BW - ______27______

SUBSIDENCE MONITORING REPORTS

DATE:

SONARWIRE, INC.

P.O. BOX 576
ABITA SPRINGS, LA 70420
Office: 985-893-9221
Toll Free: 888-211-6037
Fax: 985-893-4798
Email: sean@sonarwire.com

Survey conducted by: Brent Grubbs

MESQUITE SWD
CARLSBAD, NM
DUNAWAY NO. #2
JANUARY 19, 2010
SONAR THROUGH PIPE SURVEY

Survey from 1170 ft. to 1205 ft.
7 inch cemented casing at 1208 ft.
Zero sonar tool at B.H.F.
Site personnel: Mr. Clay Wilson

SONARWIRE INC.
Depth versus Volume

MESQUITE SWD, INC
DUNAWAY NO. 1

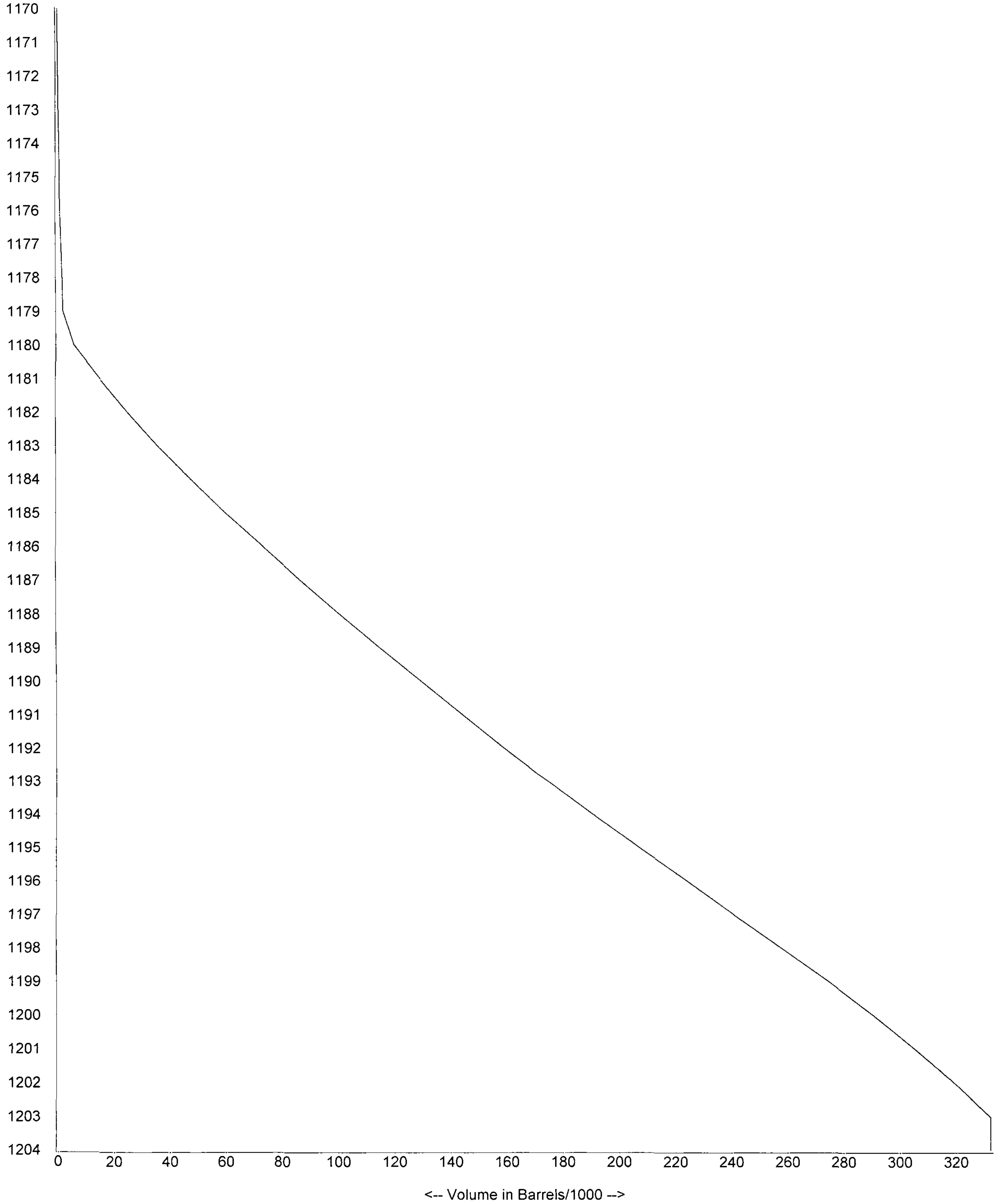
CARLSBAD, NM
Tue, Jan 19, 2010

Depth	Cubic ft. per ft.	Cubic ft. total	Barrels per ft.	Barrels total
1171	1.7	1.7	0.3	0.3
1172	408.4	410.1	72.7	73.0
1173	695.5	1105.5	123.9	196.9
1174	872.5	1978.1	155.4	352.3
1175	1023.5	3001.6	182.3	534.6
1176	1301.9	4303.4	231.9	766.5
1177	1372.0	5675.4	244.4	1010.8
1178	1624.4	7299.8	289.3	1300.2
1179	1710.0	9009.8	304.6	1604.7
1180	1824.0	10833.8	324.9	1929.6
1181	21334.2	32168.0	3799.8	5729.4
1182	52608.6	84776.6	9370.0	15099.4
1183	55125.2	139901.8	9818.2	24917.6
1184	59836.6	199738.4	10657.4	35575.0
1185	66705.9	266444.3	11880.8	47455.8
1186	68930.0	335374.3	12277.0	59732.8
1187	75448.0	410822.4	13437.9	73170.6
1188	74168.7	484991.1	13210.0	86380.7
1189	78499.7	563490.8	13981.4	100362.1
1190	81665.4	645156.2	14545.2	114907.3
1191	82520.4	727676.6	14697.5	129604.8
1192	82658.5	810335.1	14722.1	144326.9
1193	83272.0	893607.1	14831.4	159158.3
1194	87536.4	981143.4	15590.9	174749.2
1195	89500.1	1070643.6	15940.7	190689.9
1196	92979.0	1163622.6	16560.3	207250.2
1197	95517.3	1259139.8	17012.4	224262.5
1198	93511.6	1352651.4	16655.1	240917.7
1199	95138.1	1447789.5	16944.8	257862.5
1200	95925.5	1543715.0	17085.1	274947.5
1201	88759.7	1632474.7	15808.8	290756.3
1202	83350.8	1715825.5	14845.4	305601.8
1203	78274.1	1794099.7	13941.2	319543.0
1204	72775.3	1866874.9	12961.8	332504.8

MESQUITE SWD, INC
DUNAWAY NO. 1

SONARWIRE, INC
Depth -vs- Volume

CARLSBAD, NM
Tue, Jan 19, 2010



SONARWIRE INC.
Max Radius & Depth vs Bearing

MESQUITE SWD, INC
DUNAWAY NO. 1

CARLSBAD, NM
Tue, Jan 19, 2010

This table lists the maximum radius (in feet) found at each of the 128 bearings at which soundings were taken. Also listed after each radius, (separated by ':'), is the depth (in feet) at which that maximum radius was found. Bearings are shown, (in degrees), for each row of four 'radius : depth' pairs.

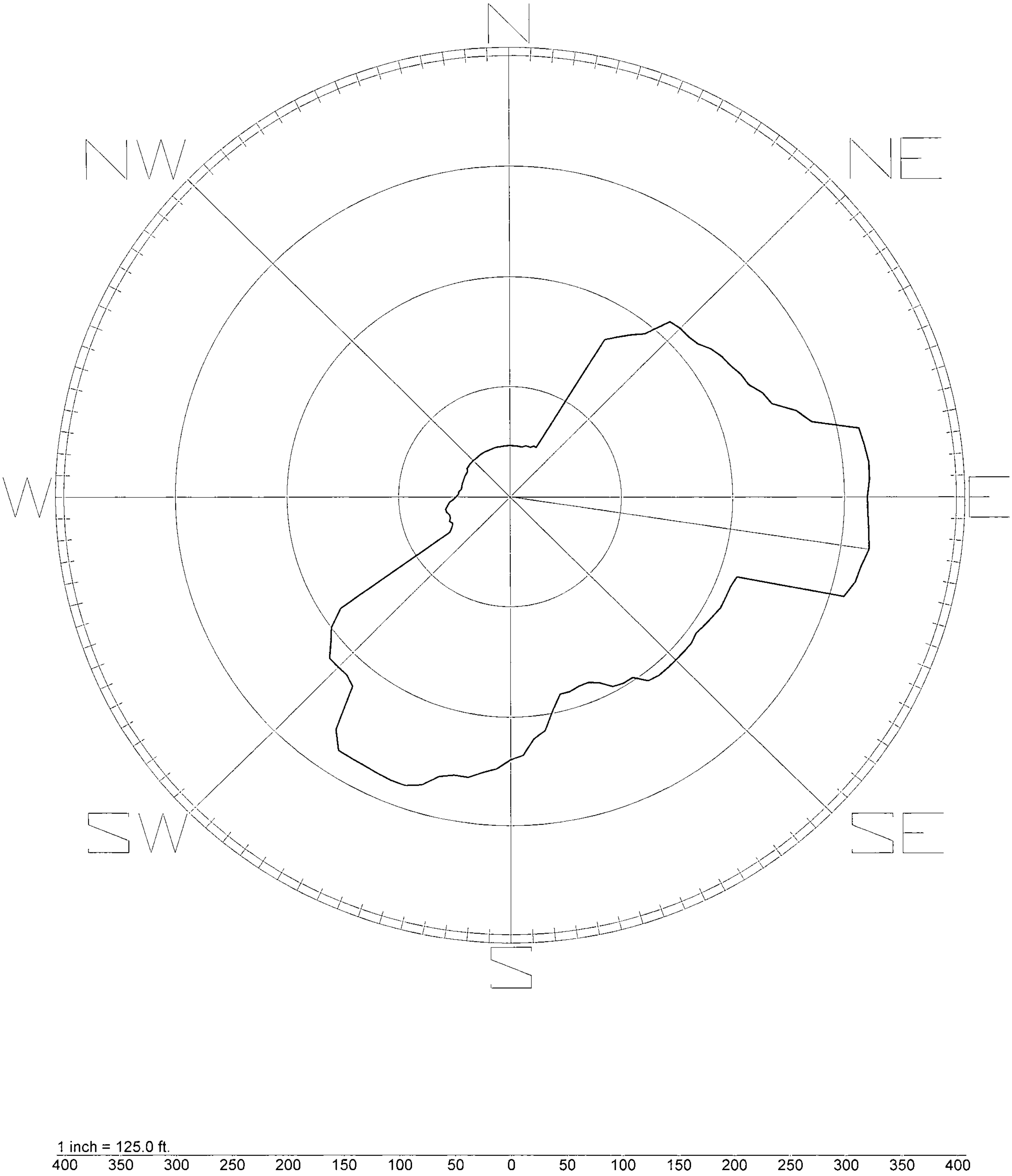
Bearing	+0.0	+2.8	+5.6	+8.4
0.0	46.4: 1201	46.4: 1201	46.4: 1201	46.4: 1201
11.3	46.4: 1201	46.4: 1201	48.3: 1204	48.5: 1201
22.5	48.5: 1201	50.6: 1201	50.6: 1201	166.0: 1195
33.8	174.4: 1195	182.8: 1195	191.2: 1195	214.3: 1199
45.0	216.4: 1199	216.4: 1198	218.5: 1194	224.8: 1197
56.3	229.0: 1197	231.1: 1194	235.3: 1194	237.4: 1193
67.5	245.8: 1193	250.0: 1194	268.9: 1197	279.4: 1198
78.8	319.3: 1197	321.4: 1199	323.5: 1194	322.8: 1201
90.0	320.7: 1201	321.4: 1188	323.5: 1189	325.6: 1184
101.3	321.4: 1190	319.3: 1190	313.0: 1186	216.4: 1197
112.5	214.3: 1197	214.3: 1197	214.3: 1197	212.2: 1197
123.8	210.1: 1197	208.0: 1198	210.1: 1199	210.1: 1198
135.0	210.1: 1197	210.1: 1197	210.1: 1198	208.0: 1198
146.3	197.5: 1182	197.5: 1182	195.4: 1182	187.0: 1182
157.5	182.8: 1182	182.8: 1198	184.9: 1198	184.9: 1198
168.8	197.5: 1199	214.3: 1199	220.6: 1199	235.3: 1196
180.0	239.5: 1196	247.9: 1199	252.1: 1199	258.4: 1199
191.3	258.4: 1199	262.6: 1199	274.3: 1201	279.4: 1198
202.5	279.4: 1198	278.5: 1201	277.3: 1186	277.3: 1187
213.8	277.3: 1184	262.6: 1188	222.7: 1196	218.5: 1198
225.0	218.5: 1199	218.5: 1199	208.0: 1199	199.6: 1199
236.3	182.8: 1198	63.0: 1202	59.1: 1201	57.0: 1201
247.5	58.8: 1204	56.7: 1204	56.7: 1204	58.8: 1204
258.8	58.8: 1204	56.7: 1204	54.6: 1204	50.4: 1204
270.0	48.3: 1204	46.2: 1204	46.2: 1204	44.1: 1199
281.3	44.1: 1199	44.3: 1201	44.3: 1201	44.3: 1201
292.5	44.3: 1201	44.3: 1201	44.3: 1201	44.3: 1201
303.8	46.2: 1199	46.2: 1199	46.4: 1201	46.4: 1201
315.0	46.4: 1201	46.2: 1199	46.2: 1199	46.2: 1199
326.3	46.4: 1201	46.4: 1201	46.4: 1201	46.2: 1199
337.5	46.2: 1199	46.2: 1199	46.4: 1201	46.4: 1201
348.8	46.2: 1199	46.2: 1202	46.4: 1201	46.4: 1201

Between 1170 and 1204 foot depths, maximum radius was 325.6 feet at bearing 98.4 at 1184.0 foot depth

MESQUITE SWD, INC
CARLSBAD, NM
DUNAWAY NO. 1

SONARWIRE, INC
Max Range vs Bearing

Max Radius=325.6 ft @ 98.4 deg
Depth= 1184 ft. Tue, Jan 19, 2010



SONARWIRE INC.
Average Wall Range versus Depth (ft.)

MESQUITE SWD, INC
DUNAWAY NO. 1

CARLSBAD, NM
Tue, Jan 19, 2010

Depth	Avg Rad ft.	Min Rad ft @ Az	Max Rad ft @ Az	Min Dia ft @ Az	Max Dia ft @ Az
1170	1	1 @ 180.1	1 @ 0.1	2 @ 0.1-180.1	2 @ 0.1-180.1
1171	12	7 @ 233.5	16 @ 213.8	16 @ 56.3-236.3	28 @ 0.1-180.1
1172	15	13 @ 25.4	19 @ 202.6	27 @ 64.7-244.7	33 @ 160.4-340.4
1173	17	15 @ 50.7	19 @ 199.7	31 @ 115.4-295.4	37 @ 19.7-199.7
1174	18	16 @ 95.7	23 @ 227.9	33 @ 95.7-275.7	40 @ 8.5-188.5
1175	21	17 @ 47.9	24 @ 211.0	39 @ 78.8-258.8	45 @ 151.9-331.9
1176	21	18 @ 11.3	26 @ 199.7	39 @ 95.7-275.7	44 @ 0.1-180.1
1177	23	20 @ 50.7	27 @ 180.1	43 @ 98.5-278.5	50 @ 0.1-180.1
1178	24	21 @ 78.8	29 @ 354.4	42 @ 78.8-258.8	56 @ 174.4-354.4
1179	24	22 @ 121.0	30 @ 180.1	44 @ 129.4-309.4	57 @ 171.6-351.6
1180	53	24 @ 222.2	248 @ 216.6	49 @ 76.0-256.0	278 @ 36.6-216.6
1181	97	24 @ 230.7	248 @ 90.0	51 @ 50.7-230.7	276 @ 36.6-216.6
1182	101	26 @ 115.4	250 @ 90.0	55 @ 45.0-225.1	280 @ 90.0-270.1
1184	109	28 @ 250.4	326 @ 98.5	66 @ 45.0-225.1	356 @ 98.5-278.5
1186	120	30 @ 244.7	320 @ 95.7	72 @ 36.6-216.6	351 @ 95.7-275.7
1187	120	30 @ 250.4	316 @ 92.9	74 @ 36.6-216.6	351 @ 98.5-278.5
1188	125	34 @ 250.4	322 @ 92.9	85 @ 42.2-222.2	356 @ 92.9-272.9
1189	128	34 @ 261.6	324 @ 95.7	85 @ 42.2-222.2	362 @ 95.7-275.7
1190	131	40 @ 2.9	324 @ 98.5	89 @ 42.2-222.2	366 @ 98.5-278.5
1191	130	34 @ 253.2	323 @ 98.5	87 @ 42.2-222.2	359 @ 98.5-278.5
1192	131	34 @ 275.7	320 @ 90.0	179 @ 42.2-222.2	356 @ 90.0-270.1
1193	134	24 @ 289.7	322 @ 84.4	204 @ 151.9-331.9	372 @ 45.0-225.1
1194	138	28 @ 272.9	324 @ 84.4	204 @ 149.1-329.1	410 @ 47.9-227.9
1195	143	36 @ 264.4	320 @ 81.6	204 @ 146.3-326.3	427 @ 31.0-211.0
1196	146	34 @ 247.6	322 @ 84.4	206 @ 146.3-326.3	421 @ 31.0-211.0
1197	143	34 @ 241.9	320 @ 78.8	206 @ 146.3-326.3	421 @ 50.7-230.7
1198	145	32 @ 0.1	320 @ 78.8	211 @ 149.1-329.1	429 @ 45.0-225.1
1199	148	32 @ 250.4	322 @ 81.6	213 @ 146.3-326.3	435 @ 45.0-225.1
1201	136	43 @ 261.6	323 @ 84.4	209 @ 146.3-326.3	387 @ 45.0-225.1
1202	133	43 @ 264.4	320 @ 84.4	208 @ 146.3-326.3	362 @ 81.6-261.6
1203	129	43 @ 0.1	316 @ 87.2	202 @ 149.1-329.1	364 @ 87.2-267.2
1204	128	40 @ 323.5	274 @ 84.4	200 @ 151.9-331.9	358 @ 36.6-216.6

SONARWIRE INC.
Wall Ranges versus Depth (ft.)

MESQUITE SWD, INC
DUNAWAY NO. 1

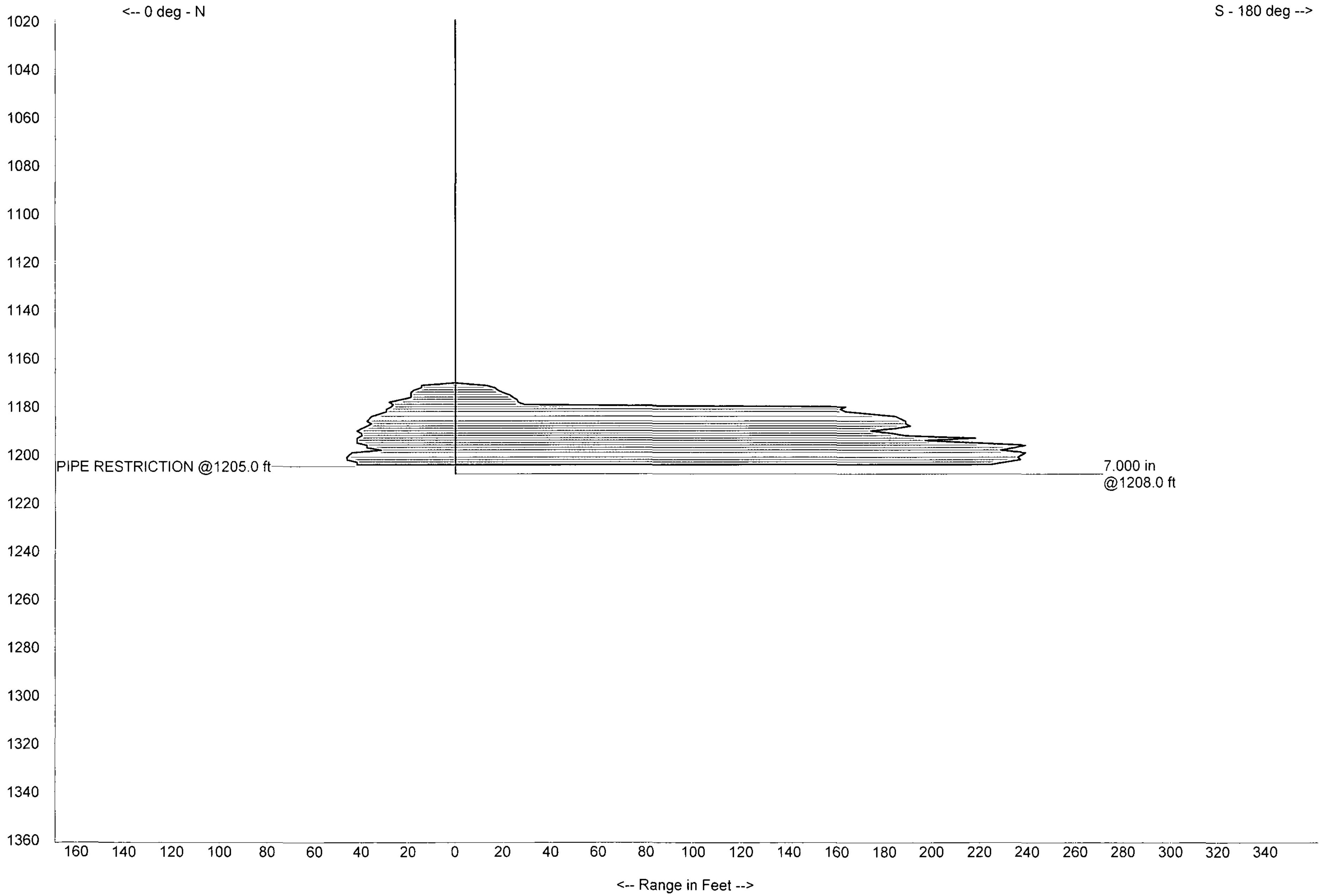
CARLSBAD, NM
Tue, Jan 19, 2010

Depth	Tilt	N	NE	E	SE	S	SW	W	NW
1170	0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
1171	0	14.3	9.7	9.2	11.3	13.4	8.4	8.0	13.9
1172	0	14.3	12.6	13.9	15.1	16.8	16.0	13.4	16.0
1173	0	17.6	15.1	15.5	16.0	18.1	18.5	16.8	15.5
1174	0	18.9	17.2	16.8	17.2	20.2	21.8	16.8	16.8
1175	0	18.9	17.2	18.1	20.6	23.1	23.5	20.2	19.3
1176	0	18.9	17.6	19.3	20.6	24.4	24.4	19.3	20.6
1177	0	23.1	20.2	19.7	21.4	26.0	25.2	22.7	21.8
1178	0	28.1	21.8	20.2	21.4	26.5	21.8	21.8	21.8
1179	0	26.5	22.3	22.7	21.8	29.4	23.1	23.5	22.7
1180	0	27.3	29.4	23.1	25.2	163.9	23.1	25.2	29.4
1181	0	29.4	29.4	247.9	168.1	161.8	25.2	23.1	31.5
1182	0	29.4	27.3	250.0	187.0	163.9	27.3	29.4	31.5
1184	0	35.7	35.7	306.7	197.5	184.9	29.4	29.4	37.8
1186	0	37.8	37.8	302.5	197.5	189.1	37.8	29.4	35.7
1187	0	35.7	39.9	306.7	199.6	189.1	37.8	31.5	35.7
1188	0	37.8	46.2	319.3	203.8	191.2	42.0	33.6	37.8
1189	0	39.9	44.1	319.3	201.7	184.9	44.1	33.6	37.8
1190	0	42.0	134.4	315.1	195.4	174.4	46.2	42.0	42.0
1191	0	40.1	139.2	318.6	192.0	183.5	46.4	33.8	42.2
1192	0	39.9	142.9	319.3	195.4	189.1	46.2	35.7	42.0
1193	0	42.0	180.7	317.2	195.4	218.5	191.2	37.8	35.7
1194	0	42.0	201.7	319.3	184.9	197.5	205.9	29.4	35.7
1195	0	42.0	205.9	315.1	195.4	218.5	210.1	35.7	35.7
1196	0	37.8	205.9	313.0	201.7	239.5	212.2	44.1	37.8
1197	0	37.8	203.8	310.9	210.1	235.3	210.1	33.6	33.6
1198	0	31.5	212.2	317.2	210.1	229.0	216.4	35.7	37.8
1199	0	44.1	216.4	317.2	208.0	239.5	218.5	44.1	46.2
1201	0	46.4	170.9	320.7	204.6	236.3	215.2	42.2	46.4
1202	0	46.2	161.8	317.2	189.1	237.4	178.6	42.0	44.1
1203	0	42.0	159.7	266.8	176.5	231.1	184.9	46.2	44.1
1204	0	42.0	161.8	210.1	189.1	224.8	193.3	48.3	42.0

