TEXAS A&M ENGINEERING

Design Suction Envelope for Drilled Shafts in Expansive Soil

Robert L. Lytton

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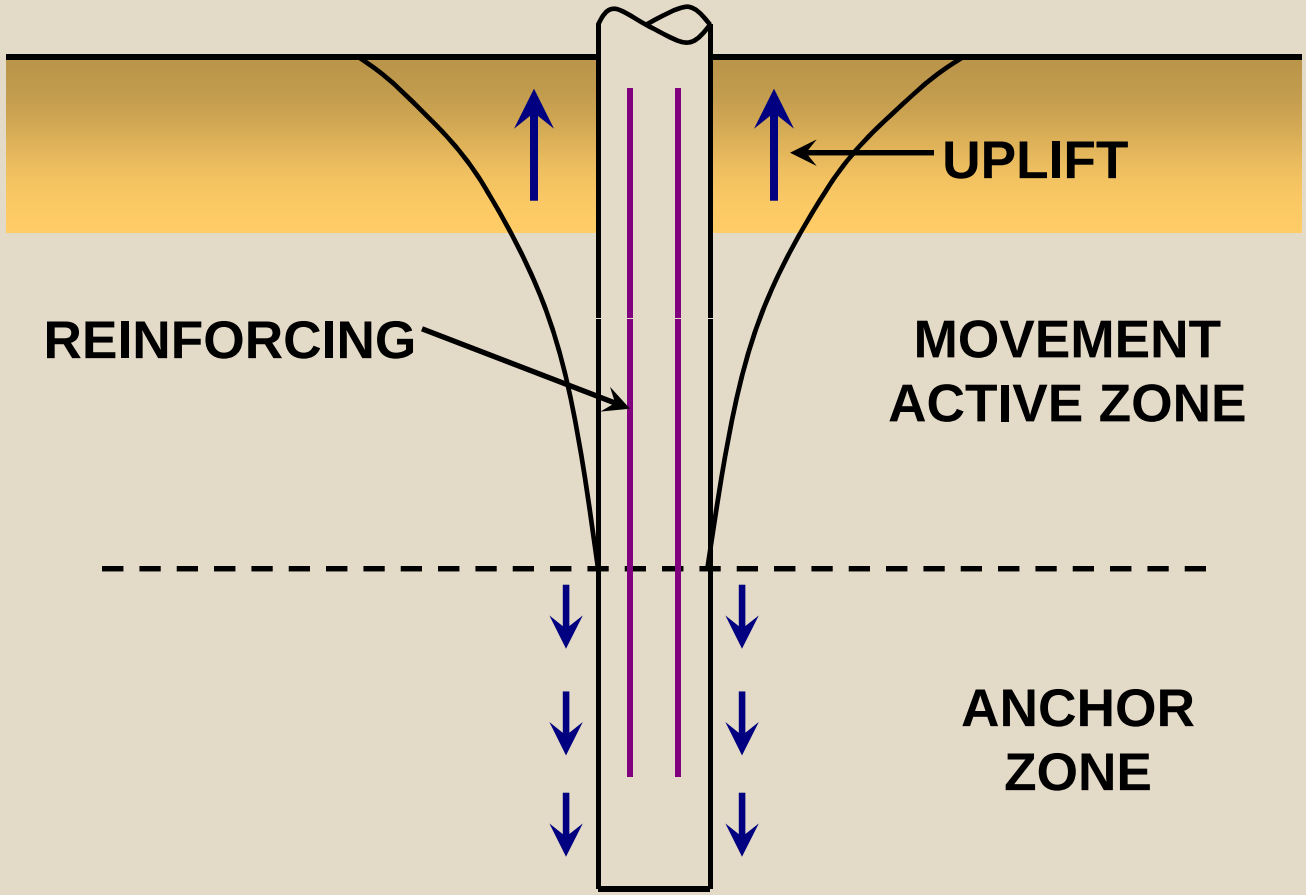
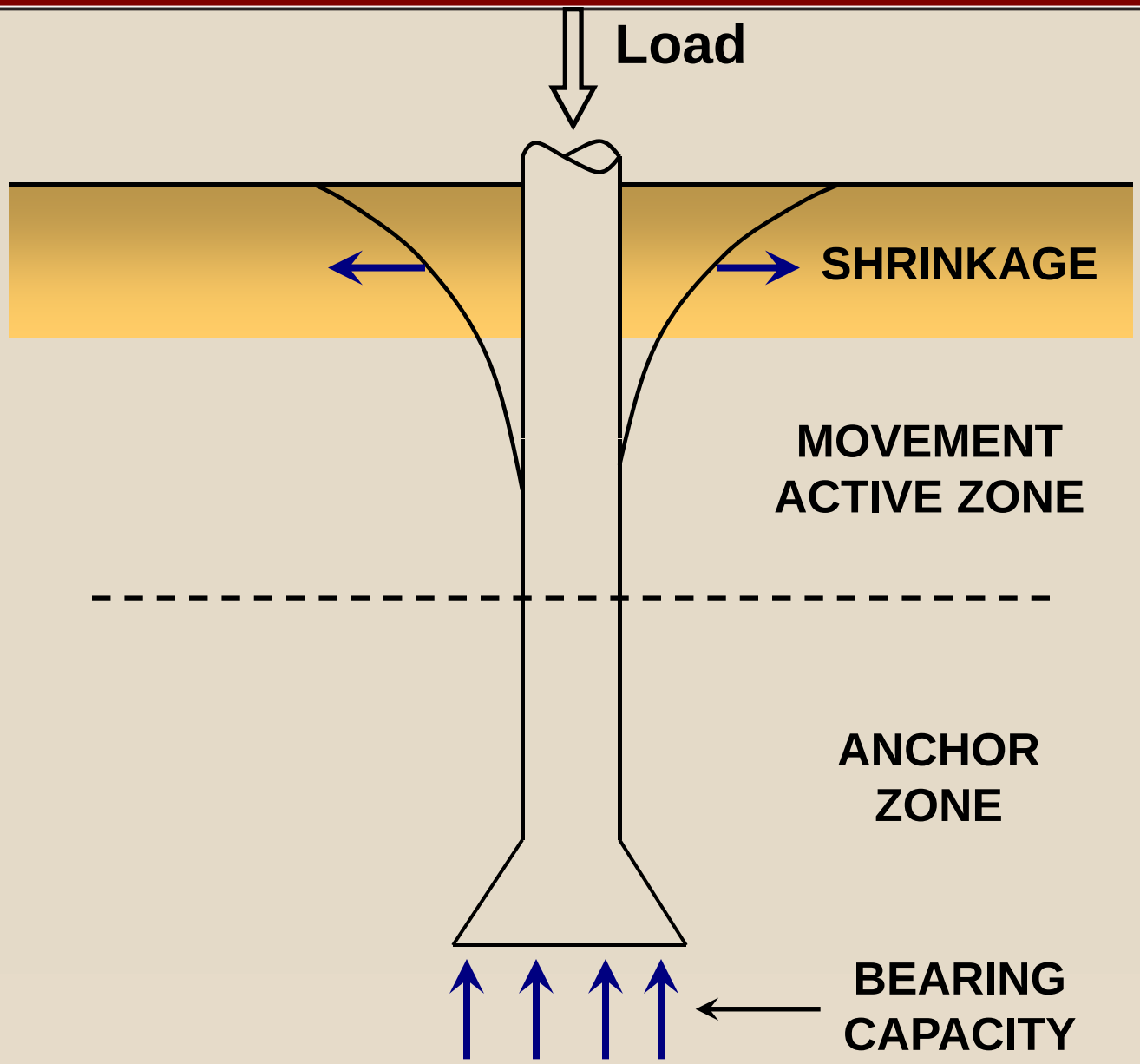
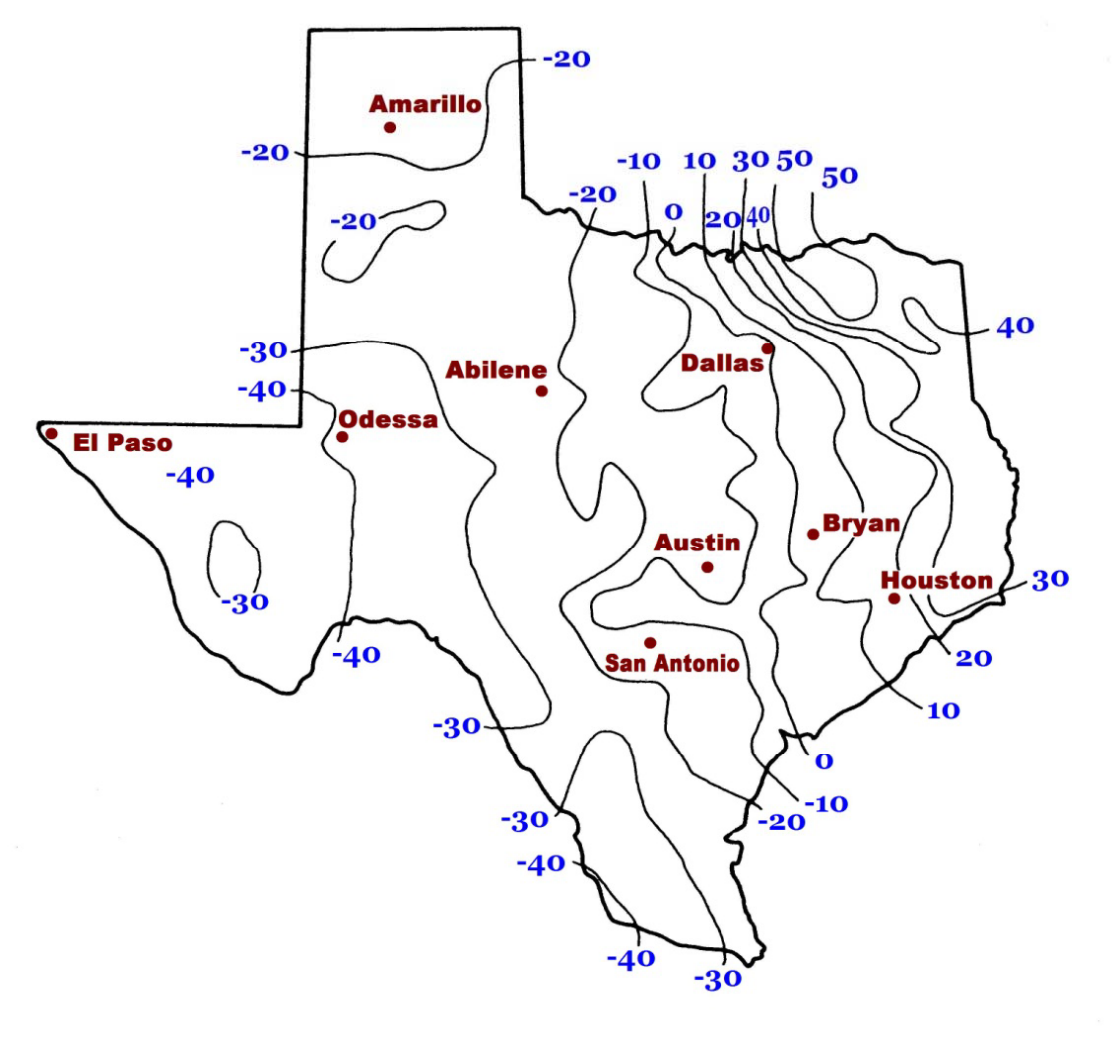
Texas A&M University

