United States Department of Agriculture	**Natural Resources Conservation Service**	**c/o USDA Forest Service 11 Campus Boulevard Suite 200 Newtown Square, PA 19073** (610) 557-4233; FAX: (610) 557-4200

Subject: SOILS -- Geophysical Assistance

Date: 31 October 2002

To: Russell A. Collett
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PURPOSE:
Ground-penetrating radar (GPR) was used to determine the depths to bedrock and the composition (by soil depth class) of soil map units. In many areas of Maine, it is exceedingly difficult to examine soil profiles and determine the depth to bedrock with conventional soil survey tools. Rock fragments limit the depth of observation and our understanding of the depth to bedrock within many soil map units. GPR provides a continuous profile of the subsurface and can be effectively used to chart bedrock depths.

PARTICIPANTS:
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ACTIVITIES:
All field activities were completed during the period of 21 to 24 October 2002. GPR surveys were conducted in Penobscot, Hancock, and Washington counties.

STUDY AREAS:
Southern Penobscot County:
During this field visit, GPR was used to characterize the depths to bedrock within six soil map units in Penobscot County. The map units are: 34A, 55B, 136B, 332C, 417B, and 432C. Table 1 lists the names of these map units.

Table 1. Soil Map Units traversed with GPR

Symbol	Soil Map Unit Name
34A	Dixmont-Penobscot silt loams complex, 0 to 3 percent slopes.
55B	Corinna-Penobscot silt loams complex, 3 to 8 percent slopes.
136B	Penobscot-Bangor' silt loams complex, 3 to 8 percent slopes
332C	Plaisted-Howland-Penquis association, 3-15 percent slopes, very stony.
417B	Dixmont-Penobscot-Corinna complex, 1 to 8 percent slopes, very stony.
32C	Penobscot-Bangor’ silt loam, 3 to 15 percent slopes, very stony.

Four potentially new soil series have been recognized in Penobscot County. These potential soil series include Bangor', Corinna, Dixmont', and Penobscot. Bangor' soil is deep and well drained. Corinna soil is shallow and somewhat excessively drained. Dixmont' soil is deep, moderately well drained. Penobscot soil is moderately deep and well drained. These soils contain para rock fragments and are underlain by soft bedrock. Tables 2 lists the soil series recognized in the names of the soil map units that were profiled with GPR in Penobscot County.

Table 2. Soil Series Profiled with GPR in Penobscot County, Maine

Series	Taxonomic Classification
Bangor	Coarse-loamy, mixed, semiactive, frigid, Typic Eutrudepts♦
Corinna	Coarse-loamy, mixed, active, frigid, Lithic Dystrudepts♦
Dixmont	Coarse-loamy, mixed, active, Frigid, Oxyaquic Eutrudepts♦
Howland	Coarse-loamy, isotic, frigid Aquic Haplorthods
Penobscot	Coarse-loamy, mixed, semiactive, frigid, Typic Eutrudepts♦
Penquis	Coarse-loamy, isotic, frigid Typic Haplorthods
Plaisted	Coarse-loamy, isotic, frigid Oxyaquic Haplorthods

Northern Hancock and Washington Counties

Multiple transect were conducted in areas of map units 48C, Dixfield-Colonel-Tunbridge association, 3 to 15 percent slopes; 48D, Marlow-Tunbridge-Dixfield associations, 12 to 30 percent slopes; Colton-Adams association, 5 to 15 percent slopes; Colonel-Brayton-Dixfield association, 1 to 15 percent slopes; and Monadnock-Berkshire-Tunbridge association, 5 to 16 percent slopes. Table 3 lists the soil series recognized in the names of the soil map units that were profiled with GPR in Hancock and Washington counties.

Table 3. Soil Series Profiled with GPR in Northern Hancock and Washington Counties, Maine

Series	Taxonomic Classification
Adams	Sandy, isotic, frigid Typic Haplorthods
Berkshire	Coarse-loamy, isotic, frigid Typic Haplorthods
Brayton	Coarse-loamy, mixed, active, nonacid, frigid Aeric Epiaquepts
Colonel	Coarse-loamy, isotic, frigid, shallow Aquic Haplorthods
Colton	Sandy-skeletal, isotic, frigid Typic Haplorthods
Dixfield	Coarse-loamy, isotic, frigid Aquic Haplorthods
Marlow	Coarse-loamy, isotic, frigid Oxyaquic Haplorthods
Monadnock	Coarse-loamy over sandy or sandy-skeletal, isotic, frigid Typic Haplorthods
Tunbridge	Coarse-loamy, isotic, frigid Typic Haplorthods

EQUIPMENT:

The radar unit is the Subsurface Interface Radar (SIR) System-2000, manufactured by Geophysical Survey Systems, Inc. Morey (1974), Doolittle (1987), and Daniels (1996) have discussed the use and operation of GPR. The SIR System-2000 consists of a digital control unit (DC-2000) with keypad, VGA video screen, and connector panel. A 12-volt battery powers the system. This unit is backpack portable and, with an antenna, requires two people to operate. The 120 MHz and 200 MHz antennas were used in this study.

