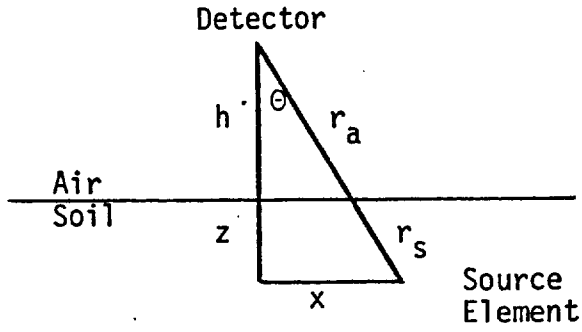
Enclosure for E

IMP CONVERSION FACTOR DERIVATION

410161



Unscattered flux at height h given by

$$\phi = \int_0^\infty \int_0^\infty \frac{S_v}{4\pi r^2} \exp\left\{-\left[\mu/\rho)_a \rho_a r_a + \mu/\rho)_s \rho_s r_s\right]\right\} 2\pi x \, dx \, dz \quad (1)$$

where

S_v = activity per unit volume ($\frac{\gamma/sec}{cm^3}$)

$r = r_a + r_s$

$\mu/\rho)_a$, $\mu/\rho)_s$ = air and soil mass attenuation coefficients $(\frac{cm^2}{g})$

ρ_a, ρ_s = air and soil density (g/cm^3)

Assume an exponential source distribution

$$S_v = S_v^o e^{-\alpha z} \quad (2)$$

where

S_v^o = activity per unit volume at the surface $(\frac{\gamma/sec}{cm^3})$

α = reciprocal of the relaxation depth (cm^{-1})

Rewrite Eq.1 in terms of θ and z, combine with Eq.2 and integrate over z. Leads to

$$\Phi = \frac{S_v^o}{2} \int_0^{\pi/2} \frac{\tan\theta \exp\left[-\mu/\rho)_a \rho_a h \sec\theta\right]}{\alpha + \mu/\rho)_s \rho_s \sec\theta} d\theta \quad (3)$$

Detector response defined in terms of an effective detector area, A, given by

$$A = \frac{N_p}{\phi} \tag{4}$$

where

N_p = net photopeak count rate

The detector response, in general, varies as a function of the gamma ray angle of incidence and is normally written as

$$A = A_o R(\Theta) \tag{5}$$

where

A_o = detector photopeak count rate for unit flux incident perpendicular to detector face

$$\left(\frac{cps}{\gamma/cm^2\ sec}\right)$$

$R(\Theta)$ = ratio of detector response at angle Θ to that at $\Theta = 0^o$

Determine A_o and $R(\Theta)$ experimentally for a given detector.

Combining Eq's 4 and 5 with Eq. 3 leads to an expression relating measured photopeak count rate to source activity in the soil.

$$\frac{N_p}{S_v^o} = \left[\frac{A_o}{2} \int_0^{\pi/2} \frac{R\ (\theta)\ \tan\theta\ \exp\left[-\mu/\rho)_a \rho_a\ h\ \sec\ \theta\right]}{\alpha\ +\ \mu/\rho)_s\ \rho_s\ \sec\theta} d\theta \right] \quad (6)$$

in units of $\frac{cps}{\gamma/cm^3\text{-sec}}$

Normally convert γ/sec to μCi or pCi for a specific isotope. Can change from activity per unit volume to activity per unit mass by multiplying by the soil density (g/cm^3).

For Enewetak want average concentration in top 3 cm. In general, average concentration in top z cm, S_v^z, is given by

$$S_v^z = \frac{1}{z} \int_0^z S_v^o\ e^{-\alpha z}\ dz = \frac{S_v^o}{\alpha z} (1-e^{-\alpha z}) \quad (7)$$

Combining Eq's 6 and 7 leads to the final expression for the conversion factor used at Enewetak

$$\frac{(S_v^z/\rho)}{N_p} = \frac{(1-e^{-\alpha z})}{\alpha z} B \left[\frac{A_o\ \rho_s}{2} \int_0^{\pi/2} \frac{R\,(\theta)\ \tan\theta\ \exp\left[-\mu/\rho)_a \rho_a h\ \sec\theta\right]}{\alpha\ +\ \mu/\rho)_s \rho_s\ \sec\theta} d\theta \right]^{-1}$$

in units of $\left[\frac{pCi/g}{cps}\right]$

where B converts γ/sec to pCi for a specific isotope.