Foundation Performance Association
Houston, Texas
December 11, 2013


UPLIFT
REINFORCING
MOVEMENT
ACTIVE ZONE
ANCHOR
ZONE


Load
SHRINKAGE
MOVEMENT
ACTIVE ZONE
ANCHOR
ZONE
BEARING
CAPACITY

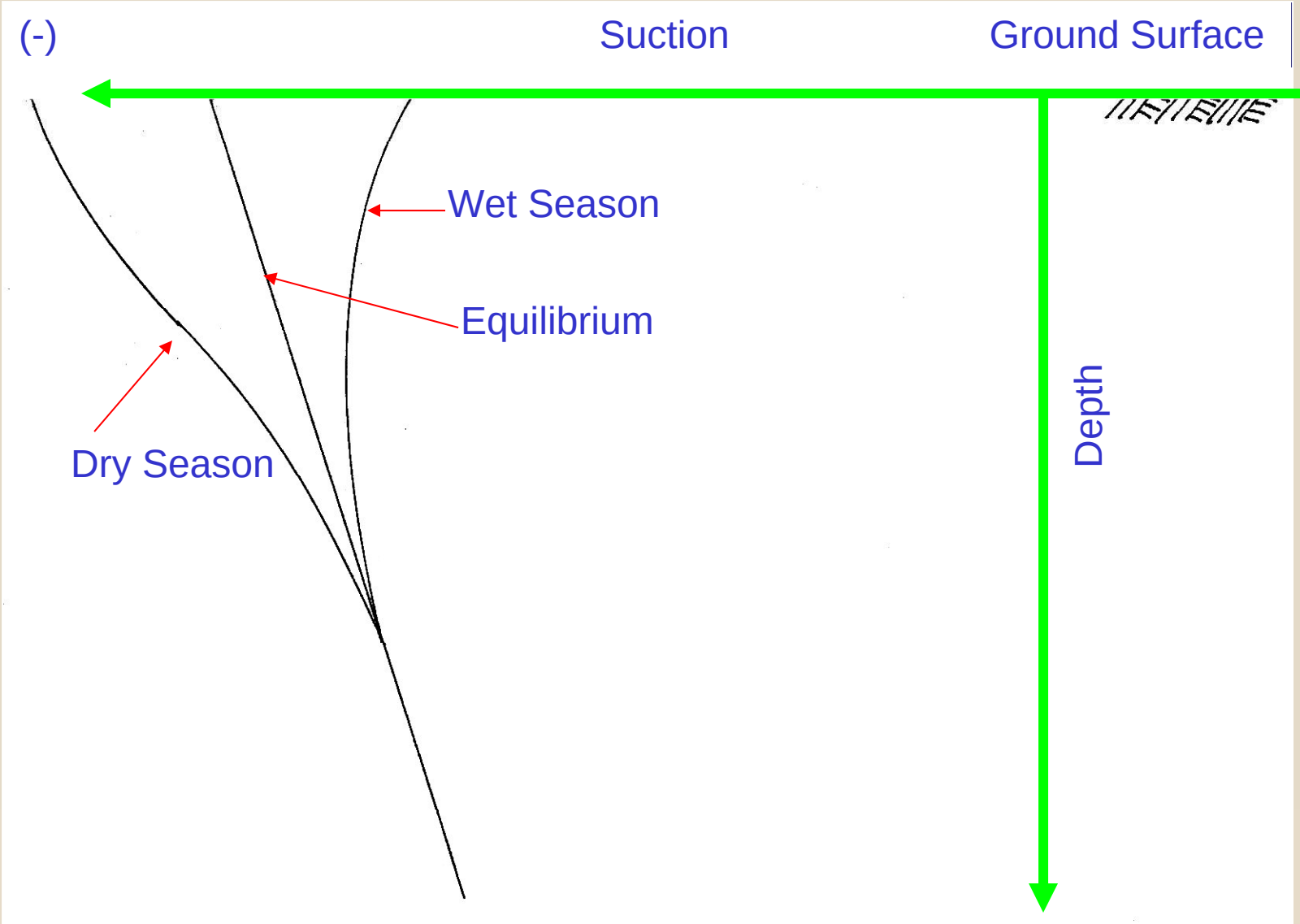
Thornthwaite Moisture Index (TMI, 1948)