MESQUITE SWD, INC
DUNAWAY NO. 1

SONARWIRE, INC
Vertical Cross Section

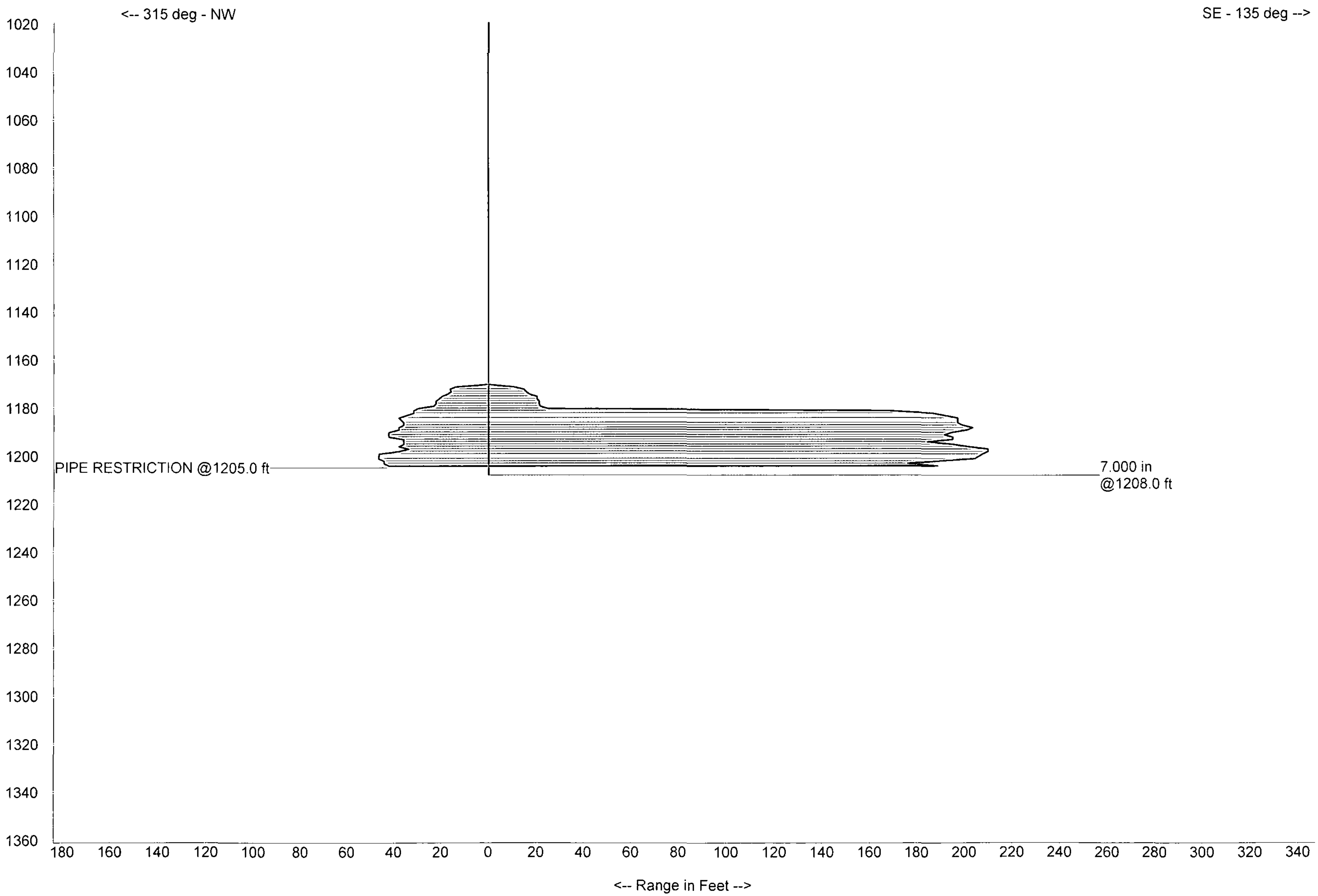
CARLSBAD, NM
Tue, Jan 19, 2010



MESQUITE SWD, INC
DUNAWAY NO. 1

SONARWIRE, INC
Vertical Cross Section

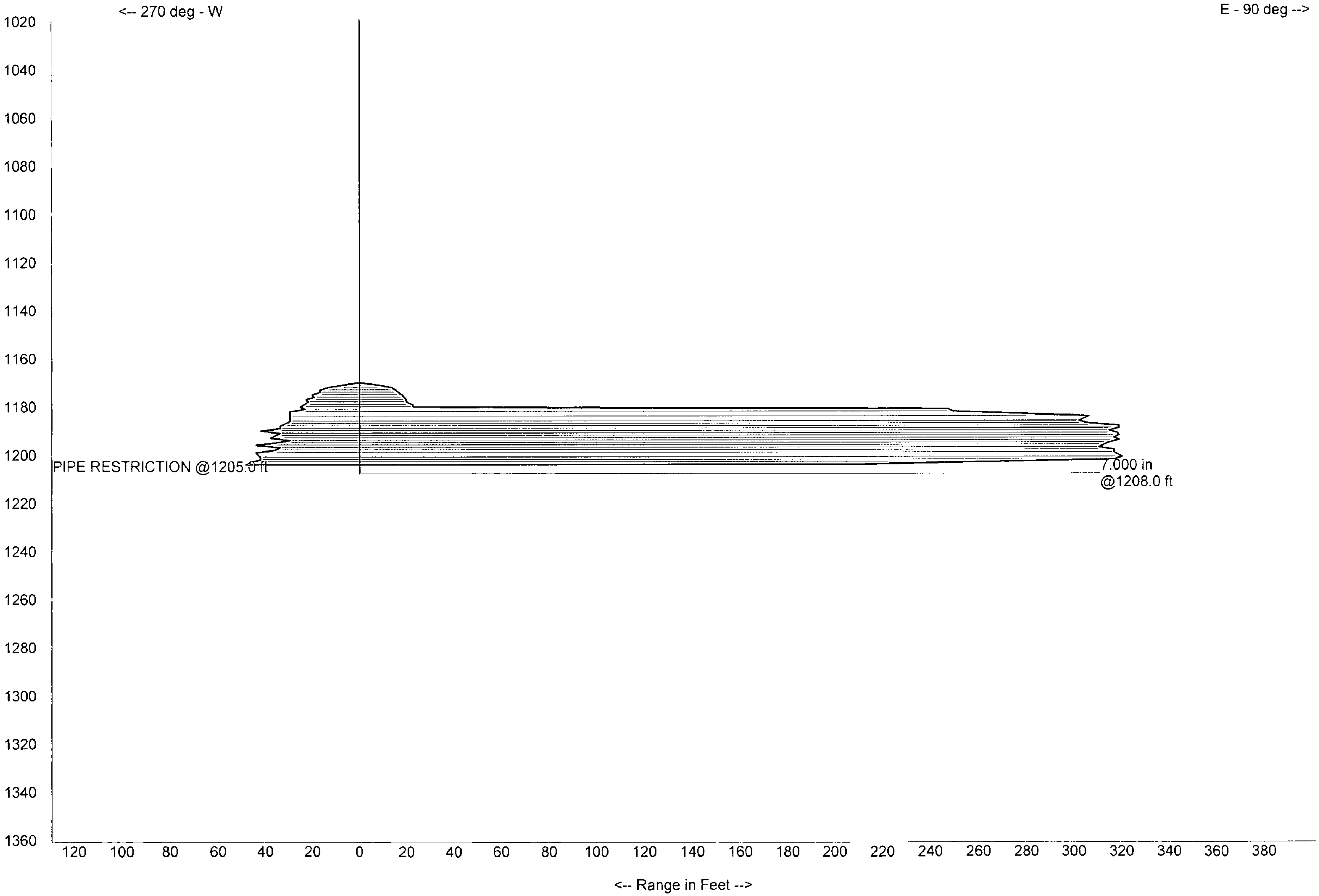
CARLSBAD, NM
Tue, Jan 19, 2010



MESQUITE SWD, INC
DUNAWAY NO. 1

SONARWIRE, INC
Vertical Cross Section

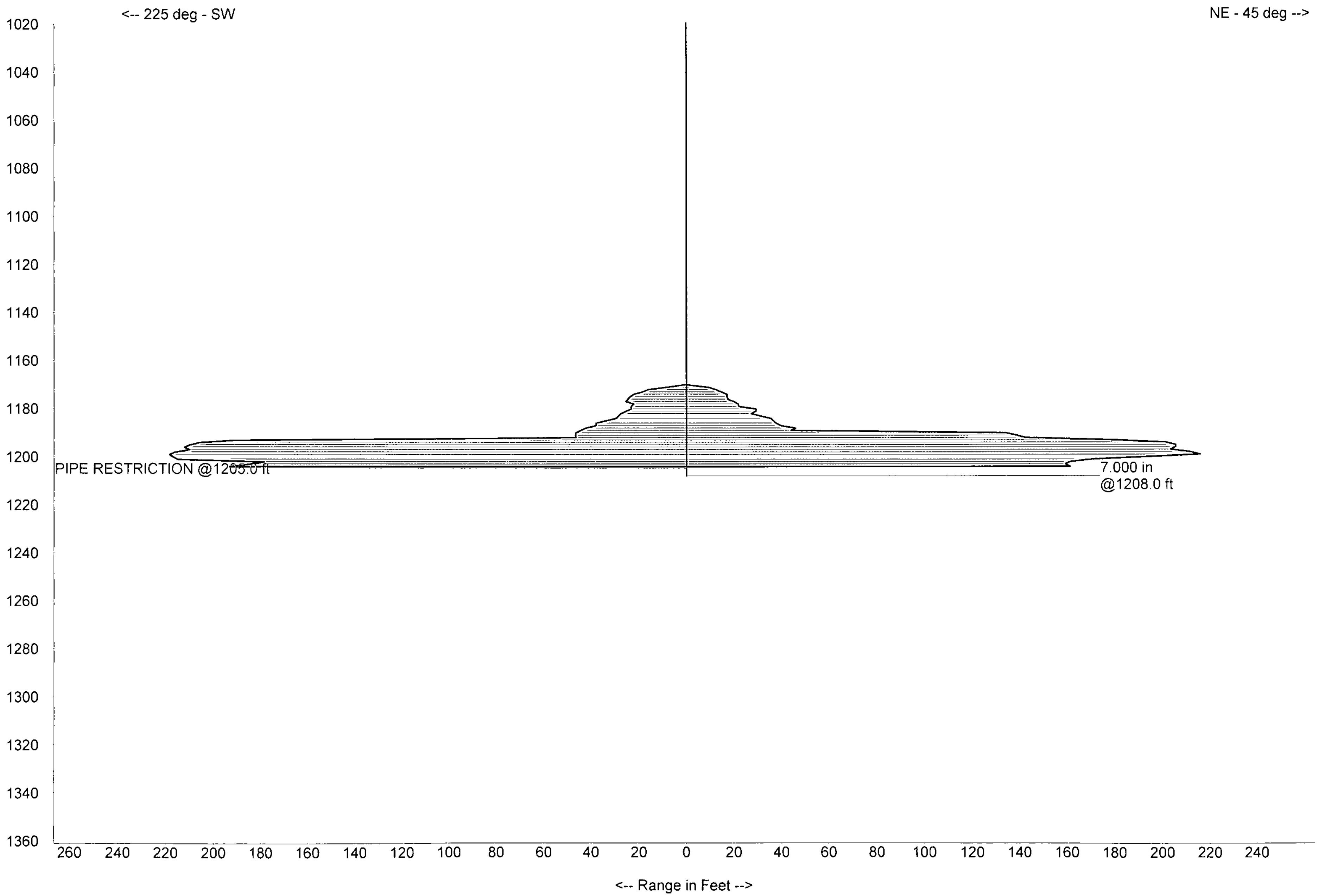
CARLSBAD, NM
Tue, Jan 19, 2010



MESQUITE SWD, INC
DUNAWAY NO. 1

SONARWIRE, INC
Vertical Cross Section

CARLSBAD, NM
Tue, Jan 19, 2010



3D SHADE PLOT

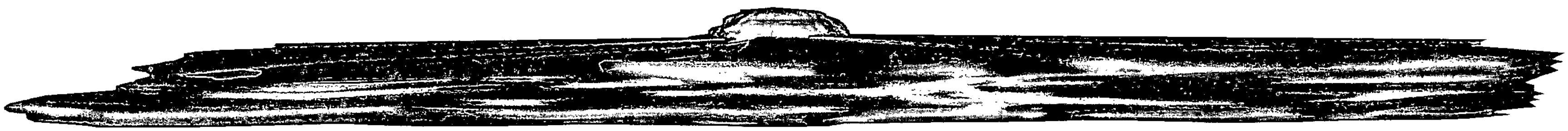
MESQUITE SWD, INC.
CARLSBAD, NM
DUNAWAY NO. 1
JANUARY 19, 2010

VIEWING AZIMUTH: 45
AXIS TILT: -2 DEGS

3D SHADE PLOT

MESQUITE SWD, INC.
CARLSBAD, NM
DUNAWAY NO. 1
JANUARY 19, 2010

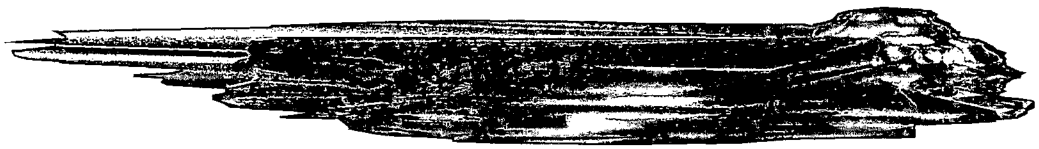
VIEWING AZIMUTH: 135
AXIS TILT: -2 DEGS



MESQUITE SWD, INC.
CARLSBAD, NM
DUNAWAY NO. 1
JANUARY 19, 2010

3D SHADE PLOT

VIEWING AZIMUTH: 225
AXIS TILT: -2 DEGS



3D SHADE PLOT

MESQUITE SWD, INC.
CARLSBAD, NM
DUNAWAY NO. 1
JANUARY 19, 2010

VIEWING AZIMUTH: 315
AXIS TILT: -2 DEGS

SONARWIRE INC.
Wall Ranges versus Depth (ft.)

MESQUITE SWD, INC
DUNAWAY NO. 1

CARLSBAD, NM
Tue, Jan 19, 2010

DEPTH: 1170 TILT: 0 RANGE: 24.9 VOS: 5953

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
22.5	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
45.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
67.5	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
90.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
112.5	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
135.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
157.5	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
180.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
202.5	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
225.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
247.5	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
270.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
292.5	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
315.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
337.5	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7

DEPTH: 1171 TILT: 0 RANGE: 99.6 VOS: 5953

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	14.3	13.9	13.9	13.4	13.0	13.0	13.0	12.6
22.5	12.2	11.8	11.3	10.9	10.5	10.5	10.1	10.1
45.0	9.7	9.7	9.7	9.7	9.2	9.2	9.2	9.2
67.5	9.2	8.8	8.8	8.8	8.8	8.8	8.8	9.2
90.0	9.2	9.2	9.7	9.7	9.7	9.7	9.7	10.1
112.5	10.1	10.1	10.5	10.9	10.9	11.3	11.3	11.3
135.0	11.3	11.3	11.3	11.3	11.3	11.8	11.8	12.2
157.5	12.2	12.6	12.6	12.6	12.6	13.0	13.0	13.4
180.0	13.4	13.4	13.4	13.9	13.9	13.9	14.3	14.3
202.5	14.3	14.7	15.1	15.1	15.5	15.5	9.7	9.2
225.0	8.4	7.6	7.6	6.7	6.7	6.7	7.1	7.1
247.5	7.1	7.1	7.1	7.1	7.1	7.1	7.6	7.6
270.0	8.0	8.0	8.4	8.4	8.4	8.8	8.8	8.8
292.5	9.2	9.7	10.1	10.5	11.3	11.8	12.2	13.4
315.0	13.9	13.9	14.3	14.3	14.7	14.7	14.7	14.7
337.5	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.3

DEPTH: 1172 TILT: 0 RANGE: 99.5 VOS: 5958

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	14.3	13.9	13.9	13.9	13.4	13.0	13.0	12.6
22.5	12.6	12.2	12.2	12.2	12.2	12.2	12.2	12.2
45.0	12.6	12.6	13.0	13.0	13.0	13.4	13.4	13.0
67.5	13.4	13.4	13.4	13.4	13.9	13.9	13.9	13.9
90.0	13.9	13.9	14.3	14.3	14.3	14.3	14.3	14.3
112.5	14.7	14.7	14.7	14.7	14.7	15.1	15.1	15.1
135.0	15.1	15.1	15.1	15.1	15.5	15.5	15.5	16.0
157.5	16.0	16.4	16.4	16.4	16.4	16.4	16.4	16.8
180.0	16.8	16.8	17.2	17.6	17.6	17.6	18.1	18.1
202.5	18.5	18.5	18.5	18.5	18.5	18.1	17.2	16.4
225.0	16.0	15.5	15.1	14.7	14.3	13.9	13.4	13.4
247.5	13.0	13.0	13.0	13.0	13.0	13.0	13.4	13.4
270.0	13.4	13.4	13.9	13.9	13.9	13.9	14.3	14.3
292.5	14.3	14.7	14.7	15.1	15.1	15.5	15.5	16.0
315.0	16.0	16.4	16.4	16.0	16.0	16.0	16.0	16.0
337.5	16.0	16.0	15.5	15.5	15.1	14.7	14.7	14.3

DEPTH: 1173 TILT: 0 RANGE: 99.6 VOS: 5957

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	17.6	17.6	17.2	17.2	17.2	17.2	17.2	17.2
22.5	17.2	17.2	16.8	16.4	16.0	15.1	15.1	15.1
45.0	15.1	15.1	14.7	15.1	15.1	15.1	15.1	15.5
67.5	15.5	15.1	15.1	15.1	15.1	15.1	15.1	15.1
90.0	15.5	15.5	15.1	15.1	15.1	15.5	15.1	15.5
112.5	15.1	15.1	15.1	15.1	15.5	15.5	15.5	15.5
135.0	16.0	16.0	16.0	16.0	16.4	16.4	16.4	16.8
157.5	16.8	16.8	16.8	17.2	17.2	17.2	17.6	17.6
180.0	18.1	18.1	18.1	18.1	18.5	18.5	18.5	18.9
202.5	18.9	18.9	18.9	18.5	18.5	18.5	18.5	18.5
225.0	18.5	18.5	18.9	18.9	18.5	18.1	18.1	17.6
247.5	17.6	17.2	17.2	17.2	16.8	16.8	16.8	16.8
270.0	16.8	16.8	16.8	16.4	16.4	16.4	16.4	16.4
292.5	16.0	15.5	15.5	15.5	15.5	15.5	15.5	15.5
315.0	15.5	15.5	16.0	16.0	16.4	16.4	16.4	16.8
337.5	16.8	17.2	17.2	17.6	17.6	17.6	17.6	17.6

DEPTH: 1174 TILT: 0 RANGE: 99.5 VOS: 5958

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	18.9	18.9	18.5	18.5	18.1	18.5	18.1	18.1
22.5	18.1	18.1	18.1	18.1	17.6	17.6	17.6	17.2
45.0	17.2	17.2	16.8	16.8	16.8	16.8	16.4	16.4
67.5	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.8
90.0	16.8	16.8	16.0	16.0	16.4	16.4	16.4	16.4
112.5	16.4	16.4	16.8	16.8	17.2	17.2	17.2	17.2
135.0	17.2	17.2	17.2	16.8	17.2	17.2	17.6	17.6
157.5	18.1	18.1	18.5	18.5	18.5	18.9	19.3	19.7
180.0	20.2	20.2	20.6	21.0	21.0	21.0	21.4	21.4
202.5	21.4	21.4	21.4	21.4	21.0	21.4	21.4	21.8
225.0	21.8	22.3	21.8	21.0	18.5	17.6	17.6	17.2
247.5	17.2	17.2	17.2	17.2	16.8	16.8	16.8	16.8
270.0	16.8	16.8	16.8	17.2	17.2	17.2	16.8	16.8
292.5	16.4	16.4	16.4	16.4	16.4	16.8	16.8	16.8
315.0	16.8	16.8	17.6	17.6	18.1	18.1	18.5	18.5
337.5	18.5	18.5	18.5	18.5	18.9	18.9	18.5	18.9

DEPTH: 1175 TILT: 0 RANGE: 99.5 VOS: 5958

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	18.9	19.3	19.3	18.9	18.5	18.1	17.6	17.2
22.5	17.2	17.2	17.2	17.6	17.6	17.6	17.2	17.2
45.0	17.2	16.8	16.8	16.8	16.8	16.8	16.8	16.8
67.5	16.8	17.2	16.8	17.2	17.2	17.6	17.6	18.1
90.0	18.1	18.5	18.5	18.5	18.9	18.9	18.9	18.9
112.5	19.3	19.3	19.7	20.2	20.2	20.2	20.6	20.6
135.0	20.6	21.0	21.0	21.8	22.3	23.5	23.9	23.9
157.5	23.9	23.9	23.5	23.5	23.5	23.1	23.1	23.1
180.0	23.1	23.1	23.1	23.1	22.7	23.1	23.1	23.1
202.5	23.1	23.5	23.5	23.9	23.9	23.9	23.9	23.5
225.0	23.5	23.5	23.5	23.5	22.7	22.7	22.3	22.3
247.5	21.8	21.8	21.8	21.4	21.0	20.6	20.6	20.2
270.0	20.2	20.2	20.2	19.7	19.7	19.7	19.7	19.7
292.5	19.7	19.7	18.9	18.5	18.5	18.5	18.5	18.9
315.0	19.3	19.7	20.2	20.6	20.6	20.6	20.6	20.6
337.5	20.2	19.7	19.7	19.3	19.3	18.9	18.5	18.5

DEPTH: 1176 TILT: 0 RANGE: 99.5 VOS: 5958

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	18.9	18.5	18.1	18.1	17.6	17.6	17.6	17.6
22.5	17.6	18.1	18.1	17.6	17.6	17.6	17.6	17.6
45.0	17.6	18.1	18.1	18.1	18.1	18.1	18.1	18.9
67.5	18.9	18.9	19.3	19.3	19.3	19.3	19.7	19.3
90.0	19.3	19.3	18.9	18.9	18.9	18.5	18.9	18.9
112.5	18.9	19.3	19.3	19.3	19.3	19.7	19.7	19.7
135.0	20.6	20.6	21.4	21.8	22.3	22.3	22.7	23.1
157.5	23.5	23.5	23.9	23.9	23.9	23.9	23.9	24.4
180.0	24.4	24.4	24.4	24.4	24.8	25.2	25.2	25.6
202.5	25.2	24.8	24.4	24.8	24.8	25.2	24.8	24.8
225.0	24.4	24.4	24.4	24.4	24.4	24.4	24.4	24.4
247.5	23.9	23.5	22.7	21.4	21.0	20.2	20.2	19.7
270.0	19.3	19.3	19.3	19.3	19.7	19.7	19.7	19.7
292.5	19.7	20.2	20.2	20.2	20.2	20.2	20.6	20.6
315.0	20.6	20.6	20.2	20.2	20.2	19.7	19.7	19.7
337.5	19.7	19.7	19.3	19.3	19.3	19.3	19.3	18.9

DEPTH: 1177 TILT: 0 RANGE: 99.6 VOS: 5957

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	23.1	23.1	22.7	22.7	22.7	22.7	22.7	22.3
22.5	22.7	21.8	22.3	21.8	21.8	21.4	21.0	20.6
45.0	20.2	20.2	19.7	19.7	19.7	19.7	19.7	19.7
67.5	19.7	19.7	19.7	19.7	20.6	20.2	19.7	19.7
90.0	19.7	19.7	19.7	19.7	20.2	19.7	19.7	19.7
112.5	20.2	20.2	20.2	20.6	20.6	21.0	21.0	21.4
135.0	21.4	21.8	21.8	22.3	22.7	23.5	23.9	24.4
157.5	24.8	25.2	25.6	26.0	26.0	26.0	26.0	26.0
180.0	26.0	25.6	25.6	25.6	25.6	25.6	25.2	25.2
202.5	25.6	25.2	25.6	25.6	25.2	24.8	25.2	25.6
225.0	25.2	25.2	25.2	25.2	24.8	24.8	24.8	24.8
247.5	24.8	24.8	24.8	24.4	23.9	23.9	23.5	23.1
270.0	22.7	22.7	22.7	22.3	22.3	22.3	22.3	22.3
292.5	22.3	21.8	21.8	21.8	21.4	21.8	21.8	21.8
315.0	21.8	21.8	21.8	21.8	22.3	22.3	22.3	22.3
337.5	22.3	22.7	22.7	22.7	23.1	23.1	23.1	23.1

DEPTH: 1178 TILT: 0 RANGE: 99.5 VOS: 5958

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	28.1	28.1	27.3	27.3	26.5	25.6	24.8	24.4
22.5	24.4	23.9	23.1	22.7	22.3	22.7	22.3	21.8
45.0	21.8	21.4	21.4	21.4	21.0	21.0	21.0	21.0
67.5	21.0	21.0	20.6	20.6	20.2	20.2	20.2	20.2
90.0	20.2	20.2	20.2	20.6	20.6	20.6	21.0	21.0
112.5	21.0	21.0	21.0	21.4	21.8	22.3	22.3	22.3
135.0	21.4	21.8	22.3	22.3	22.3	23.5	24.4	24.8
157.5	24.8	25.2	25.6	26.5	26.5	26.9	26.9	26.5
180.0	26.5	26.5	26.9	26.9	26.9	26.5	26.5	26.9
202.5	27.3	26.9	26.5	26.9	26.5	26.5	26.5	22.3
225.0	21.8	21.8	21.4	21.8	21.8	21.8	22.3	21.8
247.5	21.8	21.4	21.4	21.4	21.4	21.4	21.4	21.8
270.0	21.8	21.8	21.8	21.8	21.8	21.8	22.3	21.8
292.5	21.8	21.8	21.8	21.8	22.3	22.3	21.8	21.8
315.0	21.8	21.8	21.8	22.3	22.7	22.7	23.9	23.9
337.5	23.9	24.4	24.8	24.8	28.1	28.1	28.6	28.6

DEPTH: 1179 TILT: 0 RANGE: 99.5 VOS: 5958

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	26.5	26.5	26.0	25.6	25.2	24.4	23.9	23.5
22.5	23.5	23.5	23.1	22.7	22.7	22.7	22.3	22.7
45.0	22.3	22.3	22.3	22.3	22.3	22.3	22.7	22.3
67.5	22.3	22.3	22.3	22.3	22.3	22.3	22.7	22.7
90.0	22.7	22.7	22.3	22.3	22.3	21.8	21.8	21.8
112.5	21.4	21.4	21.4	21.0	21.4	21.4	21.0	21.8
135.0	21.8	22.3	22.7	23.1	23.5	23.5	24.4	24.4
157.5	25.2	26.0	26.9	27.3	28.1	29.0	28.6	29.0
180.0	29.4	29.0	28.6	28.1	28.1	27.7	28.1	27.7
202.5	28.1	28.1	27.7	27.3	26.5	26.0	24.8	23.5
225.0	23.1	22.3	22.3	22.7	22.3	22.3	22.3	22.7
247.5	22.7	22.7	23.1	23.1	23.1	23.5	23.1	23.5
270.0	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5
292.5	23.5	23.1	23.1	22.7	22.7	22.7	22.3	22.7
315.0	22.7	22.7	23.1	23.1	23.1	23.5	23.9	24.4
337.5	24.8	25.6	26.0	26.9	27.7	27.7	27.7	27.3

DEPTH: 1180 TILT: 0 RANGE: 497.9 VOS: 5957

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3
22.5	27.3	27.3	27.3	27.3	29.4	29.4	29.4	29.4
45.0	29.4	29.4	29.4	29.4	29.4	29.4	27.3	27.3
67.5	27.3	27.3	27.3	25.2	25.2	25.2	25.2	23.1
90.0	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1
112.5	23.1	25.2	25.2	25.2	25.2	25.2	25.2	25.2
135.0	25.2	25.2	25.2	25.2	25.2	27.3	27.3	27.3
157.5	27.3	29.4	159.7	159.7	159.7	159.7	166.0	166.0
180.0	163.9	166.0	166.0	170.2	178.6	197.5	216.4	229.0
202.5	237.4	239.5	243.7	245.8	245.8	247.9	27.3	23.1
225.0	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1
247.5	23.1	23.1	23.1	23.1	23.1	25.2	25.2	25.2
270.0	25.2	25.2	25.2	25.2	27.3	27.3	27.3	29.4
292.5	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4
315.0	29.4	29.4	29.4	29.4	27.3	27.3	27.3	27.3
337.5	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3

DEPTH: 1181 TILT: 0 RANGE: 497.9 VOS: 5953

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	29.4	29.4	29.4	29.4	27.3	29.4	29.4	29.4
22.5	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4
45.0	29.4	29.4	27.3	174.4	174.4	178.6	178.6	180.7
67.5	191.2	212.2	226.9	237.4	241.6	243.7	243.7	245.8
90.0	247.9	245.8	247.9	27.3	27.3	27.3	23.1	25.2
112.5	25.2	25.2	199.6	195.4	193.3	189.1	182.8	178.6
135.0	168.1	172.3	182.8	187.0	187.0	184.9	178.6	172.3
157.5	168.1	166.0	166.0	159.7	166.0	163.9	161.8	163.9
180.0	161.8	163.9	170.2	174.4	178.6	191.2	214.3	231.1
202.5	235.3	237.4	239.5	241.6	243.7	245.8	25.2	27.3
225.0	25.2	25.2	23.1	23.1	23.1	23.1	23.1	23.1
247.5	23.1	25.2	23.1	23.1	23.1	23.1	23.1	23.1
270.0	23.1	29.4	25.2	27.3	27.3	29.4	29.4	29.4
292.5	29.4	29.4	29.4	31.5	31.5	31.5	31.5	31.5
315.0	31.5	31.5	31.5	29.4	29.4	29.4	29.4	29.4
337.5	29.4	29.4	29.4	29.4	31.5	29.4	31.5	29.4

DEPTH: 1182 TILT: 0 RANGE: 497.9 VOS: 5957

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	29.4	27.3	27.3	29.4	29.4	29.4	29.4	31.5
22.5	29.4	29.4	31.5	29.4	31.5	29.4	29.4	29.4
45.0	27.3	27.3	27.3	174.4	174.4	174.4	174.4	176.5
67.5	176.5	184.9	229.0	237.4	239.5	241.6	245.8	245.8
90.0	250.0	250.0	250.0	29.4	27.3	29.4	27.3	27.3
112.5	27.3	25.2	205.9	203.8	201.7	199.6	195.4	189.1
135.0	187.0	187.0	189.1	193.3	197.5	197.5	195.4	187.0
157.5	182.8	176.5	176.5	174.4	172.3	170.2	170.2	166.0
180.0	163.9	168.1	174.4	180.7	199.6	216.4	226.9	229.0
202.5	233.2	237.4	239.5	239.5	243.7	245.8	27.3	27.3
225.0	27.3	29.4	29.4	29.4	27.3	27.3	27.3	29.4
247.5	29.4	27.3	29.4	29.4	29.4	31.5	29.4	29.4
270.0	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4
292.5	29.4	29.4	31.5	31.5	31.5	31.5	31.5	31.5
315.0	31.5	31.5	33.6	33.6	33.6	33.6	33.6	33.6
337.5	31.5	33.6	31.5	31.5	29.4	29.4	31.5	29.4

