REPORT OF

GEOTECHNICAL INVESTIGATION

-

(2) FIRE STATION ADDITIONS & NEW POLICE STATION

10340 VT ROUTE 116

HINESBURG, VERMONT

FOR

TOWN OF HINESBURG

VERMONT

Prepared by:

Knight Consulting Engineers, Inc.
51 Knight Lane
Williston, VT 05495

Report Issued: May 6, 2013

KCE Knight Consulting Engineers, Inc.

May 6, 2013

Rocky Martin
Department of Buildings and Facilities
Town of Hinesburg
10632 Route 116
Hinesburg, VT 05461

Re: Geotechnical investigation for the (2) proposed Fire Station additions & a proposed new Police Station at 10340 Route 116 in Hinesburg, VT.

Dear Mr. Martin:

This is a report of our interpretation of the subsurface conditions at the site of the (2) proposed Fire Station additions & a proposed new Police Station at 10340 Route 116 in Hinesburg, Vermont. Our soil findings are based upon 3 soil borings performed by Mike's Boring & Coring (MB&C) of East Barre, Vermont. DIG-SAFE was contacted to locate utilities near the proposed borings (DIG-SAFE #2013-160-4257). Boring locations are represented on the plan provided by Otter Creek Engineering.

No attempt was made by Knight Consulting Engineers to investigate for the presence, extent or nature of hazardous or toxic substances.

We appreciate the opportunity to conduct this geotechnical investigation, and stand ready to assist in future phases of this project.

Sincerely,

Eric Goddard

Eric Goddard, P.E.
Senior Vice President
13189_Report.doc

STATE OF VERMONT ERIC H. GODDARD No. 6035 REGISTERED PROFESSIONAL ENGINEER

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DESCRIPTION OF EXPLORATION PROGRAM

The soil investigation was comprised of 3 soil borings (B-1 thru B-3), one each at the sites of the 2 Fire Station additions and at the site proposed new Police Station at 10340 Route 116 in Hinesburg, Vermont. All soil borings were performed using hollow stem augers and Standard Penetration Test (SPT) split-spoon sampling procedures. Typically, continuous (2-foot) sampling was performed in the top 12 feet. The soil boring locations are indicated on the Boring Location Plan in **Appendix B.**

Auger soil borings were advanced by use of hollow stem augers and SPT sampling procedures. In this method, the augers are advanced to a predetermined sampling depth. A standard 2" OD split spoon sampler is attached to the end of the drill rod and driven out ahead of the open end of the hollow augers. The SPT value (units are blows per foot) is recorded as the sum of the number of blows of a 140 pound hammer, free falling 30 inches, required to drive the sampler over the second and third of four 6 inch increments. Once the SPT value is recorded and a disturbed sample obtained, the augers are advanced to the next sampling depth and the process is repeated.

It should be noted that the information reported on the boring logs is a field interpretation by the boring contractor, and does not always match the engineer's interpretation, which is based on inspection and/or laboratory analysis of the submitted samples.

SITE OVERVIEW

The site of the proposed project (10340 Route 116) is located on the westerly side of VT Route 116 at the site of the existing Fire Station. The site is bounded by Route 116 to the east, commercial property to the north and south, and residential property to the west. The existing site generally slopes from east to west. Existing elevations range from 330' to 336'. The 2 proposed Fire Station additions and the proposed new Police Station are assumed to have finished floor elevations matching the existing Fire Station (335.6' +/-). All building are assumed to be slab-on-grade construction.

The native soils at the proposed site are indicated (generally) as silt, silty clay, and/or clay containing ice-rafted boulders according to the **1970 Surficial Geologic Map of Vermont**. The **1989 USDA-SCS Soil Survey of Chittenden County, Vermont** lists the surficial soils as Limerick silt loam (See **Appendix A**).

According to the **1961 Geologic Map of Vermont**, this site is located approximately 5000 feet WSW of the (inactive) Hinesburg Thrust and approximately 31,000 feet east of the (inactive) Champlain Thrust.

The deeper glacial till and hardpan materials were formed by compression of the older soils beneath advancing glacial ice. The last glacier started forming approximately 60,000 years ago and reached its maximum advance approximately 18,000 years ago with an estimated ice thickness of 3000 to 4000 feet over this region. The surficial soils in this area consist of post-glacial lacustrine deposits of sands, silts and clays overlying glacial till and rock. The natural topography of this area is due to erosional cutting of these surficial deposits.

As the glacier was retreating from the Champlain Valley about 14,000 to 15,000 years ago, a series of fresh-water lakes, collectively known as Lake Vermont, covered much of this area, bounded to the north by retreating ice. During this period glacio-lacustrine silts and clays were deposited over the Champlain Valley. Seasonal melting and freezing of the glacier led to fluctuations in runoff; these fluctuations led to erosion resulting in coarser materials (i.e. silts and sands) being deposited in layers during the summers. This process is exhibited in the varved clays found throughout the Champlain Valley.

As the ice withdrew beyond the St. Lawrence Valley about 13,000 years ago, an invasion of salt water, known as the Champlain Sea, flooded the area and left behind the blanket of fine sand further to the north. The horizontal limits of the fine marine sand extend up to (post-rebound) elevations of approximately 340' to 400' over the northwestern portion of the State (generally north of Shelburne Bay). Over the next few millennia, marine clays were deposited over the low-lying portions of the Champlain Valley.

By approximately 11,000 years ago, the land previously beneath the glacier rebounded to the point where the Champlain Valley was cut-off from the ocean and the Champlain Sea was replaced by freshwater, thereby forming Lake Champlain. Deposition of lacustrine silts and clays resumed over the low-lying portions of the Champlain Valley. As the land continued to rebound, the soil originally submerged beneath the lake & sea became upland soil and was subjected to erosion due to runoff.

SUBSURFACE CONDITIONS

South Fire Station Addition: the boring samples indicated that the soils are generally comprised of 6 feet of medium dense-to-dense sand & gravel (Moist-to-Damp), then 9 to 14 feet of very loose-to-medium dense sand & gravel with layers of clay (Wet), then medium stiff-to-soft gray clay (Wet) to an unknown depth. Total elastic settlements were calculated to be 0.94" and total inelastic settlements (clay recompression) were calculated to be 0.25". Differential settlements were estimated to be 40% to 50% of these values. These values are based upon a finished floor elevation matching the existing Fire Station (335.60').

North Fire Station Addition: the boring samples indicated that the soils are generally comprised of 4 feet of medium dense sand & gravel (Moist-to-Damp), then 6 feet of very stiff-to-stiff brown/gray silt & clay (Damp), then 12 to 15 feet of medium stiff brown/gray clay (Wet), then very soft gray clay (Wet) to an unknown depth. Total elastic settlements were calculated to be 0.51" and total inelastic settlements (clay recompression) were calculated to be 0.93". Differential settlements were estimated to be 40% to 50% of these values. These values are based upon a finished floor elevation matching the existing Fire Station (335.60').

New Police Station: the boring samples indicated that the soils are generally comprised of 10 feet of stiff silt & clay (Moist-to-Damp), then 22 to 24 feet of medium stiff to soft gray clay (Wet), then soft-to-very soft gray clay (Wet) to an unknown depth. Total elastic settlements were calculated to be 0.85" and total inelastic settlements (clay recompression) were calculated to be 0.97". Differential settlements were estimated to be 40% to 50% of these values. These values are based upon a finished floor elevation matching the existing Fire Station (335.60').

Based upon the conditions at the time of the soil borings, the following clay information was encountered:

Boring	Depth	LL	PL	PI	W_N	Type	Qu (PP)
B-2	10'-12'	41	20	21	45.4	CL	0.74 TSF (Disturbed)
B-3	10'-12'	32	22	10	44.5	CL	0.62 TSF (Undisturbed)
B-2	20'-22'	-	-	-	-	CL	1.05 TSF (Undisturbed)
B-1	25'-27'	-	-	-	-	CH	0.60 TSF (Undisturbed)
B-2	25'-27'	65	25	40	73.2	CH	<0.17 TSF (Disturbed)
B-3	24'-26'	63	27	36	70.6	CH	0.46 TSF (Undisturbed)
B-3	34'-36'	61	23	38	67.6	CH	<0.17 TSF (Disturbed)
B-3	44'-46'	66	29	37	72.6	CH	0.21 TSF (Disturbed)

Though all the clay samples tested exhibited in-situ moisture contents above their respective liquid limits, the undisturbed clay samples exhibited medium stiff-to-stiff shear strengths. For the deeper fat clays, the disturbed clay samples exhibited very soft shear strengths. These results indicate that the deeper fat clays are moderately "sensitive". This finding is supported by the concave shape of the deeper consolidation curve (B-3, 24'-26') and an apparent pre-consolidation pressure well above what would be expected based upon the sample depth.

FINDINGS AND CONCLUSIONS:

A. Soil strength parameters are based upon blow-count and pocket penetrometer analysis, laboratory testing and physical review of the samples. The boring logs are contained in **Appendix C** and the physical test results are contained in **Appendix D**. Consolidation test results are contained in **Appendix E**. Soil chemical test results are contained in **Appendix G**. All physical testing results are listed on the boring logs, including moisture content, organic content, soil classification, Atterberg Limits and pocket penetrometer results.

B. In order to mitigate most of the INELASTIC consolidation settlements, replace the equivalent amount of existing soil mass with high density foam blocks to counteract any added underslab structural fill weight. Extend footings below foam blocks to bear on native soils. Based upon blow-count and pocket penetrometer data, as well as, visual review of the boring samples, these soils have sufficient strength to support conventional strip and spread footings with the following Allowable Net Foundation Loading:

Deep footings (FFE = 335.6', BOF = 329.6'+/-)

Footing width:	Strip Ftg.	Sq. Ftg.
B ≤ 1.33'	1750 PSF	2000 PSF
B = 2.50'	1500 PSF (3.75 KPF)	2000 PSF
B = 3.00'	1250 PSF (3.75 KPF)	2000 PSF
B = 3.75'	1000 PSF (3.75 KPF)	1915 PSF
B = 5.00'	750 PSF (3.75 KPF)	1740 PSF
B = 7.50'	500 PSF (3.75 KPF)	1220 PSF (68.5 Kips)
B = 10.00'	375 PSF (3.75 KPF)	685 PSF (68.5 Kips)
B = 15.00'	250 PSF (3.75 KPF)	340 PSF
B = 23.80'	230 PSF	250 PSF

Shallow footings (FFE = 335.6', BOF = 332.6' +/-)

Footing width:	Strip Ftg.	Sq. Ftg.
B ≤ 3.00'	2000 PSF	2000 PSF
B = 3.33'	1800 PSF (6.00 KPF)	2000 PSF
B = 4.00'	1500 PSF (6.00 KPF)	2000 PSF
B = 5.00'	1200 PSF (6.00 KPF)	2000 PSF
B = 6.00'	1000 PSF (6.00 KPF)	1960 PSF
B = 7.06'	850 PSF (6.00 KPF)	1800 PSF
B = 9.52'	630 PSF (6.00 KPF)	1500 PSF
B = 11.76'	510 PSF (6.00 KPF)	1200 PSF
B = 13.79'	435 PSF (6.00 KPF)	1000 PSF
B = 17.39'	345 PSF (6.00 KPF)	750 PSF
B = 21.44'	280 PSF (6.00 KPF)	500 PSF
B = 25.53'	235 PSF (6.00 KPF)	350 PSF

Note:

(1) Footing & subgrade conditions should be inspected prior to placement of the stone or footing. Inspections should be performed by a qualified geotechnical engineer licensed in the State of Vermont.

(2) At these design loads and footing depths, the bearing strength factor-of-safety should be a minimum of 3.0 and the projected differential and total ELASTIC settlements should be less than ½" and 1", respectively.

C. With the exception of the **North Fire Station** addition, construction de-watering should not be required for installation of the deeper foundations unless these operations are performed in the Spring (March-June). Care should be taken during construction to divert surface water away from open excavations since saturation of the sandy soils will cause unstable excavation sidewalls and the inability to achieve proper compaction.

D. The local frost depth is between 5.5 and 6 feet; perimeter foundations and utilities should be designed accordingly or properly insulated. Please note that the thickness of any clean stone placed beneath the footings may be considered part of the foundation depth relative to frost protection. Clean crushed stone should be wrapped in filter fabric to prevent the migration of soil into the voids.

E. If neither groundwater, overly damp soils nor signs of subgrade instability are present, all fill materials beneath the footing elevation should be compacted to 95% of the Standard Proctor dry density value in order to achieve the bearing capacities listed above. If the soils at footing elevation appear to be too damp or saturated such that compaction cannot be achieved, consult the Project Geotechnical Engineer.

F. If any organic material/topsoil is encountered in the bearing strata below the building footprints, it should be removed and replaced with compacted structural fill.

G. Any areas within the foundation footprints requiring fill to achieve the desired foundation or finish grades should be filled in accordance with the foundation drawings with: (1) approved native material, (2) structural fill, or (3) fabric-wrapped crushed stone.

H. Neither concrete rubble nor other construction debris should be used as structural fill or backfill.

I. Structural fill should be placed and compacted in layers of 8-inch maximum thickness. Field density tests should be accomplished on each lift to verify that adequate compaction is achieved. A reasonable guideline would be to perform at least 1 test per 2500 SF per lift for bulk filling; additional tests may be conducted on each lift at isolated footing locations.

J. If construction is to take place during periods of freezing temperatures, the existing materials must be protected against freezing heave until they can be properly backfilled.

K. The existing surface soils are marginally to very frost-active. Perimeter foundations should be installed at least as deep as the local frost depth or properly insulated (see note "D"). Exterior structural slabs-on-grade resistant to frost heaving should be constructed on 60" of clean crushed stone wrapped in filter fabric (Miraffi 500X) or on 24" of clean crushed stone wrapped in filter fabric (Miraffi 500X) on top of 3" of rigid insulation (extend the insulation out 3 feet beyond the edges of the slab). Utilities susceptible to damage from frost should be installed at least 6 feet below grade or properly insulated to stop the frost penetration above the top of the utility. A 6% maximum silt content should be specified for all fills less than 6 feet deep and below structures sensitive to frost heaving. If the fill is not below a structure sensitive to heave or the fill is placed deeper than 6 feet, then higher silt contents are allowable as long as the material is not saturated (i.e. compactable).

L. With regard to Section 1613 of the 2012 IBC (International Building Code), the Site Classification is "E" based upon inverse average-weighted shear strengths below 1000 PSF. Site Class "E" results in Seismic Design Category "D" for Use Group 4 (Site Class "E", S_S=0.320, Fa=2.276, S_1=0.100, Fv=3.500). Because the site is not located directly over an active fault, the risk of surface rupture during a seismic event is relatively low. Using the SPT values contained in the B-1 boring log along with estimated & tested silt contents from the boring samples, and a (2% in 50-year) design 6.05 Magnitude earthquake (0.18g peak ground acceleration) obtained from the U.S.G.S. Probable Seismic Hazard Deaggregation, our firm calculated that the on-site soils would be liquefiable at the proposed **South Fire Station Addition** based upon a minimum Factor-of-Safety of 0.65 below the groundwater elevation. Seismic settlements were calculated to be approximately 4.25". Based upon on Seismic Design Category "D", lateral (seismic) earth pressures on basement or retaining walls should be calculated as 0.194 times the weight of the soil contained above the line starting at the outer toe of the foundation and sloping upward at 45 degrees for at-rest conditions (60 degrees from horizontal for active earth conditions). This pressure is additive to the static earth pressures in the seismic design.

M. Excavation and trenching in excess of 4 feet should be kept to a maximum slope of 1.5 Horizontal to 1 Vertical (OSHA Class C). Permanent (unsaturated) slopes should be 2 Horizontal to 1 Vertical or flatter; Permanent (saturated) slopes should be 5 Horizontal to 1 Vertical or flatter.

N. Allowable resisting/bearing pressures may be increased 33% for wind loading. Because of the sensitive nature of the on-site clays, our firm would not recommend increasing the resisting/bearing pressures for seismic or dynamic loading.