$$TMI = \frac{100R - 60DEF}{E_p}$$

R = runoff moisture depth
DEF =deficit moisture depth
Ep = evapotranspiration

Suction Distribution with Depth



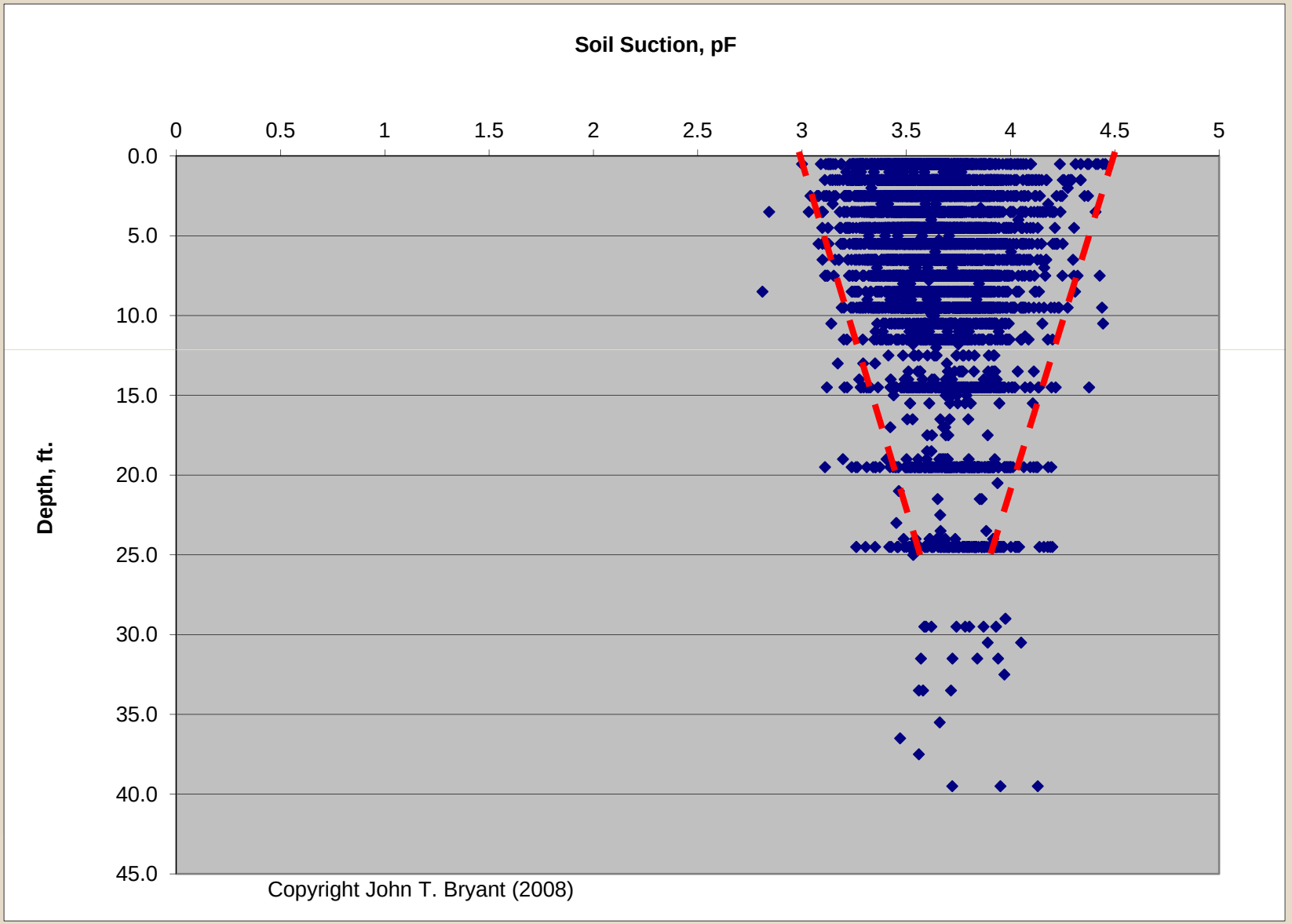
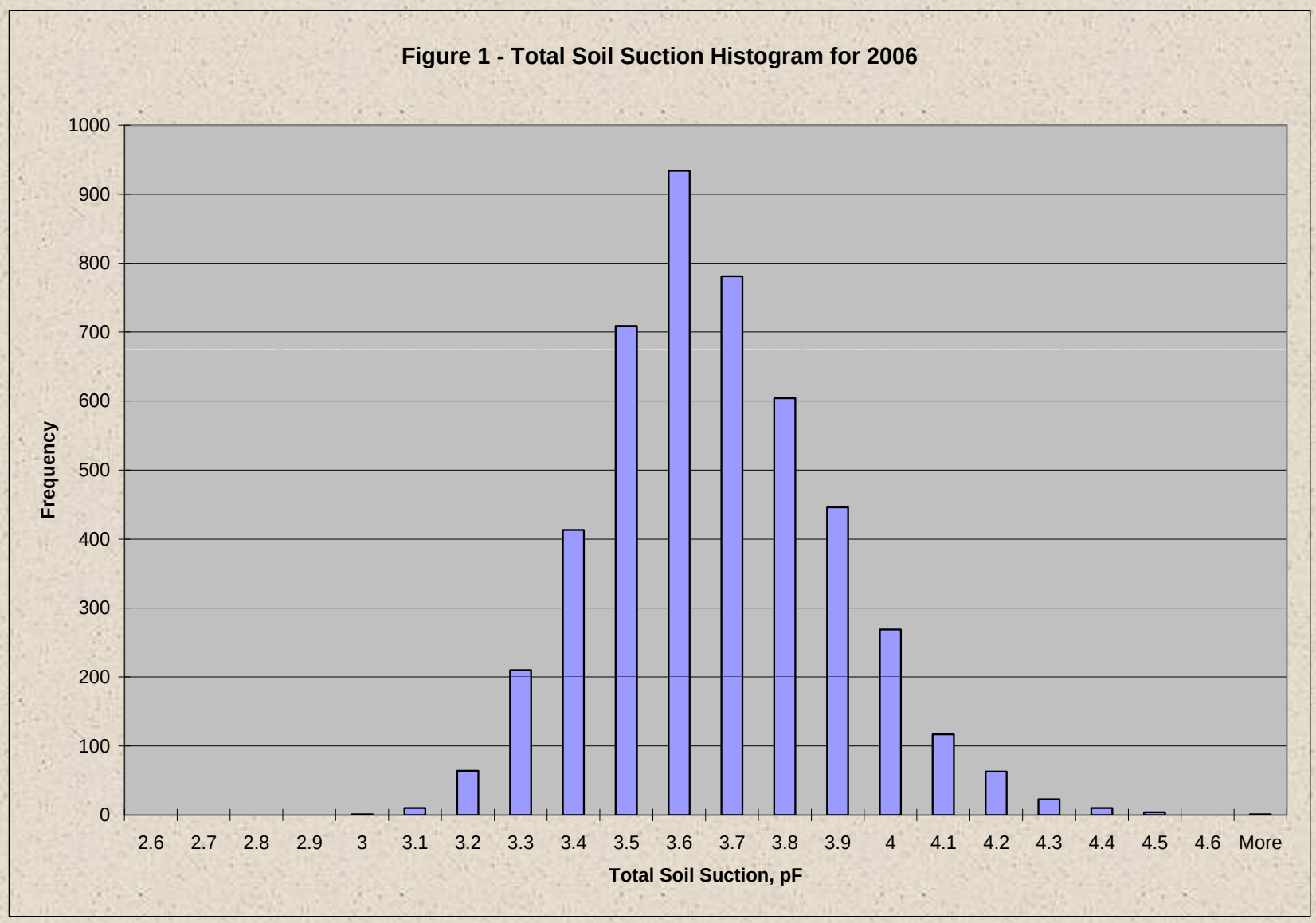
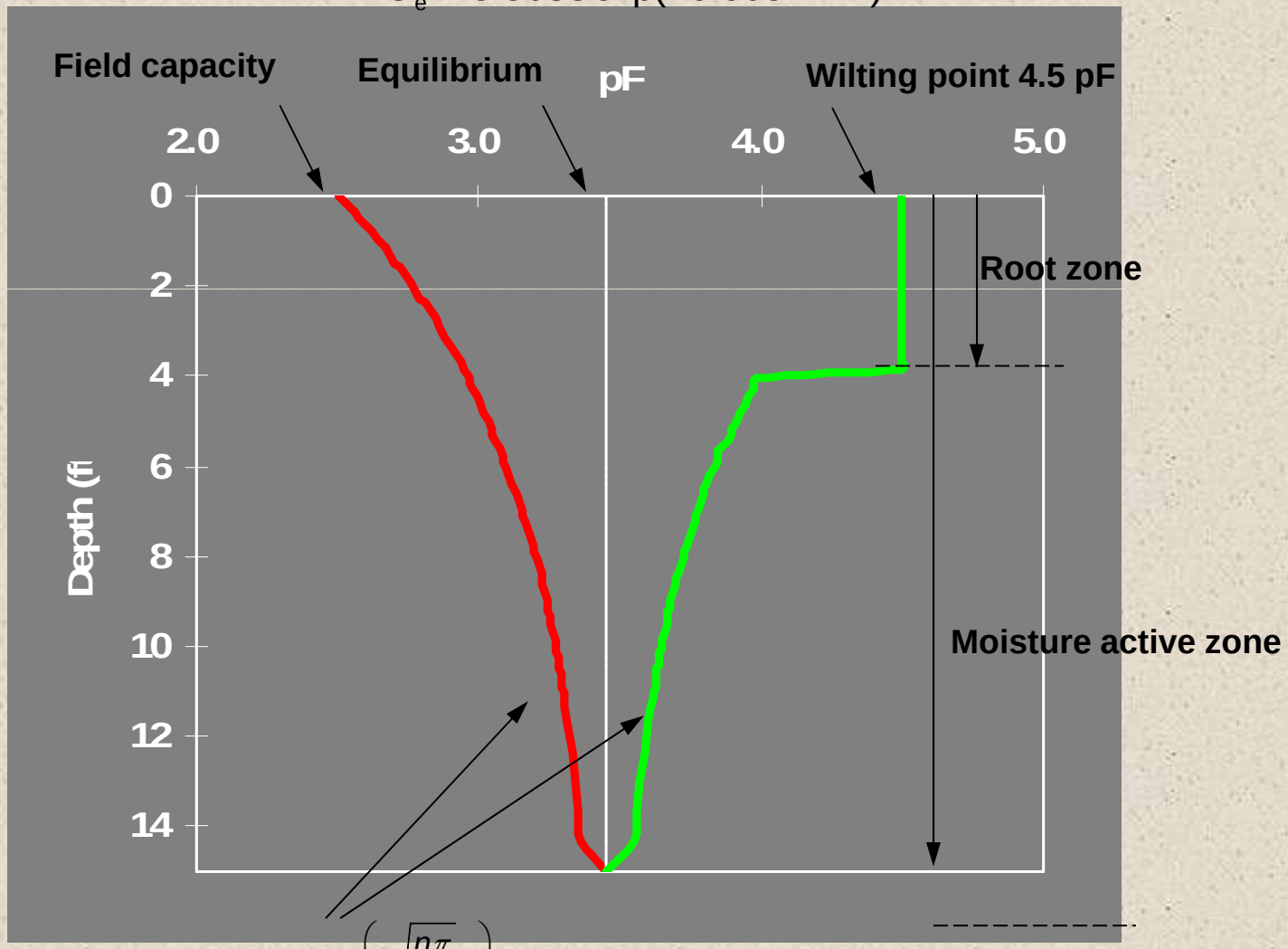