^{241}Am INPUT PARAMETERS

$h = 7.4m$

$\mu/\rho)_a = 0.188 \frac{cm^2}{g}$

$\rho_a = 1.15\ (10^{-3})\ g/cm^3$ (dry air at 750 mmHg and 86^oF)

$z = 3\ cm$

$A_o = 19.0 \frac{cps}{\gamma/cm^2\text{-}sec}$

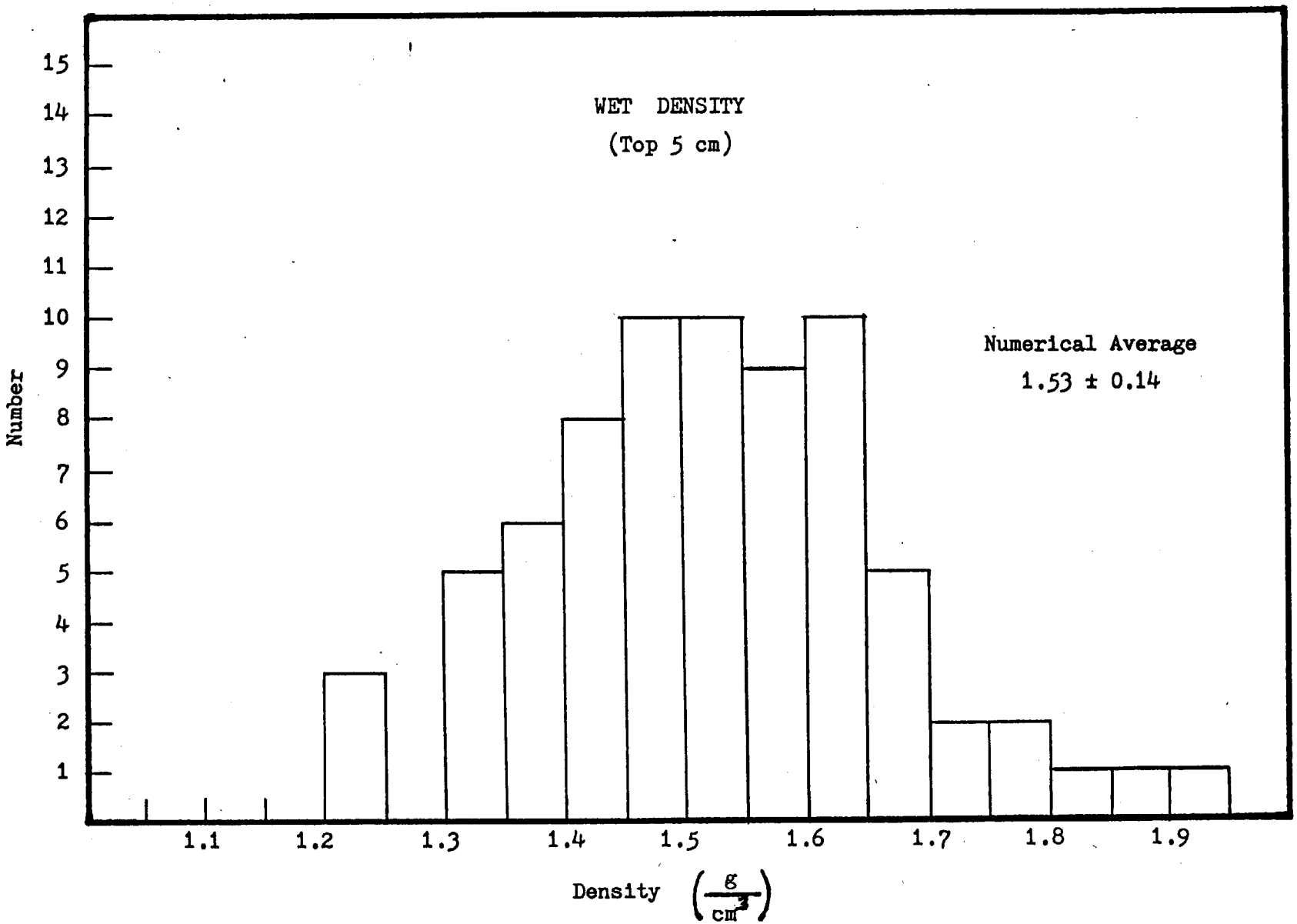
$B = 75.3$ (γ/dis. = 35.9%, pCi = 3.7×10^{-2} dis./sec)