DEPTH: 1184 TILT: 0 RANGE: 497.9 VOS: 5957

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	35.7	33.6	33.6	33.6	35.7	35.7	35.7	33.6
22.5	33.6	33.6	33.6	33.6	33.6	33.6	33.6	35.7
45.0	35.7	35.7	37.8	180.7	184.9	191.2	197.5	208.0
67.5	218.5	226.9	235.3	239.5	252.1	264.7	283.6	298.3
90.0	306.7	315.1	321.4	325.6	35.7	33.6	33.6	35.7
112.5	35.7	35.7	203.8	203.8	203.8	201.7	195.4	195.4
135.0	197.5	193.3	184.9	180.7	176.5	172.3	166.0	166.0
157.5	168.1	170.2	170.2	170.2	170.2	174.4	174.4	180.7
180.0	184.9	193.3	216.4	229.0	237.4	245.8	254.2	262.6
202.5	268.9	273.1	273.1	273.1	277.3	33.6	33.6	33.6
225.0	29.4	29.4	29.4	29.4	29.4	31.5	29.4	29.4
247.5	29.4	27.3	27.3	31.5	31.5	27.3	27.3	29.4
270.0	29.4	29.4	31.5	29.4	31.5	31.5	31.5	33.6
292.5	33.6	33.6	35.7	33.6	33.6	33.6	33.6	37.8
315.0	37.8	35.7	35.7	29.4	33.6	31.5	31.5	33.6
337.5	31.5	31.5	33.6	33.6	33.6	33.6	33.6	33.6

DEPTH: 1186 TILT: 0 RANGE: 497.9 VOS: 5954

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	37.8	37.8	35.7	33.6	35.7	33.6	33.6	33.6
22.5	33.6	33.6	33.6	35.7	35.7	35.7	37.8	37.8
45.0	37.8	39.9	46.2	52.5	203.8	214.3	220.6	222.7
67.5	226.9	233.2	239.5	235.3	231.1	229.0	235.3	239.5
90.0	302.5	315.1	319.3	319.3	317.2	317.2	313.0	208.0
112.5	203.8	199.6	199.6	201.7	201.7	199.6	195.4	195.4
135.0	197.5	195.4	195.4	193.3	174.4	170.2	168.1	166.0
157.5	163.9	163.9	163.9	163.9	168.1	172.3	174.4	182.8
180.0	189.1	205.9	222.7	235.3	235.3	243.7	254.2	262.6
202.5	271.0	277.3	277.3	275.2	273.1	35.7	35.7	35.7
225.0	37.8	35.7	35.7	35.7	35.7	33.6	31.5	29.4
247.5	29.4	31.5	31.5	31.5	31.5	29.4	29.4	29.4
270.0	29.4	29.4	31.5	31.5	33.6	33.6	35.7	35.7
292.5	35.7	37.8	37.8	37.8	37.8	35.7	35.7	35.7
315.0	35.7	37.8	37.8	37.8	37.8	35.7	35.7	35.7
337.5	35.7	35.7	35.7	35.7	35.7	35.7	35.7	37.8

DEPTH: 1187 TILT: 0 RANGE: 497.9 VOS: 5957

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	35.7	35.7	35.7	35.7	35.7	33.6	35.7	33.6
22.5	33.6	35.7	35.7	35.7	37.8	37.8	37.8	37.8
45.0	39.9	39.9	44.1	50.4	210.1	212.2	222.7	235.3
67.5	237.4	235.3	235.3	235.3	235.3	237.4	241.6	241.6
90.0	306.7	315.1	315.1	315.1	313.0	220.6	216.4	212.2
112.5	208.0	203.8	203.8	203.8	201.7	201.7	199.6	201.7
135.0	199.6	197.5	191.2	187.0	172.3	172.3	168.1	166.0
157.5	163.9	166.0	168.1	170.2	172.3	176.5	178.6	184.9
180.0	189.1	210.1	224.8	237.4	235.3	245.8	256.3	264.7
202.5	273.1	275.2	277.3	277.3	277.3	35.7	35.7	37.8
225.0	37.8	37.8	37.8	37.8	37.8	35.7	35.7	31.5
247.5	31.5	29.4	29.4	29.4	29.4	31.5	29.4	31.5
270.0	31.5	31.5	33.6	35.7	37.8	37.8	37.8	37.8
292.5	37.8	37.8	37.8	37.8	37.8	37.8	37.8	35.7
315.0	35.7	35.7	35.7	37.8	37.8	37.8	37.8	37.8
337.5	35.7	35.7	37.8	35.7	37.8	37.8	37.8	37.8

DEPTH: 1188 TILT: 0 RANGE: 497.9 VOS: 5958

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	37.8	37.8	37.8	37.8	37.8	37.8	39.9	37.8
22.5	37.8	37.8	37.8	39.9	39.9	39.9	42.0	42.0
45.0	46.2	54.6	58.8	176.5	210.1	214.3	226.9	235.3
67.5	235.3	235.3	237.4	239.5	237.4	239.5	239.5	300.4
90.0	319.3	321.4	321.4	317.2	313.0	222.7	220.6	212.2
112.5	210.1	210.1	208.0	208.0	205.9	201.7	199.6	203.8
135.0	203.8	203.8	199.6	197.5	187.0	170.2	170.2	168.1
157.5	166.0	170.2	172.3	172.3	176.5	176.5	180.7	182.8
180.0	191.2	193.3	216.4	226.9	233.2	247.9	258.4	266.8
202.5	273.1	273.1	273.1	275.2	271.0	262.6	44.1	42.0
225.0	42.0	39.9	39.9	37.8	35.7	35.7	35.7	35.7
247.5	35.7	33.6	33.6	33.6	33.6	33.6	33.6	33.6
270.0	33.6	33.6	33.6	33.6	35.7	35.7	35.7	35.7
292.5	35.7	35.7	35.7	35.7	37.8	37.8	37.8	37.8
315.0	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8
337.5	37.8	37.8	35.7	35.7	37.8	35.7	37.8	37.8

DEPTH: 1189 TILT: 0 RANGE: 497.9 VOS: 5958

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	39.9	39.9	39.9	37.8	37.8	37.8	37.8	35.7
22.5	35.7	37.8	37.8	37.8	37.8	37.8	37.8	37.8
45.0	44.1	44.1	178.6	189.1	203.8	216.4	220.6	229.0
67.5	233.2	237.4	241.6	243.7	247.9	260.5	275.2	302.5
90.0	319.3	321.4	323.5	321.4	321.4	319.3	210.1	205.9
112.5	205.9	205.9	205.9	208.0	208.0	205.9	201.7	199.6
135.0	201.7	199.6	195.4	193.3	170.2	172.3	168.1	166.0
157.5	166.0	168.1	170.2	172.3	174.4	174.4	178.6	182.8
180.0	184.9	193.3	203.8	216.4	237.4	245.8	254.2	264.7
202.5	268.9	271.0	273.1	273.1	273.1	262.6	205.9	46.2
225.0	44.1	44.1	42.0	42.0	42.0	39.9	37.8	37.8
247.5	37.8	39.9	39.9	35.7	35.7	33.6	33.6	33.6
270.0	33.6	37.8	37.8	37.8	37.8	37.8	37.8	37.8
292.5	35.7	37.8	37.8	37.8	37.8	37.8	37.8	37.8
315.0	37.8	37.8	37.8	39.9	39.9	39.9	39.9	39.9
337.5	39.9	37.8	44.1	44.1	37.8	37.8	37.8	37.8

DEPTH: 1190 TILT: 0 RANGE: 497.9 VOS: 5957

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	42.0	39.9	39.9	42.0	42.0	42.0	42.0	44.1
22.5	42.0	42.0	42.0	42.0	39.9	39.9	42.0	42.0
45.0	134.4	153.4	178.6	184.9	201.7	214.3	218.5	226.9
67.5	233.2	237.4	241.6	245.8	256.3	273.1	285.7	300.4
90.0	315.1	319.3	321.4	323.5	321.4	319.3	201.7	203.8
112.5	208.0	205.9	205.9	205.9	205.9	203.8	197.5	197.5
135.0	195.4	193.3	189.1	189.1	168.1	168.1	166.0	163.9
157.5	166.0	168.1	168.1	168.1	168.1	170.2	172.3	174.4
180.0	174.4	176.5	212.2	226.9	239.5	247.9	256.3	266.8
202.5	271.0	273.1	273.1	275.2	275.2	260.5	197.5	46.2
225.0	46.2	46.2	44.1	44.1	42.0	42.0	42.0	44.1
247.5	44.1	44.1	44.1	44.1	42.0	42.0	42.0	44.1
270.0	42.0	42.0	42.0	42.0	39.9	39.9	39.9	39.9
292.5	42.0	39.9	42.0	42.0	44.1	44.1	44.1	42.0
315.0	42.0	42.0	42.0	42.0	39.9	42.0	39.9	39.9
337.5	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0

DEPTH: 1191 TILT: 0 RANGE: 500.0 VOS: 5958

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	40.1	40.1	40.1	40.1	40.1	40.1	40.1	40.1
22.5	38.0	38.0	38.0	38.0	40.1	40.1	40.1	40.1
45.0	139.2	156.1	173.0	187.8	208.9	217.3	219.4	230.0
67.5	238.4	242.6	244.7	248.9	263.7	278.5	293.2	305.9
90.0	318.6	320.7	320.7	322.8	320.7	318.6	206.7	206.7
112.5	204.6	204.6	202.5	198.3	196.2	196.2	196.2	196.2
135.0	192.0	187.8	183.5	181.4	170.9	166.7	166.7	164.6
157.5	164.6	164.6	166.7	168.8	168.8	173.0	177.2	177.2
180.0	183.5	196.2	215.2	225.7	238.4	248.9	257.4	265.8
202.5	270.0	272.2	272.2	272.2	272.2	255.3	204.6	46.4
225.0	46.4	44.3	44.3	42.2	42.2	40.1	38.0	38.0
247.5	35.9	35.9	33.8	33.8	33.8	33.8	33.8	33.8
270.0	33.8	35.9	35.9	35.9	35.9	35.9	35.9	35.9
292.5	38.0	38.0	40.1	40.1	40.1	42.2	42.2	42.2
315.0	42.2	42.2	40.1	40.1	40.1	40.1	40.1	40.1
337.5	40.1	40.1	40.1	40.1	40.1	40.1	40.1	40.1

DEPTH: 1192 TILT: 0 RANGE: 497.9 VOS: 5958

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	39.9	39.9	39.9	39.9	39.9	39.9	39.9	39.9
22.5	39.9	39.9	39.9	39.9	37.8	37.8	39.9	42.0
45.0	142.9	159.7	168.1	191.2	212.2	220.6	218.5	231.1
67.5	239.5	243.7	243.7	250.0	266.8	283.6	300.4	308.8
90.0	319.3	319.3	319.3	319.3	319.3	313.0	214.3	201.7
112.5	199.6	197.5	197.5	193.3	193.3	193.3	195.4	195.4
135.0	195.4	189.1	180.7	176.5	172.3	168.1	166.0	166.0
157.5	166.0	166.0	166.0	170.2	172.3	174.4	174.4	180.7
180.0	189.1	201.7	218.5	229.0	241.6	250.0	258.4	264.7
202.5	268.9	271.0	273.1	271.0	268.9	250.0	216.4	136.5
225.0	46.2	46.2	44.1	42.0	39.9	37.8	35.7	37.8
247.5	37.8	37.8	37.8	35.7	35.7	35.7	35.7	35.7
270.0	35.7	35.7	33.6	33.6	33.6	33.6	33.6	35.7
292.5	35.7	35.7	35.7	37.8	37.8	37.8	39.9	39.9
315.0	42.0	39.9	42.0	39.9	42.0	42.0	39.9	42.0
337.5	42.0	42.0	39.9	39.9	39.9	39.9	39.9	39.9

DEPTH: 1193 TILT: 0 RANGE: 497.9 VOS: 5958

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	42.0	42.0	42.0	42.0	42.0	39.9	39.9	39.9
22.5	37.8	37.8	37.8	37.8	39.9	44.1	44.1	163.9
45.0	180.7	199.6	205.9	212.2	218.5	220.6	224.8	237.4
67.5	245.8	247.9	250.0	260.5	279.4	313.0	321.4	319.3
90.0	317.2	317.2	317.2	315.1	313.0	273.1	197.5	195.4
112.5	193.3	193.3	191.2	191.2	193.3	195.4	197.5	197.5
135.0	195.4	187.0	180.7	176.5	170.2	168.1	163.9	166.0
157.5	170.2	172.3	172.3	176.5	180.7	182.8	189.1	193.3
180.0	218.5	226.9	231.1	241.6	250.0	260.5	268.9	273.1
202.5	277.3	275.2	266.8	254.2	233.2	208.0	205.9	203.8
225.0	191.2	44.1	44.1	44.1	39.9	39.9	42.0	42.0
247.5	42.0	39.9	39.9	39.9	37.8	37.8	37.8	37.8
270.0	37.8	37.8	37.8	27.3	25.2	25.2	25.2	23.1
292.5	23.1	23.1	23.1	23.1	23.1	35.7	35.7	35.7
315.0	35.7	35.7	35.7	35.7	37.8	37.8	39.9	42.0
337.5	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0

DEPTH: 1194 TILT: 0 RANGE: 497.9 VOS: 5958

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	42.0	39.9	39.9	39.9	39.9	39.9	39.9	39.9
22.5	39.9	39.9	42.0	42.0	42.0	168.1	180.7	187.0
45.0	201.7	212.2	218.5	220.6	224.8	231.1	235.3	237.4
67.5	245.8	250.0	258.4	264.7	285.7	319.3	323.5	321.4
90.0	319.3	319.3	321.4	321.4	205.9	205.9	203.8	203.8
112.5	201.7	197.5	195.4	193.3	191.2	189.1	191.2	189.1
135.0	184.9	182.8	178.6	170.2	170.2	166.0	166.0	170.2
157.5	170.2	178.6	178.6	180.7	178.6	180.7	180.7	184.9
180.0	197.5	222.7	231.1	237.4	243.7	247.9	256.3	268.9
202.5	273.1	275.2	273.1	266.8	254.2	229.0	216.4	208.0
225.0	205.9	197.5	44.1	44.1	42.0	37.8	37.8	37.8
247.5	37.8	37.8	37.8	35.7	35.7	35.7	33.6	29.4
270.0	29.4	27.3	27.3	27.3	29.4	31.5	35.7	35.7
292.5	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7
315.0	35.7	35.7	37.8	37.8	37.8	37.8	37.8	39.9
337.5	39.9	39.9	37.8	39.9	42.0	42.0	42.0	42.0

DEPTH: 1195 TILT: 0 RANGE: 497.9 VOS: 5958

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	42.0	42.0	39.9	39.9	42.0	42.0	42.0	39.9
22.5	39.9	42.0	42.0	166.0	174.4	182.8	191.2	199.6
45.0	205.9	212.2	216.4	220.6	224.8	231.1	235.3	235.3
67.5	243.7	250.0	260.5	273.1	310.9	319.3	319.3	319.3
90.0	315.1	313.0	308.8	216.4	210.1	210.1	212.2	210.1
112.5	208.0	205.9	203.8	203.8	201.7	199.6	197.5	195.4
135.0	195.4	191.2	174.4	170.2	166.0	166.0	170.2	172.3
157.5	176.5	178.6	178.6	182.8	182.8	187.0	193.3	208.0
180.0	218.5	233.2	237.4	241.6	241.6	247.9	266.8	273.1
202.5	277.3	275.2	273.1	260.5	231.1	226.9	220.6	214.3
225.0	210.1	205.9	201.7	44.1	46.2	44.1	39.9	39.9
247.5	39.9	37.8	37.8	37.8	37.8	37.8	35.7	35.7
270.0	35.7	35.7	35.7	35.7	35.7	37.8	37.8	37.8
292.5	37.8	37.8	35.7	35.7	35.7	35.7	35.7	35.7
315.0	35.7	35.7	35.7	37.8	37.8	37.8	37.8	37.8
337.5	37.8	37.8	39.9	39.9	39.9	39.9	39.9	39.9

DEPTH: 1196 TILT: 0 RANGE: 497.9 VOS: 5958

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	37.8	37.8	37.8	39.9	39.9	42.0	44.1	44.1
22.5	44.1	48.3	48.3	166.0	170.2	182.8	189.1	199.6
45.0	205.9	212.2	216.4	222.7	226.9	231.1	235.3	237.4
67.5	243.7	250.0	264.7	277.3	317.2	319.3	321.4	319.3
90.0	313.0	310.9	212.2	212.2	212.2	212.2	212.2	210.1
112.5	210.1	208.0	208.0	208.0	205.9	203.8	201.7	203.8
135.0	201.7	197.5	195.4	195.4	170.2	170.2	170.2	174.4
157.5	176.5	180.7	180.7	180.7	187.0	197.5	214.3	235.3
180.0	239.5	241.6	243.7	243.7	241.6	252.1	262.6	271.0
202.5	275.2	275.2	273.1	254.2	237.4	229.0	222.7	214.3
225.0	212.2	208.0	201.7	184.9	174.4	42.0	39.9	35.7
247.5	33.6	33.6	33.6	33.6	35.7	35.7	35.7	44.1
270.0	44.1	44.1	42.0	42.0	42.0	39.9	39.9	37.8
292.5	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8
315.0	37.8	35.7	35.7	35.7	35.7	35.7	35.7	35.7
337.5	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7

DEPTH: 1197 TILT: 0 RANGE: 497.9 VOS: 5958

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8
22.5	37.8	37.8	37.8	50.4	166.0	170.2	178.6	193.3
45.0	203.8	210.1	216.4	224.8	229.0	229.0	231.1	233.2
67.5	241.6	250.0	268.9	275.2	319.3	319.3	319.3	313.0
90.0	310.9	218.5	214.3	214.3	216.4	216.4	216.4	216.4
112.5	214.3	214.3	214.3	212.2	210.1	205.9	203.8	208.0
135.0	210.1	210.1	208.0	203.8	172.3	174.4	170.2	174.4
157.5	178.6	180.7	180.7	182.8	187.0	195.4	205.9	233.2
180.0	235.3	239.5	239.5	241.6	241.6	245.8	252.1	275.2
202.5	277.3	277.3	277.3	243.7	241.6	226.9	216.4	212.2
225.0	210.1	208.0	203.8	191.2	176.5	35.7	33.6	35.7
247.5	35.7	35.7	35.7	35.7	42.0	33.6	35.7	33.6
270.0	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6
292.5	33.6	35.7	35.7	35.7	33.6	33.6	33.6	33.6
315.0	33.6	33.6	33.6	33.6	33.6	33.6	35.7	35.7
337.5	35.7	35.7	35.7	35.7	35.7	35.7	35.7	37.8

DEPTH: 1198 TILT: 0 RANGE: 497.9 VOS: 5958

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	31.5	31.5	35.7	37.8	39.9	42.0	44.1	46.2
22.5	48.3	48.3	50.4	52.5	168.1	170.2	172.3	203.8
45.0	212.2	216.4	216.4	218.5	224.8	229.0	233.2	235.3
67.5	237.4	243.7	260.5	279.4	319.3	319.3	319.3	317.2
90.0	317.2	317.2	212.2	212.2	212.2	210.1	212.2	214.3
112.5	210.1	212.2	212.2	212.2	210.1	208.0	208.0	210.1
135.0	210.1	210.1	210.1	208.0	174.4	172.3	176.5	178.6
157.5	176.5	182.8	184.9	184.9	191.2	197.5	205.9	216.4
180.0	229.0	237.4	239.5	241.6	241.6	243.7	247.9	279.4
202.5	279.4	277.3	271.0	254.2	233.2	224.8	222.7	218.5
225.0	216.4	210.1	203.8	197.5	182.8	33.6	33.6	33.6
247.5	33.6	33.6	33.6	33.6	33.6	33.6	33.6	35.7
270.0	35.7	35.7	35.7	35.7	37.8	35.7	37.8	37.8
292.5	37.8	37.8	37.8	37.8	44.1	37.8	37.8	37.8
315.0	37.8	35.7	37.8	35.7	37.8	37.8	35.7	35.7
337.5	35.7	35.7	35.7	31.5	33.6	31.5	31.5	31.5

DEPTH: 1199 TILT: 0 RANGE: 497.9 VOS: 5958

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	44.1	44.1	44.1	44.1	46.2	46.2	46.2	48.3
22.5	48.3	46.2	48.3	46.2	168.1	170.2	172.3	214.3
45.0	216.4	216.4	216.4	220.6	224.8	226.9	231.1	233.2
67.5	235.3	239.5	254.2	273.1	317.2	321.4	321.4	319.3
90.0	317.2	317.2	212.2	210.1	212.2	212.2	212.2	212.2
112.5	212.2	212.2	212.2	212.2	210.1	208.0	210.1	210.1
135.0	208.0	205.9	205.9	203.8	166.0	168.1	170.2	174.4
157.5	176.5	178.6	176.5	180.7	197.5	214.3	220.6	231.1
180.0	239.5	247.9	252.1	258.4	258.4	262.6	271.0	273.1
202.5	277.3	275.2	275.2	212.2	210.1	216.4	220.6	218.5
225.0	218.5	218.5	208.0	199.6	63.0	60.9	58.8	56.7
247.5	54.6	31.5	33.6	35.7	39.9	42.0	44.1	44.1
270.0	44.1	44.1	44.1	44.1	44.1	42.0	44.1	44.1
292.5	44.1	44.1	44.1	44.1	46.2	46.2	46.2	46.2
315.0	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2
337.5	46.2	46.2	46.2	46.2	46.2	44.1	44.1	44.1

DEPTH: 1201 TILT: 0 RANGE: 500.0 VOS: 5958

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	46.4	46.4	46.4	46.4	46.4	46.4	46.4	48.5
22.5	48.5	50.6	50.6	50.6	50.6	48.5	160.3	162.4
45.0	170.9	175.1	213.1	215.2	223.6	227.8	230.0	234.2
67.5	234.2	238.4	240.5	240.5	242.6	320.7	322.8	322.8
90.0	320.7	208.9	206.7	206.7	206.7	206.7	208.9	208.9
112.5	213.1	211.0	208.9	206.7	181.4	183.5	200.4	204.6
135.0	204.6	198.3	198.3	166.7	162.4	166.7	168.8	170.9
157.5	173.0	175.1	173.0	177.2	177.2	175.1	175.1	227.8
180.0	236.3	242.6	240.5	242.6	242.6	244.7	274.3	274.3
202.5	276.4	278.5	244.7	225.7	213.1	215.2	215.2	215.2
225.0	215.2	48.5	48.5	44.3	46.4	59.1	59.1	57.0
247.5	54.9	54.9	52.7	44.3	44.3	42.2	42.2	42.2
270.0	42.2	42.2	42.2	42.2	42.2	44.3	44.3	44.3
292.5	44.3	44.3	44.3	44.3	44.3	44.3	46.4	46.4
315.0	46.4	44.3	44.3	44.3	46.4	46.4	46.4	44.3
337.5	44.3	44.3	46.4	46.4	42.2	42.2	46.4	46.4

DEPTH: 1202 TILT: 0 RANGE: 497.9 VOS: 5958

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	46.2	46.2	44.1	44.1	44.1	44.1	44.1	44.1
22.5	44.1	46.2	44.1	44.1	44.1	44.1	46.2	155.5
45.0	161.8	170.2	182.8	208.0	220.6	224.8	226.9	229.0
67.5	231.1	237.4	237.4	239.5	241.6	317.2	319.3	319.3
90.0	317.2	205.9	205.9	205.9	201.7	195.4	174.4	172.3
112.5	172.3	178.6	180.7	182.8	182.8	182.8	184.9	187.0
135.0	189.1	184.9	172.3	166.0	163.9	166.0	168.1	168.1
157.5	172.3	172.3	172.3	172.3	174.4	172.3	174.4	224.8
180.0	237.4	241.6	241.6	237.4	241.6	243.7	268.9	273.1
202.5	268.9	247.9	245.8	235.3	208.0	205.9	201.7	189.1
225.0	178.6	174.4	98.7	98.7	96.6	63.0	54.6	52.5
247.5	52.5	50.4	48.3	46.2	46.2	44.1	42.0	42.0
270.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0
292.5	42.0	42.0	42.0	44.1	44.1	44.1	44.1	44.1
315.0	44.1	44.1	44.1	44.1	44.1	44.1	44.1	46.2
337.5	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2

DEPTH: 1203 TILT: 0 RANGE: 497.9 VOS: 5958

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	42.0	42.0	42.0	42.0	44.1	46.2	46.2	46.2
22.5	48.3	48.3	48.3	48.3	48.3	48.3	153.4	157.6
45.0	159.7	170.2	172.3	176.5	201.7	201.7	197.5	201.7
67.5	205.9	205.9	205.9	208.0	210.1	208.0	306.7	315.1
90.0	266.8	210.1	210.1	210.1	208.0	201.7	189.1	180.7
112.5	178.6	180.7	180.7	180.7	178.6	178.6	180.7	180.7
135.0	176.5	174.4	172.3	166.0	161.8	159.7	159.7	161.8
157.5	166.0	168.1	168.1	172.3	170.2	170.2	174.4	176.5
180.0	231.1	235.3	237.4	237.4	239.5	247.9	260.5	266.8
202.5	266.8	258.4	245.8	241.6	224.8	208.0	201.7	195.4
225.0	184.9	189.1	92.4	88.2	67.2	58.8	56.7	56.7
247.5	54.6	54.6	52.5	52.5	52.5	50.4	48.3	48.3
270.0	46.2	44.1	44.1	44.1	44.1	44.1	44.1	44.1
292.5	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0
315.0	44.1	44.1	44.1	44.1	42.0	42.0	42.0	42.0
337.5	42.0	42.0	42.0	42.0	42.0	44.1	44.1	42.0

DEPTH: 1204 TILT: 0 RANGE: 497.9 VOS: 5958

Bearing	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3	+14.1	+16.9	+19.7
0.0	42.0	42.0	42.0	44.1	44.1	44.1	48.3	48.3
22.5	46.2	46.2	46.2	46.2	46.2	149.2	155.5	157.6
45.0	161.8	166.0	168.1	172.3	172.3	172.3	172.3	176.5
67.5	193.3	205.9	205.9	208.0	210.1	208.0	273.1	273.1
90.0	210.1	214.3	214.3	216.4	216.4	210.1	201.7	193.3
112.5	178.6	176.5	174.4	174.4	176.5	178.6	180.7	189.1
135.0	189.1	189.1	187.0	163.9	163.9	161.8	159.7	159.7
157.5	159.7	163.9	166.0	168.1	168.1	168.1	168.1	178.6
180.0	224.8	231.1	235.3	237.4	243.7	262.6	266.8	266.8
202.5	266.8	266.8	264.7	252.1	241.6	208.0	199.6	195.4
225.0	193.3	191.2	48.3	48.3	48.3	48.3	52.5	54.6
247.5	58.8	56.7	56.7	58.8	58.8	56.7	54.6	50.4
270.0	48.3	46.2	46.2	44.1	44.1	44.1	44.1	44.1
292.5	44.1	44.1	42.0	42.0	42.0	42.0	42.0	42.0
315.0	42.0	42.0	42.0	39.9	39.9	39.9	39.9	39.9
337.5	42.0	42.0	42.0	42.0	42.0	44.1	44.1	42.0

Chavez, Carl J, EMNRD

From: Chavez, Carl J, EMNRD
Sent: Tuesday, December 09, 2008 10:20 AM
To: 'Clay Wilson'
Cc: Price, Wayne, EMNRD; Guye, Gerry, EMNRD
Subject: Subsidence Monument Guidance (BW-27)
Attachments: KS Subsid Monitor Case.tif; Monument Construction Examples 2-29-08.tif

Clay:

Here's the guidance that you requested earlier today. Thanks.

Carl J. Chavez, CHMM
New Mexico Energy, Minerals & Natural Resources Dept.
Oil Conservation Division, Environmental Bureau
1220 South St. Francis Dr., Santa Fe, New Mexico 87505
Office: (505) 476-3491
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E-mail: CarlJ.Chavez@state.nm.us
Website: http://www.emnrd.state.nm.us/ocd/index.htm
(Pollution Prevention Guidance is under "Publications")

86-2001-5

IC 9083

Bureau of Mines Information Circular/1986

Subsidence Investigations Over Salt-Solution Mines, Hutchinson, KS

By Robert C. Dyni

UNITED STATES DEPARTMENT OF THE INTERIOR

Information Circular 9083

Subsidence Investigations Over Salt-Solution Mines, Hutchinson, KS

By Robert C. Dyni

UNITED STATES DEPARTMENT OF THE INTERIOR
Donald Paul Hodel, Secretary

BUREAU OF MINES
Robert C. Horton, Director

This report is based upon work done under an agreement between the Solution Mining

SUBSIDENCE INVESTIGATIONS OVER SALT-SOLUTION MINES, HUTCHINSON, KS

By Robert C. Dynl[1]

ABSTRACT

The Bureau of Mines in cooperation with the Solution Mining Research Institute conducted surface and subsurface investigations over five solution-mined salt cavities in the Hutchinson, KS, area. The purpose of these investigations was to determine the mechanisms that lead to the formation of sinkholes above collapsed solution cavities. Of the five salt-solution cavities investigated, four had collapsed and produced sinkholes prior to the time of the investigations; the fifth cavity was considered stable. Exploratory drilling and coring operations were conducted at all five sites; surface stability monitoring was conducted at three of them. The results of these studies indicate that excessive dissolution at the salt-shale contact of each collapsed cavity produced large, unsupported roof spans that ultimately exceeded the structural integrity of the overburden. The stable cavity was not exposed to excessive dissolution at the salt-shale contact; this limited the roof span and ensured a stable cavity. The data also show that surface settlement in the vicinity of the two surface-monitored sinkholes continued for approximately 7 years after the sinkholes formed, indicating that the rubble piles of the collapsed cavities were undergoing gradual consolidation.