FIELD PROCEDURES:

Pulling the antenna by hand completed radar surveys. In Penobscot County, at the request of the soil survey project leader, transect were of varying lengths and cross the breadth of most map units.

♦ Tentative soil series.

Although, GPR provides a continuous profile of the subsurface, interpretations were restricted to observation points. For each transect, observation points were spaced at a uniform time interval of 10 sec. At each observation point, the radar operator impressed a dashed, vertical line on the radar profile. This line identified an observation point on the radar record. The distance between observation points ranged from about 10 to 12 meters.

Each radar traverse was stored as a separate file on a hard disc. Radar files were reviewed and the bedrock surface was identified. At each observation point, the depth to bedrock was interpreted from the radar profile. Calibration trials were performed to determine the velocity of propagation and the observation depth of the GPR.

DISCUSSION:

Calibration of GPR:

Ground-penetrating radar is a time scaled system. This system measures the time that it takes electromagnetic energy to travel from the antenna to an interface (e.g., bedrock, soil horizon, stratigraphic layer) and back. To convert the travel time into a depth scale, either the velocity of pulse propagation or the depth to a reflector must be known. The relationships among depth (D), two-way pulse travel time (T), and velocity of propagation (V) are described in the following equation (Morey, 1974):

$$V = 2D/T \qquad [1]$$

The velocity of propagation is principally affected by the dielectric permittivity (E) of the profiled material(s) according to the equation:

$$E = (C/V)^2 \qquad [2]$$

Where C is the velocity of propagation in a vacuum (0.298 m/ns). Velocity is expressed in meters per nanosecond (ns). A nanosecond is one billionth of a second. The amount and physical state of water (temperature dependent) have the greatest effect on the dielectric permittivity of a material.

The velocity of propagation and the depth scale were determined by comparing the interpreted depth to known reflector (buried metallic reflector) on the radar profile with the measured depth. Based on the measured depth and the two-way travel time to this interface, and equation [1], the velocity of propagation was estimated to be about 0.086 m/ns. The dielectric permittivity was 12. A scanning time of 60 ns was used in this investigation. Using equation [1], a scanning time of 60 ns, and a propagation velocity of 0.086 m/ns, the maximum depth of observation was 2.58 m.

During fieldwork in Penobscot County, the radar was dragged across three soil pits with known depths to bedrock. At these pits the maximum difference between measured and interpreted depths to bedrock was only 0.14 m. In Hancock County, the velocity of propagation was confirmed by pulling the antenna over a buried culvert of known depth.

Interpretation of radar profiles:

The soil/bedrock interface was identifiable and traceable on most radar profiles. The soil/bedrock interface was variable in expression. In some areas, this interface consisted of a smooth and continuous high amplitude reflector that is indicative of an abrupt and highly contrasting boundary. In other areas, the soil/bedrock interface consisted of numerous segmented reflectors of varying amplitudes that suggest a boundary consisting of both paralithic and lithic materials. In some areas, because of the abundance of similar rock-type fragments in the overlying soil, the often highly fractured bedrock surface, and the varying degree of hardness exhibited by both rock fragments and the underlying bedrock, the soil/bedrock interface was ambiguous.

In Washington County, radar traverses were conducted in areas of Monadnock-Berkshire-Tunbridge association, 5 to 16 percent slopes. This area was located to the northeast of Lead Mountain. Although numerous subsurface interfaces were evident on radar profiles, the soil/bedrock interface could not be distinguished with either the 120 or 200 MHz antennas. The site was underlain by the Bucksport formation, a lower Paleozoic original deposited as calcareous mudstone and sandstone that have been metamorphosed to schist. The upper boundary of this highly fractured and weakly calcareous bedrock could not be distinguished with GPR.

RESULTS:
Appendix 1 summarizes the interpreted depths to bedrock for each transect conducted in Penobscot County (files 4 to 43) and in Hancock and Washington counties (files 44 to 49). Depths are expressed in meters.

