

GeoSystems Consultants, Inc.

COPY

August 23, 1993
Project 93G019

Vesper Boat Club
c/o Mr. Larry Wittig
244 E. Broad Street
Tamaqua, PA 18252

Re: Vesper Boat Club

Dear Larry:

GeoSystems Consultants Inc. (GSC) is pleased to present this construction monitoring report associated with the compaction grouting program conducted at the Vesper Boat Club (VBC), Boathouse Row, Philadelphia, Pennsylvania. GSC was retained by the VBC via its representative, Mr. Larry Wittig, to observe and document (only) the "compaction grouting" program associated with the party wall between VBC and MALTA Boat Club. The scope of work was expanded verbally during a telephone conversation between Mr. Wittig and Mr. C.R. Calabria of GSC to provide spot documentation of other grouting being performed at the site. These services performed by GSC commenced on 7/June/93, and concluded on 2/July/93. GSC monitored portions of the drilling operation, the compaction grouting operation, and monitored building movement using contractor's level control equipment and a crack gauge installed by MALTA Boat Club to evaluate wall, and floor slab movement.

PROJECT DESCRIPTION

The Vesper Boat Club occupies part of a three-story stone, brick and wood frame structure located at 10 Boathouse Row, Philadelphia, Pennsylvania. The MALTA Boat Club occupies the other portion of this building. The Vesper/MALTA building is situated on the east bank of the Schuylkill River in northwestern Philadelphia. A stone/concrete sea wall, reportedly supported on pile foundation, forms the east bank of the river at this location and is approximately 15 feet from the western face of the building. The ground floor of the building consists of open bays for storage of rowing skulls. The upper two stories house the locker room, shower facilities, and meeting rooms for the clubs. The original structure was built in the mid-1860's. Several additions to the building have been

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made in the subsequent 130-year history of the structure. The most recent reported addition by VBC was in the 1940's.

The entire structure has experienced damage due to settlement of the building foundations, and ground level concrete floorslabs. It is noted that most, if not the entire structure, is reported to be supported by a shallow foundation system. Based on test boring data supplied, site subsoil conditions are generally not suitable for support of shallow foundation systems. Cosmetic repairs of the settlement damage have been made. However, prior to the grouting program, no attempt was reported to have been made to address the continuing settlement problem.

Remedial Alternative

An engineering report prepared by Schnabel Engineering Associates, West Chester, Pennsylvania, dated 28/October/92 recommended various remedial alternatives to address the settlement problem, among which was the selected alternative, "compaction grout piles." The proposed layout and grout quantities of the compaction grout piles in Schnabel's report of 28/October/92 is presented as Figure 1. This original layout, which shows paired injection points on both sides of the load bearing walls to be compaction grouted, was subsequently modified to a single row grouting pattern. The modified unpaired grouting pattern recommended by Schnabel, (undated) is presented as Figure 2. The single row grouting pattern was further modified to accommodate the accessibility for the various compaction grout locations. This final injection point layout is presented as Figure 3. It is noted that in the initial Schnabel report, the paired grout hole layout scheme proposed the injection of two cubic feet and three cubic feet of grout per linear foot of grouted depth, as indicated in Figure 1. When the scheme was modified for the unpaired grout location scheme, the quantity for grout injection was doubled for each location. This increased quantity was used during the implemented grouting program performed.

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Grouting Program

Denver Grouting Services, Inc. (DGS) of Broomfield, Colorado, was retained by VBC to perform the compaction grouting services at the site. A total of 51 locations/injection points were compaction grouted. In addition, three secondary grout holes were placed at locations 14/15E(ast), 43R and 42R to supplement primary locations 14/15, 43, and 42, respectively. A summary of all locations is presented in Table 1. The grouting logs for all locations are presented in Appendix 1. GSC was present during the grouting of locations along the party wall (i.e. 41-49) and selected other locations (i.e. 17, 25, 35 and 40) associated with other bearing walls.

