

Memorandum

UTAH DEPARTMENT OF TRANSPORTATION

DATE: June 2, 1986

TO : P.K. Monson, P.E., District Three Preconstruction Engineer

FROM : Heber Vlam, P.E., Engineer of Materials & Research *H.V.*

SUBJECT: I-70-1(23)36, South Richfield to North Richfield;
Collapsible Soil Study Near W.B. I-70
Stations 1908+00 to 1922+00

This office was requested by District No. 3 to assess the impact of impounding Dairy Canyon runoff water in a proposed detention reservoir near Sta. 1912+00 W.B. I-70. Collapsible soils have been encountered at other locations on this project (see memo. dated 2-24-86), and were suspected at this site. A collapsible soil is a soil that shows a sudden and dramatic volume decrease when saturated with water.

Seven test holes were drilled along the I-70 alignment next to the site of the proposed detention reservoir. These holes ranged from 30 feet to 37 feet deep and correlation between test holes is good. In general, the subsoils may be described as follows: from the ground surface to the maximum depth of exploration - alternating lenses of sandy silt and silty sand with some gravel, cobbles, boulders and clay. See Fig. 1 - A & B, Log of Borings for more detailed descriptions and test hole locations.

Laboratory testing of samples taken reveals that there are collapsible soils in all seven test holes. The soils that showed collapse generally ranged from 4 feet to 31 feet in depth.

Using laboratory test results we calculate that leakage from Dairy Canyon detention basin could cause hydrocompaction of soils under the nearby I-70 embankment and result in settlement of approximately 40 inches.

Even with a leak resistant design this reservoir could leak enough water to cause significant damage to the I-70 embankment and surfacing. We therefore recommend against placing any water retaining earth structure within 500 feet of the I-70 embankment.

In the event the Dairy Canyon detention basin cannot be eliminated or moved, we recommend flooding the I-70 right of way at this site. This should precollapse and stabilize the subsoils. The area between Sta. 1908+70 W.B. (1910+70 E.B.L.) and 1917+90 W.B.L. (1919+00 E.B.L.) should be temporarily diked off and kept covered with a minimum of 2 feet of water. The dikes should extend as close to the right of way limits as possible. The flooding should continue for a minimum of 180 days and then should be stopped only if tests show that the hydrocompaction process is complete and there is no more evidence of ground subsidence.

It should be anticipated that ground subsidence may cause continual maintenance to be made on the dikes.

To facilitate percolation of water into the subsurface we recommend the installation of infiltration holes at this site. These holes should be 1.5 feet in diameter by 30 feet deep and should be back filled with granular material. The maximum hole spacing should be 75 feet and the beginning row of holes should be 20 feet inside the west right of way line.

If bedrock is encountered at depths shallower than 30 feet the holes need not penetrate the bedrock.

Attachments

PSizemore/cak

UTAH STATE DEPARTMENT OF TRANSPORTATION

MATERIALS AND RESEARCH

Summary of Test Data

Project Number I-70-1(23)36

Sheet 1 Of 3

Project Name So. Richfield to No. Richfield

Structure Collapsible Soil Study

Boring No.	Depth	Grading Analysis				Group Classification	Atterberg Limits		Water Cont. ω %	Wet Unit Weight γ P.C.F.	Dry Unit Weight γ_s P.C.F.	Specific Gravity Gs	Permeability k 10^{-4} cm/sec.		Unconfined Strength q_u T.S.F.	Shear Strength				
		Gravel	Coarse Sand	Fine Sand	Silt and Cloy		Liquid Limit L.L.	Plastic Index P.I.					Total Stress			Effective Stress		Type Of Test		
													ϕ^o	C T.S.F.		ϕ^o	C' T.S.F.			
1	02.0	2	10	35	53	A-4 (4)	26	6	12											
1	06.5	26	14	33	27	A-2-4 (0)	NA	NP	2	93	92	2.71								
1	12.0	88	4	4	4	A-1-a	-	-	2											
1	16.5	0	14	46	40	A-4 (1)	22	3	0.5	97	96	2.76								
1	21.5	18	18	36	28	A-2-4	NA	NP	9	106	96	2.80								
1	26.5	32	11	32	25	A-2-4	NA	NP	5											
1	30.8	0	6	42	52	A-6 (4)	31	11	6	94	88	2.76								
2	01.9	0	7	29	64	A-6 (7)	28	12	16											
2	07.0	0	13	48	39	A-4 (1)	23	6	5	86	83	2.73								
2	14.5	1	8	54	37	A-4 (0)	NA	NP	5											
2	16.5	1	10	52	37	A-4 (0)	NA	NP	6	84	79	2.69								
2	21.5	22	21	29	28	A-2-4	25	7	12	81	72	2.80								
2	26.5	4	4	38	54	A-4 (4)	24	5	6											
3	02.0	33	7	34	26	A-2-4	NA	NP	14											
3	04.5	0	8	57	35	A-2-4	NA	NP	3	87	85	2.71								
3	07.0	2	7	41	50	A-4 (3)	23	5	8	125	116	2.74								

S - Shelby Sample P - Penetration Sample T - Triaxial Shear Test C - Consolidation DIR - Direct Shear Test UU - Unconsolidated, Undrained

CU - Consolidated, Undrained CD - Consolidated, Drained

UTAH STATE DEPARTMENT OF TRANSPORTATION

MATERIALS AND RESEARCH

Project Number I-70-1(23)36

Summary of Test Data

Sheet 2 Of 3

Project Name So. Richfield to No. Richfield

Structure Collapsible Soil Study

Boring No.	Depth	Grading Analysis				Group Classification	Atterberg Limits		Water Cont. ω %	Wet Unit Weight γ P.C.F.	Dry Unit Weight γ_s P.C.F.	Specific Gravity Gs	Permeability k 10^{-4} cm/sec.		Unconfined Strength q_u T.S.F.	Shear Strength					Type Of Test
		Percent					Liquid Limit L.L.	Plastic Index P.I.					Total Stress			Effective Stress					
		Gravel	Coarse Sand	Fine Sand	Silt and Clay								ϕ^o	C T.S.F.		ϕ^o	C' T.S.F.				
3	11.5	4	5	30	61	A-4 (5)	29	9	8	91	84	2.76									
3	16.5	3	13	40	44	A-4 (2)	23	6	5												
3	22.0	1	8	52	39	A-4 (1)	NA	NP	9	96	88	2.80									
3	26.5	38	16	31	15	A-1-b	NA	NP	4												
4	02.0	14	27	34	25	A-2-4	NA	NP	9												
4	06.5	4	7	33	56	A-4 (4)	25	8	12	73	65	2.74									
4	09.5	1	15	42	42	A-4 (1)	NA	NP	8	76	70	2.69									
4	12.5	1	14	45	40	A-4 (1)	23	4	7												
4	16.5	2	4	40	54	A-4 (4)	NA	NP	3	90	87	2.74									
4	27.0	5	8	40	47	A-4 (2)	NA	NP	7	81	76	2.70									
5	01.5	13	5	36	46	A-4 (2)	22	5	10												
5	13.0	0	10	45	45	A-4 (2)	NA	NP	9	93	86	2.67									
5	15.0	1	3	34	62	A-4 (5)	24	6	8	96	89	2.71									
5	17.0	5	38	46	11	A-2-4	NA	NP	8	88	81	2.72									
5	22.0	19	10	24	47	A-6 (2)	30	12	7												

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CU - Consolidated, Undrained CD - Consolidated, Drained

UTAH STATE DEPARTMENT OF TRANSPORTATION

MATERIALS AND RESEARCH

Summary of Test Data

Project Number I-70-1(23)36

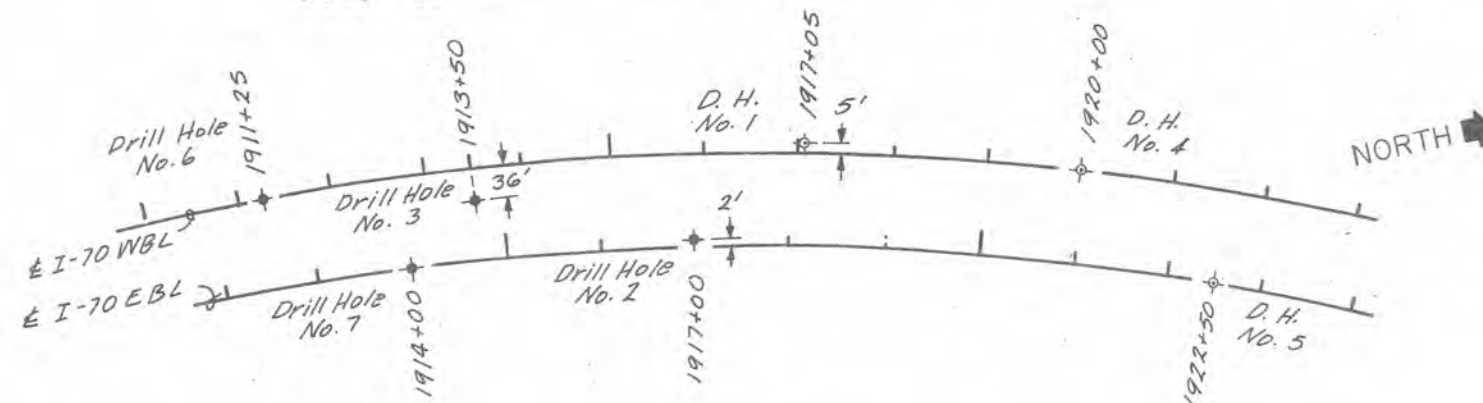
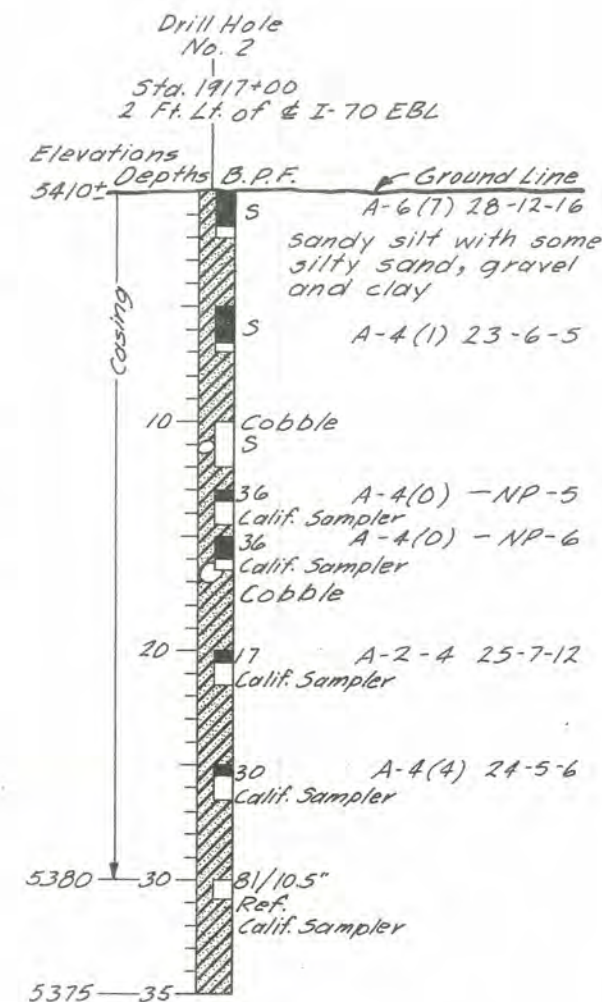
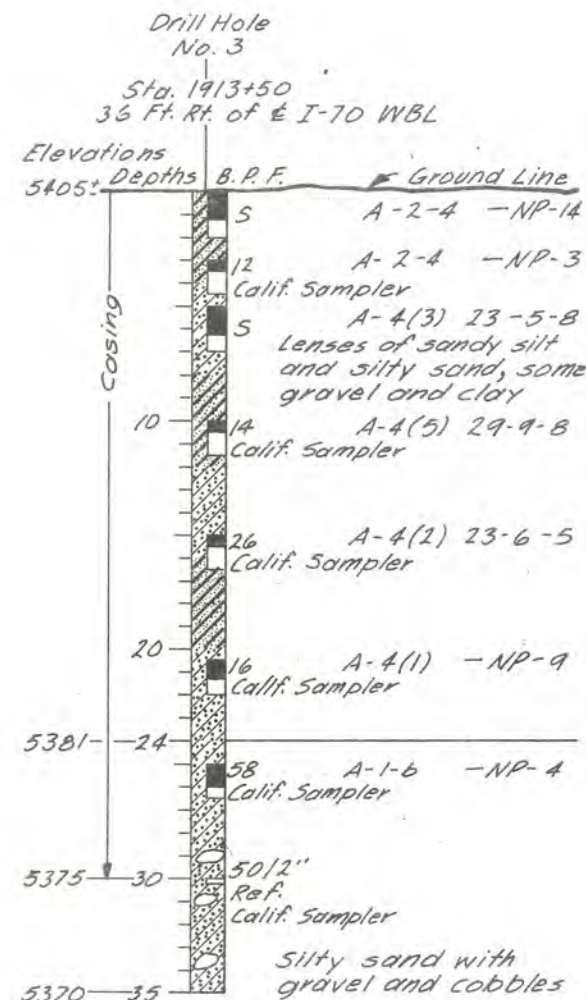
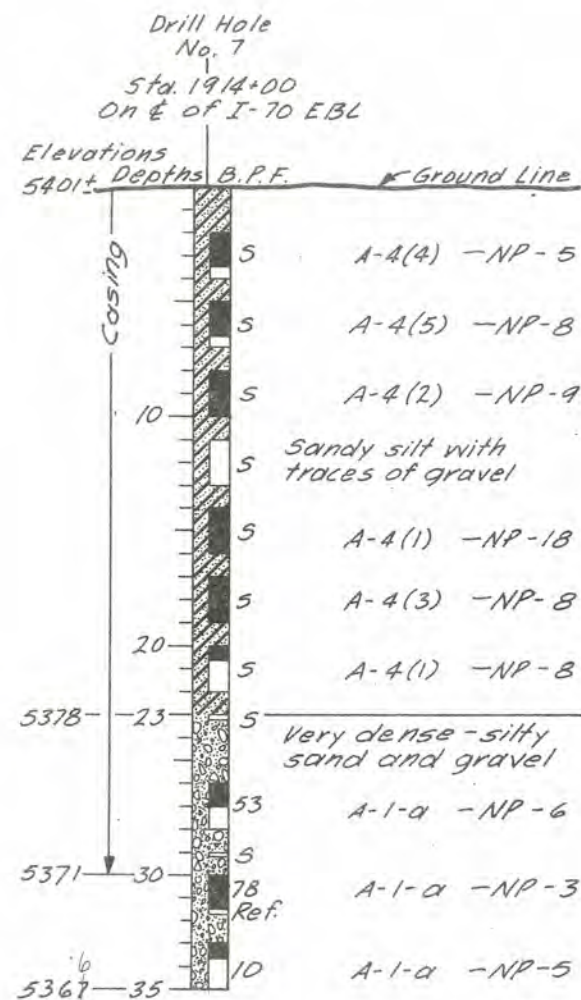
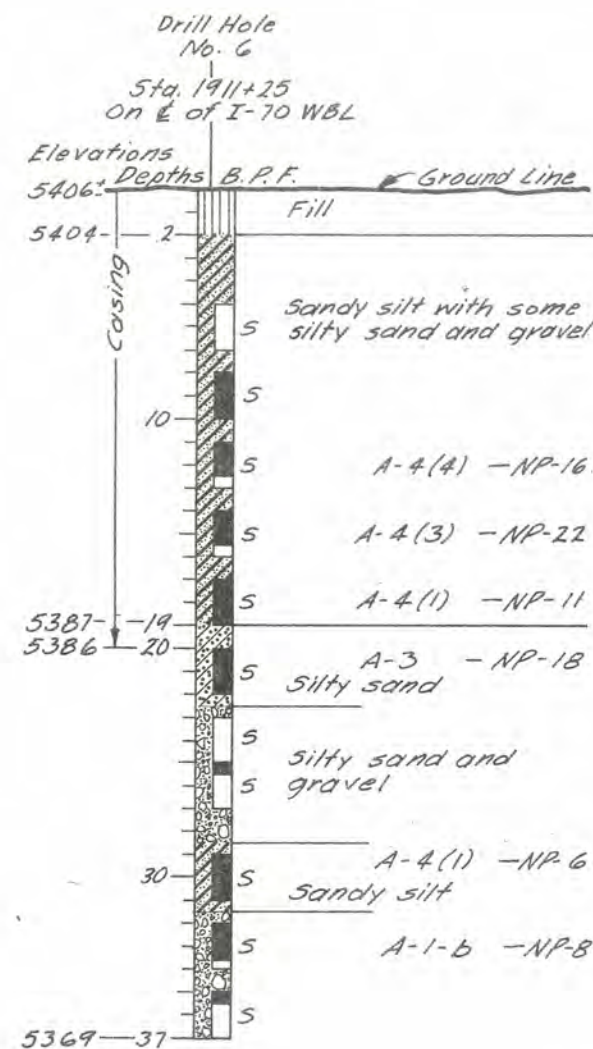
Sheet 3 Of 3