$R(\Theta)$ = measured with collimator in place

Original	Revised
$\mu/\rho)_s = 0.248 \frac{cm^2}{g}$	$\mu/\rho)_s = 0.333 \frac{cm^2}{g}$
$\rho_s = 1.2\ g/cm^3$	$\rho_s = 1.5\ g/cm^3$
α: graphical analysis	α: weighted average from NVO-140

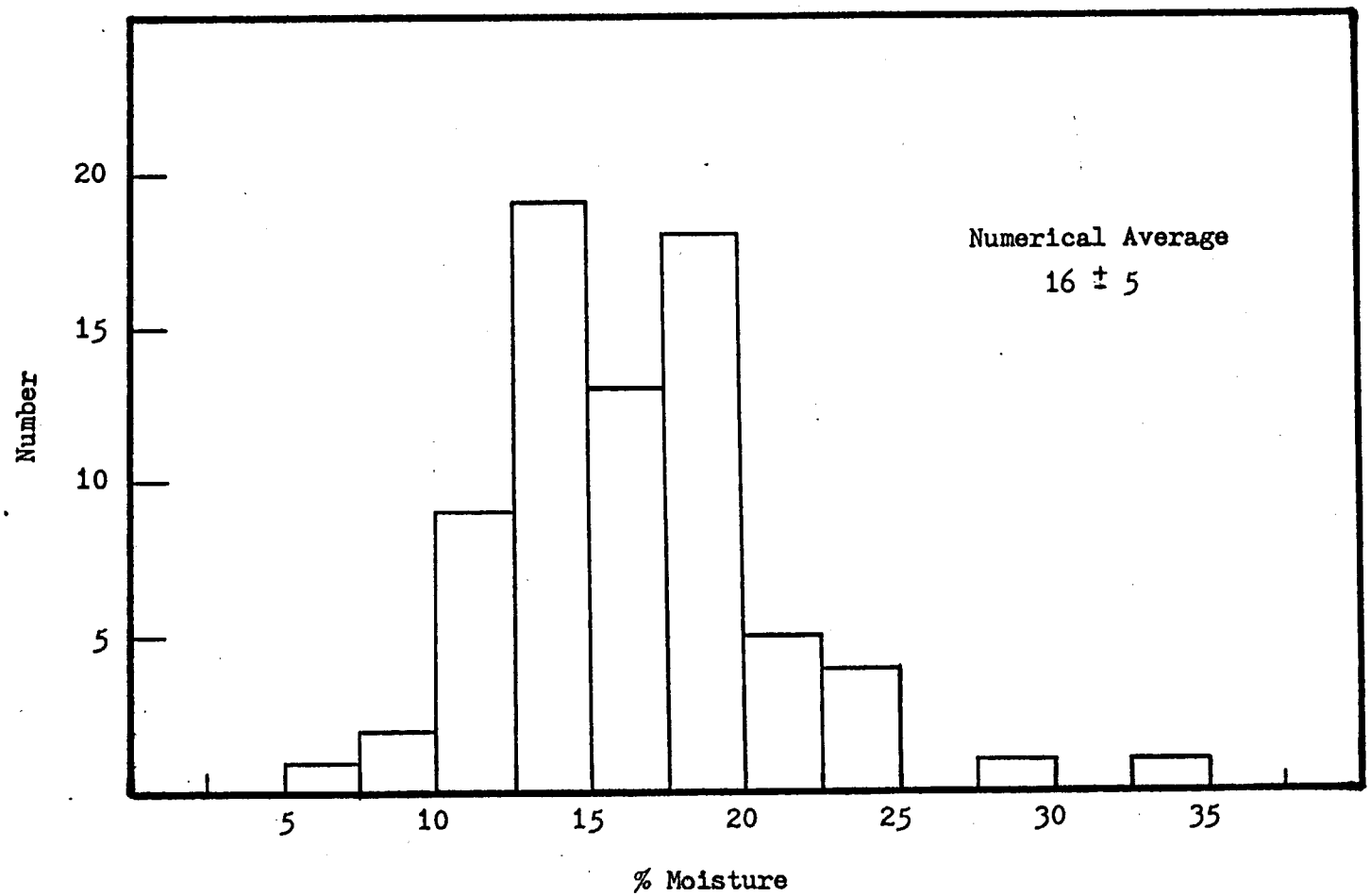
