ALTERNATIVES EVALUATION MEMORANDUM FOR VACANT LOT NORTH OF RADIALL

TO: Mr. Michael Piscitelli/City of New Haven

FROM: Mr. David Arpin/RTG
Mr. Jim Russell/RTG

COPY: Ms. Helen Rosenberg/ City of New Haven
Ms. Dawn Henning/ City of New Haven
Mr. Bill Neale/Radiall New Haven

DATE: December 16, 2016

RE: **Flood Protection Alternative Selection**
Mill River District Shoreline Analysis
City of New Haven
CNH Project No. 15-195-21
RTG Project No. 15103.02

Introduction

RT Group, Inc. (RTG) recently completed a Geotechnical Investigation at the vacant lot located north of Radiall on John Murphy Drive (Figures 1 and 2). The investigation was performed in order to evaluate which of the flood protection alternatives presented in the *Alternatives Evaluation Report* for the Mill River District (RTG, September 6, 2016) would be the most appropriate based on the actual subsurface conditions encountered.

The two (2) alternatives being considered for the subject property include (1) Raising Grade and (2) constructing an Elevated Development. Under the Raising Grade Alternative, granular backfill would be imported to the site in order to raise grade to the Design Flood Elevation (DFE). Under the Elevated Development Alternative, a pile supported foundation would be installed so that the finish floor elevation of the development could be elevated above the DFE.

Purpose and Scope

This Memorandum was prepared to summarize the results of the geotechnical investigation that was performed at the vacant lot located north of radial and provide recommendations with respect to which flood protection alternative (Raising Grade or Elevated Development) would be the most appropriate based on the actual subsurface conditions encountered. Following the selection of an alternative, RTG will prepare 50% Plans for the City's review.

Geotechnical Investigation

Between October 25 and 28, 2016, New England Boring Contractors of Glastonbury, CT completed a total of three (3) soil borings (RTG-SB-1, RTG-OW-2, and RTG-SB-3) (Figure 2). The soil borings were advanced to depths of between about 62 and 122 feet, depending on their location. Bedrock was not encountered in any of the soil borings during the investigation. Following the investigation, RTG prepared soil boring logs which are provided in Appendix A.

A groundwater observation well was installed in soil boring RTG-OW-2 as part of the geotechnical investigation (Figure 2). The well consisted of a 2-inch-diameter slotted Sch. 40 PVC screen installed from about 15 to 25 feet below the existing ground surface. The observation well was topped with a 6-inch-diameter bolting road box installed at grade. Water elevation data is provided in the Observation Well Log included in Appendix B.

Representative soil samples were obtained during the Geotechnical Investigation. Of these samples, three (3) undisturbed Shelby tube samples and five (5) split spoon samples were selected by RTG and submitted to Thielsch Engineering (THIELSCH) of Cranston, Rhode Island for analysis. The laboratory testing performed on the selected samples included the following:

- Moisture Content
- USCS Classification
- Grain Size Analyses
- Atterberg Limits
- Dry Unit Weight Determination
- Pocket Penetrometer
- Torvane
- CIU Shear Strength Testing
- Consolidation Testing

The laboratory testing results are provided in Appendix C and are summarized in Table 1.

Site and Subsurface Conditions

The subject property consists of a relatively flat 1.9 $\pm$ acre lot (Figure 2). The western third of the subject property is clear and grassed. The remainder of the property is vegetated with trees and brush.

The soil boring logs from the Geotechnical Investigation (Appendix A) were simplified and combined to develop an understanding of the general stratigraphy at the subject property. This general stratigraphy, from top to bottom, consists of the following strata (Figure 3):

- Stratum 1 – Fill consisting of Sand and Silt
- Stratum 2 – Organic Elastic Silt
- Stratum 3 - Sand and Silt

Stratum 1 is fill that generally consists of loose to medium dense sand with silt and very stiff to hard sandy silt. This stratum was observed in all of the soil borings completed. It extends from existing grade to a depth of about 10 to 15 feet below the existing ground surface.

Stratum 2 generally consists of very soft organic elastic silt. This stratum was observed in all of the soil borings completed. It is about 15 to 17 feet thick and extends from below Stratum 1 to a depth of about 30 feet below the existing ground surface.

Stratum 3 generally consists of medium dense sand with silt to very stiff sandy silt. This stratum was observed in all of the soil borings completed. It extends from below Stratum 2 to a depth of at least 62 to 122 feet below the existing ground surface (i.e., the depth of the completed soil borings).

