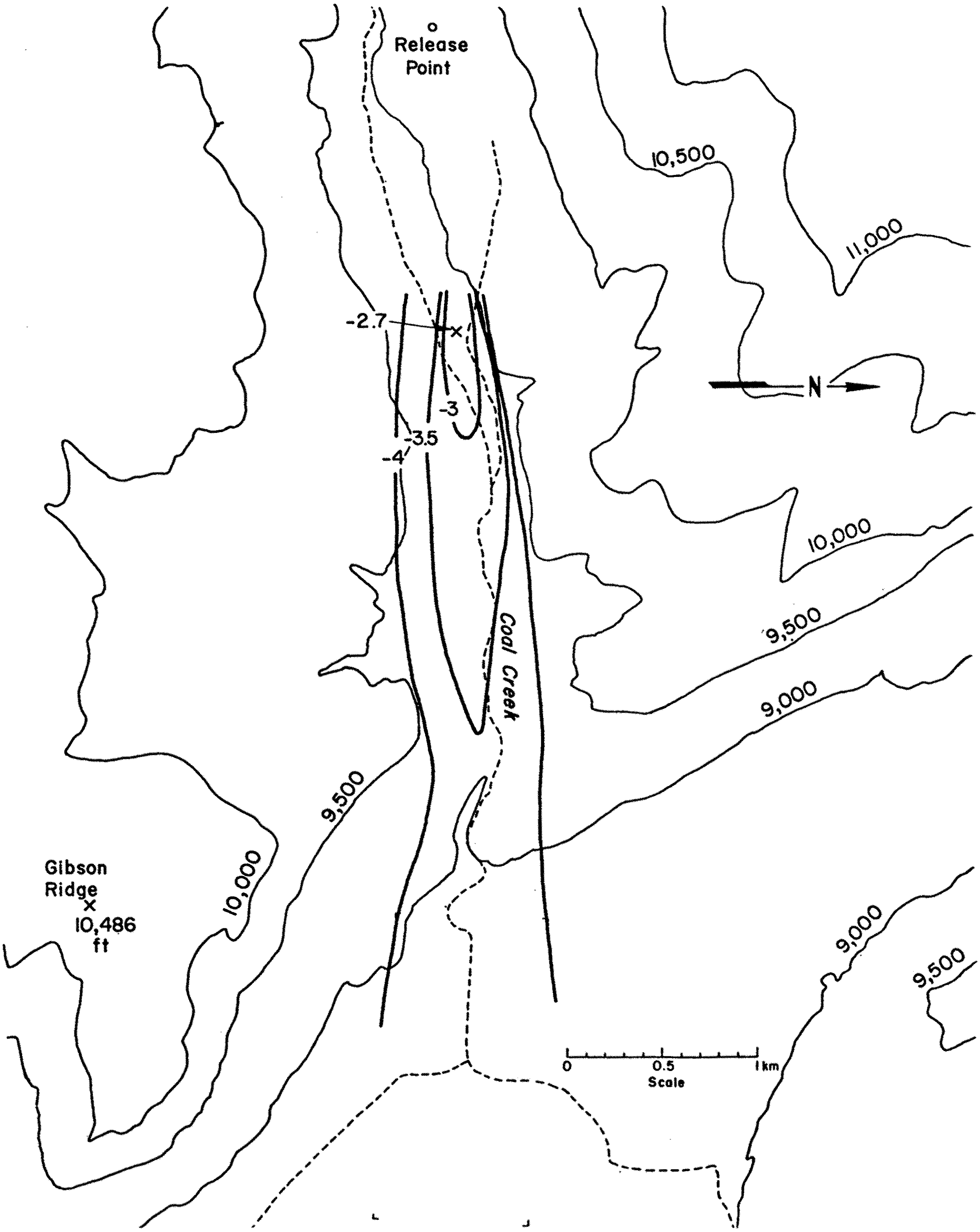


Figure 6-2-6. Isopleths of Ground-level Normalized Concentrations (plotted $\log_{10}$ K) for the Coal Creek Neutral Stability Test with a Free-stream Velocity of 3.0 m/s and a 0.318 cm (6.1 m full-scale) Release - 60 cm (1.2 km) Upwind from T16

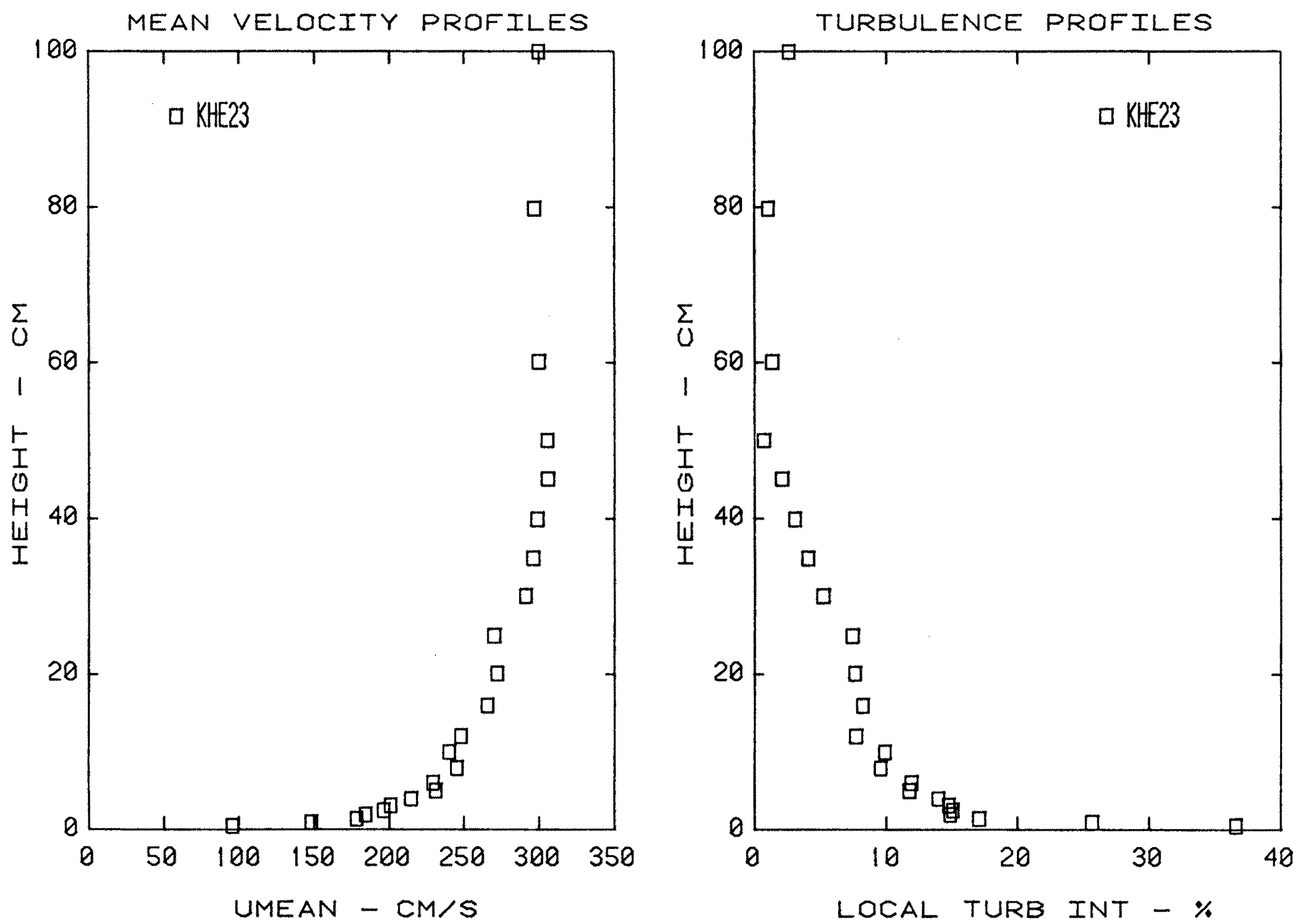


Figure 7-1-1. Mean Velocity and Turbulence Intensity Profiles Taken at Location A (see Figure 3-2-4) for the Alkali Creek Neutral Stability Tests

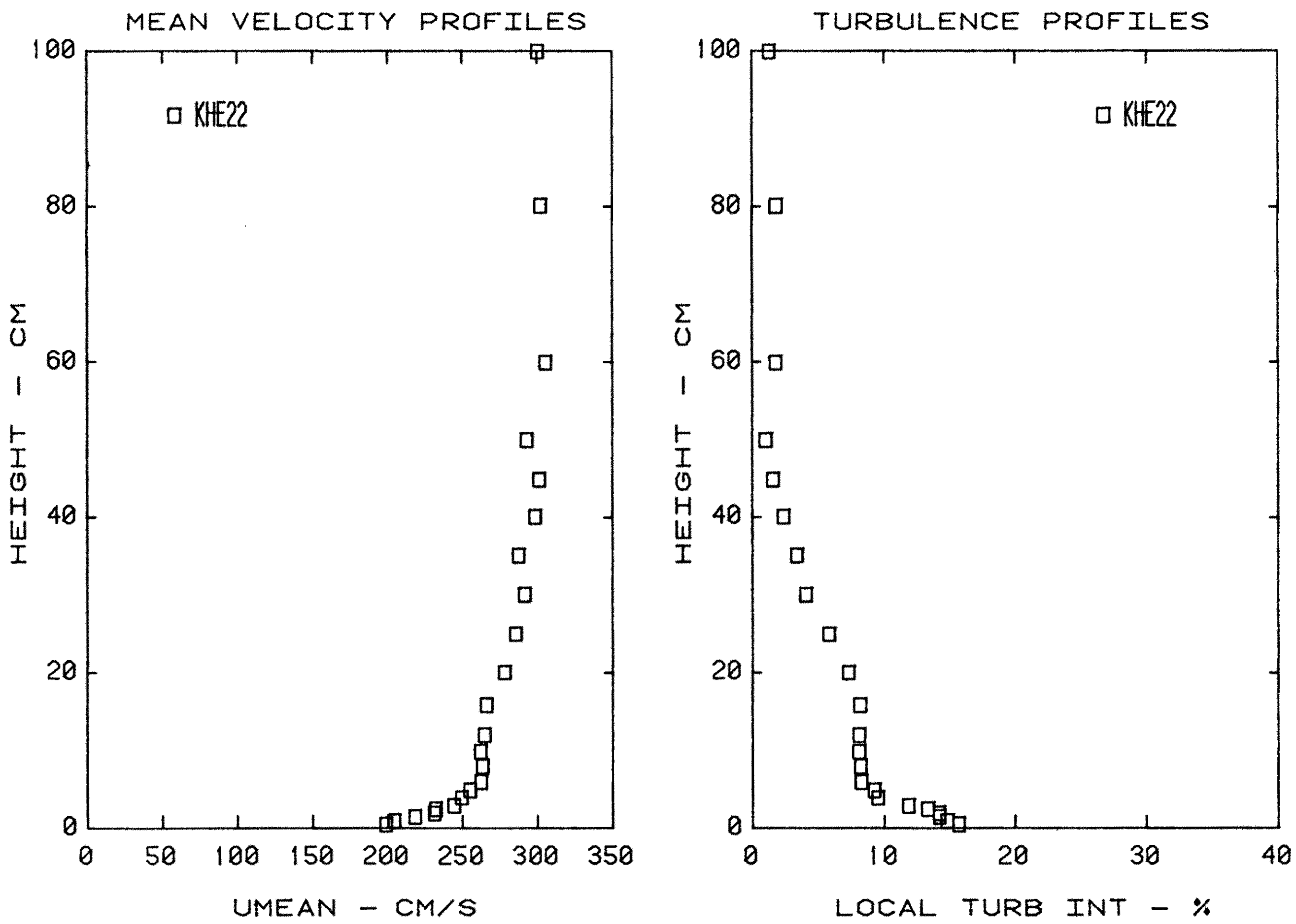


Figure 7-1-2. Mean Velocity and Turbulence Intensity Profiles Taken at Location B (see Figure 3-2-4) for the Alkali Creek Neutral Stability Tests

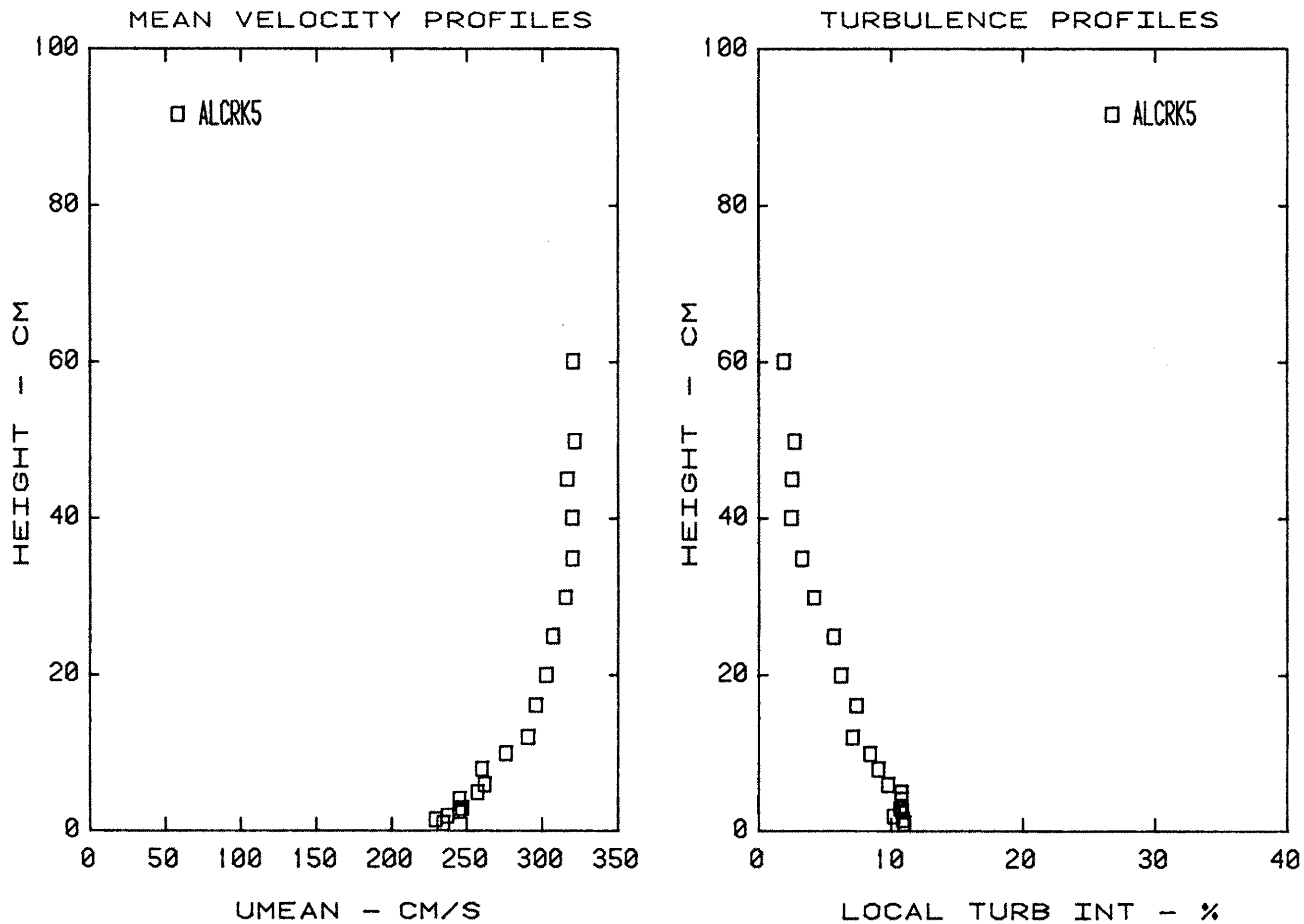


Figure 7-1-3. Mean Velocity and Turbulence Intensity Profiles Taken at Location C (see Figure 3-2-4) for the Alkali Creek Neutral Stability Tests

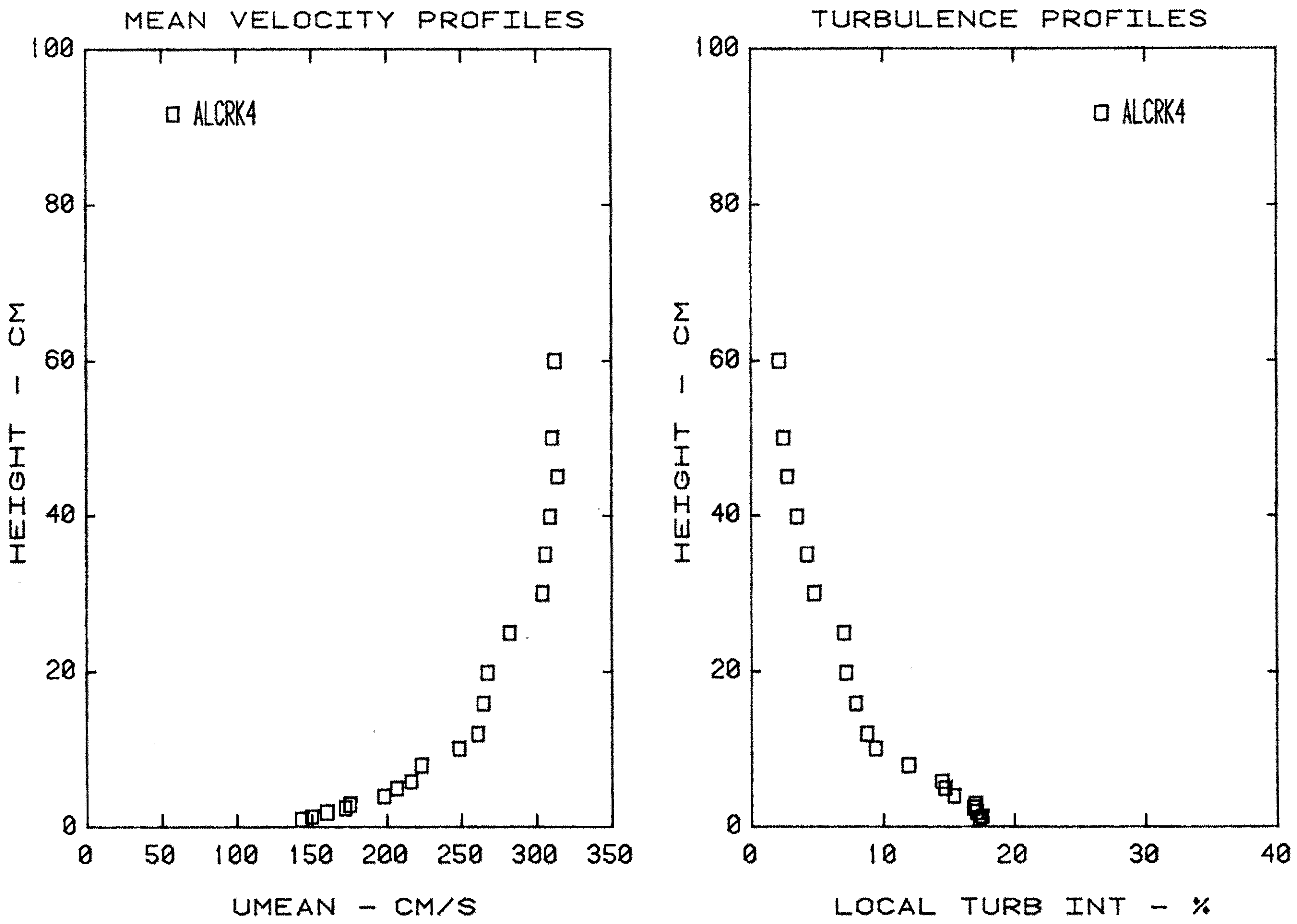


Figure 7-1-4. Mean Velocity and Turbulence Intensity Profiles Taken at Location D (see Figure 3-2-4) for the Alkali Creek Neutral Stability Tests

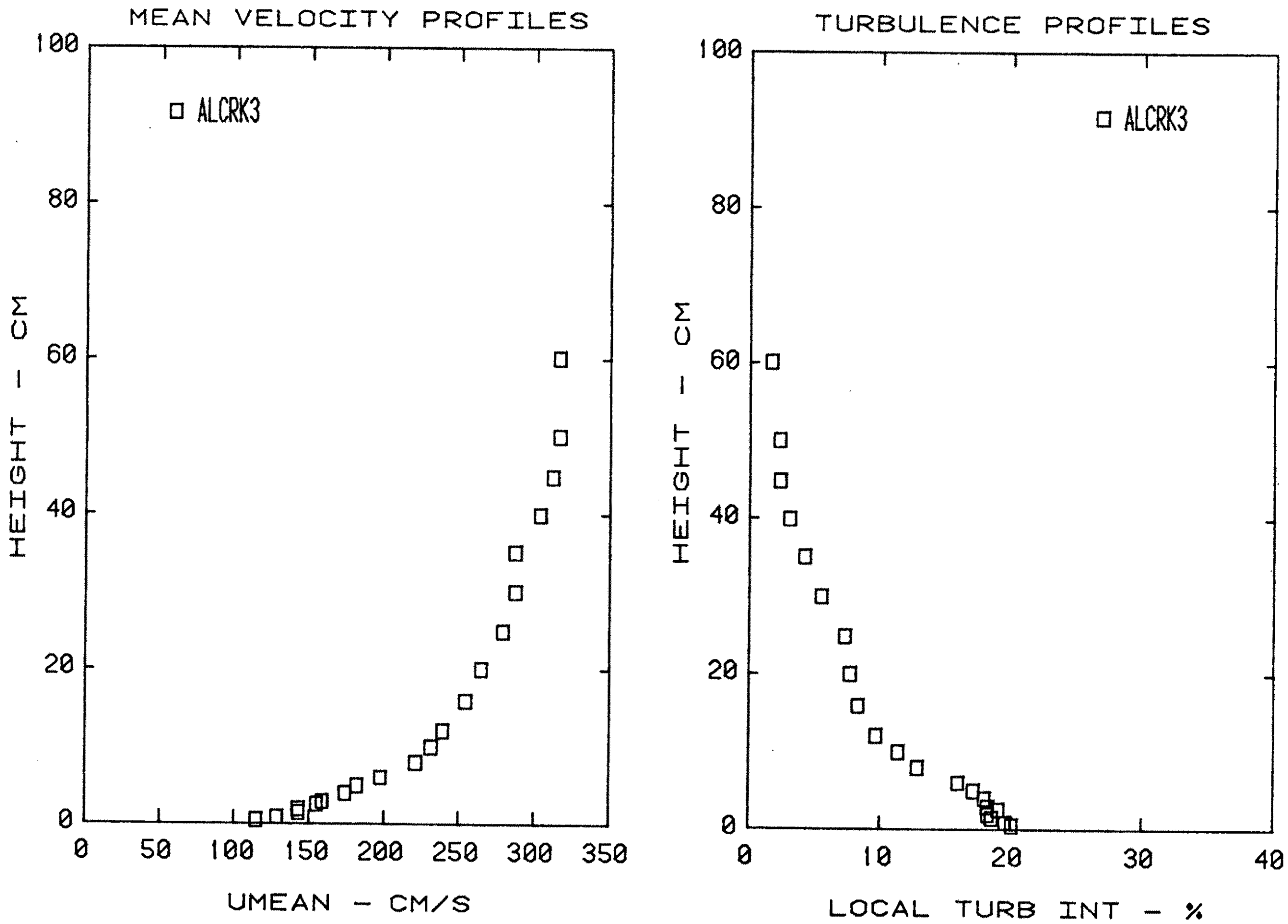


Figure 7-1-5. Mean Velocity and Turbulence Intensity Profiles Taken at Location E (see Figure 3-2-4) for the Alkali Creek Neutral Stability Tests

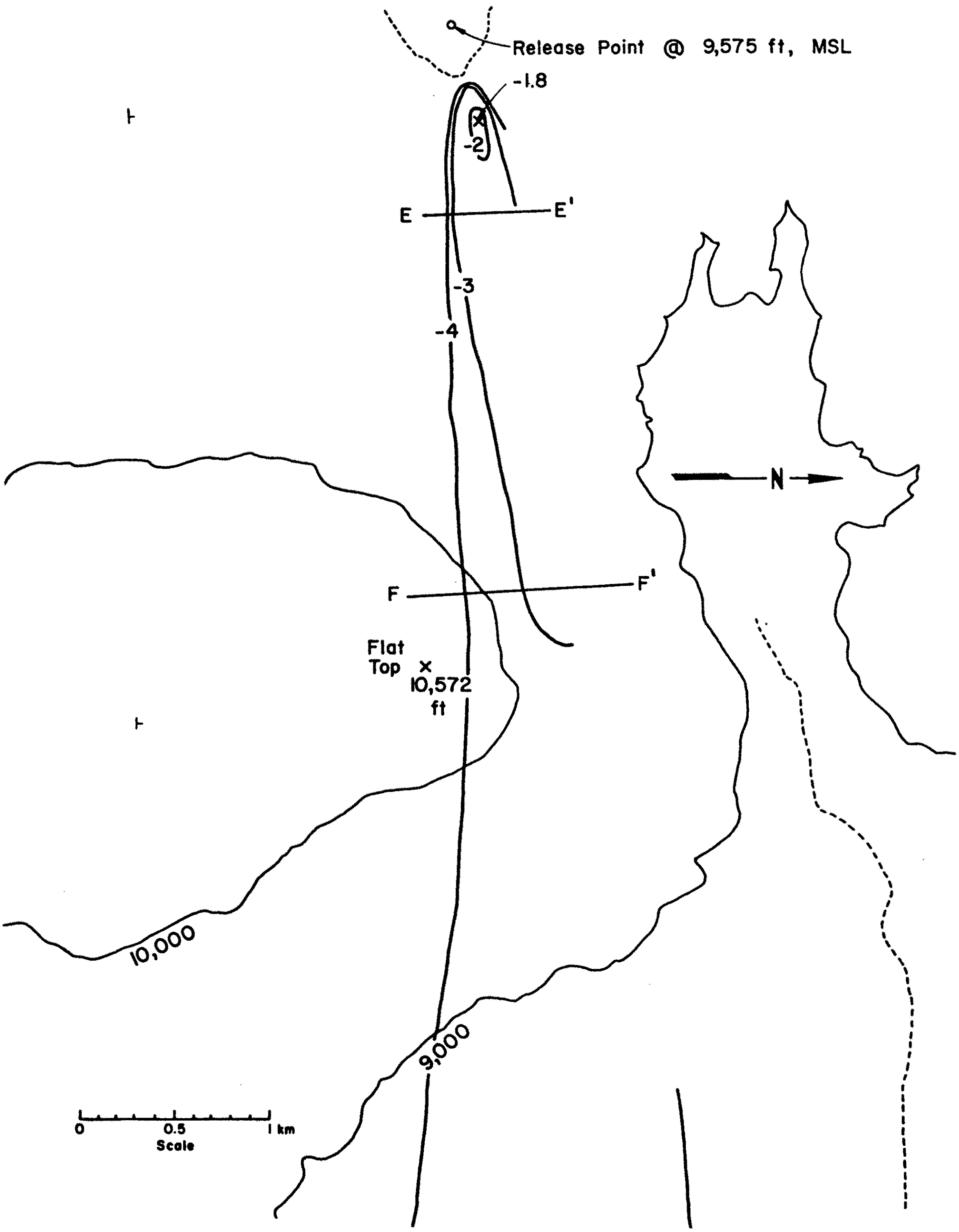


Figure 7-2-1. Isopleths of Ground-level Normalized Concentrations (plotted $\log_{10}$ K) for the Alkali Creek Neutral Stability Test with a Free-stream Velocity of 3.0 m/s and a 0.318 cm (8.1 m full-scale) Release at T4

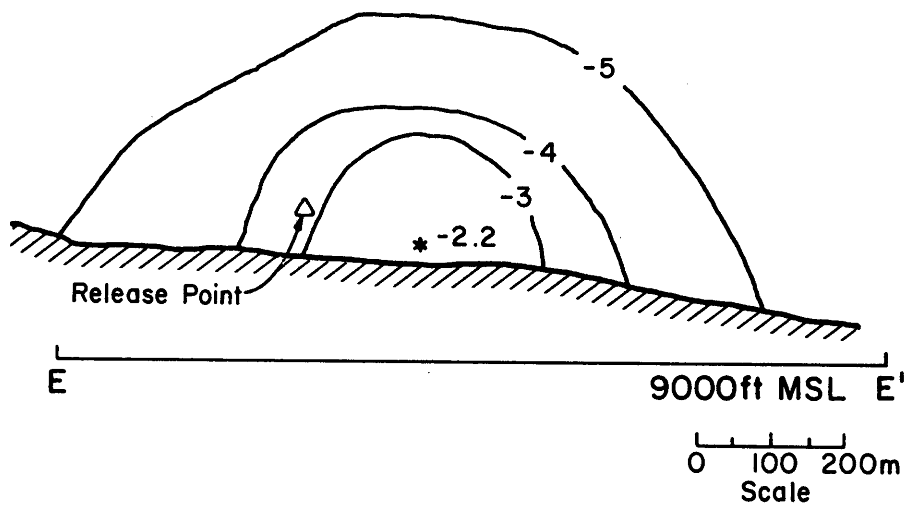


Figure 7-2-2. Isopleths in the Vertical of the Normalized Concentration (plotted $\log_{10}$ K) for the Alkali Creek Neutral Stability Tests with a Free-stream Wind Velocity of 3 m/s and Taken 39 cm (1.0 km full-scale) Downwind from a 0.318 cm (8.14 m full-scale) Release

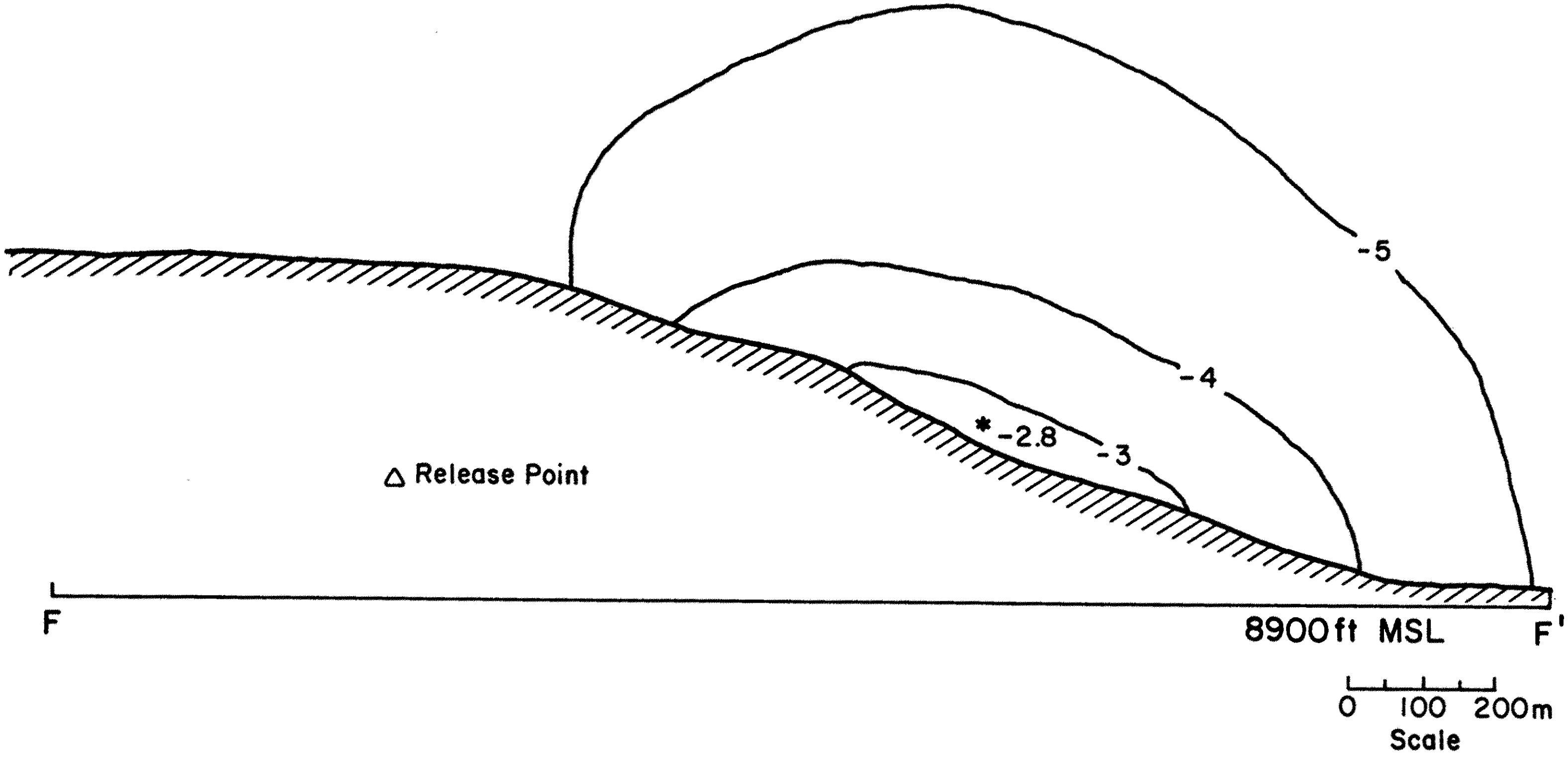


Figure 7-2-3. Isopleths in the Vertical of the Normalized Concentration (plotted $\log_{10}$ K) for the Alkali Creek Neutral Stability Tests with a Free-stream Wind Velocity of 3 m/s and Taken 117 cm (3.0 km full-scale) Downwind from a 0.318 cm (8.14 m full-scale) Release

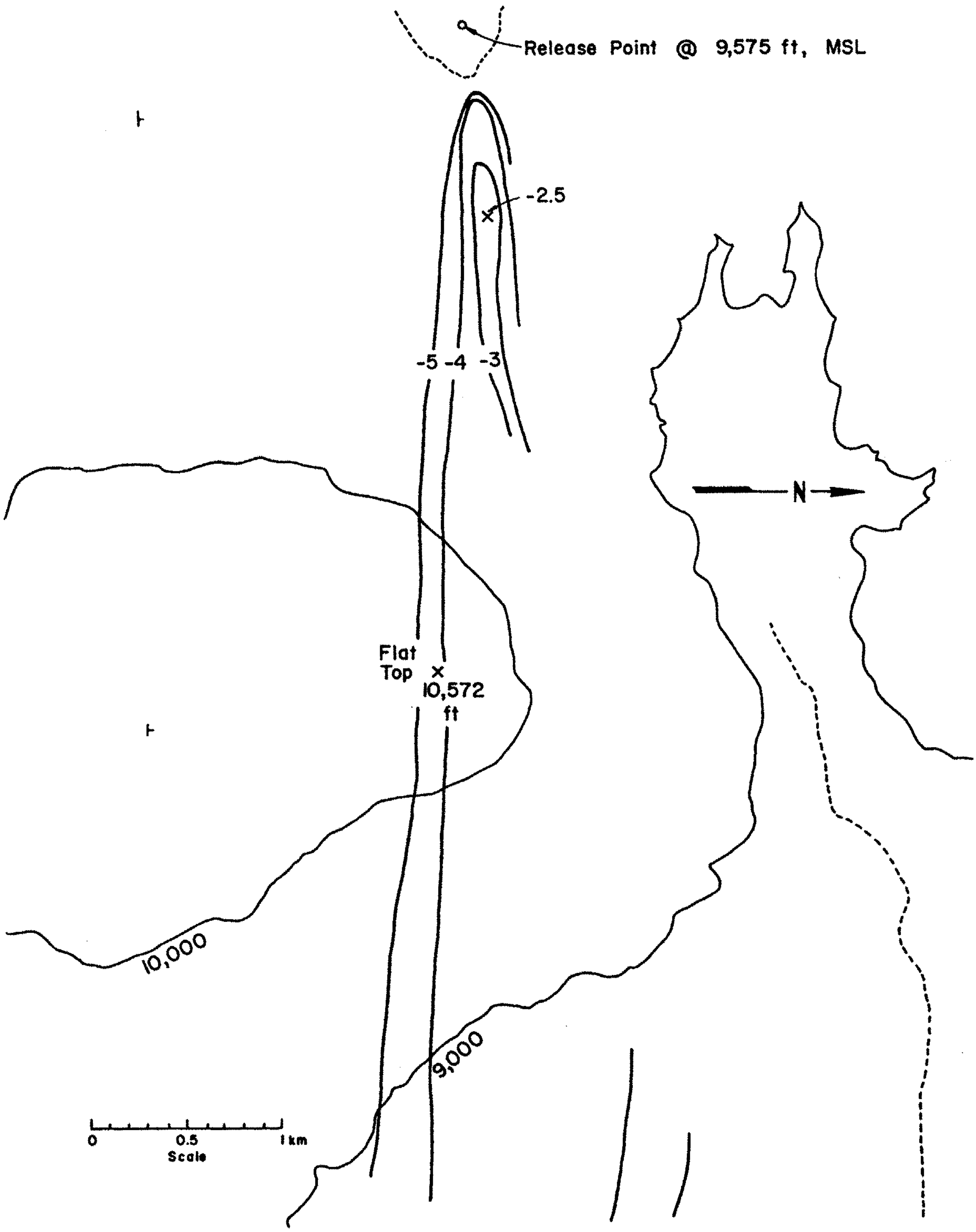


Figure 7-2-4. Isopleths of Ground-level Normalized Concentrations (plotted $\log_{10}$ K) for the Alkali Creek Neutral Stability Test with a Free-stream Velocity of 3.0 m/s and a 2.54 cm (65 m full-scale) Release at T4