Table 4. Frequency distribution of Observations along Radar Transects according to Soil Depth Classes

MU	Obs	Bedrock	Shallow	Mod. Deep	Deep	Very Deep	Location
136B	19	0.00	0.00	0.00	0.47	0.53	Crane Sr.
136B	43	0.00	0.00	0.21	0.60	0.19	Crane Sr.
136B	11	0.00	0.00	0.36	0.64	0.00	Crane Sr.
136B	40	0.00	0.00	0.15	0.73	0.13	Crane Sr.
136B	27	0.00	0.15	0.56	0.29	0.00	Crane Sr.
136B	28	0.00	0.00	0.04	0.71	0.25	Crane Jr.
136B	16	0.00	0.00	0.06	0.88	0.06	Crane Jr.
136B	21	0.00	0.05	0.00	0.57	0.38	Crane Jr.
136B	44	0.00	0.00	0.04	0.48	0.48	Crane Jr.
136B	49	0.00	0.00	0.10	0.80	0.10	Crane Jr.
417B	42	0.00	0.00	0.67	0.33	0.00	Ledge Hill Rd
34A	21	0.00	0.00	0.00	0.71	0.29	Ledge Hill Rd
34A	20	0.00	0.05	0.15	0.80	0.00	Bean Mill Rd
34A	27	0.00	0.04	0.22	0.59	0.15	Bean Mill Rd
136B	24	0.00	0.00	0.00	0.00	1.00	Bean Mill Rd
136B	15	0.00	0.00	0.00	0.67	0.33	Bean Mill Rd
136B	15	0.00	0.00	0.00	0.00	1.00	Bean Mill Rd
136B	29	0.00	0.00	0.00	0.10	0.90	Bean Mill Rd
136B	21	0.00	0.00	0.00	0.14	0.86	Bean Mill Rd
136B	24	0.00	0.04	0.04	0.08	0.84	Bean Mill Rd
34A	35	0.00	0.03	0.20	0.66	0.11	Bean Mill Rd
34A	31	0.00	0.00	0.14	0.57	0.29	Bean Mill Rd
136B	26	0.00	0.00	0.15	0.54	0.31	Dorman
136B	25	0.00	0.00	0.32	0.52	0.16	Dorman
136B	30	0.00	0.07	0.30	0.57	0.07	Pike's Place
34A	22	0.00	0.00	0.27	0.59	0.14	Pike's Place
417B	30	0.03	0.17	0.20	0.30	0.30	SE Exter
432C	23	0.04	0.09	0.39	0.30	0.18	SE Exter
417B	46	0.06	0.18	0.45	0.27	0.04	S Exter
332C	45	0.05	0.44	0.31	0.18	0.02	S Exter
417B	39	0.00	0.05	0.23	0.41	0.31	Old Cold Bath Rd
55B	24	0.00	0.00	0.42	0.46	0.12	Perkin
55B	22	0.00	0.18	0.28	0.45	0.09	Perkin
34A	17	0.00	0.00	0.12	0.70	0.18	Exter H20
34A	10	0.00	0.10	0.70	0.20	0.00	Exter H20
136B	26	0.00	0.07	0.12	0.54	0.27	Dorman
136B	26	0.00	0.04	0.27	0.50	0.19	Dorman
55B	41	0.00	0.04	0.27	0.50	0.19	N Cider Hill Rd
55B	41	0.00	0.07	0.24	0.54	0.15	N Cider Hill Rd

Table 4 summarizes the frequency distribution of observations by soil depth classes (depth to bedrock) for each radar transect collected in Penobscot County. Table 5 summarizes the frequency distribution of observations by soil depth classes for each radar transect collected in areas of Dixfield-Colonel-Tunbridge association, 3 to 15 percent and 12 to 30 percent slopes, in Hancock and Washington counties. In each table, for each transect, a file number and the map unit symbol, as well as the total number of observations (Obs) has been provided. Depth classes are shallow (0 to .5 m), moderately deep (.5 to 1.0 m), deep (1.0 to 1.5 m) and very deep (>1.5 m). Where bedrock was exposed at the surface the observation depth was 0 and the depth class was "Bedrock."

In addition, in Hancock and Washington counties, multiple GPR transect were conducted in different map units to help impress map unit concepts and mapping techniques on new soil scientists. By comparing radar profiles with field observations, increased levels of confidence in mapping were obtained by these soil scientists. This procedure was carried out across the boundary of Colton-Adams association, 5 to 15 percent slopes, and Colonel-Brayton-Dixfield association, 1 to 8 percent slopes, in an attempt to characterize the transition from outwash to till deposits. On the radar profiles, this transition was broad and poorly defined. The till was water reworked; the outwash was dirty. As a consequence, no boundary was distinguishable on the radar profiles. This confirmed the observations of the soil scientist who completed the mapping. In another area, a GPR transect was run across a steep, north-facing slope of Dixfield-Colonel-Tunbridge association, 12 to 30 percent slopes. The soil scientist who map this area and I suspected a dominance of shallow and moderately deep soils on this slope. The soil project leader did not and wanted to convince the soil scientists that her mapping was correct. The radar profiled revealed that 78 percent of the transected area was underlain by soils that were deep and very deep to bedrock.