Soil Suction, pF
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
Depth, ft.
Copyright John T. Bryant (2008)

Figure 1 - Total Soil Suction Histogram for 2006



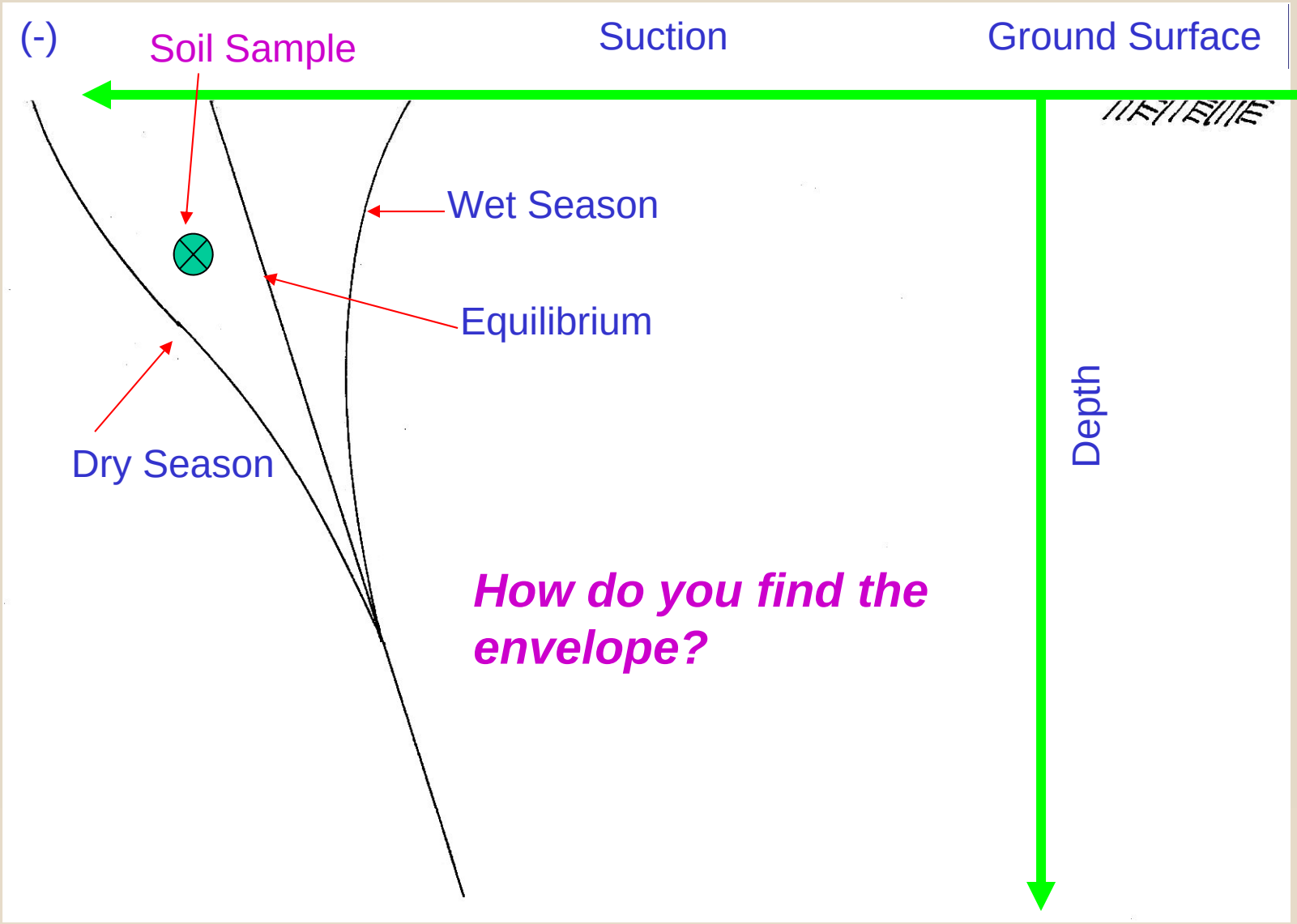
Field Conditions

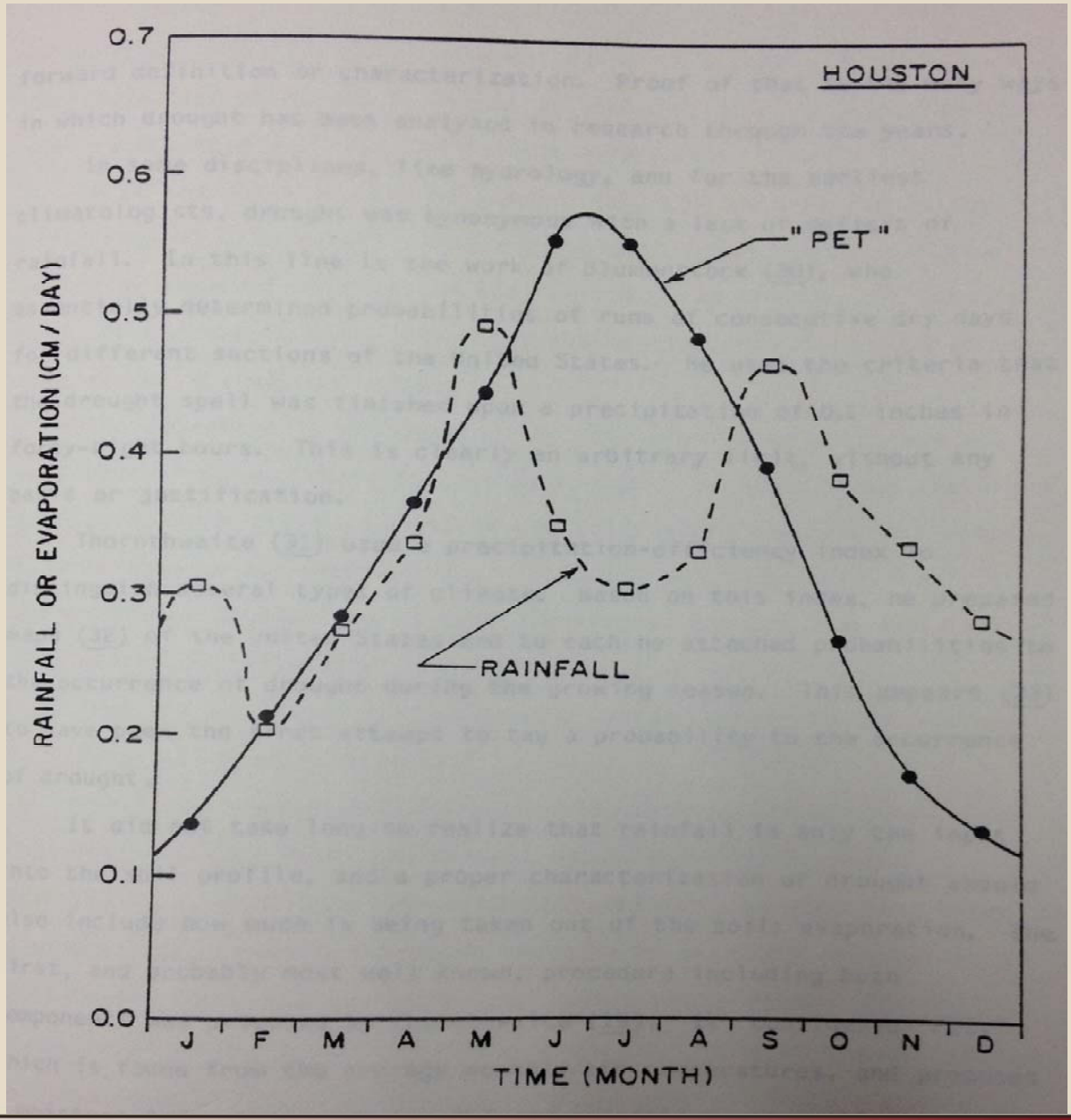
$$U_e = 3.5633 \exp(-0.0051 \mathrm{TMI})$$