Groundwater Conditions

Groundwater was observed to be about 7.5 feet below the existing ground surface in RTG-OW-2 about one week following the completion of the soil borings (i.e., after groundwater had stabilized). Groundwater levels may fluctuate due to season, temperature, local construction activities, and other factors, and could be different at the time of construction.

Flood Protection Alternatives

As mentioned, two (2) flood protection alternatives are being considered for the preparation of 50% Plans. Both alternatives are discussed in more detail below.

Raising Grade

Under this alternative, vegetation would be cleared and existing topsoil stripped from within the limits of the proposed development. Following this work, the subgrade would be compacted and then backfilled with imported granular backfill up to the DFE. For this alternative, it was assumed that the DFE was equal to elevation 15.0 feet (NAVD 88) (12.0 feet Base Flood Elevation + 1.5 feet Sea Level Rise + 1.0 foot Freeboard).

It was assumed that after raising grade to the DFE, the new development would be constructed on the raised grade utilizing conventional spread footings. Following construction, the exposed side slopes would be protected from scour/erosion using riprap. Accordingly, the area of the proposed development would be located entirely above the FEMA Base Flood Elevation (BFE) and would be protected from flooding during the 100-year storm event.

Should this alternative be implemented, compensatory flood storage would need to be provided so that the water holding capacity of the floodplain was not reduced. Given the size of the assumed development (20,000 SF), this storage would need to be provided off-site and would need to be approved by the City.

Elevated Development

Under this alternative, the new development would be designed to provide a Finish Floor Elevation (FFE) equal to or above the DFE. For this alternative, it was assumed that the DFE was equal to elevation 15.0 feet, similar to the Raising Grade Alternative.

It was assumed that the final configuration of the new development would consist of an elevated finish floor supported on a pile foundation system. Accordingly, during the 100-year storm event, flooding would be allowed to occur in the area below the finish floor, but would not extend above the finish floor elevation. As such, the area below the finish floor elevation would be designed to resist erosion and scour from the flooding.

Should this alternative be implemented, compensatory flood storage would need to be provided so that the water holding capacity of the floodplain was not reduced. However, given the minimal size of the theoretical development below the DFE, this storage could potentially be provided on-site and would need to be approved by the City.

Challenges Due to Subsurface Conditions Encountered

Based on the subsurface conditions that were encountered, there will be some challenges associated with the implementation of both alternatives. This is due to the presence of the very soft organic silt layer (Stratum 2) (Figure 3).

Raising Grade

About 6.5 feet of granular fill would need to be imported to the site in order to raise grade to the DFE of 15.0 feet. Based on RTG's preliminary analyses, raising grade will induce about 20 inches of immediate settlement, consolidation settlement, and long-term secondary compression. It is estimated that it would take about 10 months for the consolidation settlement and another 30 years for the secondary compression to occur within the very soft organic silt.

The magnitude of the estimated settlement and its duration would be detrimental to any new buildings that were constructed at this site. To mitigate this issue, an additional surcharge load (i.e., pre-load) would need to be installed at the site to induce the estimated immediate settlement, consolidation settlement, and long-term secondary compression under the proposed fill and building service loads. Based on our preliminary analyses, this would require that grade be raised an additional 6 feet (about 12.5 feet total), and that the surcharge load be stripped and removed from the site after it had induced the required settlement.

The fill and the surcharge loads would need to be placed in lifts in order to minimize the likelihood for a general bearing capacity failure within the very soft organic silt layer. In addition, prefabricated vertical wick drains would need to be installed at about 6 feet on center in order to accelerate the consolidation process and allow the site to be prepared for construction in a reasonable amount of time. The vertical wick drains would be installed about 1 to 2 feet into the sand and silt layer (Stratum 3) and would terminate about 1 foot above existing grade.

A conceptual plan and section of the Raising Grade alternative is presented in Figures 4 and 5.

Elevated Development

Due to the presence of the very soft organic silt layer, about 45 pile supported concrete caps would need to be installed in order to allow the finish floor elevation of the proposed building to be raised above the DFE. Based on RTG's preliminary analyses, HP12x63 piles (or pipe piles) driven about 30 feet ± into the sand and silt layer (Stratum 3) should be sufficient to support the estimated building loads (office use assumed). Assuming 4 piles per concrete pile cap, a total of 180 piles would need to be driven and installed.

The final concrete cap layout and pile lengths will vary based on the actual building configuration, use, and loads. For the purposes of our evaluation, we assumed a maximum vertical column reaction at each concrete pile cap of about 205 tons (un-factored) and a maximum horizontal reaction of 5 tons (un-factored). This results in an allowable vertical design load of about 50 tons and an allowable horizontal design load of 1.25 tons (per pile).