O. The design internal friction angle for granular fill placed behind retaining walls should be assumed to be 30 degrees. The design coefficient of friction (ultimate, not factored) should be 0.47 for concrete cast directly onto native soils (0.31 for precast concrete). The design coefficient of friction (ultimate, not factored) should be 0.58 for concrete cast directly onto granular fill (0.38 for precast concrete). Design soil unit weights above the water table should be in the range of 105 to 120 PCF for native granular soils (unsaturated) and 120 to 130 PCF for native cohesive soils (unsaturated). Design soil unit weights below the water table should be in the range of 120 to 130 PCF for native granular soils (saturated) and 110 to 130 PCF for native cohesive soils (saturated). At 30 degrees, the following design lateral earth coefficients should be assumed:

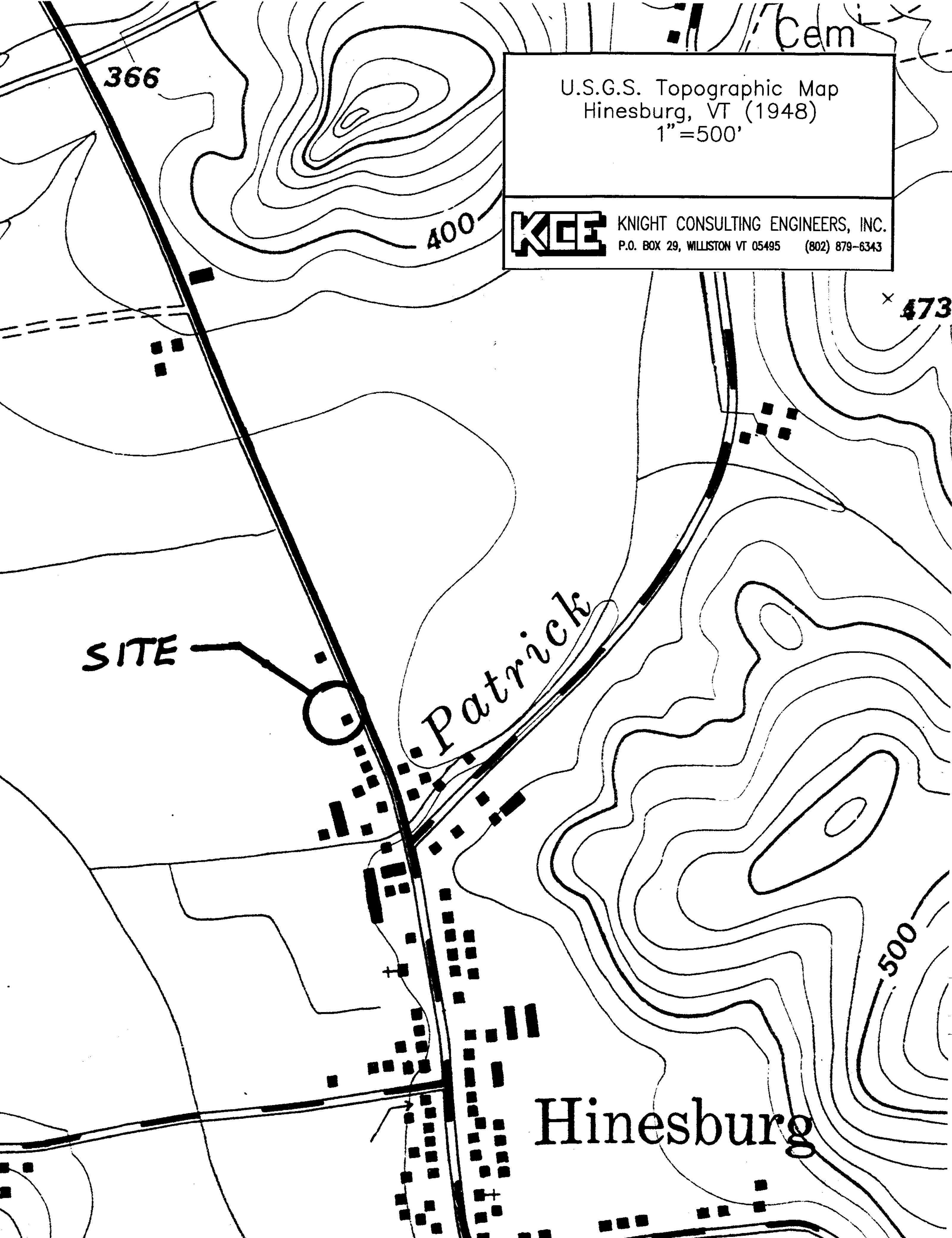
Active (Ka): 0.333
At-rest (Ko): 0.500
Passive (Kp): 3.000

If design for heavy/construction traffic is applicable, our firm recommends a lateral surcharge pressure of 0.333q (100 PSF) for active earth conditions and a lateral surcharge pressure of 0.500q (150 PSF) for at-rest earth conditions. These values are based upon a 300 PSF effective surcharge. Retaining walls free to rotate at the top should be designed using active earth pressures; retaining walls restrained at the top should be designed using at-rest earth pressures. Perimeter drains should be properly designed to eliminate hydrostatic pressures on retaining structures where practical.

P. For permanent foundation walls designed to retain soil, the design passive pressure resistance should not exceed the at-rest lateral earth pressures for soils that will remain in-place during and after backfilling of these foundation walls. This requirement is to insure that excessive displacements are not experienced in an attempt to develop the passive resistance. The appropriate Factors-of-Safety (Resistance Forces/Driving Forces) shall be a minimum of 1.5 for sliding and 2.0 for overturning. For temporary sheeting/bracing systems where lateral displacement will not have significant adverse effects, the design passive pressure resistance should not exceed 50% to 67% of the full passive pressure value for soils that will remain during the entire use of these sheeting/bracing systems. At these values the Factors-of Safety (Resistance Forces/Driving Forces) should be in the range of approximately 1.5 to 2.0.

Q. One sample from each boring was submitted for chemical testing relative to corrosion potential. Those results are pending (see **Appendix G**).

APPENDIX A

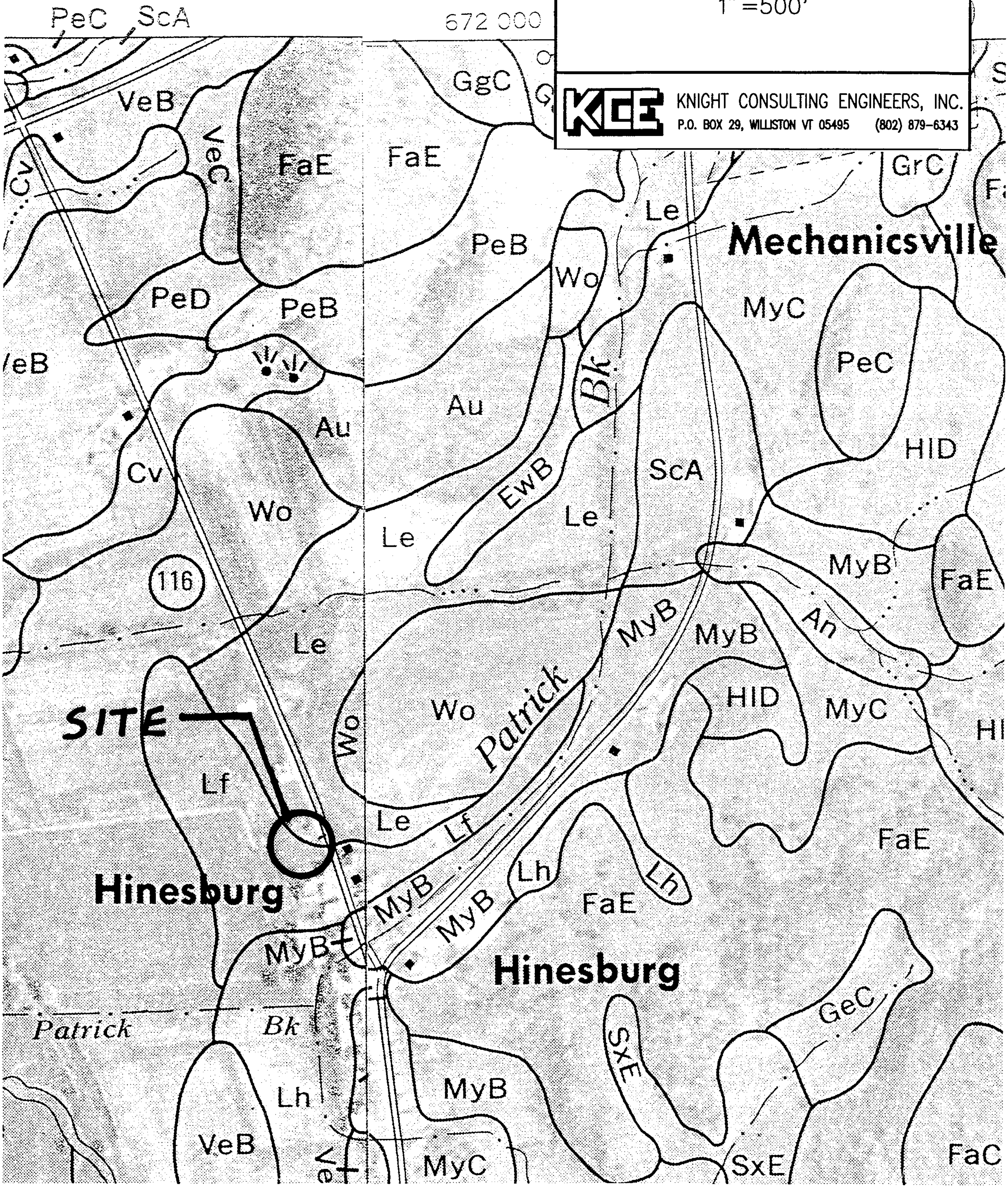


U.S.G.S. Topographic Map
Hinesburg, VT (1948)
1"=500'

KCE KNIGHT CONSULTING ENGINEERS, INC.
P.O. BOX 29, WILLISTON VT 05495 (802) 879-6343

U.S.D.A. SCS Soil Survey
Chittenden County, VT (1989)
1"=500'

KCE KNIGHT CONSULTING ENGINEERS, INC.
P.O. BOX 29, WILLISTON VT 05495 (802) 879-6343



SOIL LEGEND

The first capital letter is the initial one of the soil name. A second capital letter, A, B, C, D, or E, indicates the class of slope. Most symbols without a slope letter are those of nearly level soils, but some are for land types that have a considerable range of slope.

SYMBOL	NAME
AdA	Adams and Windsor loamy sands, 0 to 5 percent slopes
AdB	Adams and Windsor loamy sands, 5 to 12 percent slopes
AdD	Adams and Windsor loamy sands, 12 to 30 percent slopes
AdE	Adams and Windsor loamy sands, 30 to 60 percent slopes
AgA	Agawam fine sandy loam, 0 to 5 percent slopes
AgD	Agawam fine sandy loam, 12 to 30 percent slopes
AgE	Agawam fine sandy loam, 30 to 60 percent slopes
An	Alluvial land
Au	Au Gres fine sandy loam
Be	Beaches
BlA	Belgrade and Eldridge soils, 0 to 3 percent slopes
BlB	Belgrade and Eldridge soils, 3 to 8 percent slopes
BlC	Belgrade and Eldridge soils, 8 to 15 percent slopes
BlD	Belgrade and Eldridge soils, 15 to 25 percent slopes
Bo	Blown-out land
Br	Borrow pits
CaA	Cabot stony silt loam, 0 to 3 percent slopes
CaC	Cabot stony silt loam, 3 to 15 percent slopes
CbA	Cabot extremely stony silt loam, 0 to 3 percent slopes
CbD	Cabot extremely stony silt loam, 3 to 25 percent slopes
CoA	Colton gravelly loamy sand, 0 to 5 percent slopes
CoB	Colton gravelly loamy sand, 5 to 12 percent slopes
CoC	Colton gravelly loamy sand, 12 to 20 percent slopes
CsD	Colton and Stetson soils, 20 to 30 percent slopes
CsE	Colton and Stetson soils, 30 to 60 percent slopes
Cv	Covington silty clay
DdA	Duane and Deerfield soils, 0 to 5 percent slopes
DdB	Duane and Deerfield soils, 5 to 12 percent slopes
DdC	Duane and Deerfield soils, 12 to 20 percent slopes
EwA	Enosburg and Whately soils, 0 to 3 percent slopes
EwB	Enosburg and Whately soils, 3 to 8 percent slopes
FaC	Farmington extremely rocky loam, 5 to 20 percent slopes
FaE	Farmington extremely rocky loam, 20 to 60 percent slopes
FsB	Farmington-Stockbridge rocky loams, 5 to 12 percent slopes
FsC	Farmington-Stockbridge rocky loams, 12 to 20 percent slopes
FsE	Farmington-Stockbridge rocky loams, 20 to 60 percent slopes
Fu	Fill land
Fw	Fresh water marsh
GeB	Georgia stony loam, 3 to 8 percent slopes
GeC	Georgia stony loam, 8 to 15 percent slopes
GgC	Georgia extremely stony loam, 0 to 15 percent slopes
GgE	Georgia extremely stony loam, 15 to 60 percent slopes
GrA	Groton gravelly fine sandy loam, 0 to 5 percent slopes
GrB	Groton gravelly fine sandy loam, 5 to 12 percent slopes
GrC	Groton gravelly fine sandy loam, 12 to 20 percent slopes
GrD	Groton gravelly fine sandy loam, 20 to 30 percent slopes
GrE	Groton gravelly fine sandy loam, 30 to 60 percent slopes
Hf	Hadley very fine sandy loam
Hh	Hadley very fine sandy loam, frequently flooded
HlB	Hartland very fine sandy loam, 2 to 6 percent slopes
HlC	Hartland very fine sandy loam, 6 to 12 percent slopes
HlD	Hartland very fine sandy loam, 12 to 25 percent slopes
HlE	Hartland very fine sandy loam, 25 to 60 percent slopes
HnA	Hinesburg fine sandy loam, 0 to 3 percent slopes
HnB	Hinesburg fine sandy loam, 3 to 8 percent slopes
HnC	Hinesburg fine sandy loam, 8 to 15 percent slopes
HnD	Hinesburg fine sandy loam, 15 to 25 percent slopes
HnE	Hinesburg fine sandy loam, 25 to 60 percent slopes
*Le	Limerick silt loam
*Lf	Limerick silt loam, very wet
Lh	Livingston clay
Lk	Livingston silty clay, occasionally flooded
LmB	Lyman-Marlow rocky loams, 5 to 12 percent slopes
LmC	Lyman-Marlow rocky loams, 12 to 20 percent slopes
LyD	Lyman-Marlow very rocky loams, 5 to 30 percent slopes
LyE	Lyman-Marlow very rocky loams, 30 to 60 percent slopes
MaB	Marlow stony loam, 5 to 12 percent slopes
MaC	Marlow stony loam, 12 to 20 percent slopes
MaD	Marlow stony loam, 20 to 30 percent slopes
MeC	Marlow extremely stony loam, 5 to 20 percent slopes
MeE	Marlow extremely stony loam, 20 to 60 percent slopes
MnC	Massena stony silt loam, 0 to 15 percent slopes
MoC	Massena extremely stony silt loam, 0 to 15 percent slopes
Mp	Muck and peat
MuD	Munson and Belgrade silt loams, 12 to 25 percent slopes
MyB	Munson and Raynham silt loams, 2 to 6 percent slopes
MyC	Munson and Raynham silt loams, 6 to 12 percent slopes
PaB	Palatine silt loam, 3 to 8 percent slopes
PaC	Palatine silt loam, 8 to 15 percent slopes
PaD	Palatine silt loam, 15 to 25 percent slopes
PaE	Palatine silt loam, 25 to 60 percent slopes
Pc	Peacham stony silt loam
PeA	Peru stony loam, 0 to 5 percent slopes
PeB	Peru stony loam, 5 to 12 percent slopes
PeC	Peru stony loam, 12 to 20 percent slopes
PeD	Peru stony loam, 20 to 30 percent slopes
PsC	Peru extremely stony loam, 0 to 20 percent slopes
PsE	Peru extremely stony loam, 20 to 60 percent slopes
Qd	Quarries
Rk	Rock land
ScA	Scantic silt loam, 0 to 2 percent slopes
ScB	Scantic silt loam, 2 to 6 percent slopes
Sd	Scarboro loam
StA	Stetson gravelly fine sandy loam, 0 to 5 percent slopes
StB	Stetson gravelly fine sandy loam, 5 to 12 percent slopes
StC	Stetson gravelly fine sandy loam, 12 to 20 percent slopes
SuB	Stockbridge and Nellis stony loams, 3 to 8 percent slopes
SuC	Stockbridge and Nellis stony loams, 8 to 15 percent slopes
SuD	Stockbridge and Nellis stony loams, 15 to 25 percent slopes
SxC	Stockbridge and Nellis extremely stony loams, 3 to 15 percent slopes
SxE	Stockbridge and Nellis extremely stony loams, 15 to 60 percent slopes
TeE	Terrace escarpments, silty and clayey
VeB	Vergennes clay, 2 to 6 percent slopes
VeC	Vergennes clay, 6 to 12 percent slopes
VeD	Vergennes clay, 12 to 25 percent slopes
VeE	Vergennes clay, 25 to 60 percent slopes
Wo	Winooski very fine sandy loam

WORKS A

Highways and roads

- Dual ....
- Good motor ....
- Poor motor ....
- Trail ....

Highway markers

- National Interstate .
- U. S. ....
- State or county ....

Railroads

- Single track ....
- Multiple track .....
- Abandoned ....

Bridges and crossings

- Road ....
- Trail ....
- Railroad ....
- Ferry ....
- Ford ....
- Grade ....
- R. R. over ....
- R. R. under ....

Tunnel ....

Buildings ....

- School ....
- Church ....

Mine and quarry .....

Gravel pit ....

Power line ....

Pipeline ....

Cemetery ....

Dams ....

Levee ....

Tanks ....

Well, oil or gas .....

Forest fire or lookout

Beacon ....

loam and silt loam under the sandy material. In a few places the surface layer is fine sand or loamy fine sand. A few areas are gullied. The gullies are crossable with farm machinery in some places and uncrossable in others.

This soil is used mainly for pasture and trees. A small acreage is used for hay, and a few areas are idle.