The grouting was performed using a modified Thompson pump. This is a piston pump with a volume of approximately 1/4 cubic foot per stroke. Volume estimates were made by counting the number of strokes of the grout pump per injection increment. The grout mix consisted of low slump grout (no slump measurements were made) and consisted of a well-graded sandy material with approximately 15% fines (i.e. 15% material passing the #200 sieve opening size 0.074 mm) mixed with approximately six bags of cement per cubic yard. The intent of the mix design was to achieve minimum 28-day grout strength of 2000 psi in 28 days. The grouting operation began on 18/May/93. Grout pressure was monitored using a pressure gauge at the sweep neck connected to the injection pipe. Grout pressures ranged from a low of 50 psig to in excess of 500 psig. At the higher grout pressures, less grout per linear foot was injected, as indicated in the logs in Appendix 1. At lower pressures, full volume (as per the Schnabel design) were injected, except in cases where excessive slab movement or wall movement was encountered. In such cases, volumes may have been less than design quantities.

On 17/June a site meeting among the architect, Mr. Fred Kaulbach of Armstrong Kaulbach, Ms. structural engineer Ann Rothman, the contractor Mr. Joseph Harris (DGS), and Mr. C.R. Calabria (GSC) took place. During this meeting, the structural engineer approved the inject plan layout as presented in Figure 2, and suggested a grouting sequence for the party wall (i.e. pump the wall segment parallel to the river first, let set, then proceed with the wall segment perpendicular to the river). The grouting sequence

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was performed as suggested. During this meeting, grouting of the brick/blockwall (1940's addition) was discussed.

During the course of the grouting, program, the materials supplier changed the cement from Type I to a pigmented variety. It was later reported that the pigmented variety was Type II cement. This change occurred on 7/June/93. The strengths of the cured grout material for the Type II case were variable and generally low, as indicated on strength tests presented in Appendix 2. Grout cylinders for strength testing were prepared by GSC on 10 occasions as listed in Table 2, and specimens were tested by E.L. Conwell of Bridgeport, Pennsylvania. Strength tests of grout specimens prepared on June 9, 14, 15 and 16 were significantly below the 2000 psi strength recommended by Schnabel Engineering Associates. These grout specimens are representative of grout locations 35, 41, 42, and 43. The results of the strength testing of grout samples prepared by GSC and other specimens prepared by DGS are presented in Appendix 2.

As a consequence of this lower strength material which (in the opinion of GSC) was not likely to meet the design requirements, the grout mix was changed on 25/June/93. Those locations affected by the low grout strength where samples were taken were redrilled and regouted. These injection points are identified with the extension "R" (see Table 1) after the grout location. A total of 12 locations were regouted. Of these 12 locations, 3 injection points (42, 43, and 45) were relocated and reinjected. In the case of injection point #44, this injection point was not reinjected, due to party wall movement during the previous injection point grouting. It is also noted that, based on records reviewed, injection point #35 was apparently not completely grouted. The records indicated grouting occurred between levels 31 to 16, and 9 to 5 feet below grade.

Monitoring

The monitoring conducted by GSC along the party wall included observation of quantities of materials injected at each location, and movement of the floor slab and party wall. Movement of the party wall included checking a crack gauge installed on the MALTA Boat Club side of the party wall, near the river side of the building, and observing level

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indicators while pumping each injection point. In addition, measurements of relative movement between wall and the floor slab were also made. The crack gauge showed a total movement of approximately 5 millimeters out (i.e. toward the river) and 2 millimeters down. Total lift of the party wall was on the order of 1/8 inch to 3/16 inch based on level indicators recorded during grout placement. Floor slab movement during the grouting program was generally less than 1/4 inch. Subsequent to the grouting program, mudjacking of the floor slabs was performed during the grouting program by DGS.