Table 5. Frequency distribution of Observations along Radar Transects according to Soil Depth Classes

MU	Obs	Bedrock	Shallow	Mod Deep	Deep	Very Deep
48C	34	0	0	12	79	9
48C	10	0	0	20	80	0
48C	42	0	10	40	43	7
48C	26	0	4	26	58	12
48C	44	0	0	39	43	18
48D	32	0	0	22	69	9

In Washington County, GPR traverses were also conducted across an area of Sebago and Waskish soils to determine the subsurface form of the peat/ mineral soil interface. Sebago is a member of the Dysic, frigid Fibric Haplohemists family. Waskish is a member of the Dysic, frigid Typic Sphagnofibrists family. The peat basin is remarkably pan shaped; the thickness of peat increased rapidly along the basin's boundary only to remained relatively uniform across most of the breath of the basin.

As always, it was my pleasure to work in Maine and with members of your fine staff.

With kind regards,

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Morey, R. M. 1974. Continuous subsurface profiling by impulse radar. p. 212-232. *IN:* Proceedings, ASCE Engineering Foundation Conference on Subsurface Exploration for Underground Excavations and Heavy Construction, held at Henniker, New Hampshire. Aug. 11-16, 1974.

Appendix 1.

Depth to bedrock (m) as interpreted from GPR records. File represent transect number and map unit.

File 4-136B

OBS	DEPTH
1	1.20
2	1.23
3	1.26
4	1.33
5	1.46
6	1.88
7	1.29
8	1.20
9	2.58
10	2.58
11	1.25
12	1.38
13	2.58
14	2.58
15	2.58
16	2.58
17	2.58
18	2.58
19	2.58

File 5-136B

OBS	DEPTH
1	1.25
2	1.30
3	1.33
4	1.63
5	1.82
6	1.77
7	0.97
8	1.57
9	1.21
10	1.22
11	1.63
12	1.12
13	1.08
14	1.25
15	1.20
16	0.95
17	1.12
18	1.16
19	0.85
20	0.82
21	0.93
22	1.02
23	1.04
24	1.25
25	1.13
26	1.36
27	1.54
28	0.95
29	1.50
30	1.01

File 5-136B

OBS	DEPTH
31	1.22
32	1.25
33	1.33
34	1.79
35	1.22
36	1.38
37	1.16
38	1.00
39	1.20
40	0.74
41	0.98
42	0.86
43	1.18

File 6-136B

OBS	DEPTH
1	1.08
2	0.83
3	0.89
4	1.23
5	1.25
6	1.29
7	1.44
8	0.68
9	1.40
10	1.13
11	0.95

File 7-136B

OBS	DEPTH
1	1.04
2	1.14
3	1.55
4	1.35
5	1.35
6	1.12
7	1.01
8	1.41
9	1.35
10	2.58
11	0.81
12	1.07
13	0.86
14	1.64
15	1.37
16	1.07
17	1.21
18	0.92
19	1.14
20	1.23
21	1.14
22	1.12

File 7-136B

OBS	DEPTH
23	1.17
24	1.45
25	2.13
26	1.27
27	1.32
28	1.34
29	1.18
30	1.32
31	0.98
32	1.06
33	0.72
34	1.01
35	0.98
36	1.18
37	1.28
38	1.57
39	1.34
40	1.04

File 8-136B

OBS	DEPTH
1	1.02
2	0.87
3	1.25
4	1.12
5	1.12
6	0.72
7	1.55
8	2.58
9	1.63
10	1.17
11	1.08
12	0.95
13	1.68
14	1.12
15	1.18
16	1.79
17	1.83
18	1.16
19	1.04
20	1.44
21	1.14
22	1.56
23	2.58
24	1.03
25	1.06
26	0.90
27	1.36

File 9-136B

OBS	DEPTH
1	1.74
2	1.72
3	1.01
4	1.58
5	2.58
6	1.26
7	1.42
8	1.48
9	1.40
10	2.03
11	1.45
12	1.35
13	1.04
14	1.20
15	1.40
16	1.25
17	1.13
18	1.13
19	1.04
20	1.14
21	1.27
22	1.51
23	1.60
24	1.27
25	0.85
26	1.14
27	1.29
28	1.22