Surface runoff is medium. The erosion hazard is severe where this soil is being prepared for seeding. Because of the steep slopes, water does not stand on the soil surface. These slopes make the use of modern farm machinery hazardous. This soil has limitations for many nonfarm uses, especially those for which steepness and permeability are considerations. (Capability unit IVe-6; woodland suitability group 4s5)

Hinesburg fine sandy loam, 25 to 60 percent slopes (HnE).—This soil occupies irregularly shaped, long, narrow, smooth areas that are 2 to 20 acres in size. Slopes range from 50 to 200 feet in length.

Included with this soil in mapping are small areas of Adams and Windsor soils. A few included areas have not been vegetated and are eroded. At the lower elevations, a few areas have silty clay loam, silty clay, or clay instead of very fine sandy loam and silt loam under the sandy material. In a few areas the surface layer is fine sand or loamy fine sand.

This soil is used mainly for trees. A small acreage is in unimproved pasture, and a few areas are idle.

Surface runoff is rapid. The hazard of water erosion is very severe where this soil is not vegetated. Steep slopes make the use of modern farm machinery hazardous. This soil has severe limitations for many nonfarm uses, especially those for which steepness and permeability are considerations. (Capability unit VIIe-2; woodland suitability group 4s5)

Limerick Series

The Limerick series consists of soils that are deep, poorly drained, and loamy throughout their profile. These soils range from depressional to level. They are most extensive near the mouths of the Winooski, Lamoille, and La Platte Rivers. A smaller acreage is near the Browns River in the towns of Jericho, Essex, and Westford and near most other small streams in the county. Limerick soils formed in silt loam and very fine sandy loam. These soils are flooded or ponded at least once a year, and the kind of sediment often differs with each flood. In most places sediment has not been in place long enough for a strongly developed soil profile to form.

A representative profile of a Limerick soil has a very dark grayish-brown silt loam surface layer about 3 inches thick. The subsoil is friable, olive-gray silt loam about 8 inches thick. It is mottled throughout with dark red, dusky red, and very dusky red. The substratum starts at a depth of about 11 inches and continues to more than 72 inches below the soil surface. It is friable, dark-gray to olive-gray, stratified silt loam and very fine sandy loam. Mottles, mostly of dark reddish brown and dusky red, occur throughout the substratum.

Limerick soils have high natural fertility and a moderately high available moisture capacity. Permeability is moderate in the upper part of the soil profile and moderately slow in the lower part. Limerick soils have low shrink-swell potential.

In most areas Limerick soils are low enough in relation to stream level that they are often under water for periods of 1 to 2 weeks in the spring and fall. A few areas are flooded for periods of only a few days. The dull colors and mottles in the soil profile indicate that these soils are saturated with water for extended periods. A normally high water table keeps them wet from late in fall to late in spring. During the wetter part of the year, water stands at or near the soil surface. Water ponds on the surface of the more nearly level areas during the wetter part of the year and following heavy rains.

These soils occupy positions that receive runoff water from other adjacent soils at higher elevations. Limerick soils remain wet for significant periods after rains. These soils warm slower in the spring than the other soils in the county. They remain moist beneath the surface layer during the growing season. The normally high water table restricts plant rooting depth. The hazard of erosion is severe when swift floodwater flows across areas of these soils. Deposition or removal of soil material during flooding is a problem. Removal of manure spread from the stable commonly occurs. Farm machinery is easily bogged down when these soils are wet. Weed control is a concern on these wet soils. Cultivating and spraying are hampered unless the water table is lowered. Artificial drainage is necessary for best growth of crops.

Limerick soils are used mainly for hay and pasture. A small acreage is in corn grown for silage. The wetter areas and areas not practical to drain because of lack of suitable outlets are idle or are woodland.

A representative profile of a pastured Limerick silt loam in the town of Colchester, about 2.2 miles northwest of the city of Winooski, 600 yards southwest of Pine Island, and 500 yards north of the Winooski River:

Ap—0 to 3 inches, very dark grayish-brown (2.5Y 3/2) silt loam; moderate, fine, granular structure; friable; many grass roots; strongly acid; abrupt, smooth boundary.

B21g—3 to 7 inches, olive-gray (5Y 4/2) silt loam; few, fine, prominent, dark-red (2.5YR 3/6) and dusky-red (2.5YR 3/2) mottles; weak, fine, subangular blocky and weak, thin, platy structure; friable; many grass roots; a few concretions less than 3 millimeters in diameter cemented with iron; strongly acid; clear, wavy boundary.

B22g—7 to 11 inches, olive-gray (5Y 4/2) silt loam; few, fine, prominent, very dusky red (2.5YR 2/2) mottles and many, fine and medium, prominent, dark-red (2.5YR 3/6) mottles; weak, medium, platy structure; friable; common grass roots; strongly acid; clear, wavy boundary.

IIC1g—11 to 18 inches, dark-gray (5Y 4/1) silt loam; common, fine, prominent, dark reddish-brown (5YR 3/4) mottles; horizon contains layers of olive-gray (5Y 4/2) loamy very fine sand that are one-half inch thick and have few, fine, distinct, light olive-brown (2.5Y 5/6) mottles; average texture for entire horizon is very fine sandy loam; massive; friable; common grass roots; strongly acid; clear, wavy boundary.

IIC2g—18 to 28 inches, olive-gray (5Y 4/2) very fine sandy loam that has few, fine, distinct, dark yellowishbrown (10YR 4/4) mottles; horizon contains a few layers of olive-gray (5Y 4/2) very fine sand that are one-half inch thick and have common, medium, prominent, dark reddish-brown (5YR 3/4) mottles; average texture for entire horizon is very fine sandy loam; massive; friable; common grass roots; strongly acid; clear, wavy boundary.

IIIC3g—28 to 40 inches, dark-gray (5Y 4/1) silt loam that has thin bands of coarser material; many, fine and medium, prominent, dark reddish-brown (2.5YR 2/4 and 3/4) mottles; massive; friable; few grass roots; medium acid; clear, wavy boundary.

IVC4g—40 to 50 inches, dark-gray (5Y 4/1) silt loam; common, coarse, prominent, dusky-red (10R 3/3) mottles on ped faces and dusky-red (10R 3/3) coatings in root and worm channels; weak, coarse, prismatic structure; friable; few grass roots; slightly acid; gradual, smooth boundary.

VC5g—50 to 58 inches, dark-gray (5Y 4/1) very fine sandy loam; many, coarse, prominent, dusky-red (10R 3/3) and few, fine, distinct, dark-brown (10YR 4/3) mottles; massive; friable; few grass roots; medium acid; clear, wavy boundary.

VIC6g—58 to 65 inches, dark-gray (5Y 4/1) silt loam; common, coarse, prominent, dusky-red (10R 3/3) mottles and common, coarse, distinct, weak-red (10R 4/4) mottles; weak, coarse, prismatic structure; friable; slightly acid; clear, wavy boundary.

VIC7g—65 to 72 inches, dark-gray (N 4/0) silt loam; olive (5Y 4/3) stains in old root channels; massive; friable; neutral.

These soils are dominantly silt loam or very fine sandy loam to a depth of 40 inches. Lenses of loamy very fine sand and very fine sand are present in a few profiles, but average content of fine sand and coarser material is less than 15 percent.

The A horizon is 10YR to 5Y in hue, 2 to 4 in value, and 2 to 3 in chroma. It ranges from strongly acid to neutral. The B and C horizons have a hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2, or colors are neutral and have a value of 4 or 5. The B and C horizons range from strongly acid to neutral.

In most places Limerick soils are near the well drained Hadley soils, the moderately drained Winooski soils, and the very poorly drained Muck and peat. Limerick soils have distinct and prominent mottles mainly beneath the surface layer, but the Winooski and Hadley soils do not. The parent material of Limerick soils is mineral, but that of Muck and peat is organic.

Limerick silt loam (Le).—This soil has slopes of 0 to 3 percent. It occupies irregularly shaped areas that are 2 to 200 acres in size. The profile of this soil is the one described as typical for the Limerick series.

Included with this soil in mapping are the Winooski soils on the higher mounds or slightly elongated rises. Also included are small areas of soils that are sandy loam or fine sandy loam in the subsoil and substratum. In other included areas, sandy material commonly is within 40 inches of the soil surface. Where sandy material is in the soil profile, the soils are commonly in the small areas and are in the smaller stream valleys. In a few included areas, slopes are more than 3 percent. Included in some areas are soils that have thin layers of organic material, silty clay loam, or silty clay in the subsoil and substratum. In a few areas the surface layer is fine sandy loam, very fine sandy loam, mucky fine sandy loam, or mucky very fine sandy loam.

This soil is used mainly for hay and pasture. A small acreage is in corn grown for silage or is idle.

Artificial drainage is necessary for best growth of crops but, in many places, is difficult because suitable outlets are lacking. This soil can be farmed intensively without risk of damage if the fertility and good soil structure are maintained. The addition of organic matter helps in maintaining good soil structure and in increasing infiltration. Surface runoff is very slow. The erosion hazard is very slight. Lime, manure, or commercial fertilizer spread on the soil surface or stockpiled is likely to be removed or damaged by floodwater. Also, farm equipment left on this soil may be damaged or ruined by floods. In most areas considerable time is needed to remove the debris left by the floodwater. This soil has severe limitations for many nonfarm uses, especially those for which flooding and wetness are considerations. (Capability unit IIIw-2; woodland suitability group 4w3)

Limerick silt loam, very wet (Lf).—This soil is depressional or level and has slopes of less than 1 percent. It occupies irregularly shaped areas that are 2 to 100 acres in size. The profile of this soil is similar to that described as representative for the series, but it has organic material in the subsoil, the substratum, or both.

Included with this soil in mapping are soils on the higher mounds and slightly elongated rises that are not flooded for such long periods as is this soil. In a few included areas, slopes are more than 1 percent. Also included are small areas of soils that are sandy loam or fine sandy loam in the subsoil and substratum. A few areas have sandy material within 40 inches of the soil surface. The soils that have sandy material in their profile are commonly in small areas and in the smaller stream valleys. In a few areas the surface layer is fine sandy loam, very fine sandy loam, mucky fine sandy loam, or mucky silt loam. Included in some areas are soils that have thin layers of finer textured material in the subsoil and substratum.

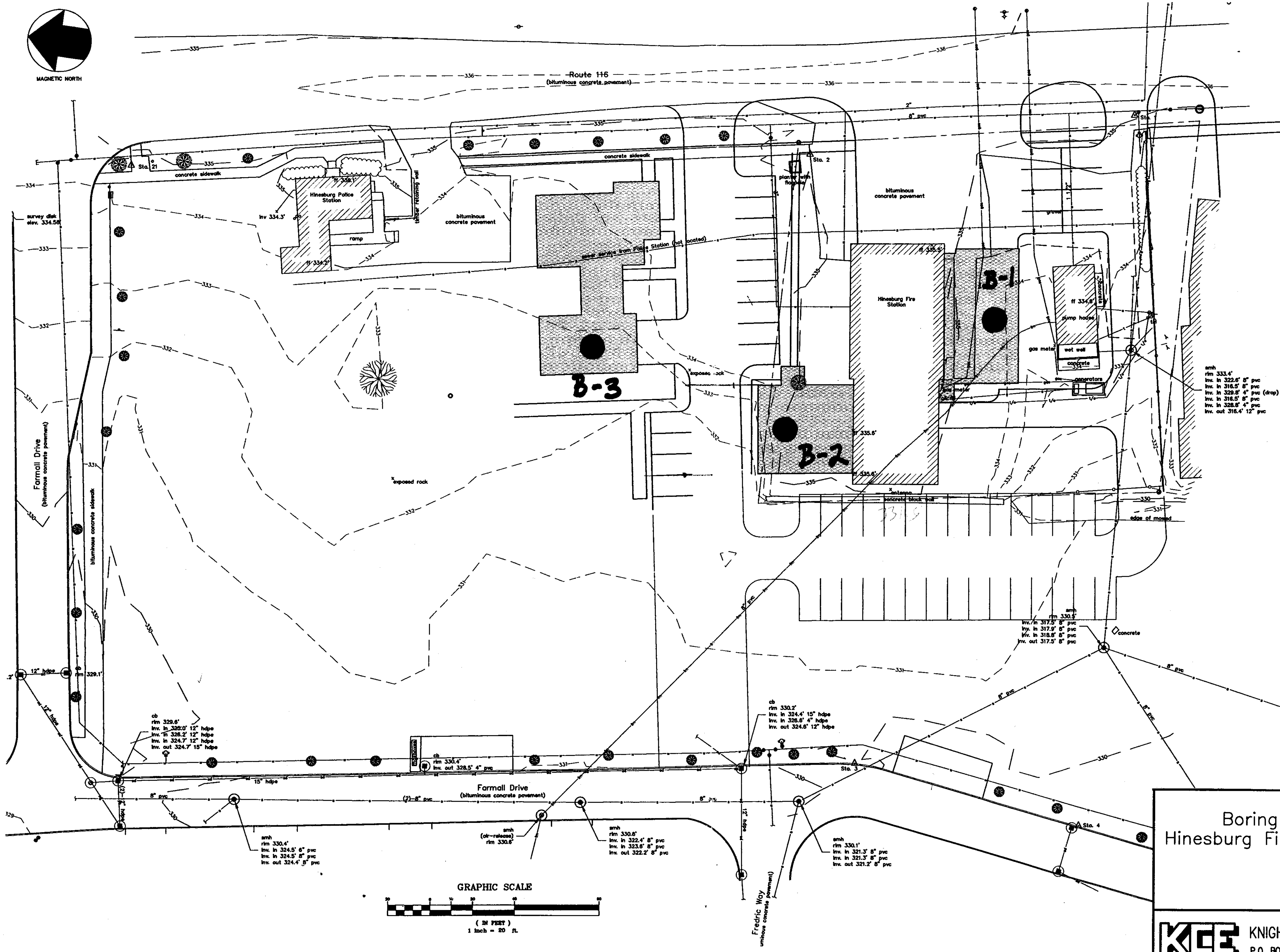
This soil is idle or is in woodland. If it is drained, it is used for hay and pasture. The potential for the development of habitat for wetland wildlife is good.

Artificial drainage is necessary for best growth of crops. Water commonly ponds on this soil, but drainage is difficult because suitable outlets are lacking in many areas. This soil can be farmed intensively without risk of damage if the fertility and good structure are maintained. The addition of organic matter helps in maintaining good structure. The hazard of water erosion is slight. Lime, manure, or commercial fertilizer spread on the soil surface or stockpiled is likely to be removed or damaged by floodwater. Also, farm equipment left on this soil may be damaged or ruined by floods. In most areas considerable time is needed to remove the debris left by the floodwater. Because of the flooding in many areas, planting is late and harvesting is hindered where corn for silage or a similar crop is grown. This soil has severe limitations for many nonfarm uses, especially those for which wetness and flooding are considerations. (Capability unit VIIw-1; woodland suitability group not assigned)

Livingston Series

The Livingston series consists of soils that are deep, very poorly drained, and clayey throughout their profile. These soils are depressional or level. They occur through-

APPENDIX B



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DATE ISSUED: 4/8/13

Drawn: HB
Checked: BR
REVISIONS:

HINESBURG
PUBLIC
SAFETY
FACILITY

Boring Location Plan
Hinesburg Fire & Police Stations
1" =45'±

KCE KNIGHT CONSULTING ENGINEERS, INC.
P.O. BOX 29, WILLISTON VT 05495 (802) 879-6343

APPENDIX C

MIKE'S BORING & CORING LLC.
PO Box 75 ° East Barre, Vermont 05649 ° 802 476-5073

TO: Eric Goddard Knight Consulting Engineers, Inc. 51 Knight Lane Williston, VT 05495	PROJECT NAME: Hinesburg Fire Station LOCATION: Hinesburg, VT MBC JOB #: 13030	SHEET: 1 DATE: 4-19 -13 HOLE #: B-1 LINE & STA. OFFSET: 5' South

Ground Water Observations 8' Est. at _0_ hours	Augers-Size I.D. 3.25 Split Spoon 2" Hammer Wt. 140# Hammer Fall 30"	Surface Elevation: 334.2' +/- Date Started: 4-19 -13 Date Completed: 4-19 -13 Boring Foreman: Mike McGinley Inspector: Eric Goddard Soils Engineer: Eric Goddard

LOCATION OF BORING: As shown

Sample Depths From/To (Feet)	Type of Sample	Blows per 6" on Sampler	Moisture Density or Consist.	Strata Change Elev.	Soil Identification	Sample		
						No.	Pen. Inches	Rec. Inches
0'-2'	Dry	6/7/8/8	Damp	6"	Top soil into medium dense brown cmf sand & f gravel	1	24	2
2'-4'	Dry	15/14/13/6	Damp		Dense brown cmf sand & mf gravel	2	24	12
4'-6'	Dry	11/3/2/2	Moist	4.5'	Dense brown cmf sand & cmf gravel into medium stiff-to-stiff gray clay	3	24	12
6'-8'	Dry	11/44/15/6	Moist		Dense brown cmf sand & cmf gravel with a stiff clay layer	4	24	10
8'-10'	Dry	1/2/2/1	Wet		Soft-to-medium stiff gray silty clay & peat	5	24	24
10'-12'	UT	12 sec at 50 PSI	Wet		Pushed tube (Cmf sand, some mf gravel & silt, SM)	6	24	6
15'-17'	Dry	10/1/1/1	Wet		Very loose brown cmf sand, some mf gravel, trace silt (SW-SM)	7	24	12
20'-22'	Dry	5/1/0/1	Wet		Very soft-to-soft gray clay (PP=0.17 TSF)	8	24	20
25'-27'	UT	5 sec at 50 PSI	Wet		Pushed tube (Medium stiff gray clay, PP=0.60 TSF)	9	24	24