In addition to the observations listed above the various grout hole locations, GSC videotaped the site before the grouting of the party wall, and at the completion of grouting the party wall, and made the appropriate notations on the videotape. The videotape has been submitted to Mr. Larry Wittig under separate cover for documentation purposes.

Conclusions

Based on our observations and review of contractor's documents, the work was performed in general accordance with requirements established in the Schnabel report, and modifications thereto, as noted in Figure 3. The exceptions to this included grout strengths were low for sample numbers 35, 41, 42, and 43, for samples collected on June 9, 14, 15, and 16, 1993, and an apparent uncompleted grout pier at location 35.

When low grout strengths (7-day break strength) was revealed for grout cylinder (3" x 6" specimens) which used Type II cement, the mix design was changed back to Type I cement. The new mix design 7-day strength was near the required 28-day strength for the grout cylinders. It is noted that sample preparation was outside the initial scope of work by GSC. GSC prepared these samples as a check and informed Mr. Wittig that the same was being done as a check for performance. The lower grout strength required that several locations be redrilled and reinjected to compensate for the lower strength grout injected. It is anticipated at this time that the lower grout strengths encountered for samples 35, 41, 42, and 43 will not make the 2000 psi requirement criteria; however, this grout is stronger than the in situ material and (in the opinion of GSC) will perform a useful function. The intent of the compaction grouting program was to provide vertical support

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of VBC bearing walls and to mitigate the settlement problems associated with the VBC portion of the structure. It is noted that the VBC side is now relatively stable with regard to settlement compared to that of the MALTA Boat Club. This condition will likely result in differential settlement between the VBC portion and MALTA portion of the structures.

Limitations

GSC observed and documented grouting activities of the party wall between VBC and MALTA Boat Club and other selected locations on an as-requested basis. This report summarizes the information reviewed by GSC and observations made during periodic site visits. GSC's purpose on this project was to document that the modified grouting program developed by Schnabel Engineering Associates was performed in general accord with the intended design.

It has been a pleasure to have been of service to you on this project, and look forward to working with you in the future as the need may occur.

Very Truly Yours,

GeoSystems Consultants



Craig R. Calabria, P.E.