[1]Physicist, Denver Research Center, Bureau of Mines, Denver, CO.

upper shale surface, then the roof will start receiving support by the rubble and the bulking process will be stopped (fig. 2*A*). A shallow sinkhole may develop as a result of the downward deflection of the shale roof and the consolidation of the rubble pile even though the bulking process has been halted (fig. 2*B*). If, however, the distance between the top of the cavity and the top of the rubble pile does not become zero before the roof reaches the upper shale layers, then a chimney forms and propagates through the upper shale layers to the unconsolidated soils near the surface. This material then flows down into the remaining void and can create a deep sinkhole (fig. 2*C*).

A trigger mechanism that reduces critical support from a marginally stable roof can consist of a reduction of brine pressure inside the cavity, a reduction of the buoyancy effect on shale fragments suspended from the roof of the cavity, or the removal of critical roof support by continuing salt dissolution. Hendron (4) indicates that these conditions most likely are interrelated and act simultaneously to initiate the failure of a cavity roof.

If all four conditions for rapid sinkhole development are met, a deep sinkhole as shown in figure 2*C* will most likely be the result. If, however, only a large unsupported roof span at the salt-shale contact and triggering mechanisms are present, shallow sinkholes as shown in figure 2*B* can possibly form. Shallow sinkholes do not develop as rapidly as deep sinkholes, and their dimensions may increase with time. As mentioned earlier, the bulking process in shallow sinkholes does not progress up to the ground surface, and no chimney is formed in the shale layers. If only the first condition is met, the unsupported shale layers above the cavity will tend to deflect down into the opening, producing subsidence on the ground surface. This subsidence develops gradually over a long period and affects a large surface area over the cavity (4, pp. 3-4). Further analysis on sinkhole failure mechanisms is provided by Hendron (4).

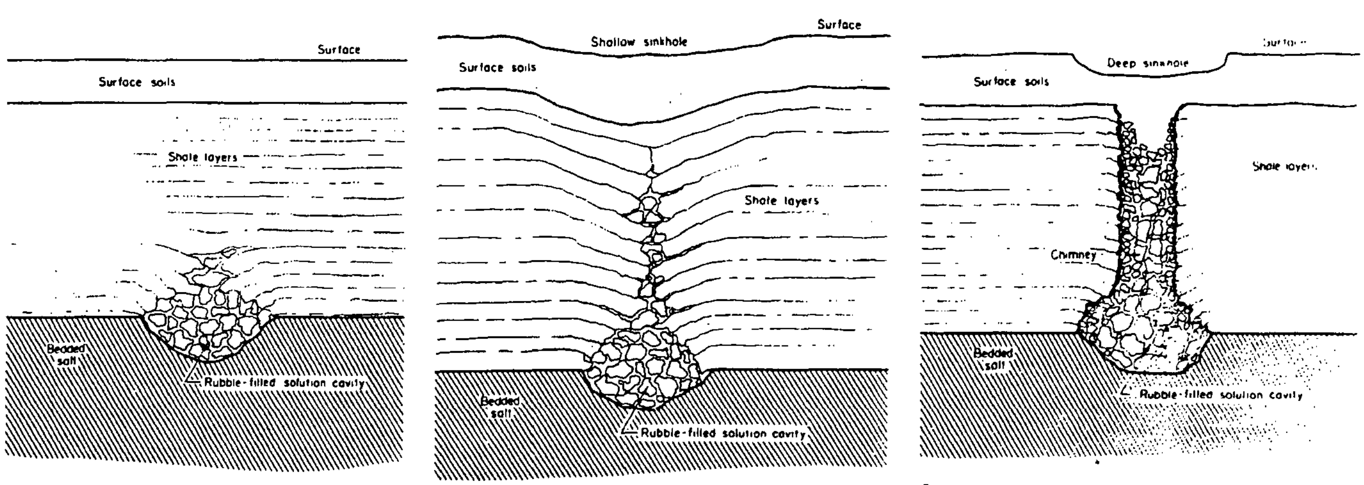

FIGURE 2.—Cavity collapse with surface deformations.

boring V-3. The inclined boreholes I-1 and I-2 were each about 260 ft in depth. Complete details on the drilling and coring procedures are given by Hendron (1, pp. 1-2).

Borings V-3 and V-4 each encountered the top of the salt deposit at a depth of approximately 420 ft. These borings found no evidence of any surface sands from the sinkhole, or any voids or disturbances in the strata overlying the salt. Borings V-1 and V-2, however, both found evidence of voids and disturbances in the shale at depths of approximately 240 to 245 ft, and boring V-1 also found a large void and surface sands from the sinkhole at a depth of about 388 ft. These findings indicate that an elongated cavity had developed in the northeast-southwest direction under the sinkhole, caused by the solution activity of the neighboring brine wells. The evidence also suggests that the roof shale over the salt had caved upward about 30 ft at the location of boring V-1, and that some large block movements of the shale had extended as much as 180 ft into the shale above the elongated cavity (1, pp. 7-8). Walters (6, p. 45) suggests that the configuration of the elongated cavity exceeded the span capabilities of the overlying rock layers. This allowed the failure of these layers to breach the uppermost shale layer and permit approximately 90,000 yd^3 of sand and gravel to move down into the opening (2, p. 2). The sand that was encountered in the inclined borings I-1 and I-2 indicates that an approximately 100-ft-diam chimney of sand was located below the center of the sinkhole. The sinkhole and the chimney both were elongated in the northeast-southwest direction, indicating that the influence of the underlying cavity elongated along the line of brine wells in the area (1, p. 8). Figure 5 shows

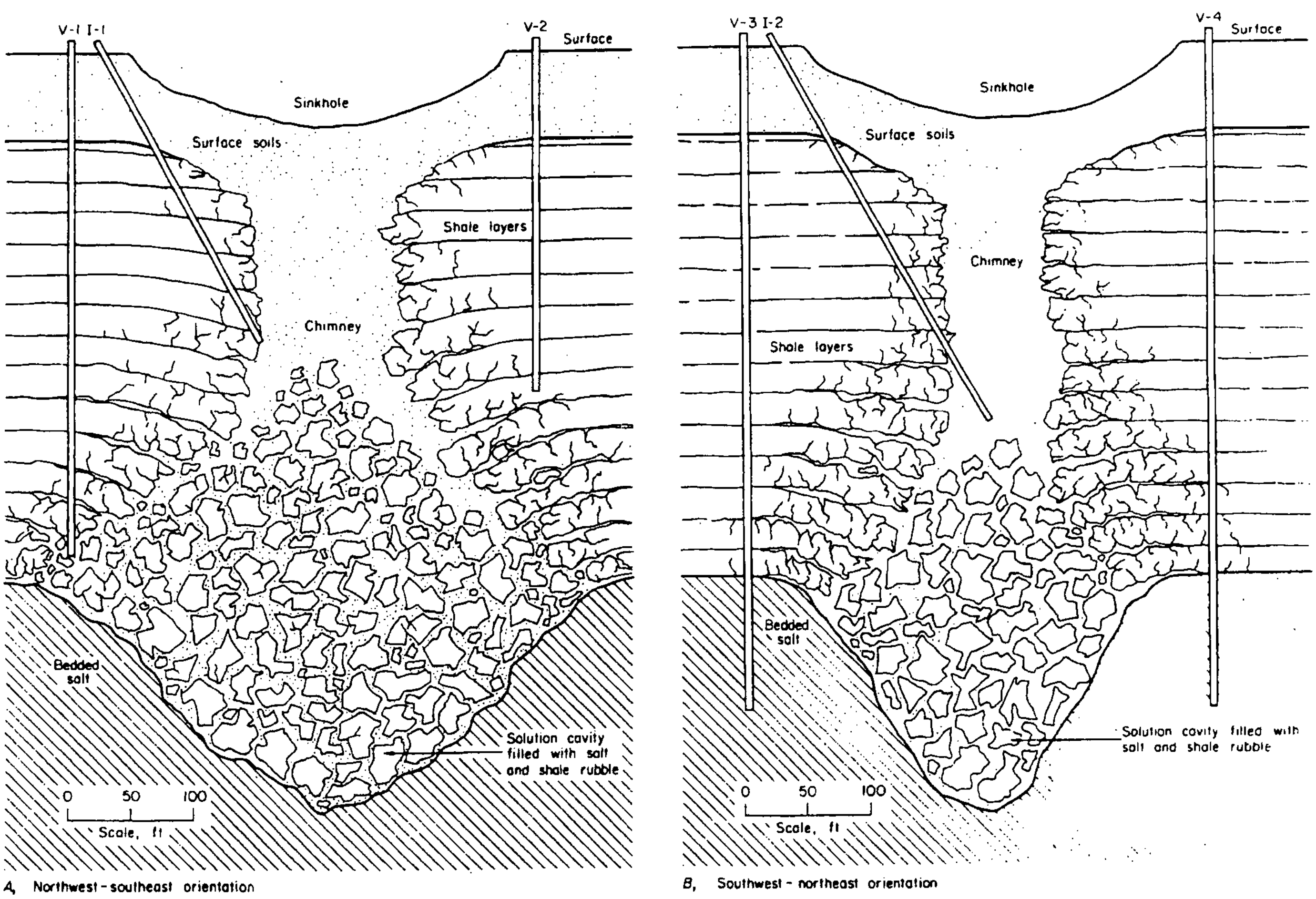

FIGURE 5.—Cross sections of Cargill sinkhole.

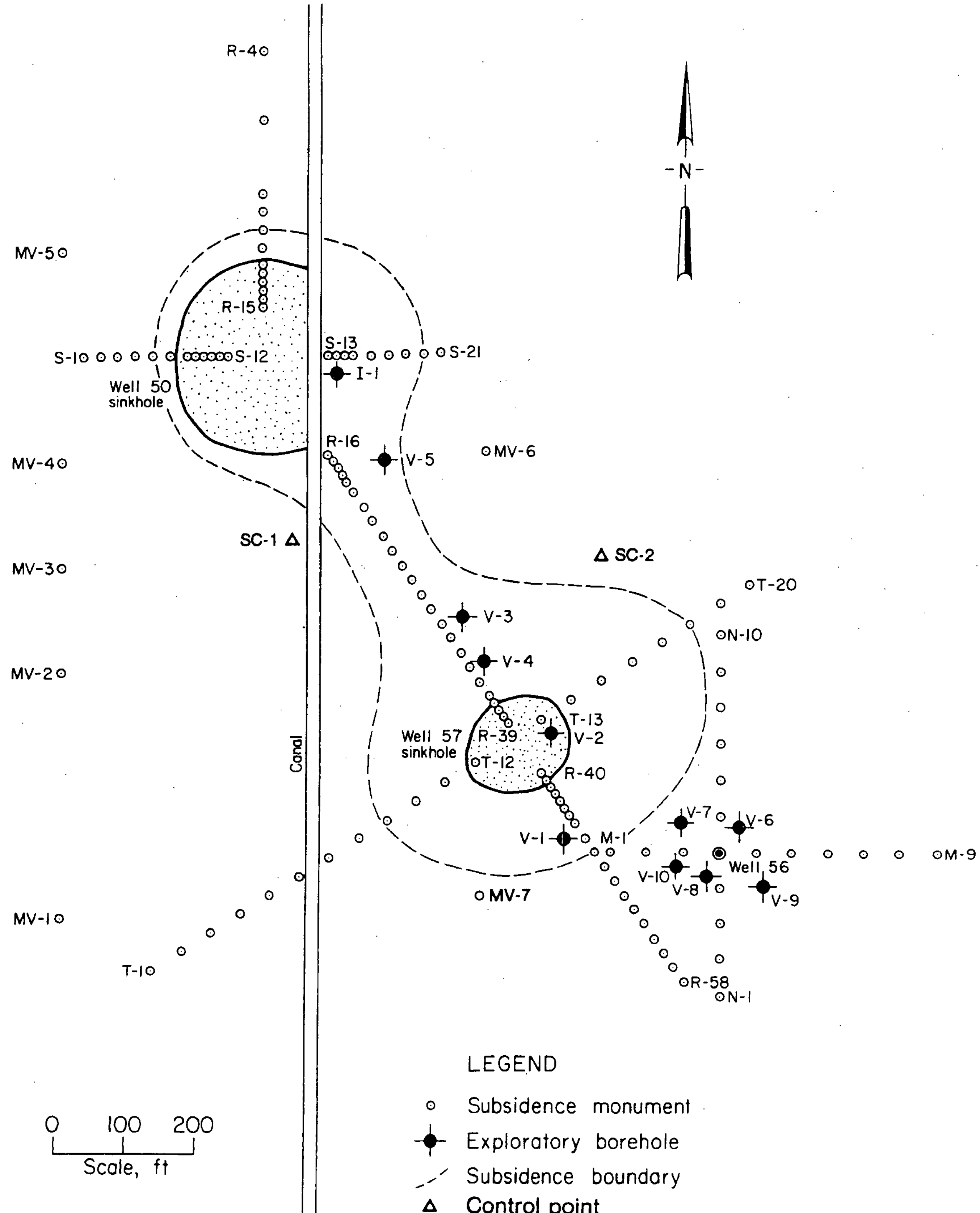

FIGURE 9.—Location of boreholes and subsidence monuments at Carey brinefield.

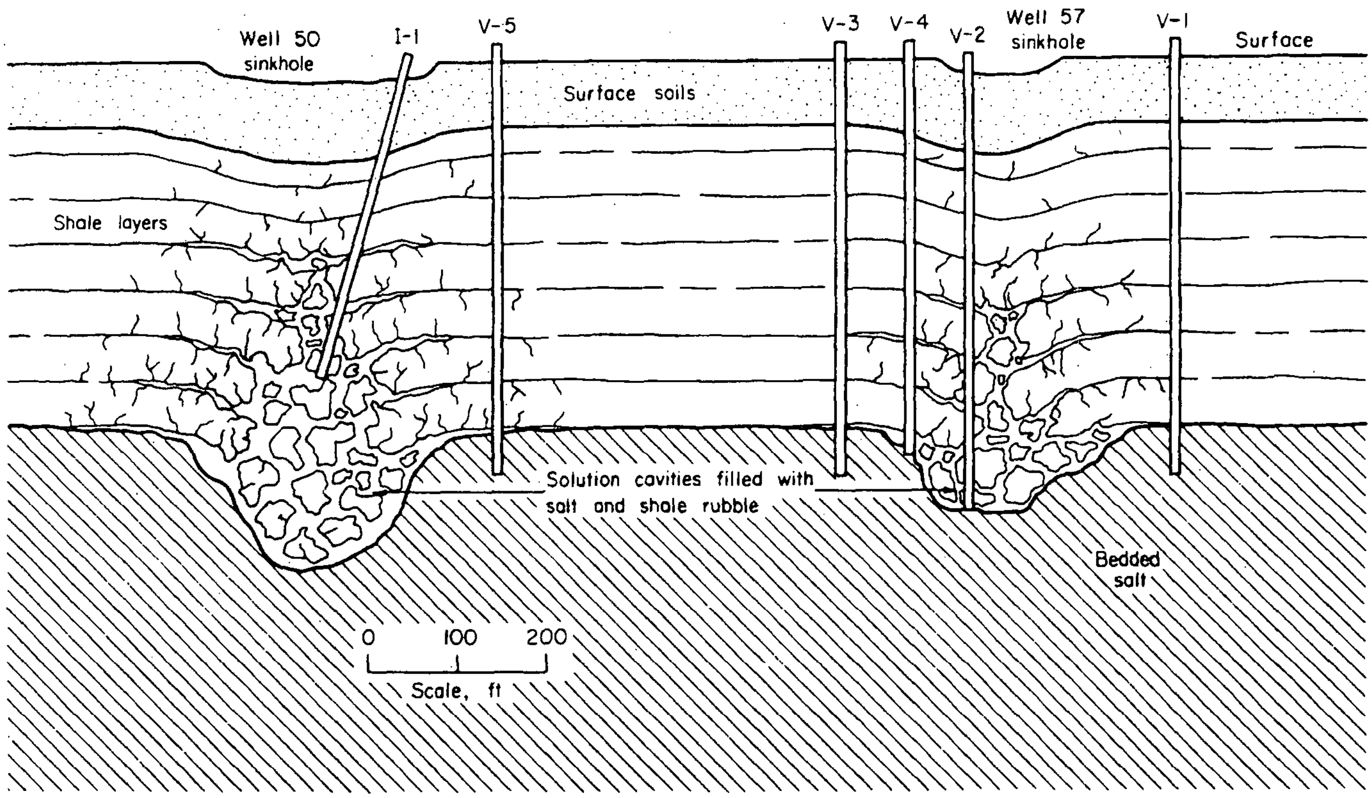

FIGURE 10.—Cross section of Carey sinkholes.

the cavity was in some stage of progressive failure, or if the cavity was presently stable but likely to fail in the future.

The investigation consisted of drilling and coring five (V-6 to V-10) exploratory borings and extending the subsidence-monitoring network to the area around well 56 (fig. 9). The Bureau was responsible for extending and monitoring the network, and SMRI was responsible for supervising the drilling and coring operations funded by the Bureau. Boring V-6 was advanced to a depth of 565 ft, boring V-7 to 436.5 ft, boring V-8 to 515 ft, boring V-9 to 502.5 ft, and boring V-10 to 552.5 ft (2, pp. 8-9). Details on the drilling and coring procedures are given by Hendron (2, pp. 8-9).

The drilling and coring results indicated the shale overlying the solution cavity was intact and undisturbed to within several feet of the salt-shale contact (fig. 11). Near the roof, the shale had softened and undergone bed separations. The cavity appeared to be elongated in the southeast-northwest direction with a roof span of about 150 ft. In the southwest-northeast direction, the roof span was estimated to be approximately 50 ft. The restricted roof span dimensions near the shale were most likely due to the fact that well 56 had been operated by pumping fresh water down the tubing that extended close to the bottom of the salt deposit. This resulted in most of the solutioning occurring deep in the salt and away from the overlying shale. The borings also indicated that there was only a limited amount of shale exposed in the roof of the cavity that was subjected to deterioration by fresh water (2, pp. 37-39). Hendron (2, p. 39) suggests that the limited exposure of the shale to the deteriorating action of fresh water beneath the well in combination with the limited roof spans over the cavity led to a stronger roof support and a stable cavity.

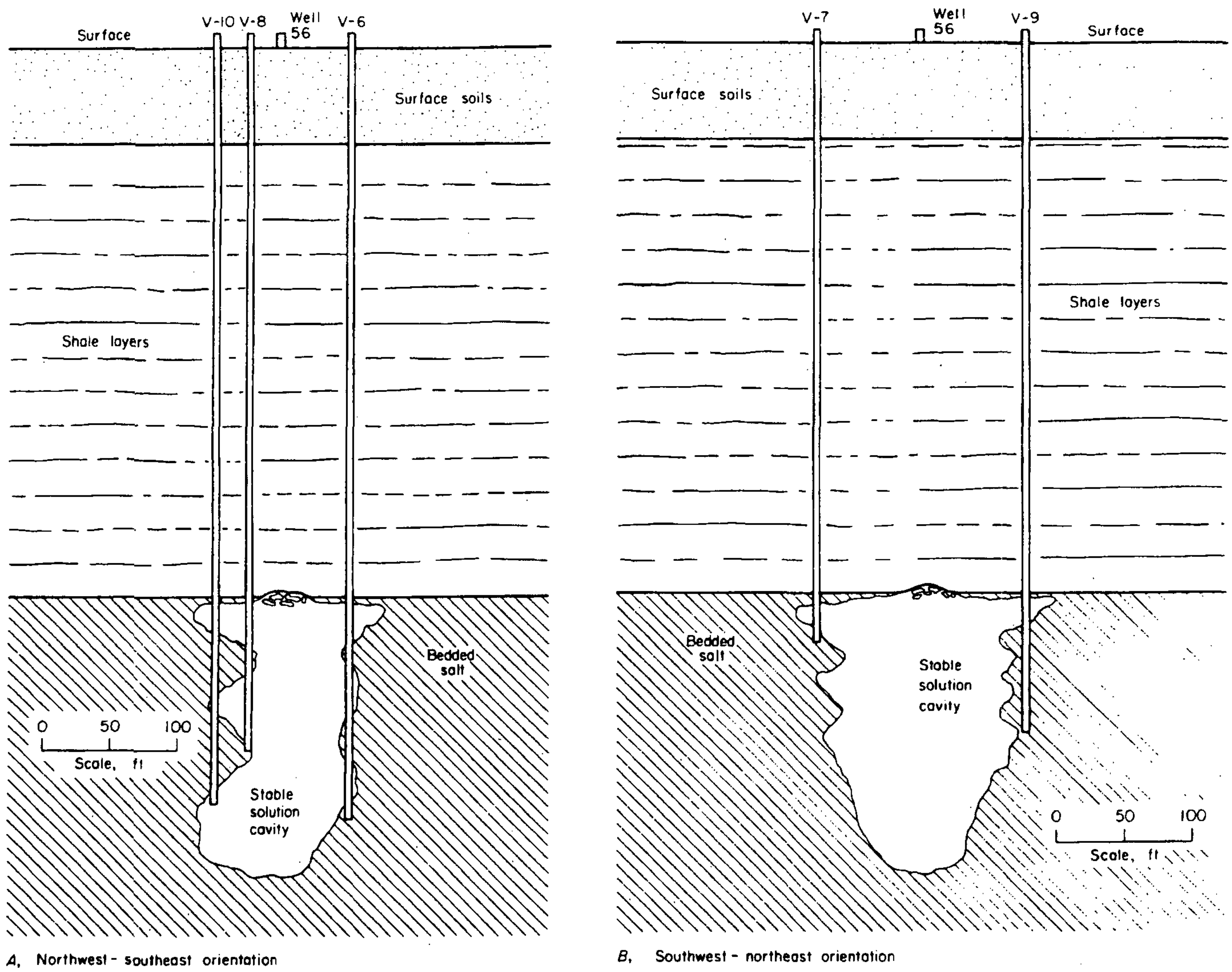

FIGURE 11.—Cross section of Carey well 56.

BUREAU OF MINES SURFACE SUBSIDENCE INVESTIGATIONS

FIRST AND SECOND INVESTIGATIONS

The investigations carried out at the Barton and Cargill sinkholes did not include surface monitoring programs.

CAREY 1978 SINKHOLES (THIRD INVESTIGATION)

Background

In 1979 the Bureau installed a subsidence-monitoring network around wells 50 and 57 in the Carey brinefield. A total of 154 survey points were used to monitor the horizontal and vertical ground surface movements in the vicinity of the two sinkholes. The network consisted of 1 existing control point, 4 Bureau-installed control points, 103 Bureau-installed subsidence monuments, 10 Carey-installed subsidence monuments, and survey marks set on the 6 exploratory borings and on 30 brine wells.

Subsidence-Monitoring Network Design and Construction

The network (fig. 9) was designed to monitor any positional changes of the ground surface associated with the two sinkholes around wells 50 and 57, as well as in other areas of the brinefield. The S-line (S-1 to S-21) and a portion of the

R-line (R-4 to R-15) subsidence monuments were positioned in the area around the well 50 sinkhole. These two monument lines intersected at right angles near the center of the well 50 sinkhole. The T-line (T-1 to T-20) and the remainder of the R-line (R-16 to R-58) monuments were positioned in the area around the well 57 sinkhole. These two monument lines intersected at right angles near the center of the well 57 sinkhole. The monuments R-16 to R-58 were also designed to monitor the area between the two sinkholes and were therefore oriented along the axis between the two sinkhole centers. The MV-line monuments were distributed throughout the area around the sinkholes to monitor any ground surface movements due to neighboring wells. The remainder of the survey points, including the wells, boreholes, and previously installed survey movements, were used to monitor movements of the ground surface over a large area around the two sinkholes. Control points P-1, P-2, and P-3 were placed in areas that were considered to be stable and not affected by solution mining activities; these control points were located in areas outside the area shown in figure 9. Control points SC-1 and SC-2 were located in the brinefield for the trilateration surveys and were checked for stability prior to each survey.

The 4 control points and the 103 monuments installed by the Bureau at the Carey brinefield were all of the same design and construction (fig. 12). The monument consists of a small inner pipe fitted with a pointed anchor on the bottom and a reference-marked cap on the top, and a large outer pipe which is used to drive the anchor below frost depth. The inner pipe extends through a cap on top of the outer pipe. The outer pipe is free to undergo movements due to frost heave or swelling and shrinking soils without affecting the inner pipe on which measurements are made. The monuments proved to be very stable and effectively guarded against soil distances throughout the entire time of the investigation.

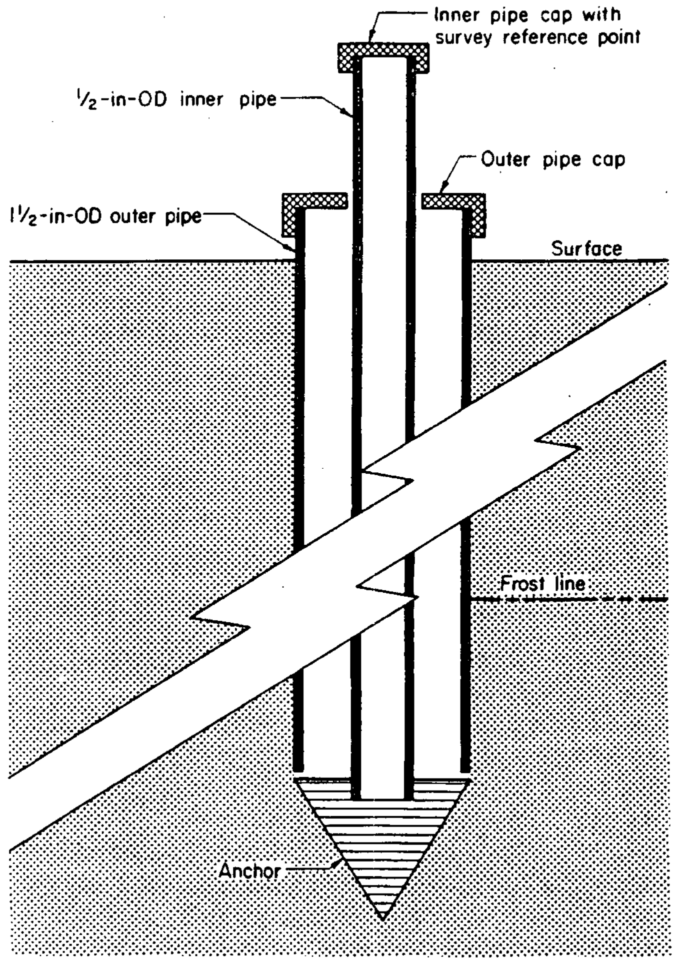

FIGURE 12.—Detail of Bureau-designed subsidence monument.

The wells, boreholes, and structures that were used as subsidence monuments all had survey marks that provided consistent reference points.

Monitoring Procedures

The procedures used to monitor positional changes in the network involved various survey techniques. Trialteration and traverse surveying procedures were used for horizontal control, and trigonometric and differential leveling procedures for vertical control. The horizontal control surveys, as well as the trigonometric level surveys, established initial and subsequent coordinates and elevations by measuring angles and distances from control points SC-1 and SC-2 to the monuments in the network. Although SC-1 and SC-2 were located within the brinefield boundaries, their stability was verified before each survey by using trilateration and differential leveling procedures from control points P-1, P-2, and P-3, which were located on stable ground away from the brinefield. The Bureau began surveying the network in June 1979 and continued through February 1983. A total of 17 vertical and 12 horizontal control surveys were performed.

Results--Vertical Movement

The results from the vertical control surveys indicated that both sinkholes experienced vertical settlements between June 1979 and February 1983. Appendix A contains data from the final vertical control survey of the Carey brinefield; these data were used to calculate the maximum vertical displacements of the subsidence monuments.