Ground Surface to 25'   Used 3.25" augers: Then S.S. to 27'

Earth Borings	27'
Rock Coring	
Samples:	9
HOLE NUMBER	B-1

MIKE'S BORING & CORING LLC.
PO Box 75 ° East Barre, Vermont 05649 ° 802 476-5073

TO:	PROJECT NAME: Hinesburg Fire Station	SHEET: 2
Eric Goddard Knight Consulting Engineers, Inc. 51 Knight Lane Williston, VT 05495	LOCATION: Hinesburg, VT MBC JOB #: 13030	DATE: 4-19 -13 HOLE #: B-2 LINE & STA. OFFSET:

Ground Water Observations		
6' Est. at _0 _ hours	Augers-Size I.D. 3.25 Split Spoon 2" Hammer Wt. 140# Hammer Fall 30"	Surface Elevation: 335.0' +/- Date Started: 4-19 -13 Date Completed: 4-19 -13 Boring Foreman: Mike McGinley Inspector: Eric Goddard Soils Engineer: Eric Goddard

LOCATION OF BORING: As shown

Sample Depths From/To (Feet)	Type of Sample	Blows per 6" on Sampler	Moisture Density or Consist.	Strata Change Elev.	Soil Identification	Sample No.	Pen. Inches	Rec. Inches
0'-2'	Dry	3/4/5/6	Moist	6"	Top soil into medium dense brown cmf sand & f gravel	1	24	10
2'-4'	Dry	6/5/6/10	Damp/ moist	2.5'	Medium dense brown cmf sand & f gravel into medium dense brown silt & f sand, some f gravel	2	24	18
4'-6'	Dry	3/5/6/8	Moist		Very stiff gray silt, some clay & f sand	3	24	16
6'-8'	Dry	7/8/9/13	Wet	6'	Very stiff gray silt & clay (PP=2.67 TSF) into stiff clay, silt, sand & f gravel (PP=1.14 TSF)	4	24	16
8'-10'	Dry	6/8/8/6	Wet		Stiff gray silty clay, some f sand layers (PP=1.65 TSF)	5	24	24
10'-12'	Dry	3/3/3/3	Wet		Medium stiff gray clay (CL, LL=41, PL=20, PI=21, w=45.4, PP=0.74 TSF)	6	24	16
15'-17'	Dry	1/1/1/1	Wet		Soft-to-medium stiff gray/brown clay (CH, LL=65, PL=25, PI=40, w=73.2, PP=0.59 TSF)	7	24	24
20'-22'	UT	10 sec at 50 PSI			Pushed tube (Medium stiff-to-stiff gray clay, PP=1.05 TSF)	8	24	8
25'-27'	Dry	WORH/WORH/2/1	Wet		Very soft gray clay (PP=0.17 TSF)	9	24	20

Ground Surface to 25' Used 3.25" augers: Then S.S. to 27'

Earth Borings 27'
Rock Coring
Samples: 9
HOLE NUMBER B-2

MIKE'S BORING & CORING LLC.
PO Box 75 ° East Barre, Vermont 05649 ° 802 476-5073

TO: Eric Goddard Knight Consulting Engineers, Inc. 51 Knight Lane Williston, VT 05495	PROJECT NAME: Hinesburg Police Station LOCATION: Hinesburg, VT MBC JOB #: 13030	SHEET: 3 DATE: 4-19 -13 HOLE #: B-3 LINE & STA. OFFSET: 5' SE

Ground Water Observations 6' Est. at _0_ hours	Augers-Size I.D. 3.25 Split Spoon 2" Hammer Wt. 140# Hammer Fall 30"	Surface Elevation: 332.8' +/- Date Started: 4-19 -13 Date Completed: 4-19 -13 Boring Foreman: Mike McGinley Inspector: Eric Goddard Soils Engineer: Eric Goddard

LOCATION OF BORING: As shown

Sample Depths From/To (Feet)	Type of Sample	Blows per 6" on Sampler	Moisture Density or Consist.	Strata Change Elev.	Soil Identification	Sample No.	Sample Pen. Inches	Sample Rec. Inches
0'-2'	Dry	1/2/1/1	Moist	6"	Medium stiff silty clay topsoil into loose brown/gray fine silty sand, trace f gravel	1	24	0
2'-4'	Dry	3/4/5/7	Moist		Very stiff brown/gray silt, some vf sand (PP=2.32 TSF)	2	24	19
4'-6'	Dry	7/7/8/8	-		No recovery (Very stiff)	3	24	0
6'-8'	Dry	5/6/7/7	-		No recovery (Stiff)	4	24	0
8'-10'	Dry	3/5/4/3	Wet		Stiff brown/gray silty sand into loose-to-medium dense gray clay, silt, sand & f gravel into stiff gray clay (PP=1.67 TSF)	5	24	24
10'-12'	UT	9 sec at 50 PSI	Wet		Pushed tube (Medium stiff gray clay, CL, LL=32, PL=22, PI=10, w=44.5, PP=0.62 TSF)	6	24	24
14'-16'	Dry	WORH/WORH/1/2	Wet		Soft gray clay (PP=0.26 TSF)	7	24	20
19'-21'	Dry	WORH/WORH/WORH/1	Wet		Soft gray clay (PP=0.23 TSF)	8	24	24
24'-26'	UT	6 sec at 50 PSI	Wet		Pushed tube (Soft-to-medium stiff gray clay, CH, LL=63, PL=27, PI=36, w=70.6, PP=0.46 TSF)	9	24	15
29'-31'	Dry	WORH/WORH/WORH/WORH	Wet		Soft gray clay (PP=0.36 TSF)	10	24	24
34'-36'	Dry	WORH x 4	Wet		Very soft gray clay (CH, LL=61, PL=23, PI=38, w=67.6, PP=0.17 TSF)	11	24	24
39'-41'	Dry	WORH x 4	Wet		Very soft gray clay (PP=0.21 TSF)	12	24	24
44'-46'	Dry	WORH x 4	Wet		Very soft gray clay (CH, LL=66, PL=29, PI=37, w=72.6, PP=0.21 TSF)	13	24	24

Ground Surface to 44' Used 3.25" augers: Then S.S. to 46"

Earth Borings 46'
Rock Coring
Samples: 13
HOLE NUMBER B-3

APPENDIX D

Date: 4-26-13

Client: Hinesburg

KCE #: 13189

Project: Hinesburg Fire Station

Subject: As received Moisture and Organic Content (%) of sample received on 4-20-13.

The Moisture and Organic Content, was determined by the Standard Test Method for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils, ASTM D2974.

Sample:

Sample I.D.	As Received Moisture Content (%)	Organic Content (%)
B-1 (4'-6')	16.72	1.3
B-2 (4'-6')	32.90	2.6
B-1 (8'-10')	27.23	2.1

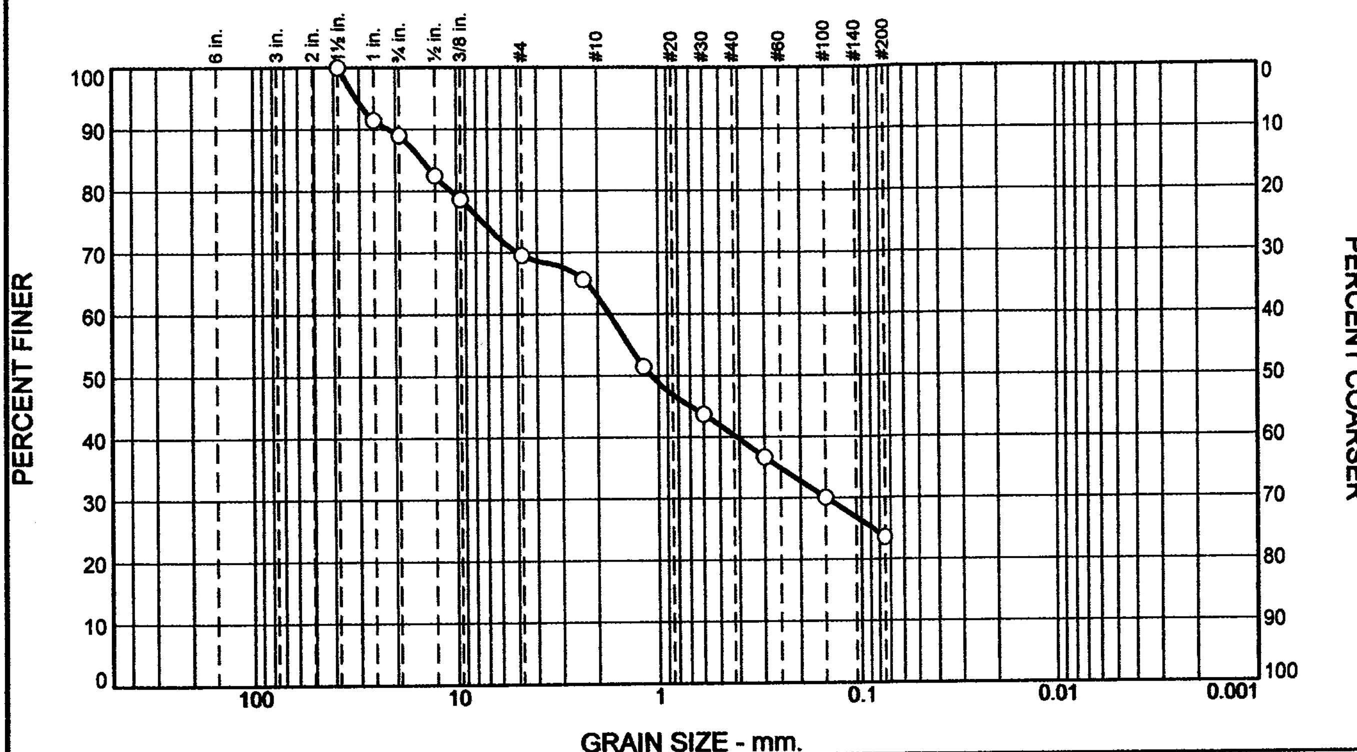
Submitted by,

Tirah L. ~~Boyd~~ Brothers
Engineering Technician

TLB/nmv

S:\Nancy's Forms\Moisture & Organic Content.doc

Grain Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	11	19	7	23	16	24	

Test Results (ASTM D 422 & ASTM C 117)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1-1/2"	100		
1"	91		
3/4"	89		
1/2"	82		
3/8"	79		
#4	70		
#8	66		
#16	51		
#30	44		
#50	37		
#100	30		
#200	24		

* (no specification provided)

Material Description

B-1 (10'-12') Bottom
Cmf Sand, some mf Gravel & Silt

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)=

Coefficients

D_{90}= 21.4161 D_{85}= 14.6959 D_{60}= 1.7442
D_{50}= 1.0814 D_{30}= 0.1481 D_{15}=
D_{10}= C_u= C_c=

Remarks

Sampled and Delivered by E. Goddard with KCE.
F.M.=3.35

Date Received: 4-28-13 **Date Tested:** 5-1-13

Tested By: M. Chapek

Checked By: E. Goddard

Title: Senior Vice President

Source of Sample: Borings **Date Sampled:** 4-28-13

Sample Number: 1

Results reflect soil gradation only and not other specification requirements.

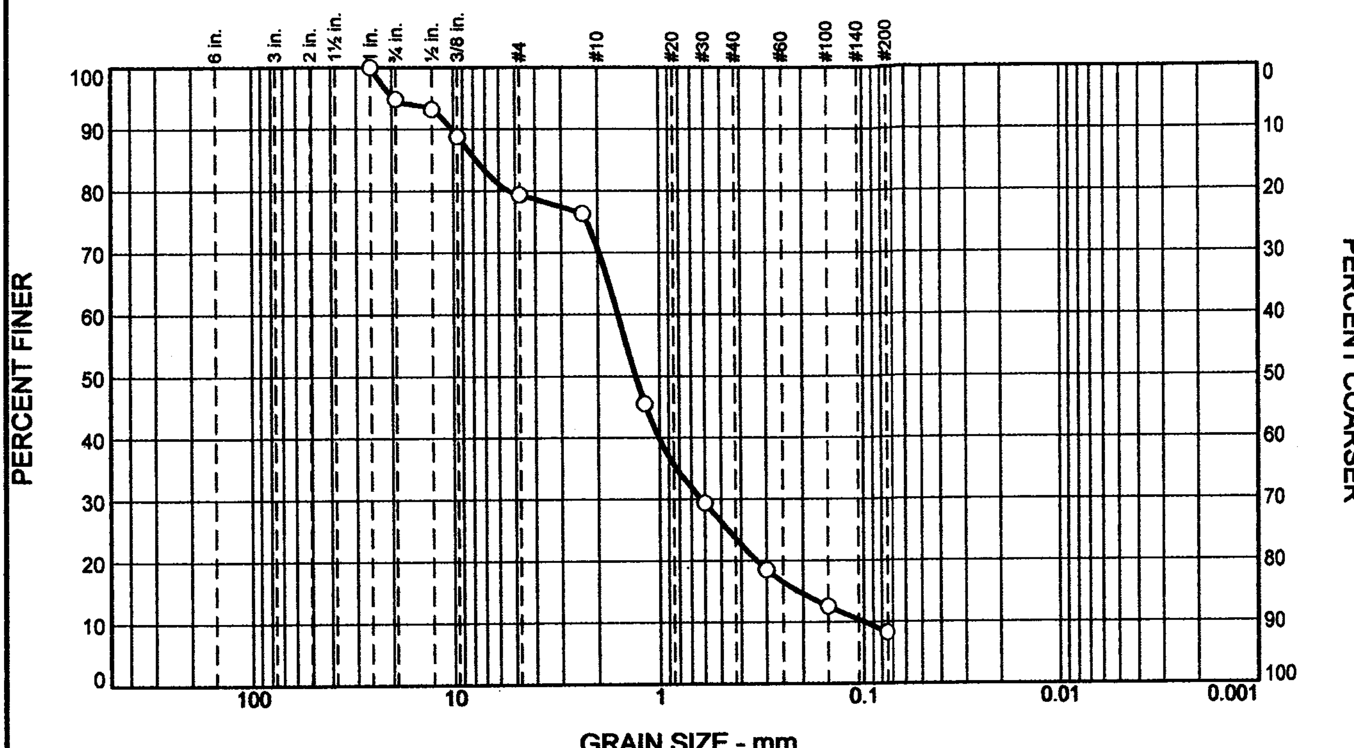
Knight Consulting Engineers, Inc. Williston, Vermont

Client: Town of Hinesburg

Project: Hinesburg Fire House

Project No: 13189 **Figure** 1-2

Grain Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	5	16	8	47	16	8	

Test Results (ASTM D 422 & ASTM C 117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1"	100		
3/4"	95		
1/2"	93		
3/8"	89		
#4	79		
#8	76		
#16	46		
#30	29		
#50	19		
#100	13		
#200	8.3		

* (no specification provided)

Material Description

B-1 (15'-17')
Cmf Sand, Some mf Gravel, tr Silt

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS (D 2487)= SW-SM AASHTO (M 145)=

Coefficients

D_{90}= 10.1415 D_{85}= 7.7402 D_{60}= 1.5978
D_{50}= 1.3062 D_{30}= 0.6217 D_{15}= 0.2107
D_{10}= 0.0995 C_u= 16.05 C_c= 2.43

Remarks

Sampled and Delivered by E. Goddard with KCE.
F.M.=3.54

Date Received: 4-28-13 **Date Tested:** 5-1-13
Tested By: M. Chapek
Checked By: E. Goddard
Title: Senior Vice President