CRC/ima

Enclosures: Table 1
Table 2
Figure 1
Figure 2
Figure 3

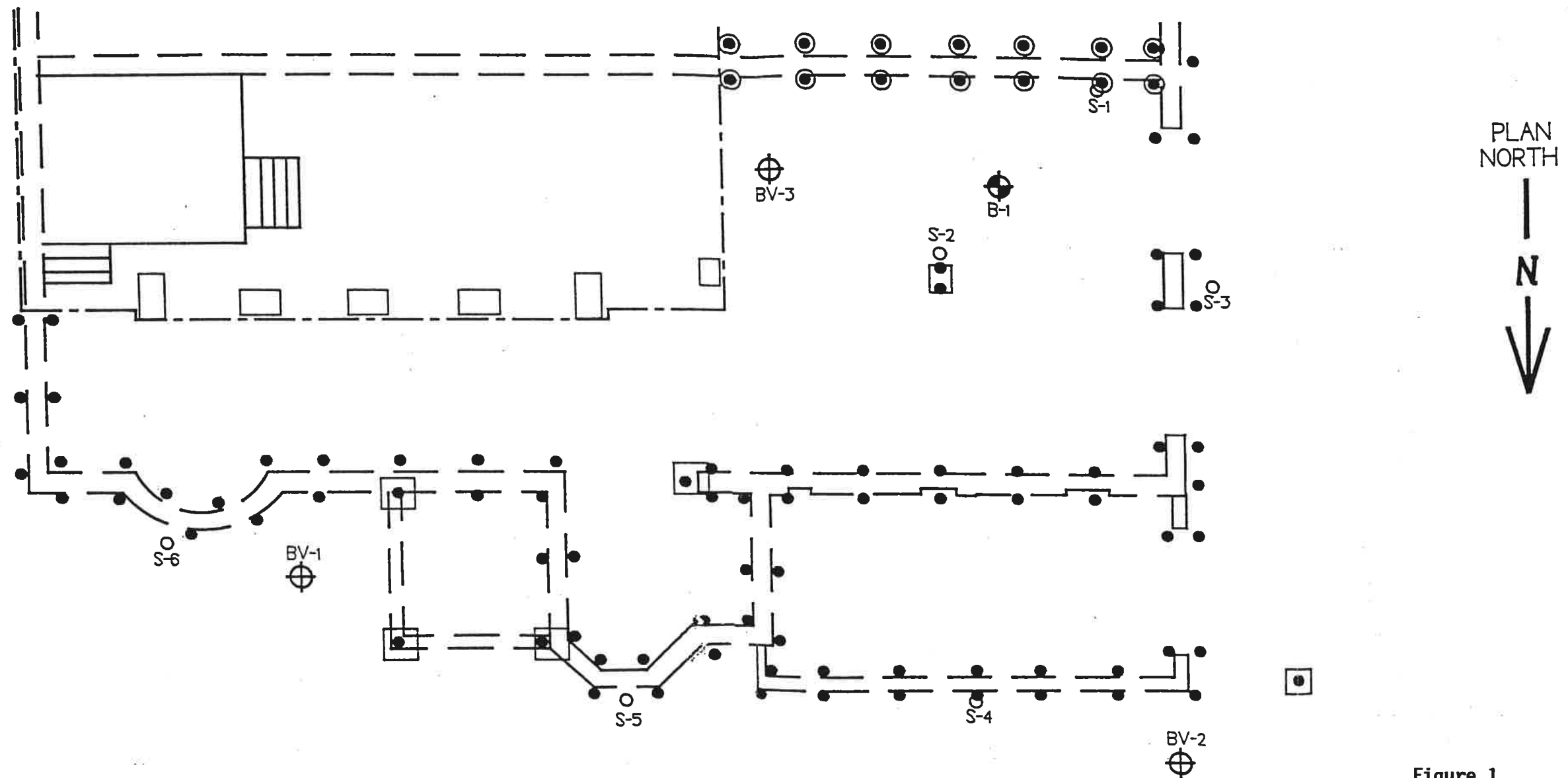
TABLES

TABLE 1
SUMMARY OF GROUTING PROGRAM
VESPER BOAT CLUB

Injection Point	Date of Injection	Total Grout Injected	Approx. Depth of Fdn. below grade (ft)	Depth of Injection below grade (ft)
1	06/29	39.0	5.6	22/3
2	05/18	52.3	5.6	23/5
3	05/24	46.8	5.6	17/5.5
4	05/18	85.0	5.6	27/5.5
5	05/24	73.5	5.6	27/5.5
6	05/20	78.0	5.6	27/6
7	06/23 , 06/27	84.5	5.6	26/5
8	06/23	72.5	5.6	25/5
9	06/08	15.5	5.6	8.6/6
9R	06/23	47.8	5.6	24/6
10	06/08	21.5	5.6	8.6/6
10R	06/22	63.8	5.6	26/5
11	06/02	74.5	5.6	29/3
12	05/19	91.0	7.6	29/7
13	05/18	94.5	5.6	29/5
14	05/25 , 06/01	83.0	7.6	28/7
15	05/25 , 06/02	81.3	7.6	28/6
16	05/19	102.0	7.6	32/6.5
17	06/09 , 06/17	71.5	7.6	31/8
17 R	06/28	81.0	7.6	30/4
18	05/26 , 06/01	113.0	4.0	31/4
19	05/19	102.0	4.0	32/5
20	05/26	99.8	4.0	32/5
21	05/20	110.0	4.0	32.5/5
22	05/26 , 06/02	98.0	4.0	32/3
23	05/26 , 06/02	100.3	4.0	32/4
24	05/21 , 05/24	140.0	4.0	34/4
25	06/30 , 07/02	79.5	4.0	32/4
26	05/26 , 06/03	108.5	7.6	29/5
27	06/14	71.3	7.6	26/7
28	06/08	15.5	7.6	8.6/6
28R	06/22	74.5	7.6	29/6
29	06/04 , 06/08	72.5	5.3	29/3
30	06/04 , 06/07	111.0	5.3	28/5.5
31	05/26 , 06/03	110.5	5.3	32/6
32	06/04 , 06/07 , 06/09	116.0	5.3	30/6