A conceptual plan and section of the Elevated Development alternative is presented in Figures 6 and 7.

Budget-Level Cost Estimates

Budget-level cost estimates (2016 USD) were prepared for each flood protection alternative to help allow an informed decision to be made based on funding limitations/other constraints. The cost estimates include construction as well as design, permitting, bidding phase, and construction phase services (e.g., Submittal Review, Responding to RFI's, and Construction Observation). It should be noted that the estimates have been prepared without the benefit of final plans and specifications.

Based on the above, the cost estimates are considered "order of magnitude" level and include a 25% Scope & Budget Contingency. Final costs are expected to vary from the estimates presented based on actual labor and material costs, competitive market conditions, final agreed to project scope, final implementation schedule, and other variable factors. A breakdown of the budget level costs for each flood protection alternative is presented in Tables D-1 and D-2 of Appendix D. A summary of estimated project costs follows:

- Raising Grade (20,000 SF Development): $ 90/SF
- Elevated Development (20,000 SF Development): $115/SF

The budget-level cost estimates represent the cost for flood proofing only. The cost of the development itself (e.g., buildings, utilities, roads, parking, and site restoration) would be in addition to the budget-level cost estimates presented above.

Alternatives Evaluation

For the purposes of preparing this Memorandum, RTG established six (6) criteria to help rank each alternative. These criteria include (1) Project Cost, (2) Long-Term Building Performance (e.g., potential for additional settlement), (3) Design Life, (4) Constructability, (5) Risk

During Construction, and (6) Permitting Ease. Each of these criteria were ranked on a scale of 1 (least favorable) to 10 (most favorable) and the results are presented in Table 2.

Conclusions and Recommendations

Based on the alternative ranking (Table 2), the Elevated Development Alternative ranks slightly higher than the Raising Grade Alternative, despite it being about $25/SF more expensive to implement, and is the recommended alternative for the vacant lot and for preparing 50% Design Plans.

Tables

Table 1
Laboratory Test Results for Shelby Tube and Split Spoon Soil Samples
Alternatives Evaluation Memorandum
Flood Protection Alternative Selection - Vacant Lot North of Radiall
New Haven, CT

Boring No.	Sample No.	Depth (ft)[1]	Sample Stratum	Soil Description[2]	USCS[3]	w (%)[3]	Atterberg Limits[3]			Sieve (-200) (%)[3]	Hydrometer (-1.5 Microns) (%)[3]	γ_{dry} (pcf)[3]	Pocket Penetrometer Shear Strength, C_u (psf)[3]	Torvane Shear Strength, C_u (psf)[3]	CIU[3]	Consolidation[3]						
							LL	PL	PI						Undrained Shear Strength, C_u (psf)	C_c	C_r	e_o	σ_{vo}' (psf)[4]	σ_p' (psf)	OCR	C_u/σ_p'[5]
RTG-SB-01	ST-2	22-24	ORGANIC ELASTIC SILT	ORGANIC ELASTIC SILT, (OH), dark gray, wet, very soft	OH	77.6	89	44	45	97.7	15.1 (-1.3 microns)	54.2	600	250	See Laboratory Data	0.740	0.1700	1.629	2,246	2,200	NC	0.27
	SS-12	45-47	SAND AND SILT	SILTY SAND, (SM), red-brown, wet, stiff, fine sand	SM	26.7				48.7	3.5											
RTG-OW-02	ST-2	19-21	ORGANIC ELASTIC SILT	ORGANIC ELASTIC SILT, (OH), gray, wet, very soft	OH	66.6	60	35	25	75.4	9.4 (-1.4 microns)	64.2	500	200	See Laboratory Data	0.840	0.1800	2.306	1,901	1,000	NC	0.50
	SS-8	30-32	SAND AND SILT	SILTY SAND, (SM), black, wet, soft, medium to fine sand	SM	33.1				43.5	3.1											
	SS-12	50-52	SAND AND SILT	SILT WITH SAND, (ML), red-brown, wet, very stiff, fine sand	ML	27.3				81.7	4.6											
	SS-24	110-112	SAND AND SILT	SILTY SAND, (SM), red-brown, wet, medium dense, fine to medium sand	SM	19.1				12.9	2.1											
RTG-SB-03	ST-1	17-19	ORGANIC ELASTIC SILT	ORGANIC ELASTIC SILT, (OH), gray, wet, very soft	OH	78.1	74	45	29	88.6	11.8 (-1.4 microns)	53.6	100	150	See Laboratory Data	0.760	0.1700	2.334	1,670	1,200	NC	0.08
	SS-12	45-47	SILT AND SAND	SILT WITH SAND, (ML), red-brown, wet, stiff, fine sand	ML	28.1				82.0	3.4											