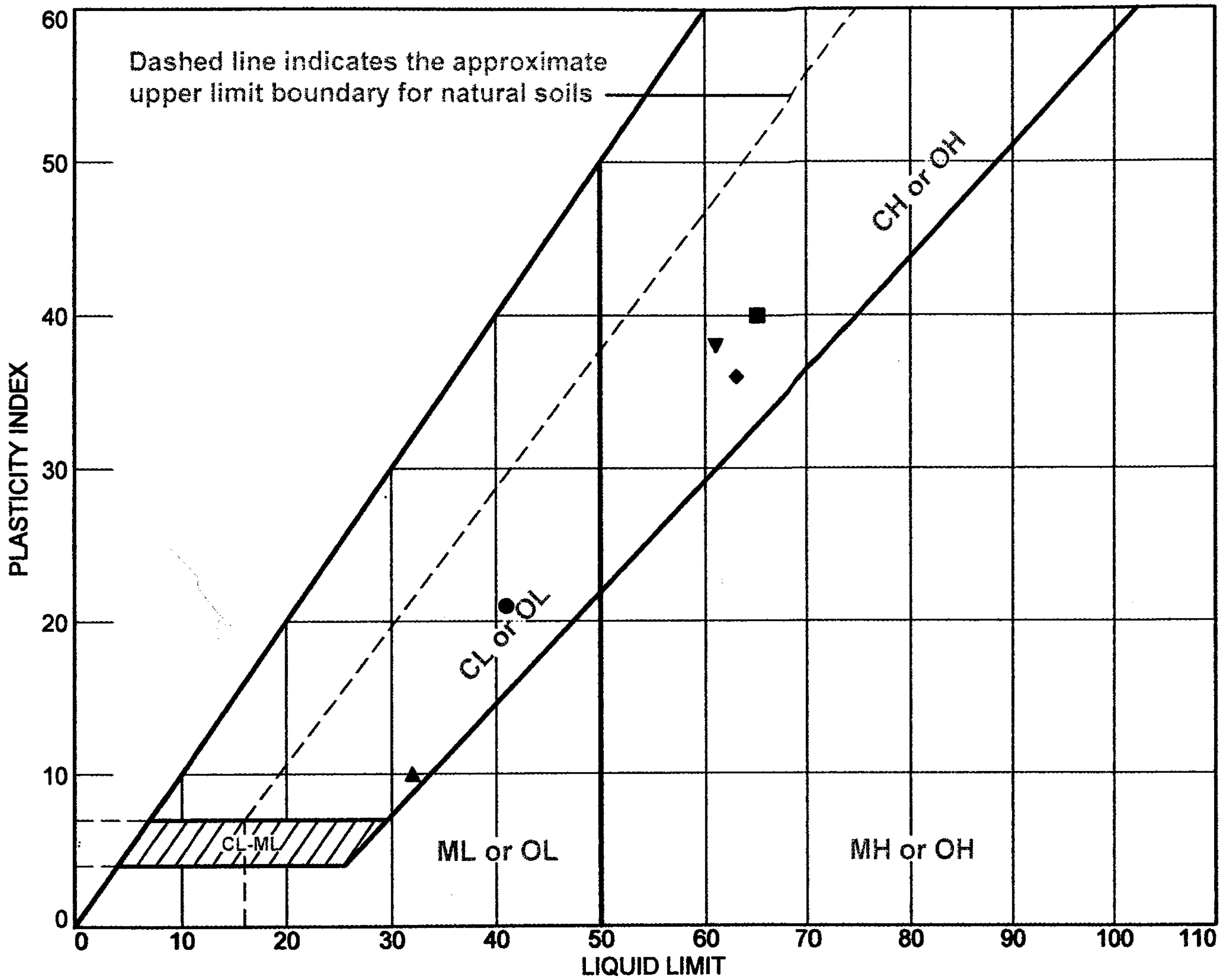
Source of Sample: Borings **Date Sampled:** 4-28-13
Sample Number: 2

Knight Consulting Engineers, Inc.
Williston, Vermont

Client: Town of Hinesburg
Project: Hinesburg Fire House
Project No: 13189 **Figure** 2-2

Results reflect soil gradation only and not other specification requirements.

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	Borings	B-2	10'-12'	45.4	20	41	21	CL
■	Borings	B-2	25'-27'	73.2	25	65	40	CH
▲	Borings	B-3	10'-12'	44.5	22	32	10	CL
◆	Borings	B-3	24'-26'	70.6	27	63	36	CH
▼	Borings	B-3	34'-36'	67.6	23	61	38	CH

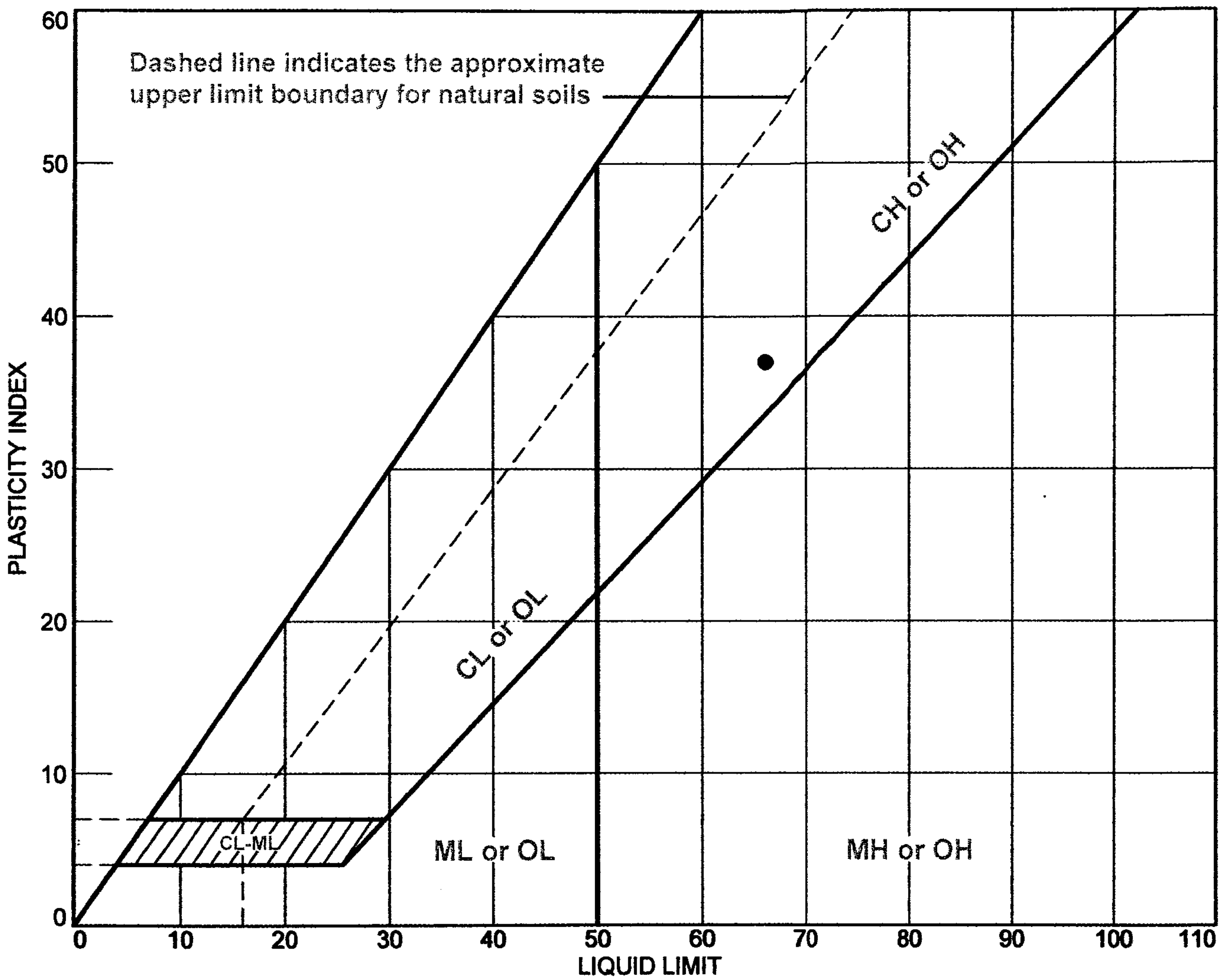
Knight Consulting Engineers, Inc.
Williston, Vermont

Client: Town of Hinesburg
Project: Hinesburg Fire House
Project No.: 13189 **Figure** 1-2

Results reflect soil gradation only and not other specification requirements.

Tested By: T. Brothers **Checked By:** E. Goddard

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	Borings	B-3	44'-46'	72.6	29	66	37	CH

Results reflect soil gradation only and not other specification requirements.

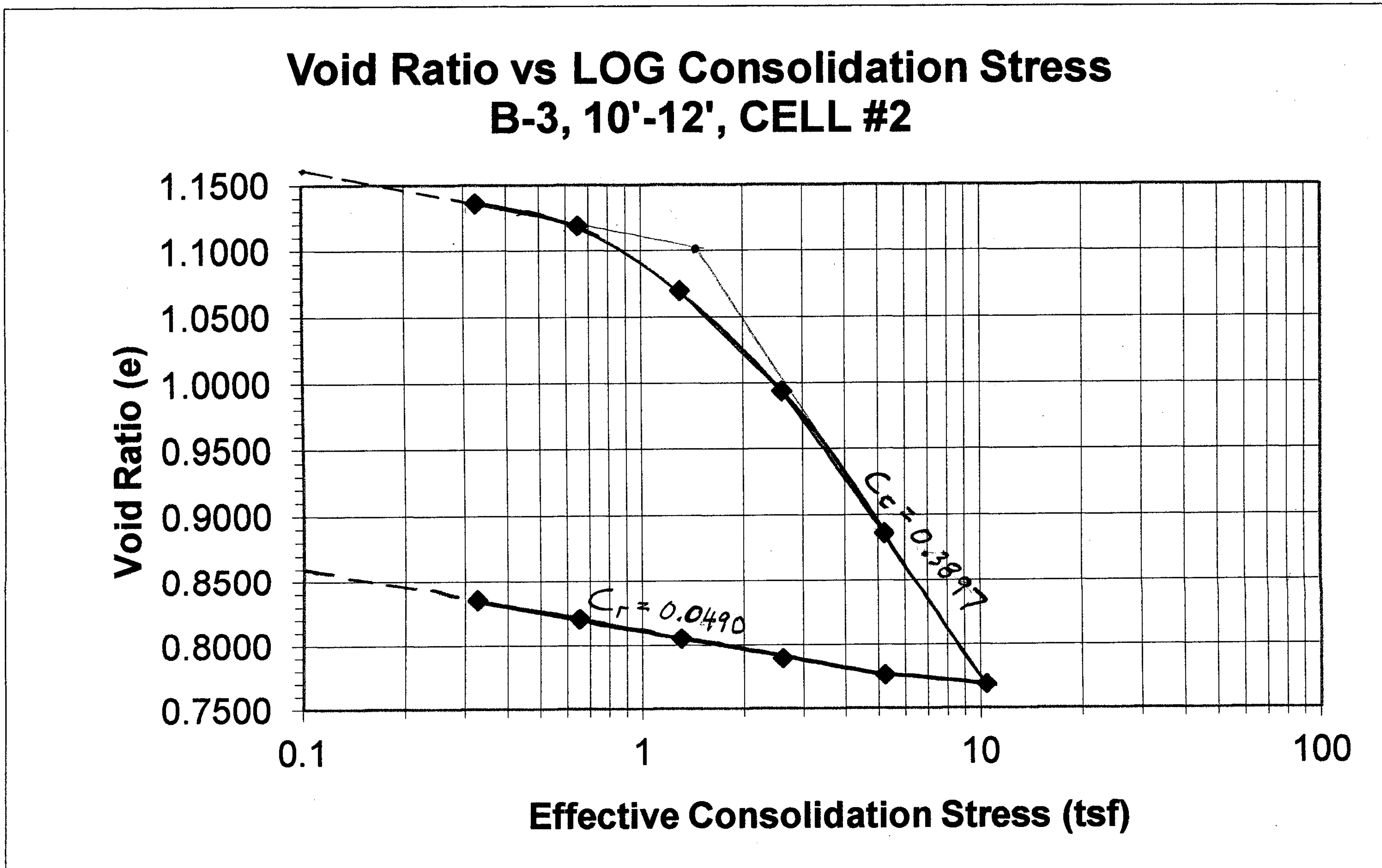
Knight Consulting Engineers, Inc. Williston, Vermont

Client: Town of Hinesburg
Project: Hinesburg Fire House

Project No.: 13189 **Figure** 2-2

Tested By: T. Brothers **Checked By:** E. Goddard

APPENDIX E

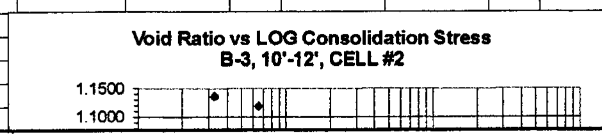

Void Ratio vs LOG Consolidation Stress
B-3, 10'-12', CELL #2
Void Ratio (e)
1.1500
1.1000
1.0500
1.0000
0.9500
0.9000
0.8500
0.8000
0.7500
0.1
1
10
100
Effective Consolidation Stress (tsf)
Cc = 0.3897
Cr = 0.0490

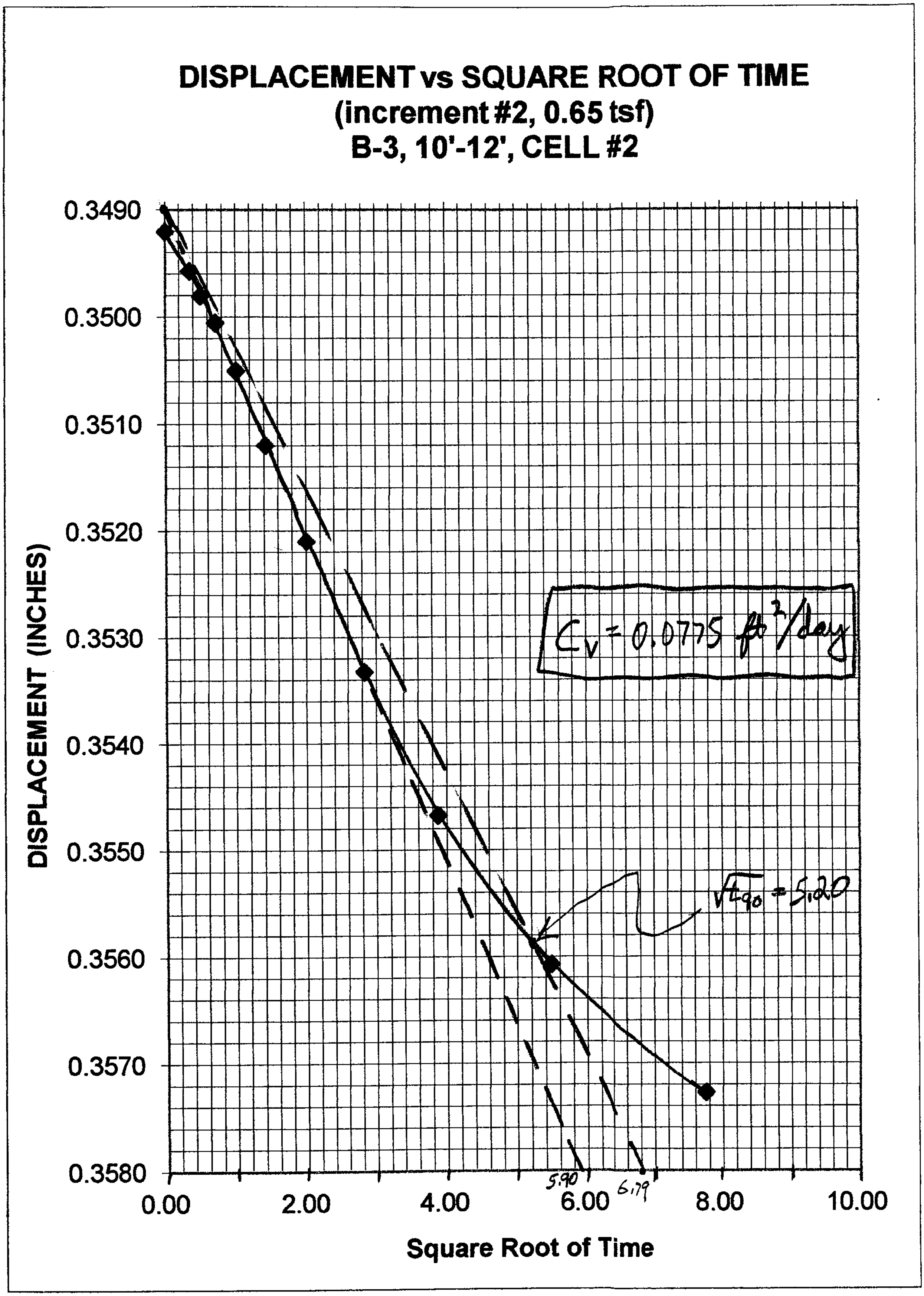
Knight Consulting Engineers		CONSOLIDATION REDUCTION WORKSHEET		
PROJECT:	Hinesburg Fire Station (13189)			

WATER CONTENT FROM TRIMMINGS			VOID RATIO CALCULATION		
TARE	20.85	grams	WT OF RING	524.0	grams
TARE + WET SOIL	142.22	grams	WT OF RING AND WET SOIL	667.7	grams
TARE + DRY SOIL	104.84	grams	WT OF DRY SOIL	99.44	grams
MOISTURE CONTENT	44.51%		DENSITY OF DRY SOIL	77.17	pcf
			INITIAL VOID RATIO	1.1429	