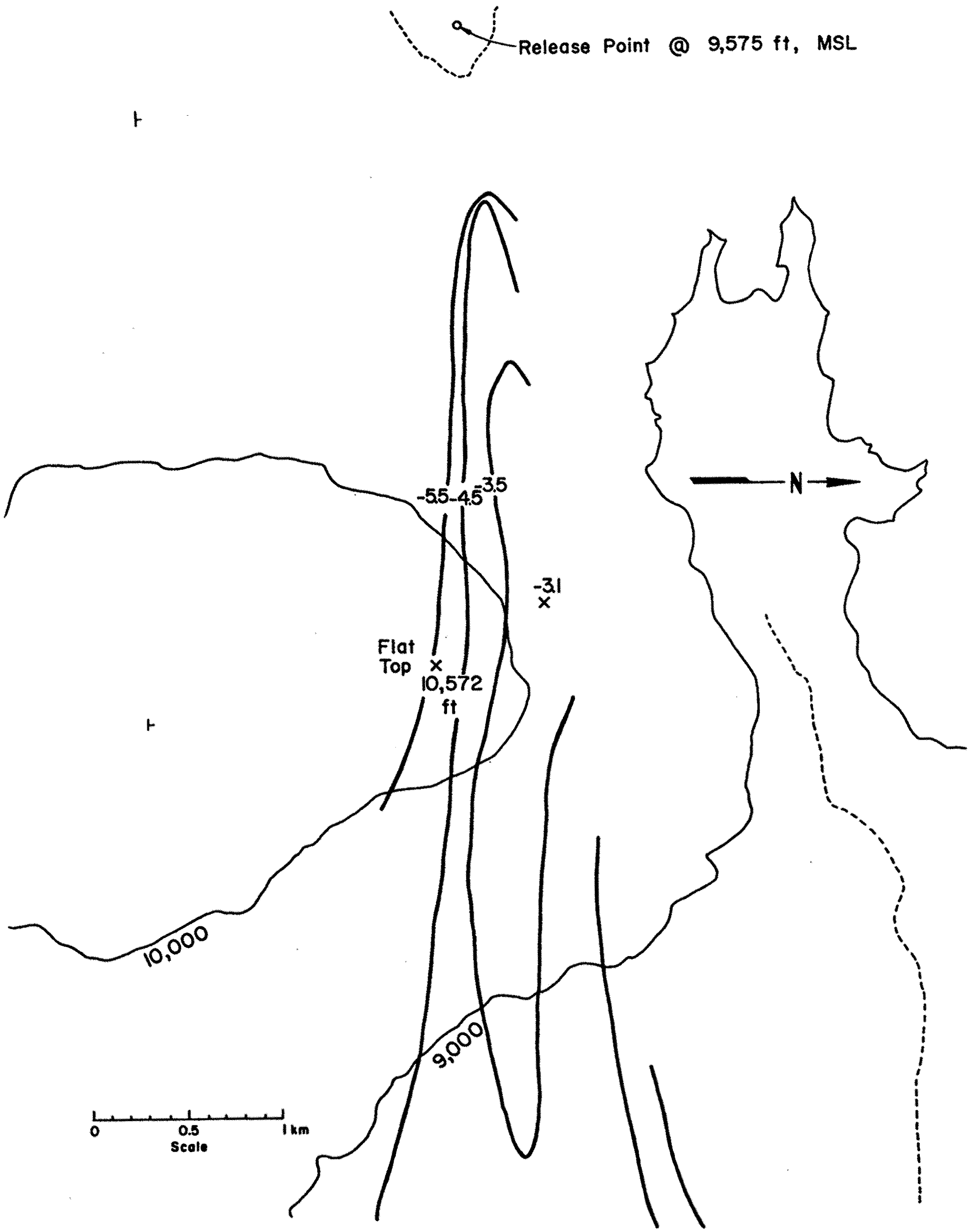


Figure 7-2-5. Isopleths of Ground-level Normalized Concentrations (plotted $\log_{10}$ K) for the Alkali Creek Neutral Stability Test with a Free-stream Velocity of 3.0 m/s and a 5.08 cm (130 m full-scale) Release at T4

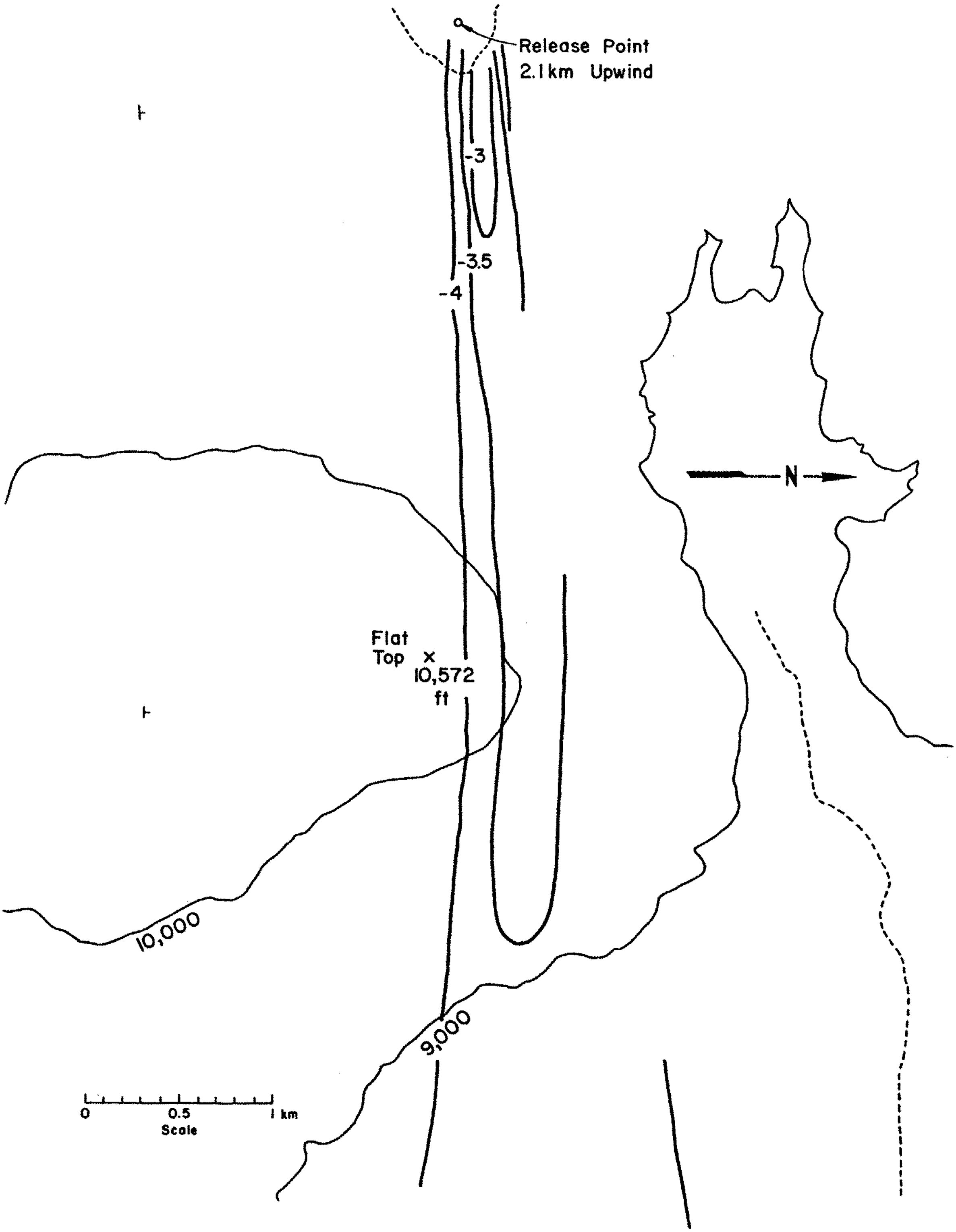


Figure 7-2-6. Isopleths of Ground-level Normalized Concentrations (plotted $\log_{10}$ K) for the Alkali Creek Neutral Stability Test with a Free-stream Velocity of 3.0 m/s and a 0.318 cm (8.1 m full-scale) Release 78 cm (2.1 km) Upwind from T4

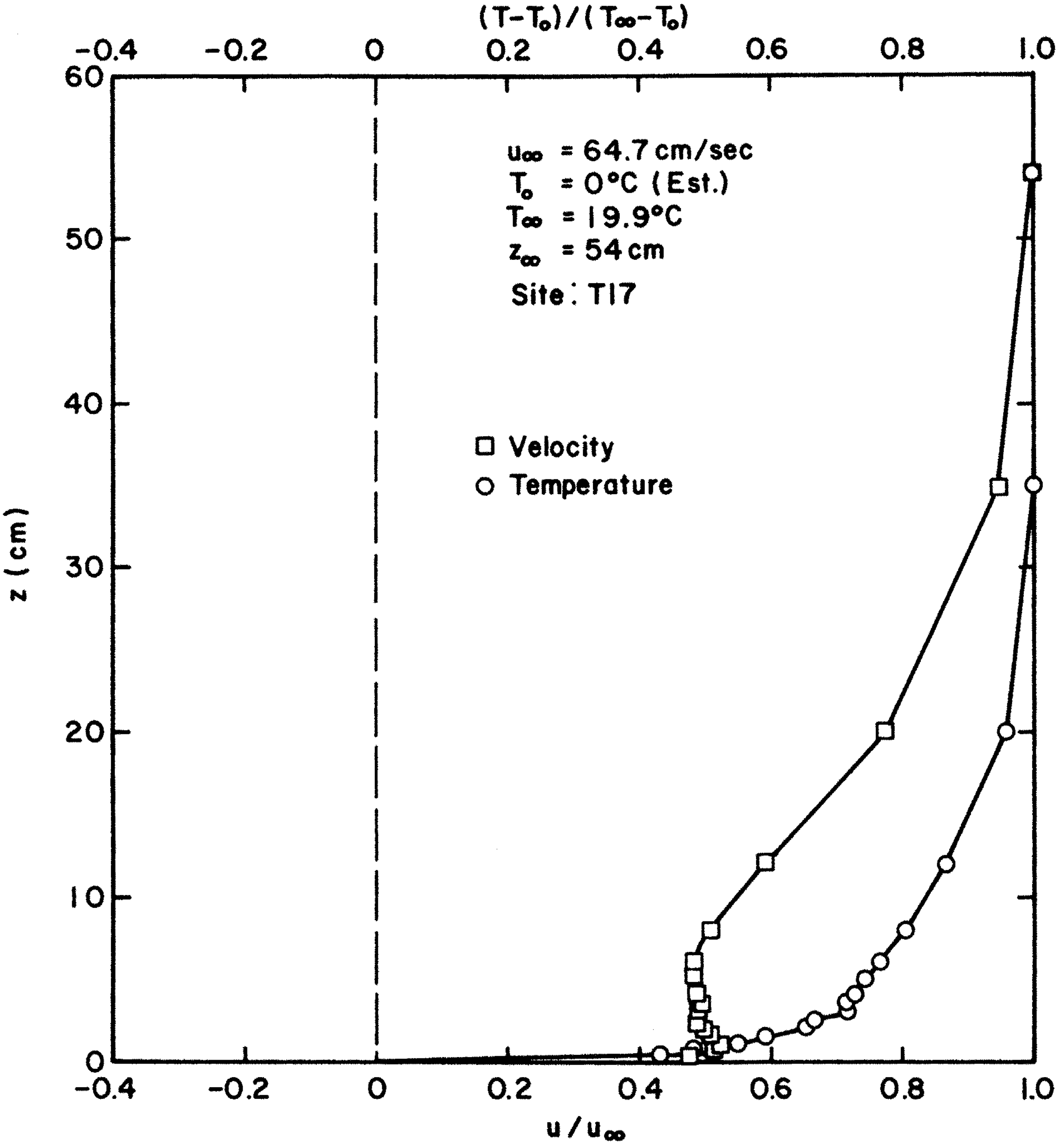


Figure 8-1-1. Velocity and Temperature Profiles Taken at T17 for the Coal Creek Stable Flow Tests (Ri = 0.5)

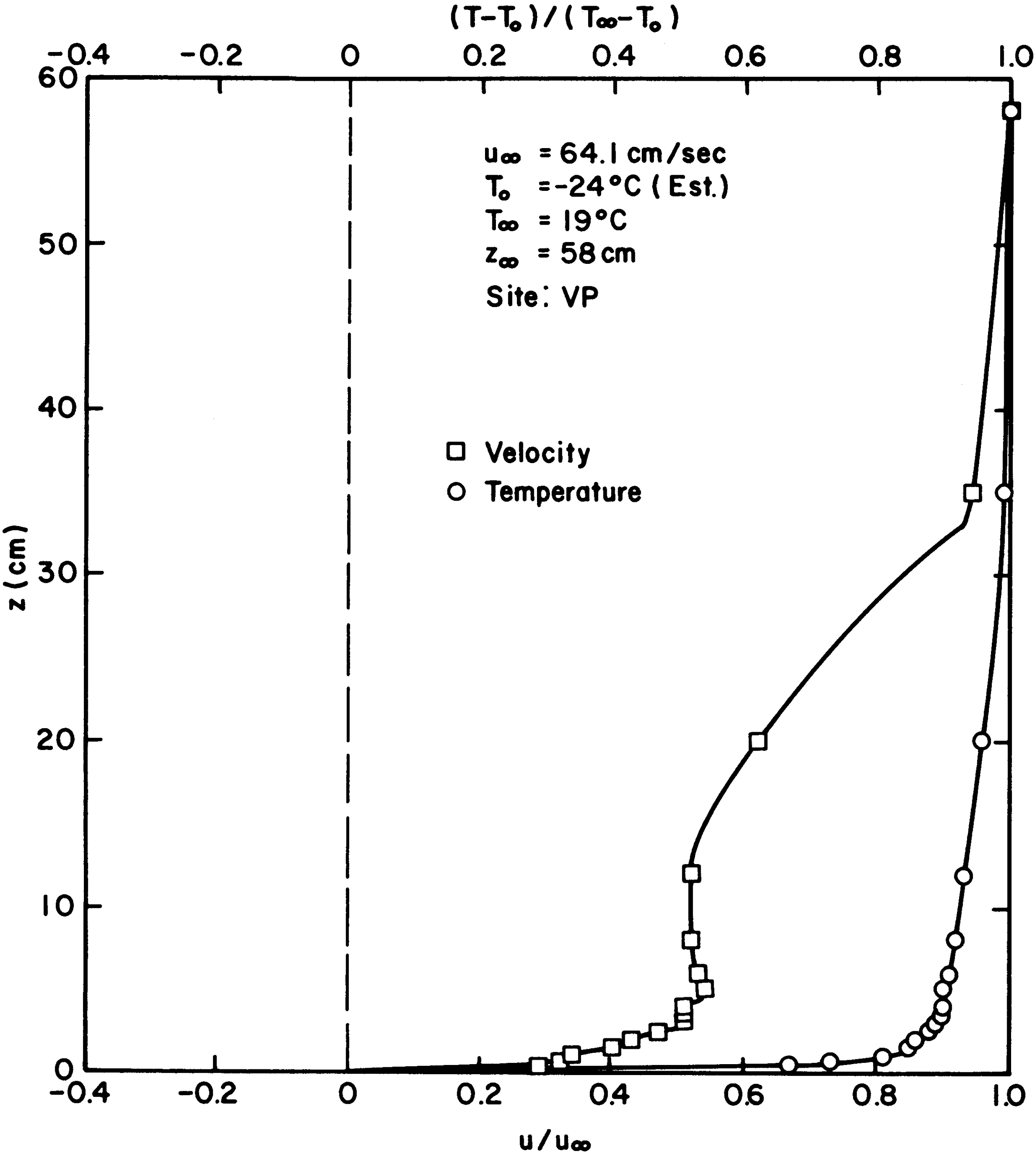


Figure 8-1-2. Velocity and Temperature Profiles Taken at VP Site for the Coal Creek Stable Flow Tests (Ri = 1.7)

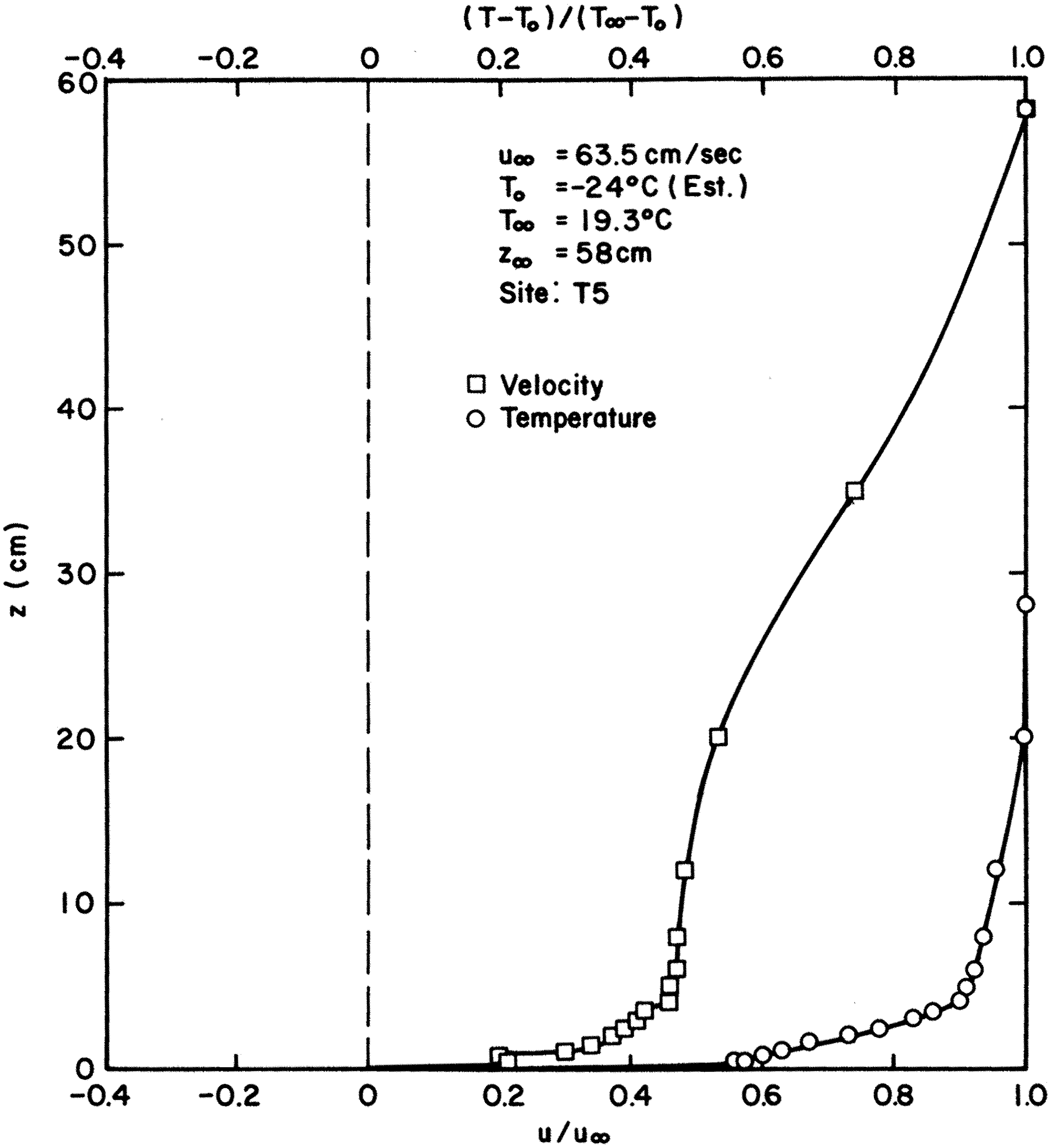


Figure 8-1-3. Velocity and Temperature Profiles Taken at T5 for the Coal Creek Stable Flow Tests (Ri = 2.1)

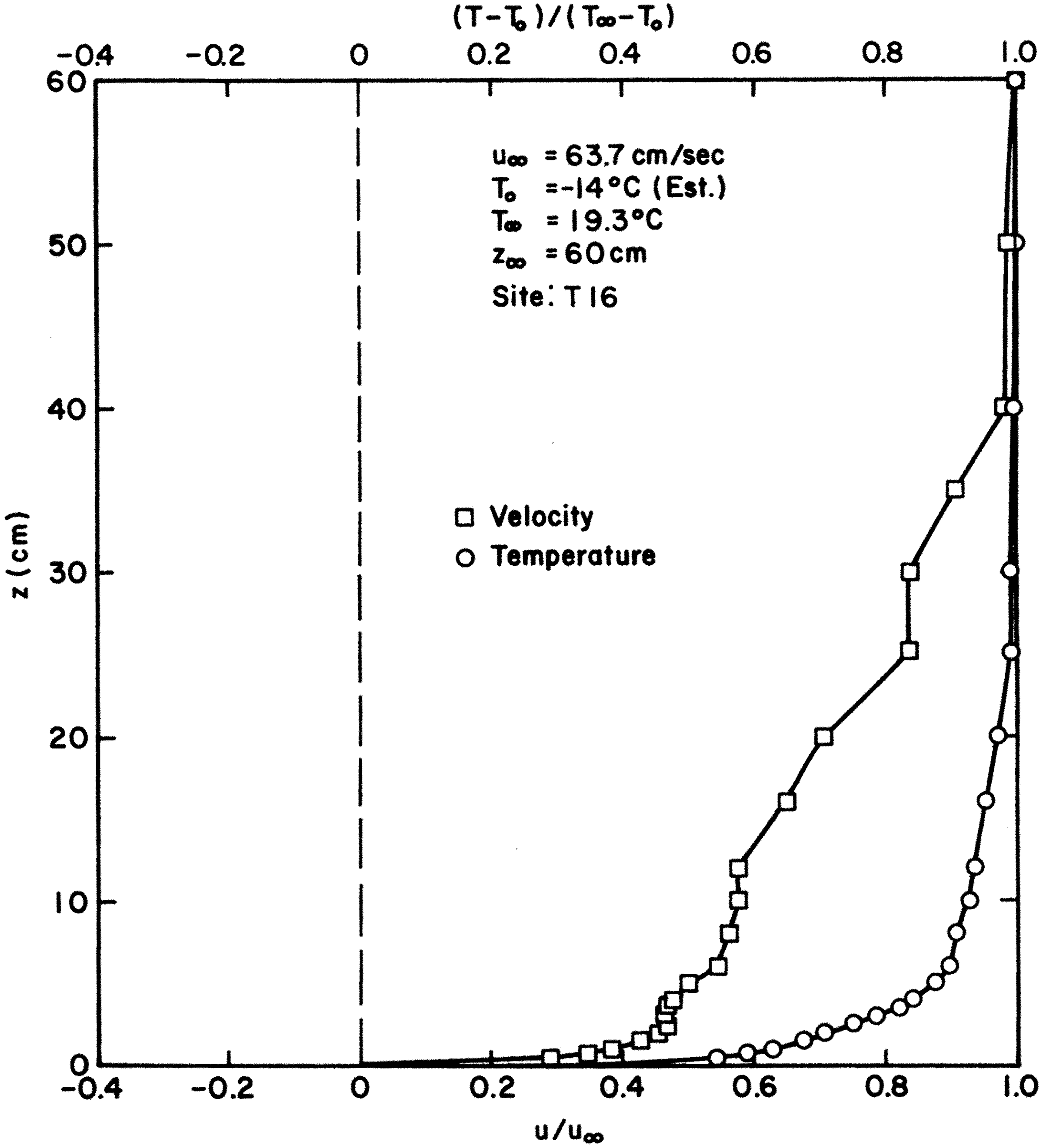


Figure 8-1-4. Velocity and Temperature Profiles Taken at T16 for the Coal Creek Stable Flow Tests ($Ri = 1.1$)

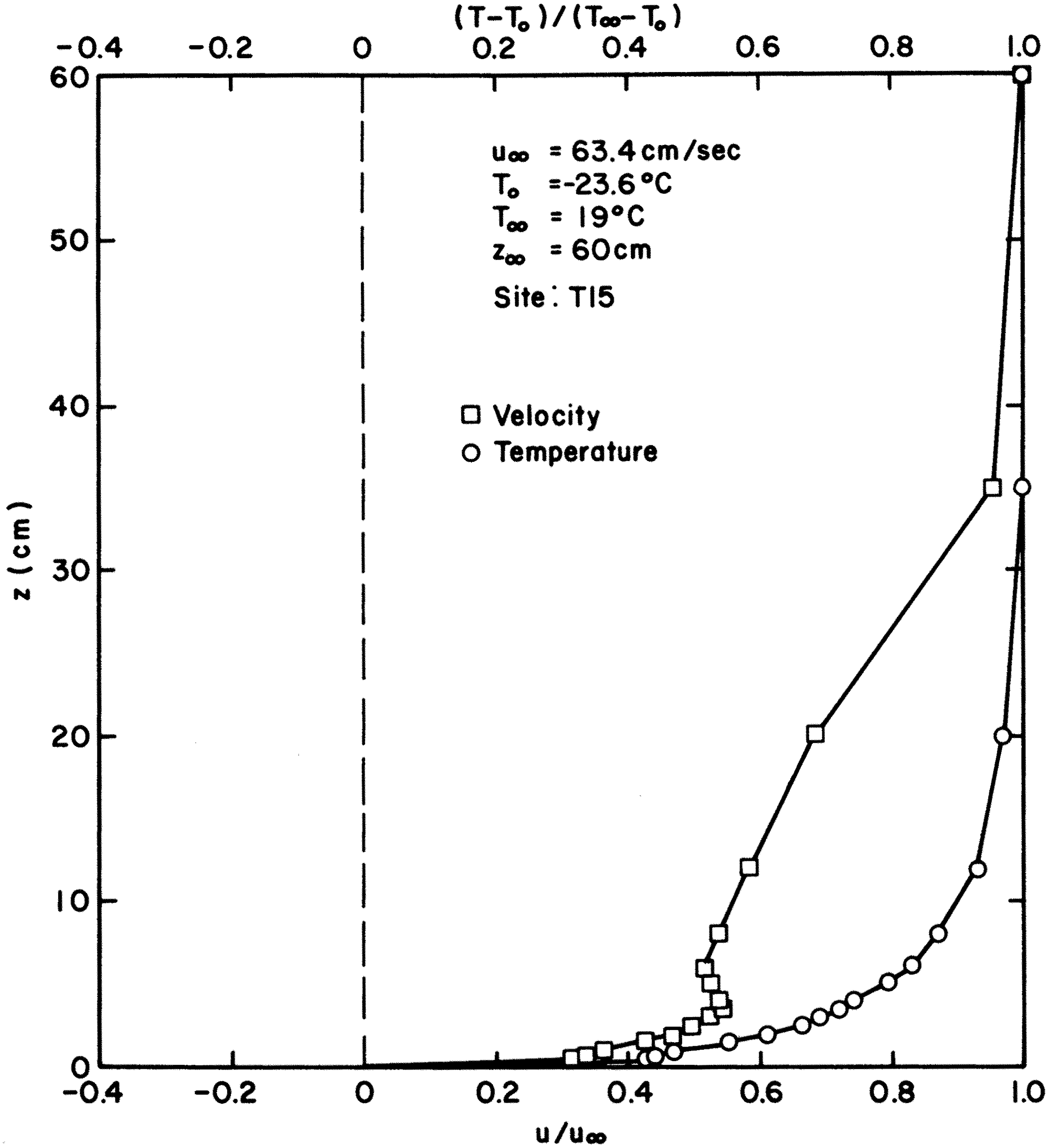


Figure 8-1-5. Velocity and Temperature Profiles Taken at T15 for the Coal Creek Stable Flow Tests (Ri = 1.4)

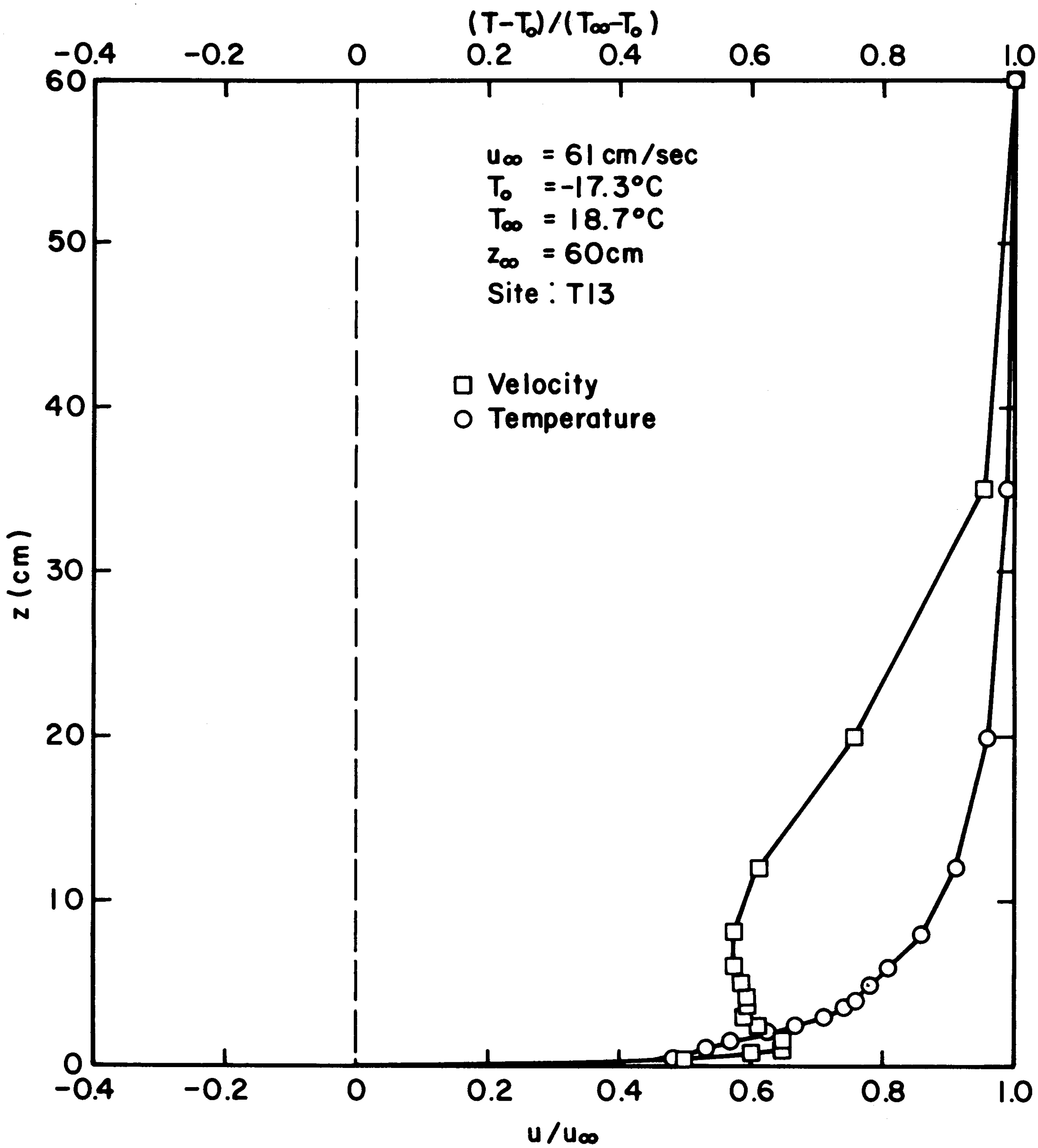


Figure 8-1-6. Velocity and Temperature Profiles Taken at T13 for the Coal Creek Stable Flow Tests (Ri = 1.0)

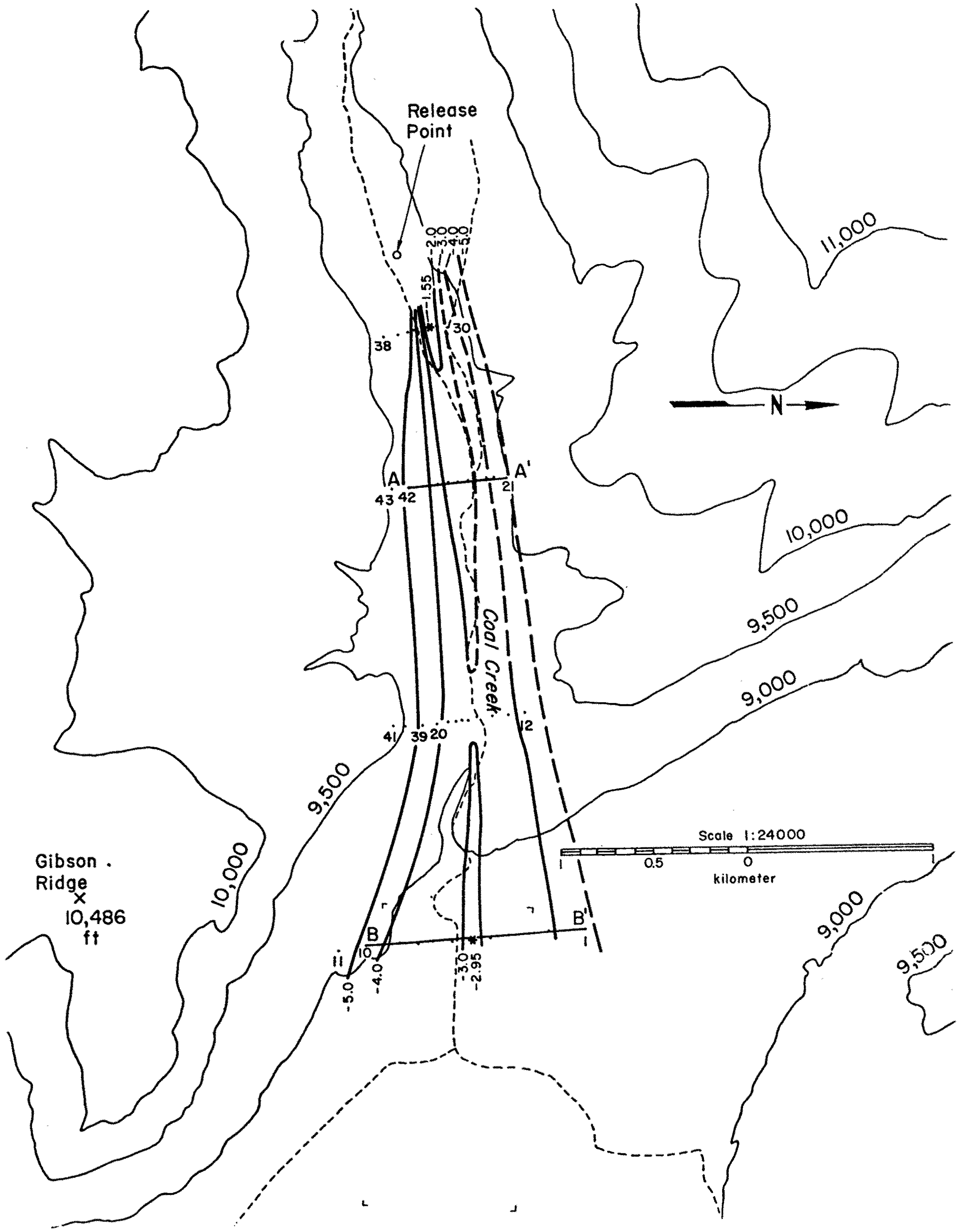


Figure 8-2-1. Isopleths of Ground-level Normalized Concentrations (plotted $\log_{10}$ K) for the Coal Creek Stable Flow Test with a Reference Velocity of 0.18 m/s and a 0.318 cm (6.1 m full-scale) Release at T16

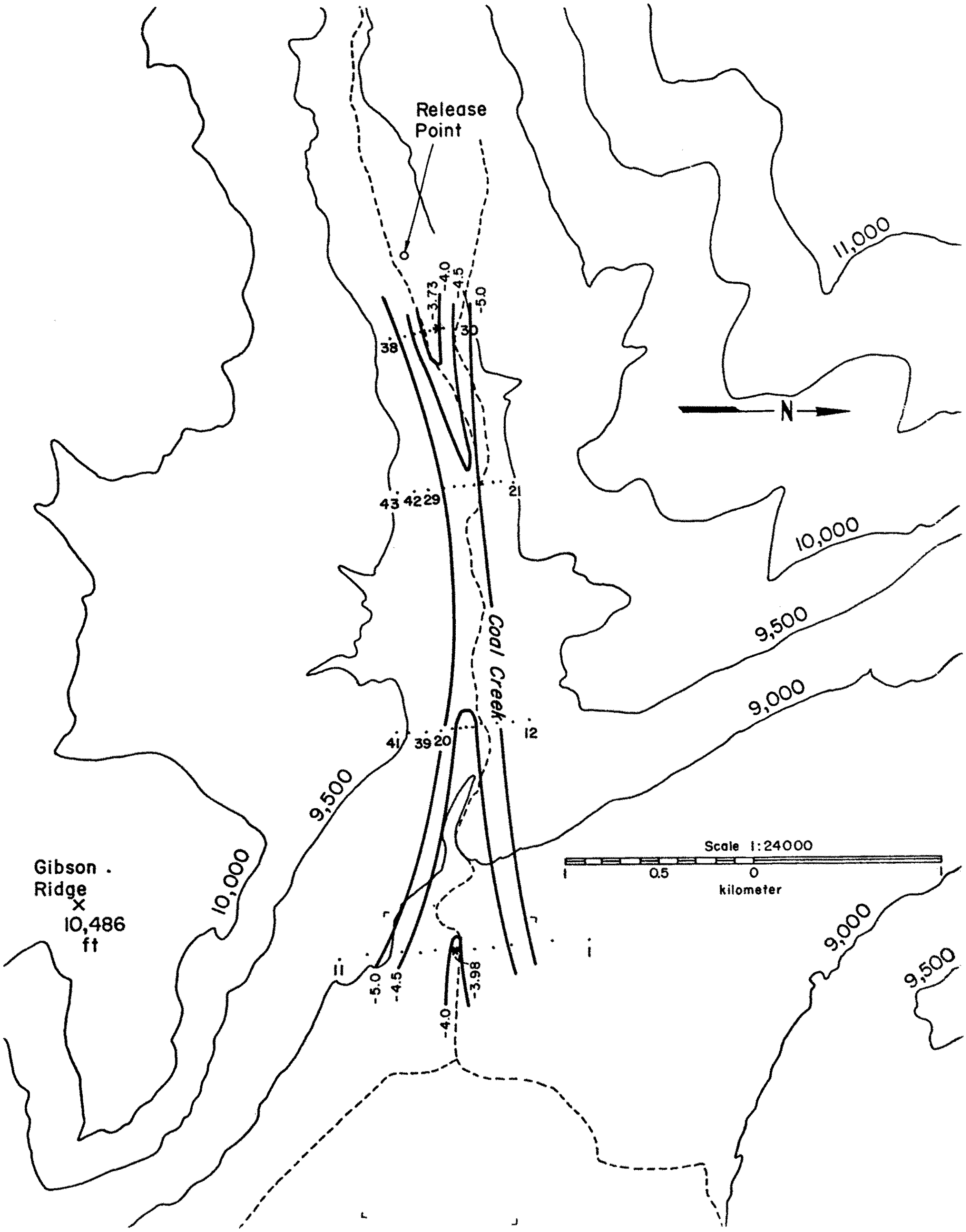


Figure 8-2-2. Isopleths of Ground-level Normalized Concentrations (plotted $\log_{10}$ K) for the Coal Creek Stable Flow Test with a Reference Velocity of 0.30 m/s and a 2.54 cm (49 m full-scale) Release at T16

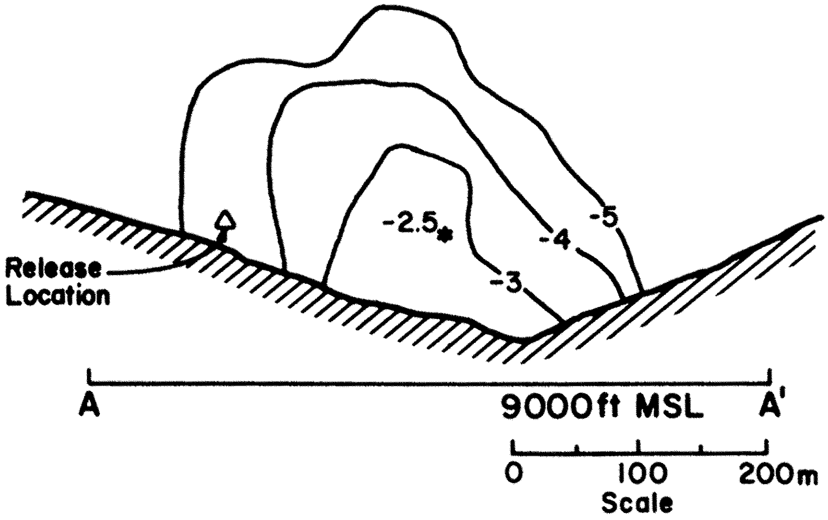


Figure 8-2-3. Isopleths in the Vertical of the Normalized Concentration (plotted $\log_{10}$ K) for the Coal Creek Stable Flow Tests Taken 6.35 cm (1.3 km full-scale) Downwind from a 0.318 cm (6.1 m full-scale) Release