**TABLE 1
SUMMARY OF GROUTING PROGRAM
VESPER BOAT CLUB**

Injection Point	Date of Injection	Total Grout Injected	Approx. Depth of Fdn. below grade (ft)	Depth of Injection below grade (ft)
33	05/21	120.0	5.3	34/6
34	05/22 , 05/24	133.0	5.3	34/4.5
35	06/04 , 06/07 , 06/09	80.5	5.3	31/16, 9/5
36	05/24 , 05/25	137.5	5.3	34/5
37	05/26 , 06/08	122.0	5.3	32/5
38	06/04 , 06/27	117.0	5.3	29/5
39	07/03	84.8	5.3	28/5
40	06/29	65.5	5.3	27/5
41	06/14	19.0	7.1	9/7
41R	06/24	133.5	7.1	33/5
42	06/14 , 06/16	18.0	7.1	30.6/4
42R	06/30	88.0	7.1	33/5
43	06/15	19.0	7.1	9/7
43R	06/29	119.0	7.1	30/3
44	06-16,06-18,06-19	152.0	7.1	30/9
45	06/15	20.0	7.1	9.6/7
45R	07/01	95.0	7.1	28/5
46	06/15 , 06/18	81.0	7.1	30/19
46R	07/02	121.0	7.1	30/7
47	06/15	19.0	7.1	9/7
47R	06/25	106.5	7.1	29/5
48	06/15	18.5	7.1	9/7
48R	06/29	129.5	7.1	27/5
49	06/15	20.0	7.1	9/7
49R	06/30	94.0	7.1	27/3
50	06/24 , 06/26	82.0	N/A	30/3
51	06/25 , 06/26	80.5	N/A	27/3