Project Name So. Richfield to No. Richfield

Structure Collapsible Soil Study

Boring No.	Depth	Grading Analysis				Group Classification	Atterberg Limits		Water Cont. ω %	Wet Unit Weight γ P.C.F.	Dry Unit Weight γ_s P.C.F.	Specific Gravity G_s	Permeability k 10^{-4} cm/sec.		Unconfined Strength q_u T.S.F.	Shear Strength				Type Of Test
		Percent					Liquid Limit L.L.	Plastic Index P.I.					Total Stress			Effective Stress				
		Gravel	Coarse Sand	Fine Sand	Silt and Clay								ϕ^o	C T.S.F.		ϕ^o	C' T.S.F.			
6	13.0	0	5	39	56	A-4(4)	NA	NP	16	102	88	2.74								
6	16.0	1	8	40	51	A-4(3)	NA	NP	22	89	73	2.74								
6	19.0	0	8	53	39	A-4(1)	NA	NP	11											
6	22.0	2	23	51	24	A-3	NA	NP	18	97	82	2.81								
6	31.0	4	9	46	41	A-4(1)	NA	NP	6	88	83	2.77								
6	34.0	25	26	34	15	A-1-b	NA	NP	8											
7	04.0	0	7	40	53	A-4(4)	NA	NP	5											
7	07.0	0	5	35	60	A-4(5)	NA	NP	8	100	93	2.73								
7	10.0	21	5	31	43	A-4(2)	NA	NP	9	90	83	2.73								
7	16.0	18	15	25	42	A-4(1)	NA	NP	18	101	86	2.77								
7	19.0	2	8	42	48	A-4(3)	NA	NP	8	92	85	2.75								
7	22.0	1	18	39	42	A-4(1)	NA	NP	8											
7	28.0	53	18	14	15	A-1-a	NA	NP	6											
7	32.0	58	18	11	13	A-1-a	NA	NP	3											
7	35.0	66	21	5	8	A-1-a	NA	NP	5											

S - Shelby Sample P - Penetration Sample T - Triaxial Shear Test C - Consolidation DIR - Direct Shear Test UU - Unconsolidated, Undrained
 CU - Consolidated, Undrained CD - Consolidated, Drained



NOTE: Blows per foot on the Calif. Sampler should not be used with the charts given in the key which are for use with the Standard Penetration Test

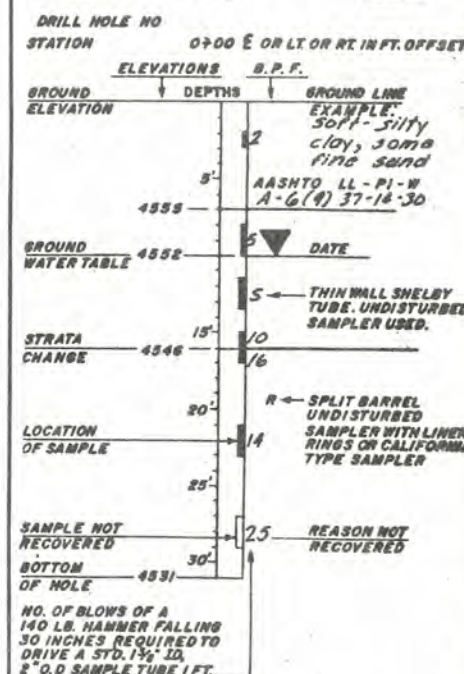
NOTE: A water table was not encountered in any of these holes.
Date Drilled: March & April 1986

NOTE: The water table depths shown on the drill logs represent hole conditions on the date shown, either with casing still in place or with perforated plastic pipe installed. It should be noted however, that other locations away from the test holes or at other times of the year the water table elevation may vary significantly.

KEY TO DRILLING LOG
RELATIVE DENSITY (NON-PLASTIC SAND & SILT)
VERY LOOSE - LESS THAN 4 BLOWS PER FOOT.
LOOSE - 4 TO 10 BLOWS PER FOOT.
MEDIUM - 10 TO 30 BLOWS PER FOOT.
DENSE - 30 TO 50 BLOWS PER FOOT.
VERY DENSE - MORE THAN 50 BLOWS PER FOOT.

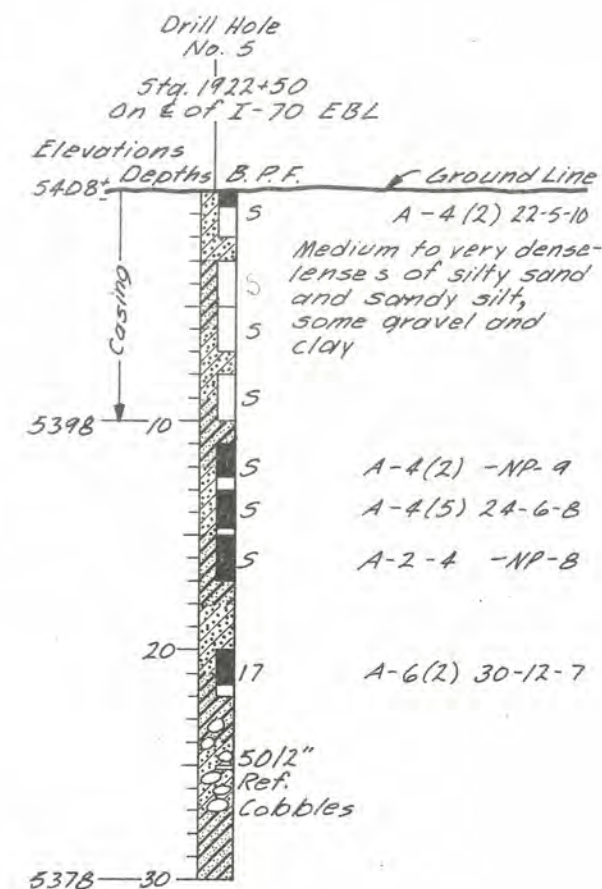
CONSISTENCY (PLASTIC SILT & CLAY)
VERY SOFT - LESS THAN 2 BLOWS PER FOOT.
SOFT - 2 TO 4 BLOWS PER FOOT.
MEDIUM - 4 TO 8 BLOWS PER FOOT.
STIFF - 8 TO 15 BLOWS PER FOOT.
VERY STIFF - 15 TO 30 BLOWS PER FOOT.
HARD - MORE THAN 30 BLOWS PER FOOT.

TOPSOIL OR FILL	IGNEOUS	SANDY CLAY
GRAVEL	LIMESTONE	CLAYEY SAND
SAND	CONGLOMERATE	SILTY CLAY
SILT	DOLOMITE	CLAYEY SILT
CLAY	SANDSTONE	SILTY SAND
SHALE	SILTSTONE	SANDY SILT

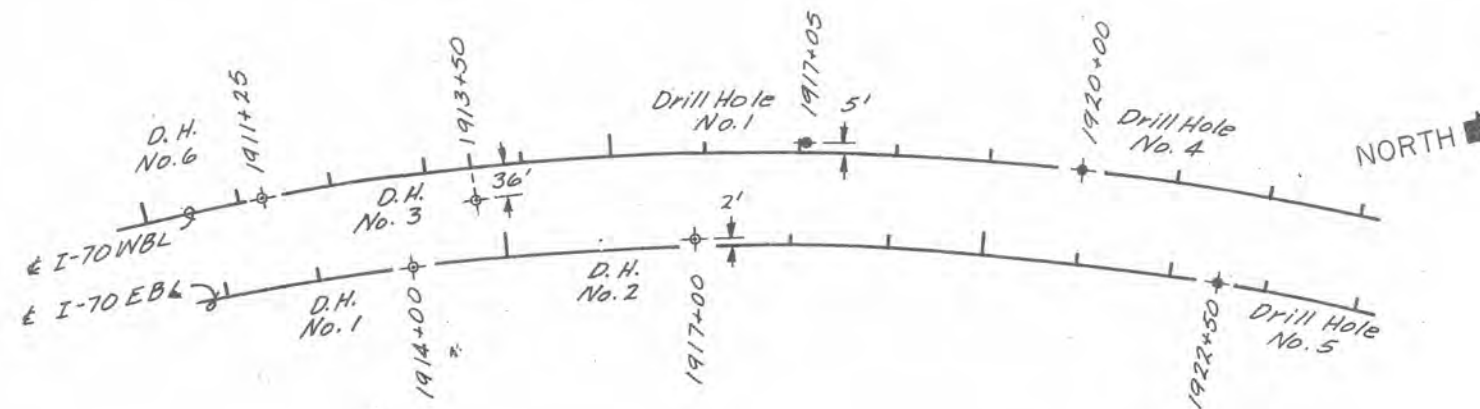


ABBREVIATIONS
L.L. - LIQUID LIMIT IN %
P.I. - PLASTIC INDEX
N. - NATURAL MOISTURE CONTENT IN %
Ref. - REFUSAL ≥ 50 BLOWS PER 6"
PEN. - PENETRATION
G.W.T. - GROUND WATER TABLE
B.P.F. - BLOWS PER FOOT.
N.P. - NON PLASTIC
AASHTO - SOIL CLASSIFICATION SYSTEM

UTAH STATE DEPARTMENT OF TRANSPORTATION SALT LAKE CITY, UTAH	
MATERIALS and RESEARCH SECTION	
SOUTH RICHFIELD TO NORTH RICHFIELD	
COLLAPSIBLE SOILS STUDY	
Drawn By KISTLER	Checked By
Checked By B. DIZENDALE	Checked By
Checked By M. BASHA	Checked By
Approved Recommended By J. H. RAUSCH	Station
Received	SEVIER
Date	County
85-7-FS-56	Dr. No.
Foundations File No.	01



NOTE: Blows per foot on the Calif. Sampler should not be used with the charts given in the key which are for use with the Standard Penetration Test.