RESULTS $\frac{S_v^3/\rho}{N_p}$

Original	Revised
7.71 $\frac{pCi/g}{cps}$	8.95 $\frac{pCi/g}{cps}$


WET DENSITY
(Top 5 cm)
Numerical Average
1.53 ± 0.14
Number
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
Density (g/cm³)

SOIL MOISTURE

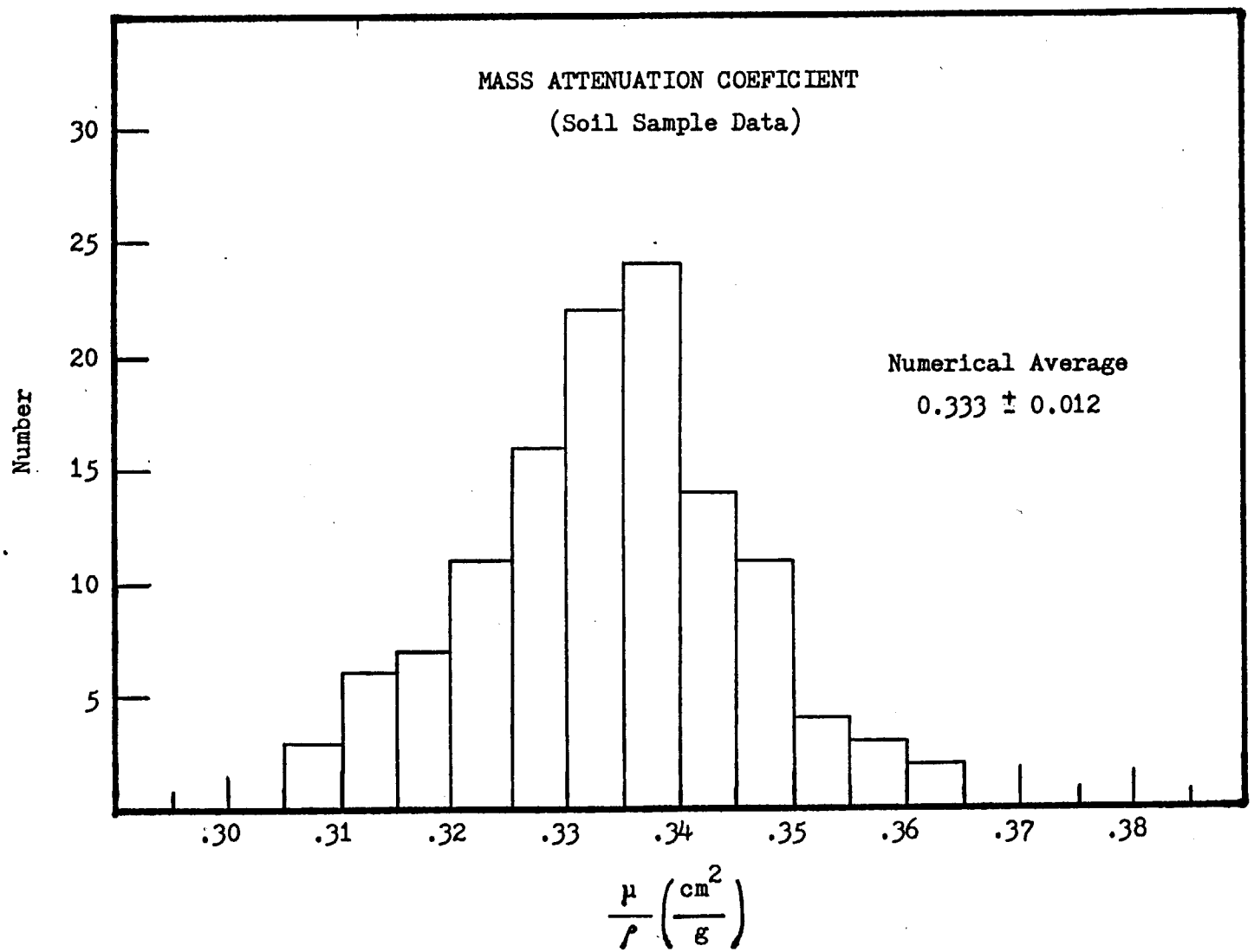
(Top 5 cm)