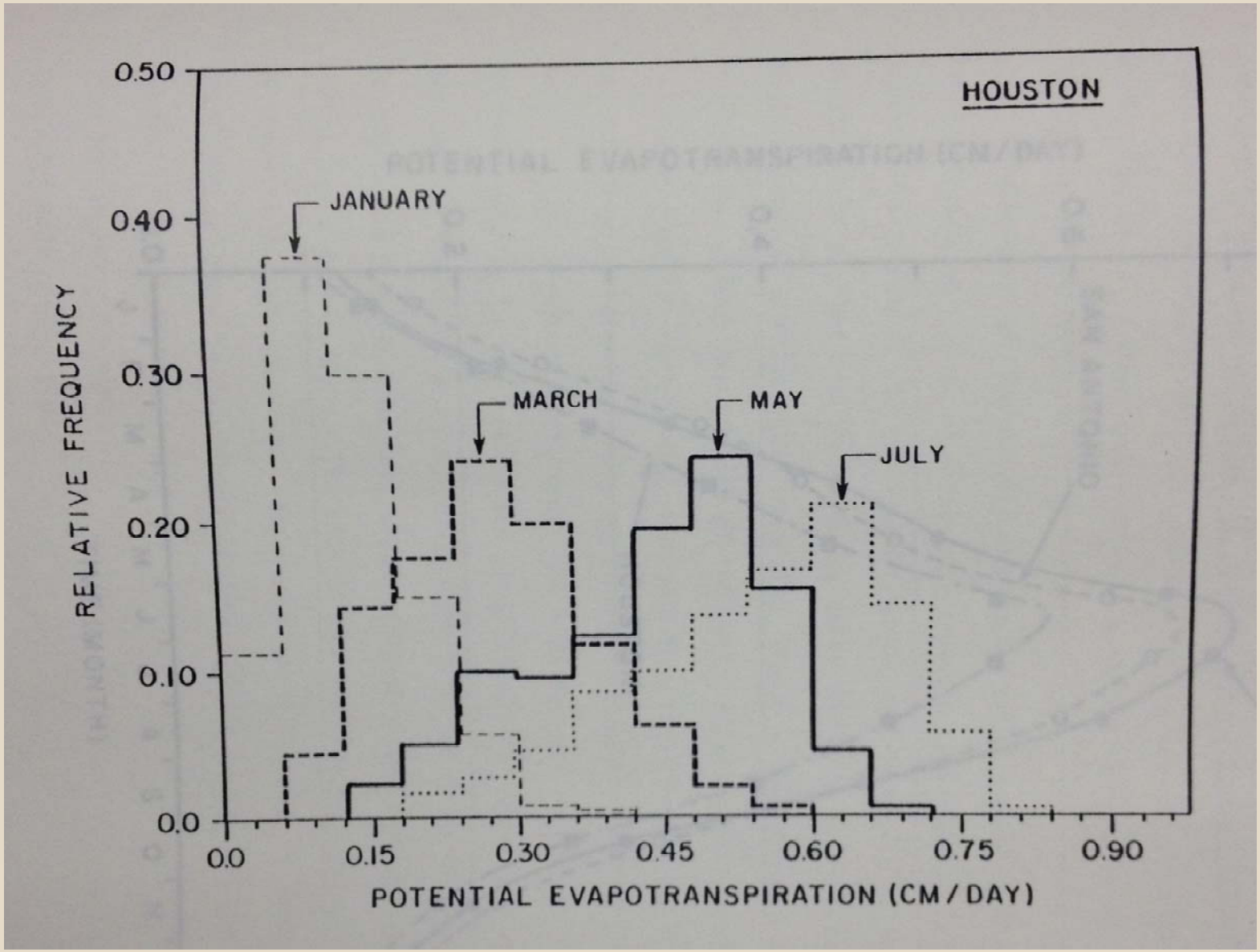


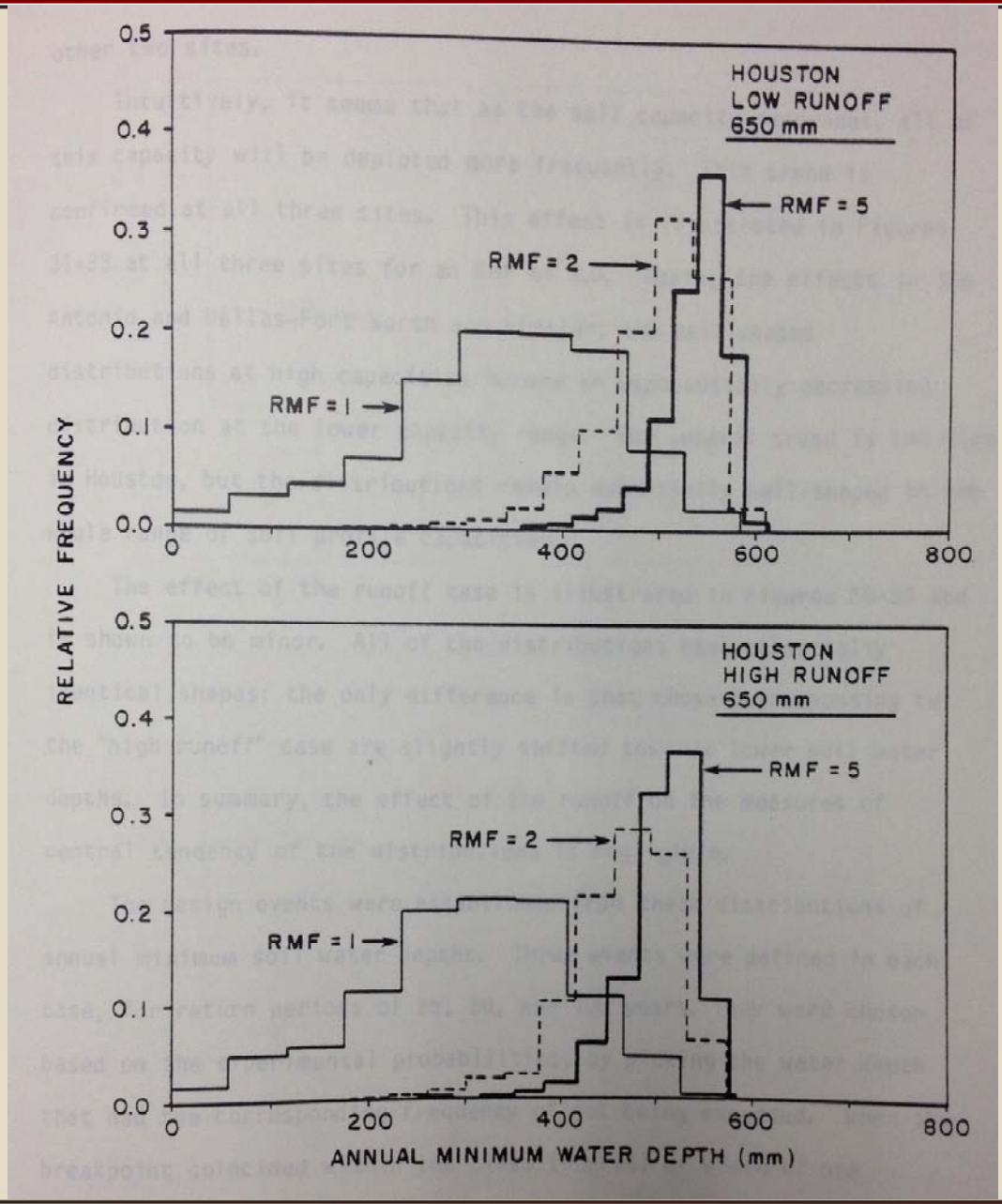
$$U(Z) = U_e \pm U_0 \exp\left(-\sqrt{\frac{n\pi}{\alpha}} Z\right)$$