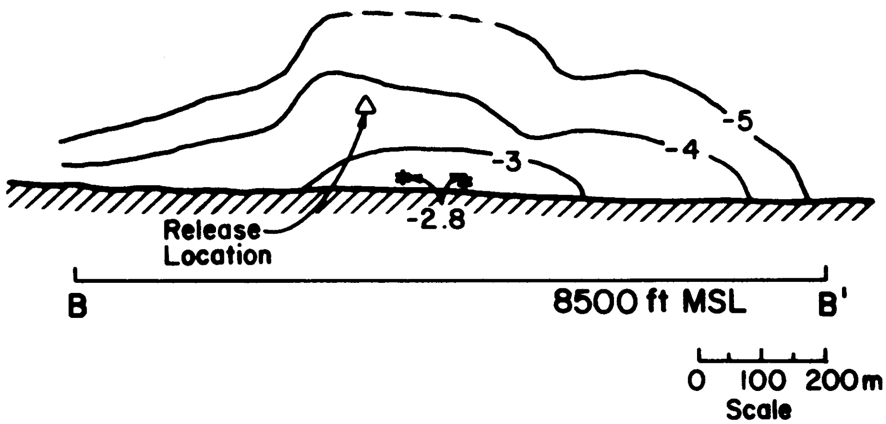


Figure 8-2-4. Isopleths in the Vertical of the Normalized Concentration (plotted $\log_{10}$ K) for the Coal Creek Stable Flow Tests Taken 190.5 cm (3.66 km full-scale) Downwind from a 0.318 cm (6.1 m full-scale) Release

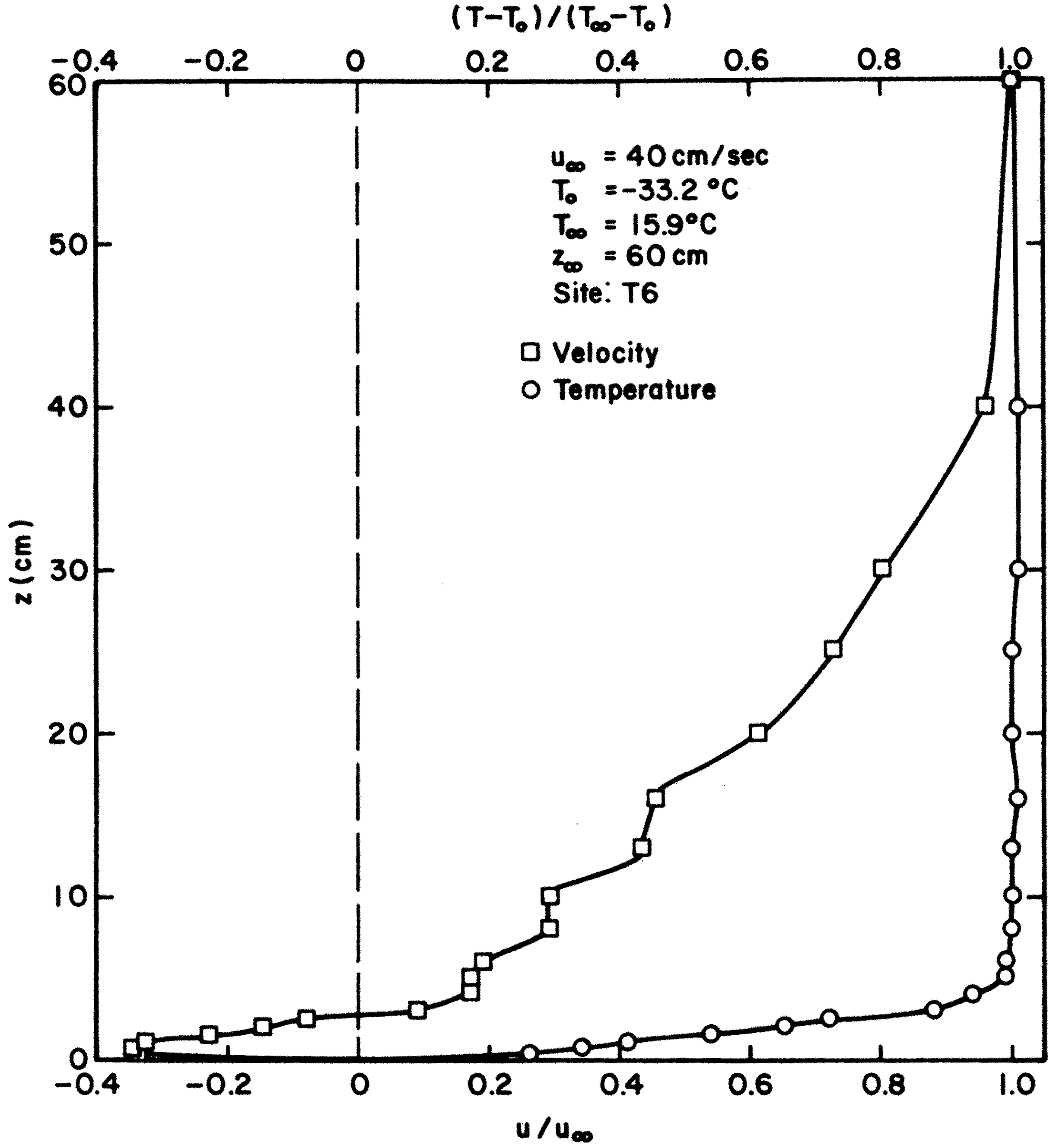


Figure 9-1-1. Velocity and Temperature Profiles Taken at T6 for the Alkali Creek Stable Flow (Westerly Wind) Tests (Ri = 14.2)

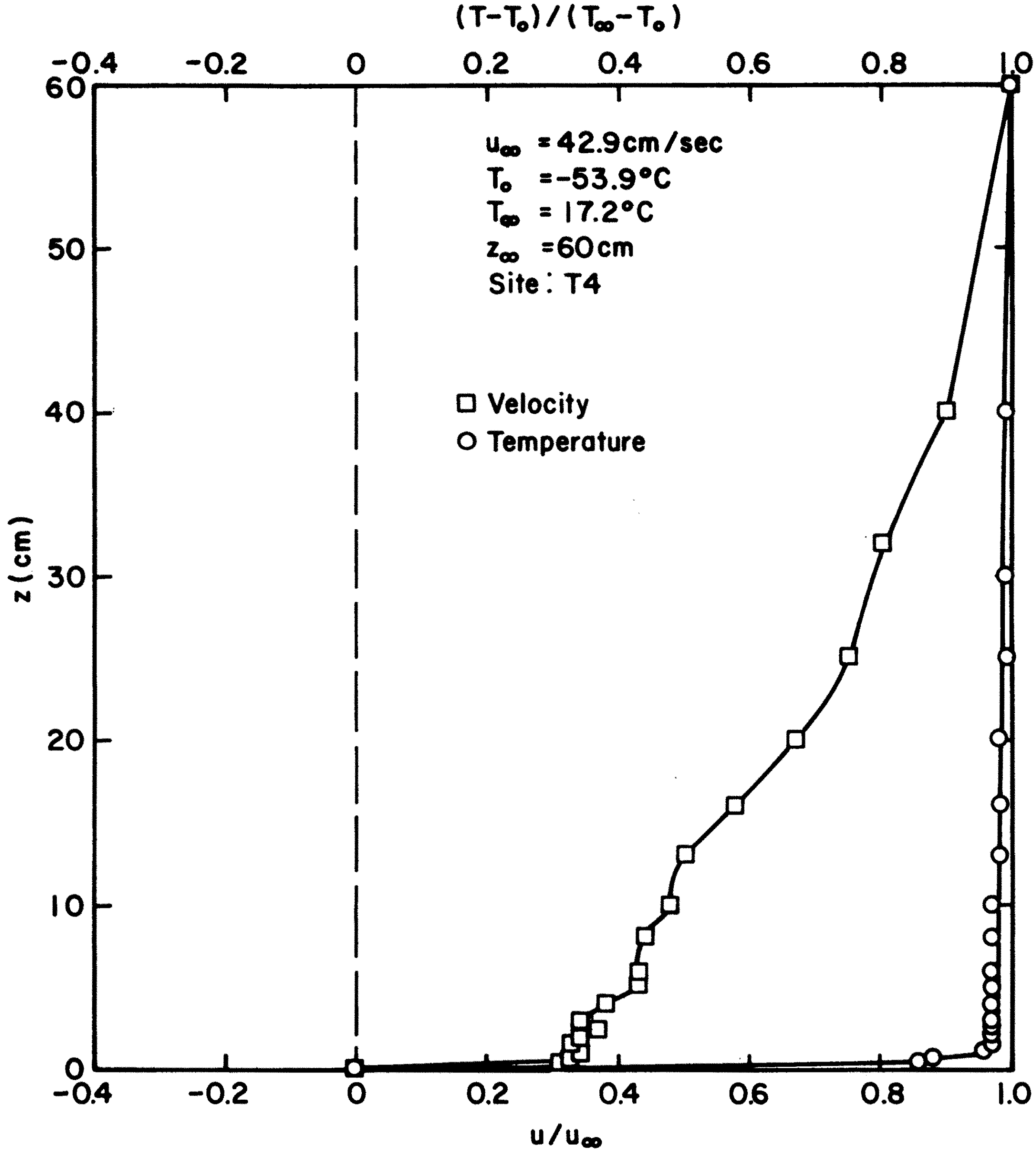


Figure 9-1-2. Velocity and Temperature Profiles Taken at T4 for the Alkali Creek Stable Flow (Westerly Wind) Tests (Ri = 6.9)

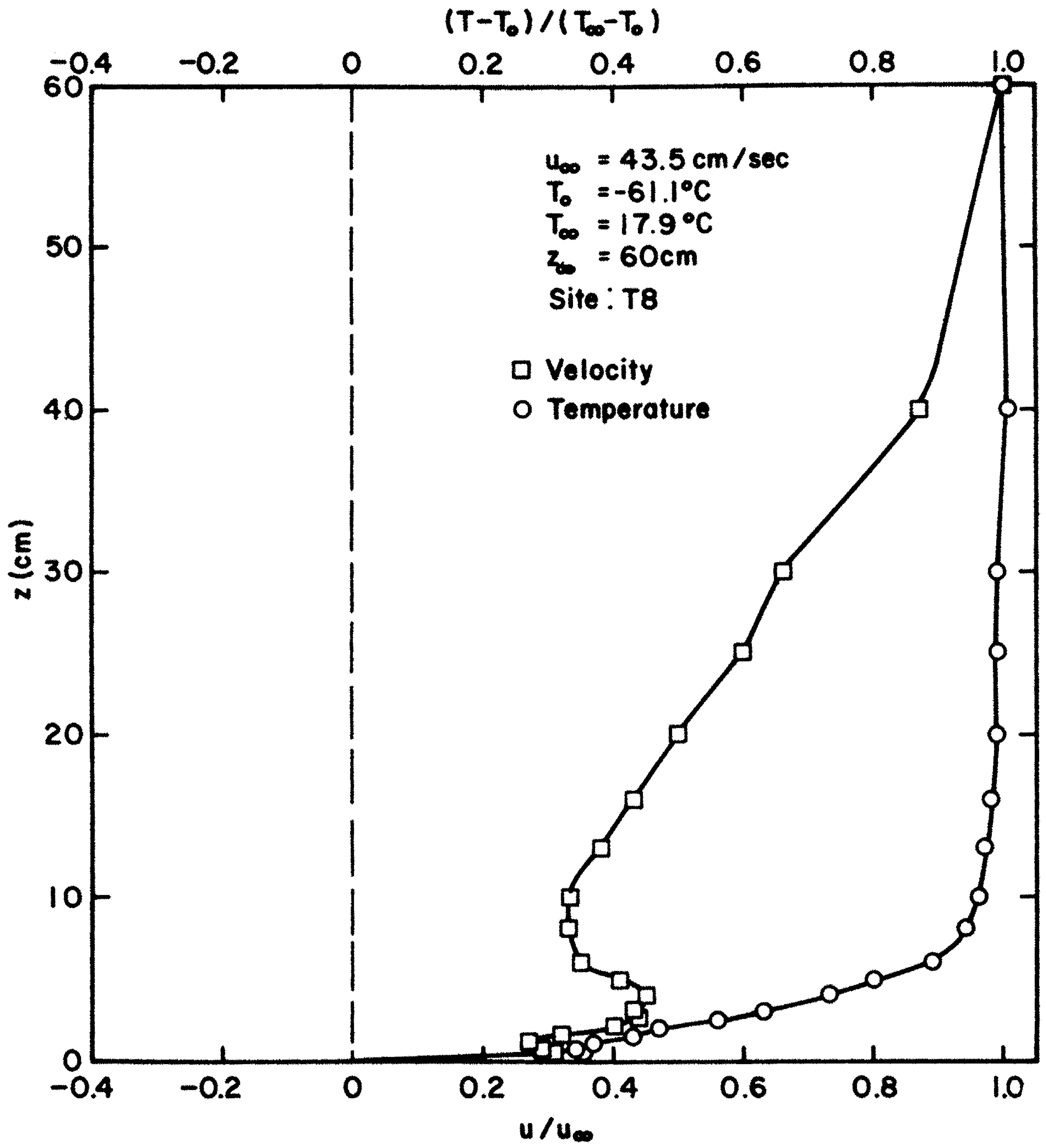


Figure 9-1-3. Velocity and Temperature Profiles Taken at T8 for the Alkali Creek Stable Flow (Westerly Wind) Tests (Ri = 13.5)

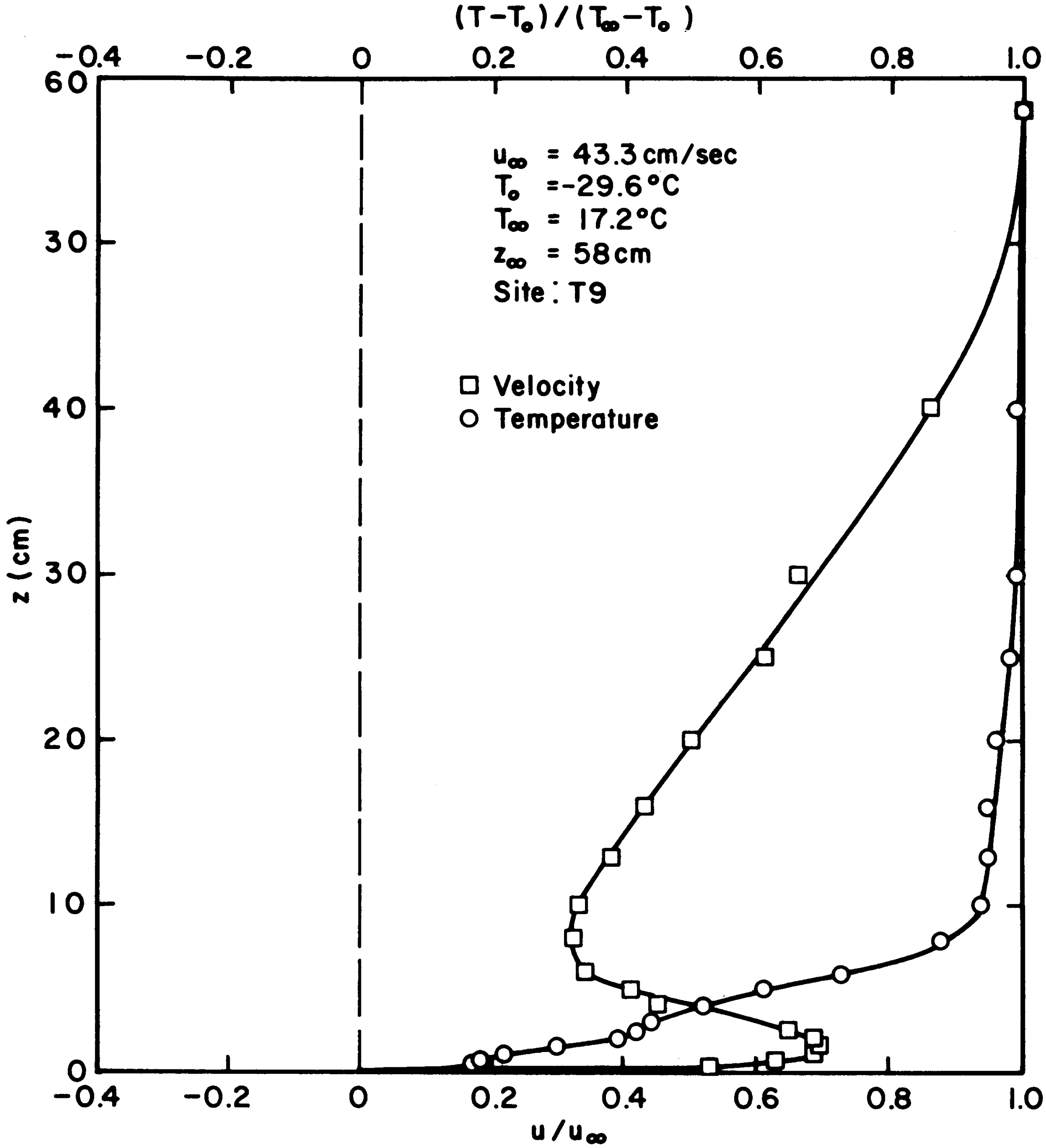


Figure 9-1-4. Velocity and Temperature Profiles Taken at T9 for the Alkali Creek Stable Flow (Westerly Wind) Tests (Ri = 7.4)

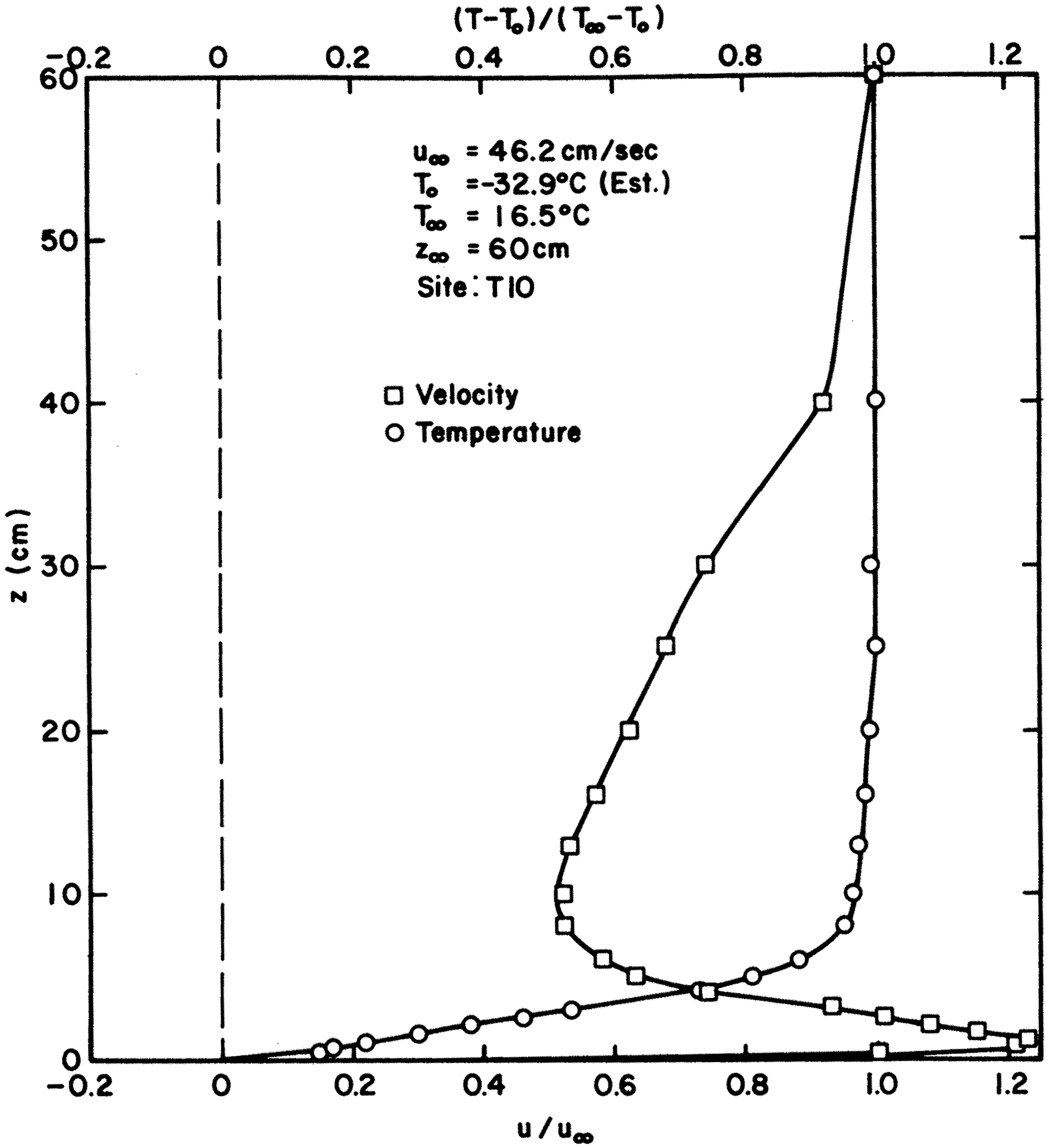


Figure 9-1-5. Velocity and Temperature Profiles Taken at T10 for the Alkali Creek Stable Flow (Westerly Wind) Tests (Ri = 3.0)

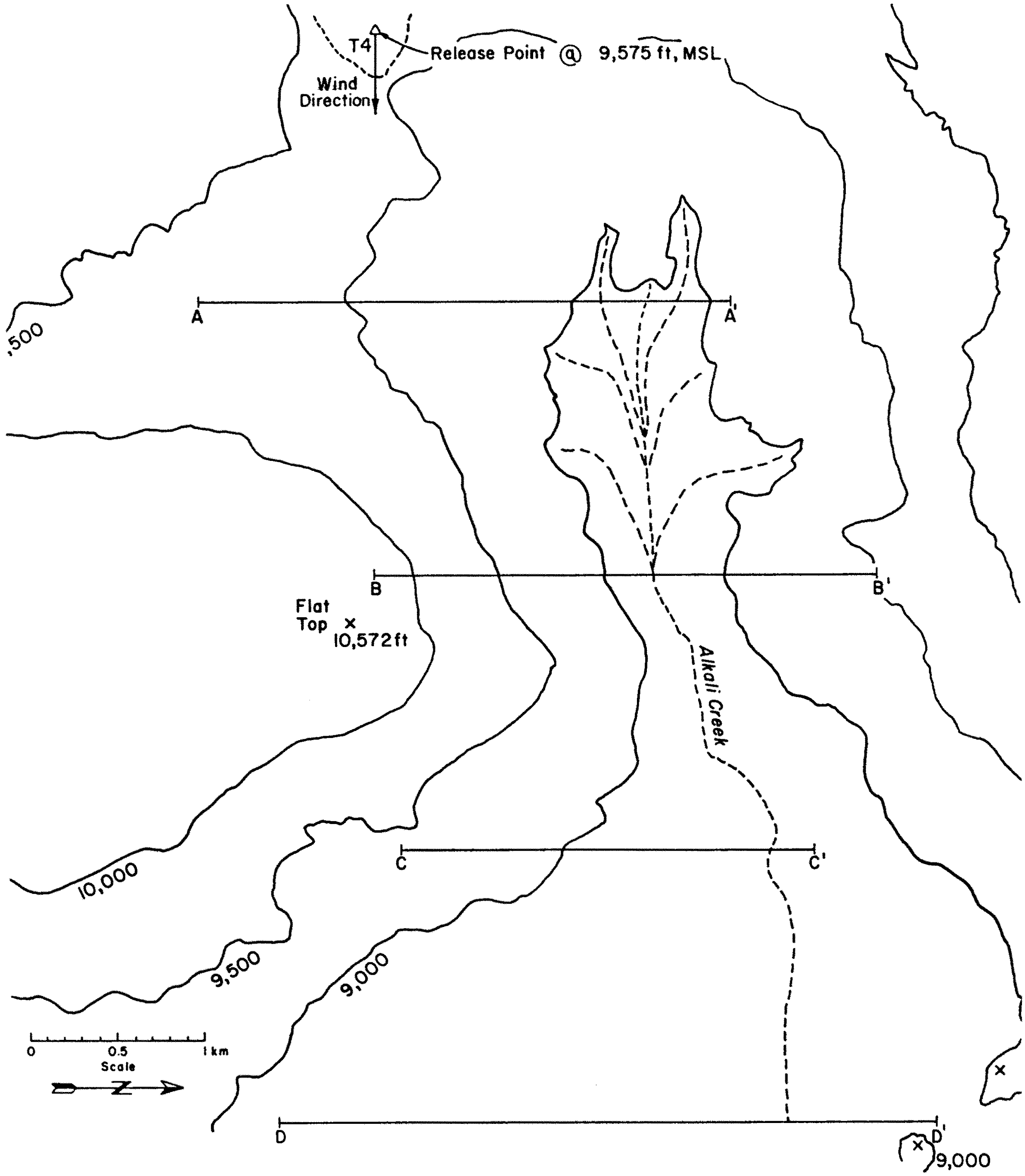


Figure 9-2-1. Map Showing Release Site and Downwind Measurement Locations for Alkali Creek Stable Flow (West Wind) Tests

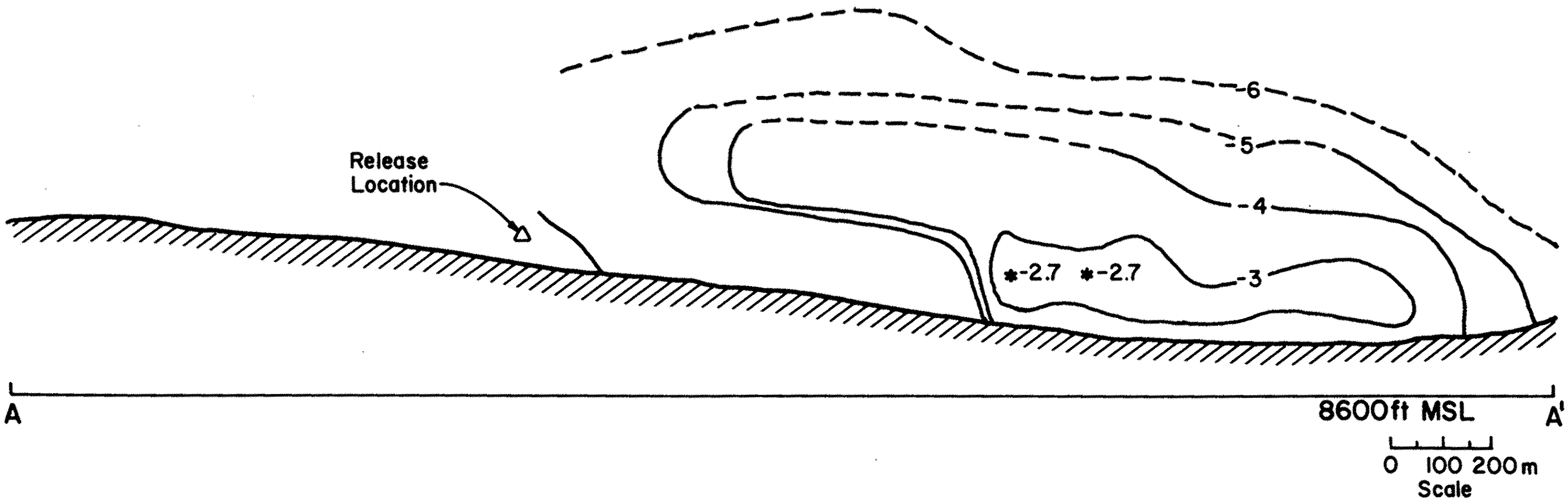


Figure 9-2-2. Isopleths in the Vertical of the Normalized Concentrations (plotted $\log_{10}$ K) for the Alkali Creek Stable Flow (West Wind) Tests Taken 60.9 cm (1.56 km full-scale) Downwind from a 0.318 cm (8.14 m full-scale) Release

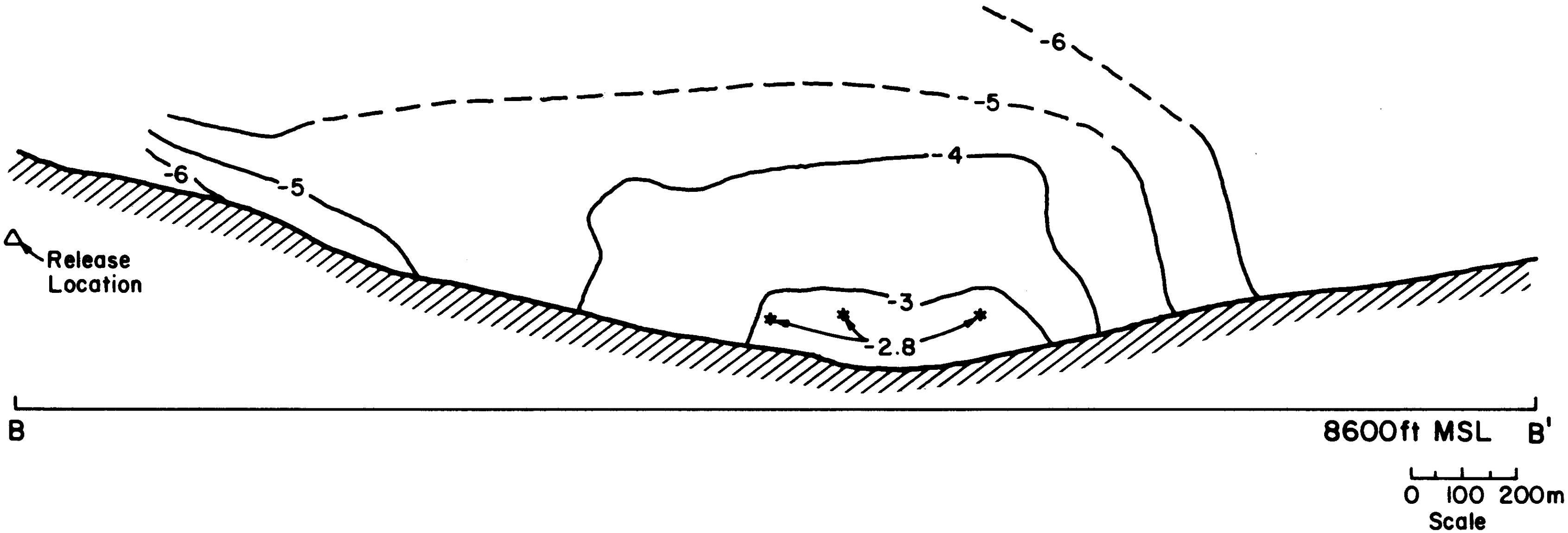


Figure 9-2-3. Isopleths in the Vertical of the Normalized Concentrations (plotted $\log_{10} K$) for the Alkali Creek Stable Flow (West Wind) Tests Taken 121.9 cm (3.12 km full-scale) Downwind from a 0.318 cm (8.14 m full-scale) Release

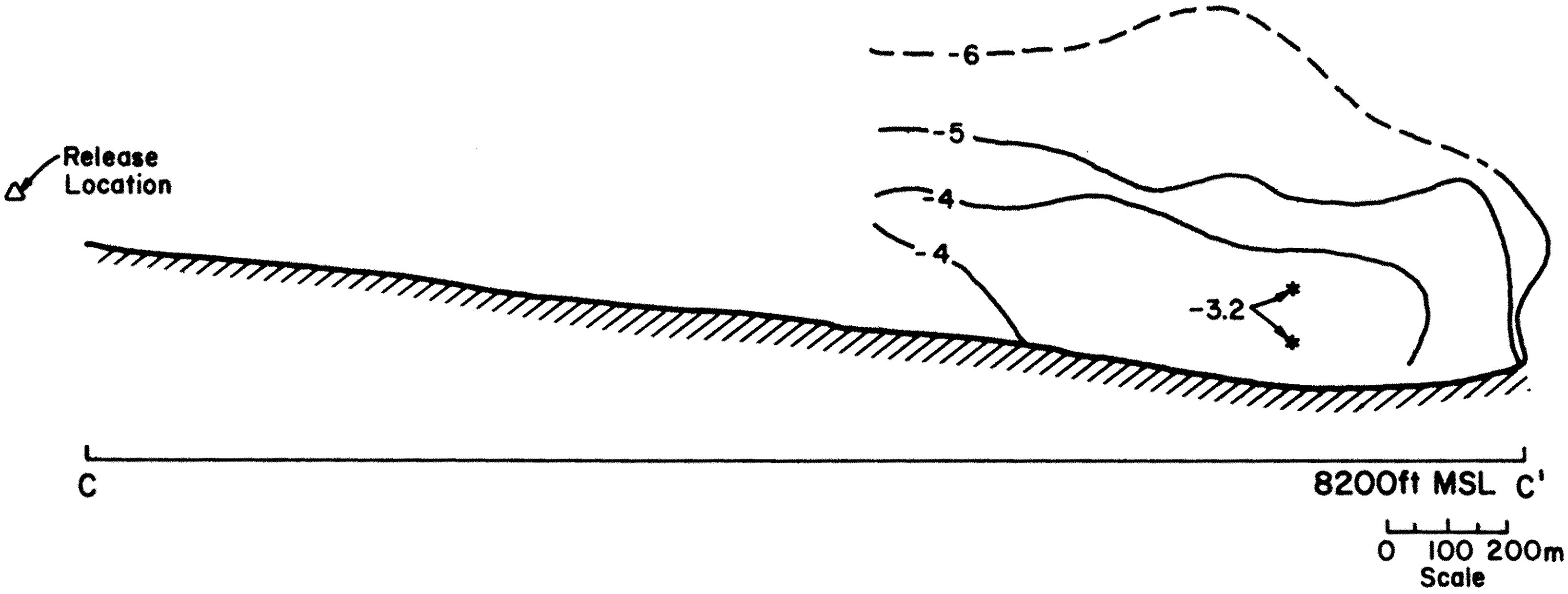


Figure 9-2-4. Isopleths in the Vertical of the Normalized Concentrations (plotted $\log_{10} K$) for the Alkali Creek Stable Flow (West Wind) Tests Taken 182.8 cm (4.68 km full-scale) Downwind from a 0.318 cm (8.14 m full-scale) Release

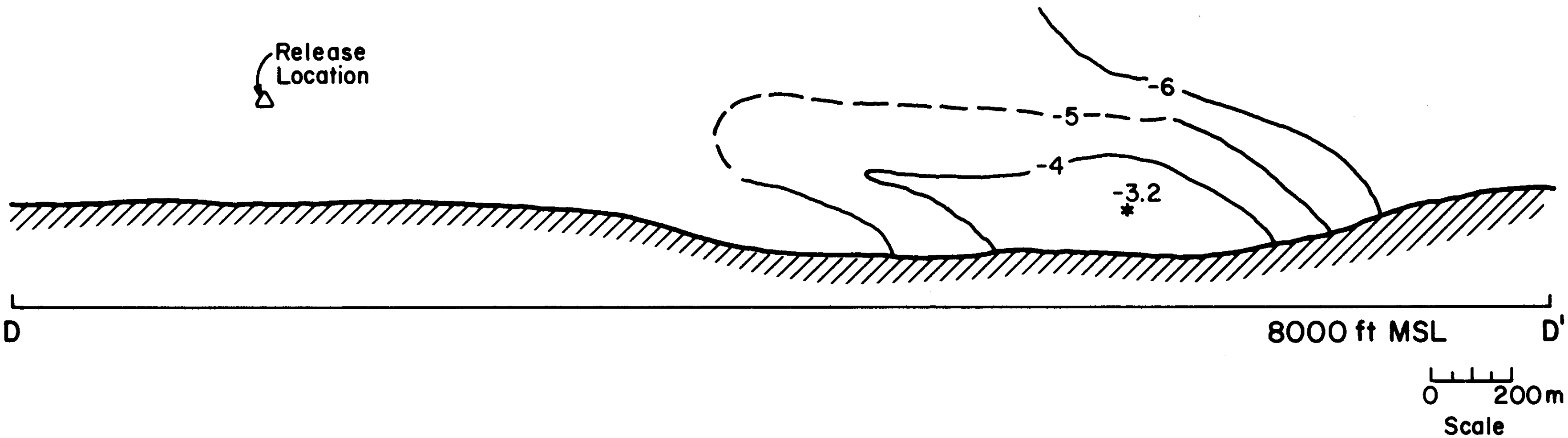


Figure 9-2-5. Isopleths in the Vertical of the Normalized Concentrations (plotted $\log_{10}$ K) for the Alkali Creek Stable Flow (West Wind) Tests Taken 243.8 cm (6.24 km full-scale) Downwind from a 0.318 cm (8.14 m full-scale) Release

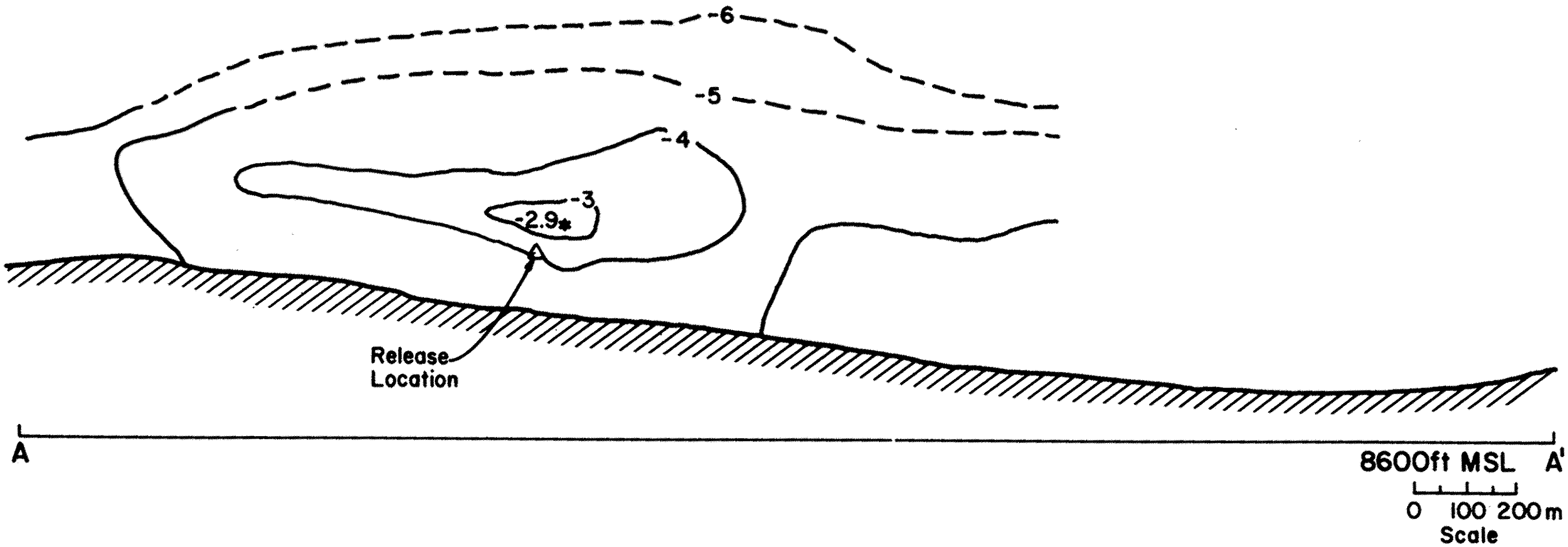


Figure 9-2-6. Isopleths in the Vertical of the Normalized Concentrations (plotted $\log_{10}$ K) for the Alkali Creek Stable Flow (West Wind) Tests Taken 60.9 cm (1.56 km full-scale) Downwind from a 2.54 cm (65.02 m full-scale) Release