NOTE: The water table depths shown on the drill logs represent hole conditions on the date shown, either with casing still in place or with perforated plastic pipe installed. It should be noted however, that other locations away from the test holes or at other times of the year the water table elevation may vary significantly.

NOTE: A ground water table was not encountered in any of these hole.

Date Drilled: March & April 1986

				Approval Recommended By <u>Loren H. Rauscher</u>
--	--	--	--	--

				Date	Chief Structural Engr.
NO.	BY	DATE		05-7-80	EC

REVISIONS	Foundations File No. _____	Orig No. _____
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ENCLOSURE

KEY TO DRILLING LOG
RELATIVE DENSITY (NON-PLASTIC SAND & SILT)
VERY LOOSE — LESS THAN 4 BLOWS PER FOOT.
LOOSE — 4 TO 10 BLOWS PER FOOT.
MEDIUM — 10 TO 30 BLOWS PER FOOT.
DENSE — 30 TO 50 BLOWS PER FOOT.
VERY DENSE — MORE THAN 50 BLOWS PER FOOT.

CONSISTENCY (PLASTIC-SILT & CLAY)
 VERY SOFT— LESS THAN 2 BLOWS PER FOOT.
 SOFT— 2 TO 4 BLOWS PER FOOT.
 MEDIUM— 4 TO 8 BLOWS PER FOOT.
 STIFF— 8 TO 15 BLOWS PER FOOT.
 VERY STIFF 15 TO 30 BLOWS PER FOOT.
 HARD— MORE THAN 30 BLOWS PER FOOT.

	TOPSOIL OR FILL		IGNEOUS		SANDY CLAY
	GRAVEL		LIMESTONE		CLAYEY SAND
	SAND		CONGLOMERATE		SILTY CLAY
	SILT		DOLOMITE		CLAYEY SILT
	CLAY		SANDSTONE		SILTY SAND
	SHALE		SILTSTONE		SANDY SILT

DRILL HOLE NO	STATION	0+00 E OR LT OR RT IN FT. OFFSET
1	1+00	0
2	2+00	0
3	3+00	0
4	4+00	0
5	5+00	0
6	6+00	0
7	7+00	0
8	8+00	0
9	9+00	0
10	10+00	0
11	11+00	0
12	12+00	0
13	13+00	0
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94	94+00	0
95	95+00	0
96	96+00	0
97	97+00	0
98	98+00	0
99	99+00	0
100	100+00	0

The diagram illustrates a soil boring log with the following components:

- ELEVATIONS:** A vertical scale on the left side of the log, with major markings at 4535, 4552, 4546, and 4531.
- DEPTHS:** A vertical scale on the right side of the log, with major markings at 5', 15', 20', 25', and 30'.
- S.P.F. (Soil Penetration Factor):** A vertical scale on the far right side of the log, with major markings at 12, 15, 16, and 25.
- GROUND LINE:** A horizontal line at the top of the log, labeled "GROUND LINE".
- GROUND ELEVATION:** A label for the top of the log, with a value of 4552.
- WATER TABLE:** A horizontal line labeled "WATER TABLE" at an elevation of 4552.
- STRATA CHANGE:** A horizontal line labeled "STRATA CHANGE" at an elevation of 4546.
- LOCATION OF SAMPLE:** A label for the bottom of the log, with a value of 4531.
- SAMPLE NOT RECOVERED:** A label for the bottom of the log, with a value of 4531.
- BOTTOM OF HOLE:** A label for the bottom of the log, with a value of 4531.
- EXAMPLE:** A text block providing an example of soil description: "EXAMPLE: soft, silty clay, some fine sand".
- DATE:** A label for the date of the log, with a value of "AASHTO LL - PI - W A-G(9) 37-14-30".
- THIN WALL SNEEDY TUBE, UNDISTURBED SAMPLER USED:** A label for the sampler used, with a value of "S".
- SPLIT BARREL UNDISTURBED SAMPLER WITH LINER RINGS OR CALIFORNIA TYPE SAMPLER:** A label for the sampler used, with a value of "R".
- REASON NOT RECOVERED:** A label for the reason the sample was not recovered, with a value of "25".
- NO. OF BLOWS OF A 140 LB. HAMMER FALLING 30 INCHES REQUIRED TO DRIVE A STD. 1 1/2" ID. 2' O.D. SAMPLE TUBE 1 FT.** A label for the blow count, with a value of "12".

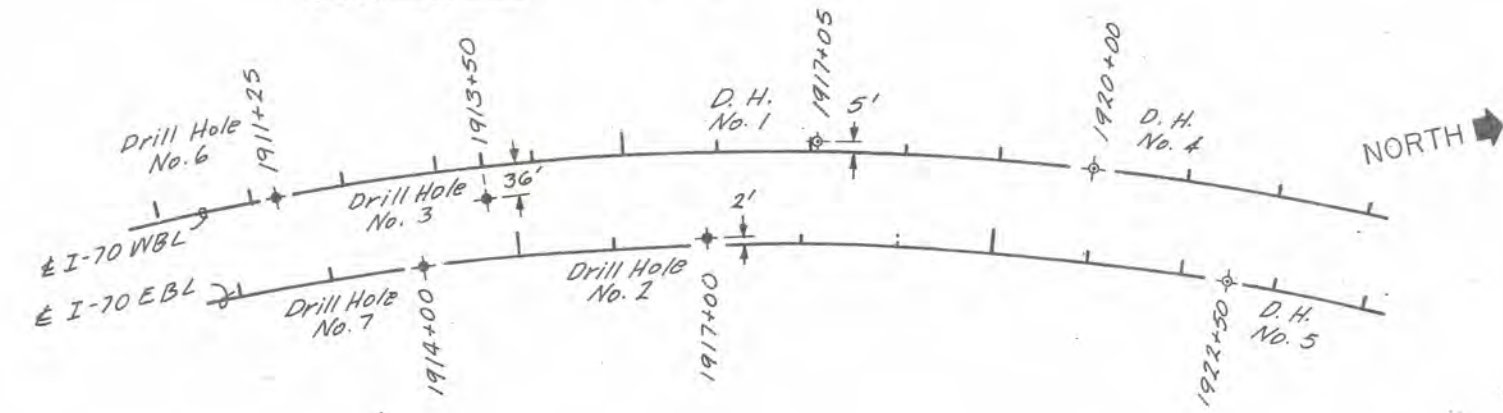
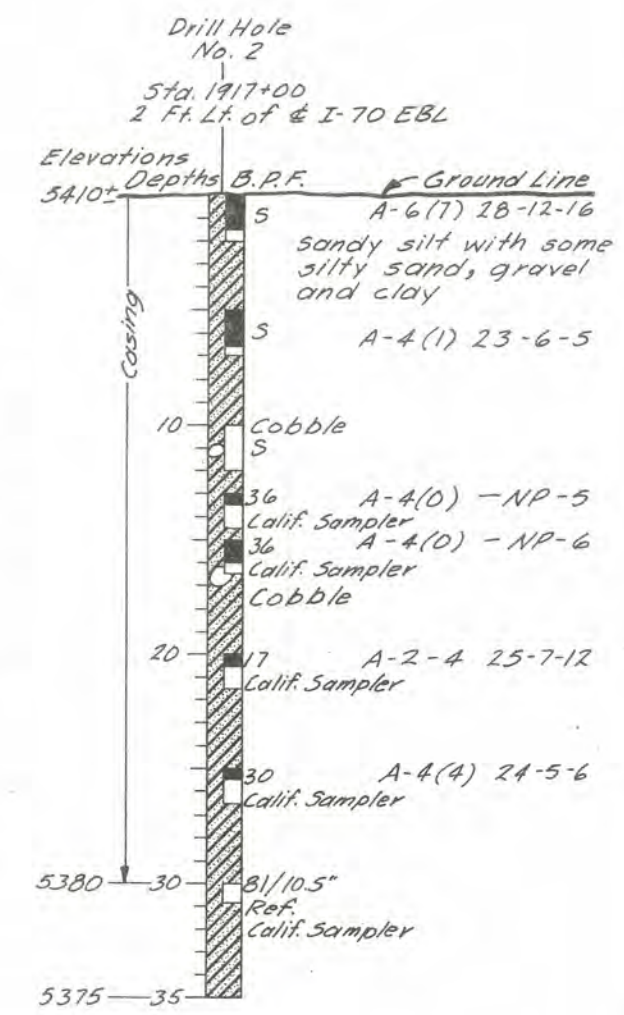
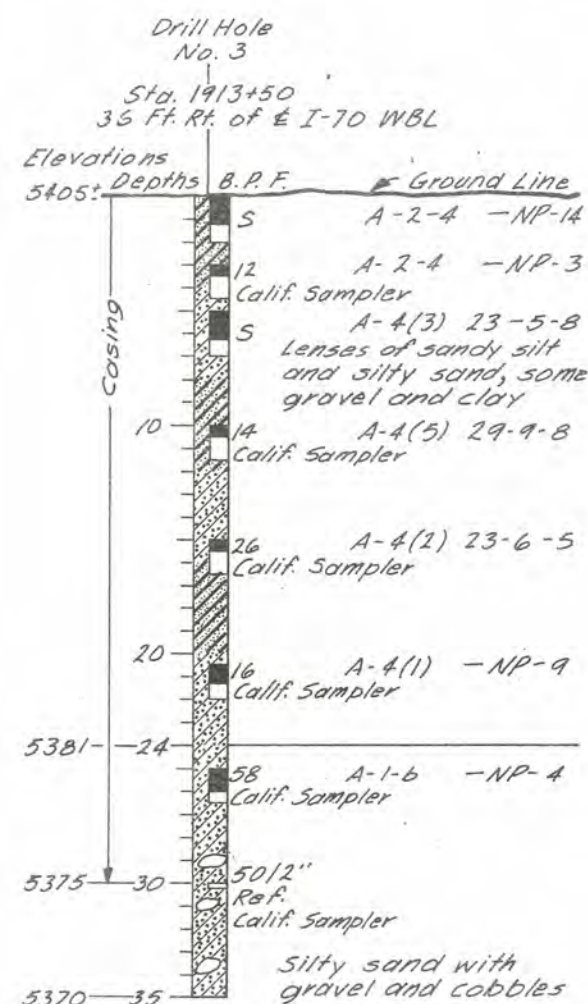
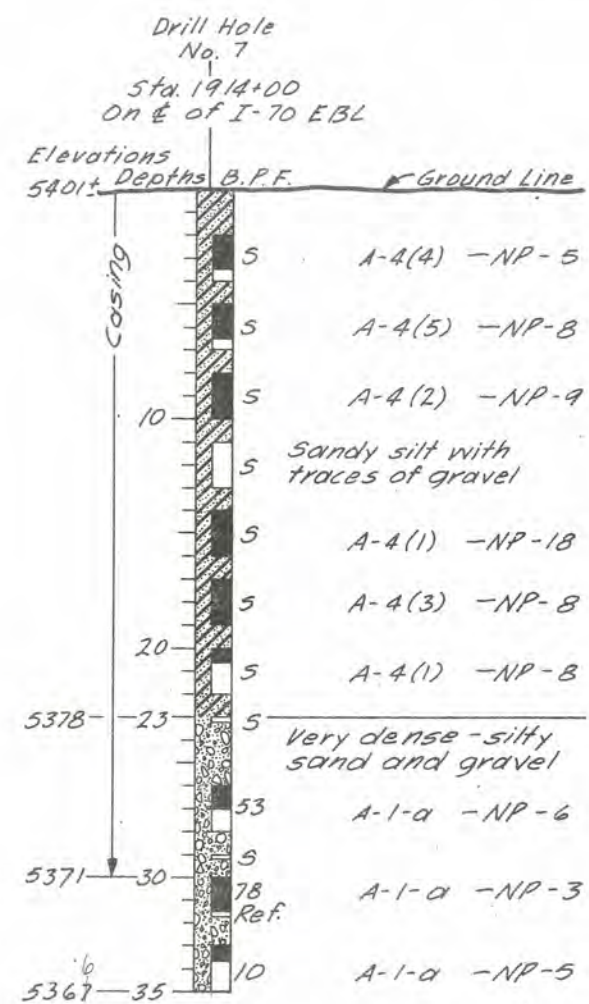
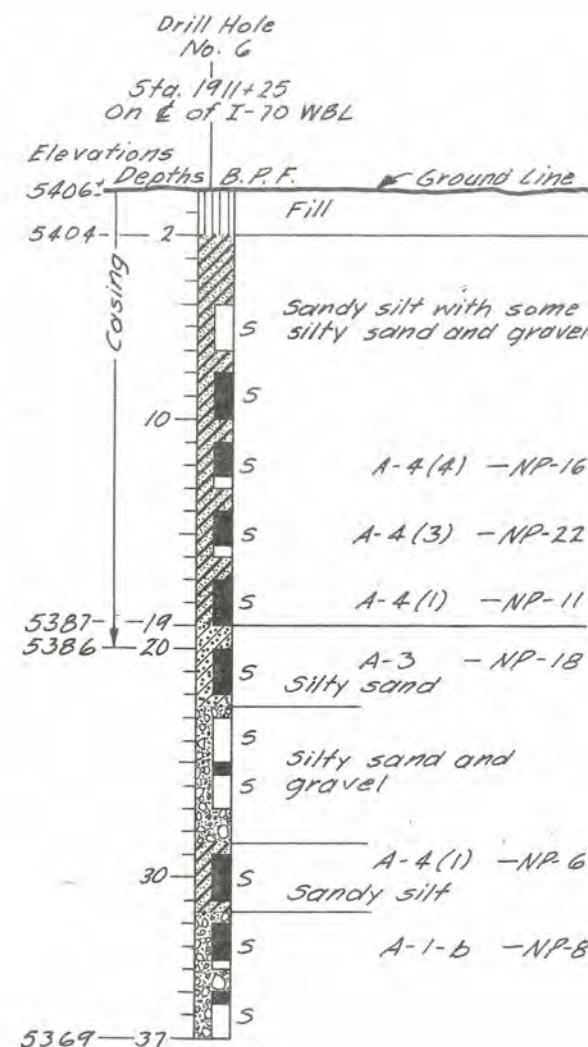
ABBREVIATIONS