File 10-136B

OBS	DEPTH
1	1.26
2	1.25
3	1.27
4	1.36
5	1.12
6	0.97
7	1.14
8	1.78
9	1.22
10	1.29
11	1.31
12	1.35
13	1.24
14	1.04
15	1.17
16	1.32

File 11-136B

OBS	DEPTH
1	1.14
2	1.22
3	2.47
4	2.58
5	1.29
6	1.15
7	1.25
8	1.51
9	1.37
10	1.12
11	1.00
12	1.30
13	0.47
14	1.65
15	1.78
16	1.32
17	1.33
18	1.56
19	1.56
20	2.58
21	1.29
22	1.26

File 12-136B

OBS	DEPTH
1	2.58
2	2.58
3	2.58
4	1.99
5	1.12
6	1.97
7	1.22
8	1.06
9	1.73
10	1.27
11	1.69
12	1.63
13	2.58
14	1.36
15	2.03
16	1.75
17	1.27
18	1.32
19	1.60
20	2.24
21	1.96
22	1.31
23	1.12
24	1.06
25	1.14
26	1.11
27	0.97
28	1.21
29	1.00
30	1.22
31	1.57
32	2.58

File 12-136B

OBS	DEPTH
33	2.05
34	1.56
35	0.98
36	1.51
37	1.63
38	2.26
39	1.17
40	1.14
41	1.13
42	1.12
43	1.20
44	1.11

File 13-136B

OBS	DEPTH
1	1.16
2	1.14
3	1.24
4	1.64
5	1.12
6	1.01
7	0.78
8	1.33
9	1.29
10	1.00
11	1.29
12	0.93
13	1.08
14	1.50
15	1.44
16	1.24
17	1.08
18	0.99
19	1.02
20	1.35
21	1.23
22	1.27
23	1.35
24	1.61
25	1.28
26	1.16
27	1.14
28	1.13
29	0.98
30	1.02
31	1.78
32	1.28
33	1.57
34	1.25
35	1.23
36	1.38
37	1.22
38	1.13
39	1.29
40	1.25
41	0.97

File 13-136B

OBS	DEPTH
42	1.29
43	1.21
44	1.24
45	1.46
46	1.27
47	1.05
48	1.00
49	1.96

File 14-417B

OBS	DEPTH
1	0.68
2	1.00
3	1.20
4	1.09
5	0.65
6	0.95
7	0.87
8	0.89
9	0.63
10	1.29
11	0.78
12	0.75
13	0.71
14	0.97
15	1.06
16	0.86
17	1.04
18	1.21
19	0.68
20	1.32
21	1.24
22	0.80
23	0.74
24	1.04
25	0.77
26	0.68
27	1.14
28	0.92
29	0.89
30	0.95
31	0.74
32	0.89
33	0.79
34	0.98
35	0.55
36	0.84
37	0.89
38	1.18
39	0.97
40	1.25
41	1.33
42	0.98
43	0.87

File 15-34A

OBS	DEPTH
1	1.69
2	1.29
3	1.08
4	1.26
5	1.45
6	1.61
7	1.19
8	1.40
9	1.14
10	1.09
11	1.51
12	1.29
13	1.69
14	2.18
15	1.18
16	1.94
17	1.27
18	1.33
19	1.36
20	1.22
21	1.18

File 16-34A

OBS	DEPTH
1	0.49
2	0.84
3	1.04
4	1.28
5	1.06
6	0.97
7	1.07
8	1.26
9	1.10
10	0.82
11	1.08
12	1.21
13	1.25
14	1.25
15	1.18
16	1.11
17	1.07
18	1.36
19	1.26
20	1.19
21	1.85

File 19-136B

OBS	DEPTH
1	1.37
2	1.42
3	1.61
4	2.58
5	1.17
6	1.14
7	1.24
8	1.57
9	1.52
10	1.12
11	1.11
12	1.60
13	1.19
14	1.29
15	1.40
16	1.34

File 20-136B

OBS	DEPTH
1	2.27
2	2.58
3	2.17
4	2.15
5	2.58
6	2.58
7	1.77
8	2.19
9	1.95
10	1.87
11	1.51
12	2.58
13	1.67
14	2.22
15	2.58

File 21-136B

OBS	DEPTH
1	2.01
2	1.65
3	1.51
4	1.54
5	1.86
6	1.63
7	1.41
8	2.33
9	2.33
10	2.00
11	2.58
12	2.14
13	2.12
14	2.58
15	2.34
16	2.07
17	2.49
18	1.49
19	2.58
20	2.58