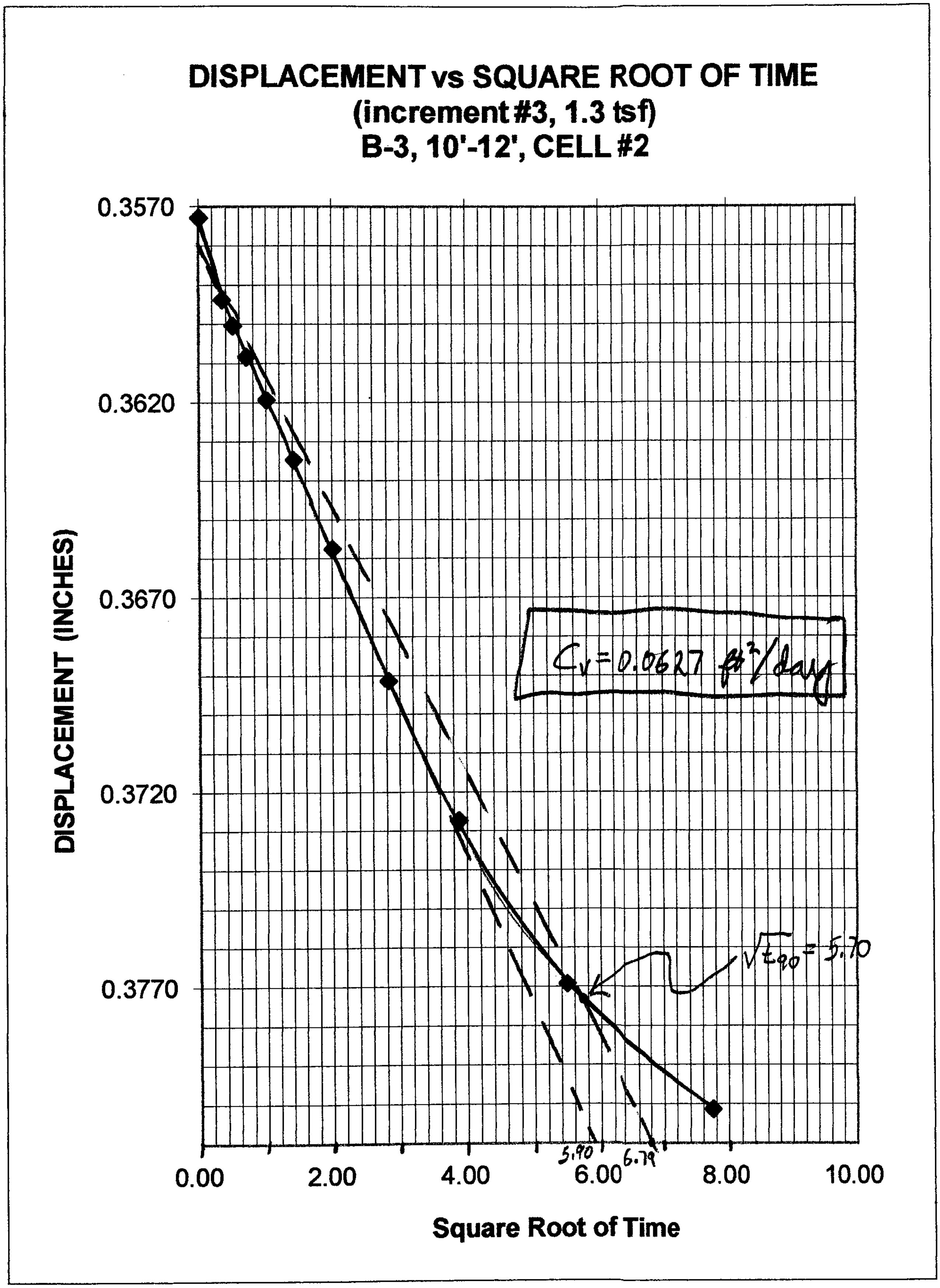
CELL #2 SAMPLE: B-3 (10'-12')

Date: 04-19-13				AVG DISPL	0.3522		0.3661		0.3935		0.4347			0.4875		
			INCRMNT1	INCRMNT2	ADJ.	INCRMNT3	ADJ.	INCRMNT4	ADJ.	INCRMNT5	ADJ.		INCRMNT6	ADJ.		
TIME	SQRT TIME		DISPL	READING	DISPL	READING	DISPL	READING	DISPL	READING	DISPL		READING	DISPL		
0.00	0.00		0.3462	0.3550	0.3492	0.3644	0.3573	0.3890	0.3801	0.4264	0.4157		0.4785	0.4659		
0.12	0.34			0.3561	0.3496	0.3675	0.3594	0.3927	0.3828	0.4314	0.4195		0.4838	0.4699		
0.25	0.50			0.3564	0.3498	0.3682	0.3600	0.3938	0.3838	0.4329	0.4209		0.4856	0.4716		
0.50	0.71			0.3567	0.3501	0.3691	0.3608	0.3950	0.3849	0.4347	0.4226		0.4878	0.4737		
1.00	1.00			0.3572	0.3505	0.3703	0.3619	0.3969	0.3867	0.4372	0.4250		0.4907	0.4765		
2.00	1.41			0.3580	0.3512	0.3719	0.3635	0.3996	0.3894	0.4409	0.4287		0.4952	0.4809		
4.00	2.00			0.3589	0.3521	0.3742	0.3657	0.4034	0.3931	0.4463	0.4340		0.5016	0.4872		
8.00	2.83			0.3602	0.3533	0.3777	0.3691	0.4084	0.3980	0.4537	0.4413		0.5103	0.4959		
15.00	3.87			0.3616	0.3547	0.3814	0.3727	0.4140	0.4035	0.4621	0.4496		0.5199	0.5054		
30.00	5.48			0.3631	0.3561	0.3857	0.3769	0.4209	0.4103	0.4714	0.4589		0.5295	0.5149		
60.00	7.75		0.3550	0.3644	0.3573	0.3890	0.3801	0.4264	0.4157	0.4785	0.4659		0.5353	0.5207		
		e=	1.1364		1.1191		1.0702		0.9940		0.8863			0.7690	0.7764	0.7896
		tsf=	0.325		0.65		1.3		2.6		5.2			10.4	5.2	2.6
													unload cycle			
											5.2	tsf	0.5311	0.5172	e=	0.7764
											2.6	tsf	0.5239	0.5111	e=	0.7896
											1.3	tsf	0.5156	0.5037	e=	0.8055
											0.65	tsf	0.5075	0.4965	e=	0.8209
											0.325	tsf	0.4999	0.4897	e=	0.8354

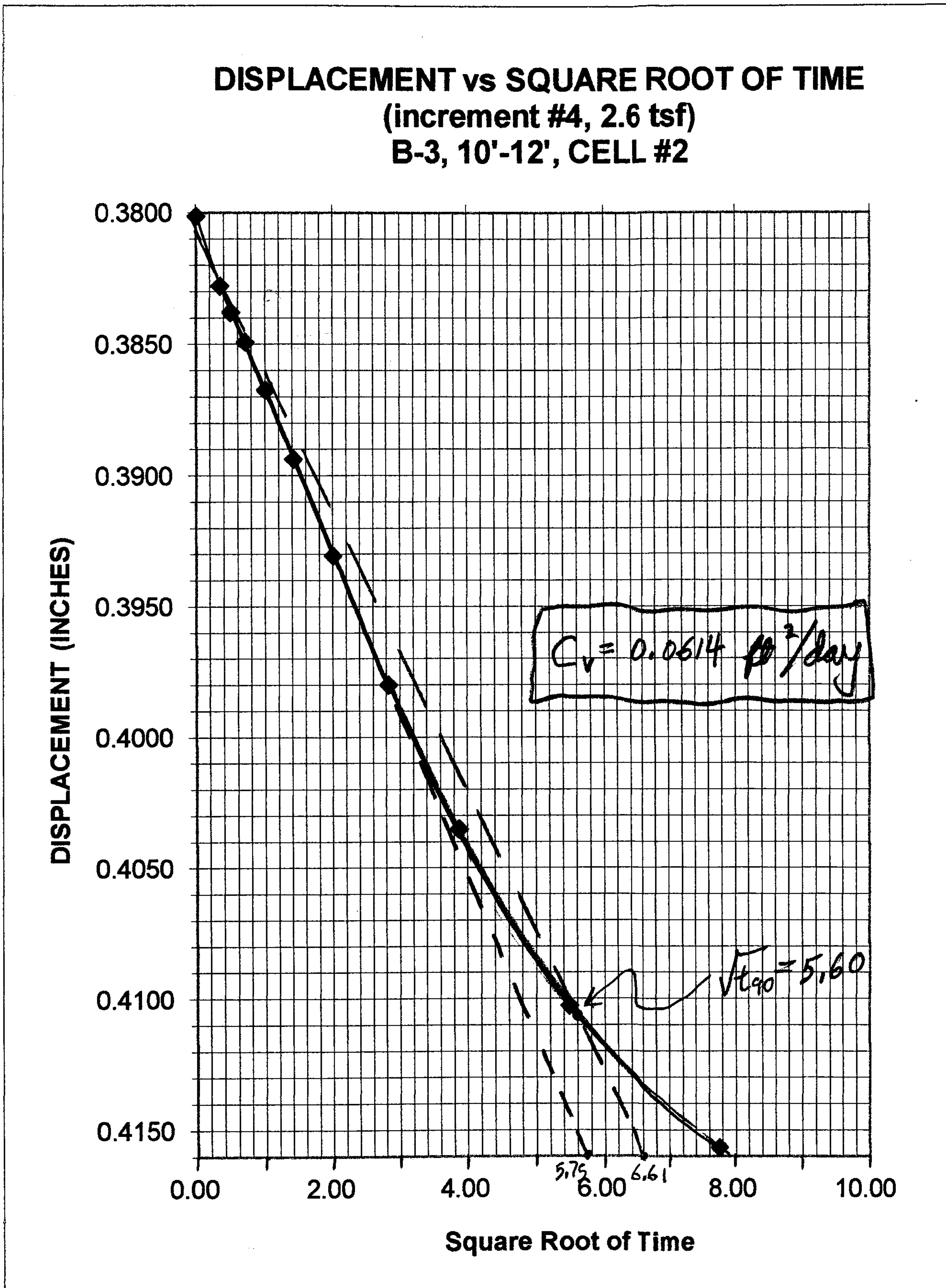


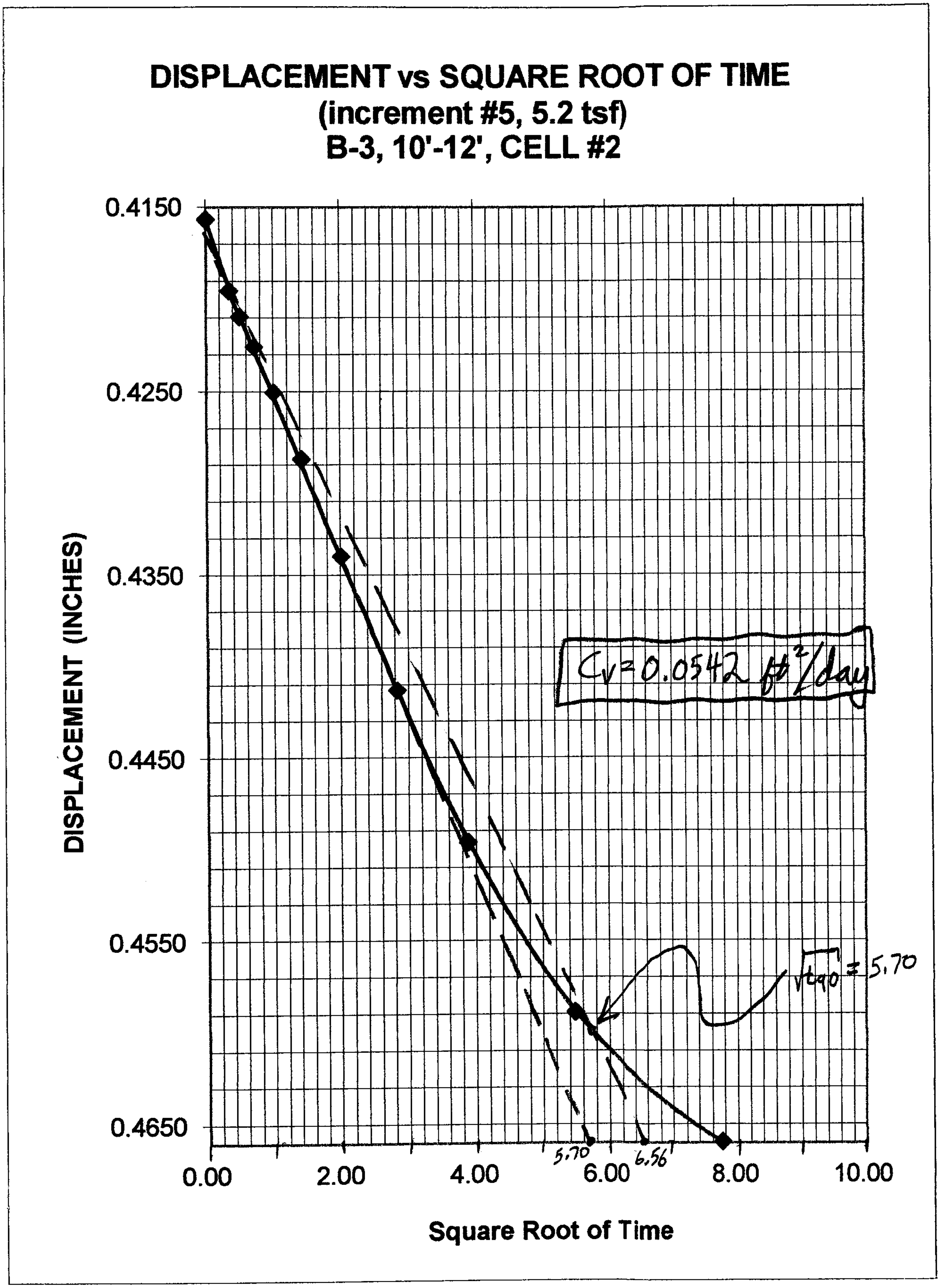


DISPLACEMENT vs SQUARE ROOT OF TIME
(increment #2, 0.65 tsf)
B-3, 10'-12', CELL #2
DISPLACEMENT (INCHES)
0.3490
0.3500
0.3510
0.3520
0.3530
0.3540
0.3550
0.3560
0.3570
0.3580
0.00
2.00
4.00
6.00
8.00
10.00
Square Root of Time
Cv = 0.0775 ft²/day
√t90 = 5.20
5.90
6.79