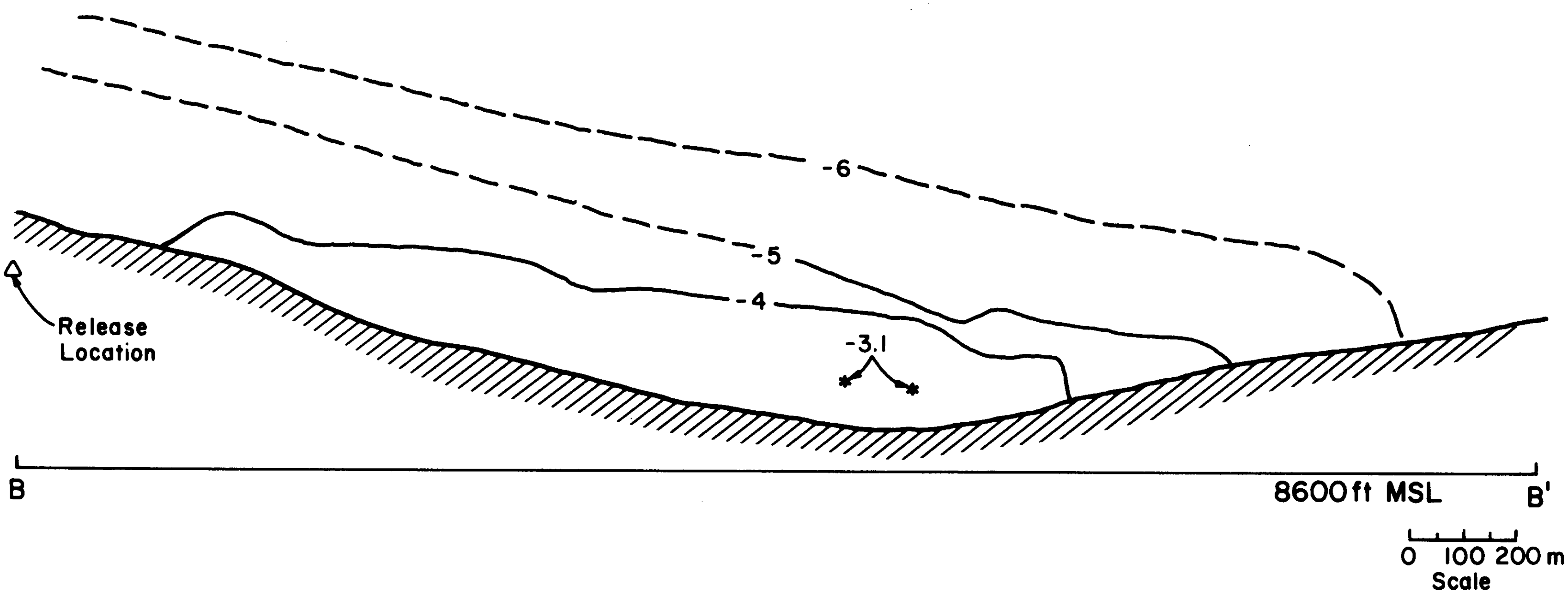


Figure 9-2-7. Isopleths in the Vertical of the Normalized Concentrations (plotted $\log_{10} K$) for the Alkali Creek Stable Flow (West Wind) Tests Taken 121.9 cm (3.12 km full-scale) Downwind from a 2.54 cm (65.02 m full-scale) Release

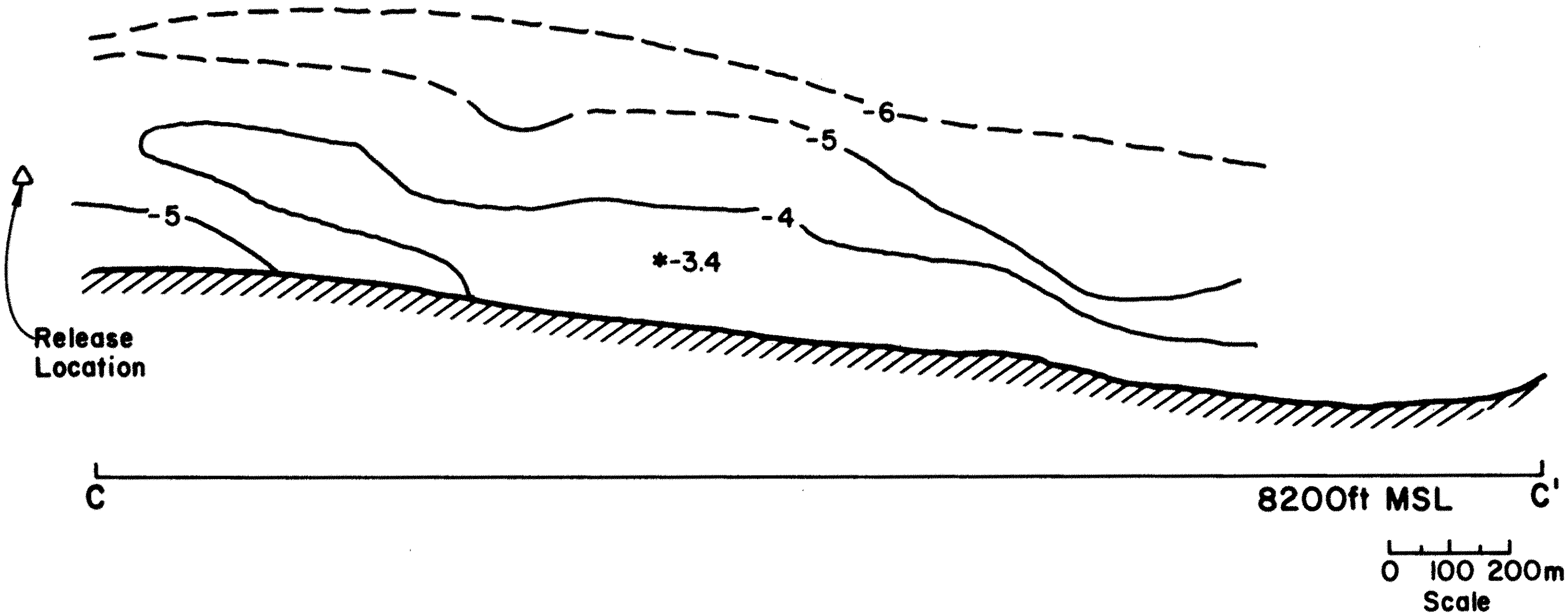


Figure 9-2-8. Isopleths in the Vertical of the Normalized Concentrations (plotted $\log_{10} K$) for the Alkali Creek Stable Flow (West Wind) Tests Taken 182.8 cm (4.68 km full-scale) Downwind from a 2.54 cm (65.02 m full-scale) Release

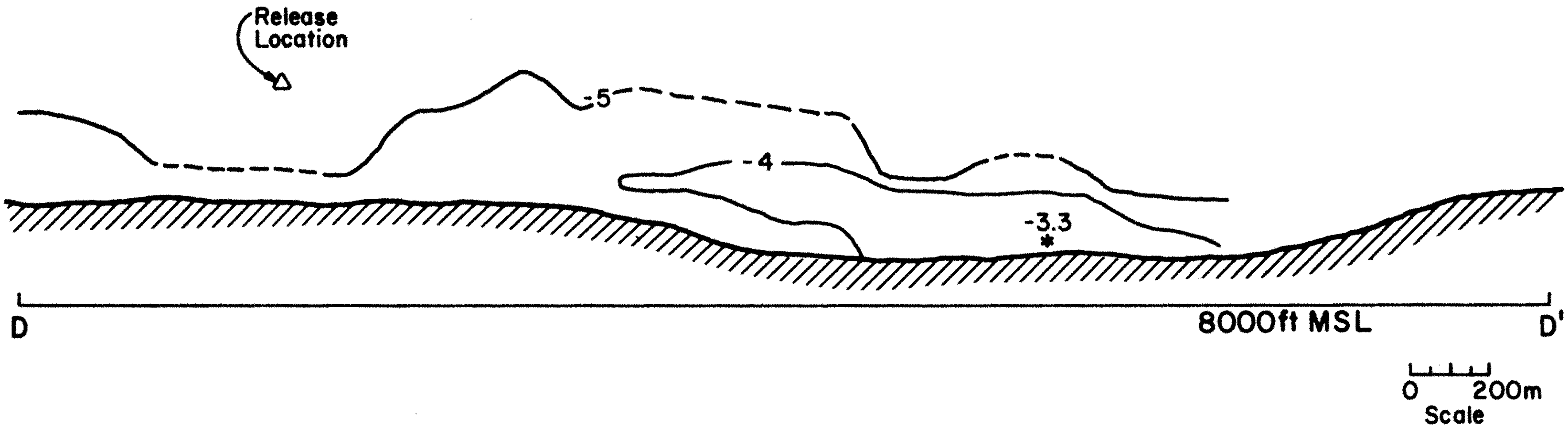


Figure 9-2-9. Isopleths in the Vertical of the Normalized Concentrations (plotted $\log_{10}$ K) for the Alkali Creek Stable Flow (West Wind) Tests Taken 243.8 cm (6.24 km full-scale) Downwind from a 2.54 cm (65.02 m full-scale) Release

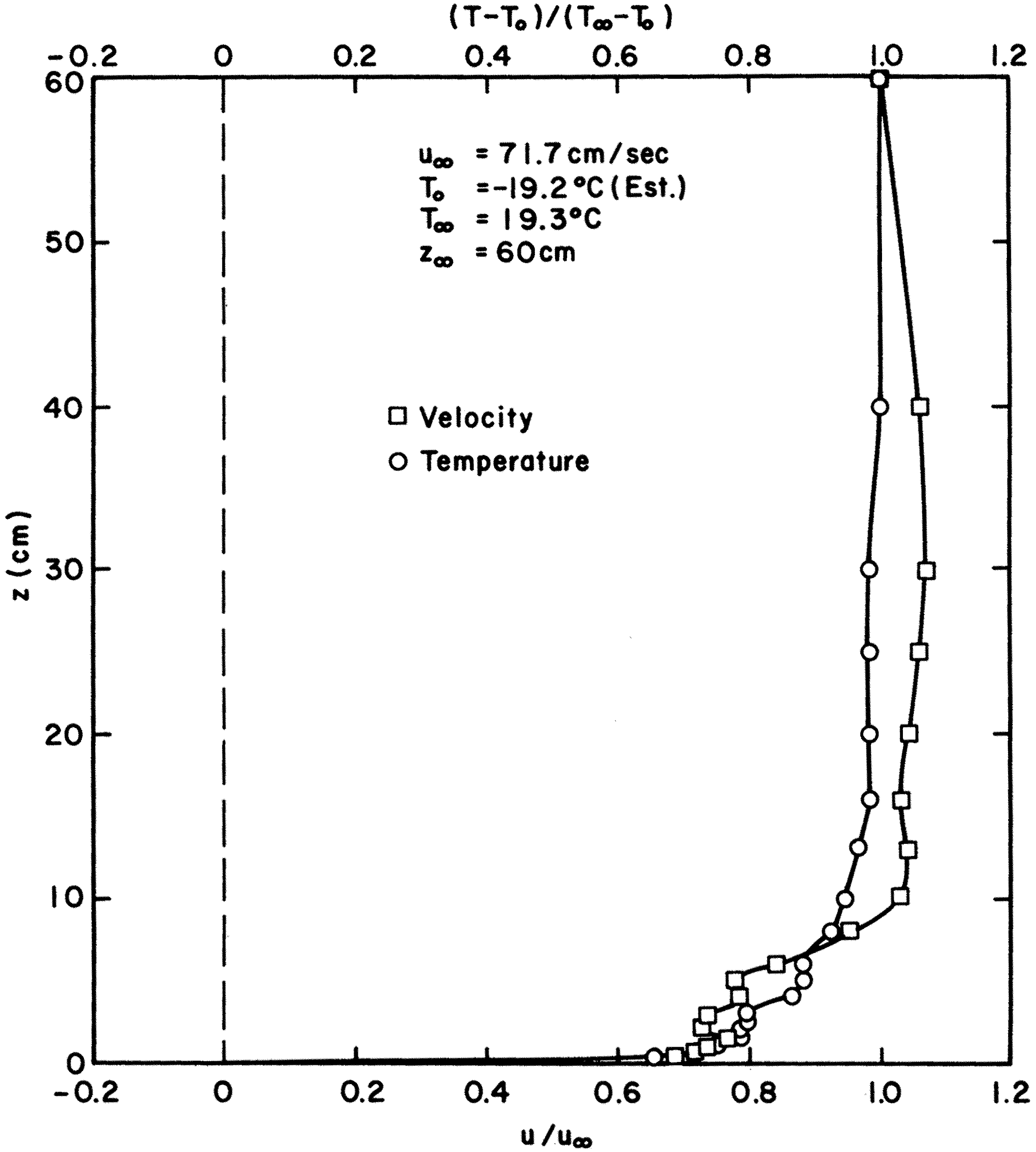


Figure 10-1-1. Velocity and Temperature Profiles Taken at Location A (see Figure 3-2-5) for the Alkali Creek Stable Flow (East Wind) Test (Ri = 0.24)

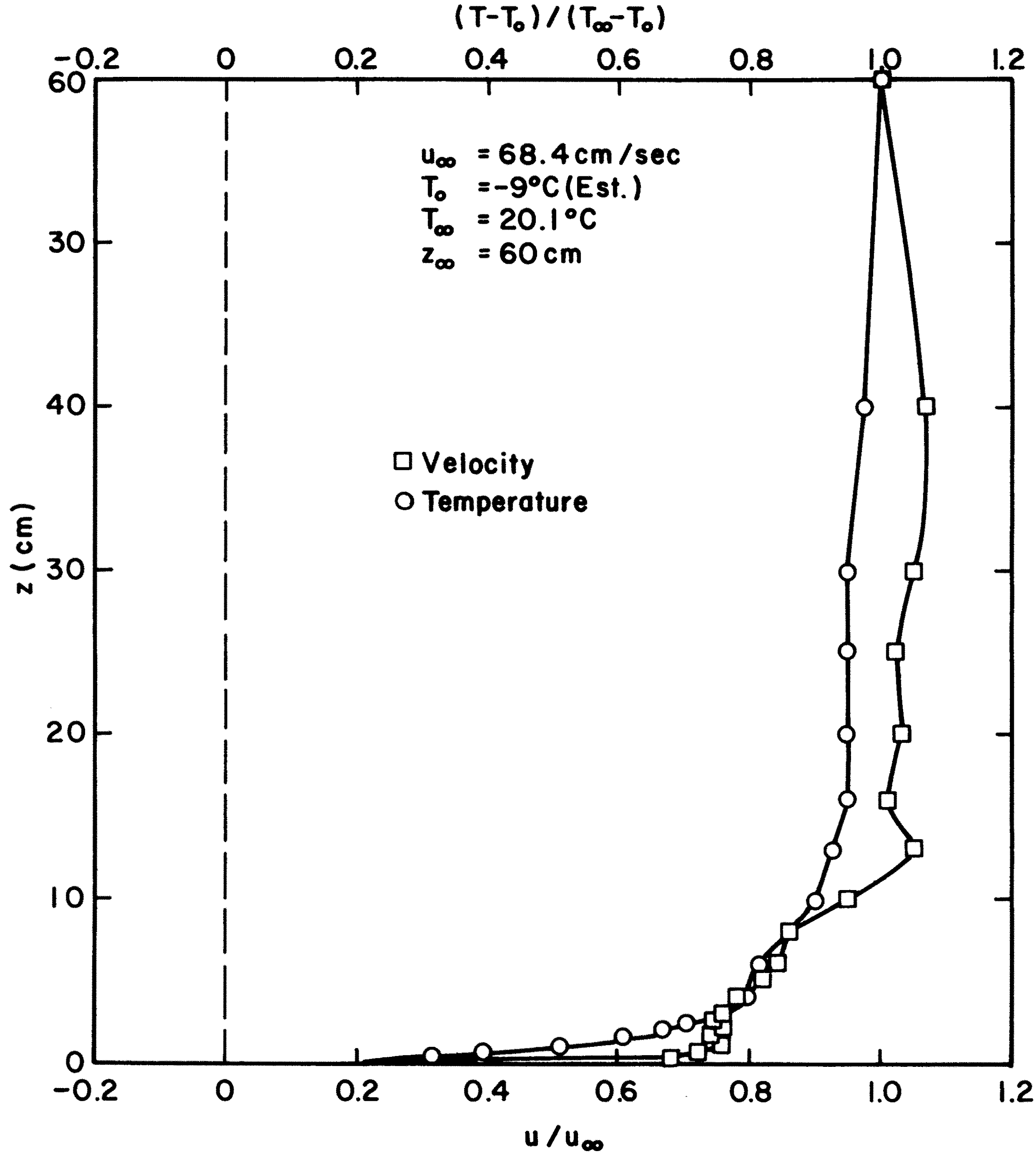


Figure 10-1-2. Velocity and Temperature Profiles Taken at Location B (see Figure 3-2-5) for the Alkali Creek Stable Flow (East Wind) Test (Ri = 0.21)

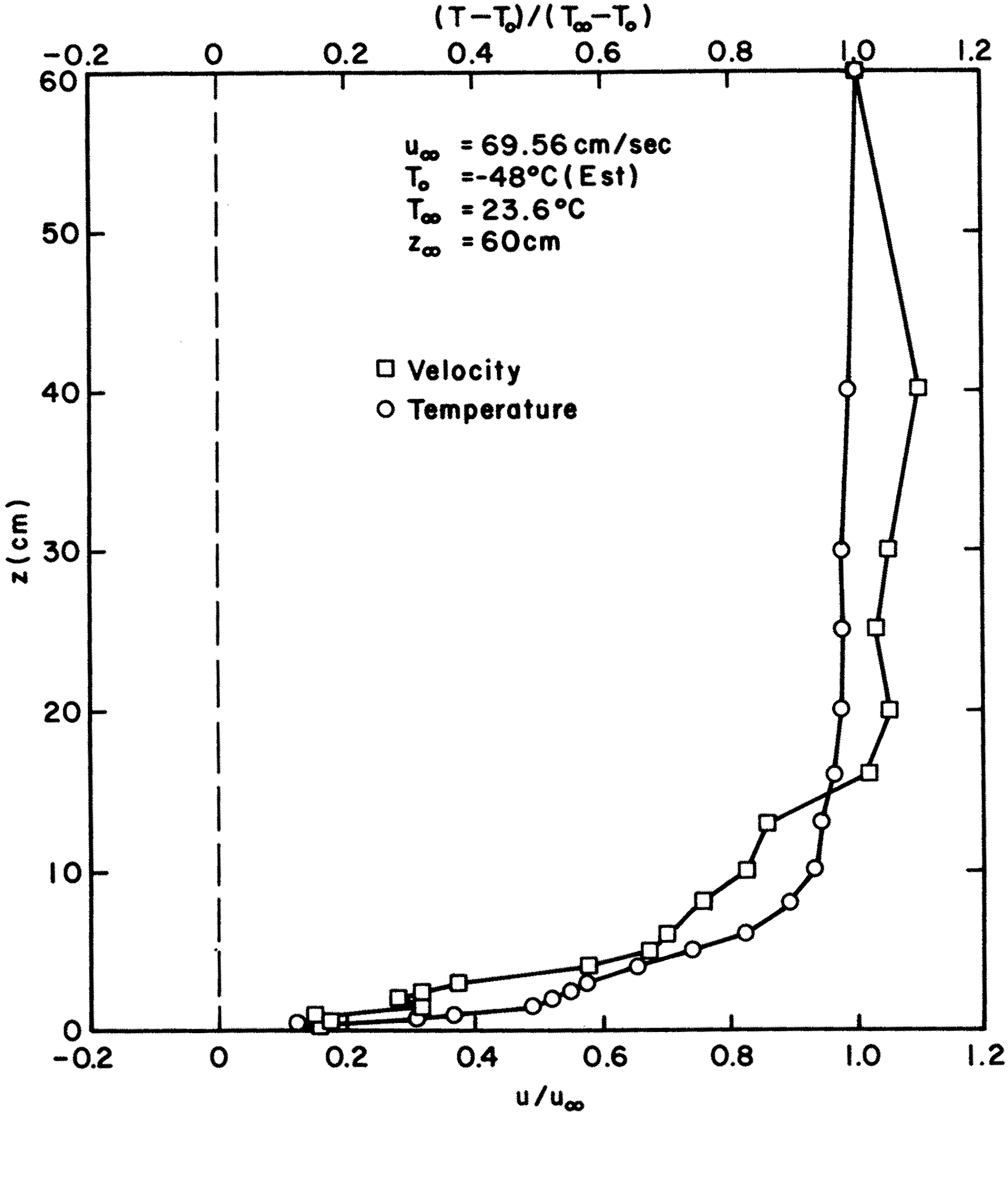


Figure 10-1-3. Velocity and Temperature Profiles Taken at Location C (see Figure 3-2-5) for the Alkali Creek Stable Flow (East Wind) Test (Ri = 0.77)

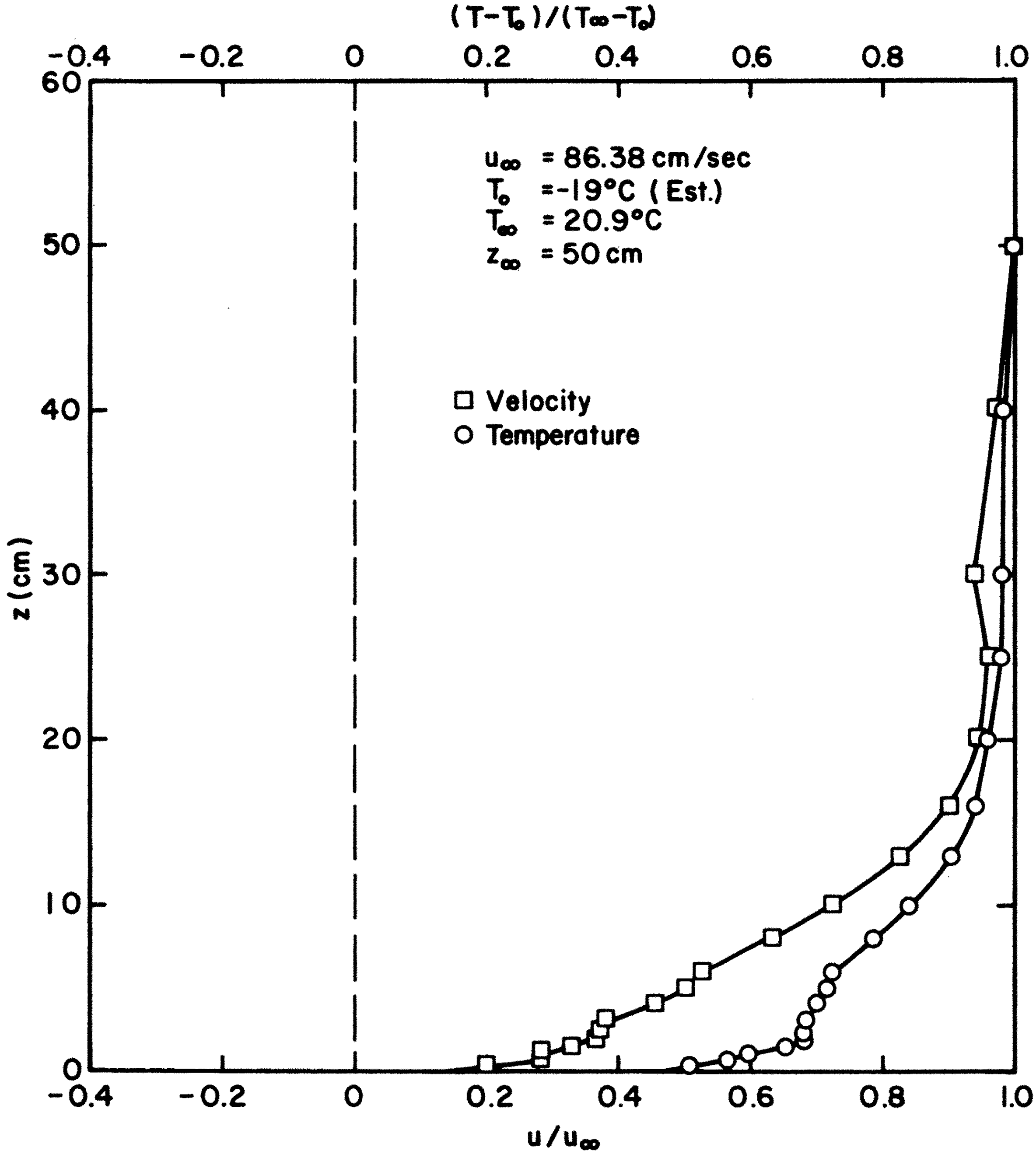


Figure 10-1-4. Velocity and Temperature Profiles Taken at Location D (see Figure 3-2-5) for the Alkali Creek Stable Flow (East Wind) Test (Ri = 0.30)

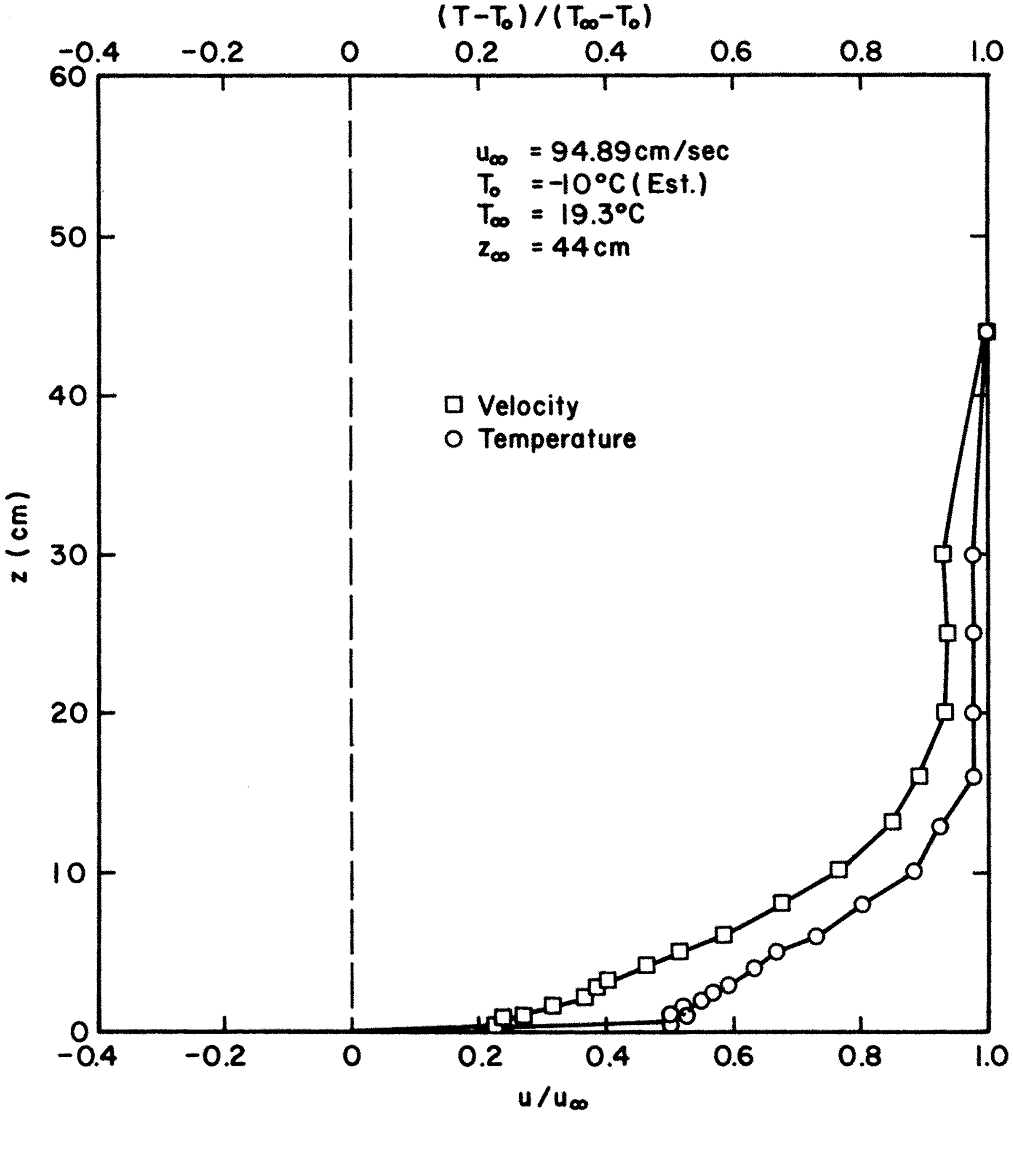


Figure 10-1-5. Velocity and Temperature Profiles Taken at Location E (see Figure 3-2-5) for the Alkali Creek Stable Flow (East Wind) Test (Ri = 0.16)

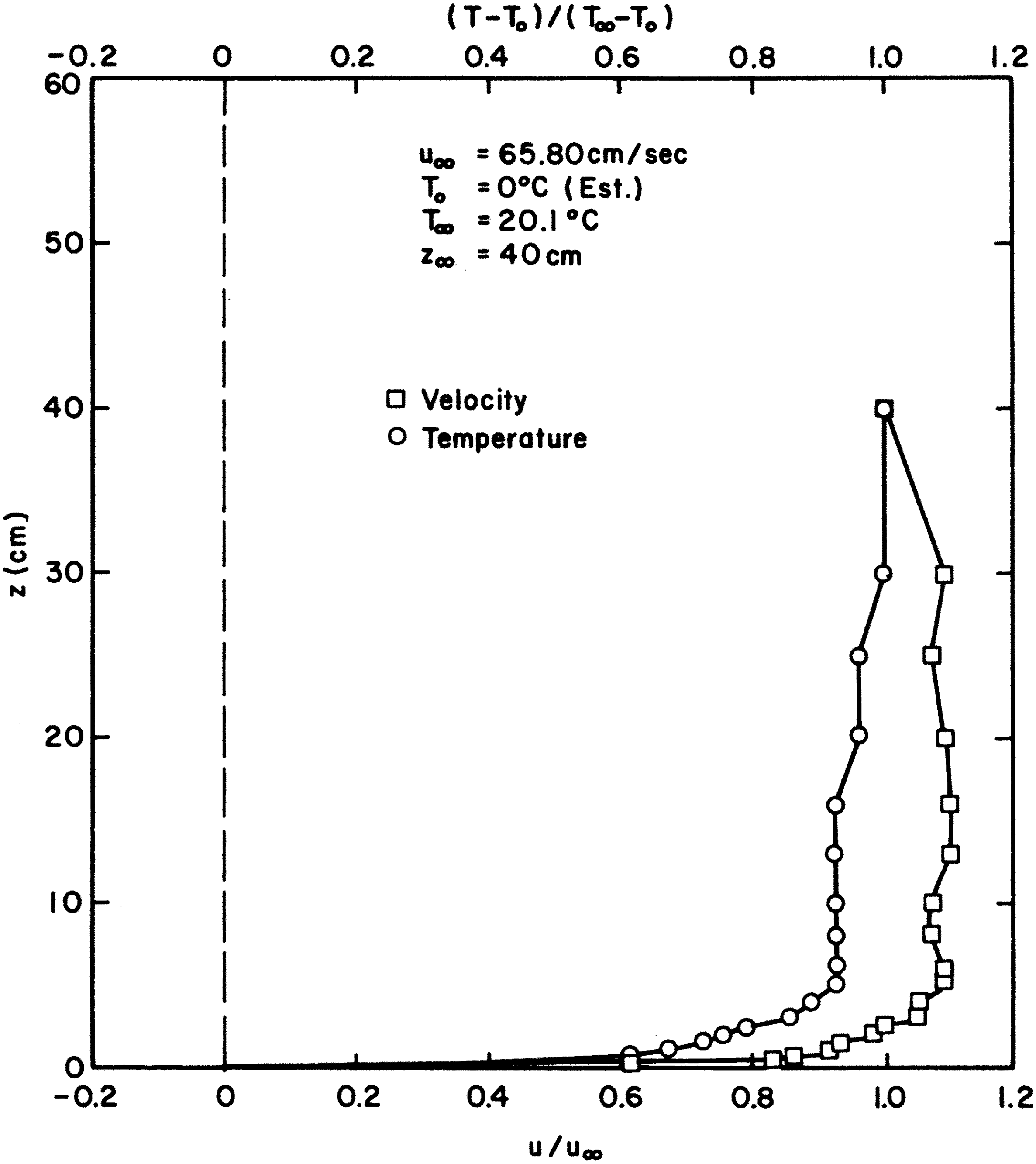


Figure 10-1-6. Velocity and Temperature Profiles Taken at Location F (see Figure 3-2-5) for the Alkali Creek Stable Flow (East Wind) Test (Ri = 0.12)

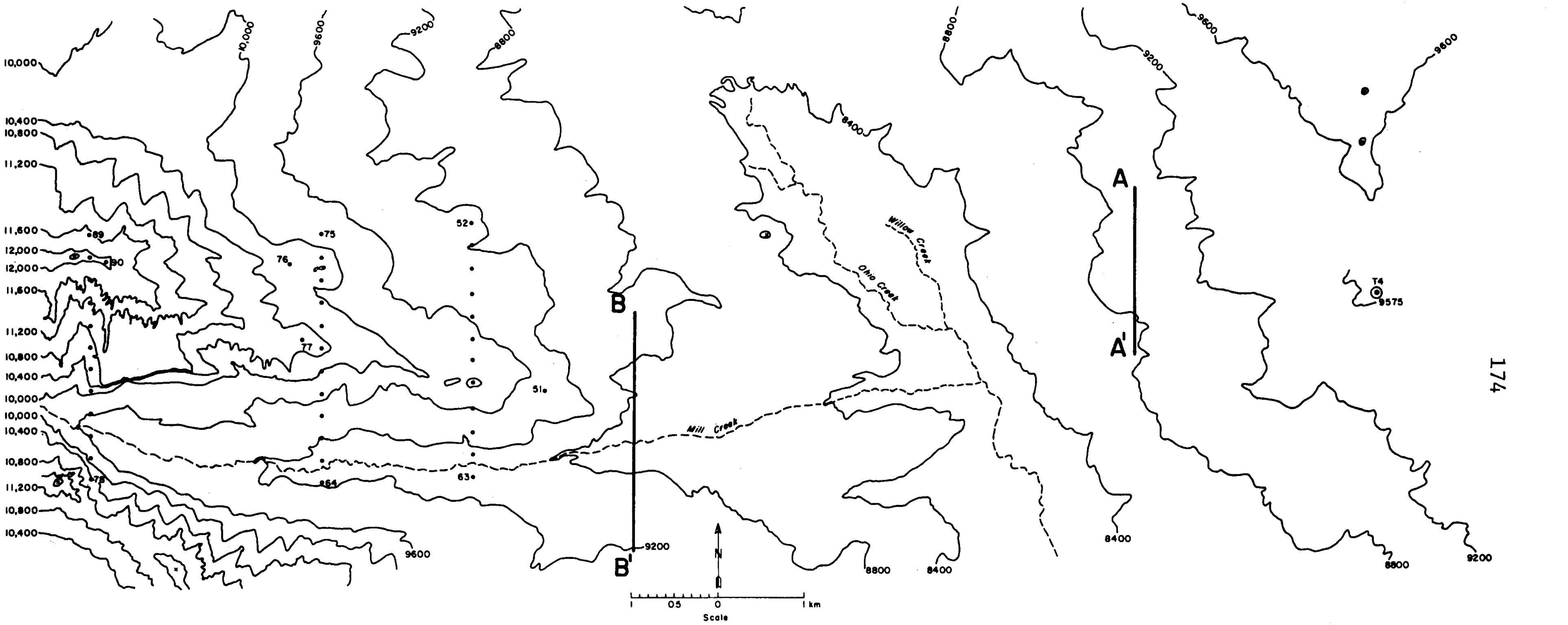


Figure 10-2-1. Map showing Location of Ground-level and Aerial (A-A' and B-B') Concentration Measurements for Alkali Creek Stable Flow (East Wind) Tests

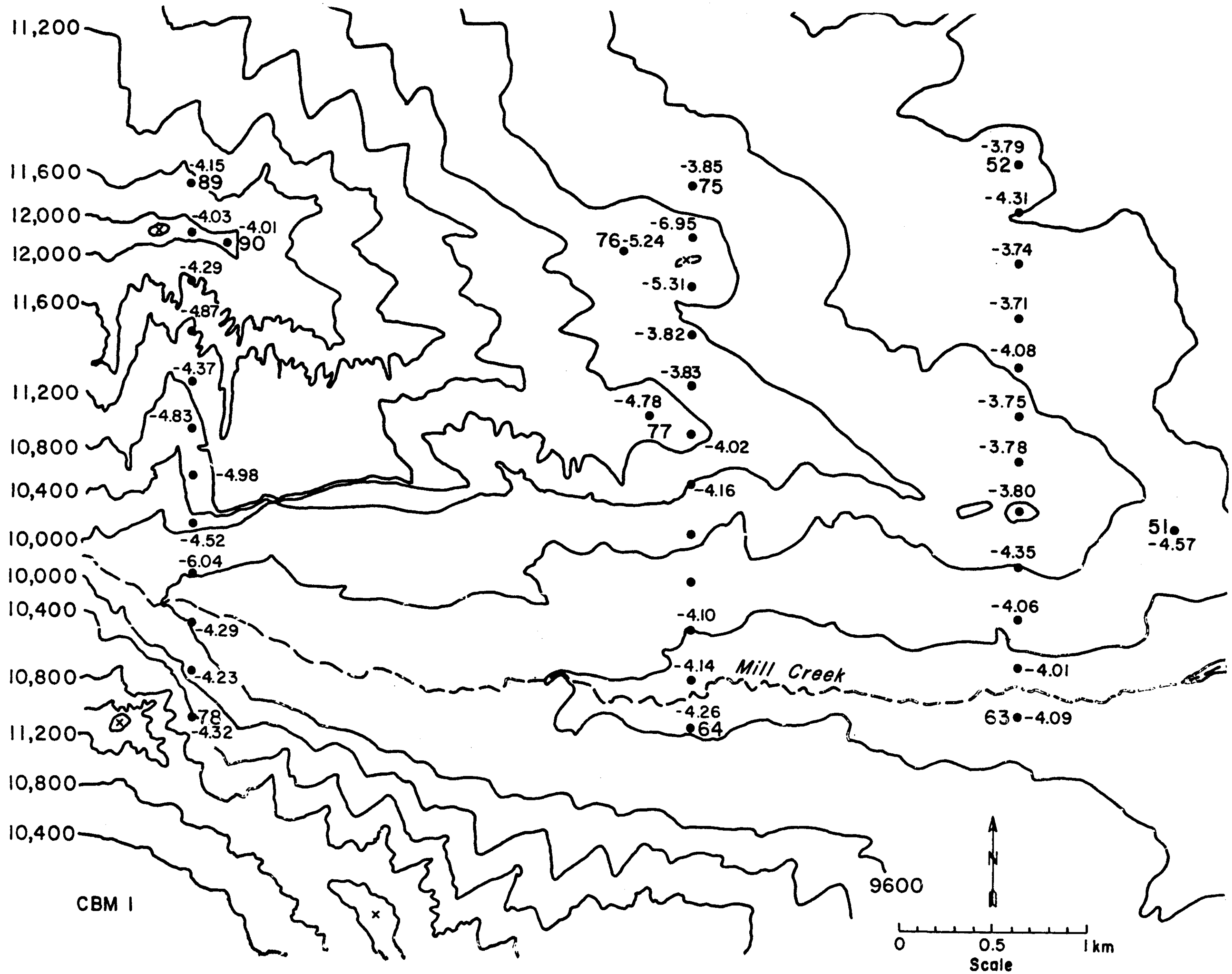


Figure 10-2-2. Ground-Level Values of Log_{10} K for the Alkali Creek Stable Flow (East Wind) Tests Taken Downwind of a 0.32 cm (8.1 m full-scale) Release