L.L.—LIQUID LIMIT IN %
P.I.—PLASTIC INDEX
W.—NATURAL MOISTURE CONTENT IN %
Ref. — REFUSAL ≥ 50 BLOWS PER 6"
PEN.—PENETRATION
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N.P.—NON PLASTIC
AASHTO—SOIL CLASSIFICATION SYSTEM

UTAH STATE DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH
MATERIALS and RESEARCH SECTION
SOUTH RICHFIELD TO NORTH RICHFIELD
COLLAPSIBLE SOILS STUDY

Drawn By <u>R. Sizler</u>	Checked By _____	1-70-1(2)336
Checked By <u>R. Sizler</u>	Checked By _____	Project Number
Checked By <u>M. Basha</u>	Checked By _____	1910 To 1923
Approval Recommended By <u>Loren H. Rauscher</u>	_____	Station
Received _____	Date _____	Chief Structural Eng'r _____
		SEVIER
		County
85-7-FS-56		01

FIGURE 1-B



KEY TO DRILLING LOG

RELATIVE DENSITY (NON-PLASTIC SAND & SILT)

VERY LOOSE - LESS THAN 4 BLOWS PER FOOT.
LOOSE - 4 TO 10 BLOWS PER FOOT.
MEDIUM - 10 TO 30 BLOWS PER FOOT.
DENSE - 30 TO 50 BLOWS PER FOOT.
VERY DENSE - MORE THAN 50 BLOWS PER FOOT.

CONSISTENCY (PLASTIC SILT & CLAY)

VERY SOFT - LESS THAN 2 BLOWS PER FOOT.
SOFT - 2 TO 4 BLOWS PER FOOT.
MEDIUM - 4 TO 8 BLOWS PER FOOT.
STIFF - 8 TO 15 BLOWS PER FOOT.
VERY STIFF - 15 TO 30 BLOWS PER FOOT.
HAND - MORE THAN 30 BLOWS PER FOOT.

TOPSOIL OR FILL	ARGILLACEOUS	SANDY CLAY
GRAVEL	LIMESTONE	CLAYEY SAND
SAND	CONGLOMERATE	SILTY CLAY
SILT	DOLomite	CLAYEY SILT
CLAY	SANDSTONE	SILTY SAND
SHALE	SILTSTONE	SANDY SILT

DRILL HOLE NO. 0700 E OR LT. OR RT. IN FT. OFFSET.

STATION ELEVATIONS B.P.F. GROUND LINE

GROUND ELEVATION DEPTHS

EXAMPLE: soft, silty clay, some fine sand

AASHTO LL - PI - W A-6(7) 37-14-30

DATE

GROUND WATER TABLE 4552

STRATA CHANGE 4546

LOCATION OF SAMPLE 14

SAMPLE NOT RECOVERED 25

REASON NOT RECOVERED

NO. OF BLOWS OF A 140 LB. HAMMER FALLING 30 INCHES REQUIRED TO DRIVE A STD. 1 1/2" ID, 2" O.D. SAMPLE TUBE 1 FT.

ABBREVIATIONS

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NOTE: Blows per foot on the Calif. Sampler should not be used with the charts given in the key which are for use with the standard Penetration Test

NOTE: A water table was not encountered in any of these holes.
Date Drilled: March & April 1986

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UTAH STATE DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH

MATERIALS and RESEARCH SECTION

SOUTH RICHFIELD TO NORTH RICHFIELD
COLLAPSIBLE SOILS STUDY

Drawn By KISTLER Checked By SEVIER 1-70-1123136

Checked By B. Sizemore Checked By SEVIER Project Number

Checked By AG-Basha Checked By SEVIER 1910 To 1923

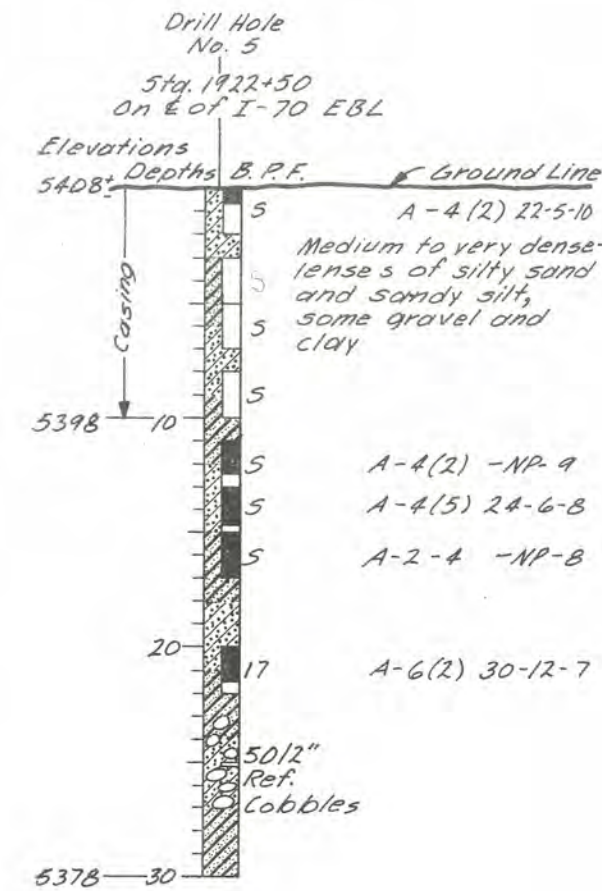
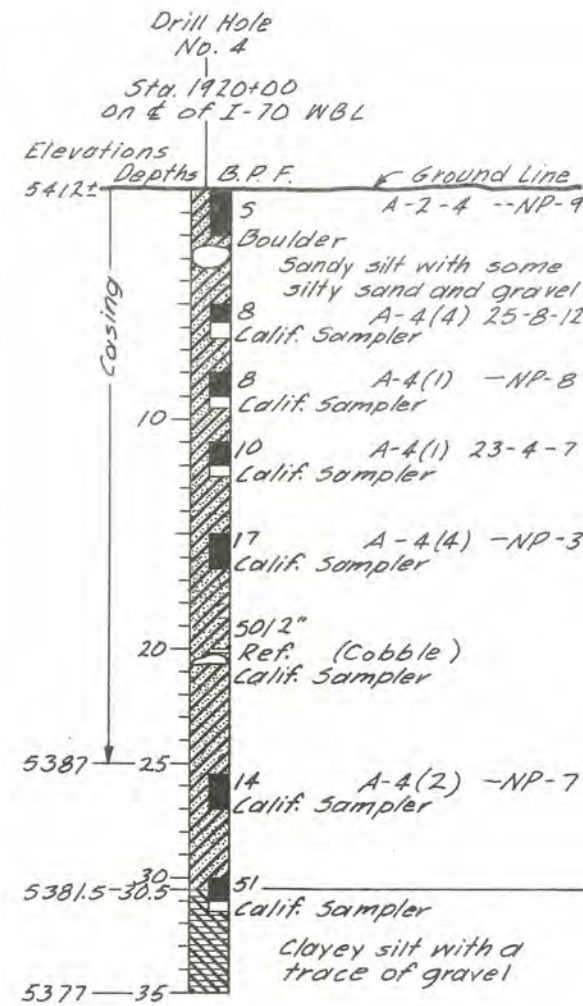
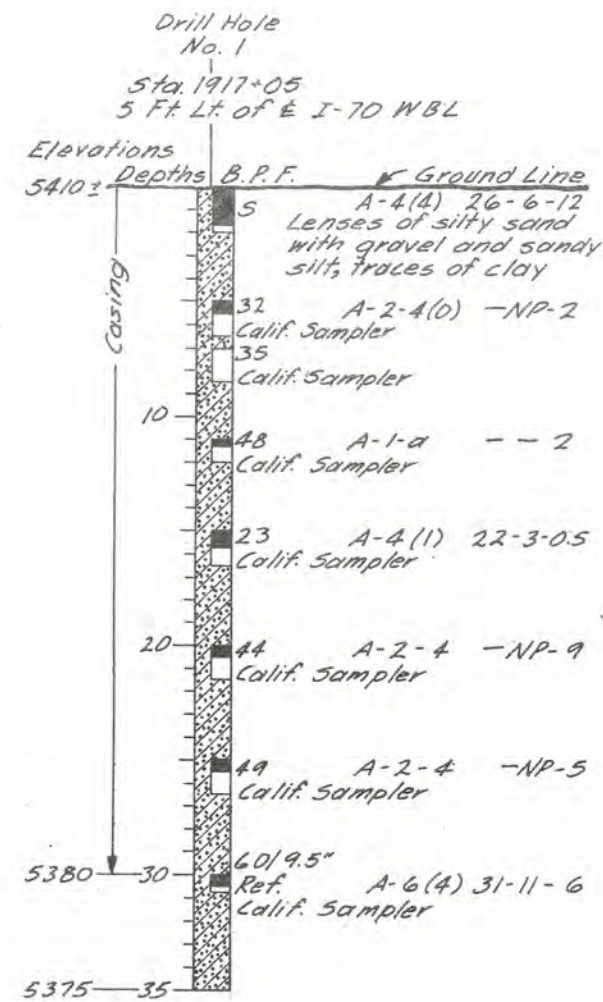
Approval Recommended By John H. Rauscher Station

Received SEVIER Date 1986 Chief Structural Eng'r. County

85-7-FS-56

Foundations File No. 1910 of

FIGURE 1-A



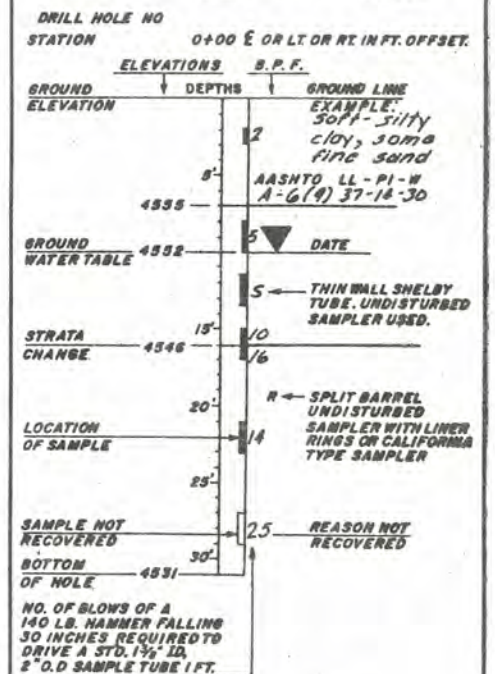
KEY TO DRILLING LOG

RELATIVE DENSITY (NON-PLASTIC SAND & SILT)

VERY LOOSE - LESS THAN 4 BLOWS PER FOOT.
LOOSE - 4 TO 10 BLOWS PER FOOT.
MEDIUM - 10 TO 30 BLOWS PER FOOT.
DENSE - 30 TO 50 BLOWS PER FOOT.
VERY DENSE - MORE THAN 50 BLOWS PER FOOT.

CONSISTENCY (PLASTIC SILT & CLAY)

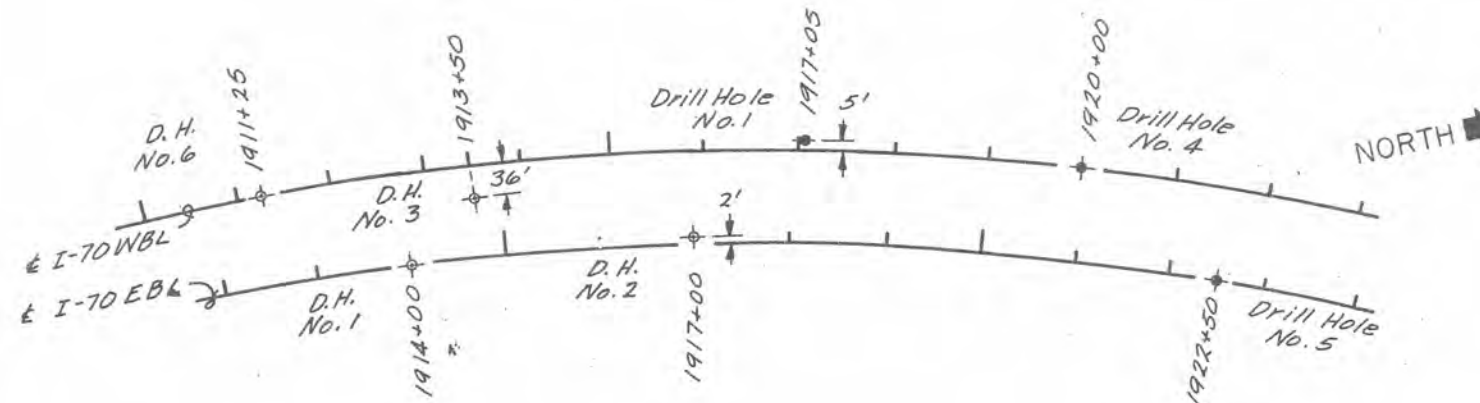
VERY SOFT - LESS THAN 2 BLOWS PER FOOT.
SOFT - 2 TO 4 BLOWS PER FOOT.
MEDIUM - 4 TO 8 BLOWS PER FOOT.
STIFF - 8 TO 15 BLOWS PER FOOT.
VERY STIFF - 15 TO 30 BLOWS PER FOOT.
HARD - MORE THAN 30 BLOWS PER FOOT.