Abbreviations:
- LL = Liquid Limit
- PL = Plastic Limit
- PI = Plasticity Index
- NP = Non Plastic
- CIU = Consolidated Isotopically Undrained
- NC = Normally Consolidated Assumed

Symbols:
- w = Water Content
- γ_{dry} = Insitu Dry Density
- C_u = Undrained Shear Strength
- C_c = Compression Index
- C_r = Recompression Index
- e_o = Initial Void Ratio
- σ_{vo}' = Existing Effective Overburden Pressure
- σ_p' = Preconsolidation Pressure
- OCR = Over Consolidation Ratio

Footnotes:
[1]Depth below existing grade.
[2]Soil descriptions are per the soils testing performed by Thielsch Engineering.
[3]Testing results shown are as provided by Thielsch Engineering.
[4]Value shown is the estimated effective vertical stress at the sample interval at the time of the Geotechnical Investigation.
[5]The ratio of C_u/σ_p' was estimated using the pocket penetrometer results, which are considered most representive of the very soft organic silt.

Table 2
Alternative Evaluation Matrix[1]
Alternatives Evaluation Memorandum
Flood Protection Alternative Selection - Vacant Lot North of Radiall
New Haven, CT

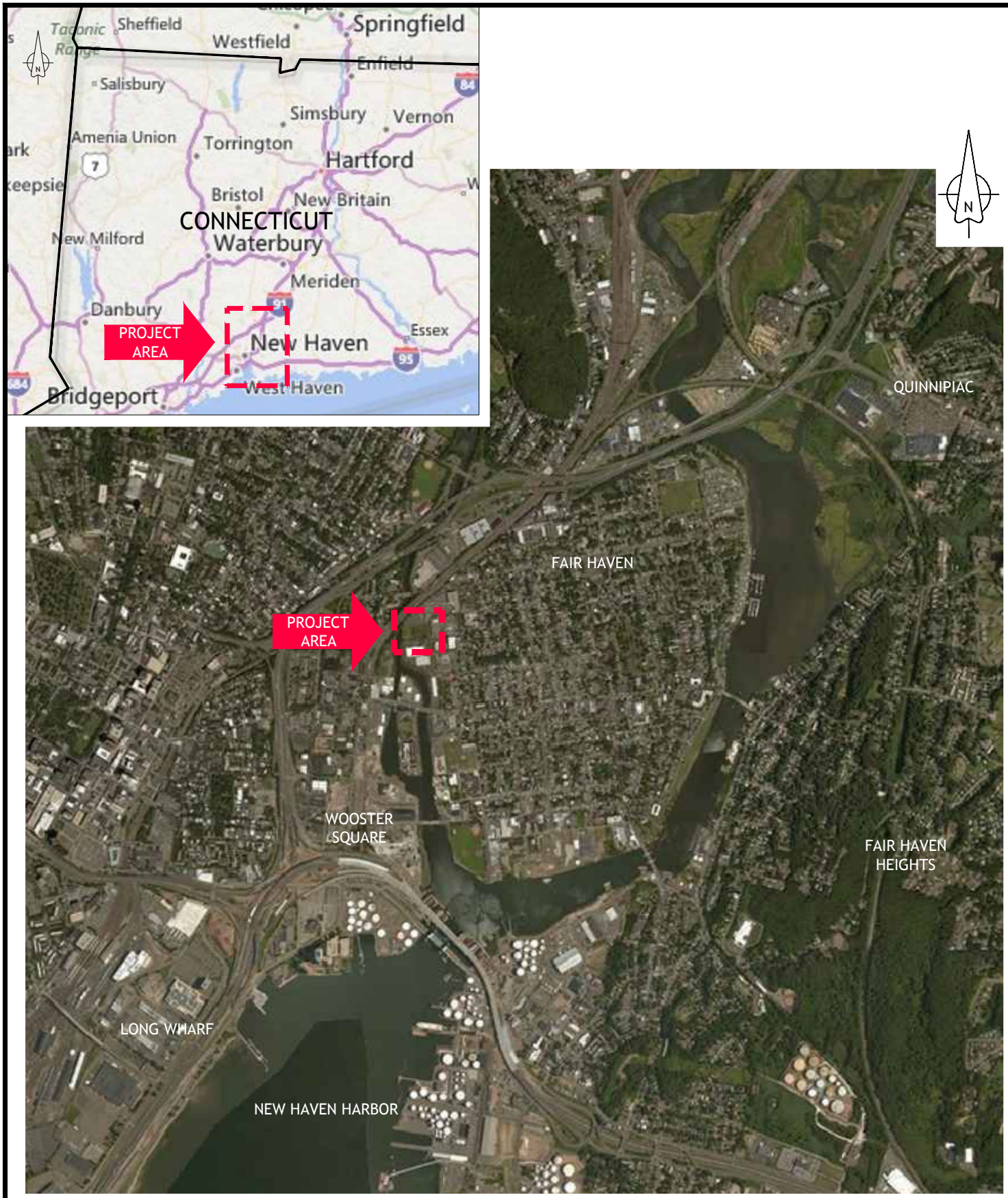
Alternative	Project Cost	Long-Term Building Performance	Design Life	Constructability	Risk During Construction	Permitting Ease	Total Points
Flood Protection Alternatives							
Raising Grade	10	7	10	8	7	7	**49**
Elevated Development	8	9	9	8	9	9	**52**