File 21-136B

OBS	DEPTH
21	1.65
22	2.58
23	2.58
24	2.58
25	2.58
26	2.58
27	1.08
28	1.87
29	1.51

File 22-136B

OBS	DEPTH
1	1.77
2	1.34
3	1.82
4	1.60
5	1.43
6	1.56
7	1.72
8	1.32
9	1.72
10	1.57
11	1.76
12	2.58
13	2.58
14	1.56
15	2.58
16	2.58
17	2.58
18	2.58
19	2.58
20	2.58
21	2.58

File 23-136B

OBS	DEPTH
1	2.58
2	2.58
3	2.58
4	2.58
5	2.58
6	2.58
7	2.58
8	2.58
9	2.58
10	2.58
11	2.58
12	2.00
13	1.95
14	1.21
15	1.91
16	0.76
17	0.38
18	2.58
19	2.58
20	2.58
21	1.84

File 23-136B

OBS	DEPTH
22	1.80
23	2.58
24	1.29
25	0.29

File 24-34A

OBS	DEPTH
1	1.13
2	0.97
3	1.01
4	1.01
5	1.19
6	1.01
7	1.01
8	0.72
9	0.32
10	0.69
11	0.80
12	1.26
13	1.27
14	1.06
15	1.12
16	0.74
17	1.25
18	1.90
19	2.29
20	1.53
21	1.20
22	1.14
23	2.58
24	1.47
25	1.36
26	1.20
27	1.16
28	1.15
29	0.85
30	1.00
31	1.32
32	1.13
33	0.99
34	1.19
35	1.31

File 25-34A

OBS	DEPTH
1	0.66
2	0.76
3	1.40
4	1.50
5	0.95
6	1.24
7	1.17
8	1.29
9	1.13
10	1.17
11	1.33
12	1.96

File 25-34A

OBS	DEPTH
13	2.53
14	1.23
15	2.58
16	1.72
17	1.80
18	1.84
19	1.41
20	1.29
21	1.08

File 27-136B

OBS	DEPTH
1	2.22
2	1.32
3	2.05
4	1.67
5	1.46
6	1.37
7	0.99
8	1.42
9	1.01
10	0.91
11	0.95
12	1.23
13	1.95
14	1.10
15	1.67
16	1.29
17	1.23
18	1.18
19	1.08
20	1.24
21	0.89
22	1.06
23	1.22
24	2.58
25	2.58
26	2.58

File 28-136B

OBS	DEPTH
1	1.90
2	1.69
3	1.33
4	1.50
5	1.43
6	1.04
7	1.26
8	1.27
9	1.22
10	1.23
11	0.91
12	1.01
13	0.62
14	0.80
15	1.42
16	0.87
17	0.97
18	1.04
19	0.55
20	1.33
21	1.06
22	0.85
23	0.71
24	1.40
25	1.80

File 29-136B

OBS	DEPTH
1	1.26
2	1.08
3	1.27
4	1.48
5	1.28
6	1.35
7	1.26
8	1.06
9	1.56
10	1.12
11	1.16
12	1.10
13	0.62
14	0.92
15	1.06
16	1.15
17	0.93
18	0.93
19	0.99
20	1.03
21	1.26
22	0.87
23	0.61
24	1.08
25	1.55
26	1.06
27	0.65
28	0.42
29	0.44

File 29-136B

OBS	DEPTH
30	0.97

File 30-136B

OBS	DEPTH
1	0.71
2	2.01
3	1.17
4	0.87
5	0.95
6	1.18
7	1.38
8	1.28
9	1.23
10	1.38
11	1.08
12	0.86
13	1.17
14	2.58
15	1.29
16	0.78
17	0.78
18	1.22
19	1.20
20	1.45
21	1.49
22	1.78

File 31-417B

OBS	DEPTH
1	1.65
2	0.93
3	1.65
4	1.46
5	2.58
6	0.78
7	0.27
8	0.34
9	0.44
10	0.49
11	0.00
12	0.32
13	0.96
14	1.52
15	1.16
16	0.97
17	0.71
18	1.47
19	1.37
20	1.39
21	0.79
22	1.17
23	1.68
24	1.54
25	1.23
26	1.25
27	1.97
28	1.65

File 31-417B

OBS	DEPTH
29	1.47
30	1.99

File 32-432C

OBS	DEPTH
1	1.29
2	0.92
3	0.99
4	0.97
5	1.22
6	1.56
7	1.10
8	0.49
9	1.36
10	1.51
11	1.20
12	1.34
13	1.56
14	1.00
15	0.83
16	0.74
17	0.94
18	0.89
19	0.98
20	2.06
21	0.98
22	0.00
23	0.34