ABBREVIATIONS

L.L. - LIQUID LIMIT IN %
P.I. - PLASTIC INDEX
W. - NATURAL MOISTURE CONTENT IN %
Ref. - REFUSAL ≥ 50 BLOWS PER 6"
PEN. - PENETRATION
G.W.T. - GROUND WATER TABLE
B.P.F. - BLOWS PER FOOT.
N.P. - NON PLASTIC
AASHTO - SOIL CLASSIFICATION SYSTEM

NOTE: Blows per foot on the Calif. Sampler should not be used with the charts given in the key which are for use with the Standard Penetration Test.



NOTE: A ground water table was not encountered in any of these hole.

Date Drilled: March & April 1986

NOTE: The water table depths shown on the drill logs represent hole conditions on the date shown, either with casing still in place or with perforated plastic pipe installed. It should be noted however, that other locations away from the test holes or at other times of the year the water table elevation may vary significantly.

NO.	BY	DATE	REVISIONS

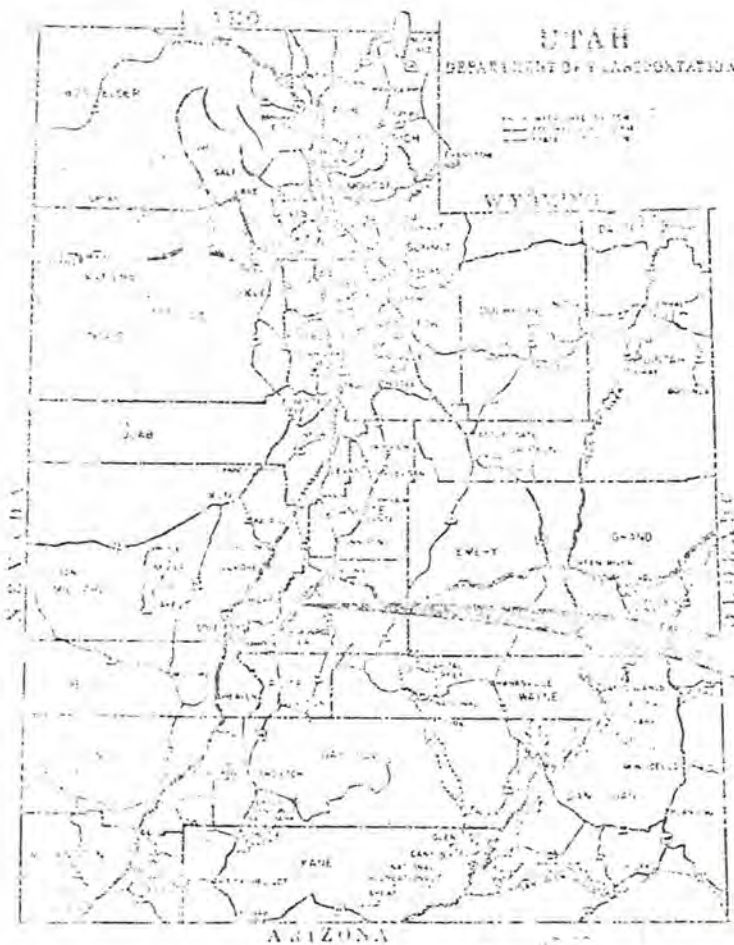
UTAH STATE DEPARTMENT OF TRANSPORTATION
SALT LAKE CITY, UTAH

MATERIALS and RESEARCH SECTION

SOUTH RICHFIELD TO NORTH RICHFIELD
COLLAPSIBLE SOILS STUDY

Drawn By R. S. J. R. Checked By 1-70-1(23)36
Checked By L. S. J. R. Checked By Project Number
Checked By M. S. J. R. Checked By 1910 To 1923
Approval Recommended By Loren H. Rauscher Station
Received Date Chief Structural Eng'r SEVIER
County

85-7-FS-56
Foundations File No. Orig. No. Of



DEPARTMENT

PLANS

SO. RICHFIELD

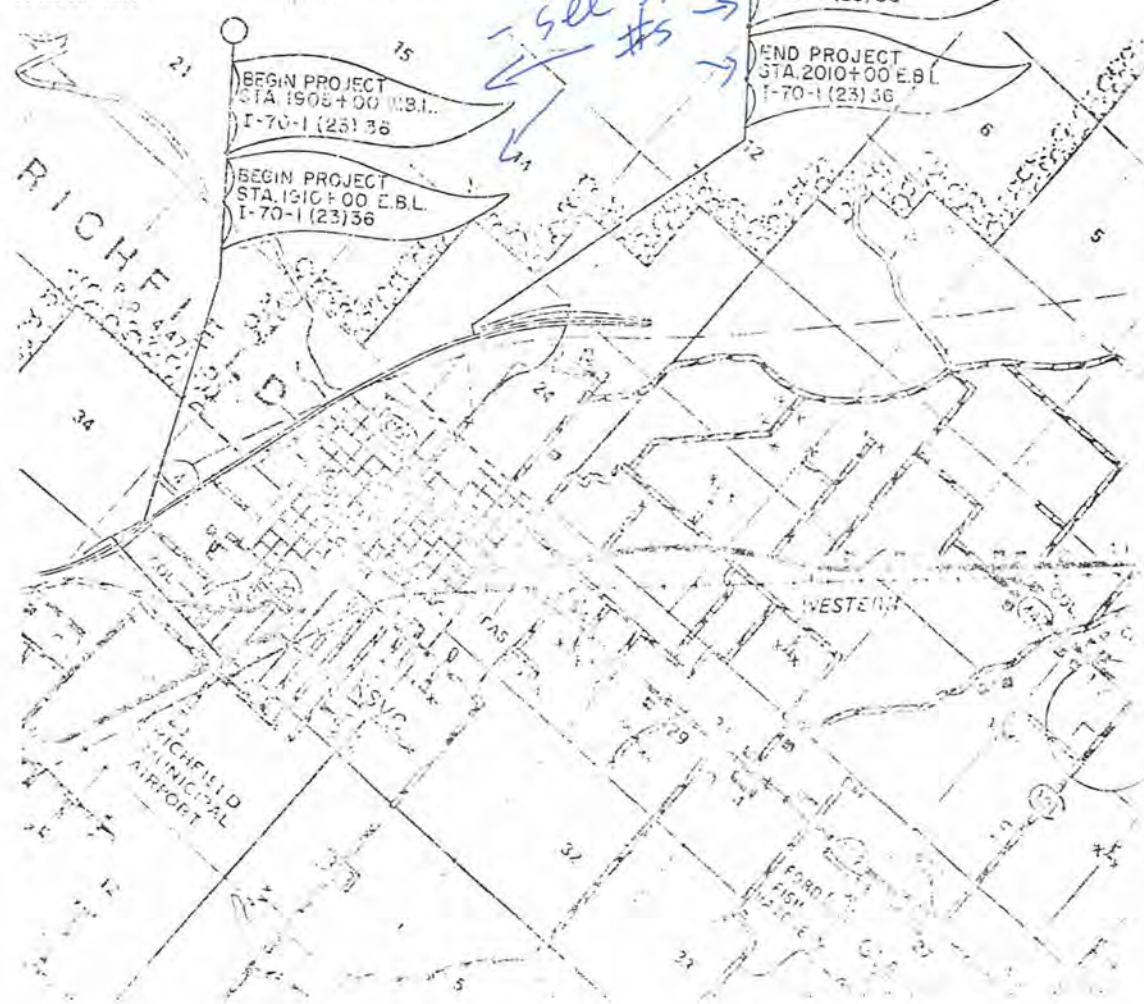
PROJ

LEN

GRADING

M.P.

Study Area for collapse see station #5 for news



Memorandum

UTAH DEPARTMENT OF TRANSPORTATION

DATE: June 5, 1986

TO : Those Listed Below

FROM : Heber Vlam, P.E., Engineer of Materials & Research *H.V.*

SUBJECT: I-70-1(23)36, South Richfield to North Richfield;
Foundation Report on I-70 over C.C. Road at I-70
Stations 1960+68 W.B.L. and 1961+99 E.B.L.,
Drg. No. F-535

SITE CONDITONS

Two single span prestressed concrete beam structures are proposed to carry I-70 over the C.C. Road. These structures will be approximately 100 feet long by 42 feet wide and will cross the C.C. Road at a 21° skew angle. The approach embankments will be about 21 feet to 24 feet high.

Surface drainage in the area is good.

SUBSURFACE EXPLORATION

Four test holes were drilled at this site and their depths ranged from 62 feet to 70.5 feet. Correlation between test holes is fair and in general the subsoils may be described as follows: From the ground surface to a depth of 22 feet - very loose to dense silty sand to sandy silt with some gravel and cobbles; from 22 feet to maximum depth of exploration - medium to very dense silty sand and gravel with some sandy silt, cobbles and boulders. See Figure 1, Log of Borings for more detailed descriptions and test hole locations.

FOUNDATION RECOMMENDATIONS

Drilled caissons are recommended to support these structures. Caissons 3.0 feet in diameter, founded at the elevations given below may be loaded to a safe bearing capacity of 360 kips per caisson. See Figure 2 for the bearing capacities of caissons with other diameters. A minimum diameter of 3.0 feet is recommended for feasibility of drilling the soils with cobbles and boulders. The recommended caisson tip elevations are as follows:

<u>Location</u>	<u>Recommended Caisson Tip Elevation, Ft.</u>	<u>Approximate Caisson Length, Ft.</u>
South Abut. W.B.L. (Abut. #1)	5372	48
North Abut. W.B.L. (Abut. #2)	5371	49
South Abut. E.B.L. (Abut. #1)	5368	49
North Abut. E.B.L. (Abut. #2)	5368	49

These recommended tip elevations are approximate and shall be verified by inspection of the bearing materials at the time of construction. Caisson settlement is not expected to exceed 1.0 inch.

All loose material at the bottom of caisson borings should be removed before concrete is placed, and concrete should be placed as soon after drilling as practicable. Care should be taken to keep all surface waters out of caisson borings. The caisson holes may have to be cased during drilling to prevent caving, and difficult drilling should be anticipated due to the presence of boulders (see Fig. 1).

These caissons will derive significant support from skin friction, it is therefore recommended that construction by the slurry method not be used.

EMBANKMENT SETTLEMENT AND STABILITY

Embankment settlement should be minor and should occur during construction. Embankment stability problems are not expected at this site.