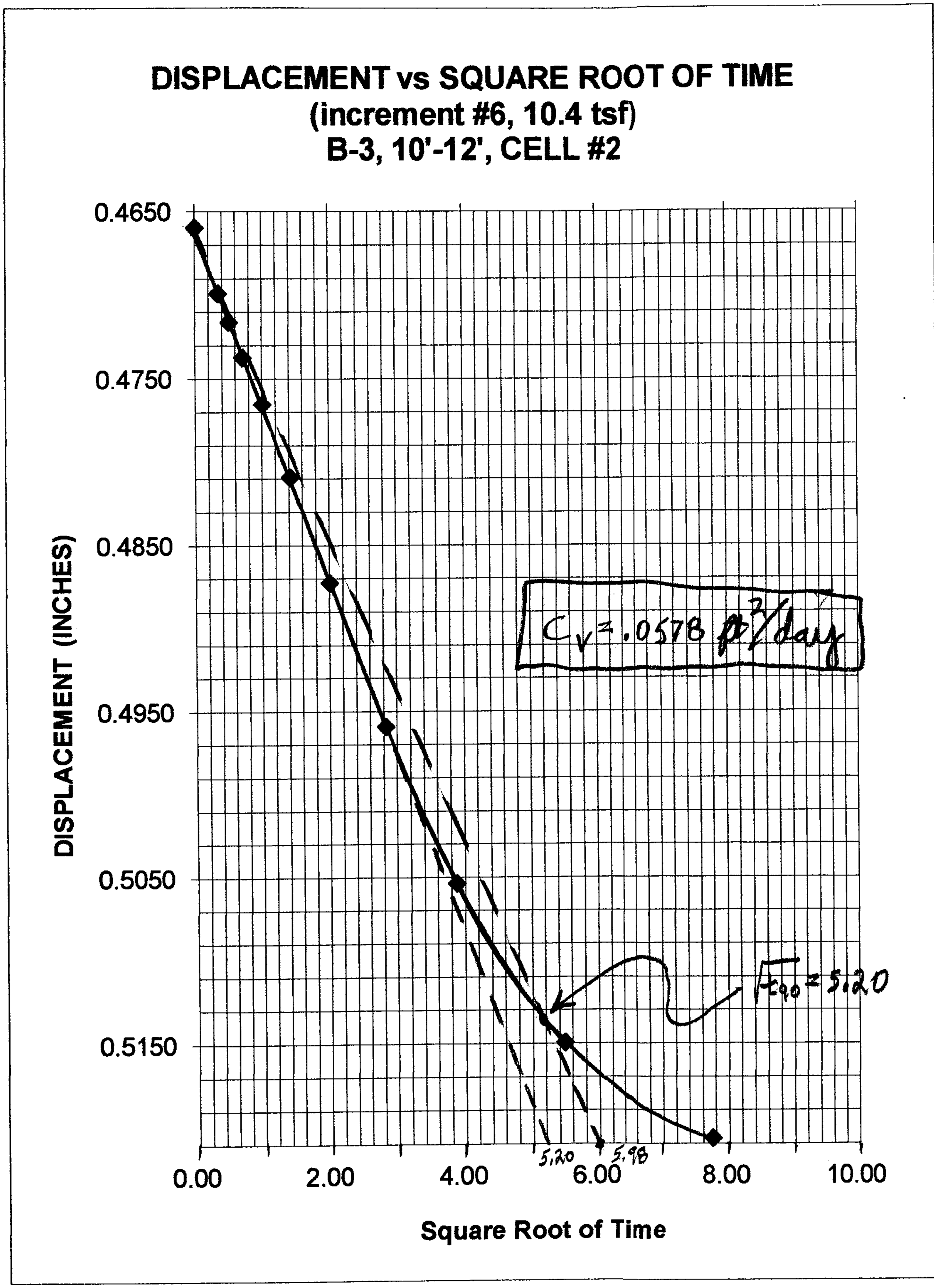


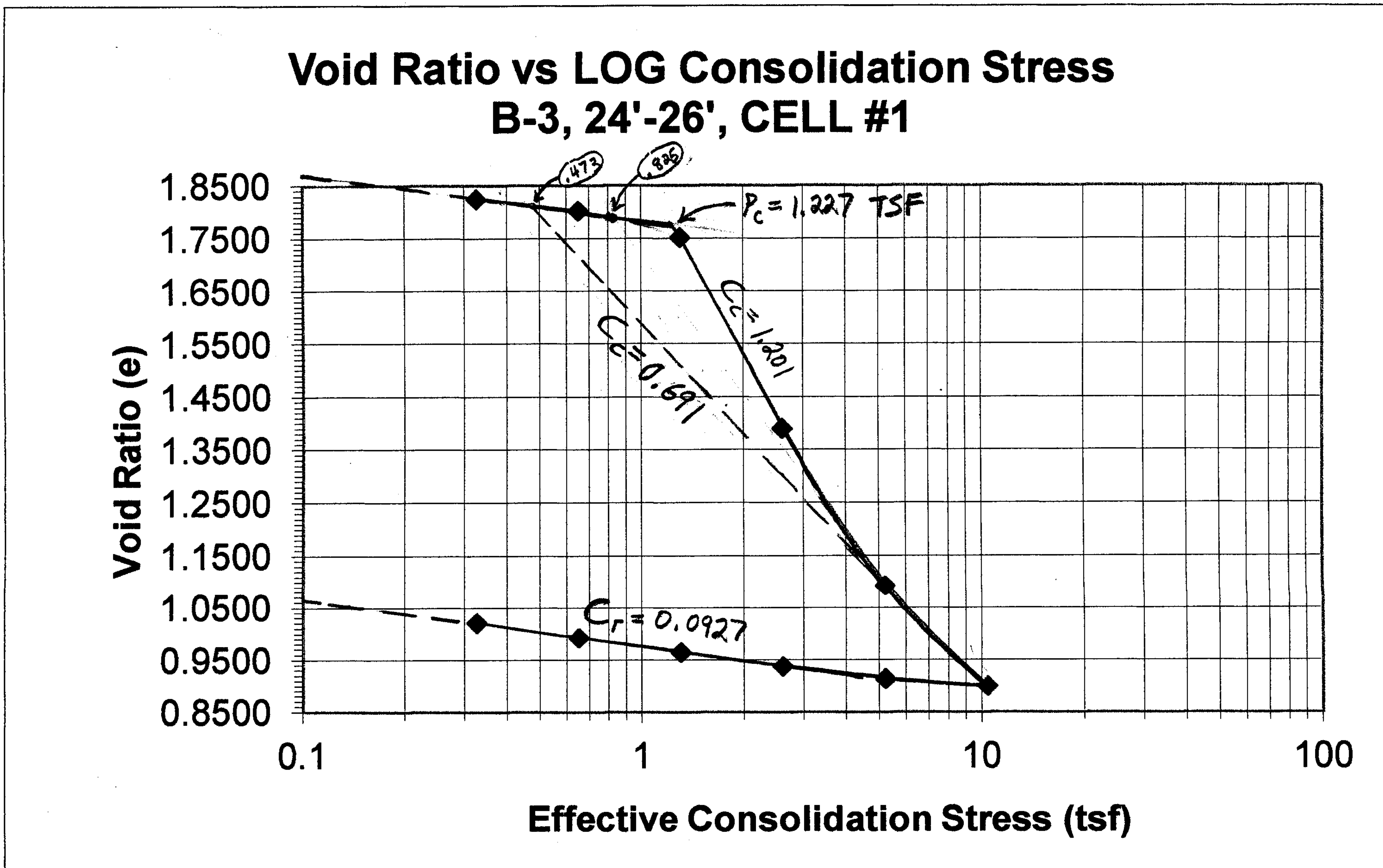
DISPLACEMENT vs SQUARE ROOT OF TIME
(increment #3, 1.3 tsf)
B-3, 10'-12', CELL #2
DISPLACEMENT (INCHES)
0.3570
0.3620
0.3670
0.3720
0.3770
Square Root of Time
0.00
2.00
4.00
6.00
8.00
10.00
5.90
6.79
Cv=0.0627 ft²/day
√t90=5.70


DISPLACEMENT vs SQUARE ROOT OF TIME
(increment #4, 2.6 tsf)
B-3, 10'-12', CELL #2
DISPLACEMENT (INCHES)
0.3800
0.3850
0.3900
0.3950
0.4000
0.4050
0.4100
0.4150
0.00
2.00
4.00
6.00
8.00
10.00
Square Root of Time
Cv = 0.0614 ft²/day
√t90 = 5.60
5.75
6.61



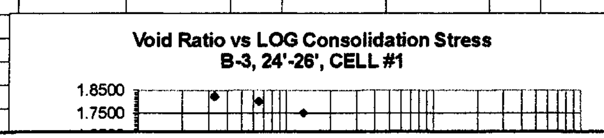
DISPLACEMENT vs SQUARE ROOT OF TIME
(increment #5, 5.2 tsf)
B-3, 10'-12', CELL #2
0.4150
0.4250
0.4350
0.4450
0.4550
0.4650
DISPLACEMENT (INCHES)
0.00
2.00
4.00
6.00
8.00
10.00
Square Root of Time
Cv=0.0542 ft²/day
√t90 = 5.70
5.70
6.56

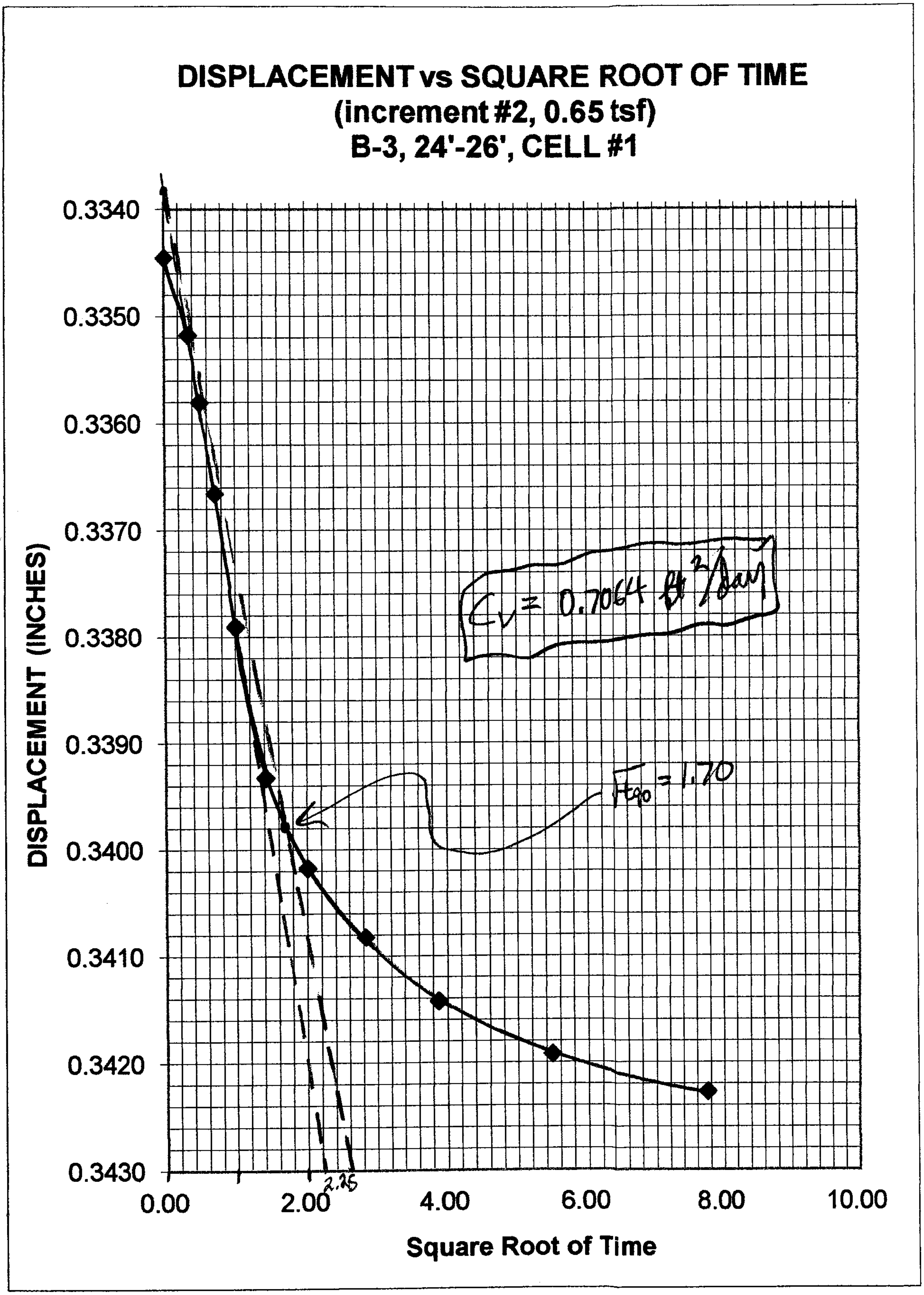

DISPLACEMENT vs SQUARE ROOT OF TIME
(increment #6, 10.4 tsf)
B-3, 10'-12', CELL #2
DISPLACEMENT (INCHES)
0.4650
0.4750
0.4850
0.4950
0.5050
0.5150
0.00
2.00
4.00
6.00
8.00
10.00
Square Root of Time
Cv = .0578 ft²/day
√t90 = 5.20
5.20
5.98

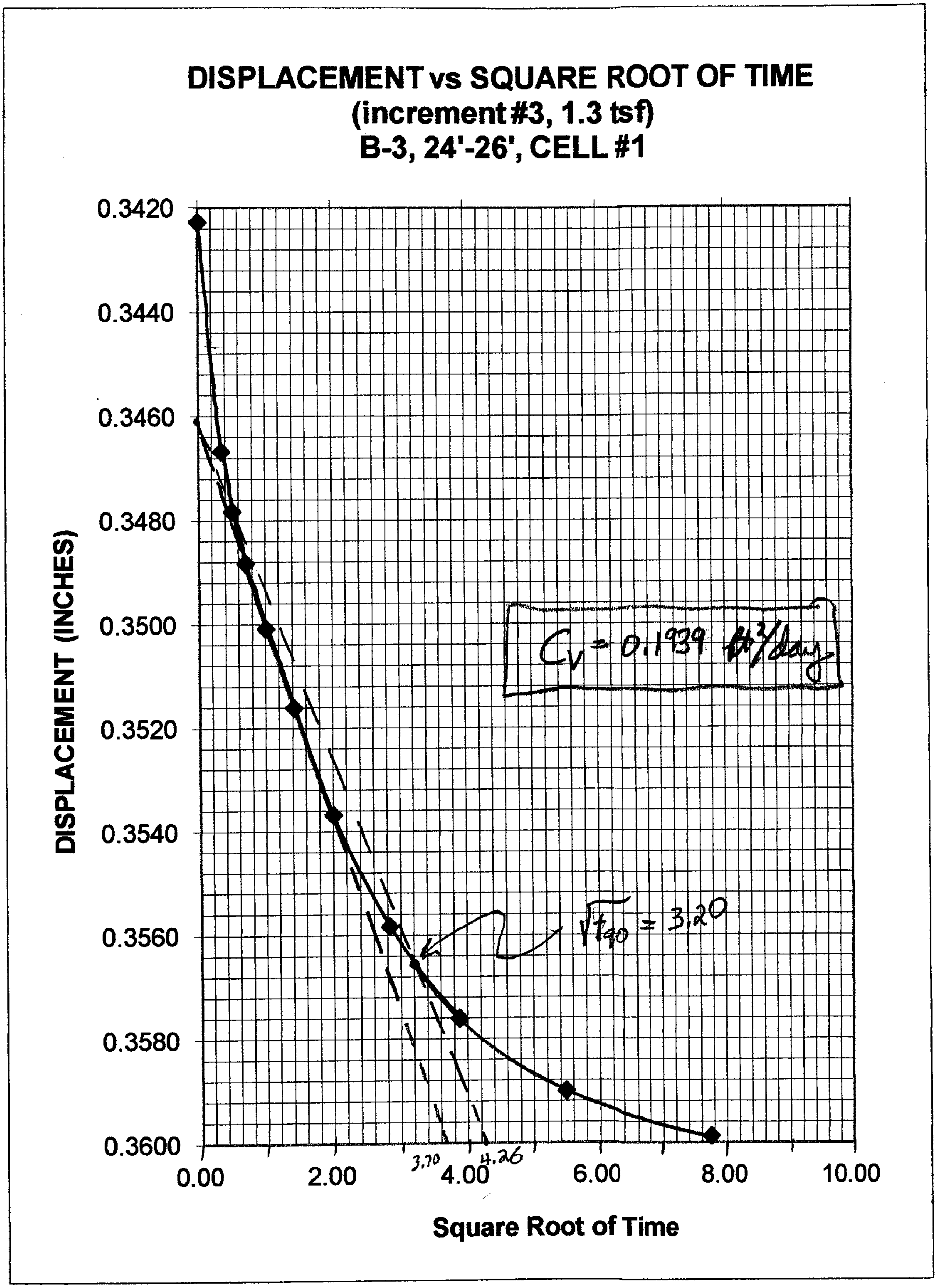


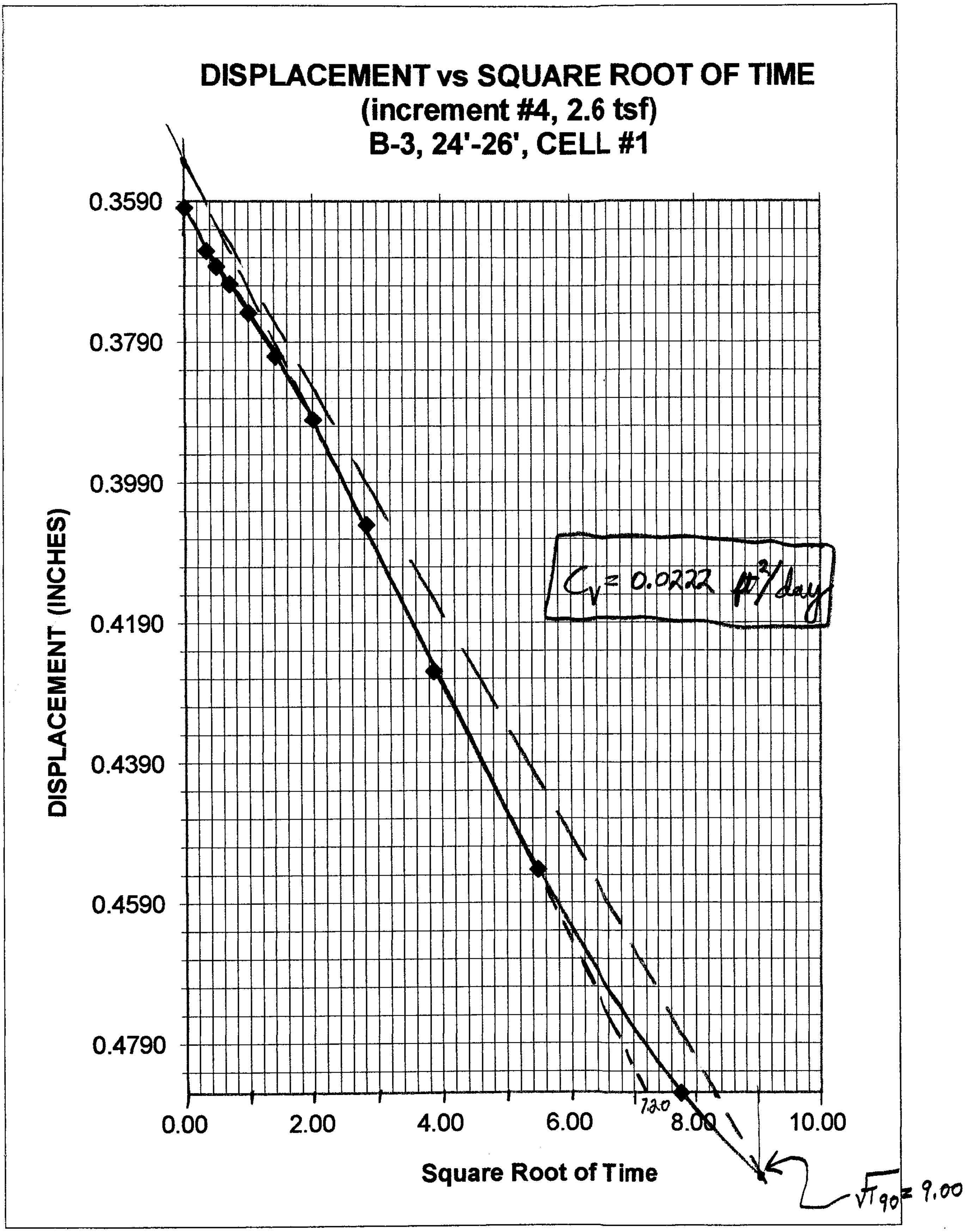
Void Ratio vs LOG Consolidation Stress
B-3, 24'-26', CELL #1
Void Ratio (e)
1.8500
1.7500
1.6500
1.5500
1.4500
1.3500
1.2500
1.1500
1.0500
0.9500
0.8500
0.1
1
10
100
Effective Consolidation Stress (tsf)
.473
.826
P_c = 1.227 TSF
C_c = 1.201
C_c = 0.691
C_r = 0.0927