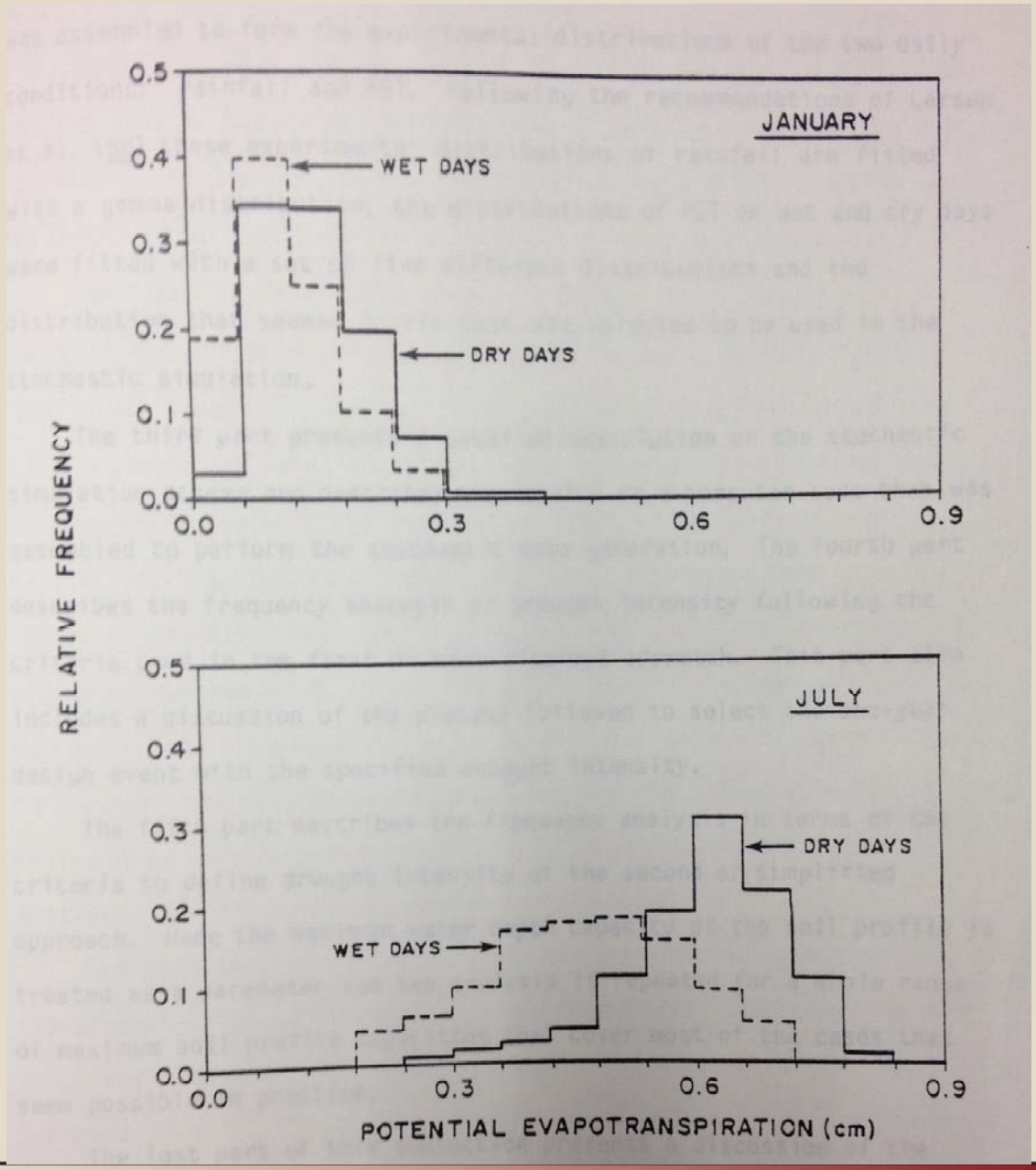
Suction Distribution with Depth

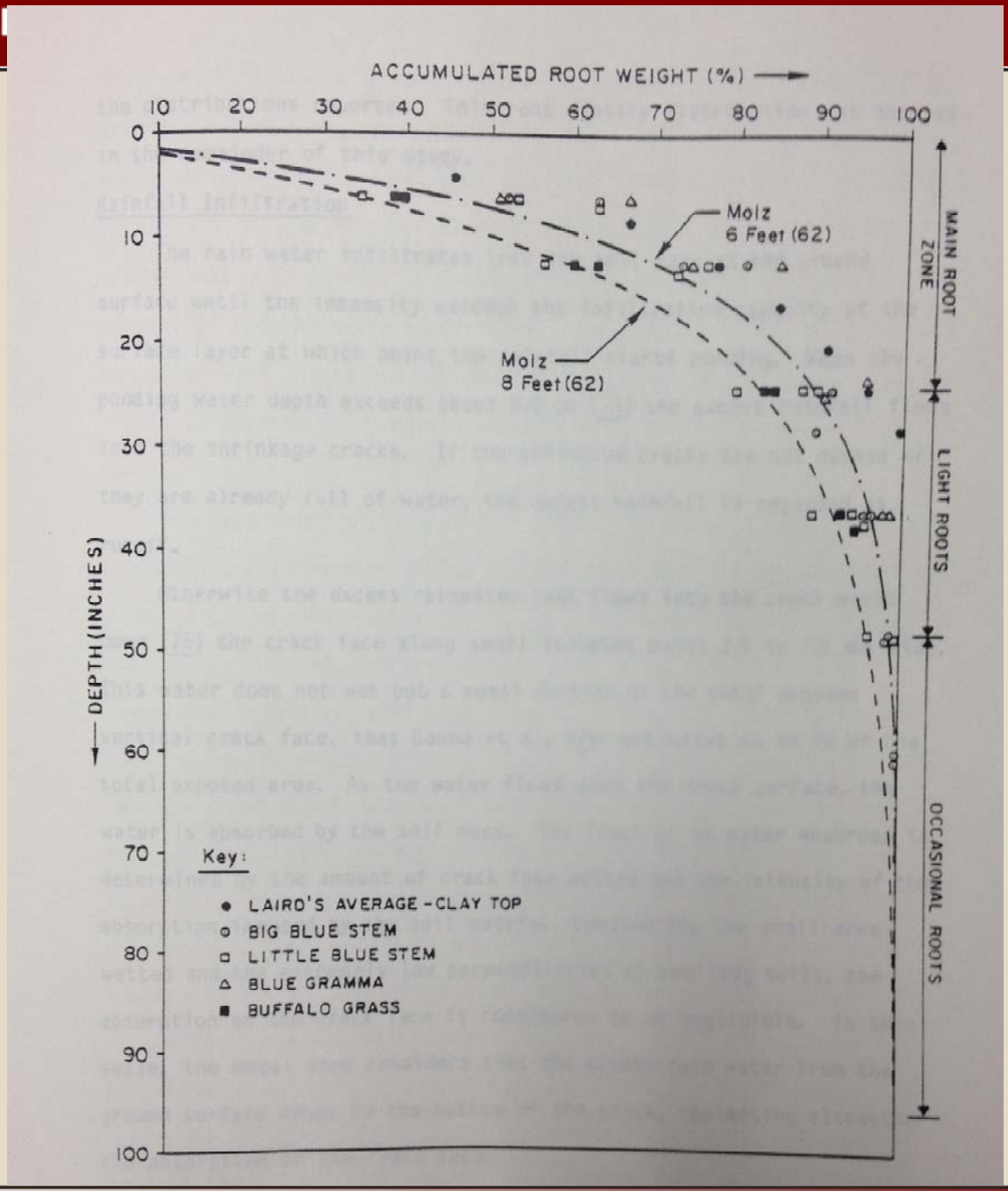



HOUSTON
"PET"
RAINFALL
RAINFALL OR EVAPORATION (CM / DAY)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
J F M A M J J A S O N D
TIME (MONTH)

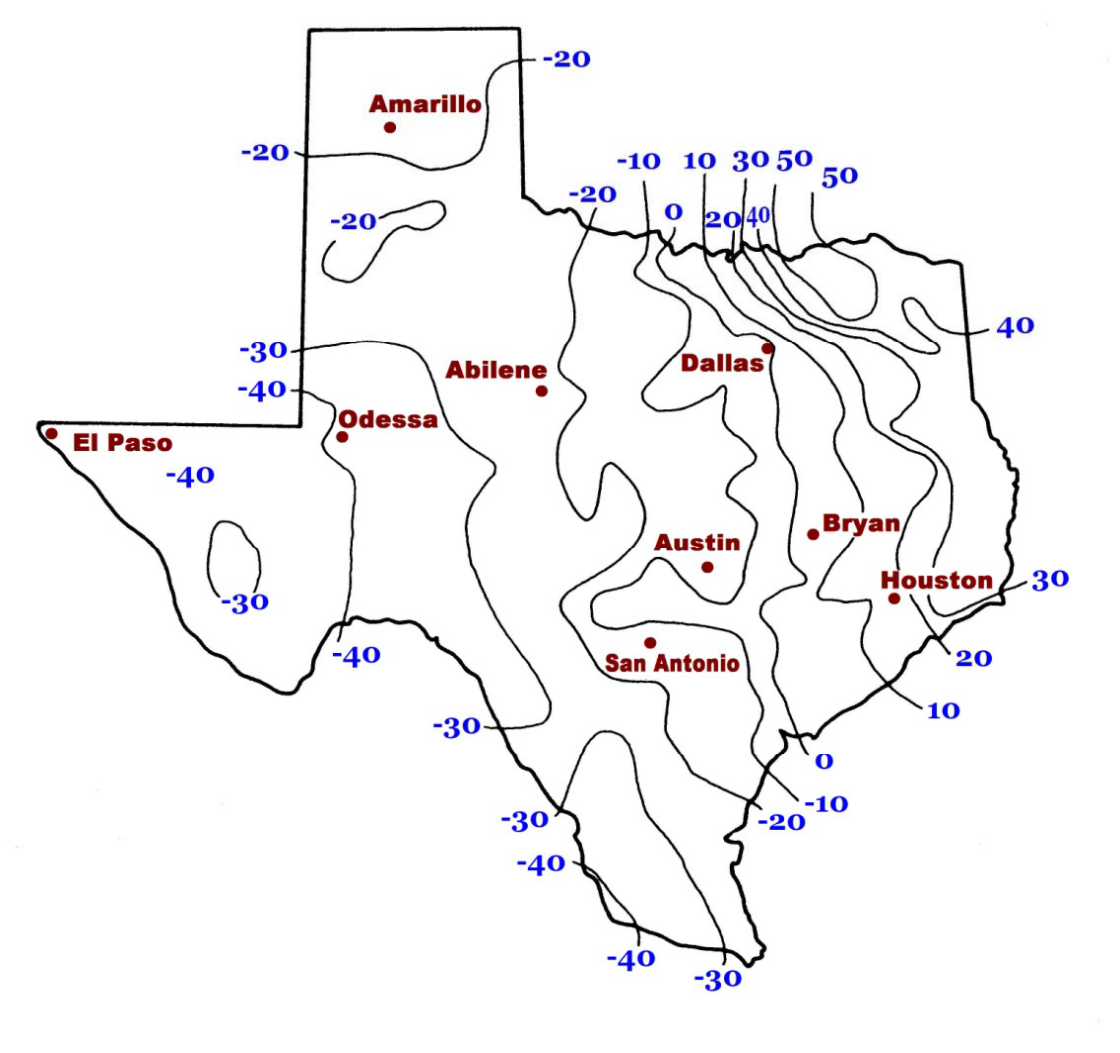

HOUSTON
JANUARY
MARCH
MAY
JULY
RELATIVE FREQUENCY
0.50
0.40
0.30
0.20
0.10
0.0
0.0
0.15
0.30
0.45
0.60
0.75
0.90
POTENTIAL EVAPOTRANSPIRATION (CM/DAY)