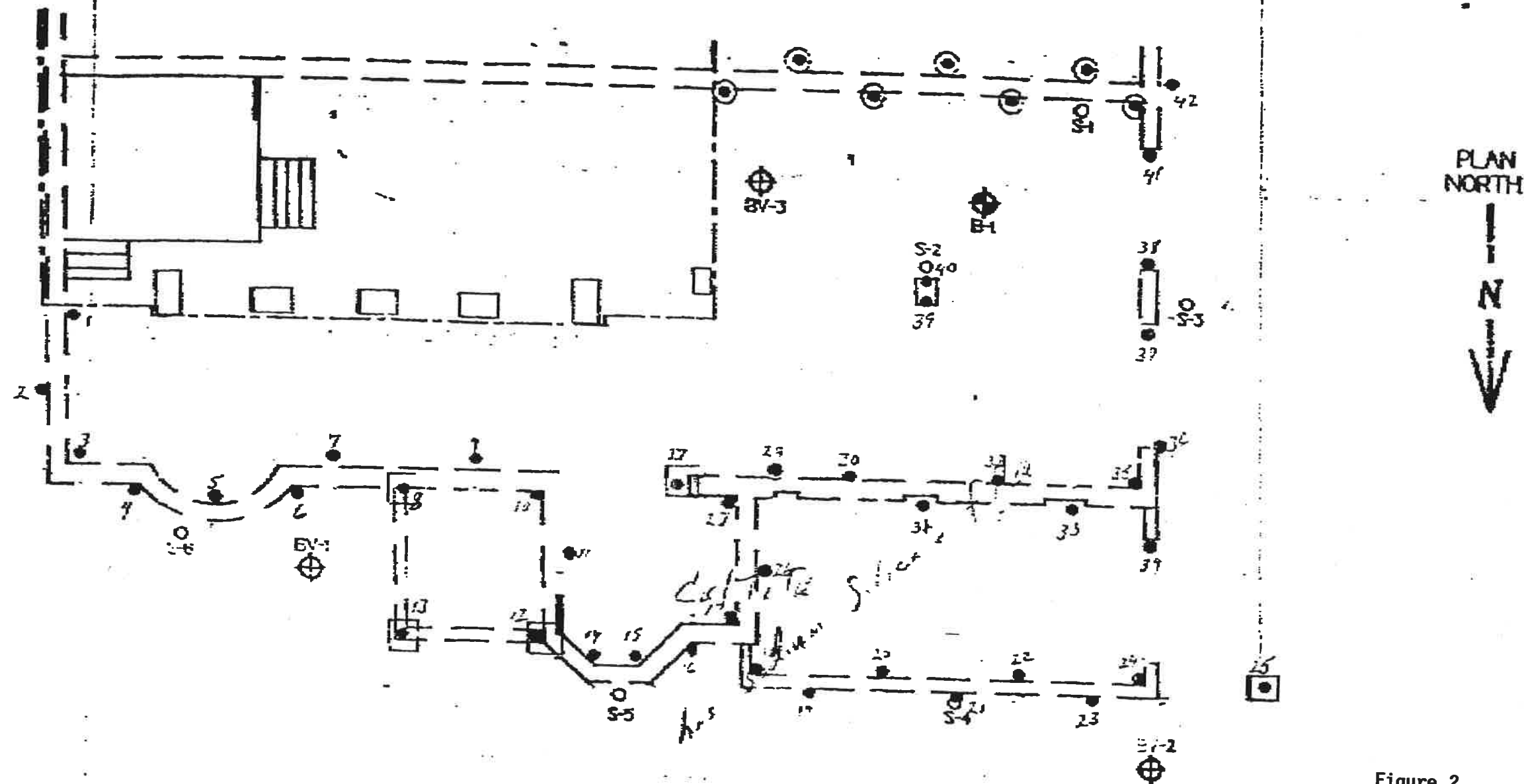
- LEGEND
- LOCATION OF GROUT INJECTION AT 2CF/FT
 - ⊙ LOCATION OF GROUT INJECTION AT 3CF/FT

NOTE : PLAN ASSUME 6' SPACING WITH PAIRED COMPACTION GROUT PILES.

Figure 1

From Schnabel 28 October 1992
Report

SCHNABEL ENGINEERING ASSOCIATES		CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS	
BETHESDA, MD	RICHMOND, VA	BALTIMORE, MD	WEST CHESTER, PA
VESPER BOAT CLUB			
10 BOAT HOUSE ROW, PHILADELPHIA, PENNSYLVANIA			
SAMPLE GROUT HOLE LAYOUT		SCALE 1" = 10'	DATE 10-28-92
		DRAWN BY NB	CHECKED BY MJB
		DRAWING NO. 920945	FIELD NO. 1



LEGEND

- 12 ● LOCATION OF GROUT INJECTION AT 4 CF/FT 5880
- 7 ○ " " " " AT 6 CF/FT 1470

NOTE: ALL SECTION GROUT PIPES MUST BE
INSTALLED VERTICALLY, WITHIN 6 INCHES
OF EXISTING WALLS AND FOUNDATIONS.

TYPICAL CARTRIDGE GROUTING DEPTH IS ESTIMATED
TO BE 35 FT.

SUPPORT REQUIREMENTS
MUST BE VERIFIED WITH
THE STRUCTURAL ENGINEER.

Figure 2

From Schnabel Communication With
Denver Grouting Services, Inc.