Data from the R-line indicated that vertical settlements occurred between monuments R-7 and R-50. From R-4 to R-15 (fig. 13) the settlements increased linearly, starting at monument R-8 and continuing toward the well 50 sinkhole. The maximum vertical settlement measured was 1.58±0.04 ft at R-15. From R-16 to R-39 (fig. 14) the subsidence was concentrated in the vicinity of the two sinkholes, with less movement at the midpoint between sinkholes. Vertical settlement in the area around R-16 was 0.18±0.04 ft; settlement in the area around the midpoint between sinkholes (R-26) was 0.09±0.04 ft; and settlement in the area around R-39 was 0.24±0.04 ft. Data from R-40 to R-58 (fig. 15) showed that the

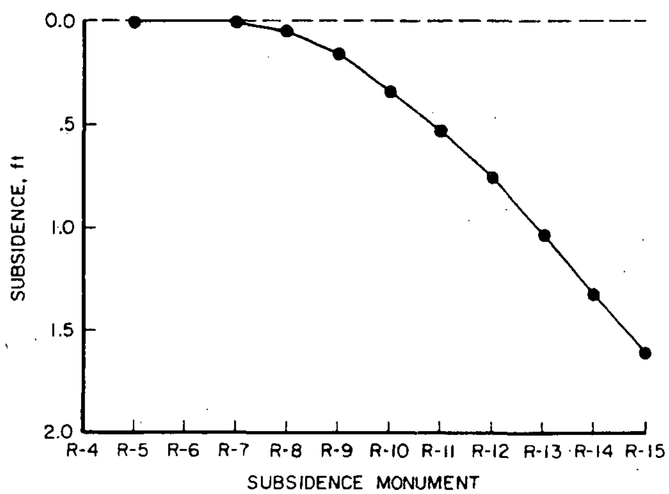

FIGURE 13.—Subsidence from R-4 to R-15.

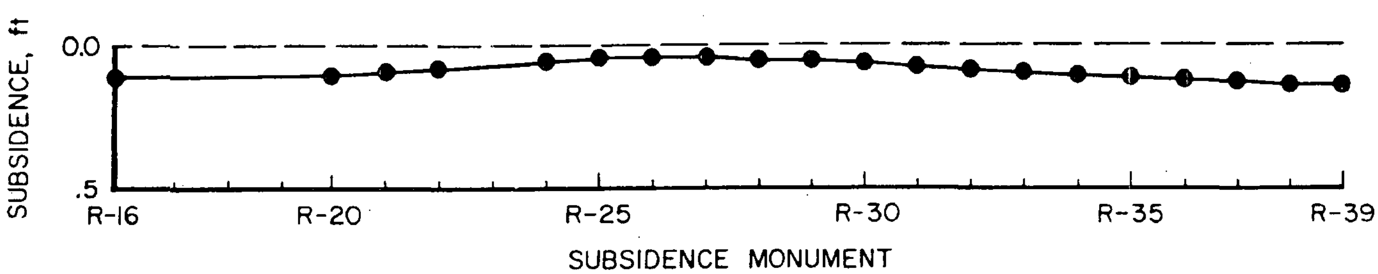

FIGURE 14.—Subsidence from R-16 to R-39.

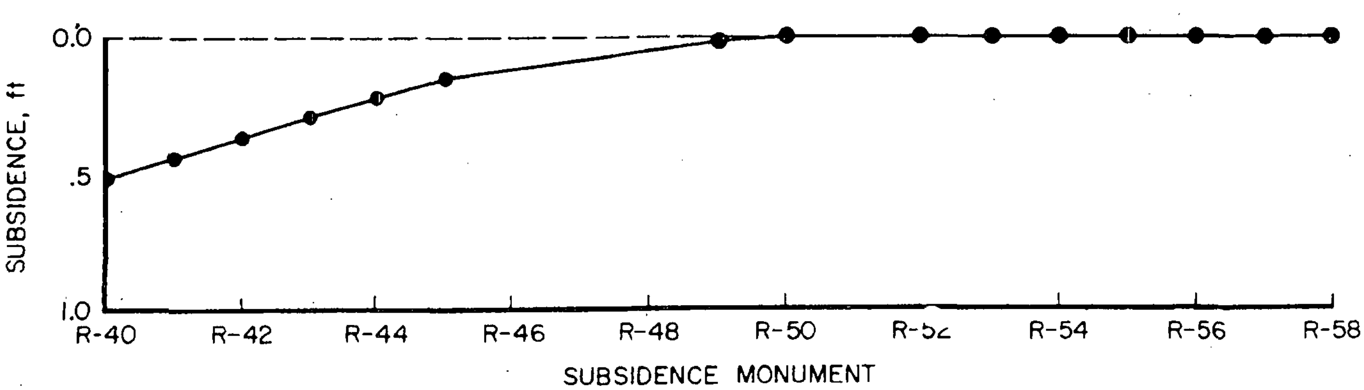

FIGURE 15.—Subsidence from R-40 to R-58.

settlement around the well 57 sinkhole began at R-49 and linearly increased toward the center of the sinkhole. The maximum settlement measured was 0.49±0.04 ft at R-40.

The S-line showed vertical settlement between S-5 and S-20. The line from S-1 to S-12 began movement at S-6 and continued to minearly increase to S-12 (fig. 16). Maximum subsidence of 1.81±0.04 ft was measured at monument S-12. Data from S-13 to S-21 (fig. 17) showed that movement began at S-20 and continued to linearly increase to S-13. The maximum subsidence at S-13 was 0.20±0.04 ft.

Data from the T-line indicated that vertical settlements occurred between T-8 and T-19. The line T-1 to T-12 (fig. 18) experienced movements that started at approximately T-9 and linearly increased to T-12; the maximum subsidence at T-12 was 0.23±0.04 ft. The line from T-13 to T-19 (fig. 19) showed movement that began at approximately T-18 and continued to linearly increase to T-13, where a movement of 0.34±0.04 ft was measured.

Results--Horizontal Movement

The results from the horizontal surveys indicated that minor horizontal movements occurred in the vicinity of the well 50 sinkhole. However, the data from the surveys were inconclusive as to whether any movement had occurred around the well 57 sinkhole. Any possible movements along the R-line from R-16 to R-58, from S-13 to S-21, and the entire T-line were of a magnitude less than could be detected by the surveys; the minimum observable movement was calculated to be ±0.35 ft. Appendix B contains data from the final horizontal control survey of the Carey brinefield; these data were used to calculate the maximum horizontal displacements of the subsidence monuments.

The R-line monuments underwent horizontal displacements oriented along the line from approximately R-10 to R-14 (fig. 20). The movement increased linearly in the direction toward the well 50 sinkhole. The movement at R-14 was approximately 1.0±0.35 ft.

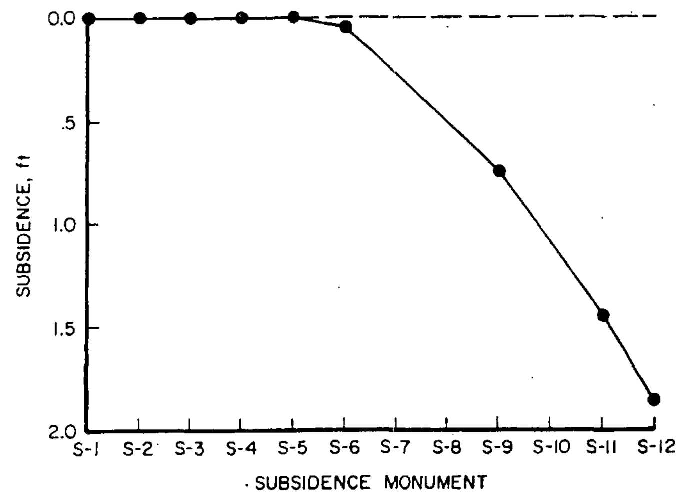

FIGURE 16.—Subsidence from S-1 to S-12.

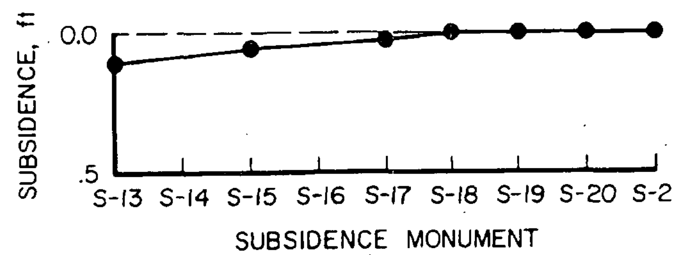

FIGURE 17.—Subsidence from S-13 to S-21.

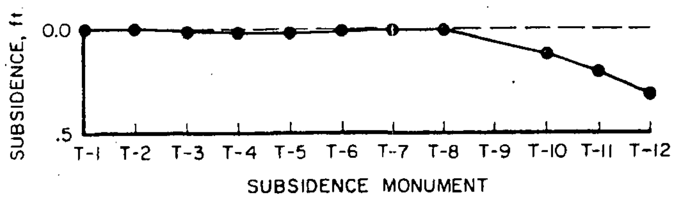

FIGURE 18.—Subsidence from T-1 to T-12.

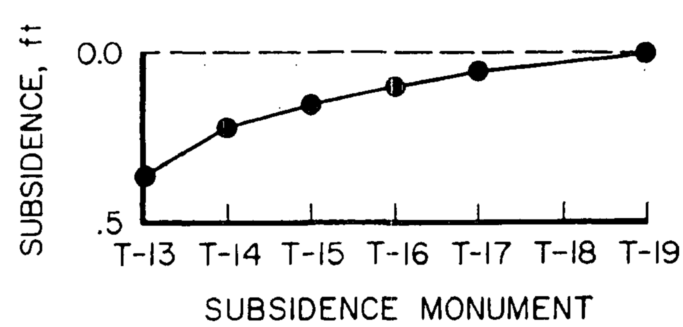

FIGURE 19.—Subsidence from T-13 to T-20.

The S-line monuments underwent horizontal movements that started at approximately S-5 and continued through S-12 (fig. 21). The movement was oriented along the line and increased linearly toward the well 50 sinkhole.

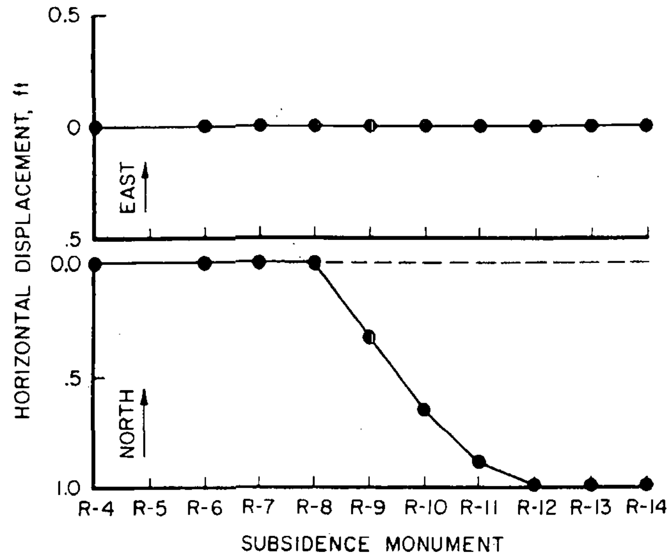

FIGURE 20.—Horizontal movement of R-4 to R-15.

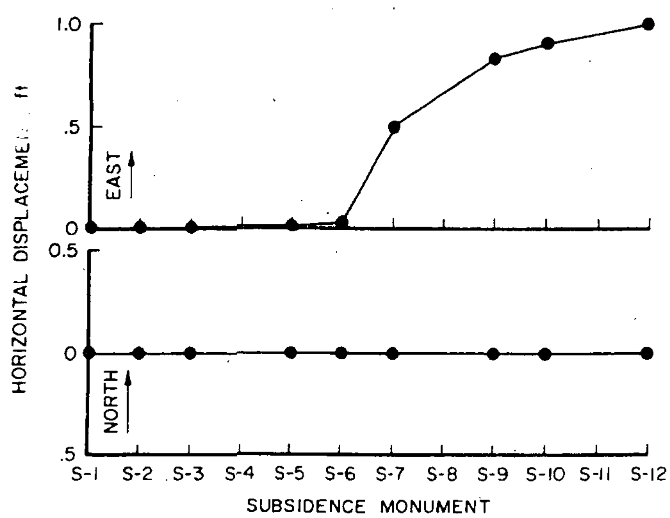

FIGURE 21.—Horizontal movement of S-1 to S-12.

The maximum horizontal movement at S-12 was measured to be approximately 1.0±0.35 ft in the direction toward the sinkhole.

The results of the surveys taken on the T-line and the R-line from R-16 to R-58 were inconclusive as to whether any horizontal movement had taken place. If any movement did occur, it was of a magnitude less than could be ascertained by the results of the horizontal surveys.

CAREY WELL 56 (FOURTH INVESTIGATION)

Background

As part of the fourth investigation, the Bureau monitored a subsidence network in the vicinity of well 56 located at the Carey brinefield. This network was designed to detect any positional changes of the ground surface due to cavity failure around well 56. The network consisted of 19 Bureau-installed subsidence monuments.

Subsidence-Monitoring Network Design and Construction

The area around well 56 was monitored by two perpendicular lines of subsidence monuments (fig. 9). The M-line (M-1 to M-9) was oriented in the east-west direction, and the N-line (N-1 to N-10) was oriented in the north-south direction. The intersection of these two lines occurred at well 56.

The design of the subsidence monuments used in the M-line and N-line was identical to that used for the monuments in the previous investigation (fig. 12). These monuments were installed by Carey personnel using the same techniques as were used by the Bureau in the third investigation.

Monitoring Procedures

As in the third investigation, the Bureau used trilateration and traverse surveying procedures for horizontal control of the subsidence-monitoring network, and trigonometric and differential surveying procedures for vertical control. The monitoring program began in May 1981 and continued through February 1983. Seven vertical and five horizontal surveys were performed.

Results

The data obtained from both the vertical and horizontal surveys indicated that no apparent movement had occurred in the area around well 56 during the time of the fourth investigation. If any movement did occur, it was of a magnitude less than could be detected by the surveys.

INTERPRETATION OF RESULTS

FIRST AND SECOND INVESTIGATIONS

The analyses of results for the first and second investigations were not performed by the Bureau and are therefore omitted from this report. The analyses can be found in publications by Hendron (1, 3-4) and Walters (6).

THIRD INVESTIGATION

The survey data indicate that the subsidence in the vicinity of the two sinkholes continued throughout the period of the investigation. The results from the exploratory drilling program indicate that sagging shale beds were resting on the roof-fall rubble pile in the well 57 solution cavity; owing to the similarity and proximity of the two wells it was inferred that the well 50 cavity roof was resting on the roof-fall rubble pile in the well 50 cavity. The behavior of the subsidence around the two sinkholes was therefore most likely a result of the gradual settling of the sagging shale beds that was caused by the continued consolidation of the rubble piles on which the shale beds rested. As the rubble piles gradually compacted, the overlying strata responded with a gradual downward deflection into the rubble-filled cavities. If the consolidation processes ceased, the subsidence would also gradually cease; however, the subsidence was not halted, implying that consolidation was still occurring in the two collapsed cavities at the end of the investigation. It is logical to assume that the consolidation processes occurring in the rubble piles will, at some point in time, be completed, and subsidence still occurring after the completion of the investigation will eventually decrease and stop.

The characteristics of the subsidence occurring over the two failed cavities indicate that gradual yet significant settlement of the ground surface can be expected after the initial collapse of a solution cavity and the formation of a sinkhole. This conclusion is further supported by the continued settling of other major sinkholes in the region; the area around the 1952 Barton sinkhole, for example, is still experiencing some minor deformations (6). It is also logical to assume that a larger volume cavity with accompanying sinkhole will experience surface deformations of greater magnitude than a smaller volume cavity; a larger volume cavity will contain a larger rubble pile, and thus experience more initial collapse and eventual consolidation. This is evidenced by comparing the deformations occurring above the well 50 cavity and the smaller well 57 cavity.

The symmetry of the ground surface deformations around the two sinkholes was due to the geometries of the underlying cavities, since the subsidence areas were similar in plan to the probable cavity geometries. The subsidence around well 50 was found to extend approximately 190 ft on the north and west sides of the sinkhole. The area east of the sinkhole was affected by a drainage canal that runs north-south in the vicinity of well 50 (fig. 9); the canal and its effects on the subsidence around the well 50 sinkhole are explained later in this section. The well 57 sinkhole, however, did not have a similar ground surface deformation pattern. The subsidence around the well 57 sinkhole was elongated in the northeast-southwest direction and had a total span of approximately 570 ft. The span of subsidence in the southeast direction was about the same as the dimensions for the well 50 sinkhole subsidence pattern. This could have been the result of a cavity extending in the northeast-southwest direction, elongated by hydraulic connections to other brine well 56 cavity to have a smaller roof span than the well 50 or well 57 cavities, it is apparent that smaller horizontal cavity dimensions were responsible for creating stable cavity conditions for well 56.

CONCLUSIONS

The four investigations performed by the Bureau in cooperation with the SMRI were designed to determine the characteristics and parameters of sinkhole formation over solution-mined salt cavities. The results from the exploratory drilling and coring investigations indicated that the Cargill sinkhole, the Barton sinkhole, and the two Carey sinkholes all were the result of solution-cavity roof failures caused by large, unsupported roof spans and deteriorating shale roof rock. In the case of the Cargill sinkhole, the cavity roof rock was completely breached, forming a chimney that piped approximately 90,000 yd^3 of surface soil into its interior. The overlying shales of the Barton and the two Carey solution cavities did not completely fail, resulting in these beds sagging and resting on the rubble piles in the solution cavities. The solution cavity of well 56 in the Carey brinefield appeared to be stable in that no sagging or major deterioration of the overlying shales had occurred.

The results of the surveying programs that monitored the ground surface around wells 50, 57, and 56 in the Carey brinefield indicated a relationship between cavity size and subsidence geometry. It was inferred from the drilling and coring program that the postfailure subsidence was due to the consolidation of the rubble piles on which the sagging shale beds rested.

It is evident after evaluating the surface monitoring and the drilling and coring data that the large, unsupported roof spans that ultimately failed were the result of the well completion and mining operation procedures used for each collapsed solution cavity. These methods allowed salt dissolution near the roofs of the cavities, creating the large, unsupported spans that eventually failed. The methods used for salt dissolution in the area have now been changed to prevent salt dissolution near the top of solution cavities so as to limit the dimensions of the cavity roofs. The resulting cavity configurations should be more stable.

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APPENDIX A.--FINAL VERTICAL CONTROL SURVEY OF CAREY BRINEFIELD

(Positive values correspond to downward movement)

Subsidence monument	Movement, ft[1]	Subsidence monument	Movement, ft[1]	Subsidence monument	Movement, ft[1]
M-1	0.02	R-19	NA	S-2	0.02
M-2	.00	R-20	0.22	S-3	.03
M-3	-.01	R-21	.13	S-4	.03
M-4	-.04	R-22	.11	S-5	.04
M-5	-.03	R-23	NA	S-6	.07
M-6	-.01	R-24	.11	S-7	NA
M-7	-.01	R-25	.09	S-8	NA
M-8	.00	R-26	.09	S-9	.75
M-9	.01	R-27	.16	S-10	NA
MV-1	.04	R-28	.10	S-11	1.44
MV-2	.01	R-29	.12	S-12	1.81
MV-3	-.01	R-30	.15	S-13	.20
MV-4	.02	R-31	.12	S-14	NA
MV-5	-.01	R-32	.14	S-15	.15
MV-6	NA	R-33	.16	S-16	NA
MV-7	.04	R-34	.18	S-17	.09
N-1	-.01	R-35	.29	S-18	.08
N-2	-.02	R-36	.23	S-19	.04
N-3	-.02	R-37	.23	S-20	.04
N-4	-.04	R-38	.26	S-21	.03
N-5	-.02	R-39	.24	T-1	.04
N-6	-.04	R-40	.49	T-2	.04
N-7	-.01	R-41	.42	T-3	.05
N-8	-.01	R-42	.32	T-4	.05
N-9	-.02	R-43	.30	T-5	.04
N-10	-.02	R-44	.30	T-6	.05
R-4	NA	R-45	.27	T-7	.01
R-5	.03	R-46	NA	T-8	.02
R-6	NA	R-47	NA	T-9	NA
R-7	.03	R-48	NA	T-10	.08
R-8	.05	R-49	.07	T-11	.14
R-9	.13	R-50	.04	T-12	.23
R-10	.37	R-51	NA	T-13	.34
R-11	.52	R-52	.02	T-14	.21
R-12	.74	R-53	.03	T-15	.15
R-13	1.03	R-54	.03	T-16	.10
R-14	1.31	R-55	.02	T-17	.05
R-15	1.58	R-56	.01	T-18	NA
R-16	.18	R-57	.01	T-19	.02
R-17	NA	R-58	.01	T-20	NA
R-18	NA	S-1	-.02		

NA Not available.

[1]Movement is elevation change between initial and final surveys.

NOTE.--Survey accuracy is ±0.04 ft. The error limits were determined by statistically averaging the standard deviations of stable subsidence monuments for all surveys.

APPENDIX B.--FINAL HORIZONTAL CONTROL SURVEY OF CAREY BRINEFIELD

(Positive values correspond to increasing easting or northing)

Subsidence monument	ΔEasting, ft[1]	ΔNorthing, ft	Subsidence monument	ΔEasting, ft[1]	ΔNorthing, ft
M-1	-0.17	0.04	R-19	NA	NA
M-2	-.19	.02	R-20	0.22	-0.20
M-3	-.06	.05	R-21	.11	-.09
M-4	-.14	.04	R-22	.23	1.61
M-5	-.20	.01	R-23	NA	NA
M-6	-.16	.02	R-24	.20	.17
M-7	-.06	.10	R-25	.14	.18
M-8	-.06	.11	R-26	.19	.03
M-9	-.04	.14	R-27	-.11	.49
MV-1	.09	.03	R-28	.17	-.02
MV-2	.07	.03	R-29	NA	NA
MV-3	.06	.03	R-30	.31	.09
MV-4	.11	.23	R-31	.13	-.03
MV-5	NA	NA	R-32	.20	-.08
MV-6	NA	NA	R-33	NA	NA
MV-7	.01	.04	R-34	.27	-.08
N-1	-.07	.05	R-35	-.02	.87
N-2	-.29	.00	R-36	.25	-.05
N-3	-.16	.03	R-37	.22	-.08
N-4	-.18	.02	R-38	.29	-.13
N-5	.01	.08	R-39	.05	-.04
N-6	-.22	-.01	R-40	-.22	.09
N-7	-.11	.05	R-41	.06	.07
N-8	-.16	.02	R-42	.04	.14
N-9	-.03	.12	R-43	.08	.13
N-10	-.12	.05	R-44	.14	.16
R-4	.26	.02	R-45	NA	NA
R-5	NA	NA	R-46	.15	.11
R-6	.26	.01	R-47	NA	NA
R-7	.22	-.04	R-48	NA	NA
R-8	.17	-.18	R-49	.26	.05
R-9	.22	-.40	R-50	.28	.01
R-10	.13	-.57	R-51	NA	NA
R-11	.17	-.62	R-52	.28	.06
R-12	.26	-.82	R-53	.28	.04
R-13	.01	-1.00	R-54	.61	.26
R-14	.13	-.97	R-55	.33	.08
R-15	NA	NA	R-56	.31	-.02
R-16	NA	NA	R-57	.20	.00
R-17	NA	NA	R-58	.25	.00
R-18	NA	NA	S-1	.26	.04

See footnotes at end of appendix.

(Positive values correspond to increasing easting or northing)

Subsidence monument	ΔEasting, ft[1]	ΔNorthing, ft	Subsidence monument	ΔEasting, ft[1]	ΔNorthing, ft
S-2............	0.31	0.13	T-1............	0.34	-0.15
S-3............	.26	.09	T-2............	.34	-.15
S-4............	NA	NA	T-3............	.33	-.15
S-5............	.27	-.02	T-4............	.21	-.27
S-6............	.36	.08	T-5............	.28	-.09
S-7............	.45	.06	T-6............	.30	-.12
S-8............	NA	NA	T-7............	.23	-.05
S-9............	.85	.09	T-8............	.26	-.07
S-10...........	.97	.30	T-9............	NA	NA
S-11...........	NA	NA	T-10...........	.31	.04
S-12...........	1.12	-.09	T-11...........	.32	.00
S-13...........	-.04	-.11	T-12...........	.30	.02
S-14...........	-.06	-.46	T-13...........	.04	-.19
S-15...........	.01	-.17	T-14...........	.08	-.06
S-16...........	NA	NA	T-15...........	.06	.04
S-17...........	.14	-.15	T-16...........	.04	.06
S-18...........	.17	-.13	T-17...........	-.70	-.14
S-19...........	.17	-.07	T-18...........	NA	NA
S-20...........	.13	-.14	T-19...........	.05	.04
S-21...........	.13	-.12	T-20...........	NA	NA

NA Not available.

[1]Movement is change in horizontal coordinates between initial and final surveys.

NOTE.--Survey accuracy is ±0.35 ft. The error limits were determined by statistically averaging the standard deviations of stable subsidence monuments for all surveys.

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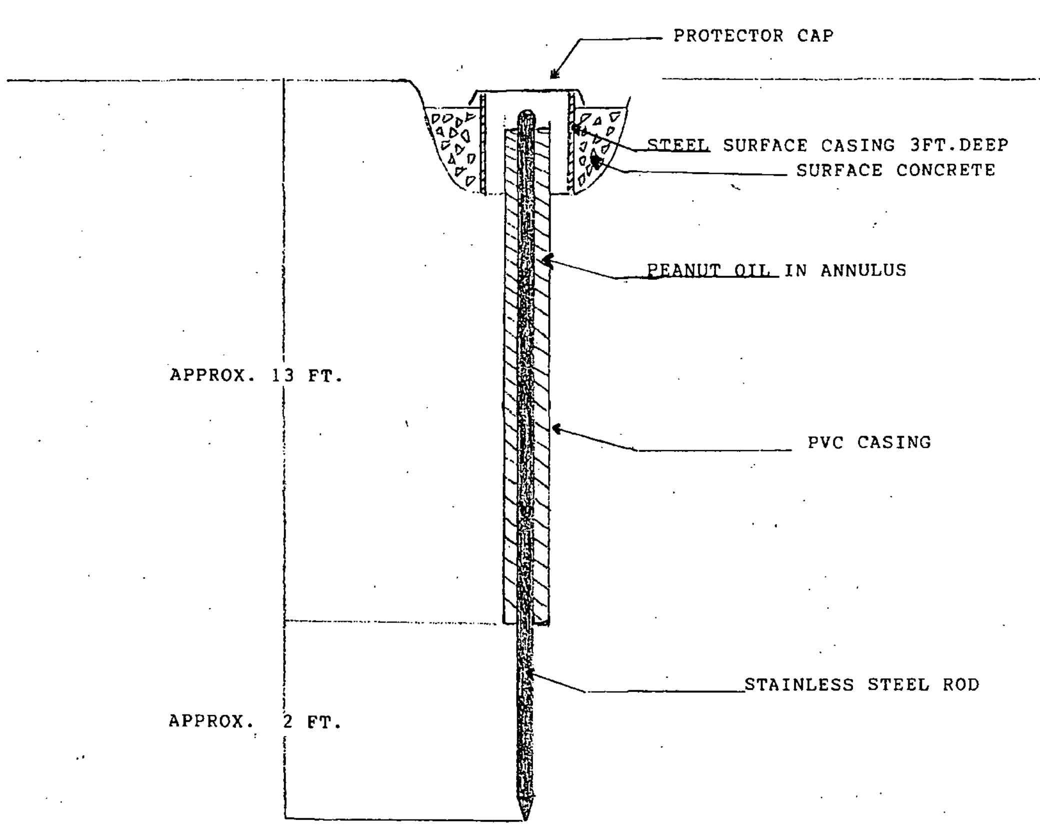

I & W, INC.
CARLSBAD, NM.
EUGENIE BRINE STATION

2.26.02

R-line (R-4 to R-15) subsidence monuments were positioned in the area around the well 50 sinkhole. These two monument lines intersected at right angles near the center of the well 50 sinkhole. The T-line (T-1 to T-20) and the remainder of the R-line (R-16 to R-58) monuments were positioned in the area around the well 57 sinkhole. These two monument lines intersected at right angles near the center of the well 57 sinkhole. The monuments R-16 to R-58 were also designed to monitor the area between the two sinkholes and were therefore oriented along the axis between the two sinkhole centers. The MV-line monuments were distributed throughout the area around the sinkholes to monitor any ground surface movements due to neighboring wells. The remainder of the survey points, including the wells, boreholes, and previously installed survey movements, were used to monitor movements of the ground surface over a large area around the two sinkholes. Control points P-1, P-2, and P-3 were placed in areas that were considered to be stable and not affected by solution mining activities; these control points were located in areas outside the area shown in figure 9. Control points SC-1 and SC-2 were located in the brinefield for the trilateration surveys and were checked for stability prior to each survey.