Attachments

PSizemore/cak

cc: Structures	- 3
Roadway Design	- 2
Plans & Estimates Eng. (James Nelson)	- 1
Construction	- 2
District #3	- 2
District #3 Materials Engineer	- 1
Project File Foundations	- 4

UTAH STATE DEPARTMENT OF TRANSPORTATION

MATERIALS AND RESEARCH

Project Number I-70-1(23)36

Summary of Test Data

Sheet 1 Of 2

Project Name So. Richfield to No. Richfield

Structure I-70 over C.C. Road

Boring No.	Depth	Grading Analysis				Group Classification	Atterberg Limits		Water Cont. ω %	Wet Unit Weight γ P.C.F.	Dry Unit Weight γ_s P.C.F.	Specific Gravity G_s	Permeability k 10^{-4} cm/sec.		Unconfined Strength q_u T.S.F.	Shear Strength				Type Of Test
		Percent					Liquid Limit L.L.	Plastic Index P.I.					Total Stress			Effective Stress				
		Gravel	Coarse Sand	Fine Sand	Silt and Clay								ϕ^o	C T.S.F.		ϕ^o	C' T.S.F.			
1	12.0	24	8	36	32	A-2-4	NA	NP	12											
1	17.0	37	10	29	24	A-1-b	NA	NP	14											
1	27.0	1	4	47	48	A-4(3)	NA	NP	9											
1	37.0	1	2	20	77	A-4(8)	NA	NP	18											
1	40.3	39.0	9	11	41	A-4(1)	NA	NP	9											
1	47.0	2	7	50	41	A-4(1)	NA	NP	13											
1	57.0	0	3	51	46	A-4(2)	NA	NP	16											
1	67.0	24	4	47	25	A-2-4	NA	NP	15											
2	12.0	11	4	56	29	A-2-4	NA	NP	15											
2	17.0	3	4	57	36	A-4(0)	NA	NP	12											
2	22.0	31	10	34	25	A-2-4	NA	NP	7											
2	27.0	34	9	26	31	A-2-4	NA	NP	8											
2	32.0	46	8	22	24	A-1-b	NA	NP	9											
2	42.0	25	0	38	37	A-4(0)	NA	NP	11											
2	47.0	16	9	42	33	A-2-4	NA	NP	10											
2	57.0	26	4	32	38	A-4(1)	NA	NP	15											
2	62.0	41	9	27	23	A-1-b	NA	NP	12											

S - Shelby Sample P - Penetration Sample T - Triaxial Shear Test C - Consolidation DIR - Direct Shear Test UU - Unconsolidated, Undrained
 CU - Consolidated, Undrained CD - Consolidated, Drained

UTAH STATE DEPARTMENT OF TRANSPORTATION

MATERIALS AND RESEARCH

Summary of Test Data

Project Number I-70-1(23)36

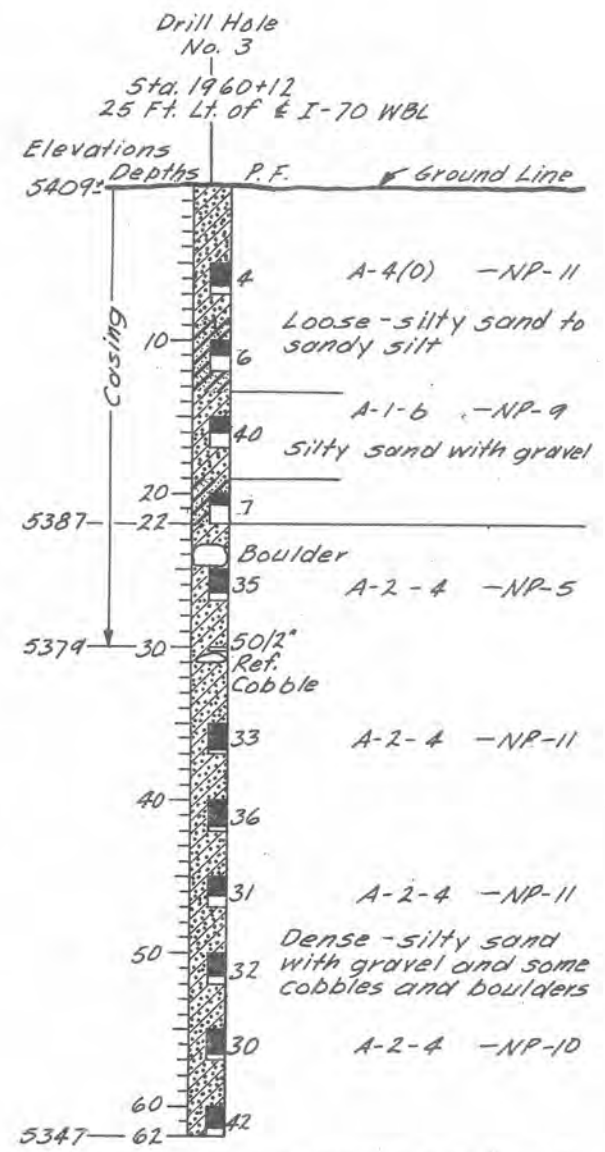
Sheet 2 Of 2

Project Name So. Richfield to No. Richfield

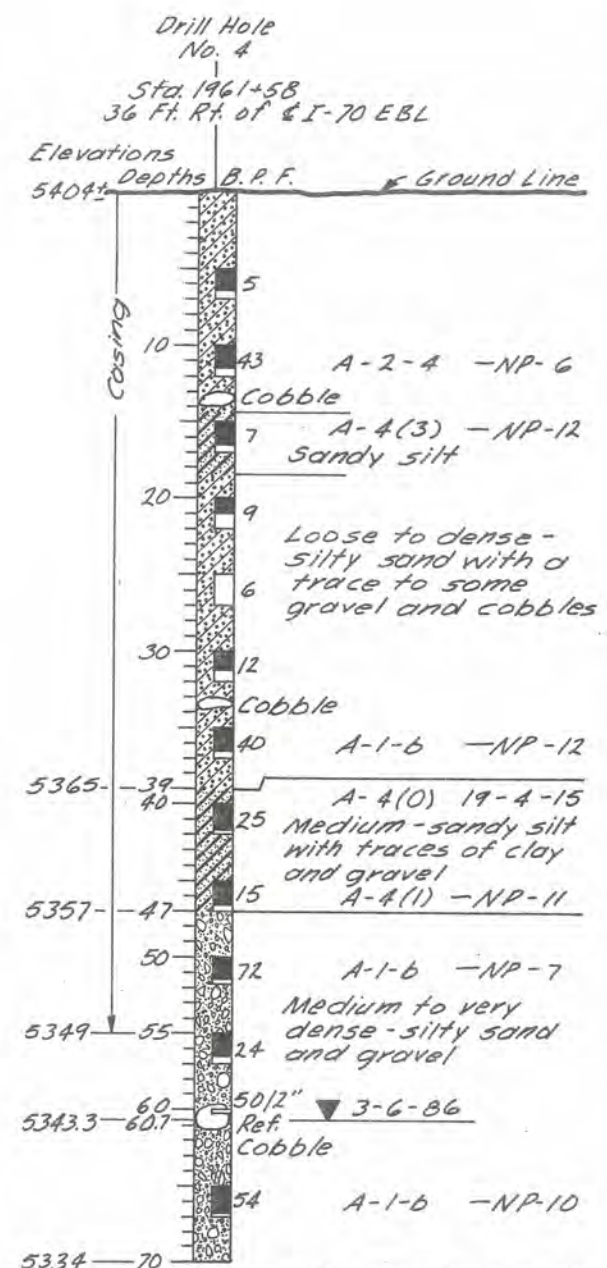
Structure I-70 over C.C. Road

Boring No.	Depth	Grading Analysis				Group Classification	Atterberg Limits		Water Cont. ω %	Wet Unit Weight γ P.C.F.	Dry Unit Weight γ_s P.C.F.	Specific Gravity Gs	Permeability k 10^{-4} cm/sec.		Unconfined Strength q_u T.S.F.	Shear Strength				
		Percent					Liquid Limit L.L.	Plastic Index P.I.					Total Stress			Effective Stress		Type Of Test		
		Gravel	Coarse Sand	Fine Sand	Silt and Clay								ϕ^o	C T.S.F.		ϕ^o	C' T.S.F.			
2	71.0	64	9	15	12	A-1-a	NA	NP	14											
3	07.0	0	7	57	36	A-4(0)	NA	NP	11											
3	12.0	(MOISTURE CONTENT ONLY)							15											
3	17.0	35	15	30	20	A-1-b	NA	NP	9											
3	22.0	(MOISTURE CONTENT ONLY)							11											
3	27.0	34	14	30	22	A-2-4	NA	NP	5											
3	37.0	37	8	26	29	A-2-4	NA	NP	11											
3	47.0	8	10	49	33	A-2-4	NA	NP	11											
3	57.0	15	9	54	22	A-2-4	NA	NP	10											
4	12.0	31	18	29	22	A-2-4	NA	NP	6											
4	17.0	3	6	42	49	A-4(3)	NA	NP	12											
4	37.0	45	14	24	17	A-1-b	NA	NP	12											
4	42.0	10	20	33	37	A-4(0)	19	4	15	134	117					31	0.30			
4	47.0	7	9	46	38	A-4(1)	NA	NP	11											
4	52.0	42	16	24	18	A-1-b	NA	NP	7											
4	67.0	45	12	21	22	A-1-b	NA	NP	10											

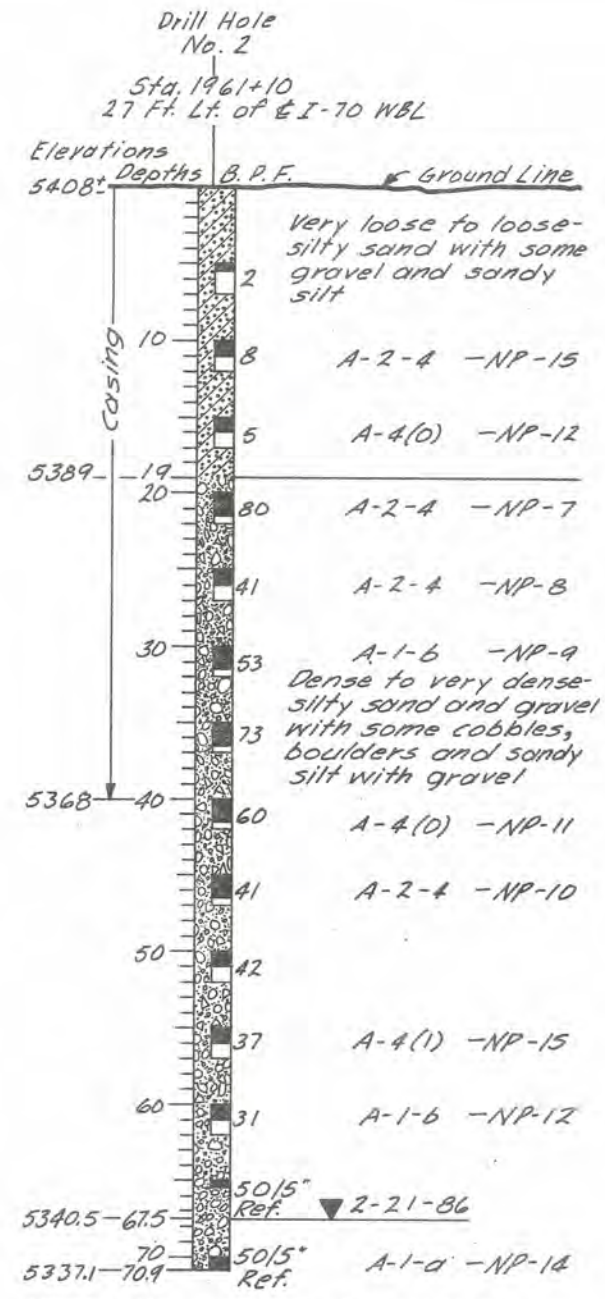
S - Shelby Sample P - Penetration Sample T - Triaxial Shear Test C - Consolidation DIR - Direct Shear Test UU - Unconsolidated, Undrained
 CU - Consolidated, Undrained CD - Consolidated, Drained



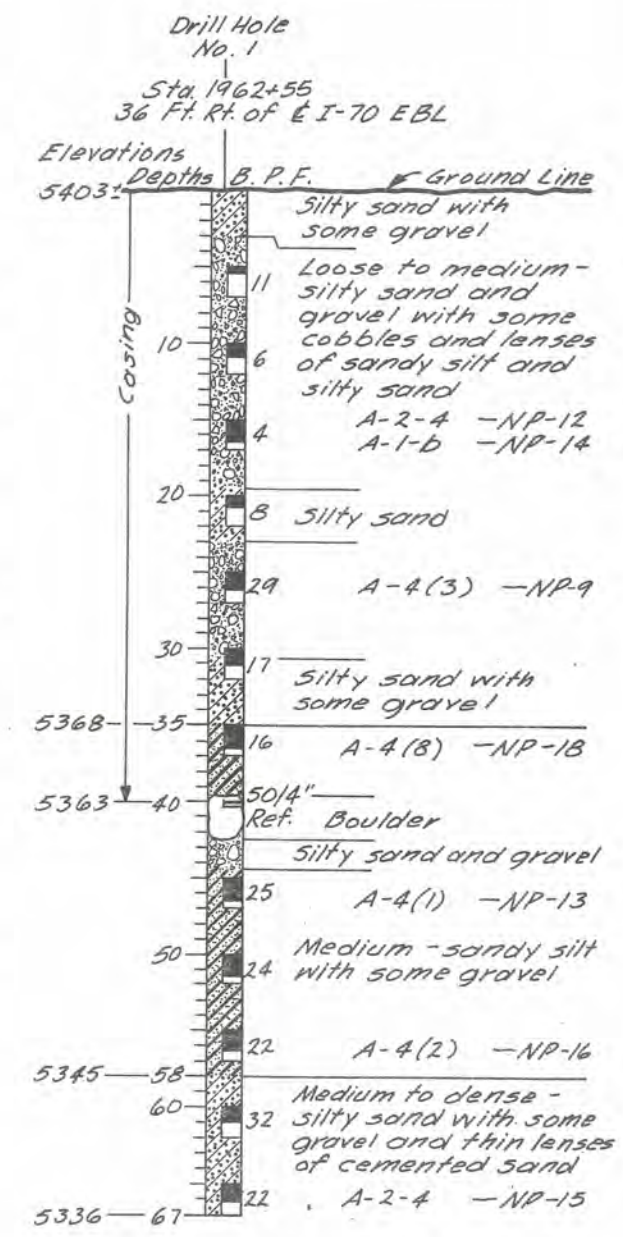
NOTE: Heavy loss of circulation water at 29 feet and a water table was not encountered.