SAND CONE COMPARISON

	WET DENSITY		DRY DENSITY		% MOISTURE	
	Sand Cone	Troxler	Sand Cone	Troxler	Sand Cone	Troxler
1.	1.69	1.66	1.46	1.43	15.8	16.1
2.	1.64	1.71	1.43	1.46	14.7	17.1
3.	1.81	1.72	1.46	1.42	24.0	20.7
4.	1.60	1.63	1.37	1.35	16.8	20.7
5.	1.83	1.77	1.67	1.60	9.6	10.6
6.	1.57	1.46	1.22	1.30	28.7	12.3
7.	1.64	1.50	1.43	1.31	14.4	14.4
8.	1.68	1.61	1.41	1.41	19.1	14.2
9.	1.71	1.71	1.49	1.48	14.8	15.5
10.	1.68	1.59	1.43	1.36	17.0	16.9
11.	1.57	1.52	1.34	1.32	16.9	15.2
12.	1.66	1.77	1.47	1.55	12.8	13.8
Enewetak 1	1.86	1.73	1.68	1.56	10.7	10.9

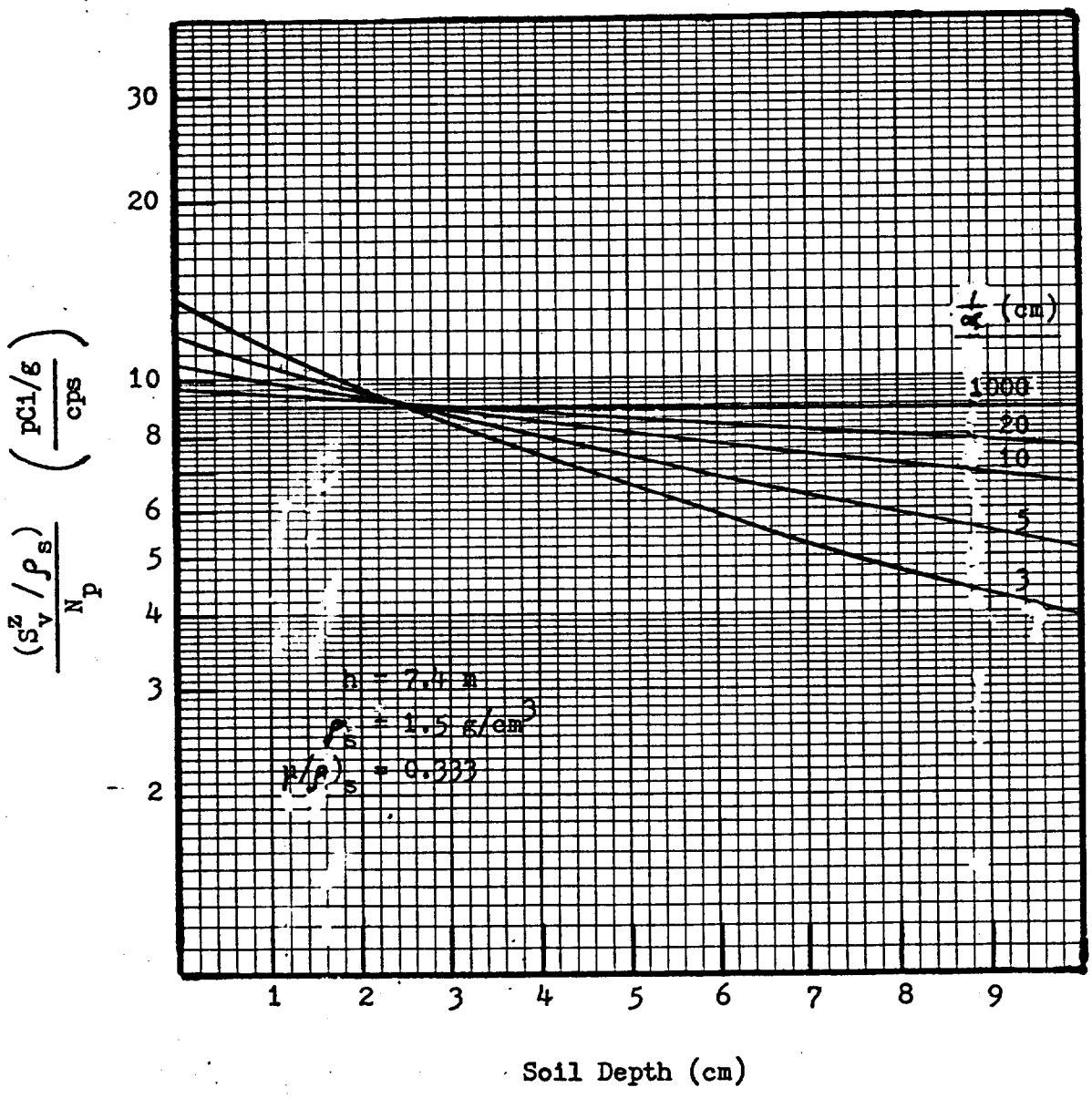
	$\frac{\text{Sand Cone}}{\text{Troxler}}$	$\frac{\text{w/o \#6}}{\text{Troxler}}$
Wet	1.03 ± 0.05	1.02 ± 0.05
Dry	1.02 ± 0.04	1.02 ± 0.04
%	$1.11 \pm .39$	1.00 ± 0.14


MASS ATTENUATION COEFICIENT
(Soil Sample Data)
Numerical Average
0.333 ± 0.012
Number
30
25
20
15
10
5
.30
.31
.32
.33
.34
.35
.36
.37
.38
$\frac{\mu}{\rho}\left(\frac{cm^2}{g}\right)$

MASS ATTENUATION COEFFICIENTS

SAMPLE	SOIL SAMPLE RESULTS	DIRECT MEASUREMENT
1	0.330	0.337
2	0.324	0.320
3	0.331	0.339
4	0.322	0.328
5	0.342	0.342
6	0.340	0.338
7	0.332	0.335
8	0.336	0.337
9	0.327	0.322
10	0.333	0.333
11	0.335	0.329
Average	0.332	0.333
Las Vegas		
Commercial Dirt		0.273
Garden Dirt		0.279
Desert Soil		0.246

IMP CONVERSION FACTORS



REPOSITORY PNNL

COLLECTION Marshall Islands

BOX No. 5686

FOLDER Miscellaneous Information

DOCUMENT DOES NOT CONTAIN ECI

Reviewed by K Schuette Date 5/1/97