SCHNABEL ENGINEERING ASSOCIATES			
VESPER BOAT CLUB			
10 BOAT HOUSE ROW, PHILADELPHIA, PENNSYLVANIA			
4-7-80 DATE		10-28-92	
SAMPLE GROUT HOLE		N.B.	
920945		MJE	

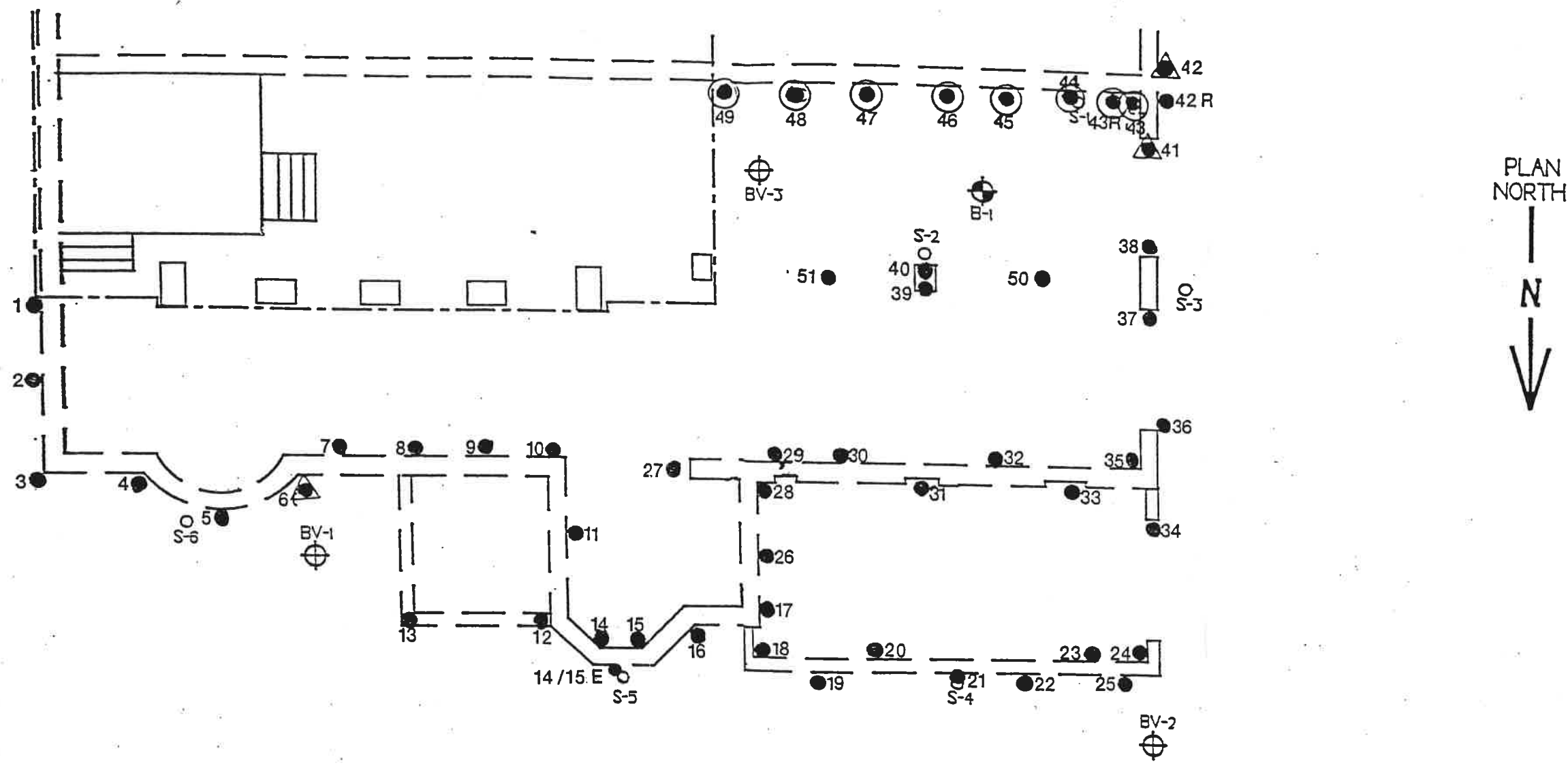


Figure 3

LEGEND

- LOCATION OF GROUT INJECTION AT 4CF/FT
- ⊙ LOCATION OF GROUT INJECTION AT 6CF/FT
- ▲ LOCATION OF GROUT INJECTION AT 6 CF/FT