Footnotes:

[1]Rating: 1-10, least favorable to most favorable.

The above criteria were established by RTG and are considered arbitrary. Prior to final design, these criteria should be reviewed and modified by the Owner as required based on their established success and/or risk factors.

Figures



RT Group, Inc.
Engineered from the Ground Up℠
458 Grand Avenue, Suite 213
New Haven, Connecticut 06513
T 203 823 9932 F 401 294 9806
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ALTERNATIVES EVALUATION
MEMORANDUM-VACANT LOT
NORTH OF RADIALL
Flood Resiliency Improvements
CITY of NEW HAVEN
New Haven, Connecticut

FIGURE 1
VICINITY MAP

SHEET 1 of 7
DATE DEC-2016
PROJ No. 15103.02

NOTES:

1. THE EXISTING TOPOGRAPHIC AND BATHYMETRIC INFORMATION SHOWN ON THESE FIGURES IS IN REFERENCE TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).

2. THE EXISTING TOPOGRAPHIC DATA SHOWN ON THESE FIGURES WAS OBTAINED FROM THE 2011 FEMA LIDAR FLOOD PLAIN MAPPING SURVEY PERFORMED AT THE QUINNIPIAC RIVER WATERSHED (CT). THIS DATA WAS SUPPLEMENTED WITH DATA OBTAINED FROM A FIELD SURVEY PERFORMED BY RTG BETWEEN DECEMBER 2015 AND MARCH 2016 AND A FOLLOW-UP SURVEY OF THE VACANT LOT PERFORMED BY RTG ON NOVEMBER 17, 2016.

3. THE EXISTING BATHYMETRIC DATA SHOWN ON THESE FIGURES WAS OBTAINED DURING THE RTG FIELD SURVEY.

4. THE RTG FIELD SURVEY WAS PERFORMED TO HELP DEVELOP THE PROJECT SITE PLAN AND WAS NOT PERFORMED TO ESTABLISH/ VERIFY PROPERTY LINES/ BOUNDARIES.