The 4 control points and the 103 monuments installed by the Bureau at the Carey brinefield were all of the same design and construction (fig. 12). The monument consists of a small inner pipe fitted with a pointed anchor on the bottom and a reference-marked cap on the top, and a large outer pipe which is used to drive the anchor below frost depth. The inner pipe extends through a cap on top of the outer pipe. The outer pipe is free to undergo movements due to frost heave or swelling and shrinking soils without affecting the inner pipe on which measurements are made. The monuments proved to be very stable and effectively guarded against soil distances throughout the entire time of the investigation.

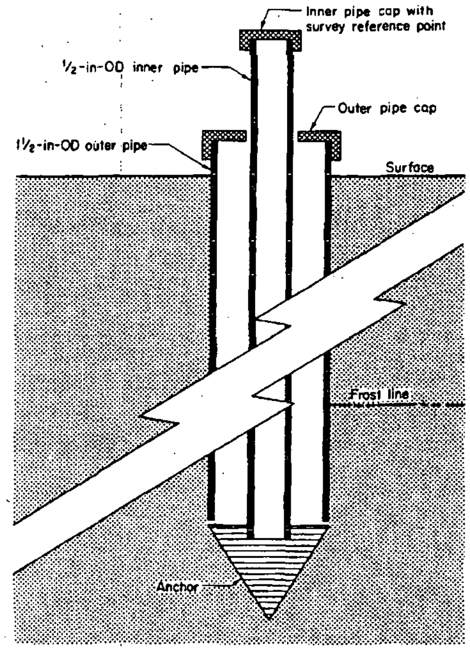

FIGURE 12.—Detail of Bureau-designed subsidence monument.

The wells, boreholes, and structures that were used as subsidence monuments all had survey marks that provided consistent reference points.

Monitoring Procedures

The procedures used to monitor positional changes in the network involved various survey techniques. Trialteration and traverse surveying procedures were used for horizontal control, and trigonometric and differential leveling procedures for vertical control. The horizontal control surveys, as well as the trigonometric level surveys, established initial and subsequent coordinates and elevations by measuring angles and distances from control points SC-1 and SC-2

Chavez, Carl J, EMNRD

From:	Chavez, Carl J, EMNRD
Sent:	Tuesday, December 09, 2008 10:17 AM
To:	'Clay Wilson'
Cc:	Price, Wayne, EMNRD; Gum, Tim, EMNRD; Guye, Gerry, EMNRD
Subject:	Sonar Testing Subsidence Monuments Information (BW-27)

Clay:

Good morning.

Please find attached some information on the construction of subsidence monuments that you requested earlier today. You indicated that you had already contacted a survey company and had some monuments constructed along with the top of well casings from your 2-well brine system. The plan was to monitor elevations monthly for 6 month to determine if there was a subsidence problem at your facility and to determine the frequency of survey monitoring at your facility. This seems like a good path forward; however, there is some concern about the construction of the monuments and we spoke about properly constructed monuments that would not fluctuate in elevation due to frost heave, etc. As requested, I have attached some guidance on monument construction.

In addition, we spoke about failed attempts to sonar test the brine wells. Please provide documentation from the sonar company of their records from their work at your facility. This information may be submitted along with the EPA 5-Yr. MIT brine well charts. In view of the lack of sonar information, subsidence monitoring will help to determine if there is a public health threat from your facility. The OCD would also recommend that a seismic monitor be placed on location that may serve as a warning to a possible collapse. Please check into this and get back with the OCD with your findings and any concerns or recommendations that you may have in regard to the seismic monitor.

Please contact me if you have questions. Thank you.

Carl J. Chavez, CHMM
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(Pollution Prevention Guidance is under "Publications")

Chavez, Carl J, EMNRD

From:	Chavez, Carl J, EMNRD
Sent:	Friday, November 14, 2008 4:38 PM
To:	'ziatransports@gmail.com'; 'jrmillett@gmail.com'; 'rharrisnm@aim.com'; 'gandy2@leaco.net'; 'seay04@leaco.net'; 'iwcarlsbad@plateautel.net'; 'Patterson, Bob'; 'Dimas Herrera'; 'gil@mull.us'; 'David Pyeatt'; 'Wayne E Roberts'; Dennis L Shearer; 'garymschubert@aol.com'; 'dgibson@keyenergy.com'; 'Clay Wilson'; 'Prather, Steve'; Ronnie D Devore
Cc:	Hill, Larry, EMNRD; Gum, Tim, EMNRD; Price, Wayne, EMNRD
Subject:	Brine Well Moratorium Press Release Today
Attachments:	PR-OCD Brine Well Moratorium.pdf

FYI, please see the attached NM OCD Press Release issued today. Thank you.

Carl J. Chavez, CHMM
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Website: http://www.emnrd.state.nm.us/ocd/index.htm
(Pollution Prevention Guidance is under "Publications")

Chavez, Carl J, EMNRD

From: Porter, Jodi, EMNRD
Sent: Friday, November 14, 2008 2:35 PM
Subject: PR-Energy, Minerals and Natural Resources Cabinet Secretary Prukop Orders a Six Month Moratorium on New Brine Wells
Attachments: PR-OCD.Brine.Well.Moratorium.pdf; image001.jpg; image015.jpg

New Mexico Energy, Minerals and Natural Resources Department

Bill Richardson
Governor

Joanna Prukop
Cabinet Secretary
Reese Fullerton
Deputy Cabinet Secretary

Mark Fesmire
Division Director
Oil Conservation Division

November 14, 2008

NEWS RELEASE

Contact: *Jodi McGinnis Porter,*
Public Information Officer 505.476.3226

Energy, Minerals and Natural Resources Cabinet Secretary Prukop Orders a Six Month Moratorium on New Brine Wells

Oil Conservation Division to Investigate Brine Well Collapses and Provide Recommendations

SANTA FE, NM – Secretary Joanna Prukop today ordered the Oil Conservation Division to place a six month moratorium on any new brine well applications located in geologically sensitive areas. Secretary Prukop's action comes following the second brine well collapse in less than four months in southeastern New Mexico. The Secretary has also directed the Oil Conservation Division to work with the Environmental Protection Agency, other states, technical experts and oil and gas industry representatives to examine the causes of recent collapses, and provide a report with recommendations to the Oil Conservation Commission for a safe path forward. The report should be completed by May 1, 2009.

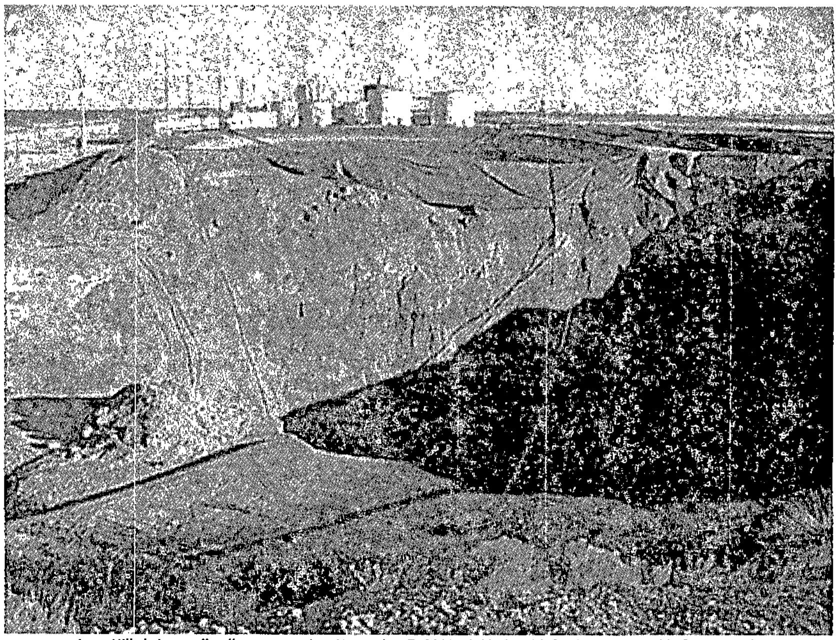
"I am deeply concerned by these two serious incidents and we are taking action to ensure the safety of our citizens and to protect the environment," stated Secretary Prukop.

Brine wells are an essential part of the oil and gas drilling industry, particularly in the southeastern part of the state. Oil and gas operators use brine water in the drilling process. Brine is saturated salt water which can be more salty than sea water. Brine is created by injecting fresh water into salt formations, allowing the water to absorb the salt and then pumping it out of the well. This method creates an underground cavity.

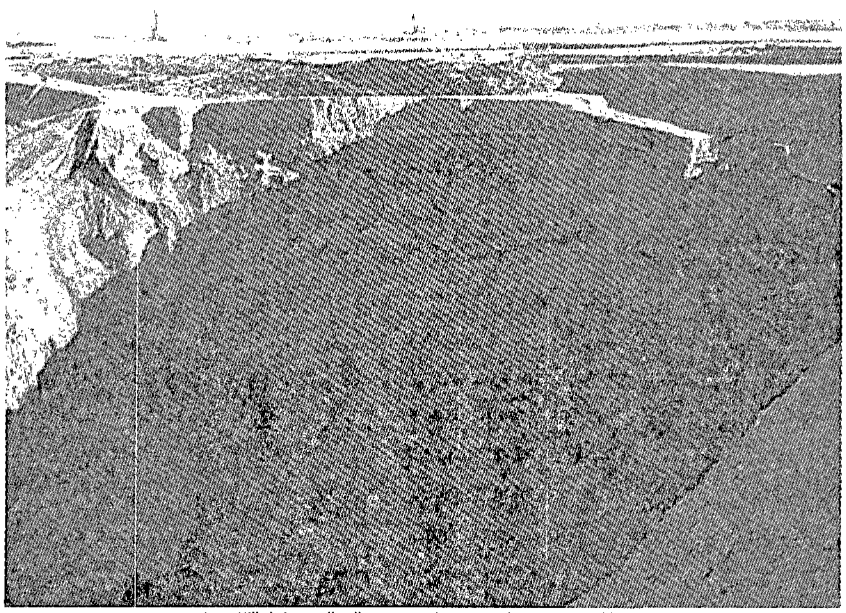
"The moratorium will provide time to properly evaluate the causes of the recent collapses and to discuss the development of new rules or guidelines to ensure the safety and stability of brine well systems," added Secretary Prukop.

The moratorium will only affect new wells and will not impact existing wells and facilities.

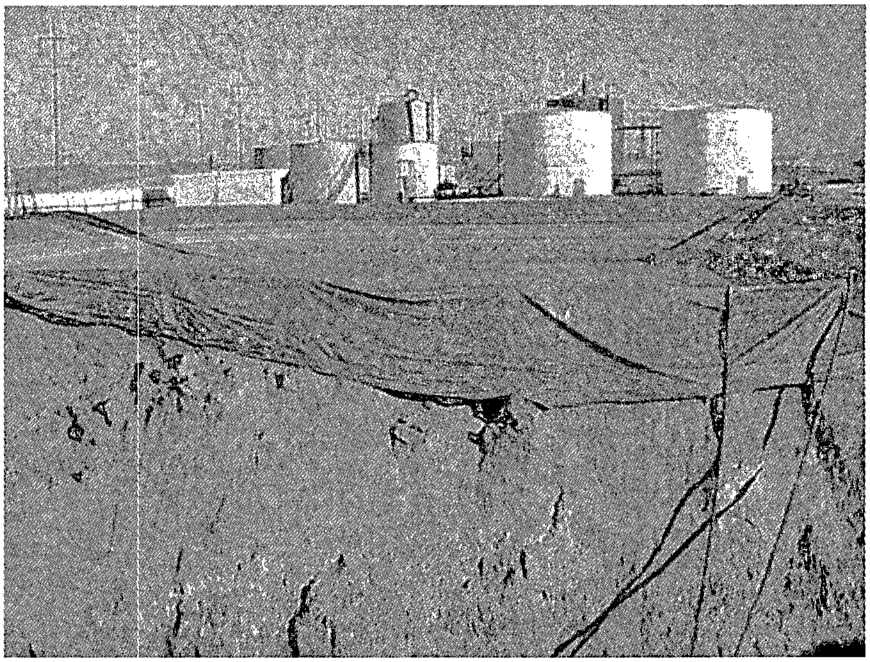
Below are photographs of the two recent collapses:



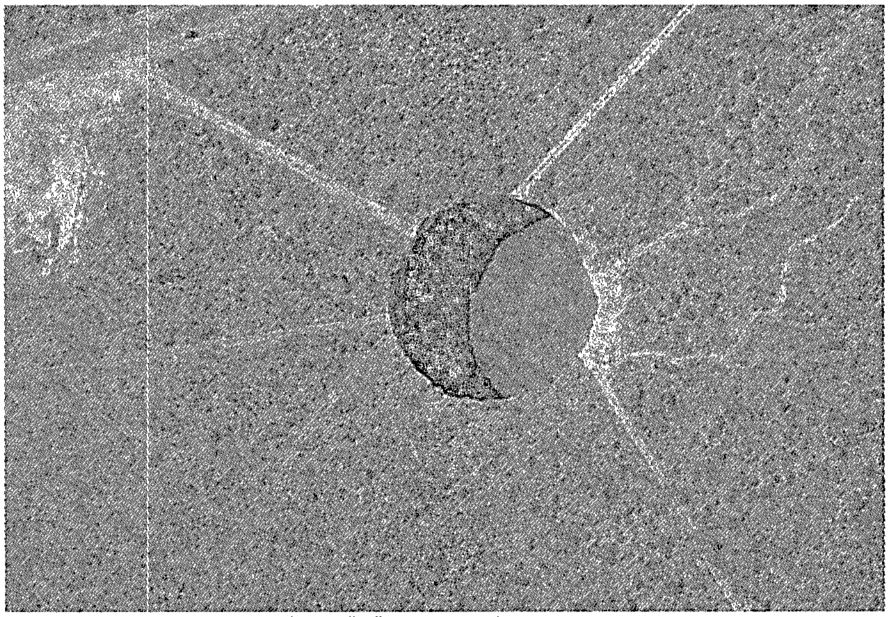
Loco Hills brine well collapse, morning, November 7, 2008, sinkhole with fresh water pond in foreground.
Photo courtesy of Oil Conservation Division



Loco Hills brine well collapse, morning, November 7, 2008 sinkhole.
Photo courtesy of Oil Conservation Division



Loco Hills brine well collapse, morning, November 7, 2008 status of fresh water pond.
Photo courtesy of Oil Conservation Division



Artesia brine well collapse, morning, July 20, 2008 at 10:44 am.
Photo courtesy of National Cave and Karst Research Institute

Artesia brine well collapse morning, July 22, 2008
Photo courtesy of National Cave and Karst Research Institute

#30#

The Energy, Minerals and Natural Resources Department provides resource protection and renewable energy resource development services to the public and other state agencies.

Oil Conservation Division
1220 South St. Francis Drive • Santa Fe, New Mexico 87505
Phone (505) 476-3440 • Fax (505) 476-3462 • www.emnrd.state.nm.us/OCD

Jodi

Jodi McGinnis Porter
Public Information Officer
Energy, Minerals and Natural Resources Department (EMNRD)
1220 South St. Francis Drive
Santa Fe, NM 87505
Phone: (505) 476-3226
Fax: (505) 476-3220
Cell: (505) 690-1689
E-mail: jodi.porter@state.nm.us
Website: www.emnrd.state.nm.us

Chavez, Carl J, EMNRD

From: Chavez, Carl J, EMNRD
Sent: Wednesday, November 12, 2008 9:09 AM
To: Chavez, Carl J, EMNRD; 'Clay Wilson'
Cc: Sanchez, Daniel J., EMNRD; Price, Wayne, EMNRD
Subject: RE: BW-27 (Dunaway No. 2) Upcoming MIT & Sonar Testing

Clay:

After speaking with my Supervisor Wayne Price, and under the current circumstances, the OCD is requiring your brine well to be sonar tested within 30 days of this notice. Since you will be performing this task, it may be prudent to conduct the MIT too. Please contact me to confirm the type of MIT this year. Thank you.

Carl J. Chavez, CHMM
New Mexico Energy, Minerals & Natural Resources Dept.
Oil Conservation Division, Environmental Bureau
1220 South St. Francis Dr., Santa Fe, New Mexico 87505
Office: (505) 476-3491
Fax: (505) 476-3462
E-mail: CarlJ.Chavez@state.nm.us
Website: http://www.emnrd.state.nm.us/ocd/index.htm
(Pollution Prevention Guidance is under "Publications")

From: Chavez, Carl J, EMNRD
Sent: Tuesday, October 21, 2008 3:24 PM
To: 'Clay Wilson'
Cc: Sanchez, Daniel J., EMNRD; Price, Wayne, EMNRD
Subject: BW-27 (Dunaway No. 2) Upcoming MIT & Sonar Testing

Clay:

Re: OCD August 1, 2008 Letter w/ Brine Well Information Request (BWIR)

Good afternoon. The Oil Conservation Division (OCD) has reviewed Mesquite's responses to the BWIRs for the above subject OCD permitted brine well. Based on the operational life and volume of brine produced from the above brine well, sonar testing is required along with your MIT on or before July 31, 2009. According to OCD records, no sonar testing has been conducted on the above subject brine well to date.

Please contact me within 8 working days to arrange the type, date and time for the MITs and corresponding date for sonar testing. Thank you.

Carl J. Chavez, CHMM
New Mexico Energy, Minerals & Natural Resources Dept.
Oil Conservation Division, Environmental Bureau
1220 South St. Francis Dr., Santa Fe, New Mexico 87505
Office: (505) 476-3491
Fax: (505) 476-3462
E-mail: CarlJ.Chavez@state.nm.us
Website: http://www.emnrd.state.nm.us/ocd/index.htm
(Pollution Prevention Guidance is under "Publications")

Chavez, Carl J, EMNRD

From: Chavez, Carl J, EMNRD
Sent: Wednesday, October 22, 2008 8:56 AM
To: Gum, Tim, EMNRD
Subject: FW: BW-27 (Dunaway No. 2) Upcoming MIT & Sonar Testing

Tim:

FYI.

Carl J. Chavez, CHMM
New Mexico Energy, Minerals & Natural Resources Dept.
Oil Conservation Division, Environmental Bureau
1220 South St. Francis Dr., Santa Fe, New Mexico 87505
Office: (505) 476-3491
Fax: (505) 476-3462
E-mail: CarlJ.Chavez@state.nm.us
Website: http://www.emnrd.state.nm.us/ocd/index.htm
(Pollution Prevention Guidance is under "Publications")

From: Chavez, Carl J, EMNRD
Sent: Tuesday, October 21, 2008 3:24 PM
To: 'Clay Wilson'
Cc: Sanchez, Daniel J., EMNRD; Price, Wayne, EMNRD
Subject: BW-27 (Dunaway No. 2) Upcoming MIT & Sonar Testing

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(Pollution Prevention Guidance is under "Publications")

New Mexico Energy, Minerals and Natural Resources Department

Bill Richardson
Governor

Joanna Prukop
Cabinet Secretary
Reese Fullerton
Deputy Cabinet Secretary

Mark Fesmire
Division Director
Oil Conservation Division

STATE OF NEW MEXICO OIL CONSERVATION DIVISION

2009 SEP 5 PM 2 14 RECEIVED

OIL CONSERVATION DIVISION
BRINE WELL INFORMATION REQUEST

GENERAL INFORMATION:

Operator Name Mesquite SWD, Inc Well Name(s) Dunaway
API Number 30-015-28083 Brine Well Permit # BW-027
Date Permit Expires? September 21, 2009

Location: Section 23 Ts 22S Rg 27E
FNL 1474 FSL ____ FEL ____ FWL 2053
GPS of well(s): Lat: Long:

Have you reviewed and understand all of your permit conditions? Yes ☒ No ☐
Are you presently deficient of any condition in your permit? Yes ☐ No ☒ Don't know ☒
Do you operate below grade tanks or pits at the site? Yes ☐ No ☒
Do all tanks, including fresh water tanks, have secondary containment? Yes ☒ No ☒
Do you think you have the expertise, knowledge and general understanding of what causes a brine well to collapse? Yes ☒ No ☐
Do you think OCD should provide guidelines on subsidence and collapse issues? Yes ☒ No ☐

SITING INFORMATION: ***Please provide the following information and depict on 7.5 minute (1": 2000') USGS Quad Map. Limit search to one mile radius.***

Is the brine well located within a municipality or city limits? Yes ☐ No ☒

Distance and direction to nearest permanent structure, house, school, *etc. if less than one mile:*

One west. 1/2 mile

Distance and direction to nearest water well *if less than one mile:*

100 yds south

Distance to nearest watercourse(s), floodplain, playa lake(s), or man-made canal(s) or pond(s) *if less than one mile:*

3/4 mile to North EAST

Distance and direction to nearest known karst features or mines *if less than one mile:*

N/A

Distance and direction to nearest producing oil or gas well(s) *if less than one mile:*
Provide API Number: 4/10 Due East 30-015-34545

Distance and direction to nearest tank battery(ies) *if less than one mile:*
Same as above.

Distance and direction to nearest pipeline(s), including fresh water pipelines *if less than one mile:* 4/10 Due West

Distance and direction to nearest paved or maintained road or railroad *if less than one mile:*
100 yards to the north.

Depth to ground water found above the Salado (salt section), regardless of yield:
180'

Name of aquifer(s):
CARLSBAD SHALLOW

WELL CONSTRUCTION: ***Please provide the following information and attach a diagram depicting the brine well. Check box if attached:***
Copy of a current well diagram: *Attached* ☒
Copy of formation record with tops: *Attached* ☒
Copy of geophysical well logs if available: *Attached* ☒ *If not, well logs within one mile* ☐

Depth of the top of the salt below ground surface (feet):
Top 1060'

Depth to the bottom of the salt below ground surface (feet):
1300' Bottom

Depth(s) to and thickness(es) of any anhydrite section(s) (located above the salt):
277' to 1054' 777' THICK

Depth of casing(s) shoe below ground surface (feet): 1064'
Is the casing shoe set in the anhydrite or other layer above the salt? Yes ☐ No ☐
Is the casing shoe set into the salt? Yes ☒ No ☐ If yes, how far into the salt? 4'

Depth of tubing(s):
1024'

Do you suspect that your cavern has partially caved in? Yes ☐ No ☐ Don't know ☒

OPERATIONS: *Please provide the following information.*

Start date of brine well operation:
1994

Total volume of fresh water injected into the brine well to date (bbls) and how determined:
N/A

Total volume of brine water produced (bbls) to date and how determined: 3,028,788 off tickets
Have you ever lost casing or tubing? If yes, please provide details. Document attached ☐
Do you maintain a surface pressure on your well during idle times? Yes☒ No☐
Have you noticed large amounts of air built up during cavity pressurization? Yes☐ No☒
Have you ever noticed fluids or air/gas bubbling up around the casing during testing or normal operations? Yes☐ No☒
MONITORING: ***Please provide the following information.***
Are you currently monitoring ground water contamination from your brine well or system? Yes ☐ No☒
Have you ever run a sonar log? Yes☐ No☒ *If yes,* please provide last date:__________
Provide cavern configuration (dimensions and volume) and method(s) used to estimate: If sonar report please attach ☐ *If other, please specify and provide a sketch of cavern:* ☐
Do you have a subsidence monitoring program in place? Yes ☐ No☒
Do you have any geophysical monitoring devices, such as a seismic device positioned near your brine well? Yes ☐ No☒
Have you submitted all of your monthly, quarterly, or annual reports to the OCD? Yes ☐ No☒
Have you failed a brine well mechanical integrity test (MIT)? If yes, please attach details and results. Attached ☐
Have you ever had a casing leak? Yes ☐ No☒ Have you ever had a cavern leak? Yes ☐ No☒ Don't know ☐ Have you ever exceeded the cavern fracture pressure? Yes ☐ No☒ Don't know ☐ Do you know how to calculate your maximum pressure? Yes ☐ No☐ Don't know ☒
Have you routinely looked for cracks or fissures in the ground surface around your brine well? Yes ☐ No☒
Do you have any minor or major cracks, fissures, tank settlement, line breakage from settlement or any minor subsidence. Yes ☐ No☒
During operations have you experienced any ground vibration, ground movement, or well movement after opening or shunting valves, pump start-up, shut-down, etc.? Yes☐ No☒

Have you ever experienced unexpected pressure gain or loss in the cavern? Yes☐ No☒ If Yes, was there a difference in your normal flow rate? Yes☐ No☐
Anytime during the past 5 years, have you experienced a noticeable difference between fresh water volume pumped into the well verses brine water produced? Yes ☐ No☒
Are you concerned about pulling the tubing due to the fact it may be difficult to re-enter the hole? Yes☐ No☒
Are you concerned about running a sonar tool in fear of losing tool because of debris in hole? Yes☐ No☒
Have you ever conducted a fly over of your well site? No☒ *Yes☐ if yes, please provide photo.* ☐ *Photo(s) attached*
Calculation: Please divide your estimated total volume of produced brine by 180,000 and multiply by 50. ***Example:*** If you have produced a total of 18,000,000 bbls of brine in the life time of the well then your calculation would be 18,000,000/180,000 = 100 x 50 = 5000. 1. Provide the calculated number above here: 3028,788/180000 = 16.83 x 50 = 841.50. 2. Now provide the depth (ft) from the surface to your casing shoe: 1064' . Is the calculated number found in #1 above greater than #2? Yes☐ No☒
Comments or recommendations for OCD:

"I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment."

MESQUITE SWD INC
Company Name-print name above

CLAY L WILSON
Company Representative- print name

Clay Wilson
Company Representative- Signature

Title: Pres.

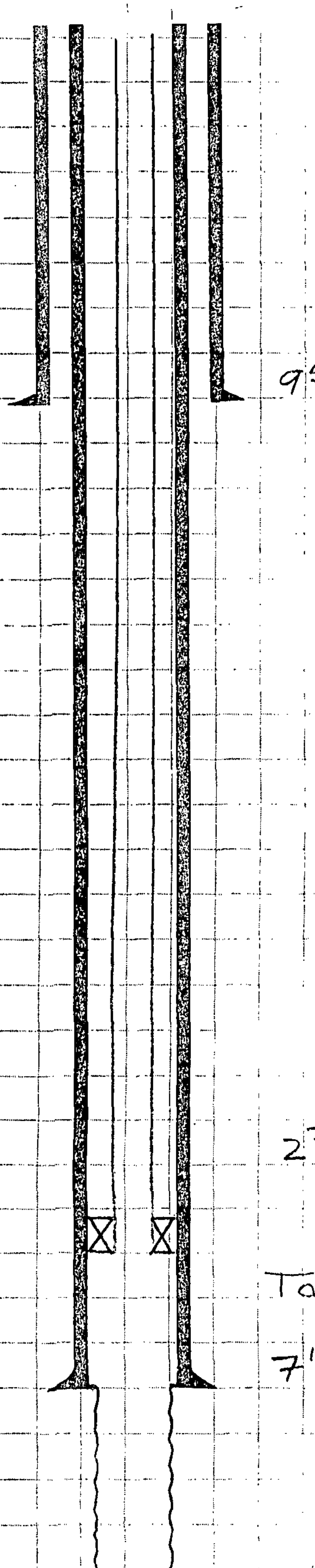
Date: 9/1/08

MESQUITE SWD, INC.

WRH inc.
Rental Tools
6482 Southeast Main
Roswell, NM 88201
Shop: (505) 347-4810
Office: (505) 622-4772

LEASE & WELL NO. DUNAWAY No. 1
FORMATION SALADO SALT
COUNTY & STATE EDDY Co. NM

1474' FNL 2053' FWL
SEC 23 T 22S R 27 E.
ELEVATION: 3091' GR



9 5/8" 36# SA 288' IN 12 1/2" HOLE W/ 160 SX PREMIUM CMT. W/ 2% $CaCl_2$. CIRC. 82 SX. OCD WITNESSED.

NOTE! 2 7/8" x 7" ANNULUS CIRC. W/ PACKER FLUID

2 7/8" 6.5# J-55 TBG - COATED SET IN HALLIBURTON R-4 TENSION PKR SA 1024'

TOP OF SALT @ 1060'

7" 23# SA 1064' IN 8 3/4" HOLE W/ 450 SX PREMIUM CMT W/ 10#/SX SALT & 2% $CaCl_2$. CIRC 150 SX TO PIT. OCD WITNESSED.

OPEN 6" HOLE TO 1300'

NOTE: NORMALLY THIS IS BRINE PRODUCTION WELL.