NOTE : PLAN ASSUME 6" SPACING WITH PAIRED COMPACTION GROUT PILES.

LEGEND

- ⊕ LOCATION OF TEST BORING COMPLETED 9-30-92
- LOCATION OF PIPES INSTALLED FOR GEOPHYSICAL TESTING 9-30-92 AND 10-1-92
- ⊕ LOCATION OF PREVIOUS BORING BY J.E. FRITTS AND ASSOCIATES 5-19-92 AND 5-20-92

SCHNABEL			
ENGINEERING			
ASSOCIATES			
CONSULTING GEOTECHNICAL ENGINEERS AND GEOLGISTS			
BETHESDA, MD	RICHMOND, VA	BALTIMORE, MD	WEST CHESTER, PA
VESPER BOAT CLUB			
10 BOAT HOUSE ROW, PHILADELPHIA, PENNSYLVANIA			
BORING LOCATION PLAN		SCALE 1" = 10'	DATE 10-28-92
		DRAWN BY NB	CHECKED BY MJB
		DESIGNED BY 920945	SHEET NO. 1

Table 2
Grout Strength Testing
3" x 6" Specimens
Vesper Boat Club

Date Samples Prepared	Laboratory Control Number	Number of Specimens Tested
6-9-93	259044	5
6-14-93	259064	5
6-15-93	259063	5
6-16-93	259087	4
6-22-93	259116	3
6-24-93	259120	4
6-25-93	259121	4
6-29-93	259157	3
6-30-93	259158	4
7-1-93	259159	4

NOTES: All samples tested by E. L. Conwell & Co., Bridgeport, Pennsylvania
Other testing performed on specimens prepared by DGS are presented on
Laboratory No. 462323 report form.
Compressive Strength Test Summary Sheets included as Appendix 2

FIGURES

APPENDIX 1

DRILLING LOG

FOR : _____

DATE	INJECTION POINT	STAGE #	BROKE THROUGH	TOTAL DRILLED DEPTH	(R)	C.F.	REMARKS
6-29-93	#1	(1)	-	22'-15"	500/700	4.5	Casing - erect / Pressure
				14'	500/220/100	8.0	L.P. Appears as if
				13'	200/150	4.0	there is more
				12'	150/100	4.0	disintegrated rock
				11'	100/100	4.0	towards the drive then
				10'	100/100	4.0	What is encountered
				9'	100/100	4.0	in the back of towards
				8'	100/75	4.0	river
				7'-3"	75/75	8.5	At 9' 1/2" wall
							lift.
							due to L.F.T. at water
							and slabs we jumped
							5' below.

PUMPING LOG FOR:

PROJECT STARTED:

PROJECT ENDED:

16.75 cm



FOR : Vaslar Bond Ho-50

DATE	INJECTION POINT	STAGE #	BROKE THROUGH	TOTAL DRILLED DEPTH	REMARKS
5-15-93	A2			0-10'	Somewhat soft,
				10'-18'	Soft to 16' firm at 17'
				18'-23'	Hard from 18'-23' 2 hrs for 5' of drilling.
					Though I felt as if I was into a sandstone or fractured rock at approx 18'-20' I continued drilling with a carbide bit to make sure. No logs were contacted on site.

PUMPING LOG FOR:

PROJECT STARTED:

PROJECT ENDED :

[illegible]