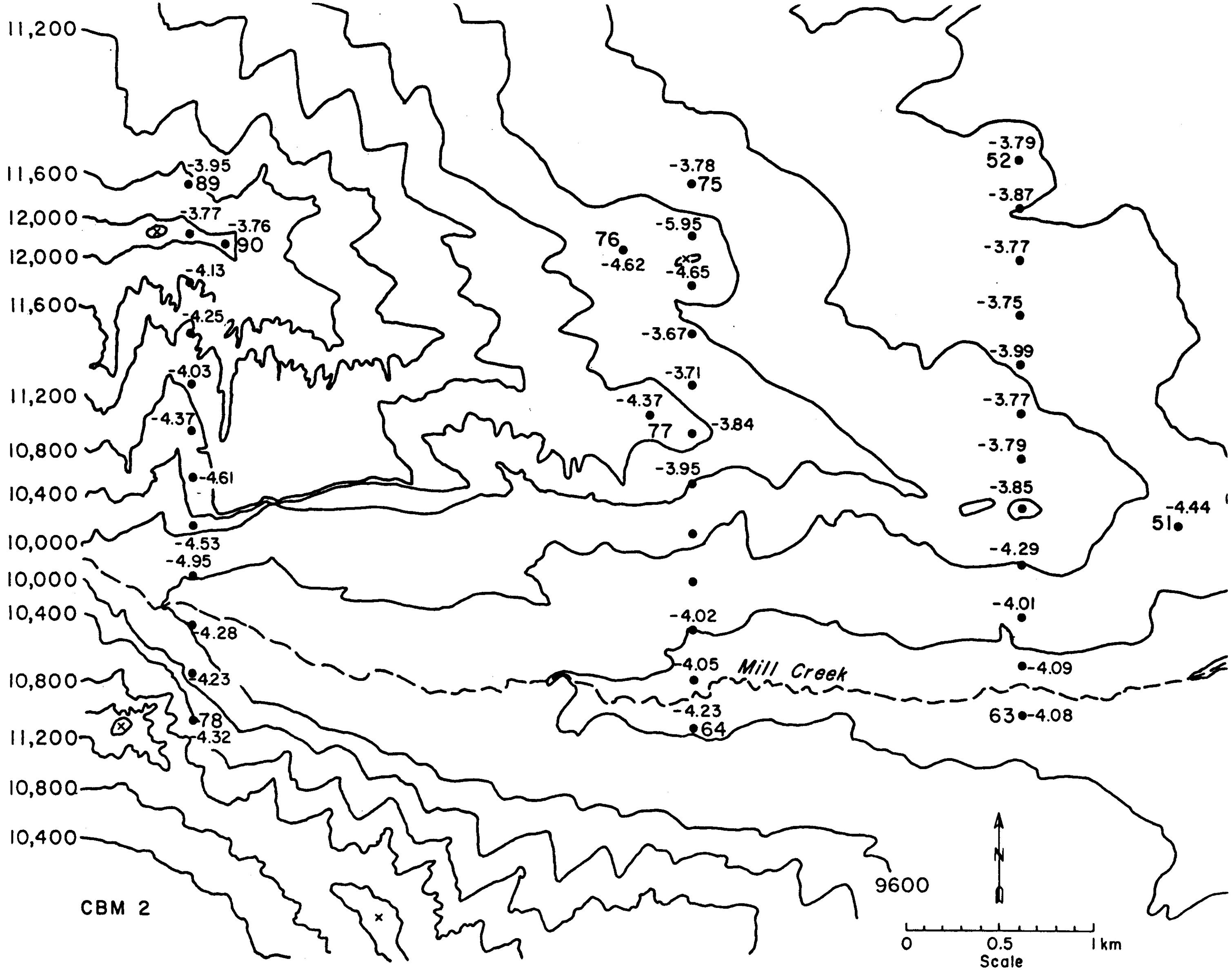


Figure 10-2-3. Ground-Level Values of $\log_{10}$ K for the Alkali Creek Stable Flow (East Wind) Tests Taken Downwind of a 2.54 cm (65 m full-scale) Release

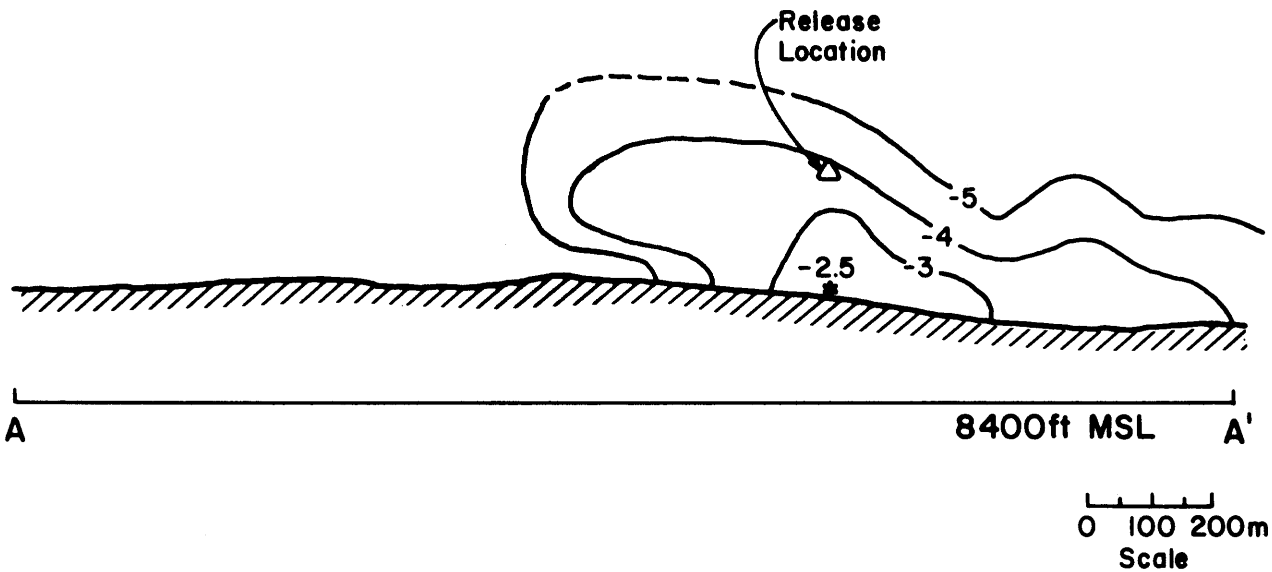


Figure 10-2-4. Isopleths in the Vertical of the Normalized Concentration (plotted $\log_{10} K$) for the Alkali Creek Stable Flow (East Wind) Tests Taken 110.5 cm (2.83 km full-scale) Downwind from a 0.318 cm (8.14 m full-scale) Release

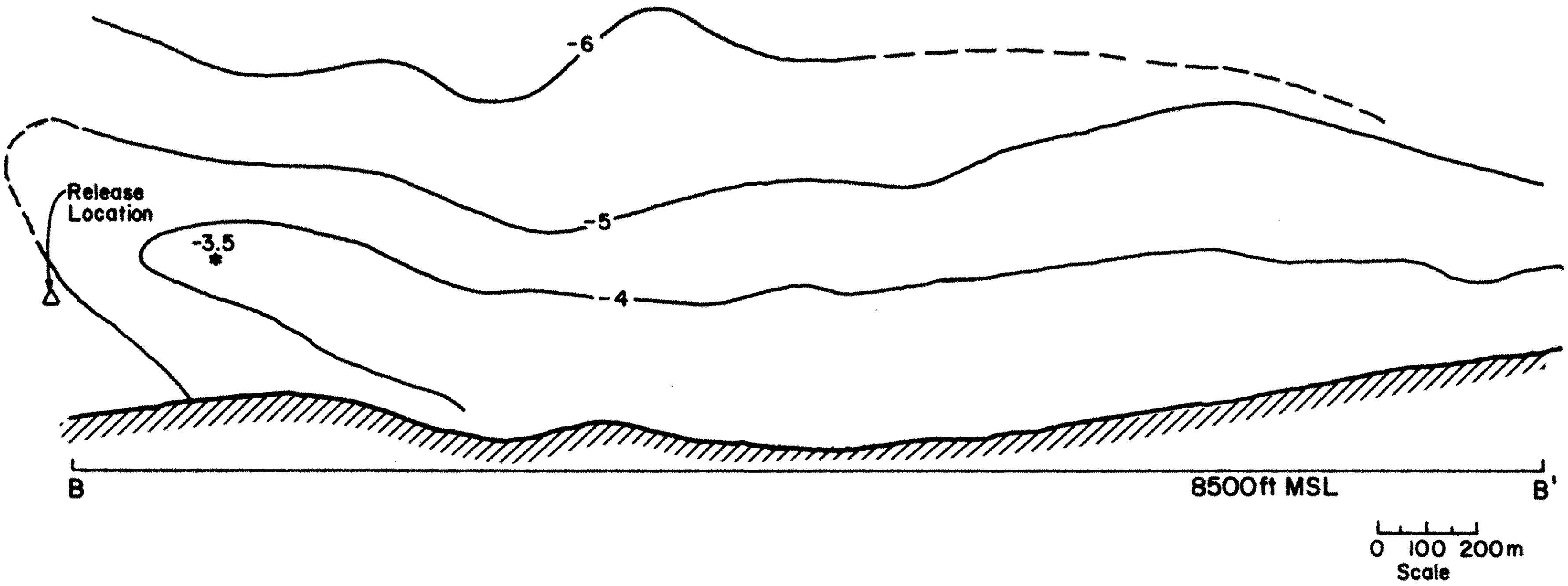


Figure 10-2-5. Isopleths in the Vertical of the Normalized Concentration (plotted $\log_{10} K$) for the Alkali Creek Stable Flow (East Wind) Tests Taken 335.2 cm (8.58 km full-scale) Downwind from a 0.318 cm (8.14 m full-scale) Release

APPENDIX A

Coal Creek Drainage Flow Concentration Data

A-1. Ground-level Data and Sample Point Locations
for Coal Creek Drainage Flow Tests

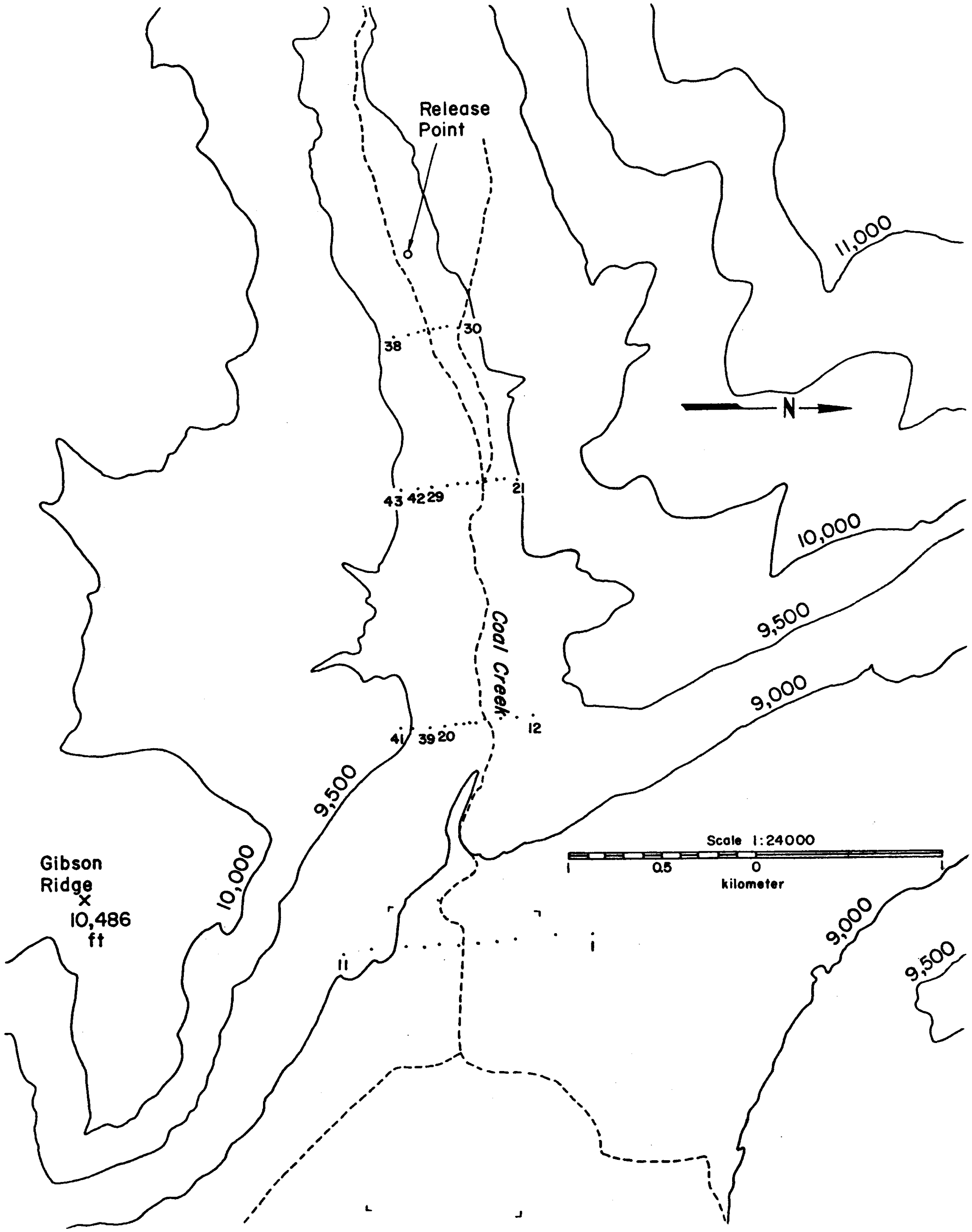


Figure A-1-1. Ground-level Sample Points Used to Obtain Concentration Data for Coal Creek Drainage Flow Tests.

RUN CCC1

	MODEL		
WIND VELOCITY	.2000 M/S		
EXIT VELOCITY	.5531 M/S		
VOLUME FLOW	.2440E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1500E+06		
BACKGROUND	.7965E+03		
CALIBRATION FACTOR	.4129E-02		
RANGE	10		
REFERENCE HEIGHT	.3180 CM		
RELEASE DIAMETER	.2370 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	323831	4303554	9400

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
2	975.	.40727E-05
3	1194.	.90695E-05
6	1241.	.10142E-04
7	38442.	.85894E-03
10	1898.	.25132E-04
11	2709.	.43636E-04
12	3478.	.61182E-04
13	16127.	.34979E-03
15	11779.	.25058E-03
18	16526.	.35889E-03
19	1384.	.13405E-04
22	25808.	.57067E-03
26	84831.	.19174E-02
28	18246.	.39814E-03
29	4580.	.86326E-04
30	1290.	.11260E-04
31	1798.	.22851E-04
32	11609.	.24670E-03
33	87511.	.19785E-02
35	1771.	.22235E-04
36	950.	.35023E-05
37	904.	.24528E-05
38	1159.	.82710E-05

RUN CCC2

	MODEL
WIND VELOCITY	.2000 M/S
EXIT VELOCITY	.5531 M/S
VOLUME FLOW	.2440E-05 M**3/S
SOURCE STRENGTH(PPM)	.1500E+06
BACKGROUND	.7250E+03
CALIBRATION FACTOR	.4192E-02
RANGE	10
REFERENCE HEIGHT	.3180 CM
RELEASE DIAMETER	.2370 CM

RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	323831	4303554	9400

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
2	747.	.50962E-06
3	744.	.44013E-06
4	755.	.69494E-06
6	1432.	.16377E-04
7	9172.	.19567E-03
10	1357.	.14640E-04
11	1424.	.16192E-04
12	3846.	.72297E-04
13	6331.	.12986E-03
15	2988.	.52421E-04
17	7800.	.16389E-03
19	8898.	.18932E-03
22	3322.	.60158E-04
26	9914.	.21286E-03
28	3623.	.67131E-04
29	1371.	.14964E-04
32	35404.	.80332E-03
33	1299.	.13296E-04
35	934.	.48414E-05
37	798.	.16910E-05
38	738.	.30114E-06

A-2. Vertical Rake Data and Rake Locations
for Coal Creek Drainage Flow Tests

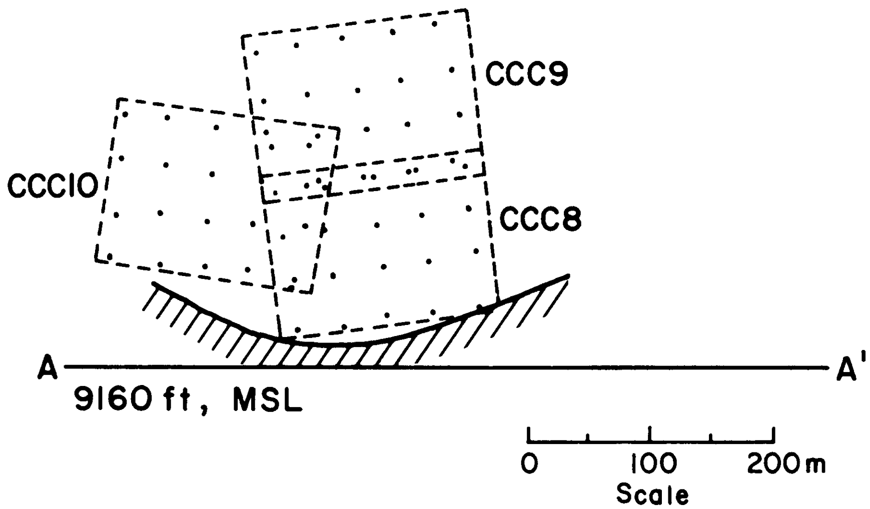


Figure A-2-1. Sampling Rake Locations for Obtaining a Vertical Cross Section of the Plume 68 cm (1.3 km) Downwind of .318 cm Release Point at T16 for the Coal Creek Drainage Flow Tests

RUN CCC10

	MODEL		
WIND VELOCITY	.2000 M/S		
EXIT VELOCITY	.5531 M/S		
VOLUME FLOW	.2440E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1500E+06		
BACKGROUND	.6695E+03		
CALIBRATION FACTOR	.4129E-02		
RANGE	10		
REFERENCE HEIGHT	.3180 CM		
RELEASE DIAMETER	.2370 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	323831	4303554	9400

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	733.	.14488E-05
2	888.	.49854E-05
3	762.	.21105E-05
4	3213.	.58034E-04
5	717.	.10838E-05
6	707.	.85562E-06
7	782.	.25669E-05
8	1146.	.10872E-04
9	688.	.42210E-06
10	678.	.19394E-06
11	722.	.11979E-05
12	878.	.47572E-05
13	708.	.87843E-06
14	663.	0.
15	844.	.39815E-05
16	918.	.56699E-05
17	711.	.94688E-06
18	0.	0.
19	801.	.30004E-05
20	904.	.53505E-05

RUN CCC9

	MODEL		
WIND VELOCITY	.2000 M/S		
EXIT VELOCITY	.5531 M/S		
VOLUME FLOW	.2440E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1500E+06		
BACKGROUND	.8525E+03		
CALIBRATION FACTOR	.4129E-02		
RANGE	10		
REFERENCE HEIGHT	.3180 CM		
RELEASE DIAMETER	.2370 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	323831	4303554	9400

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	924.	.16314E-05
2	1043.	.43465E-05
3	393.	0.
4	3131.	.51987E-04
5	98.	0.
6	0.	0.
7	1500.	.14774E-04
8	2288.	.32753E-04
9	898.	.10381E-05
10	1153.	.68563E-05
11	1505.	.14888E-04
12	2545.	.38617E-04
13	928.	.17226E-05
14	1196.	.78374E-05
15	1814.	.21938E-04
16	4147.	.75169E-04
17	782.	0.
18	1017.	.37533E-05
19	2202.	.30791E-04
20	3631.	.63396E-04

RUN CCC8

	MODEL		
WIND VELOCITY	.2000 M/S		
EXIT VELOCITY	.5531 M/S		
VOLUME FLOW	.2440E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1500E+05		
BACKGROUND	.8525E+03		
CALIBRATION FACTOR	.4095E-02		
RANGE	10		
REFERENCE HEIGHT	.3180 CM		
RELEASE DIAMETER	.2370 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	323831	4303554	9400

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	3542.	.60860E-03
2	13518.	.28660E-02
3	20034.	.43405E-02
4	97265.	.21817E-01
5	2957.	.47622E-03
6	12394.	.26117E-02
7	83096.	.18611E-01
8	160869.	.36209E-01
9	2227.	.31103E-03
10	10416.	.21641E-02
11	113646.	.25524E-01
12	164559.	.37044E-01
13	2041.	.26894E-03
14	12999.	.27486E-02
15	39009.	.86343E-02
16	187659.	.42272E-01
17	1896.	.23613E-03
18	7564.	.15187E-02
19	116415.	.26150E-01
20	245765.	.55420E-01

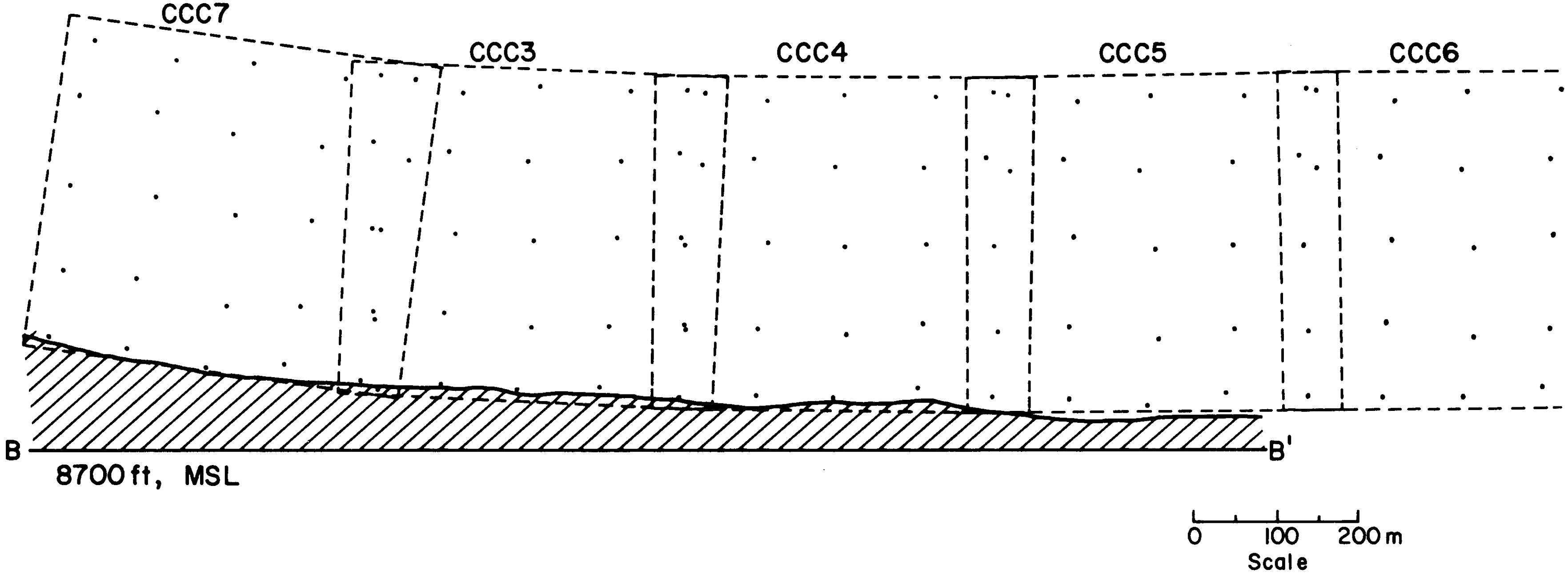


Figure A-2-2. Sampling Rake Locations for Obtaining a Vertical Cross Section of the Plume 196 (3.7 km) Downwind of .318 cm Release Point at T16 for the Coal Creek Drainage Flow Tests.

RUN CCC7

	MODEL
WIND VELOCITY	.2000 M/S
EXIT VELOCITY	.5531 M/S
VOLUME FLOW	.2440E-05 M**3/S
SOURCE STRENGTH(PPM)	.1500E+06
BACKGROUND	.7415E+03
CALIBRATION FACTOR	.4129E-02
RANGE	10
REFERENCE HEIGHT	.3180 CM
RELEASE DIAMETER	.2370 CM

RELEASE LOCATION

X (M)	Y (M)	Z (FT MSL)
323831	4303554	9400

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	0.	0.
2	1750.	.23010E-04
3	6822.	.13874E-03
4	21813.	.48078E-03
5	32469.	.72391E-03
6	2047.	.29787E-04
7	0.	0.
8	1334.	.13519E-04
9	1017.	.62859E-05
10	896.	.35251E-05
11	1863.	.25589E-04
12	1071.	.75180E-05
13	0.	0.
14	866.	.28406E-05
15	899.	.35936E-05
16	897.	.35480E-05
17	922.	.41184E-05
18	622.	0.
19	985.	.55558E-05
20	663.	0.
21	787.	.10381E-05
22	799.	.13119E-05
23	1038.	.67651E-05
24	920.	.40727E-05
25	777.	.80998E-06

RUN CCC3

	MODEL		
WIND VELOCITY	.2000 M/S		
EXIT VELOCITY	.5531 M/S		
VOLUME FLOW	.2440E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1500E+06		
BACKGROUND	.7465E+03		
CALIBRATION FACTOR	.4129E-02		
RANGE	10		
REFERENCE HEIGHT	.3180 CM		
RELEASE DIAMETER	.2370 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	323831	4303554	9400

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	45764.	.10271E-02
2	8689.	.18122E-03
3	27886.	.61923E-03
4	39078.	.87459E-03
5	42502.	.95271E-03
6	1568.	.18744E-04
7	1705.	.21870E-04
8	789.	.96970E-06
9	799.	.11979E-05
10	1138.	.89326E-05
11	738.	0.
12	775.	.65027E-06
13	938.	.43693E-05
14	1109.	.82710E-05
15	1027.	.64000E-05
16	1008.	.59665E-05
17	1105.	.81797E-05
18	1258.	.11671E-04
19	1377.	.14386E-04
20	1595.	.19360E-04
21	1447.	.15983E-04
22	1551.	.18356E-04
23	1622.	.19976E-04
24	1253.	.11557E-04
25	1546.	.18242E-04

RUN CCC4

	MODEL
WIND VELOCITY	.2000 M/S
EXIT VELOCITY	.5531 M/S
VOLUME FLOW	.2440E-05 M**3/S
SOURCE STRENGTH(PPM)	.1500E+06
BACKGROUND	.6885E+03
CALIBRATION FACTOR	.4129E-02
RANGE	10
REFERENCE HEIGHT	.3180 CM
RELEASE DIAMETER	.2370 CM

RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	323831	4303554	9400

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	38734.	.86806E-03
3	32997.	.73717E-03
4	26309.	.58457E-03
5	19366.	.42615E-03
6	1257.	.12971E-04
7	1165.	.10872E-04
8	702.	.30802E-06
9	21.	0.
10	1169.	.10963E-04
11	1135.	.10188E-04
12	1179.	.11191E-04
13	1292.	.13770E-04
14	1372.	.15595E-04
15	1821.	.25840E-04
16	1093.	.92293E-05
17	1203.	.11739E-04
18	1158.	.10712E-04
19	1149.	.10507E-04
20	1192.	.11488E-04
21	1215.	.12013E-04
22	1132.	.10119E-04
23	1281.	.13519E-04
24	1119.	.98225E-05
25	1295.	.13838E-04

RUN CCC5

	MODEL	
WIND VELOCITY	.2000	M/S
EXIT VELOCITY	.5531	M/S
VOLUME FLOW	.2440E-05	M**3/S
SOURCE STRENGTH(PPM)	.1500E+06	
BACKGROUND	.8555E+03	
CALIBRATION FACTOR	.4129E-02	
RANGE	10	
REFERENCE HEIGHT	.3180	CM
RELEASE DIAMETER	.2370	CM

	X (M)	Y (M)	Z (FT MSL)
RELEASE LOCATION	323831	4303554	9400

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	15297.	.32950E-03
2	14330.	.30744E-03
3	14278.	.30625E-03
4	1936.	.24653E-04
5	3005.	.49044E-04
6	2226.	.31270E-04
7	2270.	.32274E-04
8	2149.	.29513E-04
9	2521.	.38001E-04
10	2521.	.38001E-04
11	1912.	.24106E-04
12	1050.	.44378E-05
13	1297.	.10073E-04
14	1123.	.61034E-05
15	1137.	.64228E-05
16	1679.	.18789E-04
17	1317.	.10530E-04
18	221.	0.
19	1156.	.68563E-05
20	1180.	.74039E-05
21	2312.	.33232E-04
22	1179.	.73811E-05
23	1305.	.10256E-04
24	1965.	.25315E-04
25	1240.	.87729E-05

RUN CCC6

	MODEL		
WIND VELOCITY	.2000 M/S		
EXIT VELOCITY	.5531 M/S		
VOLUME FLOW	.2440E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1500E+06		
BACKGROUND	.9340E+03		
CALIBRATION FACTOR	.4129E-02		
RANGE	10		
REFERENCE HEIGHT	.3180 CM		
RELEASE DIAMETER	.2370 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	323831	430355	9400

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	1553.	.14123E-04
2	921.	0.
3	1528.	.13553E-04
4	1534.	.13690E-04
5	1336.	.91722E-05
6	1405.	.10747E-04
7	1348.	.94460E-05
8	1297.	.82824E-05
9	1684.	.17112E-04
10	1385.	.10290E-04
11	1282.	.79401E-05
12	1241.	.70046E-05
13	1575.	.14625E-04
14	1336.	.91722E-05
15	1318.	.87615E-05
16	1456.	.11910E-04
17	468.	0.
18	1172.	.54303E-05
19	1455.	.11887E-04
20	1425.	.11203E-04
21	1441.	.11568E-04
22	1559.	.14260E-04
23	1535.	.13713E-04
24	1477.	.12389E-04
25	1506.	.13051E-04

APPENDIX B

Alkali Creek Drainage Flow Concentration Profile Data

B-1 Vertical Rake Sampling Locations
B-2 Horizontal Rake Sampling Locations

Table B-1-1. Vertical Rake Sampling Locations for the Alkali Creek Drainage Flow Tests with Azimuths and Distances Measured from the Release Point at T4

SAMPLE POINT	RUN ACC1A			RUN ACC2A			RUN ACC3A			RUN ACC4A		
	r(m)	θ^o	z(ft,msl)	r(m)	θ^o	z(ft,msl)	r(m)	θ^o	z(ft,msl)	r(m)	θ^o	z(ft,msl)
1	699	239^o	9355	1593	245^o	9160	2341	250^o	8950	699	239^o	9652
2			9389			9194			8984			9715
3			9422			9227			9017			9778
4			9464			9269			9059			9820
5			9489			9294			9084			9862
6			9557			9362			9152			9904
7			9615			9420			9210			9988
8			9666			9471			9261			10030
9			9725			9530			9320			10072
10			9775			9580			9370			10114
11			9842			9647			9437			10240
12			9901			9706			9496			10335
13			10035			9840			9630			10366
14			10136			9941			9731			10870
15	↓	↓	10254	↓	↓	10059	↓	↓	9849	↓	↓	11290

Table B-1-2. Horizontal Rake Sampling Locations for the Alkali Creek Drainage Flow Tests with Measurements Taken from the Release Point at T4

SAMPLE POINT	RUN ACC1A			RUN ACC2A			RUN ACC3A			RUN ACC4A		
	r(m)	y(m)	z(ft,msl)	r(m)	y(m)	z(ft,msl)	r(m)	y(m)	z(ft,msl)	r(m)	y(m)	z(ft,msl)
16		-154	9355	1593	-154	9160		-305	8950		-531	9652
17		-123	↓		-123	↓		-187	↓		-294	↓
18		-102			-102			-133			-182	
19		- 82			- 82			- 82			-128	
20		- 56			- 56			- 56			- 58	
21		- 33			- 33			- 33			- 38	
22		- 18			- 18			- 18			- 26	
23	699	0		1593	0		2341	0		699	0	
24		+ 26			+ 26			+ 26			+ 26	
25		+ 38			+ 38			+ 38			+ 38	
26		+ 77			+ 77			+ 77			+ 58	
27		+ 92			+ 92			+ 92			+148	
28		+118			+118			+143			+195	
29		+141			+142			+189			+307	
30		+164			+164			+307			+563	
	$\theta = 239^{o}$			$\theta = 245^{o}$			$\theta = 250^{o}$			$\theta = 239^{o}$		

Note: 1. (Azimuths measured from T4 to center of rake at sample point 23).

2. Negative offsets (y) measured to left when facing the release point.

RUN ACC1A

	MODEL		
WIND VELOCITY	.1800 M/S		
EXIT VELOCITY	.5384 M/S		
VOLUME FLOW	.2375E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1000E+06		
BACKGROUND	.4760E+02		
CALIBRATION FACTOR	.2288E-01		
RANGE	100		
REFERENCE HEIGHT	.3180 CM		
RELEASE DIAMETER	.2370 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3234102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	23743.	.41551E-02
2	85960.	.15065E-01
3	212354.	.37229E-01
4	213650.	.37456E-01
5	129387.	.22680E-01
6	116645.	.20446E-01
7	68565.	.12015E-01
8	31878.	.55816E-02
9	17508.	.30618E-02
10	10067.	.17570E-02
11	3552.	.61452E-03
12	924.	.15368E-03
13	293.	.43032E-04
14	129.	.14274E-04
15	0.	0.
16	0.	0.
17	354.	.53729E-04
18	736.	.12071E-03
19	2005.	.34324E-03
20	40112.	.70255E-02
21	76063.	.13330E-01
22	164030.	.28755E-01
23	170386.	.29870E-01
24	171926.	.30140E-01
25	28034.	.49076E-02
26	17407.	.30441E-02
27	2514.	.43250E-03
28	379.	.58113E-04
29	151.	.18132E-04
30	77.	.51554E-05

RUN ACC2A

	MODEL		
WIND VELOCITY	.1800 M/S		
EXIT VELOCITY	.5384 M/S		
VOLUME FLOW	.2375E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1000E+06		
BACKGROUND	.9100E+02		
CALIBRATION FACTOR	.2288E-01		
RANGE	100		
REFERENCE HEIGHT	.3180 CM		
RELEASE DIAMETER	.2370 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	6613.	.11437E-02
2	56880.	.99583E-02
3	113810.	.19941E-01
4	94733.	.16596E-01
5	54824.	.95977E-02
6	36268.	.63438E-02
7	13210.	.23005E-02
8	3513.	.60007E-03
9	1225.	.19885E-03
10	607.	.90483E-04
11	319.	.39981E-04
12	225.	.23498E-04
13	62.	0.
14	94.	.52607E-06
15	82.	0.
16	959.	.15221E-03
17	792.	.12292E-03
18	16243.	.28323E-02
19	13595.	.23680E-02
20	74996.	.13135E-01
21	***********	.17536E+10
22	104315.	.18276E-01
23	96622.	.16927E-01
24	99690.	.17465E-01
25	42004.	.73497E-02
26	31591.	.55237E-02
27	***********	.17536E+10
28	9070.	.15745E-02
29	4172.	.71563E-03
30	1117.	.17991E-03

RUN ACC3A

	MODEL		
WIND VELOCITY	.1800 M/S		
EXIT VELOCITY	.5384 M/S		
VOLUME FLOW	.2375E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1000E+06		
BACKGROUND	.7300E+02		
CALIBRATION FACTOR	.2288E-01		
RANGE	100		
REFERENCE HEIGHT	.3180 CM		
RELEASE DIAMETER	.2370 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	2363.	.40156E-03
2	29172.	.51027E-02
3	61490.	.10770E-01
4	47074.	.82419E-02
5	23819.	.41640E-02
6	13837.	.24136E-02
7	4599.	.79366E-03
8	1399.	.23252E-03
9	596.	.91711E-04
10	344.	.47521E-04
11	190.	.20517E-04
12	161.	.15431E-04
13	48.	0.
14	112.	.68389E-05
15	74.	.17536E-06
16	116.	.75403E-05
17	259.	.32616E-04
18	1260.	.20815E-03
19	4746.	.81944E-03
20	21314.	.37247E-02
21	20760.	.36276E-02
22	45734.	.80069E-02
23	56736.	.99362E-02
24	72610.	.12720E-01
25	37167.	.65046E-02
26	42347.	.74130E-02
27	36790.	.64385E-02
28	27668.	.48389E-02
29	14017.	.24452E-02
30	227.	.27005E-04

RUN ACC4A

	MODEL		
WIND VELOCITY	.1800 M/S		
EXIT VELOCITY	.5384 M/S		
VOLUME FLOW	.2375E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1000E+06		
BACKGROUND	.6000E+02		
CALIBRATION FACTOR	.2288E-01		
RANGE	100		
REFERENCE HEIGHT	.3180 CM		
RELEASE DIAMETER	.2370 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	729.	.11731E-03
2	2289.	.39087E-03
3	12766.	.22281E-02
4	22274.	.38953E-02
5	25365.	.44374E-02
6	27507.	.48130E-02
7	25564.	.44723E-02
8	19071.	.33337E-02
9	12609.	.22005E-02
10	13860.	.24199E-02
11	18941.	.33109E-02
12	19221.	.33600E-02
13	18207.	.31822E-02
14	9328.	.16252E-02
15	1481.	.24918E-03
16	76.	.28057E-05
17	117.	.99953E-05
18	144.	.14730E-04
19	609.	.96270E-04
20	862.	.14064E-03
21	1096.	.18167E-03
22	2282.	.38964E-03
23	6116.	.10620E-02
24	11569.	.20182E-02
25	7302.	.12699E-02
26	11705.	.20420E-02
27	993.	.16361E-03
28	350.	.50853E-04
29	284.	.39280E-04
30	78.	.31564E-05

APPENDIX C

Coal Creek Neutral Flow Concentration Data

C-1 Ground-level Data and Sample Point Locations
C-2 Vertical Rake Data and Rake Locations

C-1. Ground-level Data and Sample Point Locations
for Coal Creek Neutral Flow Tests

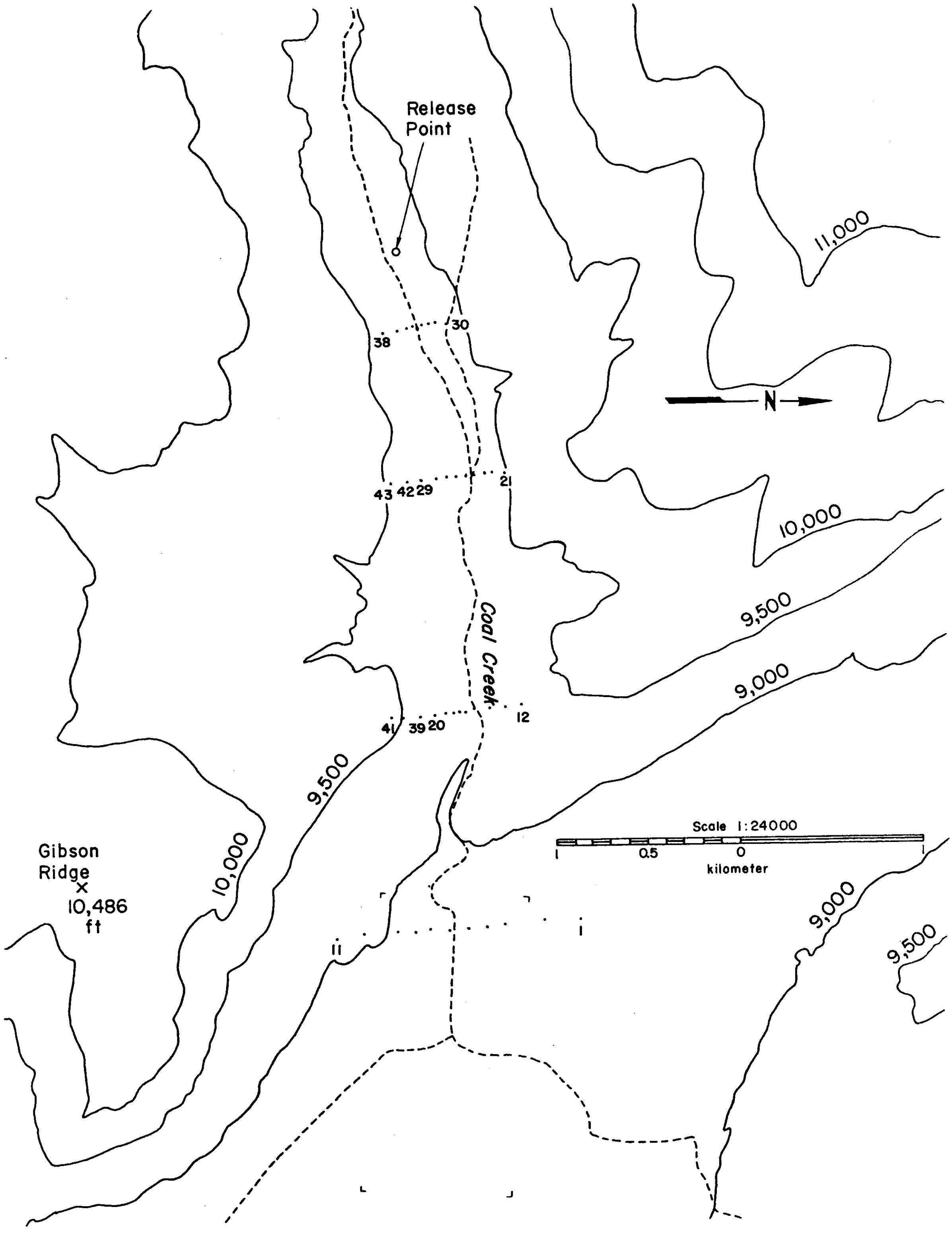


Figure C-1-1. Ground-level Sample Points Used to Obtain Concentration Data for Coal Creek Neutral Flow Tests.