HOUSTON
LOW RUNOFF
650 mm
RMF = 5
RMF = 2
RMF = 1
HOUSTON
HIGH RUNOFF
650 mm
RMF = 5
RMF = 2
RMF = 1
RELATIVE FREQUENCY
0.0
0.1
0.2
0.3
0.4
0.5
0
200
400
600
800
ANNUAL MINIMUM WATER DEPTH (mm)


JANUARY
WET DAYS
DRY DAYS
0.5
0.4
0.3
0.2
0.1
0.0
0.0
0.3
0.6
0.9
JULY
DRY DAYS
WET DAYS
RELATIVE FREQUENCY
POTENTIAL EVAPOTRANSPIRATION (cm)


ACCUMULATED ROOT WEIGHT (%)
10
20
30
40
50
60
70
80
90
100
0
10
20
30
40
50
60
70
80
90
100
DEPTH (INCHES)
Molz
6 Feet (62)
Molz
8 Feet (62)
MAIN ROOT ZONE
LIGHT ROOTS
OCCASIONAL ROOTS
Key:
LAIRD'S AVERAGE - CLAY TOP
BIG BLUE STEM
LITTLE BLUE STEM
BLUE GRAMMA
BUFFALO GRASS

Thornthwaite Moisture Index (TMI, 1948)



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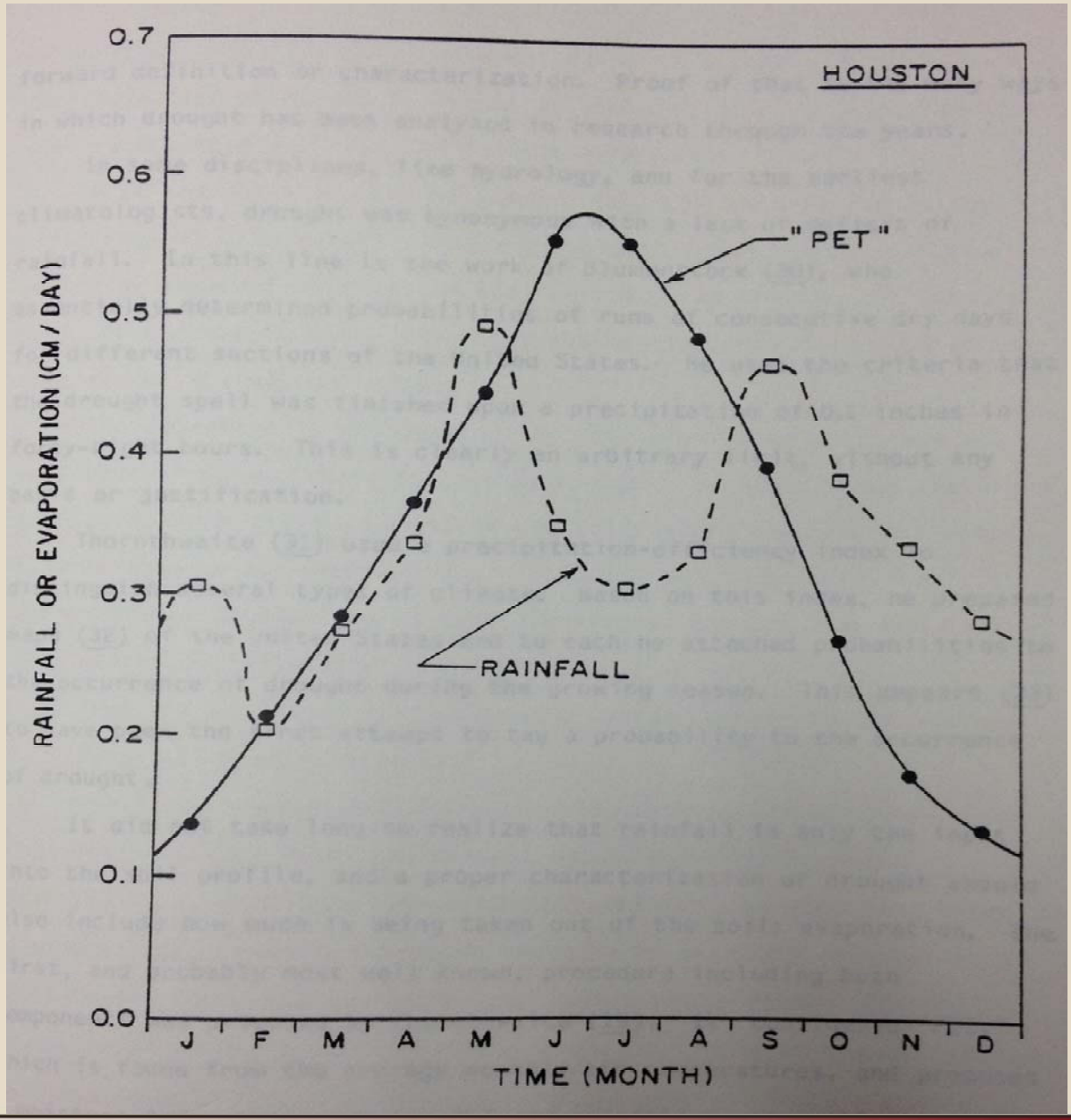
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"PET"
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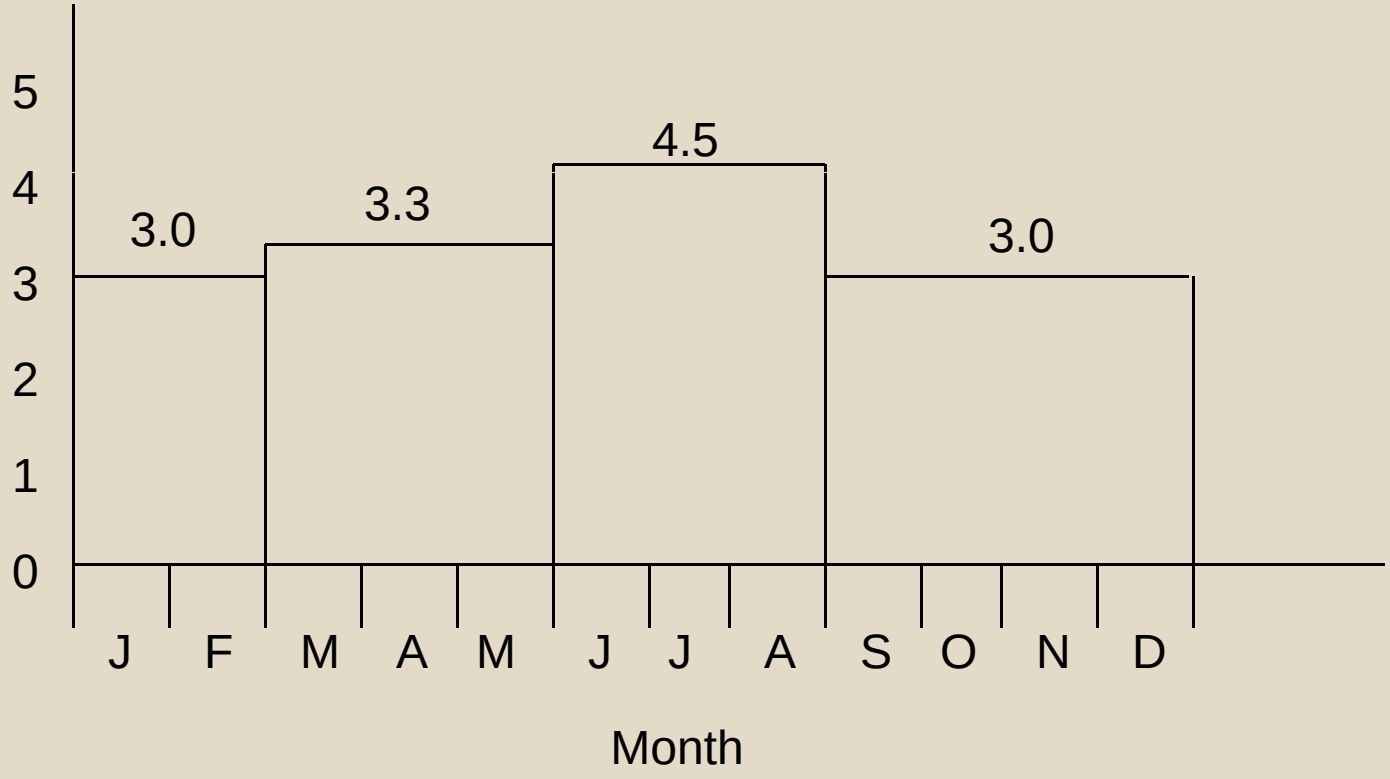
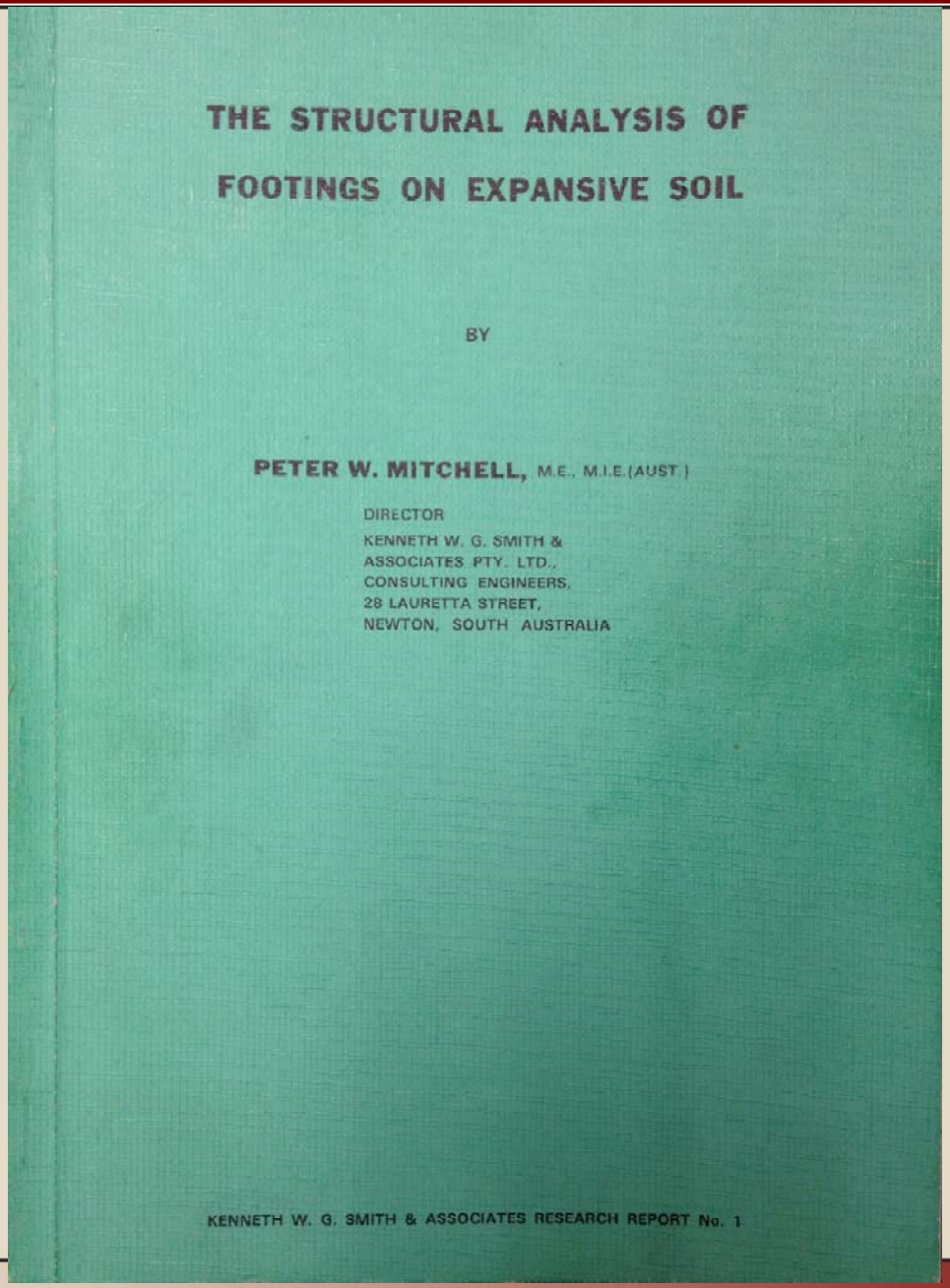
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
J F M A M J J A S O N D
TIME (MONTH)