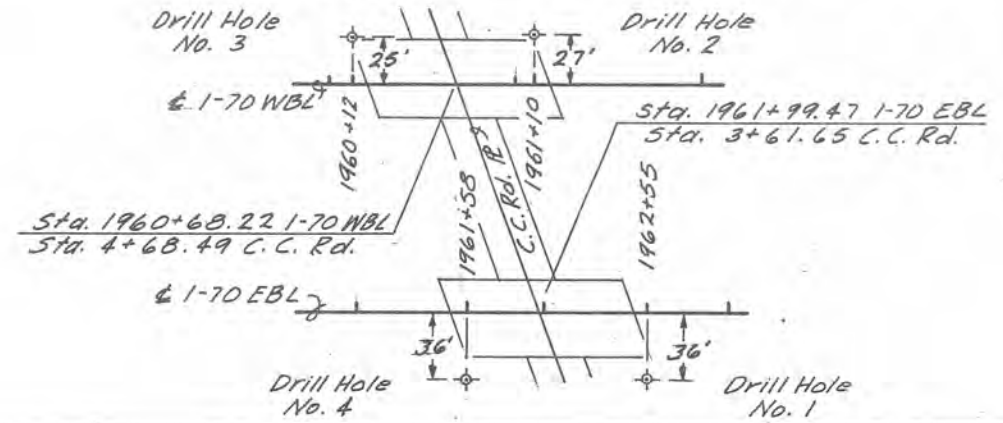
NOTE: Heavy loss of circulation water 58-59 feet.



NOTE: Heavy loss of circulation water at 38-40 feet and 63-65 feet.



NOTE: Heavy loss of circulation water 63 feet to 65 feet and a water table reading taken when bottom of the hole was at 52 feet showed hole was dry. Later readings could not be taken.



NOTE: The water table depths shown on the drill logs represent hole conditions on the date shown, either with casing still in place or with perforated plastic pipe installed. It should be noted however, that other locations away from the test holes or at other times of the year the water table elevation may vary significantly.

Date Drilled: Jan, Feb, March 86

NO	BY	DATE

KEY TO DRILLING LOG

RELATIVE DENSITY (NON-PLASTIC SAND & SILT)
 VERY LOOSE - LESS THAN 4 BLOWS PER FOOT.
 LOOSE - 4 TO 10 BLOWS PER FOOT.
 MEDIUM - 10 TO 30 BLOWS PER FOOT.
 DENSE - 30 TO 50 BLOWS PER FOOT.
 VERY DENSE - MORE THAN 50 BLOWS PER FOOT.

CONSISTENCY (PLASTIC SILT & CLAY)
 VERY SOFT - LESS THAN 2 BLOWS PER FOOT.
 SOFT - 2 TO 4 BLOWS PER FOOT.
 MEDIUM - 4 TO 8 BLOWS PER FOOT.
 STIFF - 8 TO 15 BLOWS PER FOOT.
 VERY STIFF - 15 TO 30 BLOWS PER FOOT.
 HARD - MORE THAN 30 BLOWS PER FOOT.

TOPSOIL OR FILL	IGNEOUS	SANDY CLAY
GRAVEL	LIMESTONE	CLAYEY SAND
SAND	CONGLOMERATE	SILTY CLAY
SILT	DOLomite	CLAYEY SILT
CLAY	SANDSTONE	SILTY SAND
SHALE	SILTSTONE	SANDY SILT

DRILL HOLE NO. STATION
 0+00 E OR L OR RT IN FT. OFFSET.

ELEVATIONS
 GROUND ELEVATION
 GROUND WATER TABLE
 STRATA CHANGE
 LOCATION OF SAMPLE
 SAMPLE NOT RECOVERED
 BOTTOM OF HOLE

DEPTHS
 2
 5
 15
 20
 25
 30
 35
 40
 45
 50
 55
 60
 65

B.P.F.
 2
 5
 10
 15
 20
 25
 30
 35
 40
 45
 50
 55
 60
 65

GROUND LINE
 EXAMPLE: Soft-silty clay, some fine sand
 AASHTO LL-PI-W
 A-6(9) 37-14-30
 DATE
 THIN WALL SHELBY TUBE, UNDISTURBED SAMPLER USED.
 SPLIT BARREL UNDISTURBED SAMPLER WITH LINER RINGS OR CALIFORNIA TYPE SAMPLER
 REASON NOT RECOVERED

ABBREVIATIONS
 L.L. - LIQUID LIMIT %
 P.I. - PLASTIC INDEX
 W. - NATURAL MOISTURE CONTENT %
 Ref. - REFUSAL ≥ 50 BLOWS PER 6"
 PEN. - PENETRATION
 G.W.T. - GROUND WATER TABLE
 B.P.F. - BLOWS PER FOOT.
 N.P. - NON PLASTIC
 AASHTO - SOIL CLASSIFICATION SYSTEM

UTAH STATE DEPARTMENT OF TRANSPORTATION
 SALT LAKE CITY, UTAH
MATERIALS and RESEARCH SECTION
 SOUTH RICHFIELD TO NORTH RICHFIELD
 I-70 OVER C.C. ROAD

Drawn By: KISTLEY
 Checked By: P. SHERMAN
 Checked By: M. BASHA
 Approved Recommended By: L. H. RAUSHER

1-70-1(23)36
 Project Number
 1960+68.22 WBL
 1961+99.47 EBL
 Station

SEVIER
 County

85-7-FS-41
 Foundations File No

F-535
 Fig No

01

FIGURE 1

ALLOWABLE BEARING PRESSURE DRILLED CAISSONS

I-70-1(23)36
SOUTH RICHFIELD TO NORTH RICHFIELD
I-70 OVER C.C. ROAD

STATION: 1960+68.22 WBL
1961+99.47 EBL

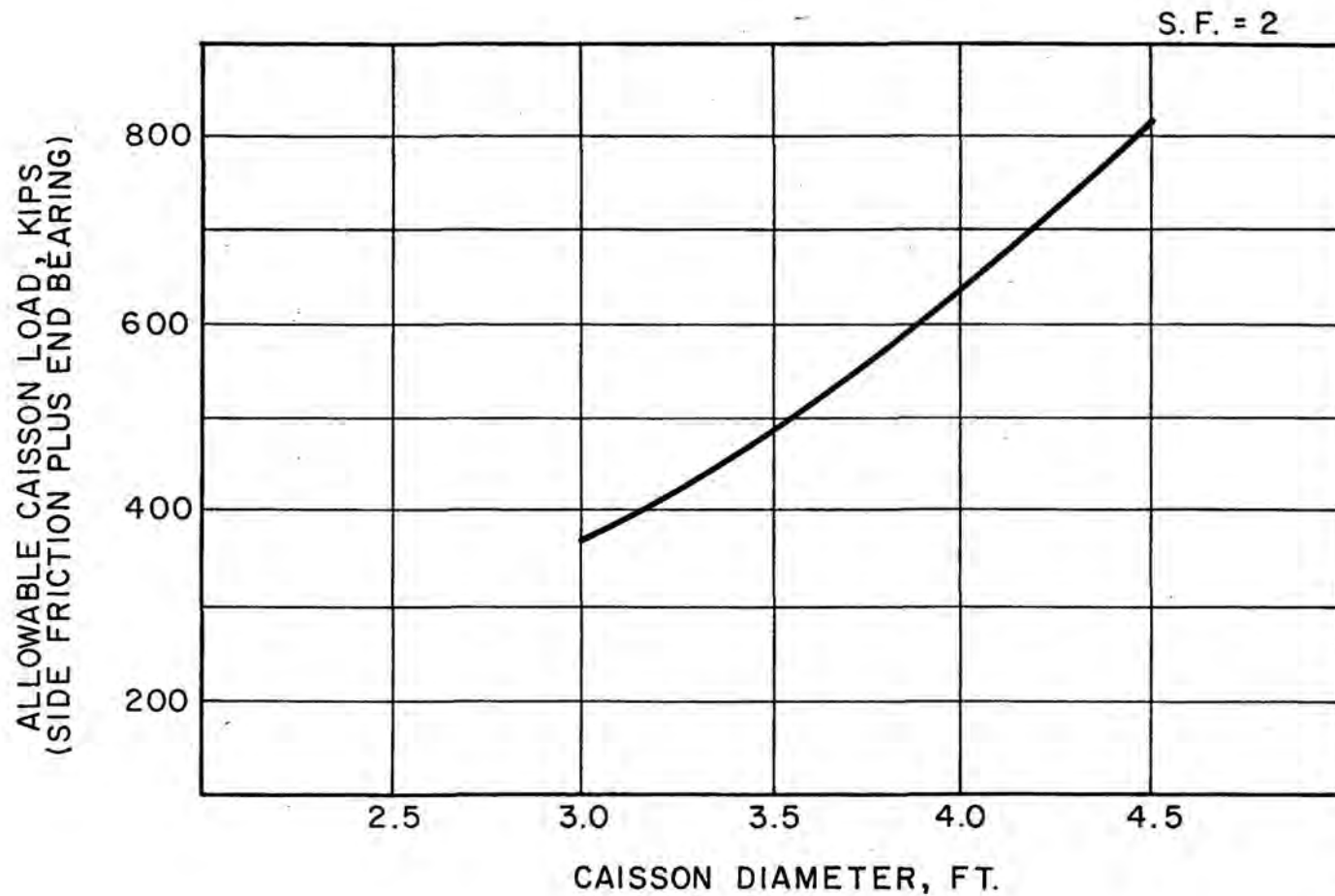


Fig. 2

Memorandum

UTAH DEPARTMENT OF TRANSPORTATION

DATE: June 4, 1986

TO : Those Listed Below

FROM : Heber Vlam, P.E., Engineer of Materials and Research *H.V.*

SUBJECT: I-70-1(23)36, South Richfield to North Richfield;
Foundation Report on I-70 over 5th South Street at I-70 Stations
1918+03.04 WBL and 1918+50 EBL, Drg. No. F-534

SITE CONDITIONS

Two single span prestressed concrete beam structures are proposed to carry I-70 over 5th South Street. These structures will be approximately 110 feet long by 42 feet wide and will cross 5th South at a skew angle of about 30°. The approach embankments will be nearly 18 feet to 20 feet high.

Surface drainage in the area is good.

SUBSURFACE EXPLORATION

Four test holes were drilled at this site with depths ranging from 50 feet to 67 feet. Correlation between test holes is fairly good and in general the subsurface materials may be described as follows: from the ground surface to a depth of 7 feet - lenses of sandy silt, cemented sand and some silty sand and gravel with cobbles; from 7 feet to 40 feet - loose to very dense silty sand with gravel, cobbles, boulders and some lenses of sandy silt and clayey silt; from 40 feet to the maximum depth of exploration - lenses of sandy silt, clayey silt, silty clay and some silty sand with gravel, cobbles and boulders. See Fig. 1, Log of Borings for more detailed descriptions and test hole locations.

FOUNDATION RECOMMENDATIONS

Drilled caissons are recommended to support these structures. Caissons 3.0 feet in diameter, founded at the elevations given below may be loaded to a safe bearing capacity of 415 kips per caisson. See Figure 2 for the bearing capacities of caissons with other diameters. A minimum diameter of 3.0 feet is recommended to facilitate drilling the soils with cobbles and boulders. The recommended caisson tip elevations are as follows:

<u>Location</u>	<u>Recommended Caisson Tip Elevation, Ft.</u>	<u>Approximate Caisson Length, Ft.</u>
South Abut. W.B.L. (Abut. #1)	5375	45
North Abut. W.B.L. (Abut. #2)	5376	45
South Abut. E.B.L. (Abut. #1)	5374	43
North Abut. E.B.L. (Abut. #2)	5375	43

These recommended tip elevations are approximate and shall be verified by inspection of the bearing materials at the time of construction. Caisson settlement is not expected to exceed 1.0 inch.

All loose material at the bottom of the caisson borings should be removed before the concrete is placed, and the concrete should be placed as soon after drilling as practicable. Care should be taken to keep all surface waters out of the caisson borings. The caisson holes may have to be cased during drilling to prevent caving, and difficult drilling should be anticipated due to the presence of cobbles and boulders (see Fig. 1).

These caissons will derive significant support from skin friction and it is therefore recommended that construction by the slurry method not be used.

EMBANKMENT SETTLEMENT AND STABILITY

Embankment settlement should be minor and should occur during construction. Embankment stability problems are not expected at this site.