File 33-417B

OBS	DEPTH
1	0.20
2	0.17
3	0.00
4	0.48
5	0.98
6	1.14
7	1.04
8	0.62
9	0.63
10	0.84
11	0.65
12	0.60
13	1.01
14	0.40
15	0.59
16	1.54
17	0.85
18	0.72
19	0.50
20	1.04
21	0.51
22	0.49
23	0.70
24	0.40
25	0.89
26	0.46

File 33-417B

OBS	DEPTH
27	1.08
28	0.00
29	0.00
30	1.01
31	0.87
32	1.22
33	0.98
34	0.81
35	0.70
36	0.71
37	1.16
38	1.44
39	1.82
40	1.05
41	1.27
42	1.10
43	0.61
44	0.43
45	0.68
46	0.72
47	1.12
48	0.90
49	0.59

File 34-332C

OBS	DEPTH
1	0.80
2	1.08
3	1.01
4	1.14
5	0.40
6	0.58
7	1.18
8	0.74
9	0.74
10	1.17
11	0.67
12	0.16
13	0.28
14	1.28
15	0.00
16	0.15
17	0.50
18	0.58
19	0.37
20	0.52
21	0.73
22	1.80
23	0.76
24	0.21
25	0.58
26	0.66
27	1.05
28	0.35
29	1.47
30	0.20
31	0.22

File 34-332C

OBS	DEPTH
32	0.15
33	0.16
34	0.81
35	0.00
36	0.43
37	0.41
38	0.71
39	0.32
40	0.62
41	0.15
42	0.16
43	0.44
44	0.27
45	0.41

File 35-417B

OBS	DEPTH
1	0.87
2	1.12
3	1.04
4	1.55
5	1.47
6	0.66
7	1.30
8	1.12
9	1.20
10	0.95
11	0.96
12	1.13
13	1.69
14	1.31
15	1.13
16	0.98
17	1.84
18	2.58
19	0.60
20	0.34
21	1.21
22	2.22
23	1.59
24	2.09
25	2.10
26	1.21
27	0.92
28	0.46
29	2.58
30	0.95
31	1.38
32	0.85
33	1.31
34	1.72
35	1.96
36	1.55
37	1.30
38	1.38
39	1.44

File 36-55B

OBS	DEPTH
1	1.61
2	0.99
3	1.76
4	0.58
5	1.27
6	1.15
7	1.12
8	1.00
9	1.02
10	1.08
11	1.44
12	0.91
13	1.18
14	0.97
15	0.54
16	0.74
17	0.77
18	1.42
19	1.17
20	0.92
21	0.98
22	0.80
23	1.31
24	2.58

File 37-55B

OBS	DEPTH
1	1.81
2	1.04
3	1.54
4	0.61
5	0.27
6	0.83
7	0.87
8	1.39
9	1.17
10	0.25
11	1.06
12	1.26
13	0.60
14	1.14
15	0.69
16	1.14
17	1.16
18	0.86
19	0.42
20	0.45
21	1.02
22	1.13

File 38-34A

OBS	DEPTH
1	1.33
2	1.38
3	1.74
4	1.35
5	1.24

File 38-34A

OBS	DEPTH
6	2.58
7	1.14
8	0.76
9	0.96
10	1.90
11	1.41
12	1.36
13	1.05
14	1.18
15	1.04
16	1.13
17	1.41

File 39-34A

OBS	DEPTH
1	0.75
2	0.85
3	0.95
4	0.93
5	0.98
6	0.76
7	0.39
8	0.74
9	1.17
10	1.23

File 40-136B

OBS	DEPTH
1	1.60
2	2.14
3	1.29
4	1.54
5	1.73
6	1.51
7	1.44
8	1.47
9	1.22
10	1.40
11	2.58
12	1.17
13	1.33
14	0.89
15	1.33
16	1.60
17	1.34
18	1.32
19	1.07
20	1.12
21	1.02
22	0.49
23	0.66
24	0.85
25	0.43
26	1.36

File 41-136B

OBS	DEPTH
1	1.92
2	0.74
3	0.82
4	1.08
5	1.37
6	0.74
7	0.81
8	1.07
9	1.59
10	0.46
11	1.32
12	1.43
13	1.56
14	1.25
15	0.89
16	1.22
17	1.17
18	1.04
19	1.73
20	1.49
21	1.83
22	1.17
23	0.88
24	0.92
25	1.08
26	1.41