Knight Consulting Engineers			CONSOLIDATION REDUCTION WORKSHEET																	
PROJECT:	Hinesburg Fire Station (13189)																			
WATER CONTENT FROM TRIMMINGS					VOID RATIO CALCULATION															
TARE		21.19	grams		WT OF RING			513.7	grams											
TARE + WET SOIL		113.65	grams		WT OF RING AND WET SOIL			640.5	grams											
TARE + DRY SOIL		75.40	grams		WT OF DRY SOIL			74.34	grams											
MOISTURE CONTENT		70.56%			DENSITY OF DRY SOIL			57.69	pcf											
					INITIAL VOID RATIO			1.8663												
CELL #1	SAMPLE:	B-3 (24'-26')																		
Date: 04-19-13					AVG DISPL	0.3387			0.3521			0.3983			0.5203			0.6158		
			INCRMNT1		INCRMNT2	ADJ.		INCRMNT3	ADJ.		INCRMNT4	ADJ.		INCRMNT5	ADJ.		INCRMNT6	ADJ.		
TIME	SQRT TIME		DISPL		READING	DISPL		READING	DISPL		READING	DISPL		READING	DISPL		READING	DISPL		
0.00	0.00		0.3200		0.3402	0.3345		0.3494	0.3423		0.3687	0.3599		0.4967	0.4860		0.6025	0.5899		
0.12	0.34				0.3417	0.3352		0.3548	0.3467		0.3759	0.3660		0.5018	0.4899		0.6071	0.5932		
0.25	0.50				0.3424	0.3358		0.3560	0.3478		0.3782	0.3682		0.5042	0.4922		0.6093	0.5952		
0.50	0.71				0.3433	0.3367		0.3571	0.3488		0.3808	0.3707		0.5072	0.4951		0.6125	0.5983		
1.00	1.00				0.3446	0.3379		0.3584	0.3501		0.3849	0.3747		0.5116	0.4994		0.6162	0.6020		
2.00	1.41				0.3461	0.3393		0.3600	0.3516		0.3912	0.3810		0.5181	0.5059		0.6217	0.6074		
4.00	2.00				0.3470	0.3402		0.3622	0.3537		0.4003	0.3900		0.5277	0.5154		0.6292	0.6149		
8.00	2.83				0.3477	0.3408		0.3644	0.3558		0.4154	0.4050		0.5421	0.5297		0.6409	0.6265		
15.00	3.87				0.3484	0.3414		0.3662	0.3576		0.4364	0.4259		0.5603	0.5478		0.6530	0.6385		
30.00	5.48				0.3490	0.3419		0.3677	0.3590		0.4648	0.4542		0.5844	0.5719		0.6652	0.6507		
60.00	7.75		0.3402		0.3494	0.3423		0.3687	0.3599		0.4967	0.4860		0.6025	0.5899		0.6719	0.6573		
		e=	1.8249			1.8025			1.7520			1.3905			1.0928			0.8997	0.9136	0.9378
		tsf=	0.325			0.65			1.3			2.6			5.2			10.4	5.2	2.6
																	unload cycle			
															5.2	tsf	0.6663	0.6524	e=	0.9136
															2.6	tsf	0.6568	0.6440	e=	0.9378
															1.3	tsf	0.6465	0.6346	e=	0.9647
															0.65	tsf	0.6359	0.6249	e=	0.9925
															0.325	tsf	0.6249	0.6148	e=	1.0215



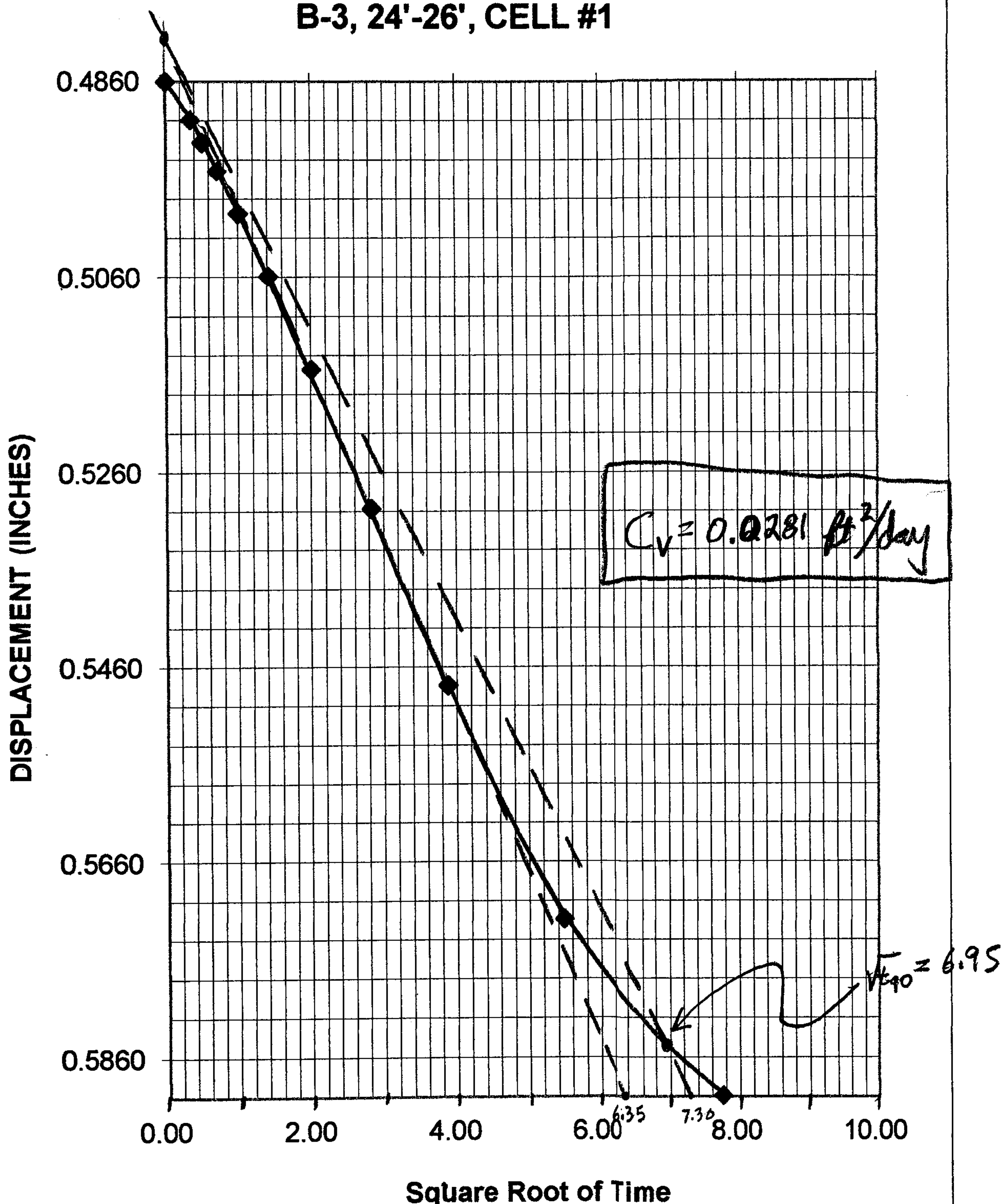

DISPLACEMENT vs SQUARE ROOT OF TIME
(increment #2, 0.65 tsf)
B-3, 24'-26', CELL #1
DISPLACEMENT (INCHES)
0.3340
0.3350
0.3360
0.3370
0.3380
0.3390
0.3400
0.3410
0.3420
0.3430
0.00
2.00
4.00
6.00
8.00
10.00
Square Root of Time
2.25
Cv = 0.7064 ft²/day
√t90 = 1.70

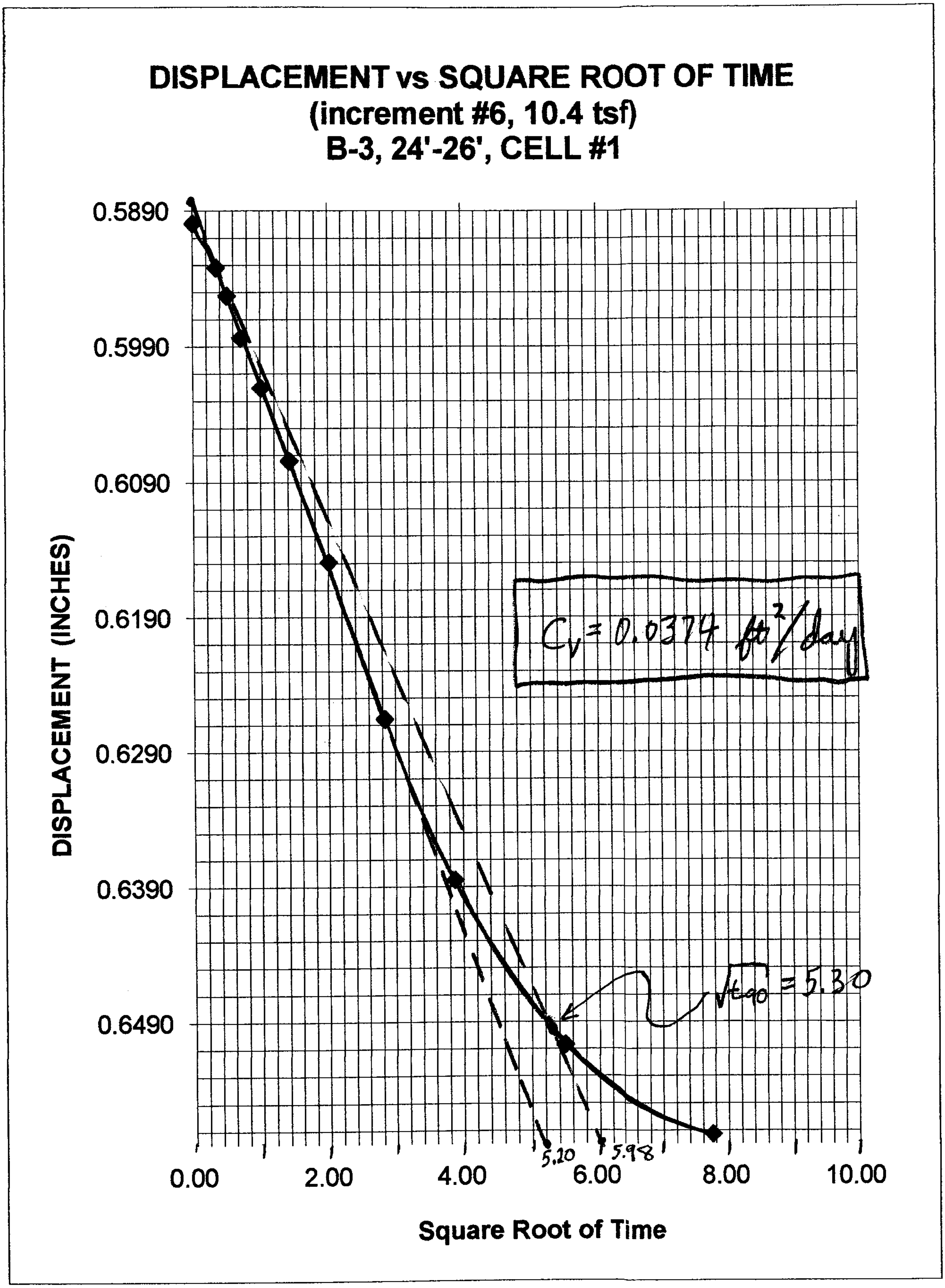

DISPLACEMENT vs SQUARE ROOT OF TIME
(increment #3, 1.3 tsf)
B-3, 24'-26', CELL #1
DISPLACEMENT (INCHES)
0.3420
0.3440
0.3460
0.3480
0.3500
0.3520
0.3540
0.3560
0.3580
0.3600
0.00
2.00
4.00
6.00
8.00
10.00
Square Root of Time
Cv = 0.1939 ft²/day
√t90 = 3.20
3.70
4.26



DISPLACEMENT vs SQUARE ROOT OF TIME
(increment #4, 2.6 tsf)
B-3, 24'-26', CELL #1
0.3590
0.3790
0.3990
0.4190
0.4390
0.4590
0.4790
DISPLACEMENT (INCHES)
0.00
2.00
4.00
6.00
8.00
10.00
Square Root of Time
720
Cv = 0.0222 ft²/day
√T90 = 9.00

DISPLACEMENT vs SQUARE ROOT OF TIME
(increment #5, 5.2 tsf)
B-3, 24'-26', CELL #1





DISPLACEMENT vs SQUARE ROOT OF TIME
(increment #6, 10.4 tsf)
B-3, 24'-26', CELL #1
DISPLACEMENT (INCHES)
0.5890
0.5990
0.6090
0.6190
0.6290
0.6390
0.6490
0.00
2.00
4.00
6.00
8.00
10.00
Square Root of Time
$C_v = 0.0374\ ft^2/day$
$\sqrt{t_{90}} = 5.30$
5.10
5.98

APPENDIX F

20-YEAR FLEXIBLE PAVEMENT DESIGN

This pavement design summary includes 3 levels of 20-year ESAL design based upon Light, Medium & Heavy Traffic loading. Light Traffic (200,000 ESAL) is equivalent to (25) 6,000# passenger vehicles and (5) 72,000# trucks per day. Medium Traffic (2,000,000 ESAL) is equivalent to (500) 6,000# passenger vehicles and (25) 72,000# trucks per day. Heavy Traffic (20,000,000 ESAL) is equivalent to (5000) 6,000# passenger vehicles and (250) 72,000# trucks per day. Subgrade Modulus numbers are based upon a pavement elevation of approximately 335' and a 12" minimum subgrade cut to remove topsoil materials. Below are the recommendations for the 3 ESAL levels:

Light Traffic Pavement Design Parameters (200,000 ESAL):

Local Road
20-year ESAL = 200,000
Serviceability Loss = 4.0 - 2.0 = 2.0 PSI
Reliability Factor = 90.9% (nomograph approach)
Overall Standard Deviation = 0.45
Design Frost Depth = 70"
Minimum Design Profile Depth = 28"
Subgrade Resilient Modulus = 2500
Min. SN = 3.90

3" Pavement + 12" Crushed Gravel + 13" Granular Fill:

Design SN = 3(0.44) + 12(0.14) + 13(0.11) = 4.43 (Thickness = 28")

Medium Traffic Pavement Design Parameters (2,000,000 ESAL):
Local Road
20-year ESAL = 2,000,000
Serviceability Loss = 4.0 - 2.0 = 2.0 PSI
Reliability Factor = 90.9% (nomograph approach)
Overall Standard Deviation = 0.45
Design Frost Depth = 70"
Minimum Design Profile Depth = 28"
Subgrade Resilient Modulus = 2500
Min. SN = 5.45

5" Pavement + 12" Crushed Gravel + 15" Granular Fill:
Design SN = 3(0.44) + 12(0.14) + 15(0.11) = 5.53 (Thickness = 32")

4" Pavement + 15" Crushed Gravel + 15" Granular Fill:
Design SN = 4(0.44) + 15(0.14) + 15(0.11) = 5.51 (Thickness = 34")

3" Pavement + 18" Crushed Gravel + 15" Granular Fill:
Design SN = 3(0.44) + 18(0.14) + 15(0.11) = 5.49 (Thickness = 36")

Heavy Traffic Pavement Design Parameters (20,000,000 ESAL):
Local Road
20-year ESAL = 20,000,000
Serviceability Loss = 4.0 - 2.0 = 2.0 PSI
Reliability Factor = 90.9% (nomograph approach)
Overall Standard Deviation = 0.45
Design Frost Depth = 70"
Minimum Design Profile Depth = 28"
Subgrade Resilient Modulus = 2500
Min. SN = 7.35

6" Pavement + 18" Crushed Gravel + 20" Granular Fill:
Design SN = 6(0.44) + 18(0.14) + 20(0.11) = 7.36 (Thickness = 44")

5" Pavement + 21" Crushed Gravel + 21" Granular Fill:
Design SN = 5(0.44) + 21(0.14) + 21(0.11) = 7.45 (Thickness = 47")

4" Pavement + 24" Crushed Gravel + 21" Granular Fill:
Design SN = 4(0.44) + 24(0.14) + 21(0.11) = 7.43 (Thickness = 49")

APPENDIX G