	ABOVE MLW	NAVD 88
MHHW	7.09	3.49
MHW	6.75	3.15
NAVD '88	3.60	0.00
MSL	3.38	-0.22
MLW	0.00	-3.60
MLLW	-0.24	-3.84

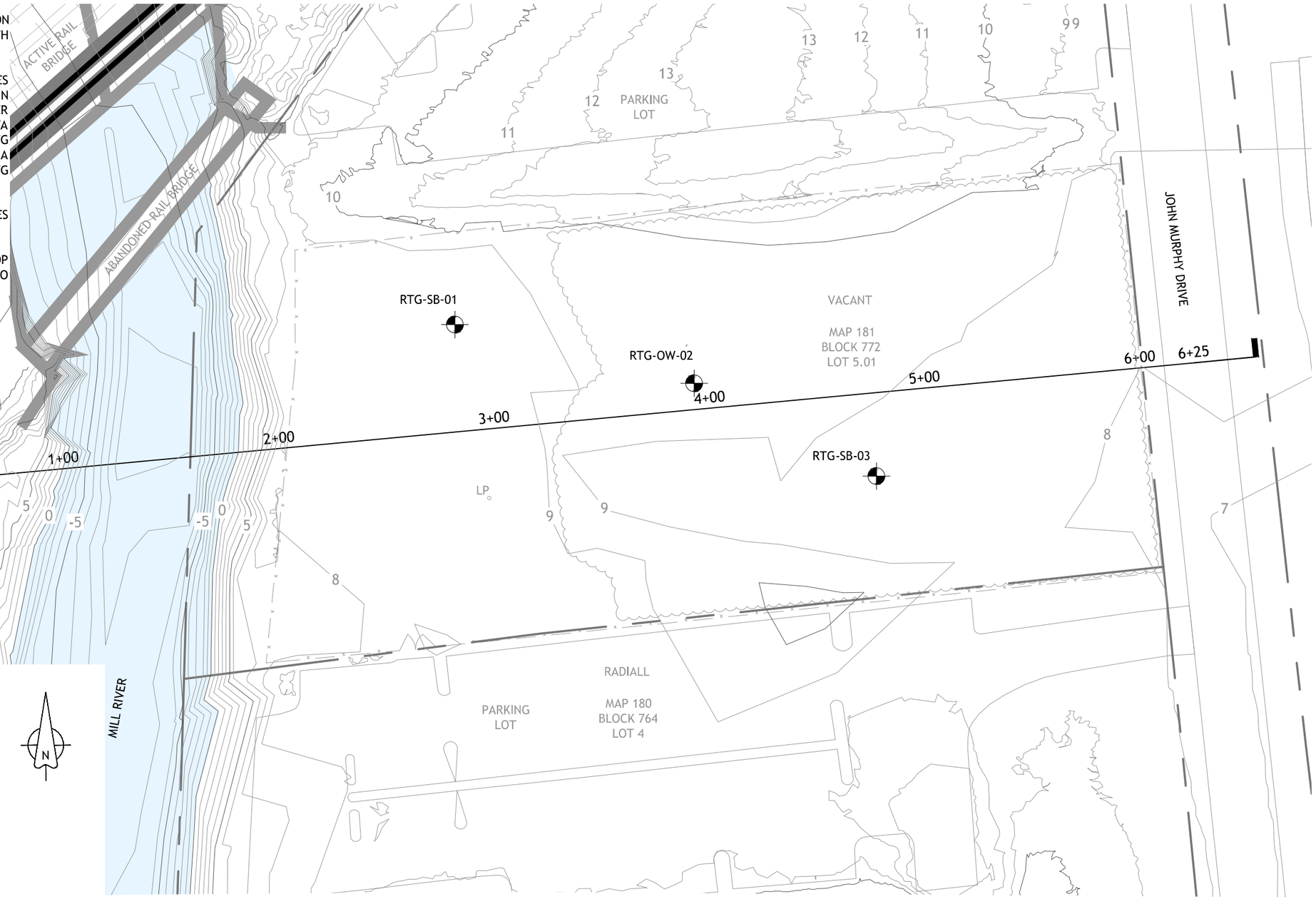
VERTICAL DATUM CONVERSION DIAGRAM

A
Fig 3

THE ABOVE TIDAL AND DATUM ELEVATION DATA WAS TAKEN FROM THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DATABASE FOR THE FOLLOWING STATION:
STATION ID: *8467150*
LOCATION: BRIDGEPORT, CONNECTICUT
LATITUDE: *41°10.4' N*
LONGITUDE: *073°10.9' W*

LEGEND:

- 5 — EXISTING CONTOUR
- EXISTING PROPERTY LINE
- EXISTING EDGE OF PAVEMENT
- x — EXISTING FENCE
- EXISTING EDGE OF VEGETATION
- EXISTING STRUCTURE
- RIVER EXTENTS AT EL. 0 (NAVD 88)
- RTG-SB-01 — DENOTES APPROXIMATE LOCATION OF SOIL BORING PERFORMED BY NEW ENGLAND BORING CONTRACTORS, INC. FOR RTG (OCTOBER 25 THROUGH OCTOBER 28, 2016)
- LP — EXISTING LIGHT POLE



EXISTING SITE PLAN
SCALE: 1"=50'

Graphic Scale 1"=50'
50' 25' 0 50' 100'

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MEMORANDUM-VACANT LOT
NORTH OF RADIALL
Flood Resiliency Improvements
CITY of NEW HAVEN
New Haven, Connecticut