File 42-55B

OBS	DEPTH
1	2.58
2	0.97
3	1.17
4	1.11
5	0.46
6	0.30
7	0.70
8	0.76
9	0.39
10	0.49
11	0.95
12	0.91
13	0.53
14	0.36
15	0.69
16	0.86
17	0.96
18	0.86
19	0.89
20	0.70
21	0.39
22	0.86
23	0.93
24	0.72
25	1.21
26	0.89
27	1.11
28	1.18

File 42-55B

OBS	DEPTH
29	2.17
30	1.16
31	1.02
32	0.96
33	1.16
34	2.16
35	2.00
36	2.58
37	1.16
38	1.44
39	1.24
40	1.50
41	1.39
42	1.24

File 43-55B

OBS	DEPTH
1	1.33
2	1.12
3	1.23
4	0.97
5	1.38
6	1.12
7	1.35
8	1.07
9	0.98
10	1.25
11	1.33
12	0.71
13	1.26
14	1.26
15	0.66
16	1.52
17	2.58
18	2.58
19	1.27
20	0.25
21	1.54
22	1.07
23	0.74
24	1.08
25	1.21
26	1.00
27	0.56
28	1.19
29	1.90
30	0.42
31	1.02
32	0.48
33	0.74
34	0.74
35	0.55
36	1.11
37	2.03
38	0.51
39	1.18
40	1.31

File 43-55B

OBS	DEPTH
41	1.42

File 44-48C

OBS	DEPTH
1	1.21
2	0.97
3	1.23
4	0.98
5	1.23
6	1.29
7	1.84
8	1.24
9	1.32
10	1.32
11	1.50
12	1.37
13	1.27
14	1.39
15	1.44
16	1.35
17	1.43
18	1.52
19	1.49
20	1.35
21	1.22
22	1.55
23	0.98
24	1.37
25	0.90
26	1.31
27	1.37
28	1.32
29	1.23
30	1.13
31	1.21
32	1.41
33	1.41
34	1.43

File 45-48C

OBS	DEPTH
1	1.30
2	1.13
3	1.48
4	1.35
5	0.98
6	1.21
7	1.24
8	0.98
9	1.13
10	1.07

File 46-48C

OBS	DEPTH
1	2.00
2	2.02
3	1.70
4	1.81
5	1.62
6	1.29
7	0.82

File 46-48C

OBS	DEPTH
8	0.63
9	0.79
10	1.43
11	1.78
12	1.02
13	0.72
14	0.48
15	0.37
16	0.41
17	0.46
18	1.11
19	0.94
20	0.84
21	1.82
22	1.67
23	1.94
24	1.56
25	0.76
26	1.50
27	1.67
28	1.36
29	1.26
30	1.58
31	1.12
32	0.81
33	0.69
34	1.08
35	1.26
36	1.00
37	0.82
38	0.64
39	0.72
40	0.77
41	1.29
42	0.99
43	0.85
44	1.08
45	1.14
46	1.03
47	1.46
48	1.23
49	0.79
50	1.07
51	1.25
52	1.61

File 47-48C

OBS	DEPTH
1	1.37
2	1.43
3	1.37
4	1.10
5	0.66
6	1.17
7	1.31
8	1.75
9	1.04

File 47-48C

OBS	DEPTH
10	0.91
11	1.10
12	1.12
13	1.51
14	1.23
15	0.73
16	1.77
17	0.49
18	1.04
19	1.10
20	1.17
21	0.81
22	0.62
23	1.11
24	0.92
25	1.15
26	0.83

File 48-48C

OBS	DEPTH
1	0.79
2	0.52
3	0.92
4	0.66
5	0.88
6	0.80
7	1.01
8	0.93
9	0.83
10	1.01
11	1.17
12	0.90
13	0.95
14	1.23
15	1.19
16	1.28
17	0.71
18	1.21
19	1.31
20	1.60
21	0.76
22	0.86
23	1.28
24	1.15
25	1.44
26	0.77
27	0.91
28	1.72
29	1.20
30	1.25
31	0.89
32	1.23
33	1.62
34	1.46
35	1.29
36	1.67
37	1.09

File 48-48C

OBS	DEPTH
38	1.63
39	0.90
40	1.09
41	1.69
42	1.54
43	1.18
44	2.12

File 49-48D

OBS	DEPTH
1	0.83
2	0.85
3	1.32
4	1.27
5	1.12
6	0.96
7	1.12
8	0.78
9	1.11
10	1.24
11	1.15
12	1.19
13	1.39
14	1.20
15	1.40
16	1.33
17	1.28
18	1.21
19	1.58
20	1.55
21	1.08
22	1.31
23	1.54
24	1.23
25	0.97
26	1.22
27	1.02
28	1.03
29	1.41
30	0.98
31	0.90
32	1.05