RUN CCC1A

	MODEL		
WIND VELOCITY	3.0000 M/S		
EXIT VELOCITY	5.2816 M/S		
VOLUME FLOW	.2330E-04 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.1869E+03		
CALIBRATION FACTOR	.3907E-01		
RANGE	100		
REFERENCE HEIGHT	.3180 CM		
RELEASE DIAMETER	.2370 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	323831	4303554	9400

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	215.	.90295E-05
2	1362.	.37374E-03
3	975.	.25044E-03
4	1498.	.41669E-03
5	1790.	.50956E-03
7	1796.	.51153E-03
9	1281.	.34792E-03
10	747.	.17798E-03
11	365.	.56752E-04
12	148.	0.
13	3285.	.98504E-03
14	3656.	.11030E-02
15	2992.	.89185E-03
16	3035.	.90552E-03
17	4178.	.12689E-02
18	3451.	.10378E-02
19	2257.	.65816E-03
20	2161.	.62764E-03
39	1586.	.44483E-03
40	708.	.16568E-03
41	452.	.84285E-04
21	265.	.24831E-04
22	3759.	.11357E-02
23	4439.	.13519E-02
24	523.	.10686E-03
25	8960.	.27893E-02
26	9833.	.30669E-02
27	9291.	.28945E-02
28	8566.	.26640E-02
29	5171.	.15846E-02
42	2668.	.78884E-03
43	747.	.17808E-03
30	126.	0.
31	2094.	.60634E-03
32	92308.	.29289E-01
33	584.	.12625E-03
34	1823.	.52018E-03
35	133.	0.
36	135.	0.
37	118.	0.
38	124.	0.

RUN CCC2A

	MODEL		
WIND VELOCITY	3.0800 M/S		
EXIT VELOCITY	5.2816 M/S		
VOLUME FLOW	.2330E-04 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.1365E+03		
CALIBRATION FACTOR	.3907E-01		
RANGE	100		
REFERENCE HEIGHT	.3180 CM		
RELEASE DIAMETER	.2370 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	323831	4303554	9400

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	151.	.46101E-05
2	715.	.18393E-03
3	583.	.14196E-03
4	991.	.27168E-03
5	1371.	.39249E-03
7	1644.	.47929E-03
9	1295.	.36833E-03
10	814.	.21540E-03
11	398.	.83141E-04
12	100.	0.
13	2148.	.63953E-03
14	2011.	.59598E-03
15	2063.	.61251E-03
16	2960.	.89770E-03
17	3079.	.93553E-03
18	2869.	.86877E-03
19	2100.	.62427E-03
20	2469.	.74159E-03
39	2022.	.59947E-03
40	899.	.24243E-03
41	572.	.13846E-03
21	149.	.39742E-05
22	1099.	.30602E-03
23	1456.	.41952E-03
24	257.	.38312E-04
25	3749.	.11486E-02
26	4952.	.15310E-02
27	6220.	.19342E-02
28	6947.	.21653E-02
29	5439.	.16859E-02
42	3011.	.91391E-03
43	660.	.16644E-03
30	97.	0.
32	570.	.13783E-03
34	697.	.17820E-03
35	346.	.66608E-04
36	104.	0.
37	105.	0.
38	100.	0.

C-2. Vertical Rake Concentration Data and Rake Locations for Coal Creek Neutral Flow Tests

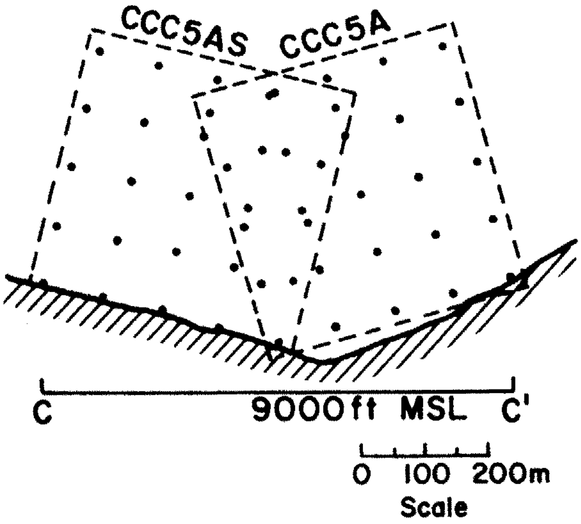


Figure C-2-1. Sampling Rake Locations for Obtaining a Vertical Cross Section of the Plume 68 cm (1.3 km) Downwind from a 0.318 cm (6.1 m) Release Point at T16 for the Coal Creek Neutral Stability Tests.

RUN CCC5AS

	MODEL		
WIND VELOCITY	3.0000 M/S		
EXIT VELOCITY	5.3270 M/S		
VOLUME FLOW	.2350E-04 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.1100E+03		
CALIBRATION FACTOR	.3907E-01		
RANGE	100		
REFERENCE HEIGHT	.3180 CM		
RELEASE DIAMETER	.2370 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	323831	4303554	9400

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	6241.	.19327E-02
2	2769.	.83820E-03
6	4107.	.12600E-02
7	2080.	.62101E-03
8	240.	.40980E-04
9	141.	.97722E-05
11	2555.	.77074E-03
12	1382.	.40098E-03
13	223.	.35621E-04
16	897.	.24809E-03
17	881.	.24304E-03
18	185.	.23642E-04
21	256.	.46024E-04
22	335.	.70927E-04
23	144.	.10718E-04

RUN CCC5A

MODEL

WIND VELOCITY	3.0000 M/S		
EXIT VELOCITY	5.3270 M/S		
VOLUME FLOW	.2350E-04 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.1020E+03		
CALIBRATION FACTOR	.3907E-01		
RANGE	100		
REFERENCE HEIGHT	.3180 CM		
RELEASE DIAMETER	.2370 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	323831	4303554	9400

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	290.	.59264E-04
2	210.	.34045E-04
3	105.	.94570E-06
4	104.	.63047E-06
5	108.	.18914E-05
6	1723.	.51099E-03
7	554.	.14249E-03
8	125.	.72503E-05
9	98.	0.
10	117.	.47285E-05
11	4793.	.14788E-02
12	1617.	.47758E-03
13	141.	.12294E-04
14	94.	0.
15	164.	.19544E-04
16	6929.	.21521E-02
17	1999.	.59800E-03
18	179.	.24273E-04
19	101.	0.
20	96.	0.
21	5804.	.17975E-02
22	3949.	.12127E-02
23	313.	.66514E-04
24	115.	.40980E-05
25	97.	0.

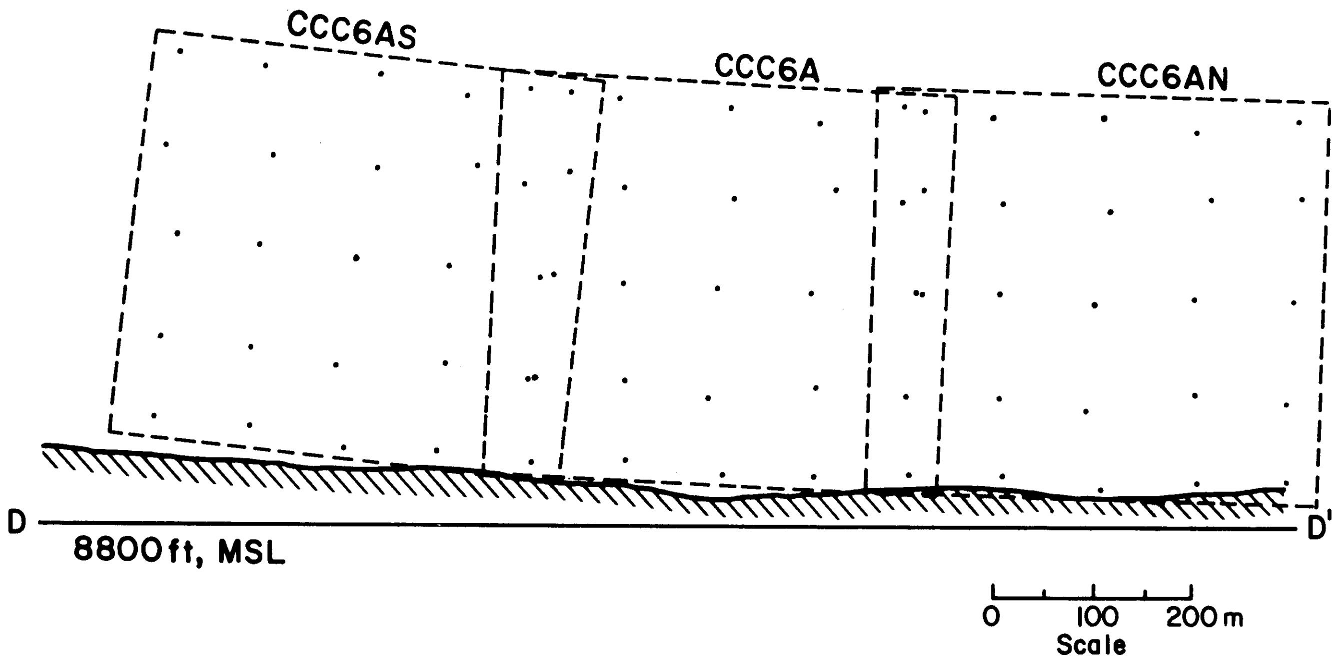


Figure C-2-2. Sampling Rake Locations for Obtaining a Vertical Cross Section of the Plume 196 cm (3.7 km full scale) Downwind from a 0.318 cm (6.1 m full scale) Release Point at T16 for the Coal Creek Neutral Stability Tests.

RUN CCC6AS

MODEL

WIND VELOCITY	3.0000 M/S		
EXIT VELOCITY	5.3270 M/S		
VOLUME FLOW	.2350E-04 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.9000E+02		
CALIBRATION FACTOR	.3896E-01		
RANGE	100		
REFERENCE HEIGHT	.3180 CM		
RELEASE DIAMETER	.2370 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	323831	4303554	9400

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	1848.	.55262E-03
2	1508.	.44574E-03
4	484.	.12385E-03
5	275.	.58154E-04
6	1606.	.47655E-03
7	1216.	.35395E-03
8	707.	.19395E-03
9	380.	.91160E-04
10	236.	.45894E-04
11	1266.	.36967E-03
12	844.	.23702E-03
13	401.	.97761E-04
14	189.	.31120E-04
15	168.	.24519E-04
16	779.	.21658E-03
17	578.	.15340E-03
18	182.	.28920E-04
19	143.	.16660E-04
20	118.	.88017E-05
21	516.	.13391E-03
22	432.	.10751E-03
23	148.	.18232E-04
24	98.	.25148E-05
25	81.	0.

RUN CCC6A

MODEL

WIND VELOCITY	3.0000	M/S
EXIT VELOCITY	5.3270	M/S
VOLUME FLOW	.2350E-04	M**3/S
SOURCE STRENGTH(PPM)	.1600E+06	
BACKGROUND	.1345E+03	
CALIBRATION FACTOR	.3896E-01	
RANGE	100	
REFERENCE HEIGHT	.3180	CM
RELEASE DIAMETER	.2370	CM

RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	323831	4303554	9400

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	1231.	.34468E-03
2	1091.	.30067E-03
4	482.	.10923E-03
5	253.	.37250E-04
6	1430.	.40723E-03
7	1187.	.33085E-03
8	866.	.22994E-03
9	636.	.15764E-03
10	275.	.44165E-04
11	1600.	.46067E-03
12	1406.	.39969E-03
13	908.	.24315E-03
14	376.	.75914E-04
15	272.	.43222E-04
16	1731.	.50185E-03
17	1229.	.34405E-03
18	713.	.18185E-03
19	548.	.12998E-03
20	320.	.58311E-04
21	1657.	.47859E-03
22	1538.	.44118E-03
23	892.	.23812E-03
24	435.	.94461E-04
25	239.	.32849E-04

RUN CCC6AN

MODEL

WIND VELOCITY	3.0000 M/S		
EXIT VELOCITY	5.3270 M/S		
VOLUME FLOW	.2350E-04 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.1030E+03		
CALIBRATION FACTOR	.3896E-01		
RANGE	100		
REFERENCE HEIGHT	.3180 CM		
RELEASE DIAMETER	.2370 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	323831	4303554	9400

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	100.	0.
3	98.	0.
4	226.	.38664E-04
5	179.	.23890E-04
6	364.	.82044E-04
7	335.	.72928E-04
8	464.	.11348E-03
9	378.	.86445E-04
10	229.	.39607E-04
11	556.	.14240E-03
12	592.	.15371E-03
13	648.	.17132E-03
14	336.	.73242E-04
15	254.	.47466E-04
16	799.	.21878E-03
17	771.	.20998E-03
18	632.	.16629E-03
19	516.	.12982E-03
20	343.	.75443E-04
21	1113.	.31749E-03
22	1270.	.36684E-03
23	977.	.27474E-03
24	492.	.12228E-03
25	205.	.32063E-04

APPENDIX D

Alkali Creek Neutral Flow Concentration Data

D-1. Ground-level Concentration Data and Sample Point Locations for Alkali Creek Neutral Flow Tests

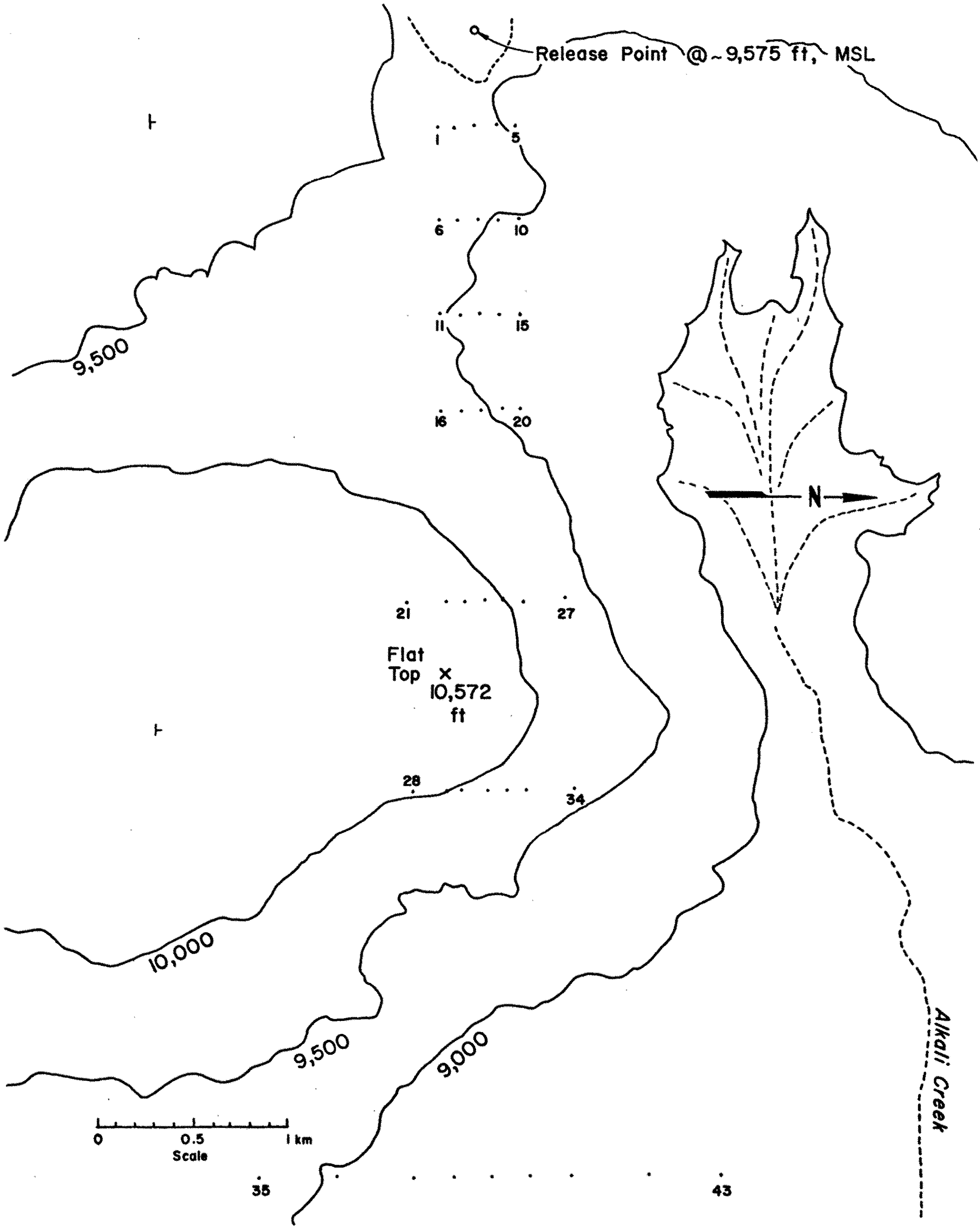


Figure D-1-1. Ground-level Sample Points Used to Obtain Concentration Data for Alkali Creek Neutral Flow Tests.

RUN ACC1

	MODEL		
WIND VELOCITY	3.0000 M/S		
EXIT VELOCITY	5.3270 M/S		
VOLUME FLOW	.2350E-04 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.8260E+03		
CALIBRATION FACTOR	.4277E-02		
RANGE	10		
REFERENCE HEIGHT	.3180 CM		
RELEASE DIAMETER	.2370 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	1458.	.21809E-04
2	793.	0.
3	65002.	.22146E-02
4	430127.	.14815E-01
5	22713.	.75529E-03
6	844.	.62115E-06
7	980.	.53143E-05
8	33244.	.11187E-02
9	200681.	.68967E-02
10	196926.	.67671E-02
11	1185.	.12389E-04
12	1492.	.22983E-04
13	18765.	.61905E-03
14	40078.	.13545E-02
15	64361.	.21925E-02
16	850.	.82821E-06
17	1057.	.79715E-05
18	9611.	.30316E-03
19	18784.	.61970E-03
20	62381.	.21242E-02
21	989.	.56249E-05
22	1030.	.70397E-05
23	2152.	.45758E-04
25	4871.	.13959E-03
26	29260.	.98122E-03
27	38923.	.13147E-02
28	1077.	.86616E-05
29	1173.	.11974E-04
30	2867.	.70432E-04
32	19265.	.63630E-03
33	24267.	.80892E-03
34	24678.	.82310E-03
35	695.	0.
36	843.	.58665E-06
37	1662.	.28849E-04
38	6729.	.20370E-03
39	7088.	.21609E-03
40	16799.	.55121E-03
41	14378.	.46766E-03
42	6904.	.20974E-03
43	1402.	.19877E-04

RUN ACC2

	MODEL		
WIND VELOCITY	3.0000 M/S		
EXIT VELOCITY	5.3270 M/S		
VOLUME FLOW	.2350E-04 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.1026E+04		
CALIBRATION FACTOR	.4289E-02		
RANGE	10		
REFERENCE HEIGHT	.3180 CM		
RELEASE DIAMETER	.2370 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	1006.	0.
2	822.	0.
3	6025.	.17299E-03
4	8426.	.25608E-03
5	844.	0.
6	1590.	.19517E-04
8	29773.	.99480E-03
9	95616.	.32733E-02
10	29151.	.97328E-03
11	1044.	.62290E-06
12	3955.	.10136E-03
13	32324.	.10831E-02
14	50598.	.17155E-02
15	41997.	.14178E-02
16	1852.	.28584E-04
17	1591.	.19552E-04
18	21807.	.71913E-03
19	28171.	.93936E-03
20	68157.	.23231E-02
21	790.	0.
22	2017.	.34294E-04
23	6182.	.17843E-03
24	16648.	.54061E-03
25	9157.	.28138E-03
26	37394.	.12585E-02
27	36175.	.12163E-02
28	916.	0.
29	2342.	.45541E-04
30	5776.	.16438E-03
32	26957.	.89735E-03
34	20186.	.66304E-03
35	924.	0.
36	0.	0.
37	1931.	.31318E-04
38	10784.	.33768E-03
39	8082.	.24418E-03
40	16181.	.52444E-03
41	9871.	.30608E-03
42	4818.	.13122E-03
43	914.	0.

RUN ACC3

	MODEL			
WIND VELOCITY	3.0000	M/S		
EXIT VELOCITY	5.3270	M/S		
VOLUME FLOW	.2350E-04	M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06			
BACKGROUND	.1544E+04			
CALIBRATION FACTOR	.4289E-02			
RANGE	10			
REFERENCE HEIGHT	.3180	CM		
RELEASE DIAMETER	.2370	CM		
RELEASE LOCATION	X (M)		Y (M)	Z (FT MSL)
	3134102		4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	1175.	0.
2	713.	0.
3	889.	0.
4	724.	0.
5	959.	0.
6	947.	0.
7	765.	0.
8	0.	0.
9	2735.	.41215E-04
10	1911.	.12700E-04
11	912.	0.
12	1295.	0.
13	6449.	.16974E-03
14	9051.	.25978E-03
15	4890.	.11579E-03
16	1106.	0.
17	1524.	0.
18	11564.	.34675E-03
19	13157.	.40187E-03
20	22343.	.71976E-03
21	1286.	0.
22	1475.	0.
23	6570.	.17393E-03
24	14312.	.44184E-03
25	6650.	.17670E-03
26	26139.	.85112E-03
27	19123.	.60833E-03
28	1834.	.10036E-04
29	2555.	.34986E-04
30	7779.	.21576E-03
31	21697.	.69740E-03
32	25126.	.81606E-03
33	21784.	.70041E-03
34	9211.	.26532E-03
35	5746.	.14541E-03
36	724.	0.
37	2718.	.40627E-04
38	10596.	.31325E-03
39	7187.	.19528E-03
40	12634.	.38377E-03
41	10462.	.30861E-03
42	3052.	.52185E-04
43	739.	0.

RUN ACC4

	MODEL		
WIND VELOCITY	3.0000 M/S		
EXIT VELOCITY	5.3270 M/S		
VOLUME FLOW	.2350E-04 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.9400E+03		
CALIBRATION FACTOR	.4289E-02		
RANGE	10		
REFERENCE HEIGHT	.3180 CM		
RELEASE DIAMETER	.2370 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	31320000	4286612	9160

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	520.	0.
2	10532.	.33193E-03
3	43374.	.14684E-02
5	14894.	.48288E-03
6	4260.	.11489E-03
7	3370.	.84091E-04
8	2132.	.41250E-04
9	54219.	.18437E-02
10	40246.	.13602E-02
11	1918.	.33844E-04
12	7813.	.23784E-03
13	5482.	.15718E-03
14	24457.	.81381E-03
15	19854.	.65453E-03
16	1854.	.31629E-04
17	720.	0.
18	10486.	.33034E-03
19	14348.	.46399E-03
20	33267.	.11187E-02
21	610.	0.
22	1556.	.21317E-04
23	3814.	.99456E-04
24	8867.	.27432E-03
25	3599.	.92016E-04
26	0.	0.
27	18599.	.61110E-03
28	0.	0.
29	2142.	.41596E-04
30	4836.	.13482E-03
31	14015.	.45247E-03
32	16245.	.52964E-03
33	18718.	.61521E-03
34	16781.	.54818E-03
35	1062.	.42219E-05
36	530.	0.
37	1717.	.26888E-04
38	7552.	.22881E-03
39	5763.	.16690E-03
40	12900.	.41388E-03
41	8081.	.24712E-03
42	7157.	.21514E-03
43	1414.	.16403E-04
4	53447.	.18170E-02

D-2. Vertical Rake Concentration Data and Rake Locations for Alkali Creek Neutral Flow Tests

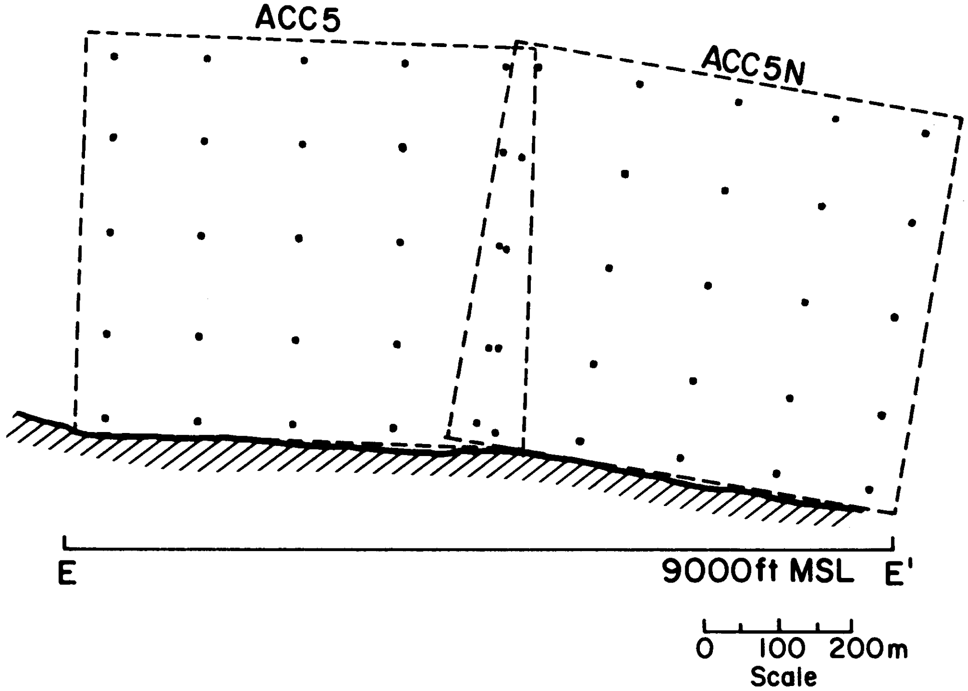


Figure D-2-1. Sampling Rake Locations for Obtaining a Vertical Cross Section of the Plume 39 cm (1.0 km full scale) Downwind from a 0.318 cm (8.14 m full scale) Release Point at T4 for the Alkali Creek Neutral Stability Tests.

RUN ACC5

	MODEL		
WIND VELOCITY	3.0000 M/S		
EXIT VELOCITY	5.3270 M/S		
VOLUME FLOW	.2350E-04 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.7560E+03		
CALIBRATION FACTOR	.4289E-02		
RANGE	10		
REFERENCE HEIGHT	.3180 CM		
RELEASE DIAMETER	.2370 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	167049.	.57546E-02
2	42105.	.14309E-02
3	1351.	.20590E-04
4	739.	0.
5	1078.	.11143E-04
6	179914.	.61998E-02
7	45092.	.15343E-02
8	577.	0.
9	581.	0.
10	2111.	.46890E-04
11	41295.	.14029E-02
12	13491.	.44070E-03
13	1041.	.98625E-05
14	1317.	.19414E-04
15	1204.	.15503E-04
16	3089.	.80734E-04
17	1272.	.17856E-04
18	588.	0.
19	133.	0.
20	602.	0.
21	1305.	.18998E-04
22	1137.	.13185E-04
23	1117.	.12493E-04
24	1111.	.12285E-04
25	651.	0.

RUN ACC5N

MODEL

WIND VELOCITY	3.0000 M/S		
EXIT VELOCITY	532.6983 M/S		
VOLUME FLOW	.2350E-02 M**3/S		
SOURCE STRENGTH(PPM)	.1500E+06		
BACKGROUND	.7720E+03		
CALIBRATION FACTOR	.4297E-02		
RANGE	10		
REFERENCE HEIGHT	.3180 CM		
RELEASE DIAMETER	.2370 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	1641.	.32137E-06
2	924.	.56212E-07
3	832.	.22189E-07
4	728.	0.
5	1417.	.23853E-06
7	821.	.18121E-07
8	1563.	.29252E-06
9	1337.	.20894E-06
10	726.	0.
11	1304.	.19674E-06
12	3487.	.10040E-05
13	801.	.10725E-07
14	1975.	.44488E-06
15	1355.	.21560E-06
16	7157.	.23613E-05
18	1210.	.16198E-06
19	878.	.39200E-07
20	1670.	.33209E-06
25	1555.	.28956E-06
21	95853.	.35162E-04
22	20636.	.73460E-05
23	953.	.66936E-07
24	746.	0.

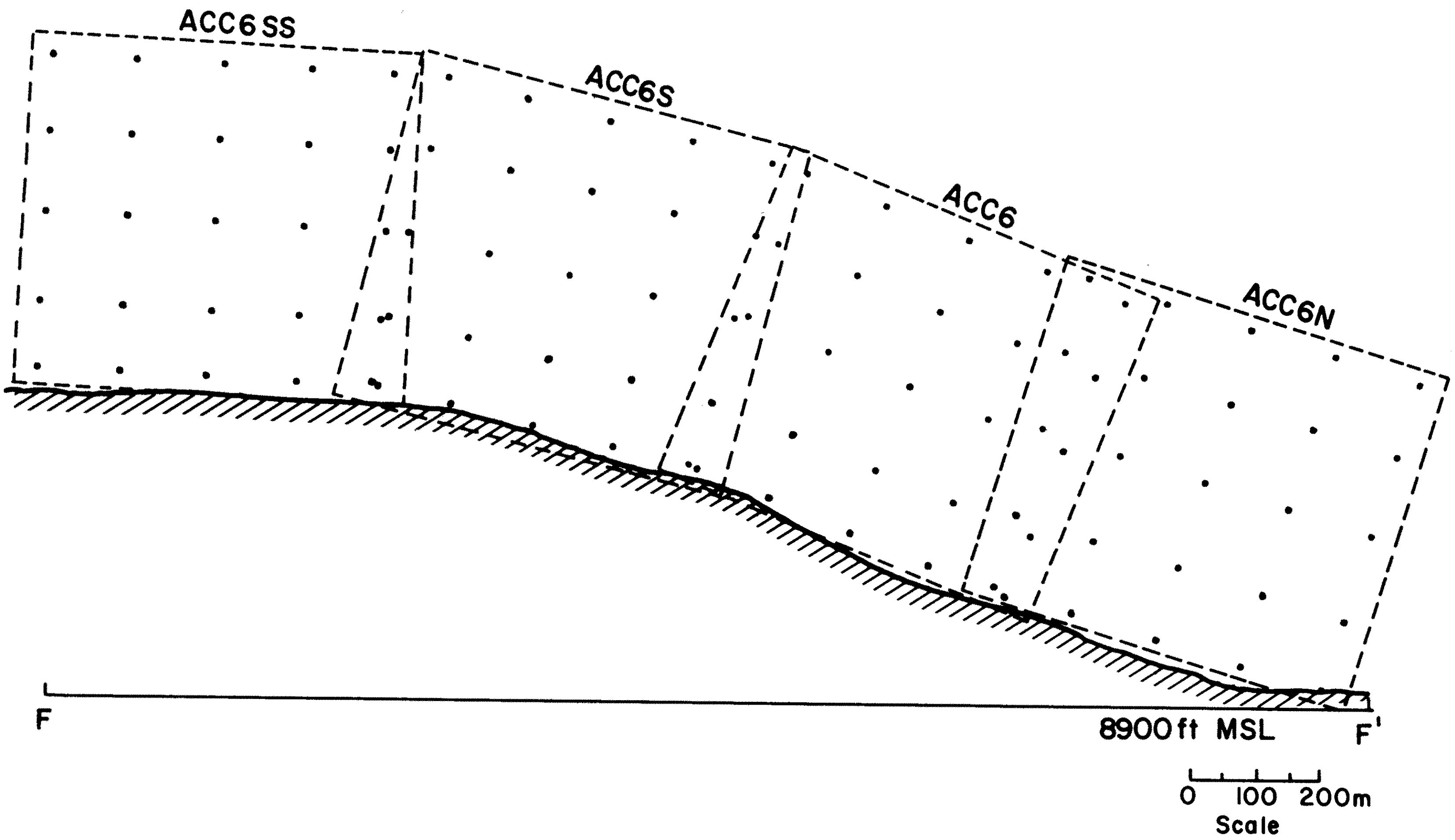


Figure D-2-2. Sampling Rake Locations for Obtaining a Vertical Cross Section of the Plume 117 cm (3.0 km full scale) Downwind from a 0.318 cm (8.14 m full scale) Release Point at T4 for the Alkali Creek Neutral Stability Tests.