FIGURE 2
EXISTING SITE PLAN

SHEET 2 of 7
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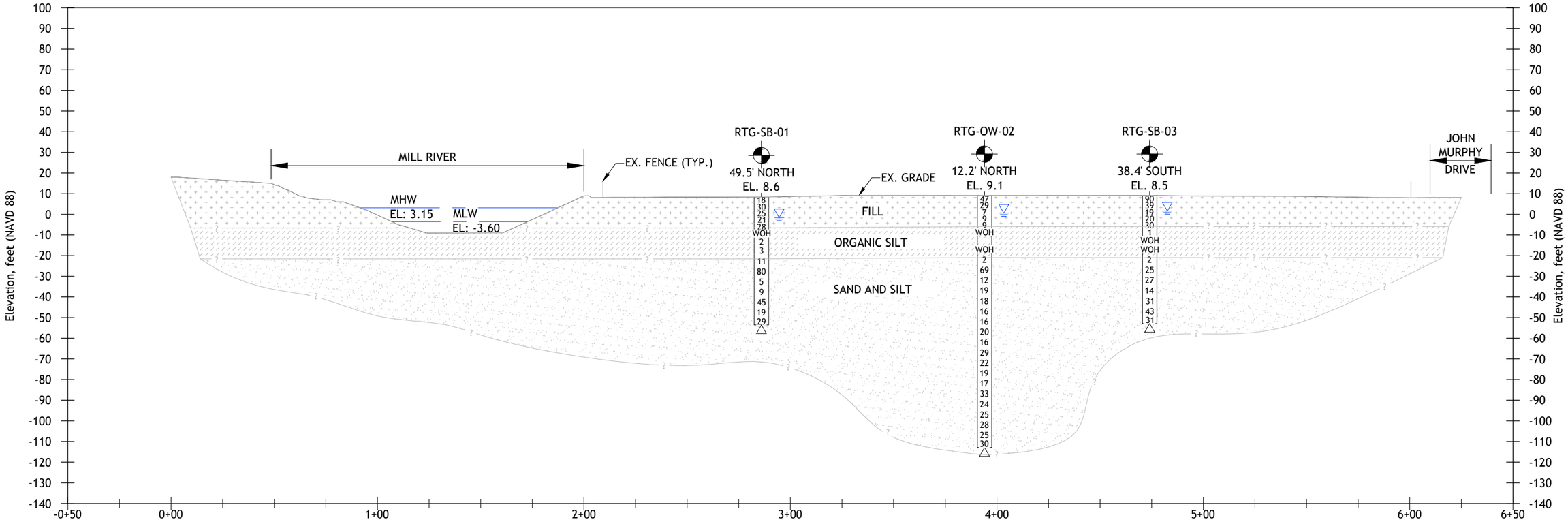

LEGEND:

RTG-SB-01 — DENOTES APPROXIMATE LOCATION OF SOIL BORING PERFORMED BY NEW ENGLAND BORING CONTRACTORS, INC. FOR RTG (OCTOBER 25 THROUGH OCTOBER 28, 2016)

BOTTOM OF SOIL BORING

15 — STANDARD PENETRATION NUMBER ("N" VALUE)

APPROXIMATE GROUNDWATER

FILL

ORGANIC SILT

SAND AND SILT

? — THE ACTUAL HORIZONTAL AND VERTICAL LIMITS MAY VARY

SECTION A / Fig 2
SCALE: 1"=50'

Graphic Scale 1"=50'
50' 25' 0 50' 100'

NOTES:

1. SOIL BORING LOCATION AND ELEVATION DATA ARE AS SURVEYED BY RTG ON NOVEMBER 8, 2016.
2. THE DEPTH AND THICKNESS OF THE SUBSURFACE STRATA INDICATED ON THE SECTIONS WERE GENERALIZED FROM AND INTERPOLATED BETWEEN SOIL BORINGS. INFORMATION ON ACTUAL SUBSURFACE CONDITIONS EXISTS ONLY AT THE SPECIFIC LOCATION AND ON THE DATES INDICATED. SOIL AND ROCK CONDITIONS, AND WATER LEVELS AT OTHER LOCATIONS MAY DIFFER FROM CONDITIONS OCCURRING AT THE BORING LOCATIONS. ALSO THE PASSAGE OF TIME MAY RESULT IN A CHANGE IN THE CONDITIONS AT THE SOIL BORING LOCATIONS.