H 4/21/05

Order No.	Amd #	Applicant	Facility Name	Facility Type	Notes	Environmental Permit Status	Exp	Reviewer
163	0	DCP MIDSTREAM, LP			Currently in litigation. 1/31/08 CC	A	04/29/2004	Chavez
175	0	DCP MIDSTREAM, LP			Currently in litigation. 1-31-08 CC	A	01/09/2005	Chavez
28	0	NAVAJO REFINING CO. PIPELINE DIVISION			Stage 4. 6/26/2008 CC	A	10/21/2006	Chavez
14	0	REFINING CO. PIPELINE DIVISION			Stage 2 1/31/2008 CC 11/7/08	A	10/30/2006	Chavez
280	0	DCP MIDSTREAM, LP	?		Stage ~~4~~ 5 1/29/2008 CC Recd 1,700 11/23/08 6/13/07	A	06/10/2007	Chavez
288	0	DCP MIDSTREAM, LP	Pardue CS	CS	Recently Rpt - Closure Recd $100 8/29/07 Stage 4. 3/12/2008 CC	A	11/24/2007	Chavez
44	0	DCP MIDSTREAM, LP	? Hobbs Booster Station		GW Monitoring - Can't close Stage 4. 3/12/2008.CC ~~(Move forward for DP.)~~	A	12/23/2007	Chavez
7	0	WESTERN REFINING COMPANY, L.P.	Jal LPG Storage Facility 6/16/08	LPG Storage	5 6/16/08 CC Stage ~~4~~ - ~~5/23/08~~ CC	A	12/29/2007	Chavez
148	0	TEPPCO GP, INC	Pump Mesa CS	CS	Stage ~~1~~ 2 ~~1/31/2008~~ CC 9/5/2008 (All Fees $1800)	A	08/19/2008	Chavez
146	0	TEPPCO GP, INC			Stage 1. 1/31/2008 CC	A	08/19/2008	Chavez
144	0	DCP MIDSTREAM, LP	?		Stage 1. 1/31/2008 CC ~~Recd $100 11/25/08~~	A	08/19/2008	Chavez
150	0	DCP MIDSTREAM, LP	Pure Gold 28 CS	CS	Stage 2 9/17/2008 CC $1,700 recd 2/26/08	A	11/22/2008	Chavez

Called left msg. on status of chk & DP Applications

8/7/08

$100 Filg Fee

Chavez, Carl J, EMNRD

From: Lang, Ruth M [RMLang@dcpmidstream.com]
Sent: Tuesday, October 07, 2008 5:48 PM
To: Chavez, Carl J, EMNRD
Cc: Price, Wayne, EMNRD; Kocis, Diane E
Subject: RE: DCP Midstream LP Status of DPs (GWs 44, 144, 150, 280 & 288)
Attachments: Discharge Permit GW-280_061307 (2).pdf

Diane's contact information is:

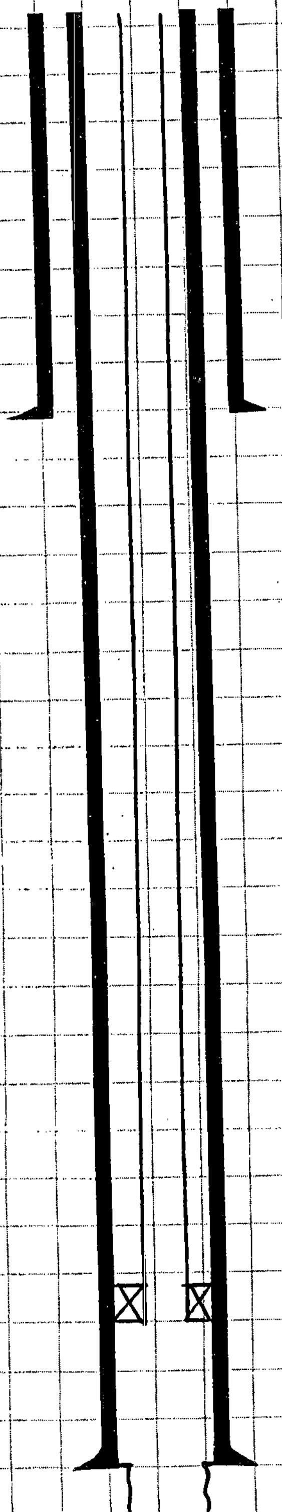
1 Diane Kocis
Dekocis@dcpmidstream.com
303-605-2176 office
DCP Midstream, LP
370 17th Street, Suite 2500
Denver, CO 80202

MESQUITE SWD, INC.

WRH inc.
Rental Tools
6482 Southeast Main
Roswell, NM 88201
Shop: (505) 347-4810
Office: (505) 622-4772

LEASE & WELL NO. DUNAWAY No. 2
FORMATION SALADO SALT
COUNTY & STATE EDDY CO. NM

1443' FNL 1698' FWL
SEC. 23 T22S R27E
ELEVATION: 3094' GR



9 5/8" 36# SA 284' IN 12 1/2" HOLE W/ 140 SX PREMIUM CMT W/ 2% $CaCl_2$. CIRC. 58 SX. OCD WITNESSED.

NOTE: 2 7/8" x 7" ANNULUS CIRC. W/ PACKER FLUID

2 7/8" 6.5 # J-55 COATED TBG SET IN HALLIBURTON R-4 TENSION PKR SA 1223'

7" 23# SA 1231' IN 8 3/4" HOLE W/ 475 SX PREMIUM CMT W/ 15#/SX SALT & 2% $CaCl_2$. CIRC 12 SX TO PIT. OCD WITNESSED.

OPEN 6" HOLE TO 1271'

NOTE: NORMALLY THIS IS FRESH WATER INJECTION WELL.

H 4/21/05

New Mexico Office of the State Engineer
POD Reports and Downloads

Township: 22S Range: 27E Sections: 23

NAD27 X: Y: Zone: Search Radius:

County: ED Basin: Number: Suffix:

Owner Name: (First) (Last) ○ Non-Domestic ○ Domestic ◉ All

POD / Surface Data Report | Avg Depth to Water Report | Water Column Report

Clear Form | iWATERS Menu | Help

WATER COLUMN REPORT 10/08/2008

(quarters are 1=NW 2=NE 3=SW 4=SE)
(quarters are biggest to smallest)

POD Number	Tws	Rng	Sec	q	q	q	Zone	X	Y	Depth Well	Depth Water	Water Column (in feet)
C 01776	22S	27E	23	1	3					157	40	117
C 00231 A	22S	27E	23	1	4	1				178	45	133
C 03063	22S	27E	23	1	4	1				163	40	123
C 01713	22S	27E	23	3	1	3				101	46	55
C 01242	22S	27E	23	3	3	1				155	40	115
C 01273	22S	27E	23	3	4					150	50	100

Record Count: 6

New Mexico Office of the State Engineer
POD Reports and Downloads

Township: 22S Range: 27E Sections: 23

NAD27 X: Y: Zone: Search Radius:

County: ED Basin: Number: Suffix:

Owner Name: (First) (Last) ○ Non-Domestic ○ Domestic ◉ All

POD / Surface Data Report | Avg Depth to Water Report

Water Column Report

Clear Form | iWATERS Menu | Help

AVERAGE DEPTH OF WATER REPORT 10/08/2008

								(Depth Water in Feet)		
Bsn	Tws	Rng	Sec	Zone	X	Y	Wells	Min	Max	Avg
C	22S	27E	23				6	40	50	44

Record Count: 6

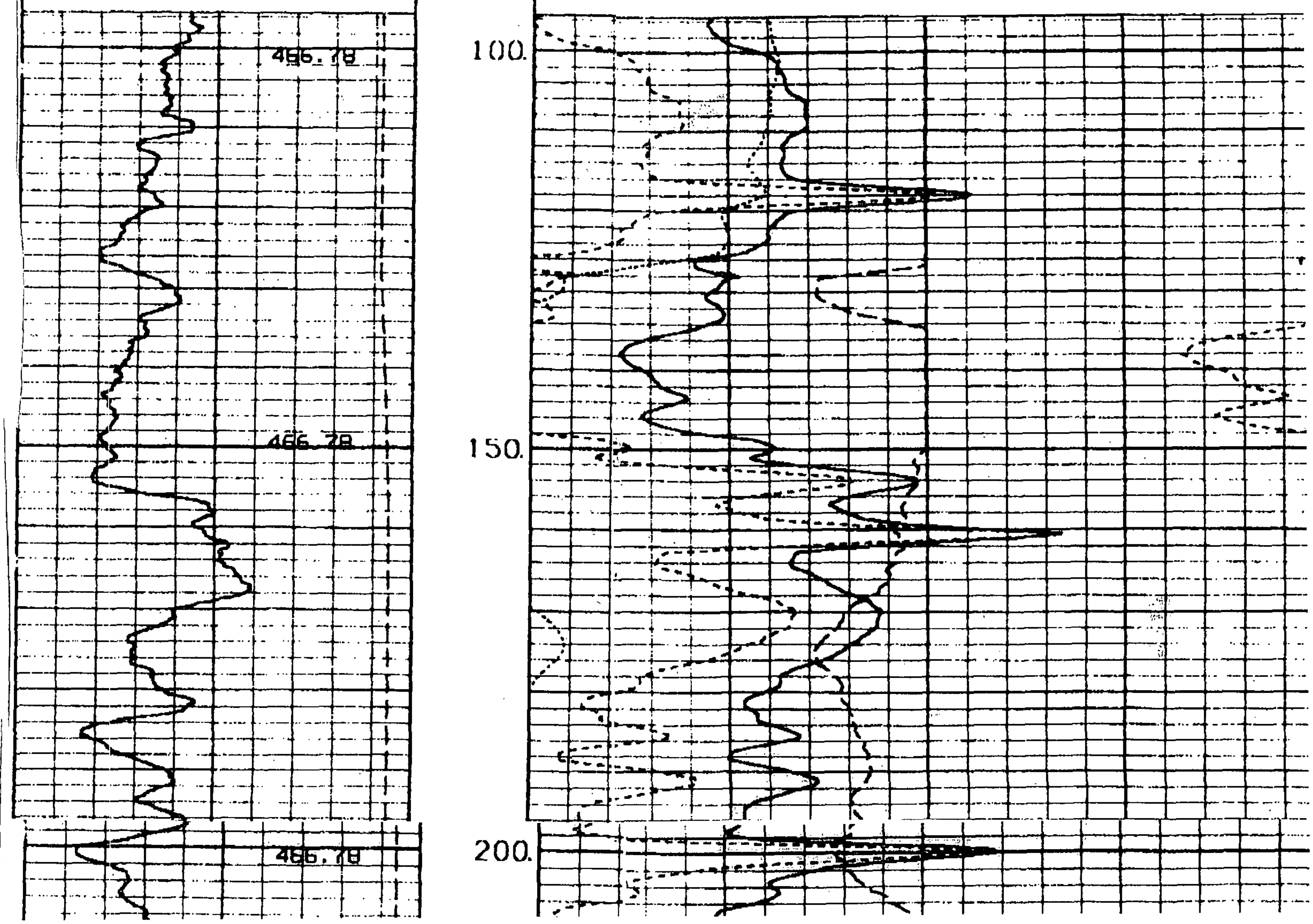
DUNAWAY

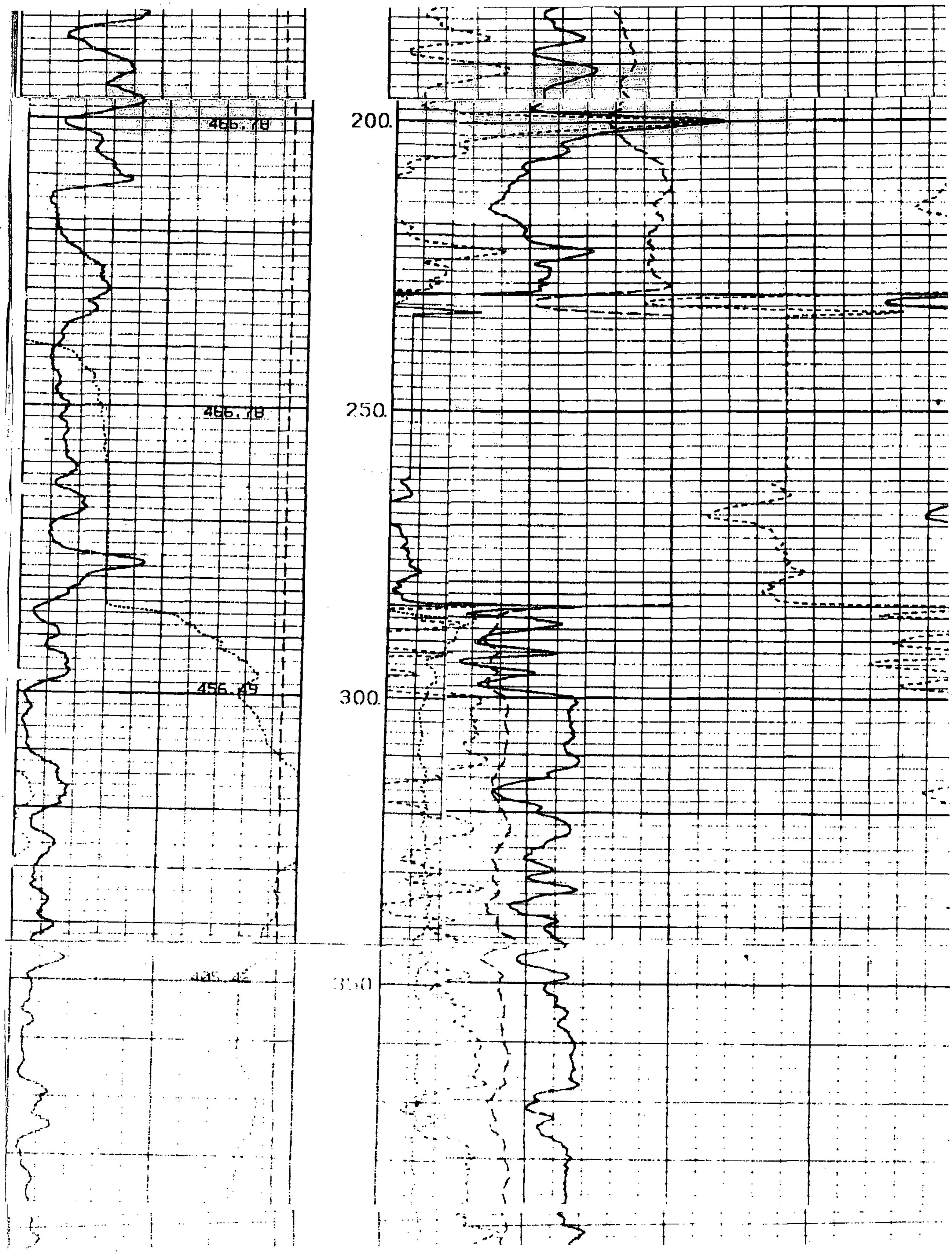
MAIN PASS 5"=100'

CALIPER		
6	INCHES	16
	GAMMA	
0	API	100
	TENSION	
10000	POUNDS	0

	DEN POROSITY	
30	PERCENT MATRIX DENSITY = 2.71	-1
SALT	BULK DENSITY	ANHY
2.0	GM/CC	3.

	DENSITY CORR	
-0.1	GM/CC	0.9
	PE	
0		10

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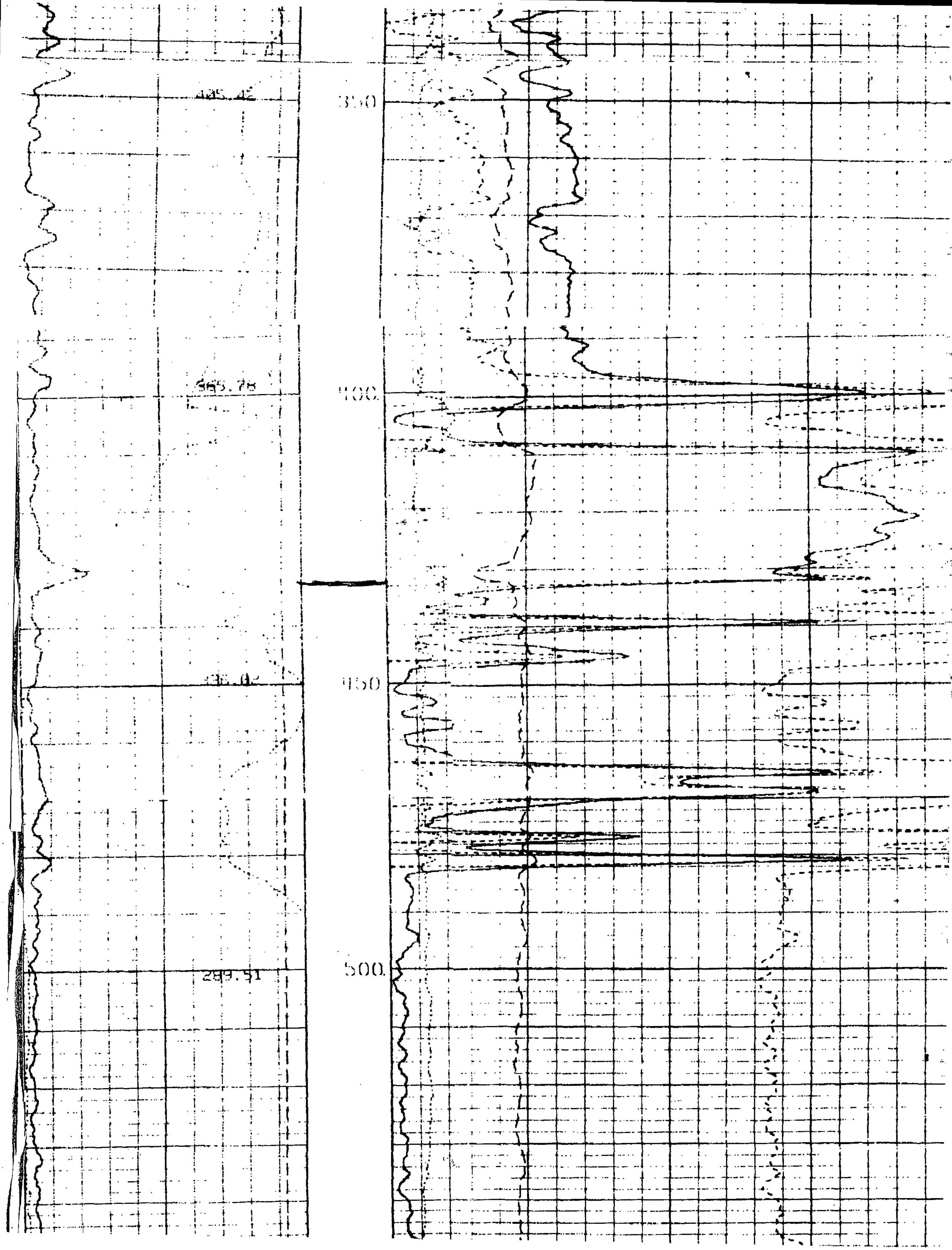
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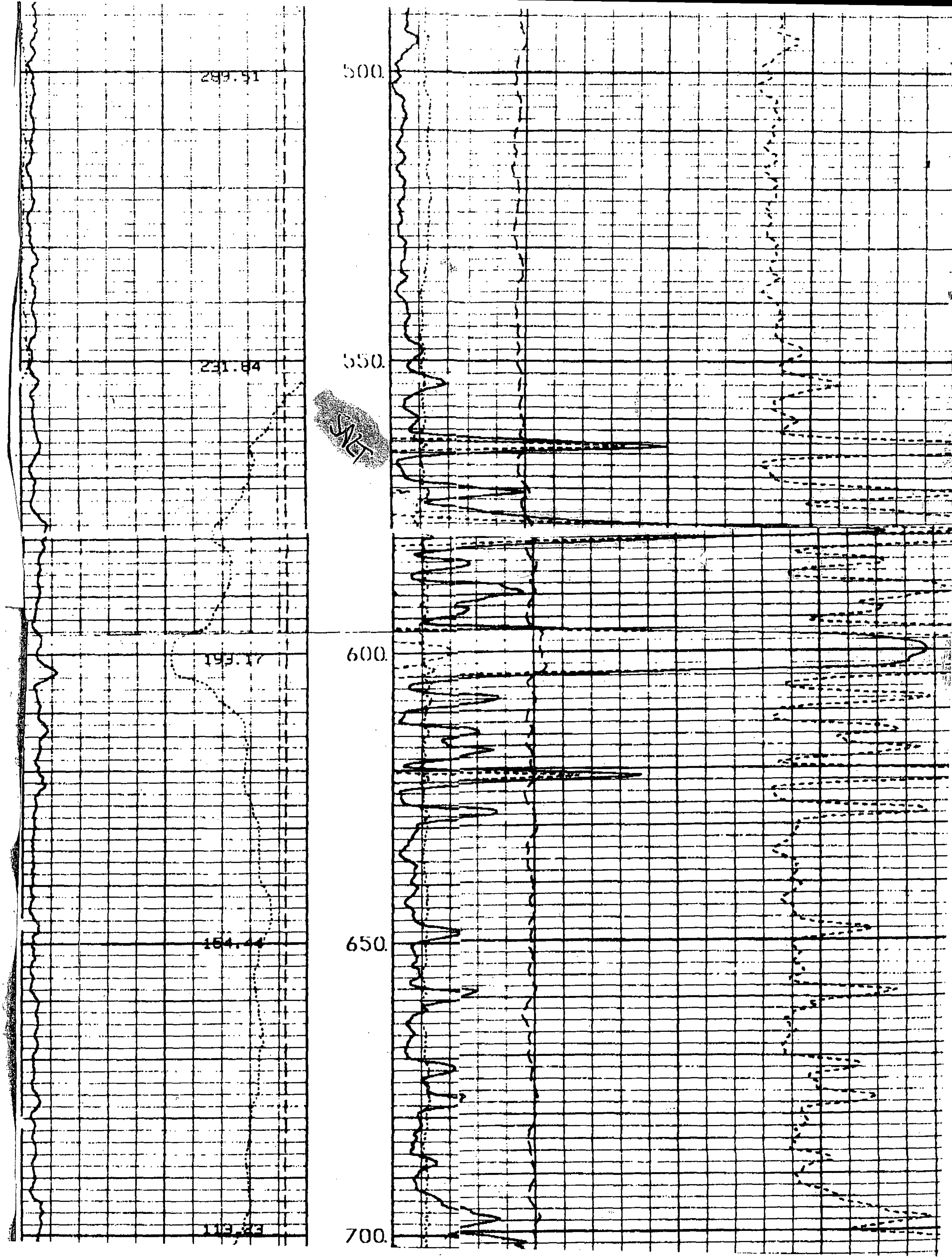
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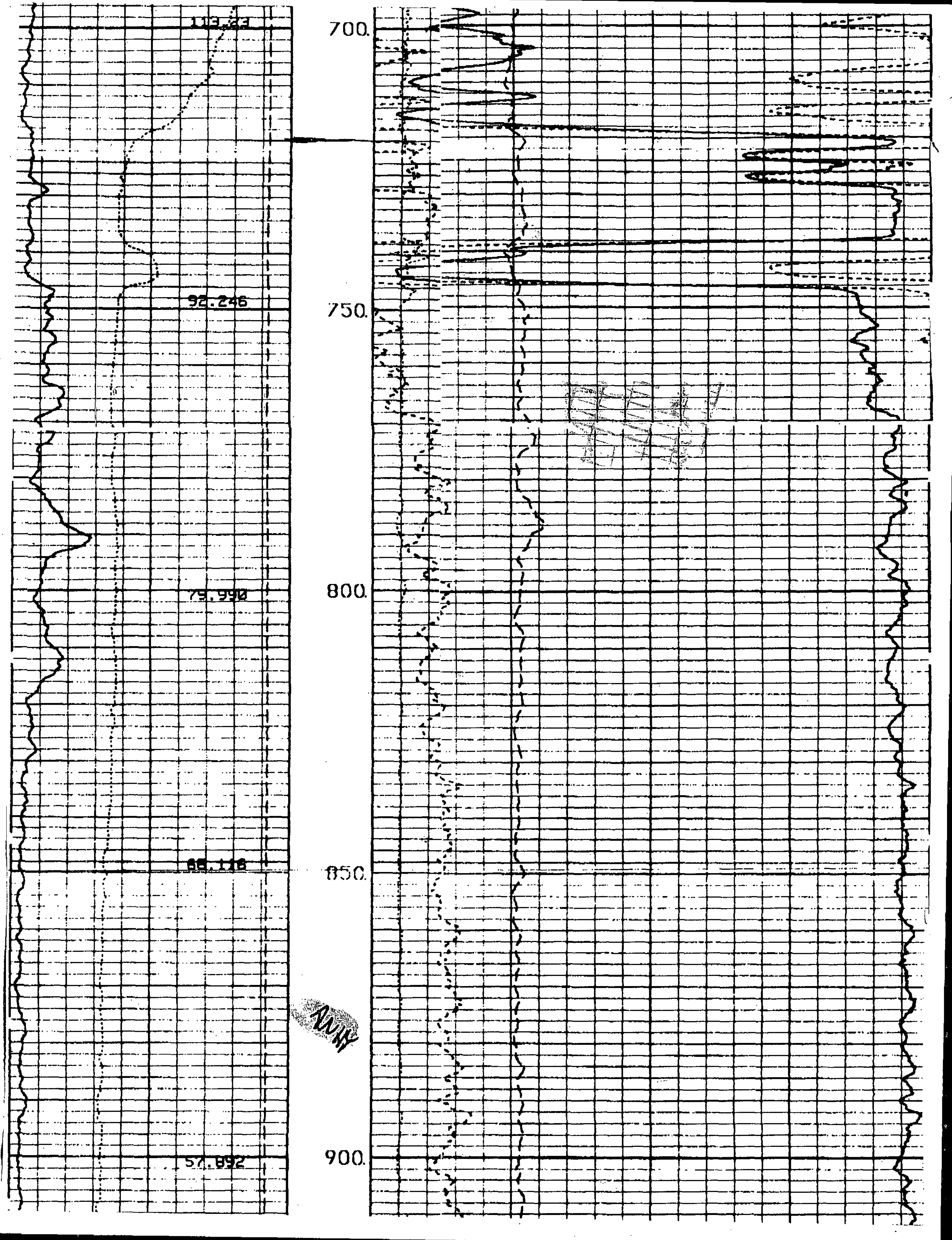
700.