RUN ACC6SS

MODEL

WIND VELOCITY	3.0000	M/S
EXIT VELOCITY	5.3270	M/S
VOLUME FLOW	.2350E-04	M**3/S
SOURCE STRENGTH(PPM)	.1600E+06	
BACKGROUND	.6280E+03	
CALIBRATION FACTOR	.4297E-02	
RANGE	10	
REFERENCE HEIGHT	.3180	CM
RELEASE DIAMETER	.2370	CM

RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	19490.	.65394E-03
2	7287.	.23087E-03
3	1027.	.13833E-04
4	722.	.32590E-05
5	1315.	.23818E-04
6	6628.	.20802E-03
7	2895.	.78597E-04
8	1502.	.30302E-04
9	981.	.12238E-04
10	718.	.31203E-05
11	3158.	.87715E-04
12	1370.	.25725E-04
13	1867.	.42956E-04
14	659.	.10748E-05
15	701.	.25309E-05
16	361.	0.
17	745.	.40564E-05
18	798.	.58939E-05
19	1615.	.34219E-04
20	681.	.18375E-05
21	883.	.88408E-05
22	1335.	.24512E-04
23	1059.	.14943E-04
24	1649.	.35398E-04
25	1081.	.15705E-04

RUN ACC6S

MODEL

WIND VELOCITY	3.0000	M/S
EXIT VELOCITY	5.3270	M/S
VOLUME FLOW	.2350E-04	M**3/S
SOURCE STRENGTH(PPM)	.1600E+06	
BACKGROUND	.6950E+03	
CALIBRATION FACTOR	.4297E-02	
RANGE	10	
REFERENCE HEIGHT	.3180	CM
RELEASE DIAMETER	.2370	CM

RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	1745.	.36403E-04
2	1395.	.24269E-04
3	387.	0.
4	1203.	.17612E-04
5	1011.	.10956E-04
6	755.	.20802E-05
7	825.	.45071E-05
8	3163.	.85565E-04
9	671.	0.
10	647.	0.
11	911.	.74887E-05
12	696.	.34670E-07
13	1266.	.19797E-04
14	1135.	.15255E-04
15	3133.	.84525E-04
16	909.	.74194E-05
17	759.	.22189E-05
18	1264.	.19727E-04
19	461.	0.
20	1833.	.39454E-04
21	1050.	.12308E-04
22	3084.	.82826E-04
23	878.	.63446E-05
24	841.	.50618E-05
25	3252.	.88651E-04

RUN ACC6

MODEL

WIND VELOCITY	3.0000	M/S
EXIT VELOCITY	5.3270	M/S
VOLUME FLOW	.2350E-04	M**3/S
SOURCE STRENGTH(PPM)	.1600E+06	
BACKGROUND	.7695E+03	
CALIBRATION FACTOR	.4289E-02	
RANGE	10	
REFERENCE HEIGHT	.3180	CM
RELEASE DIAMETER	.2370	CM

RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	33151.	.11206E-02
2	14182.	.46414E-03
3	1579.	.28013E-04
5	1877.	.38325E-04
6	31719.	.10710E-02
7	17275.	.57118E-03
8	2931.	.74800E-04
9	1241.	.16316E-04
10	574.	0.
11	43455.	.14771E-02
12	19593.	.65139E-03
13	2358.	.54971E-04
15	1594.	.28532E-04
16	39515.	.13408E-02
17	13622.	.44477E-03
18	3098.	.80579E-04
19	1466.	.24103E-04
20	705.	0.
21	26310.	.88384E-03
22	15775.	.51927E-03
23	1229.	.15901E-04
24	815.	.15745E-05
25	1441.	.23238E-04

RUN ACC6N

MODEL

WIND VELOCITY	3.0000 M/S		
EXIT VELOCITY	5.3270 M/S		
VOLUME FLOW	.2350E-04 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.6300E+03		
CALIBRATION FACTOR	.4297E-02		
RANGE	10		
REFERENCE HEIGHT	.3180 CM		
RELEASE DIAMETER	.2370 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	1024.	.13660E-04
2	894.	.91529E-05
3	687.	.19762E-05
4	630.	0.
5	1517.	.30752E-04
6	2095.	.50791E-04
7	1331.	.24304E-04
8	2411.	.61747E-04
9	1103.	.16399E-04
10	984.	.12273E-04
12	4286.	.12675E-03
13	1608.	.33907E-04
14	604.	0.
15	759.	.44724E-05
16	7232.	.22889E-03
18	1638.	.34947E-04
19	2069.	.49890E-04
20	766.	.47151E-05
21	32340.	.10994E-02
22	14381.	.47675E-03
24	1566.	.32451E-04
25	1089.	.15913E-04

APPENDIX E

Coal Creek Stable Flow Concentration Data

E-1. Ground-level Data and Sample Point Locations
for Coal Creek Stable Flow Tests

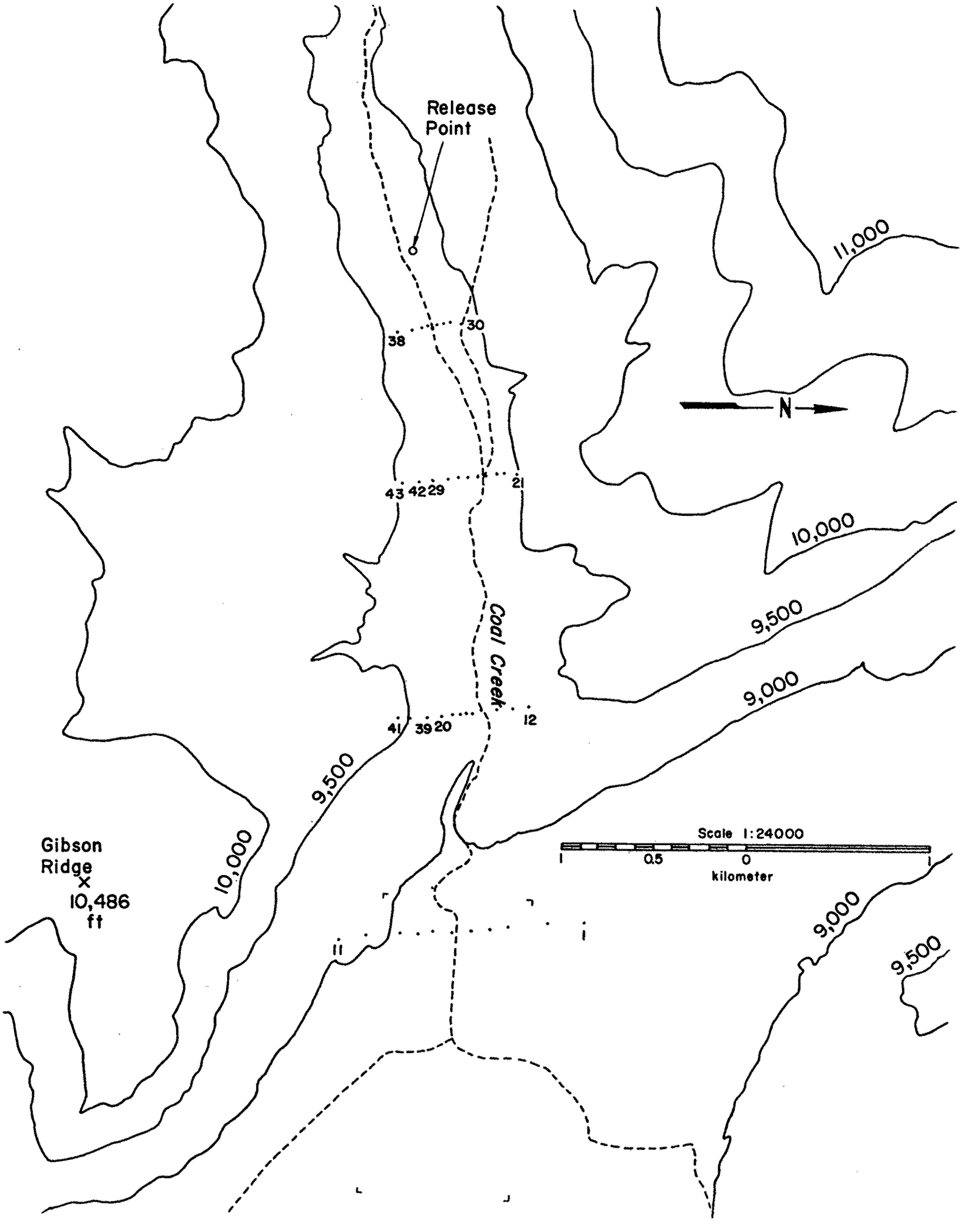


Figure E-1-1. Ground-level Sample Points Used to Obtain Concentration Data for Coal Creek Stable Flow Tests.

RUN CBC1

	MODEL
WIND VELOCITY	.1830 M/S
EXIT VELOCITY	.2709 M/S
VOLUME FLOW	.1205E-05 M**3/S
SOURCE STRENGTH(PPM)	.1600E+06
BACKGROUND	.7510E+03
CALIBRATION FACTOR	.4191E-02
RANGE	10
REFERENCE HEIGHT	.3175 CM
RELEASE DIAMETER	.2380 CM

RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	323831	4303554	9400

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	709.	0.
2	3563.	.11277E-03
3	13061.	.49365E-03
4	21744.	.84185E-03
5	28541.	.11144E-02
6	21774.	.84305E-03
7	17684.	.67904E-03
8	8147.	.29659E-03
9	5067.	.17308E-03
10	1509.	.30397E-04
11	765.	.56142E-06
12	1292.	.21695E-04
13	10047.	.37278E-03
14	16628.	.63669E-03
15	17720.	.68048E-03
16	24387.	.94784E-03
17	16626.	.63661E-03
18	741.	0.
19	719.	0.
20	723.	0.
21	696.	0.
22	732.	0.
23	742.	0.
24	741.	0.
25	77810.	.30902E-02
26	73178.	.29044E-02
27	39143.	.15396E-02
28	5496.	.19028E-03
29	1780.	.41264E-04
30	686.	0.
31	705.	0.
32	704041.	.28203E-01
33	232411.	.92899E-02
34	1404.	.26186E-04
35	682.	0.
36	779.	.11228E-05
37	728.	0.
38	690.	0.
39	607.	0.
41	765.	.56142E-06
42	1193.	.17725E-04
43	718.	0.

RUN CBC2

	MODEL		
WIND VELOCITY	.2960 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.7235E+03		
CALIBRATION FACTOR	.4191E-02		
RANGE	10		
REFERENCE HEIGHT	.3175 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	323831	4303554	9400

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	668.	0.
2	746.	.14594E-05
3	1164.	.28572E-04
4	1584.	.55815E-04
5	1989.	.82085E-04
6	2352.	.10563E-03
7	1810.	.70474E-04
8	1311.	.38107E-04
9	1168.	.28832E-04
10	792.	.44432E-05
11	651.	0.
12	969.	.15924E-04
13	999.	.17870E-04
14	884.	.10411E-04
15	1079.	.23059E-04
16	984.	.16897E-04
17	1285.	.36421E-04
18	861.	.89188E-05
19	1009.	.18519E-04
20	836.	.72972E-05
21	716.	0.
22	709.	0.
23	694.	0.
24	822.	.63891E-05
25	1128.	.26237E-04
26	1125.	.26043E-04
27	980.	.16638E-04
28	877.	.99566E-05
29	767.	.28216E-05
30	698.	0.
32	3605.	.18690E-03
33	3503.	.18029E-03
34	607.	0.
35	633.	0.
36	589.	0.
37	941.	.14108E-04
38	713.	0.
39	711.	0.
41	691.	0.
42	1377.	.42388E-04
43	698.	0.

E-2. Vertical Rake Data and Rake Locations for Coal Creek Stable Flow Tests

RUN CBC7

	MODEL		
WIND VELOCITY	.1830 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.6920E+03		
CALIBRATION FACTOR	.4191E-02		
RANGE	10		
REFERENCE HEIGHT	.3175 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	323631	4303554	9400

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
27	21774.	.84542E-03
28	7705.	.28123E-03
29	1103.	.16482E-04
1	716.	.96244E-06
2	773.	.32482E-05
3	1191.	.20011E-04
4	1143.	.18086E-04
8	1442.	.30076E-04
9	3567.	.11529E-03
10	7183.	.26030E-03
13	1140.	.17965E-04
14	4560.	.15511E-03
15	4539.	.15427E-03
19	875.	.73386E-05
20	1670.	.39219E-04

RUN CBC3

	MODEL		
WIND VELOCITY	.1830 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.7325E+03		
CALIBRATION FACTOR	.4191E-02		
RANGE	10		
REFERENCE HEIGHT	.3175 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	323831	4303554	9400

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
22	658.	0.
23	2092.	.54518E-04
24	17724.	.68139E-03
25	43284.	.17064E-02
26	52122.	.20608E-02
27	36059.	.14166E-02
28	22176.	.85992E-03
29	5545.	.19299E-03
1	22878.	.88807E-03
2	37279.	.14656E-02
3	64942.	.25749E-02
4	67667.	.26842E-02
5	36880.	.14496E-02
6	22888.	.88847E-03
8	73228.	.29072E-02
9	8234.	.30082E-03
10	4795.	.16291E-03
11	40534.	.15961E-02
12	41732.	.16441E-02
13	30272.	.11846E-02
14	19243.	.74230E-03
15	4482.	.15036E-03
16	5483.	.19050E-03
17	3783.	.12233E-03
18	1748.	.40723E-04
19	1207.	.19028E-04
20	847.	.45916E-05
21	1652.	.36873E-04
22	1219.	.19509E-04
23	736.	.14036E-06
24	586.	0.
25	725.	0.

RUN C8C8

	MODEL
WIND VELOCITY	.1830 M/S
EXIT VELOCITY	.2709 M/S
VOLUME FLOW	.1205E-05 M**3/S
SOURCE STRENGTH(PPM)	.1600E+06
BACKGROUND	.7010E+03
CALIBRATION FACTOR	.4191E-02
RANGE	10
REFERENCE HEIGHT	.3175 CM
RELEASE DIAMETER	.2380 CM

RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	323831	4303554	9400

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
22	970.	.10787E-04
23	6497.	.23243E-03
24	51883.	.20525E-02
25	90813.	.36136E-02
26	48487.	.19163E-02
21	961.	.10426E-04
1	21270.	.82485E-03
2	3510.	.11265E-03
3	717.	.64162E-06
4	698.	0.
5	682.	0.
6	6428.	.22966E-03
7	934.	.93437E-05
8	716.	.60152E-06

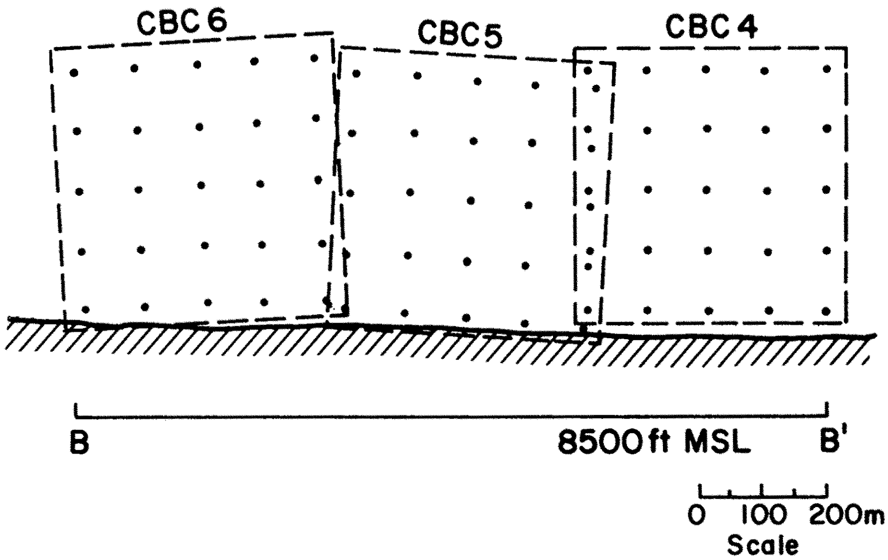


Figure E-2-2. Sampling Rake Position for Obtaining a Vertical Cross Section of the Plume 192.5 cm (3.66 km) Downwind from a .318 cm Release at T16 for the Coal Creek Stable Flow Tests.

RUN CBC6

	MODEL		
WIND VELOCITY	.1830 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.7105E+03		
CALIBRATION FACTOR	.4191E-02		
RANGE	10		
REFERENCE HEIGHT	.3175 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	323831	4303554	9400

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
7	24660.	.96041E-03
8	11701.	.44074E-03
9	8983.	.33174E-03
1	6051.	.21416E-03
2	7861.	.28675E-03
3	12026.	.45377E-03
4	17518.	.67401E-03
5	23846.	.92777E-03
6	776.	.26267E-05
7	811.	.40302E-05
8	1040.	.13213E-04
9	1112.	.16101E-04
10	8696.	.32023E-03
11	695.	0.
12	750.	.15840E-05
13	771.	.24261E-05
14	763.	.21053E-05
15	1149.	.17585E-04
16	692.	0.
17	658.	0.
18	692.	0.
19	700.	0.
20	719.	.34086E-06
21	679.	0.
22	641.	0.
23	727.	.66168E-06
24	672.	0.
25	716.	.22056E-06

RUN C8C5

	MODEL		
WIND VELOCITY	.1830 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.7210E+03		
CALIBRATION FACTOR	.4191E-02		
RANGE	10		
REFERENCE HEIGHT	.3175 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	323831	4303554	9400

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	28206.	.11022E-02
2	40705.	.16034E-02
3	42141.	.16610E-02
4	35370.	.13895E-02
5	23607.	.91776E-03
6	13719.	.52124E-03
7	4034.	.13286E-03
8	6618.	.23648E-03
9	1480.	.30437E-04
10	1987.	.50769E-04
11	1955.	.49485E-04
12	1873.	.46197E-04
13	1262.	.21695E-04
14	1504.	.31400E-04
15	823.	.40904E-05
16	710.	0.
17	704.	0.
18	690.	0.
19	711.	0.
20	750.	.11629E-05
21	682.	0.
23	647.	0.

RUN CBC4

	MODEL	
WIND VELOCITY	.2960	M/S
EXIT VELOCITY	.2709	M/S
VOLUME FLOW	.1205E-05	M**3/S
SOURCE STRENGTH(PPM)	.1600E+06	
BACKGROUND	.7015E+03	
CALIBRATION FACTOR	.4191E-02	
RANGE	10	
REFERENCE HEIGHT	.3175	CM
RELEASE DIAMETER	.2380	CM

RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	323831	4303554	9400

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	714.	.81080E-06
2	3758.	.19826E-03
3	21281.	.13349E-02
1	19018.	.11881E-02
2	9828.	.59198E-03
3	3460.	.17893E-03
4	1177.	.30843E-04
6	2375.	.10855E-03
7	1000.	.19362E-04
8	872.	.11059E-04
9	688.	0.
10	688.	0.
11	797.	.61945E-05
12	809.	.69728E-05
13	668.	0.
14	694.	0.
15	681.	0.
16	663.	0.
17	699.	0.

APPENDIX F

Alkali Creek Stable Flow (Westerly Wind) Concentration Profile Data

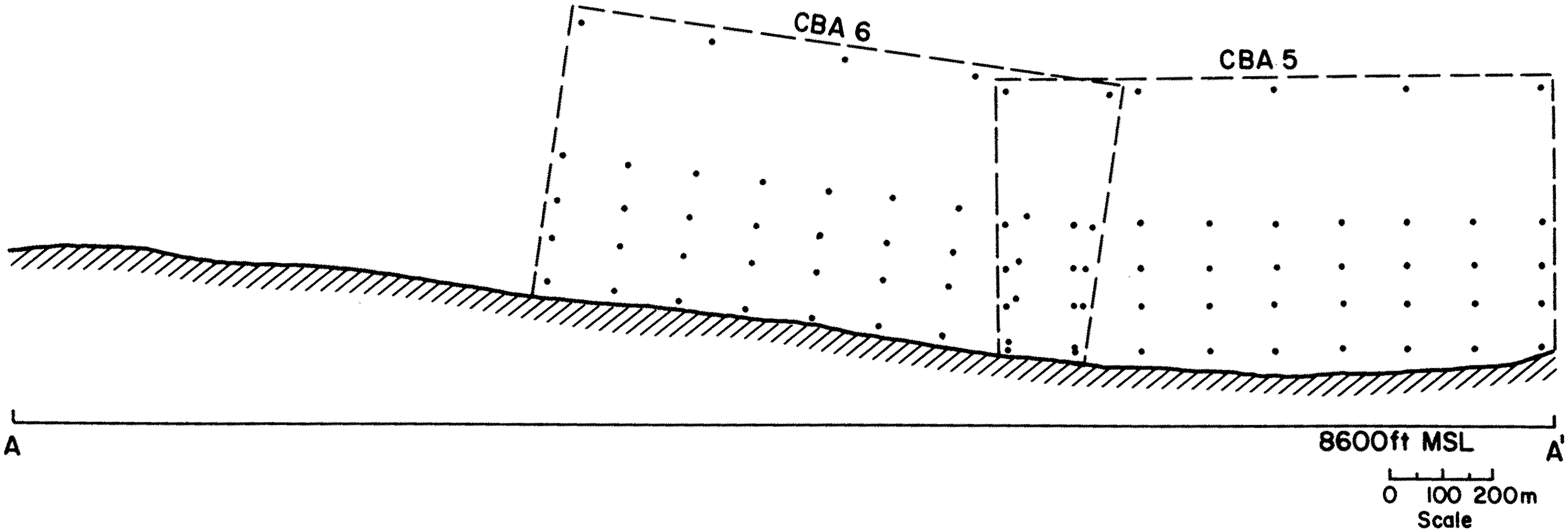


Figure F-1. Sampling Rake Locations for Obtaining a Vertical Cross Section of the Plume 60.9 cm (1.56 km) Downwind from a 0.318 cm (8.14 m) Release Point at T4 for the Alkali Creek Stable Flow (West Wind) Tests.

RUN CBA6

	MODEL		
WIND VELOCITY	.1290 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.7100E+03		
CALIBRATION FACTOR	.4149E-02		
RANGE	10		
REFERENCE HEIGHT	.3175 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	718.	.22389E-06
2	792.	.22949E-05
3	772.	.17352E-05
4	823.	.31625E-05
6	854.	.40301E-05
7	892.	.50936E-05
9	15918.	.42562E-03
13	784.	.20710E-05
14	873.	.45618E-05
15	1003.	.82001E-05
16	1032.	.90117E-05
18	37684.	.10348E-02
19	885.	.48977E-05
20	1068.	.10019E-04
21	2709.	.55946E-04
22	7309.	.18468E-03
23	7353.	.18592E-03
25	8679.	.22303E-03
27	19122.	.51529E-03
28	840.	.36383E-05
29	823.	.31625E-05
30	1572.	.24125E-04
31	17038.	.45697E-03
32	18344.	.49352E-03
33	18632.	.50158E-03
34	19658.	.53029E-03
36	33429.	.91570E-03
37	728.	.50376E-06
38	682.	0.
39	794.	.23509E-05
40	710.	0.
41	701.	0.

RUN CBA5

	MODEL		
WIND VELOCITY	.1290 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.7450E+03		
CALIBRATION FACTOR	.4149E-02		
RANGE	10		
REFERENCE HEIGHT	.3175 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	75539.	.20932E-02
3	45921.	.12643E-02
4	42088.	.11571E-02
5	17239.	.46161E-03
6	34484.	.94425E-03
7	38217.	.10487E-02
8	2186.	.40329E-04
9	783.	.10635E-05
10	67404.	.18656E-02
11	70221.	.19444E-02
12	46720.	.12867E-02
13	27384.	.74554E-03
14	34650.	.94889E-03
15	58869.	.16267E-02
16	15828.	.42212E-03
18	992.	.69127E-05
19	63440.	.17546E-02
21	37450.	.10273E-02
22	17263.	.46229E-03
25	7728.	.19543E-03
26	966.	.61851E-05
27	765.	.55974E-06
28	29400.	.80196E-03
29	9916.	.25667E-03
30	7647.	.19316E-03
31	2153.	.39405E-04
32	2217.	.41197E-04
33	1547.	.22445E-04
34	975.	.64370E-05
36	764.	.53175E-06
37	764.	.53175E-06
38	744.	0.

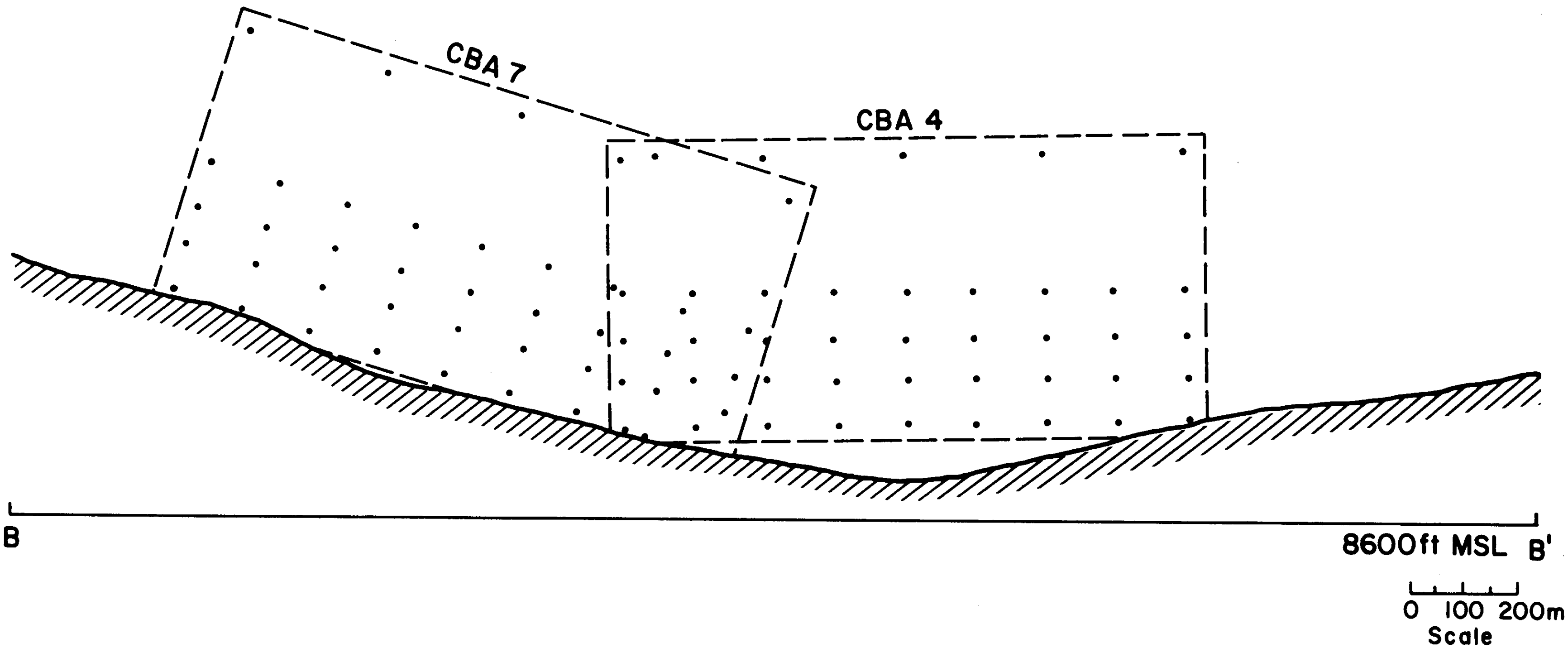


Figure F-2. Sampling Rake Locations for Obtaining a Vertical Cross Section of the Plume 121.9 cm (3.12 km) Downwind from a 0.318 cm (8.14 m) Release Point at T4 for the Alkali Creek Stable Flow (West Wind) Tests.

RUN CBA7

	MODEL		
WIND VELOCITY	.1290 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.7280E+03		
CALIBRATION FACTOR	.4149E-02		
RANGE	10		
REFERENCE HEIGHT	.3175 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	766.	.10635E-05
3	863.	.37782E-05
4	830.	.28547E-05
5	1849.	.31373E-04
6	2863.	.59752E-04
7	4070.	.93532E-04
8	10946.	.28597E-03
9	22264.	.60272E-03
10	1192.	.12986E-04
11	1327.	.16764E-04
12	1478.	.20990E-04
13	1874.	.32073E-04
16	2911.	.61095E-04
18	8944.	.22994E-03
20	877.	.41700E-05
24	1869.	.31933E-04
25	6609.	.16459E-03
26	5694.	.13898E-03
27	7777.	.19728E-03
34	1820.	.30562E-04
36	9010.	.23179E-03
39	935.	.57933E-05
40	715.	0.

RUN CBA4

	MODEL		
WIND VELOCITY	.1290 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.7420E+03		
CALIBRATION FACTOR	.4149E-02		
RANGE	10		
REFERENCE HEIGHT	.3175 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	8537.	.21816E-03
2	5839.	.14265E-03
3	53726.	.14829E-02
4	60696.	.16779E-02
5	35674.	.97763E-03
6	52491.	.14483E-02
7	17329.	.46422E-03
8	1901.	.32437E-04
9	986.	.68288E-05
10	27013.	.73524E-03
11	42521.	.11693E-02
12	25508.	.69312E-03
13	24541.	.66606E-03
14	12749.	.33604E-03
15	22349.	.60471E-03
16	18700.	.50259E-03
18	783.	.11475E-05
19	5748.	.14010E-03
21	7007.	.17534E-03
22	9458.	.24393E-03
25	1324.	.16288E-04
26	1350.	.17016E-04
27	968.	.63250E-05
28	6132.	.15085E-03
29	3620.	.80546E-04
30	5134.	.12292E-03
32	7171.	.17993E-03
33	5632.	.13686E-03
34	3929.	.89194E-04
35	1657.	.25608E-04
36	785.	.12034E-05
37	828.	.24069E-05
38	721.	0.
39	937.	.54574E-05
40	742.	0.
41	750.	.22389E-06

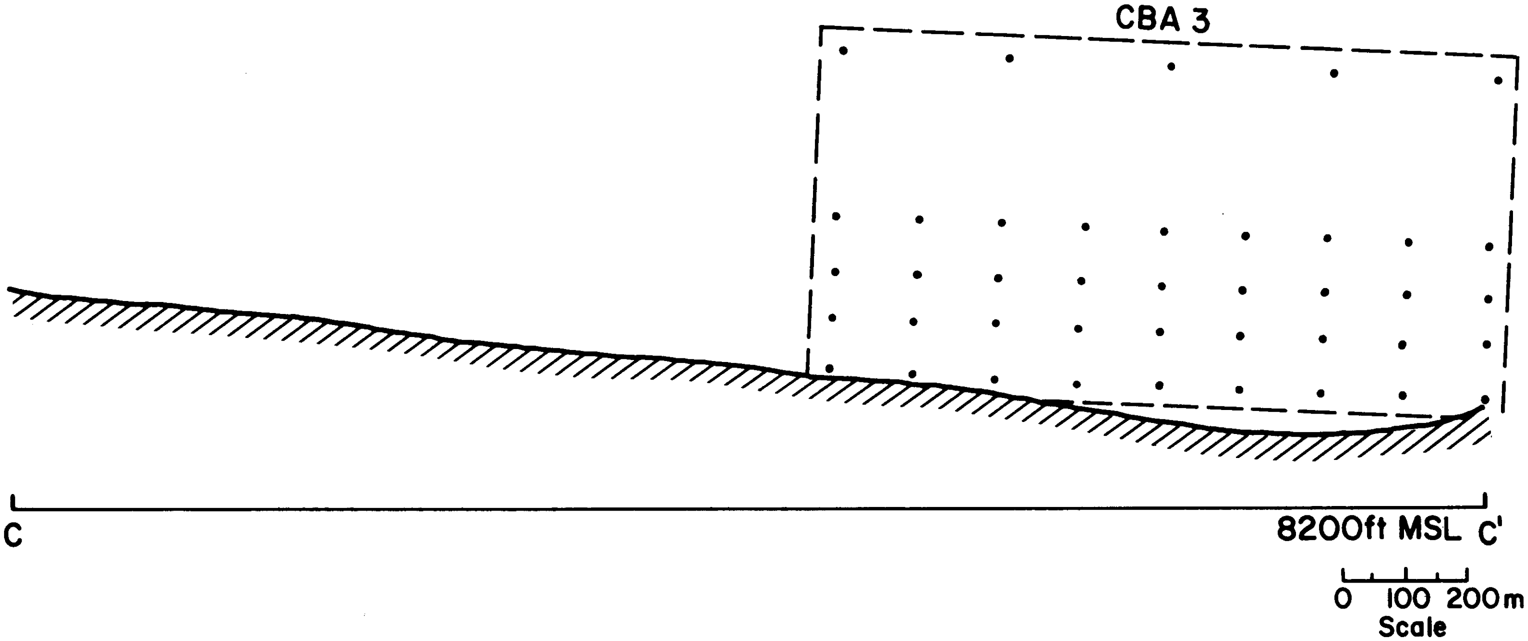


Figure F-3. Sampling Rake Locations for Obtaining a Vertical Cross Section of the Plume 182.8 cm (4.68 km) Downwind from a 0.318 cm (8.14 m) Release Point at T4 for the Alkali Creek Stable Flow (West Wind) Tests.

RUN CBA3

	MODEL		
WIND VELOCITY	.1290 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.7150E+03		
CALIBRATION FACTOR	.4149E-02		
RANGE	10		
REFERENCE HEIGHT	.3175 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	3751.	.84968E-04
2	2366.	.46206E-04
3	9275.	.23957E-03
4	13150.	.34802E-03
5	13741.	.36456E-03
6	22722.	.61591E-03
7	16385.	.43855E-03
8	1113.	.11139E-04
9	727.	.33584E-06
10	3271.	.71534E-04
11	4284.	.99885E-04
12	9906.	.25723E-03
13	12894.	.34085E-03
14	17036.	.45677E-03
15	22001.	.59573E-03
16	6522.	.16252E-03
18	730.	.41980E-06
19	4873.	.11637E-03
20	5187.	.12516E-03
21	7630.	.19353E-03
22	7045.	.17716E-03
25	2860.	.60032E-04
26	1126.	.11503E-04
27	790.	.20990E-05
28	3685.	.83121E-04
29	1832.	.31261E-04
30	2426.	.47885E-04
31	831.	.32465E-05
32	1368.	.18275E-04
33	967.	.70527E-05
35	3627.	.81498E-04
36	709.	0.
37	717.	.55974E-07
38	714.	0.
39	967.	.70527E-05
40	733.	.50376E-06
41	715.	0.

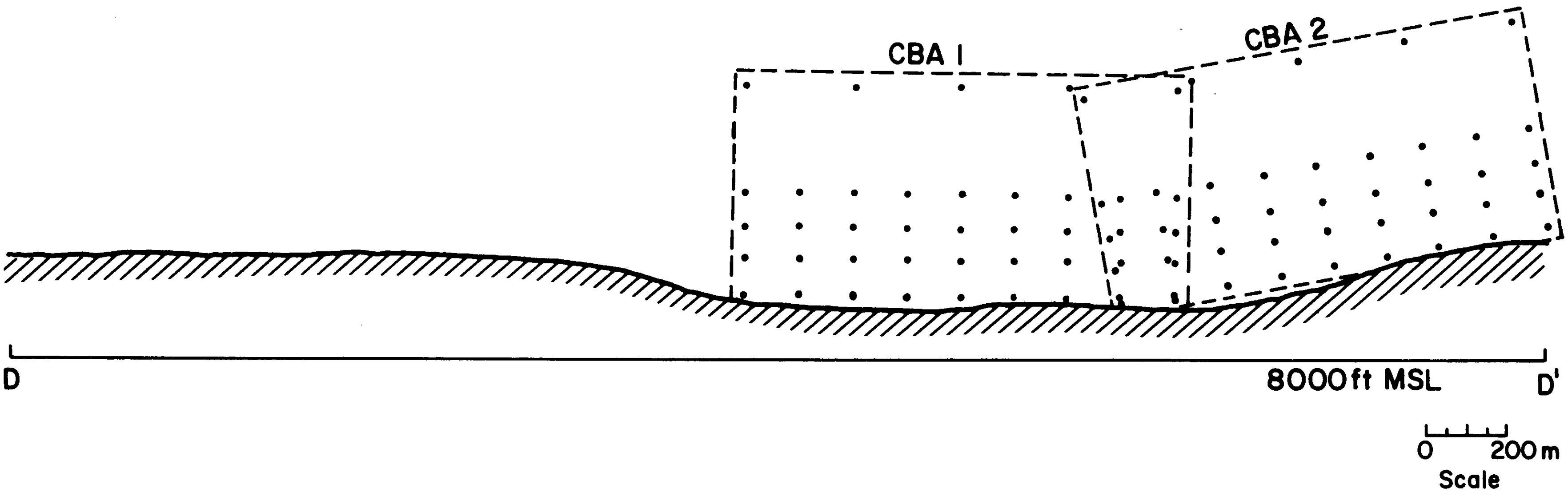


Figure F-4. Sampling Rake Locations for Obtaining a Vertical Cross Section of the Plume 243.8 cm (6.24 km) Downwind from a 0.318 cm (8.14 m) Release Point at T4 for the Alkali Creek Stable Flow (West Wind) Tests.

RUN CBA1

	MODEL		
WIND VELOCITY	.1290 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.7555E+03		
CALIBRATION FACTOR	.4149E-02		
RANGE	10		
REFERENCE HEIGHT	.3175 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	0.	0.
2	800.	.12454E-05
3	936.	.50516E-05
4	2029.	.35641E-04
5	3609.	.79860E-04
6	8187.	.20798E-03
7	11381.	.29737E-03
8	19582.	.52689E-03
9	12538.	.32975E-03
10	913.	.44079E-05
11	1093.	.94455E-05
12	1986.	.34438E-04
13	3955.	.89544E-04
14	8407.	.21414E-03
15	8133.	.20647E-03
16	7833.	.19808E-03
18	10584.	.27507E-03
19	1326.	.15966E-04
21	4094.	.93434E-04
22	3709.	.82659E-04
25	7513.	.18912E-03
27	2381.	.45493E-04
28	1833.	.30156E-04
29	2079.	.37041E-04
30	1668.	.25538E-04
31	1411.	.18345E-04
32	1716.	.26881E-04
33	1408.	.18261E-04
34	1295.	.15099E-04
35	1434.	.18989E-04
36	1303.	.15323E-04
37	740.	0.
38	729.	0.
40	726.	0.
41	732.	0.

RUN CBA2

	MODEL		
WIND VELOCITY	.1290 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.7300E+03		
CALIBRATION FACTOR	.4149E-02		
RANGE	10		
REFERENCE HEIGHT	.3175 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	19637.	.52915E-03
2	7168.	.18018E-03
3	7307.	.18407E-03
4	1927.	.33500E-04
5	724.	0.
6	741.	.30785E-06
10	20696.	.55878E-03
11	15467.	.41244E-03
12	3648.	.81665E-04
13	831.	.28267E-05
14	728.	0.
15	746.	.44779E-06
19	7876.	.19999E-03
20	5193.	.12491E-03
21	1611.	.24656E-04
22	798.	.19031E-05
23	758.	.78363E-06
28	2634.	.53287E-04
30	805.	.20990E-05
37	742.	.33584E-06
38	722.	0.
48	0.	0.

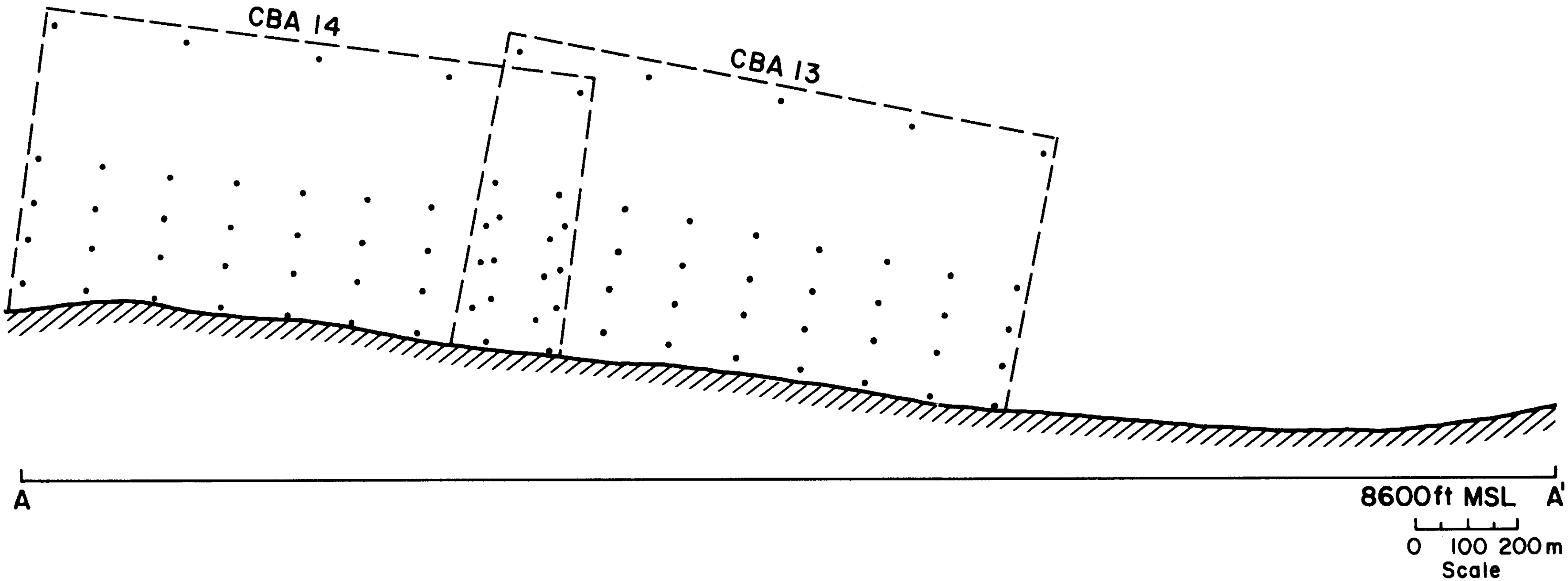


Figure F-5. Sampling Rake Locations for Obtaining a Vertical Cross Section of the Plume 60.9 cm (1.56 km) Downwind from a 2.54 cm (65.02 m) Release Point at T4 for the Alkali Creek Stable Flow (West Wind) Tests.