Attachments

PSize more/lfp

cc: Structures	-3
Roadway Design	-2
Plans & Estimates Eng. (James Nelson)	-1
Construction	-2
District #3	-2
District #3 Materials Engineer	-1
Project File Foundations	-4

UTAH STATE DEPARTMENT OF TRANSPORTATION

MATERIALS AND RESEARCH

Project Number I-70-1(23)36
 Project Name So. Richfield to No. Richfield

Summary of Test Data

Sheet 1 Of 2
 Structure I-70 over 5th South

Boring No.	Depth	Grading Analysis				Group Classification	Atterberg Limits		Water Cont. ω %	Wet Unit Weight γ P.C.F.	Dry Unit Weight γ_s P.C.F.	Specific Gravity G_s	Permeability k 10^{-4} cm/sec.		Unconfined Strength q_u T.S.F.	Shear Strength				Type Of Test
		Percent					Liquid Limit L.L.	Plastic Index P.I.					Total Stress			Effective Stress				
		Gravel	Coarse Sand	Fine Sand	Silt and Clay								ϕ°	C T.S.F.		ϕ°	C' T.S.F.			
1	12.0	26	19	34	21	A-2-4	NA	NP	12											
1	22.0	16	11	38	35	A-2-4	21	4	11											
1	37.0	38	15	18	29	A-2-6(0)	31	12	19											
1	47.0	32	8	21	39	A-6(2)	33	15	15											
1	52.0	15	9	30	46	A-4(2)	26	9	18											
1	57.0	39	13	17	31	A-2-6(1)	32	14	11											
1	67.0	3	2	25	70	A-6(9)	32	14	24											
2	12.0	45	15	19	21	A-1-b	23	5	10											
2	22.0	18	6	36	40	A-4(1)	NA	NP	20											
2	26.5	40	17	22	21	A-1-b	NA	NP	14											
2	42.0	2	4	28	66	A-6(7)	29	11	17											
2	47.0	8	12	34	46	A-4(2)	24	5	14											
2	57.0	42	11	16	31	A-2-4	25	7	14											
3	07.0	0	9	41	50	A-4(3)	NA	NP	16											
3	17.0	31	18	26	25	A-2-4	NA	NP	17											
3	27.0	46	12	19	23	A-1-b	NA	NP	13											

S - Shelby Sample P - Penetration Sample T - Triaxial Shear Test C - Consolidation DIR - Direct Shear Test UU - Unconsolidated, Undrained
 CU - Consolidated, Undrained CD - Consolidated, Drained

MATERIALS AND RESEARCH

Project Number I-70-1(23)36

Summary of Test Data

Sheet 2 Of 2

Structure I-70 over 5th South[illegible]

S - Shelby Sample	P - Penetration Sample	T - Triaxial Shear Test	C - Consolidation	DIR - Direct Shear Test	UU - Unconsolidated, Undrained
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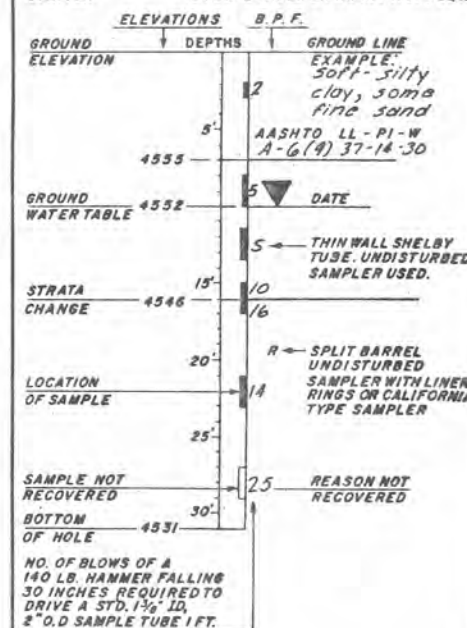
CU- Consolidated, Undrained CD- Consolidated, Drained

KEY TO DRILLING LOG
RELATIVE DENSITY (NON-PLASTIC SAND & SILT)
 VERY LOOSE - LESS THAN 4 BLOWS PER FOOT.
 LOOSE - 4 TO 10 BLOWS PER FOOT.
 MEDIUM - 10 TO 30 BLOWS PER FOOT.
 DENSE - 30 TO 50 BLOWS PER FOOT.
 VERY DENSE - MORE THAN 50 BLOWS PER FOOT.

CONSISTENCY (PLASTIC SILT & CLAY)
 VERY SOFT - LESS THAN 2 BLOWS PER FOOT.
 SOFT - 2 TO 4 BLOWS PER FOOT.
 MEDIUM - 4 TO 8 BLOWS PER FOOT.
 STIFF - 8 TO 15 BLOWS PER FOOT.
 VERY STIFF - 15 TO 30 BLOWS PER FOOT.
 HARD - MORE THAN 30 BLOWS PER FOOT.

TOPSOIL OR FILL	IGNEOUS	SANDY CLAY
GRAVEL	LIMESTONE	CLAYEY SAND
SAND	CONGLOMERATE	SILTY CLAY
SILT	DOLOMITE	CLAYEY SILT
CLAY	SANDSTONE	SILTY SAND
SHALE	SILTSTONE	SANDY SILT

DRILL HOLE NO. STATION 0+00 E OR L OR RT. INFT. OFFSET.



ABBREVIATIONS
 L.L. - LIQUID LIMIT IN %
 P.I. - PLASTIC INDEX
 W. - NATURAL MOISTURE CONTENT IN %
 Ref. - REFUSAL ≥ 50 BLOWS PER 6"
 PEN. - PENETRATION
 G.W.T. - GROUND WATER TABLE
 B.P.F. - BLOWS PER FOOT.
 N.P. - NON PLASTIC
 AASHTO - SOIL CLASSIFICATION SYSTEM

UTAH STATE DEPARTMENT OF TRANSPORTATION
 SALT LAKE CITY, UTAH
MATERIALS and RESEARCH SECTION

SOUTH RICHFIELD TO NORTH RICHFIELD
 I-70 OVER 5th SOUTH

Drawn By <i>R. Stier</i>	Checked By	I-70-1(23)36
Checked By <i>P. Steenard</i>	Checked By	Project Number
Checked By <i>M. Basha</i>	Checked By	1918+03.04 WBL
Approved Recommended By <i>Lynn H. Rauscher</i>	Checked By	1918+50.00 EBL
Received	Date	Station
	Chief Structural Eng.	SEVIER
	County	
85-7-FS-42	F-534	01

NOTE: A ground water table was not encountered in any of these holes.

Date Drilled: Feb. & March 1986

NO	BY	DATE	REVISIONS

NOTE: The water table depths shown on the drill logs represent hole conditions on the date shown, either with casing still in place or with perforated plastic pipe installed. It should be noted however, that other locations away from the test holes or at other times of the year the water table elevation may vary significantly.

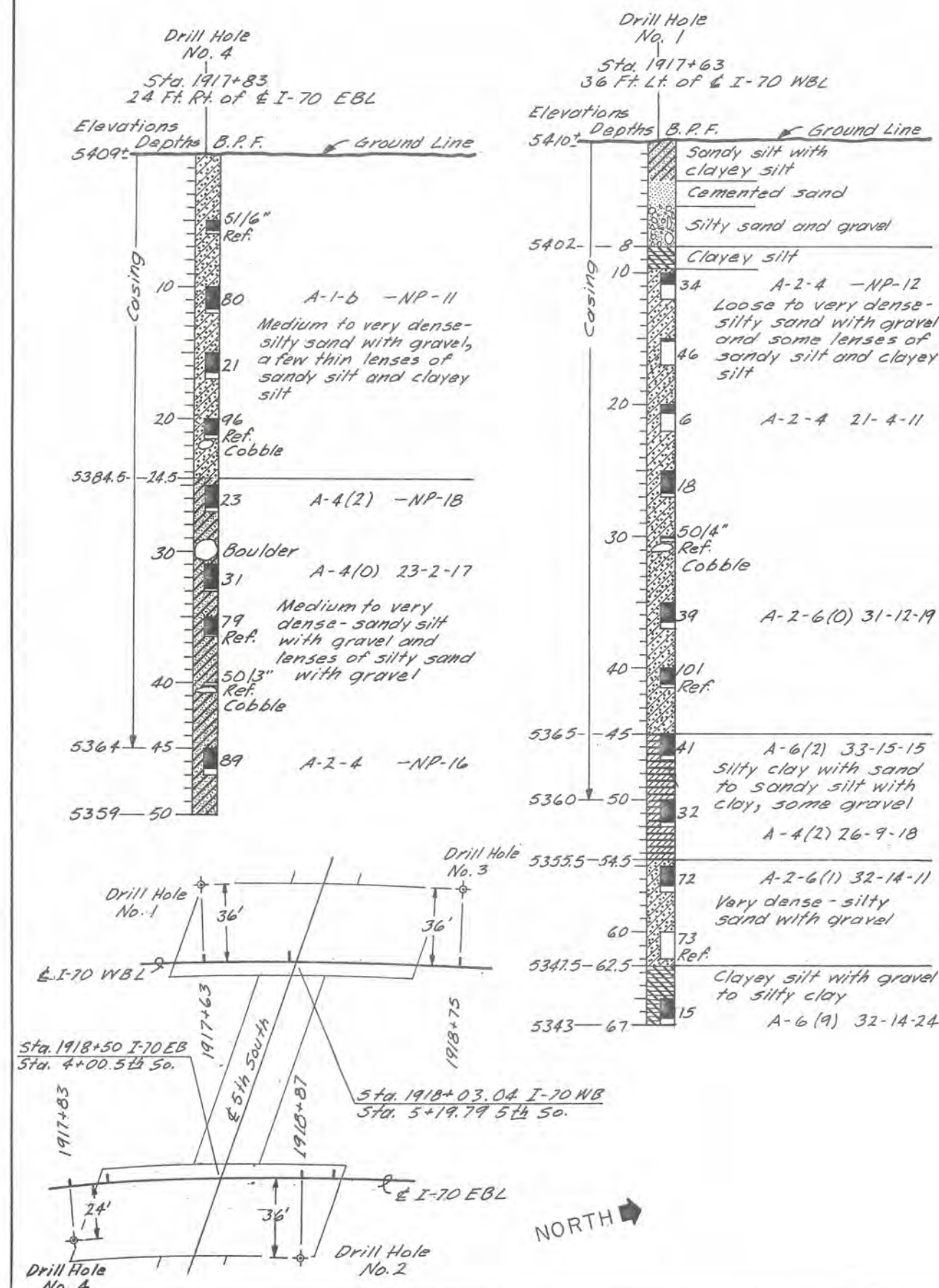


FIGURE 1

ALLOWABLE BEARING PRESSURE DRILLED CAISSONS

I-70 - I(23)36
SOUTH RICHFIELD TO NORTH RICHFIELD
I-70 OVER 5th SOUTH STREET

I-70 STATION: 1918+03.04 WBL
1918+50.00 EBL

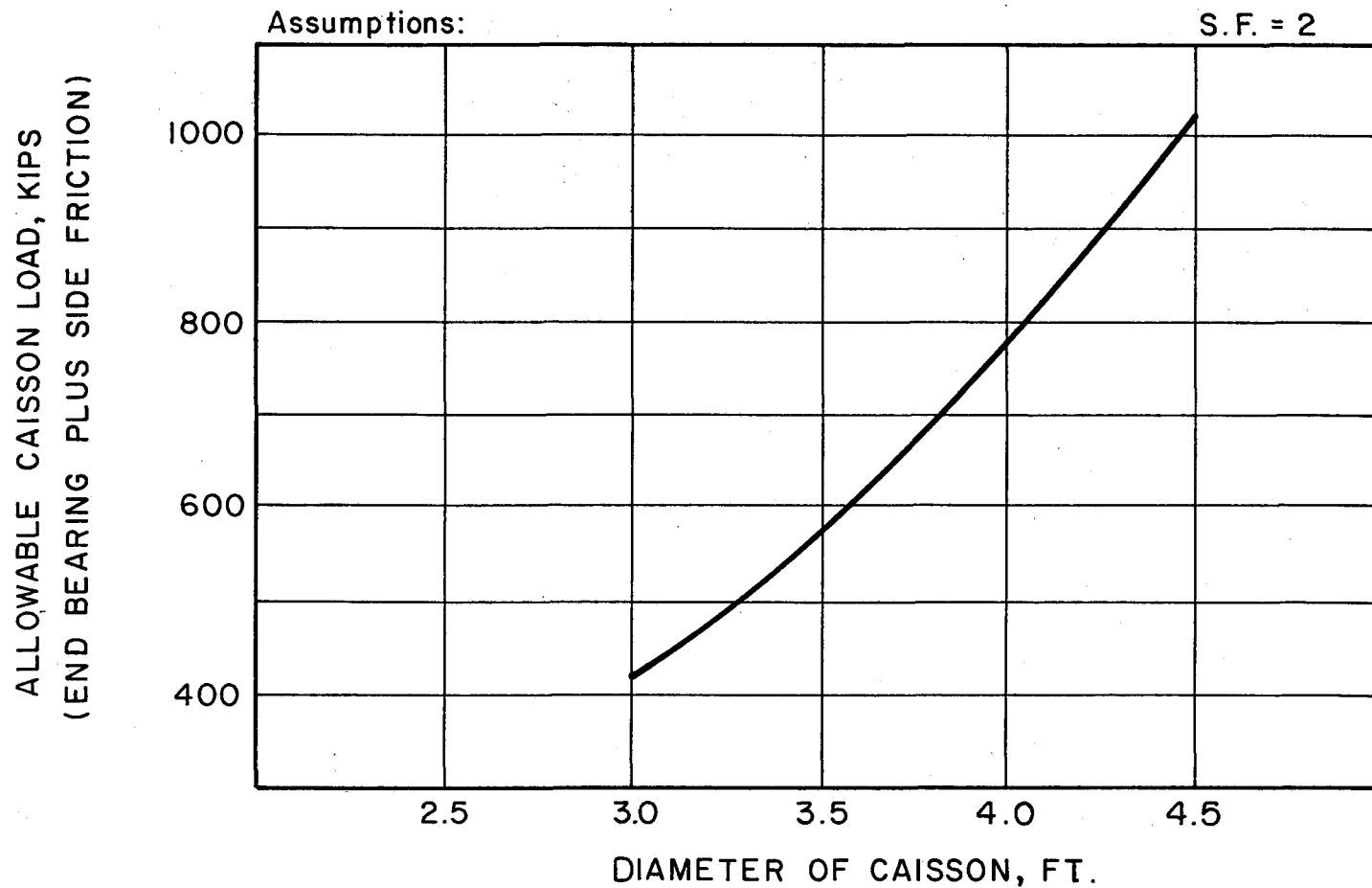


Fig. 2