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79.990
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57.892
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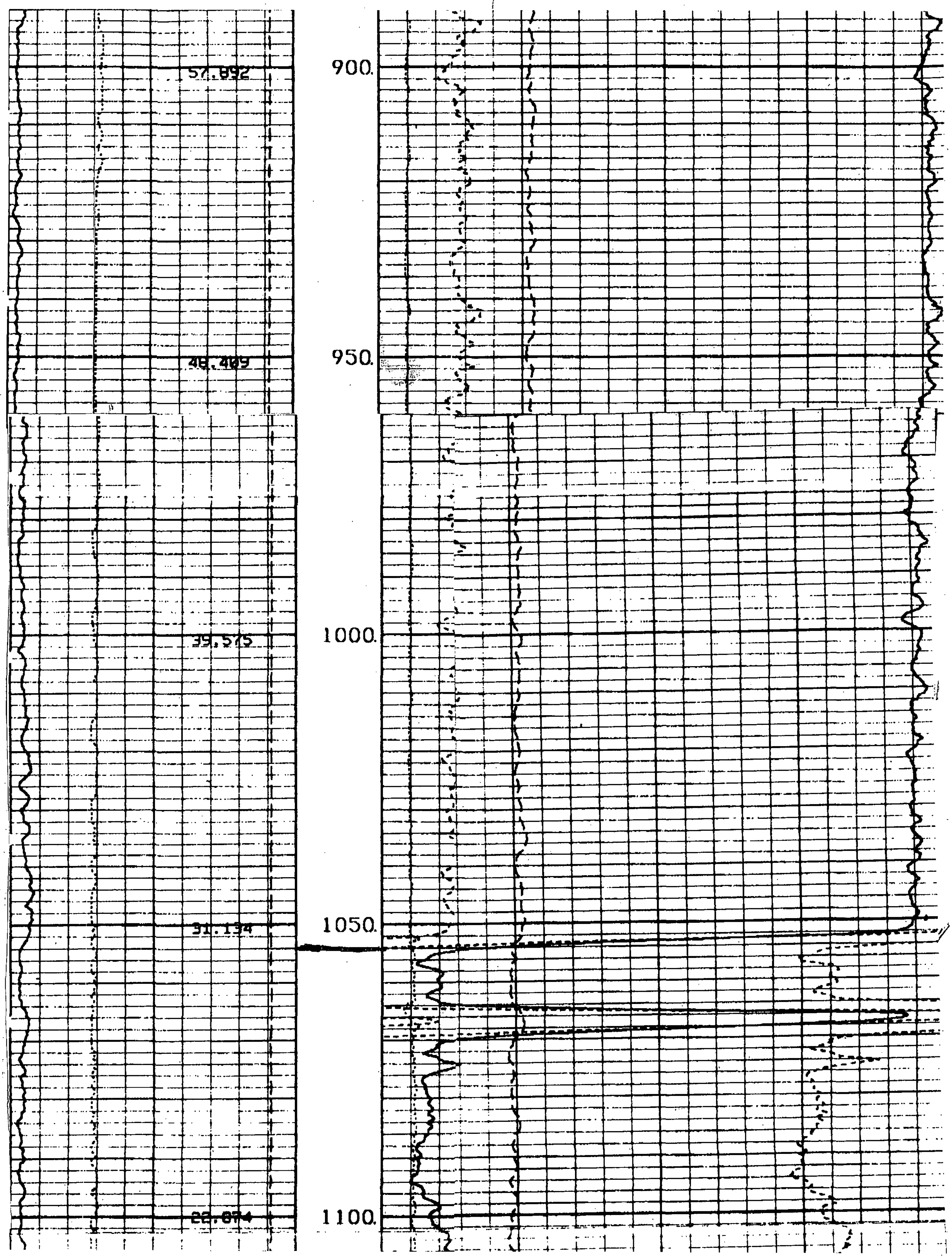
750.
800.
850.
900.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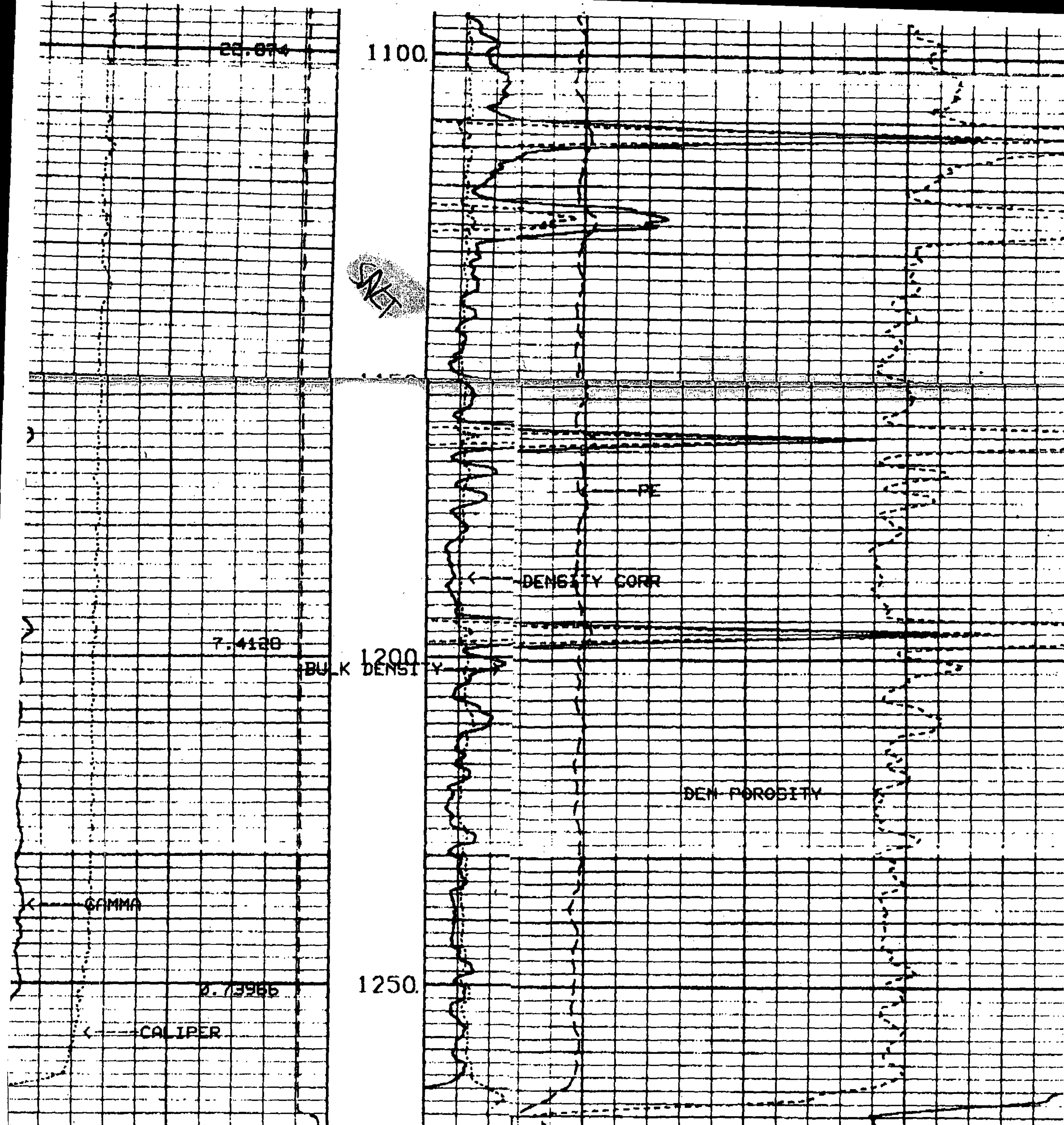
39.575
31.134
22.874
900.
950.
1000.
1050.
1100.



TENSION

10000 POUNDS 0

GAMMA

0 API 100

PE

0 10

DENSITY CORR

-0.1 GM/CC 0.9

BULK DENSITY

2.0 GM/CC 3.0

New Mexico Energy, Minerals and Natural Resources Department

Bill Richardson
Governor

Joanna Prukop
Cabinet Secretary
Reese Fullerton
Deputy Cabinet Secretary

Mark Fesmire
Division Director
Oil Conservation Division

Certified Receipt/Return Requested:

August 01, 2008

Attention Brine Well Operator(s):

One of the permitted brine wells has experienced a total collapse and created an enormous sinkhole. The well was located approximately 17 miles SE of Artesia, NM. on State Trust Land. The operator was Jim's Water Service and the brine well permit is BW-005. OCD has enclosed a press release with photos of the event.

The magnitude of this event warrants an immediate investigation of all brine wells in the state. Therefore, please find enclosed a "BRINE WELL INFORMATION REQUEST" form to be filled out and returned to this office no later than September 05, 2008. Failure to properly fill out and return the form in a timely manner may result in OCD requesting you shut down your operations until further notice. If you have any questions please do not hesitate to call me at 505-476-3490 or E-mail wayne.price@state.nm.us.

Sincerely,

Wayne Price
Environmental Bureau Chief
Oil Conservation Division

Attachments: (2)

Cc: EMNRD Cabinet Secretary-Joanna Prukop
OCD Director-Mark Fesmire
NMSLO- Brian Henington SF, Jim Carr-Carlsbad
BLM-Carlsbad Office- Dave Herrell
Eddy Co. Emergency Management-Joel Arnwine
NM State Police –Roswell Sgt. Les Clements
National Cave and Karst Research Institute- Dr. George Veni
NMOSE-John Stewart
Solution Mining Research Institute-John Voigt

Price, Wayne, EMNRD

From: Porter, Jodi, EMNRD
Sent: Wednesday, July 23, 2008 5:00 PM
Subject: PR-Secretary Prukop Proposes Stricter Conditions on Brine Wells State-wide
Attachments: PR-OCD.Brine.Wells07.23.08.pdf

New Mexico Energy, Minerals and Natural Resources Department

Bill Richardson
Governor

Joanna Prukop
Cabinet Secretary
Reese Fullerton
Deputy Cabinet Secretary

Mark Fesmire
Division Director
Oil Conservation Division

STATE OF NEW MEXICO
OIL CONSERVATION DIVISION

July 23, 2008

NEWS RELEASE

Contact: Jodi McGinnis Porter,
Public Information Officer 505.476.3226

Energy, Minerals and Natural Resources Cabinet Secretary Joanna Prukop Proposes Stricter Conditions on Brine Wells State-wide

Artesia brine well collapse prompts statewide review

SANTA FE, NM – Secretary Joanna Prukop has directed the Oil Conservation Division (OCD) to conduct a complete evaluation of the rules and regulations concerning brine wells, a method of creating saturated salt water used in oil and gas production. The OCD evaluation will include an internal audit and inspection of all existing brine wells in New Mexico. Secretary Prukop is considering strengthening oversight of brine wells to protect against well failures such as the recent collapse in Artesia that created a huge sinkhole and forced the closure of an Eddy County road.

"There are several brine wells in New Mexico and we must ensure that they are all properly monitored to ensure safety and stability," stated Cabinet Secretary Joanna Prukop. "We have now seen that these wells can collapse and the extensive damage such a collapse can generate."

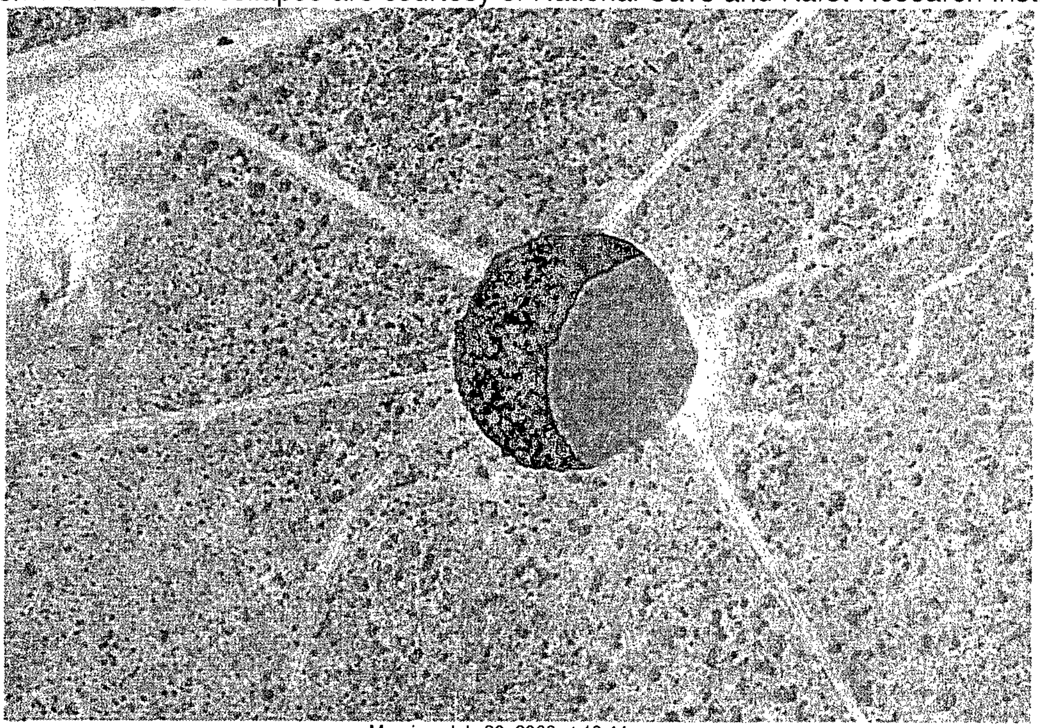
The Oil Conservation Division is continuing to monitor and investigate the collapse of the brine well, located on state trust land 17.3 miles southeast of Artesia, which is still active. The well is owned by Jim's Water Service. County Road 217 remains closed as a safety precaution, and a command center is on site. Division engineers estimate that the well is approximately 300 to 400 feet in diameter, 70 feet to the water level, and the actual depth to the bottom is unknown.

Scientists from the Oil Conservation Division, the Bureau of Land Management, State Land Office, the New Mexico

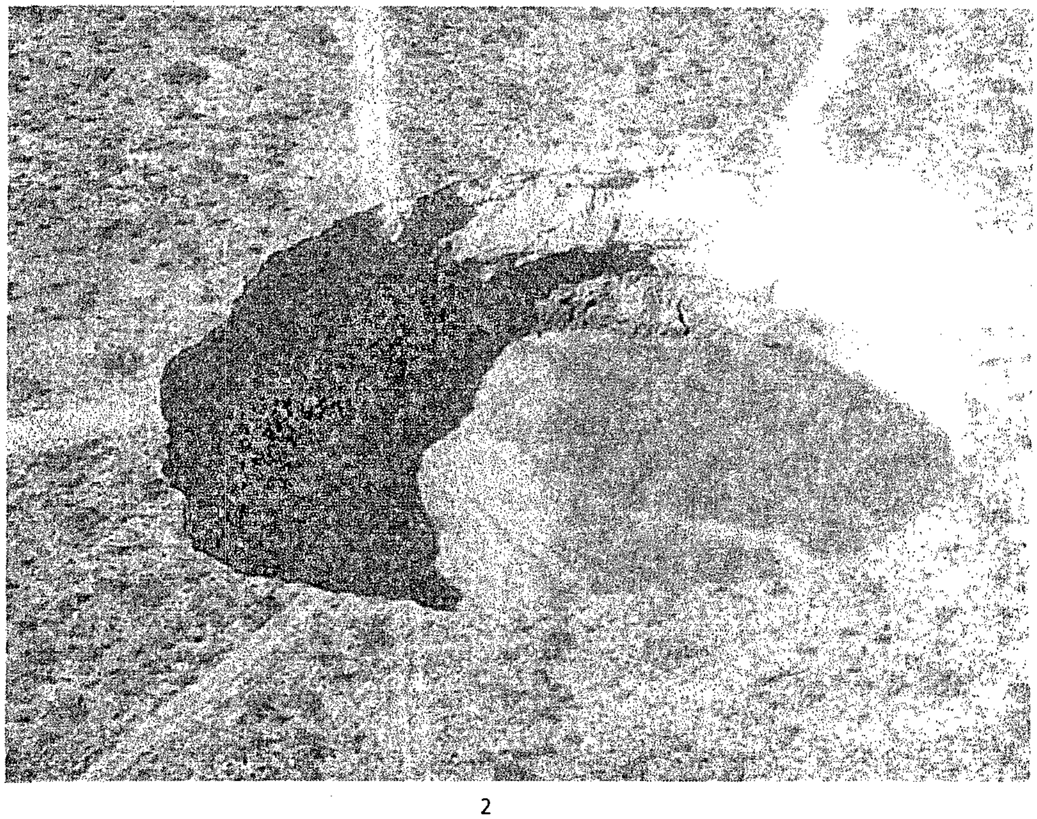
Bureau of Geology and Mineral Resources, and the National Cave & Karst Research Institute are all working together to assess horizontal and vertical movements to project any future subsidence. Work on a protective fence and keep-out signage began yesterday with completion expected on Friday.

In a related issue, the Oil Conservation Division has also been closely monitoring a brine well operated by I & W, Inc located in Carlsbad, NM. Yesterday, following ongoing inquiries from OCD the operator decided voluntarily to stop operation of the well The division will work with I & W, Inc. to ensure that the well is properly plugged, permanently abandoned, and monitored for the long term.

Images provided on the brine well collapse are courtesy of National Cave and Karst Research Institute:



Morning, July 20, 2008 at 10:44 am.
courtesy of National Cave and Karst Research Institute



Bill Richardson
Governor

Joanna Prukop
Cabinet Secretary
Reese Fullerton
Deputy Cabinet Secretary

Mark Fesmire
Division Director
Oil Conservation Division

OIL CONSERVATION DIVISION
BRINE WELL INFORMATION REQUEST

GENERAL INFORMATION:

Operator Name__________________________ Well Name(s)______________________________
API Number __________________________ Brine Well Permit # ______________________
Date Permit Expires? ________________________

Location: Section ____________Ts ____________ Rg ___________________
FNL______________FSL________________FEL_____________FWL______________
GPS of well(s): Lat: Long:

Have you reviewed and understand all of your permit conditions? Yes ☐ No☐
Are you presently deficient of any condition in your permit? Yes ☐ No☐ Don't know☐
Do you operate below grade tanks or pits at the site? Yes☐ No☐
Do all tanks, including fresh water tanks, have secondary containment? Yes☐ No☐
Do you think you have the expertise, knowledge and general understanding of what causes a brine well to collapse? Yes☐ No☐
Do you think OCD should provide guidelines on subsidence and collapse issues? Yes☐ No☐

SITING INFORMATION: ***Please provide the following information and depict on 7.5 minute (1": 2000') USGS Quad Map. Limit search to one mile radius.***

Is the brine well located within a municipality or city limits? Yes☐ No☐

Distance and direction to nearest permanent structure, house, school, *etc. if less than one mile:*

Distance and direction to nearest water well *if less than one mile:*

Distance to nearest watercourse(s), floodplain, playa lake(s), or man-made canal(s) or pond(s) *if less than one mile:*

Distance and direction to nearest known karst features or mines *if less than one mile:*

Distance and direction to nearest producing oil or gas well(s) *if less than one mile:* Provide API Number:
Distance and direction to nearest tank battery(ies) *if less than one mile:*
Distance and direction to nearest pipeline(s), including fresh water pipelines *if less than one mile:*
Distance and direction to nearest paved or maintained road or railroad *if less than one mile:*
Depth to ground water found above the Salado (salt section), regardless of yield:
Name of aquifer(s):
WELL CONSTRUCTION: ***Please provide the following information and attach a diagram depicting the brine well. Check box if attached:*** *Copy of a current well diagram:* *Attached* ☐ *Copy of formation record with tops:* *Attached* ☐ *Copy of geophysical well logs if available:* *Attached* ☐ *If not, well logs within one mile* ☐
Depth of the top of the salt below ground surface (feet):
Depth to the bottom of the salt below ground surface (feet):
Depth(s) to and thickness(es) of any anhydrite section(s) (located above the salt):
Depth of casing(s) shoe below ground surface (feet):________________________ Is the casing shoe set in the anhydrite or other layer above the salt? Yes ☐ No ☐ Is the casing shoe set into the salt? Yes☐ No☐ If yes, how far into the salt?______________
Depth of tubing(s):
Do you suspect that your cavern has partially caved in? Yes☐ No☐ Don't know☐
OPERATIONS: *Please provide the following information.*
Start date of brine well operation:
Total volume of fresh water injected into the brine well to date (bbls) and how determined:

Total volume of brine water produced (bbls) to date and how determined:
Have you ever lost casing or tubing? If yes, please provide details. Document attached ☐
Do you maintain a surface pressure on your well during idle times? Yes☐ No☐
Have you noticed large amounts of air built up during cavity pressurization? Yes☐ No☐
Have you ever noticed fluids or air/gas bubbling up around the casing during testing or normal operations? Yes☐ No☐
MONITORING: ***Please provide the following information.***
Are you currently monitoring ground water contamination from your brine well or system? Yes ☐ No☐
Have you ever run a sonar log? Yes☐ No☐ *If yes,* please provide last date:______________________________
Provide cavern configuration (dimensions and volume) and method(s) used to estimate: If sonar report please attach ☐ *If other, please specify and provide a sketch of cavern:* ☐
Do you have a subsidence monitoring program in place? Yes ☐ No☐
Do you have any geophysical monitoring devices, such as a seismic device positioned near your brine well? Yes ☐ No☐
Have you submitted all of your monthly, quarterly, or annual reports to the OCD? Yes ☐ No☐
Have you failed a brine well mechanical integrity test (MIT)? If yes, please attach details and results. Attached ☐
Have you ever had a casing leak? Yes ☐ No☐ Have you ever had a cavern leak? Yes ☐ No☐ Don't know ☐ Have you ever exceeded the cavern fracture pressure? Yes ☐ No☐ Don't know ☐ Do you know how to calculate your maximum pressure? Yes ☐ No☐ Don't know ☐
Have you routinely looked for cracks or fissures in the ground surface around your brine well? Yes ☐ No☐
Do you have any minor or major cracks, fissures, tank settlement, line breakage from settlement or any minor subsidence. Yes ☐ No☐
During operations have you experienced any ground vibration, ground movement, or well movement after opening or shunting valves, pump start-up, shut-down, etc.? Yes☐ No☐

Have you ever experienced unexpected pressure gain or loss in the cavern? Yes☐ No☐ If Yes, was there a difference in your normal flow rate? Yes☐ No☐
Anytime during the past 5 years, have you experienced a noticeable difference between fresh water volume pumped into the well verses brine water produced? Yes ☐ No☐
Are you concerned about pulling the tubing due to the fact it may be difficult to re-enter the hole? Yes☐ No☐
Are you concerned about running a sonar tool in fear of losing tool because of debris in hole? Yes☐ No☐
Have you ever conducted a fly over of your well site? No☐ *Yes☐ if yes, please provide photo.* ☐ *Photo(s) attached*
Calculation: Please divide your estimated total volume of produced brine by 180,000 and multiply by 50. ***Example:*** If you have produced a total of 18,000,000 bbls of brine in the life time of the well then your calculation would be 18,000,000/180,000 = 100 x 50 = 5000. 1. Provide the calculated number above here:____. 2. Now provide the depth (ft) from the surface to your casing shoe:__________________. Is the calculated number found in #1 above greater than #2? Yes☐ No☐
Comments or recommendations for OCD:

"I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment."

____
Company Name-print name above

____
Company Representative- print name

____
Company Representative- Signature

Title________________________________

Date:________________________________

Chavez, Carl J, EMNRD

From:	Chavez, Carl J, EMNRD
Sent:	Friday, July 25, 2008 4:21 PM
To:	Hansen, Edward J., EMNRD; Price, Wayne, EMNRD
Cc:	Sanchez, Daniel J., EMNRD
Subject:	RE: PR-Secretary Prukop Proposes Stricter Conditions on Brine Wells State-wide
Attachments:	image001.jpg; image007.jpg

Ed, Wayne, et. al:

Based on my records and knowledge of current activities at NMOCD BWs, my tally is as follows:

There are a total of 15 active UIC Class III Brine Well Permits (excluding BW-5 JWS & BW-6 I&W)

There are currently 13 active UIC Class III Brine Wells in operation (BW-2; BW-4; BW-8; BW-9; BW-12; BW-13; BW-22; BW-25; BW-27 Wells 1 & 2; BW-28; BW-30; and BW-31)

There are currently 6 brine wells that have actually been PA'd including: BW-5 JWS Collapse w/ Site Closure; BW-6 Eugenie #2; BW-21 Loco Hills Well #1 recently PA'd; BW-26 Salado Brine Sales; BW-29 Marbob; & William Brininstool.

There are currently 3 pending PAs of BWs including: BW-6 Eugenie #1 w/ Site Closure; BW-18 Key w/ redrill; and BW-19 Key w/ redrill.

There are currently 5 inactive brine wells (BW-5 Collapse w/ Site Closure; BW-6 needs PA Eugenie #1 w/ Site Closure; BW-18 needs PA w/ redrill; BW-19 needs PA w/ redrill; and BW21 needs redrill)

Let me know how we need to straighten RBDMS out. Please contact me if you have questions. Thanks.

Carl J. Chavez, CHMM
New Mexico Energy, Minerals & Natural Resources Dept.
Oil Conservation Division, Environmental Bureau
1220 South St. Francis Dr., Santa Fe, New Mexico 87505
Office: (505) 476-3491
Fax: (505) 476-3462
E-mail: CarlJ.Chavez@state.nm.us
Website: http://www.emnrd.state.nm.us/ocd/index.htm
(Pollution Prevention Guidance is under "Publications")

From: Hansen, Edward J., EMNRD
Sent: Wednesday, July 23, 2008 5:56 PM
To: Price, Wayne, EMNRD
Cc: Chavez, Carl J, EMNRD
Subject: FW: PR-Secretary Prukop Proposes Stricter Conditions on Brine Wells State-wide

Wayne,
Jane and I tallied these numbers off of RBDMS (you may want to double check).

From: Hansen, Edward J., EMNRD
Sent: Wednesday, July 23, 2008 5:54 PM
To: Porter, Jodi, EMNRD
Subject: RE: PR-Secretary Prukop Proposes Stricter Conditions on Brine Wells State-wide

Jodi,

We counted (from our database: RBDMS):

16 Active Brine Wells

11 Plugged and Abandoned Brine Wells

2 Inactive Brine Wells

From: Porter, Jodi, EMNRD
Sent: Wednesday, July 23, 2008 5:00 PM
Subject: PR-Secretary Prukop Proposes Stricter Conditions on Brine Wells State-wide

New Mexico Energy, Minerals and Natural Resources Department

Bill Richardson
Governor

Joanna Prukop
Cabinet Secretary
Reese Fullerton
Deputy Cabinet Secretary

Mark Fesmire
Division Director
Oil Conservation Division

July 23, 2008

NEWS RELEASE

Contact: Jodi McGinnis Porter,
Public Information Officer 505.476.3226

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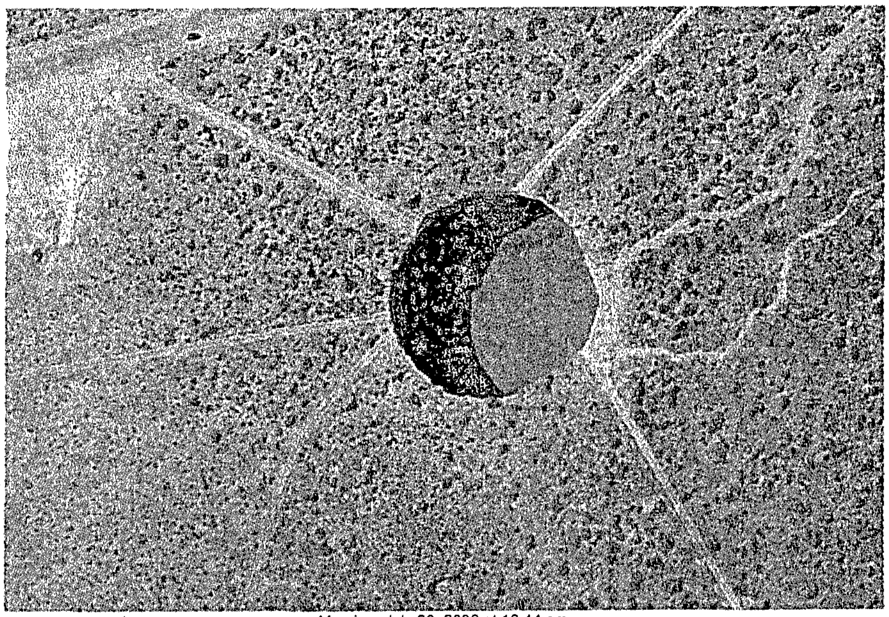

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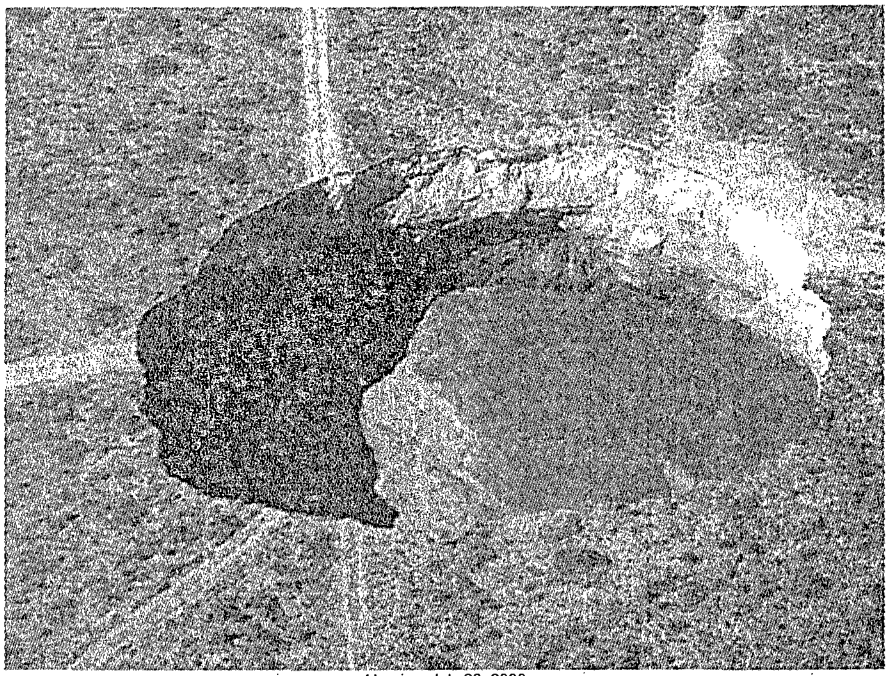

Morning, July 22, 2008
courtesy of National Cave and Karst Research Institute

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The Energy, Minerals and Natural Resources Department provides resource protection and renewable energy resource development services to the public and other state agencies.

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Phone (505) 476-3440 • Fax (505) 476-3462 • www.emnrd.state.nm.us/OCD

jodi

Jodi McGinnis Porter
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