Mean Surface Suction, pF





THE STRUCTURAL ANALYSIS OF FOOTINGS ON EXPANSIVE SOIL

BY

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KENNETH W. G. SMITH & ASSOCIATES RESEARCH REPORT No. 1

Surface suction variation with time

Suction variation with depth and time

are predicted with **Fourier Series**

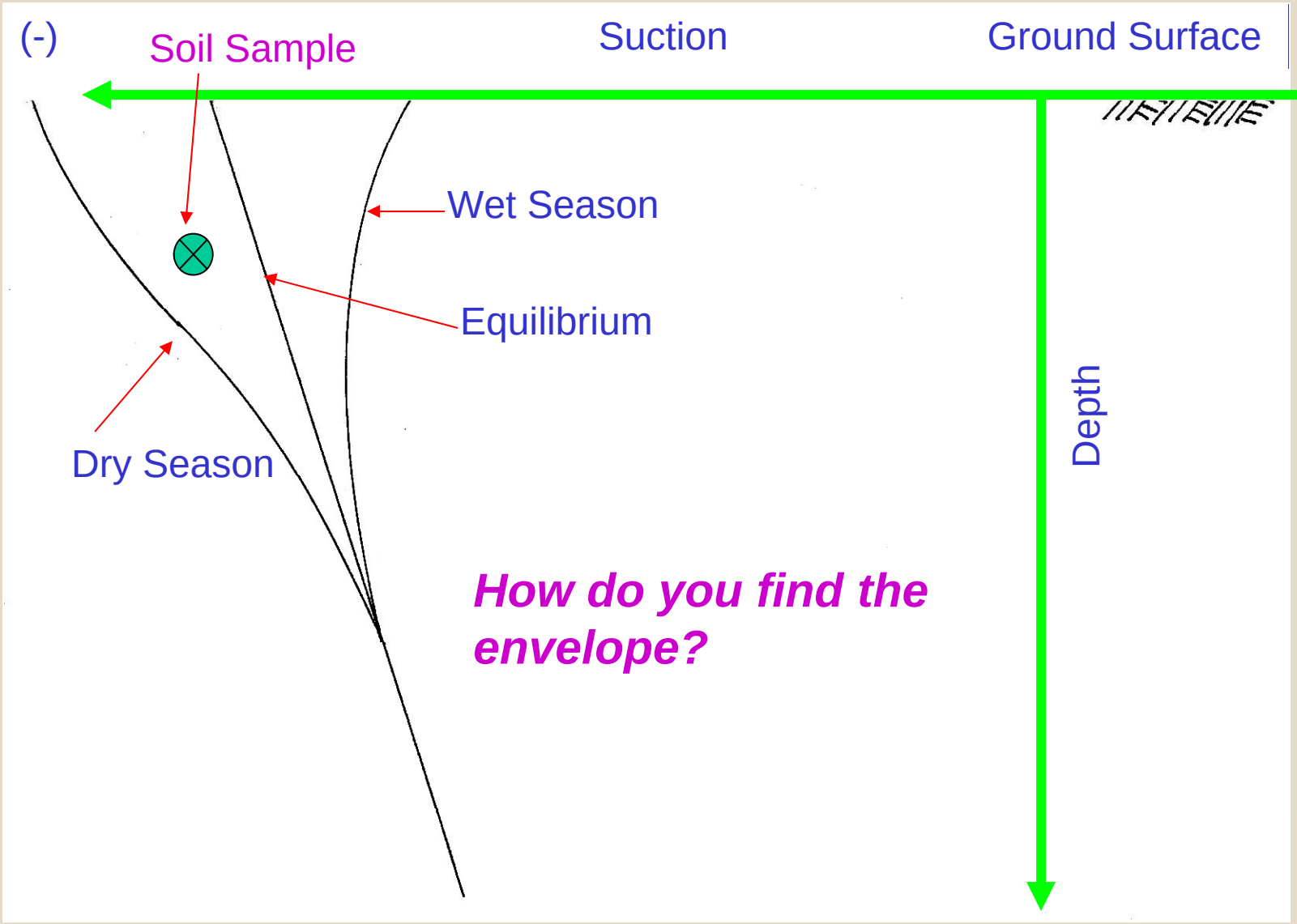
Suction envelopes are also predicted with

Fourier Series

Jean-Baptiste-Joseph Fourier
(1768-1830)

Demonstration of suction envelope spreadsheet

Suction Distribution with Depth



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