RUN CBA14

	MODEL		
WIND VELOCITY	.1550 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.6885E+03		
CALIBRATION FACTOR	.4149E-02		
RANGE	10		
REFERENCE HEIGHT	2.54 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	731.	.14292E-05
2	748.	.20008E-05
3	882.	.65069E-05
4	1034.	.11618E-04
5	973.	.95670E-05
6	1061.	.12526E-04
7	1150.	.15519E-04
8	1266.	.19420E-04
9	1467.	.26179E-04
10	934.	.82556E-05
11	942.	.85246E-05
12	1291.	.20261E-04
13	1473.	.26381E-04
14	1660.	.32669E-04
15	1378.	.23186E-04
16	1694.	.33812E-04
18	7031.	.21328E-03
19	888.	.67087E-05
21	1756.	.35897E-04
22	3772.	.10369E-03
25	18806.	.60925E-03
27	37128.	.12254E-02
28	693.	.15132E-06
29	703.	.48760E-06
30	861.	.58008E-05
31	1229.	.18176E-04
32	2715.	.68146E-04
33	2643.	.65725E-04
34	2600.	.64279E-04
36	6008.	.17888E-03
40	655.	0.
41	654.	0.
42	704.	.52123E-06

RUN CBA13

	MODEL		
WIND VELOCITY	.1550 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.6995E+03		
CALIBRATION FACTOR	.4149E-02		
RANGE	10		
REFERENCE HEIGHT	2.54 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
4	2763.	.69390E-04
5	3269.	.86406E-04
6	4467.	.12669E-03
7	4342.	.12249E-03
8	3614.	.98007E-04
9	4422.	.12518E-03
10	28637.	.93947E-03
11	33603.	.11065E-02
12	16009.	.51482E-03
13	3608.	.97806E-04
14	2346.	.55368E-04
15	5408.	.15834E-03
16	4467.	.12669E-03
18	10362.	.32493E-03
19	17758.	.57364E-03
20	24915.	.81431E-03
21	18916.	.61258E-03
22	18030.	.58278E-03
25	26590.	.87063E-03
26	7495.	.22852E-03
27	5449.	.15971E-03
28	2403.	.57285E-04
29	1123.	.14241E-04
30	4804.	.13802E-03
32	1676.	.32837E-04
33	1217.	.17402E-04
34	1082.	.12863E-04
35	1431.	.24599E-04
36	22805.	.74335E-03
37	725.	.85750E-06
38	657.	0.
39	780.	.27070E-05
40	712.	.42034E-06
43	649.	0.

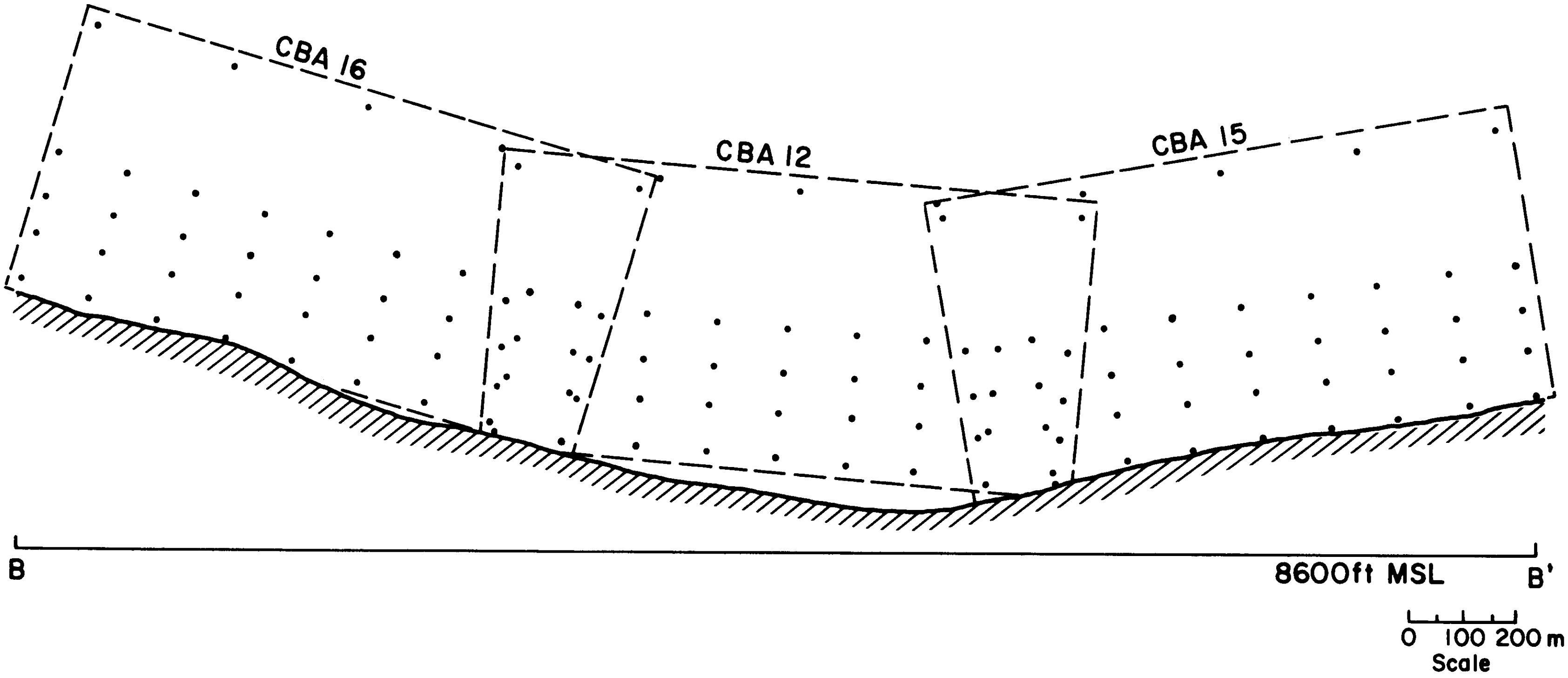


Figure F-6. Sampling Rake Locations for Obtaining a Vertical Cross Section of the Plume 121.9 cm (3.12 km) Downwind from a 2.54 cm (65.02 m) Release Point at T4 for the Alkali Creek Stable Flow (West Wind) Tests.

RUN CBA16

	MODEL		
WIND VELOCITY	.1550 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.6930E+03		
CALIBRATION FACTOR	.4149E-02		
RANGE	10		
REFERENCE HEIGHT	2.54 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	1713.	.34300E-04
2	1534.	.28281E-04
3	2470.	.59756E-04
4	6392.	.19164E-03
5	4889.	.14110E-03
6	7437.	.22678E-03
7	6912.	.20913E-03
8	8163.	.25120E-03
9	9365.	.29162E-03
10	3264.	.87129E-04
12	3147.	.82522E-04
13	3437.	.92274E-04
14	3216.	.84842E-04
15	5427.	.15919E-03
16	4623.	.13216E-03
18	10591.	.33285E-03
19	1652.	.32249E-04
21	1120.	.14359E-04
27	1504.	.27272E-04
28	980.	.96511E-05
33	670.	0.
34	672.	0.
35	1299.	.20378E-04
36	658.	0.

RUN CBA12

	MODEL		
WIND VELOCITY	.1550 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.6810E+03		
CALIBRATION FACTOR	.4149E-02		
RANGE	10		
REFERENCE HEIGHT	2.54 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	12616.	.40134E-03
3	14427.	.46224E-03
4	21085.	.68614E-03
5	15097.	.48477E-03
6	21845.	.71169E-03
7	23453.	.76577E-03
8	24649.	.80598E-03
9	3804.	.10502E-03
10	8712.	.27006E-03
11	10060.	.31539E-03
12	7329.	.22356E-03
13	8217.	.25342E-03
14	9502.	.29663E-03
15	9731.	.30433E-03
16	9951.	.31173E-03
18	3587.	.97722E-04
20	2795.	.71089E-04
21	1736.	.35477E-04
22	1323.	.21589E-04
26	1774.	.36755E-04
27	8689.	.26929E-03
34	670.	0.
37	700.	.63892E-06
39	701.	.67255E-06
40	675.	0.
41	673.	0.

RUN CBA15

	MODEL		
WIND VELOCITY	.1550 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.6780E+03		
CALIBRATION FACTOR	.4149E-02		
RANGE	10		
REFERENCE HEIGHT	2.54 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	7672.	.23519E-03
2	3407.	.91770E-04
3	1246.	.19100E-04
4	1466.	.26499E-04
5	717.	.13115E-05
6	659.	0.
7	706.	.94157E-06
8	646.	0.
9	652.	0.
10	4030.	.11272E-03
12	963.	.95838E-05
13	844.	.55822E-05
19	765.	.29256E-05
34	704.	.87432E-06
48	591.	0.

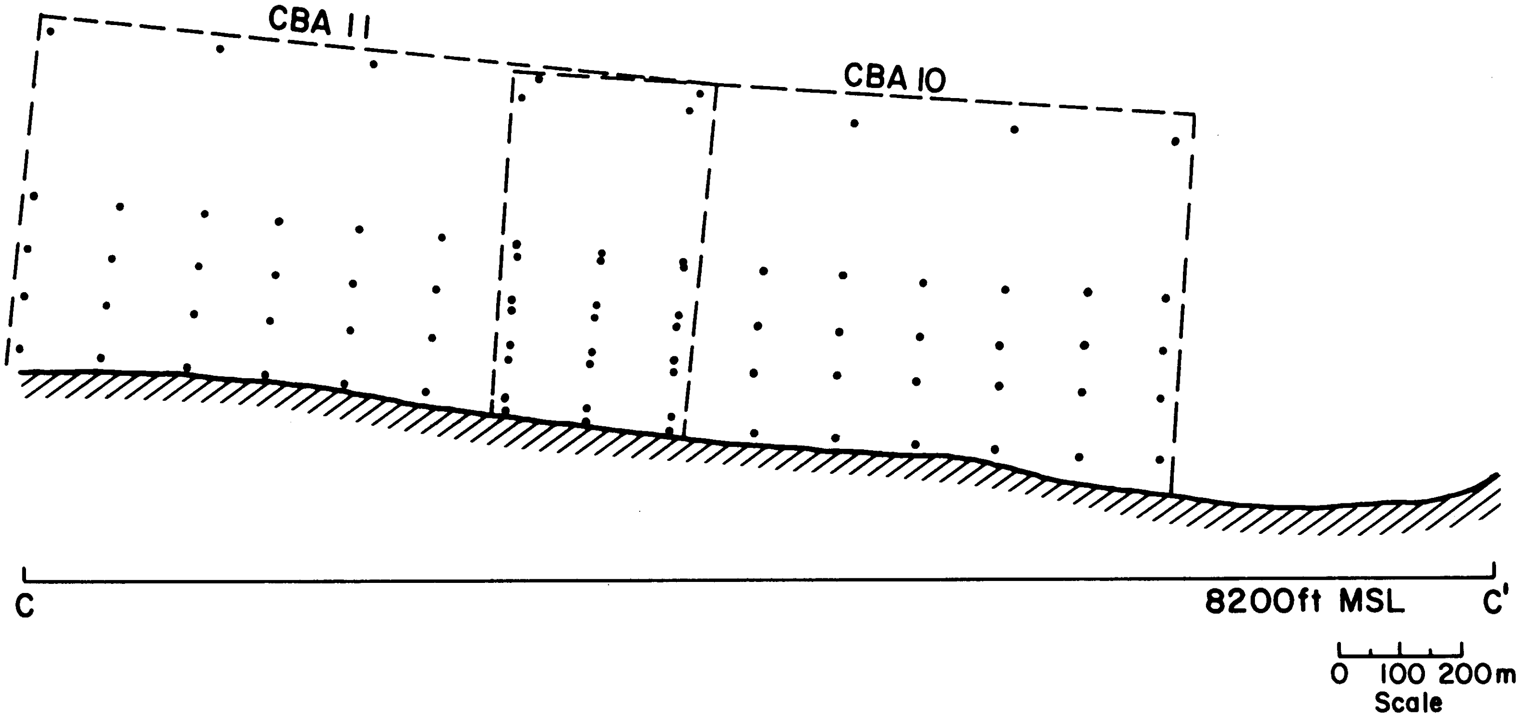


Figure F-7. Sampling Rake Locations for Obtaining a Vertical Cross Section of the Plume 182.8 cm (4.68 km) Downwind from a 2.54 cm (65.02 m) Release Point at T4 for the Alkali Creek Stable Flow (West Wind) Tests.

RUN CBA11

	MODEL		
WIND VELOCITY	.1550 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.6905E+03		
CALIBRATION FACTOR	.4149E-02		
RANGE	10		
REFERENCE HEIGHT	2.54 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	728.	.12610E-05
2	816.	.42203E-05
3	980.	.97352E-05
4	2056.	.45918E-04
5	2667.	.66465E-04
6	5435.	.15955E-03
7	8468.	.26154E-03
8	9575.	.29876E-03
9	7413.	.22606E-03
10	1937.	.41917E-04
11	1629.	.31559E-04
12	3578.	.97100E-04
13	4678.	.13409E-03
14	10356.	.32503E-03
15	10833.	.34107E-03
16	8322.	.25663E-03
18	8502.	.26268E-03
19	3127.	.81933E-04
20	5604.	.16523E-03
21	7002.	.21224E-03
22	6122.	.18265E-03
25	2447.	.59067E-04
28	2231.	.51803E-04
29	2372.	.56545E-04
30	2307.	.54359E-04
31	2251.	.52476E-04
32	1515.	.27726E-04
33	1017.	.10979E-04
37	695.	.15132E-06
38	698.	.25221E-06
39	695.	.15132E-06
40	679.	0.

RUN CBA10

	MODEL		
WIND VELOCITY	.1550 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.6945E+03		
CALIBRATION FACTOR	.4149E-02		
RANGE	10		
REFERENCE HEIGHT	2.54 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
3	6230.	.18615E-03
4	8578.	.26510E-03
5	6815.	.20582E-03
6	10392.	.32610E-03
7	8264.	.25454E-03
8	8153.	.25081E-03
9	6497.	.19512E-03
10	9208.	.28629E-03
11	13185.	.42002E-03
12	10032.	.31400E-03
13	6426.	.19274E-03
14	5874.	.17417E-03
15	7776.	.23813E-03
18	986.	.98024E-05
19	6468.	.19415E-03
20	7321.	.22283E-03
21	4076.	.11371E-03
22	2333.	.55099E-04
25	849.	.51955E-05
26	744.	.16646E-05
27	711.	.55485E-06
28	2547.	.62295E-04
29	1902.	.40605E-04
30	2372.	.56410E-04
31	1181.	.16360E-04
32	108.	0.
33	728.	.11265E-05
34	746.	.17318E-05
37	698.	.11770E-06
38	701.	.21858E-06
39	739.	.14964E-05
48	0.	0.

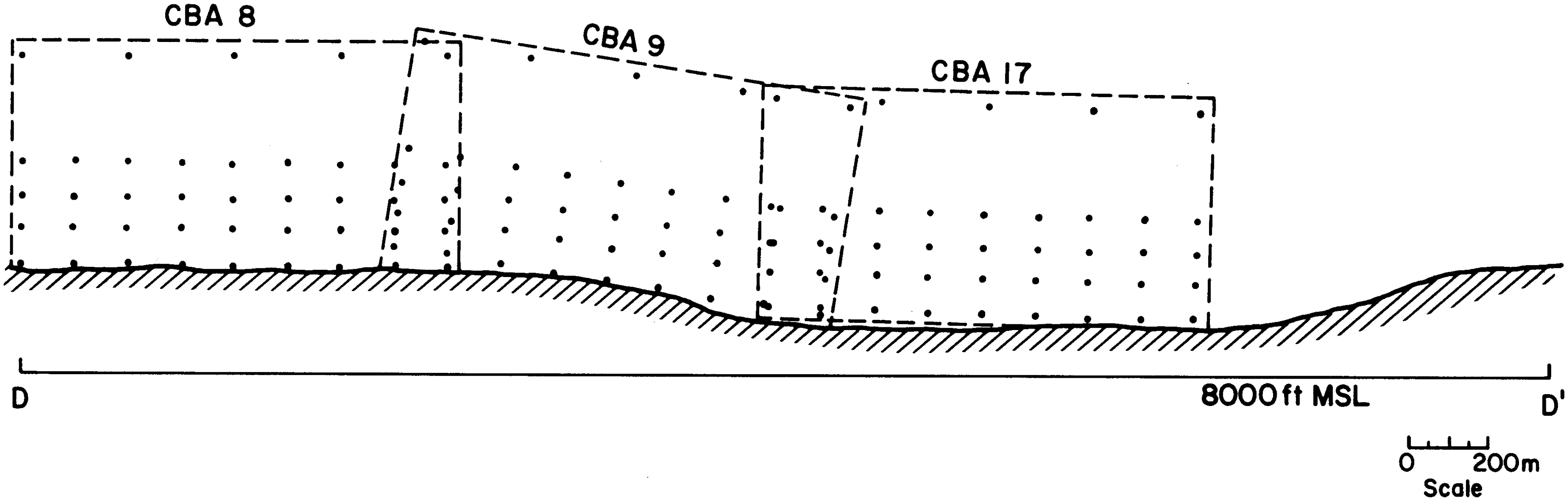


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Figure F-8. Sampling Rake Locations for Obtaining a Vertical Cross Section of the Plume 243.8 cm (6.24 km) Downwind from a 2.54 cm (65.02 m) Release Point at T4 for the Alkali Creek Stable Flow (West Wind) Tests.

RUN CBA8

	MODEL		
WIND VELOCITY	.1550 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.7130E+03		
CALIBRATION FACTOR	.4149E-02		
RANGE	10		
REFERENCE HEIGHT	2.54 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	1245.	.17890E-04
3	1595.	.29659E-04
4	1860.	.38571E-04
5	1435.	.24279E-04
6	2679.	.66112E-04
7	3006.	.77108E-04
8	3134.	.81412E-04
9	2238.	.51282E-04
10	1344.	.21219E-04
11	1275.	.18899E-04
12	1060.	.11669E-04
15	809.	.32282E-05
16	750.	.12442E-05
18	746.	.11097E-05
19	1102.	.13081E-04
20	1053.	.11433E-04
21	967.	.85414E-05
24	731.	.60530E-06
27	698.	0.
28	923.	.70618E-05
29	890.	.59521E-05
36	769.	.18831E-05

RUN CBA9

	MODEL		
WIND VELOCITY	.1550 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.7030E+03		
CALIBRATION FACTOR	.4149E-02		
RANGE	10		
REFERENCE HEIGHT	2.54 cm		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
5	723.	.67255E-06
6	789.	.28920E-05
7	741.	.12778E-05
8	3079.	.79899E-04
10	1352.	.21824E-04
11	1620.	.30836E-04
12	1938.	.41530E-04
13	2632.	.64868E-04
14	3703.	.10088E-03
15	4094.	.11403E-03
16	6175.	.18401E-03
18	8191.	.25180E-03
19	973.	.90794E-05
21	1391.	.23136E-04
22	1739.	.34838E-04
25	4034.	.11201E-03
26	3070.	.79596E-04
27	4696.	.13427E-03
28	755.	.17486E-05
29	741.	.12778E-05
30	1562.	.28886E-04
31	939.	.79361E-05
32	1233.	.17823E-04
33	1192.	.16444E-04
34	1195.	.16545E-04
35	1330.	.21084E-04
36	1562.	.28886E-04
37	543.	0.
42	711.	.26902E-06
43	703.	0.
44	716.	.43716E-06

RUN CBA17

	MODEL		
WIND VELOCITY	.1550 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.6805E+03		
CALIBRATION FACTOR	.4149E-02		
RANGE	10		
REFERENCE HEIGHT	2.54 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	6746.	.20397E-03
3	11116.	.35092E-03
4	12501.	.39749E-03
5	5944.	.17700E-03
6	14718.	.47205E-03
7	13057.	.41619E-03
8	10382.	.32624E-03
9	4120.	.11566E-03
10	5401.	.15874E-03
11	8201.	.25290E-03
12	7380.	.22529E-03
13	5781.	.17152E-03
14	5062.	.14734E-03
15	5717.	.16937E-03
16	4170.	.11734E-03
19	1984.	.43833E-04
21	672.	0.
22	838.	.52963E-05
23	1362.	.22917E-04
24	1609.	.31223E-04
25	907.	.76166E-05
27	743.	.21017E-05
28	724.	.14628E-05
36	680.	0.
43	707.	.89113E-06

APPENDIX G

Alkali Creek Stable Flow (Easterly Wind) Concentration Data

G-1 Ground-level Data and Sample Point Locations
G-2 Vertical Rake Data and Rake Locations

G-1. Alkali Creek Ground-level Data for Stable Flow (Easterly Wind) Tests

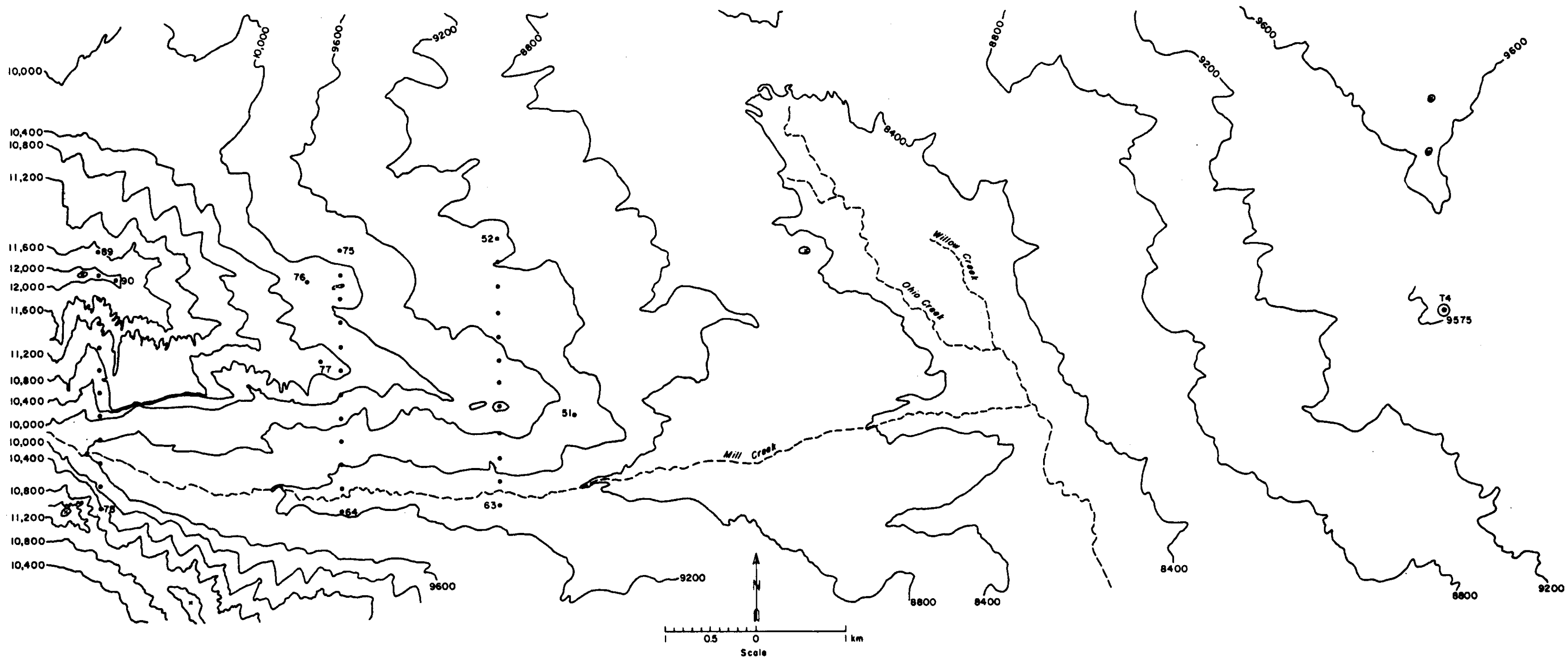

Figure G-1-1. Ground-Level Sample Points used to Obtain Concentration Data for Alkali Creek Stable Flow (Easterly Wind) Tests.

RUN CBM1

	MODEL		
WIND VELOCITY	.4870 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.6260E+03		
CALIBRATION FACTOR	.4413E-02		
RANGE	10		
REFERENCE HEIGHT	.3175 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
41	867.	.27081E-04
1	2068.	.16204E-03
2	1060.	.48768E-04
3	2243.	.18170E-03
4	2357.	.19451E-03
5	1364.	.82929E-04
6	2205.	.17743E-03
7	2107.	.16642E-03
8	2038.	.15867E-03
9	1020.	.44274E-04
10	1406.	.87648E-04
11	1487.	.96750E-04
12	1349.	.81243E-04
13	1168.	.60904E-04
14	1272.	.72591E-04
15	1336.	.79783E-04
17	626.	0.
18	1248.	.69894E-04
19	1467.	.94503E-04
21	1938.	.14743E-03
22	1964.	.15035E-03
23	670.	.49443E-05
24	627.	.11237E-06
25	1889.	.14192E-03
26	677.	.57309E-05
27	775.	.16743E-04
28	1052.	.47870E-04
29	1148.	.58657E-04
30	1085.	.51578E-04
31	634.	.89896E-06
32	893.	.30003E-04
33	722.	.10787E-04
34	756.	.14608E-04
35	1002.	.42251E-04
36	745.	.13372E-04
37	1083.	.51353E-04
38	1454.	.93042E-04
39	1250.	.70119E-04
40	1499.	.98099E-04

RUN CBM2

	MODEL		
WIND VELOCITY	.5420 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.6580E+03		
CALIBRATION FACTOR	.4413E-02		
RANGE	10		
REFERENCE HEIGHT	.3175 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
41	950.	.36518E-04
1	1940.	.16033E-03
2	1726.	.13356E-03
3	2014.	.16958E-03
4	2081.	.17796E-03
5	1480.	.10280E-03
6	2028.	.17133E-03
7	1946.	.16108E-03
8	1782.	.14057E-03
9	1066.	.51025E-04
10	1432.	.96797E-04
11	1312.	.81790E-04
12	1317.	.82415E-04
13	1132.	.59279E-04
14	1364.	.88293E-04
15	1422.	.95546E-04
17	635.	0.
18	1550.	.11155E-03
19	1808.	.14382E-03
21	2207.	.19372E-03
22	2381.	.21548E-03
24	667.	.11255E-05
25	1979.	.16520E-03
26	852.	.24262E-04
27	1001.	.42896E-04
28	1041.	.47898E-04
29	1128.	.58778E-04
30	1079.	.52650E-04
31	748.	.11255E-04
32	892.	.29264E-04
33	855.	.24637E-04
34	997.	.42395E-04
35	1400.	.92795E-04
36	1108.	.56277E-04
37	1256.	.74786E-04
38	2007.	.16871E-03
39	1549.	.11143E-03
40	2053.	.17446E-03
23	837.	.22386E-04

G-2. Vertical Rake Data and Locations

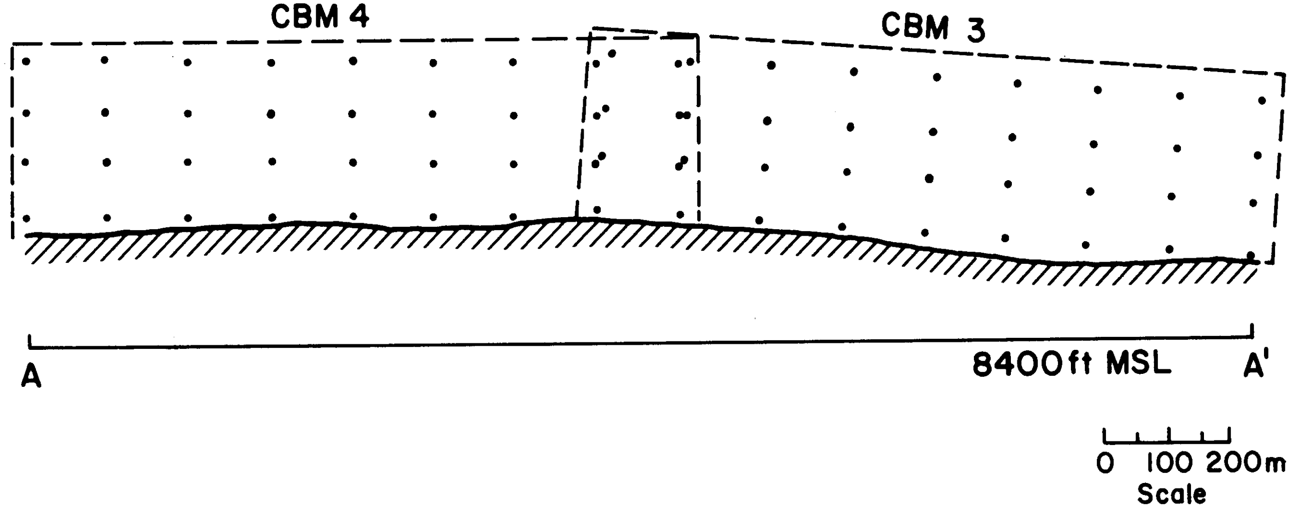

Figure G-2-1. Sampling Locations for Obtaining a Vertical Cross Section of the Plume 110.5 cm (2.83 km) Downwind from a 0.318 cm (8.14 m) Release Point at T4 for the Alkali Creek Stable Flow (East Wind) Test.

RUN CBM4

	MODEL		
WIND VELOCITY	.4870 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.5770E+03		
CALIBRATION FACTOR	.4413E-02		
RANGE	10		
REFERENCE HEIGHT	.3175 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	611.	.38206E-05
2	648.	.79783E-05
3	632.	.61803E-05
5	629.	.58432E-05
9	691.	.12810E-04
16	650.	.82030E-05
18	4958.	.49229E-03
25	647.	.78659E-05
27	2225.	.18519E-03
35	837.	.29216E-04
36	680.	.11574E-04

RUN CBM3

	MODEL		
WIND VELOCITY	.4870 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.6150E+03		
CALIBRATION FACTOR	.4413E-02		
RANGE	10		
REFERENCE HEIGHT	.3175 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	659.	.60680E-05
2	709.	.10563E-04
3	6316.	.64062E-03
4	24683.	.27045E-02
5	12308.	.13139E-02
6	9795.	.10316E-02
7	7599.	.78479E-03
8	4379.	.42296E-03
9	1536.	.10349E-03
10	6239.	.63197E-03
11	5810.	.58376E-03
13	13662.	.14661E-02
14	7705.	.79670E-03
15	875.	.29216E-04
16	1877.	.14181E-03
18	833.	.24497E-04
19	1613.	.11215E-03
21	8220.	.85457E-03
22	3740.	.35116E-03
23	729.	.12810E-04
24	629.	.15732E-05
25	991.	.42251E-04
26	645.	.33711E-05
27	683.	.76411E-05
28	907.	.32812E-04
29	1186.	.64163E-04
30	988.	.41914E-04
31	761.	.16406E-04
32	690.	.84277E-05
33	647.	.35958E-05
34	629.	.15732E-05
36	628.	.14608E-05
37	632.	.19103E-05

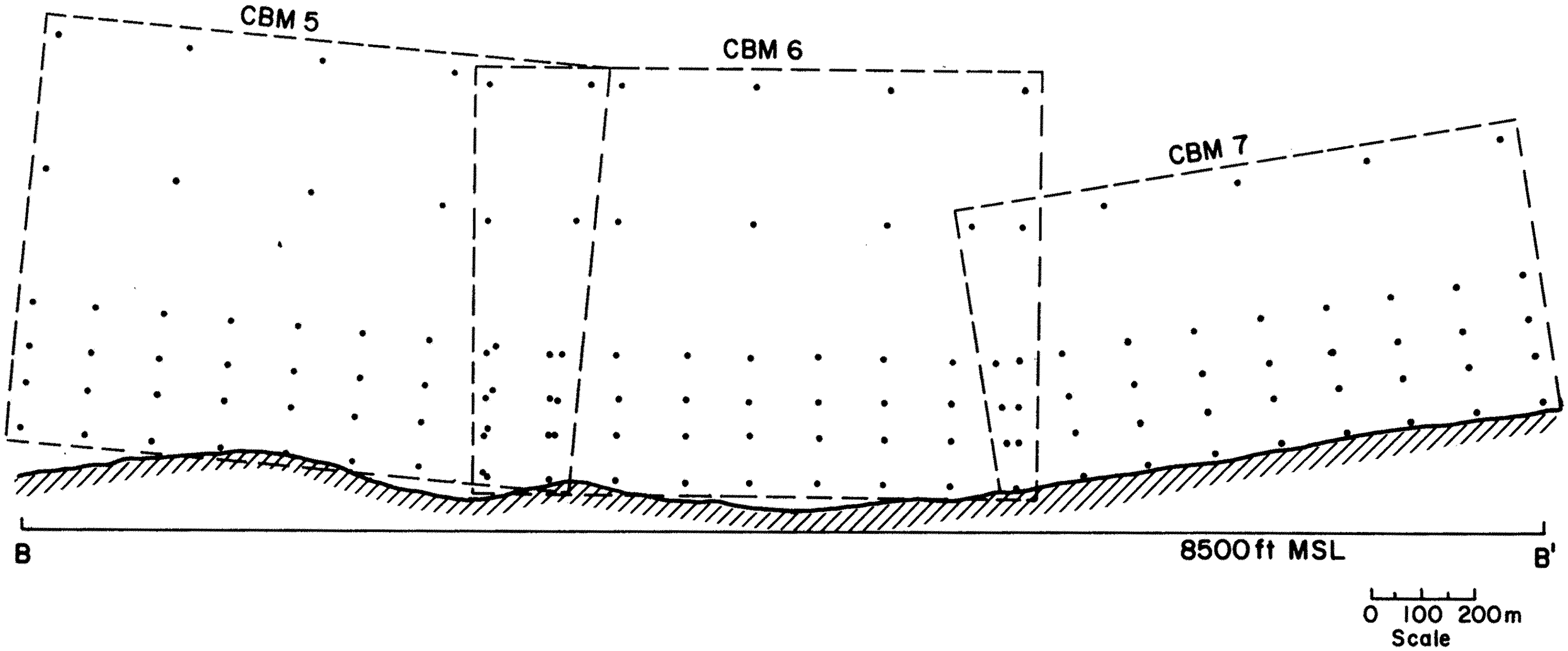

Figure G-2-2. Sampling Locations for Obtaining a Vertical Cross Section of the Plume 335.2 cm (8.58 km) Downwind from a 0.318 cm (8.14 m) Release Point at T4 for the Alkali Creek Stable Flow (East Wind) Test.

RUN CBM5

	MODEL	
WIND VELOCITY	.4870 M/S	
EXIT VELOCITY	.2709 M/S	
VOLUME FLOW	.1205E-05 M**3/S	
SOURCE STRENGTH(PPM)	.1600E+06	
BACKGROUND	.6450E+03	
CALIBRATION FACTOR	.4413E-02	
RANGE	10	
REFERENCE HEIGHT	.3175 CM	
RELEASE DIAMETER	.2380 CM	

	X (M)	Y (M)	Z (FT MSL)
RELEASE LOCATION	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	748.	.11574E-04
3	893.	.27868E-04
4	984.	.38093E-04
5	960.	.35396E-04
6	1276.	.70905E-04
7	1451.	.90570E-04
8	1521.	.98436E-04
9	1343.	.78434E-04
10	733.	.98885E-05
11	797.	.17080E-04
12	874.	.25733E-04
13	952.	.34498E-04
14	1654.	.11338E-03
15	1783.	.12788E-03
16	2812.	.24351E-03
18	2781.	.24002E-03
19	735.	.10113E-04
21	1412.	.86188E-04
22	2763.	.23800E-03
25	2693.	.23013E-03
27	1699.	.11844E-03
28	842.	.22137E-04
29	1748.	.12394E-03
30	3248.	.29250E-03
31	3054.	.27070E-03
32	2667.	.22721E-03
34	1278.	.71130E-04
36	1320.	.75850E-04
37	717.	.80906E-05
38	665.	.22474E-05
39	688.	.48319E-05
40	657.	.13484E-05
41	674.	.32587E-05
42	650.	.56185E-06
43	646.	.11237E-06
44	648.	.33711E-06
45	645.	0.

RUN CBM6

	MODEL		
WIND VELOCITY	.4870 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.6180E+03		
CALIBRATION FACTOR	.4413E-02		
RANGE	10		
REFERENCE HEIGHT	.3175 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	2059.	.16192E-03
3	2438.	.20451E-03
4	2524.	.21418E-03
5	1806.	.13350E-03
6	2507.	.21227E-03
7	2653.	.22867E-03
8	2682.	.23193E-03
9	2026.	.15822E-03
10	2746.	.23912E-03
11	2651.	.22845E-03
12	2933.	.26014E-03
13	2494.	.21081E-03
14	2855.	.25137E-03
15	2771.	.24193E-03
16	2816.	.24699E-03
18	2502.	.21170E-03
19	2740.	.23845E-03
21	2582.	.22069E-03
22	2306.	.18968E-03
25	2507.	.21227E-03
27	1886.	.14248E-03
28	1558.	.10563E-03
29	1556.	.10540E-03
30	1429.	.91132E-04
31	1306.	.77310E-04
32	1649.	.11585E-03
33	1526.	.10203E-03
34	1767.	.12911E-03
36	1994.	.15462E-03
37	632.	.15732E-05
39	693.	.84277E-05
40	666.	.53937E-05
41	739.	.13597E-04
42	622.	.44948E-06
43	636.	.20227E-05
44	623.	.56185E-06
45	618.	0.

RUN CBM7

	MODEL		
WIND VELOCITY	.4870 M/S		
EXIT VELOCITY	.2709 M/S		
VOLUME FLOW	.1205E-05 M**3/S		
SOURCE STRENGTH(PPM)	.1600E+06		
BACKGROUND	.6290E+03		
CALIBRATION FACTOR	.4413E-02		
RANGE	10		
REFERENCE HEIGHT	.3175 CM		
RELEASE DIAMETER	.2380 CM		
RELEASE LOCATION	X (M)	Y (M)	Z (FT MSL)
	3134102	4286612	9575

SAMPLE PT.	RAW (AREA)	NORMALIZED CONC(-)
1	2564.	.21744E-03
3	2101.	.16541E-03
4	1984.	.15226E-03
5	1407.	.87424E-04
6	2030.	.15743E-03
7	1896.	.14237E-03
8	1831.	.13507E-03
9	1645.	.11417E-03
10	2604.	.22193E-03
11	2545.	.21530E-03
12	2555.	.21642E-03
13	2044.	.15900E-03
14	2173.	.17350E-03
15	1943.	.14765E-03
16	1824.	.13428E-03
18	2019.	.15619E-03
19	2700.	.23272E-03
21	2616.	.22328E-03
22	2272.	.18462E-03
25	1618.	.11113E-03
27	1390.	.85513E-04
28	2470.	.20687E-03
29	2115.	.16698E-03
31	1672.	.11720E-03
32	1509.	.98885E-04
33	1344.	.80344E-04
34	1167.	.60455E-04
36	1098.	.52701E-04
37	736.	.12024E-04
38	732.	.11574E-04
39	773.	.16181E-04
40	634.	.56185E-06
41	594.	0.