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FIGURE 3
EXISTING SUBSURFACE CONDITIONS

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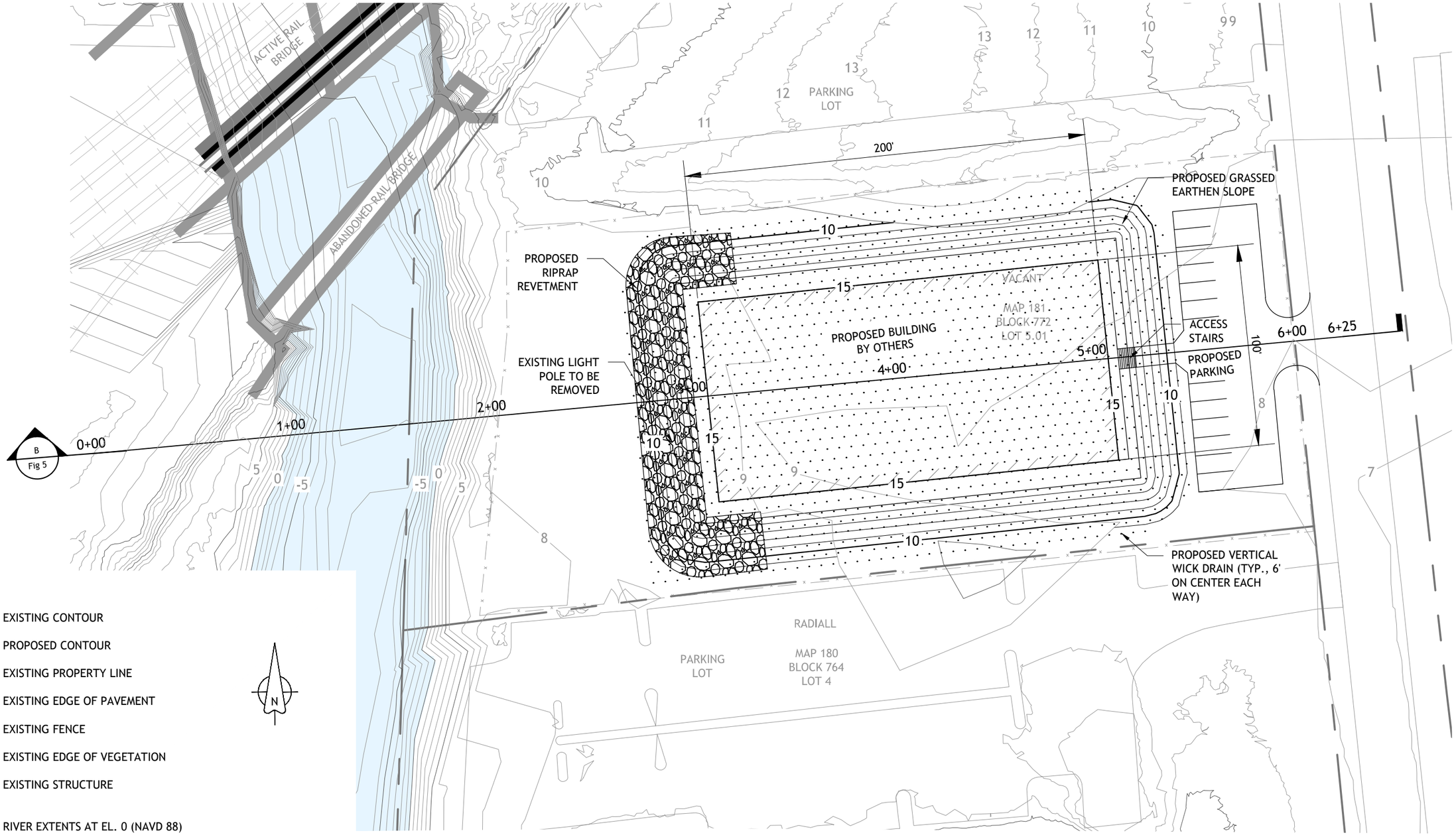

LEGEND:

- EXISTING CONTOUR
- PROPOSED CONTOUR
- EXISTING PROPERTY LINE
- EXISTING EDGE OF PAVEMENT
- EXISTING FENCE
- EXISTING EDGE OF VEGETATION
- EXISTING STRUCTURE
- RIVER EXTENTS AT EL. 0 (NAVD 88)
- EXISTING LIGHT POLE
- PROPOSED VERTICAL WICK DRAIN
- PROPOSED RIPRAP

RAISING GRADE SITE PLAN

SCALE: 1"=50'

Graphic Scale 1"=50'

50' 25' 0 50' 100'

COMPENSATORY FLOOD PLAIN STORAGE NOTE:

1. IT IS ASSUMED THAT COMPENSATORY FLOOD PLAIN STORAGE WOULD BE DEVELOPED OFF SITE WITH A CAPACITY OF 7,700 CY±.

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New Haven, Connecticut 06513
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FIGURE 4
RAISING GRADE SITE PLAN

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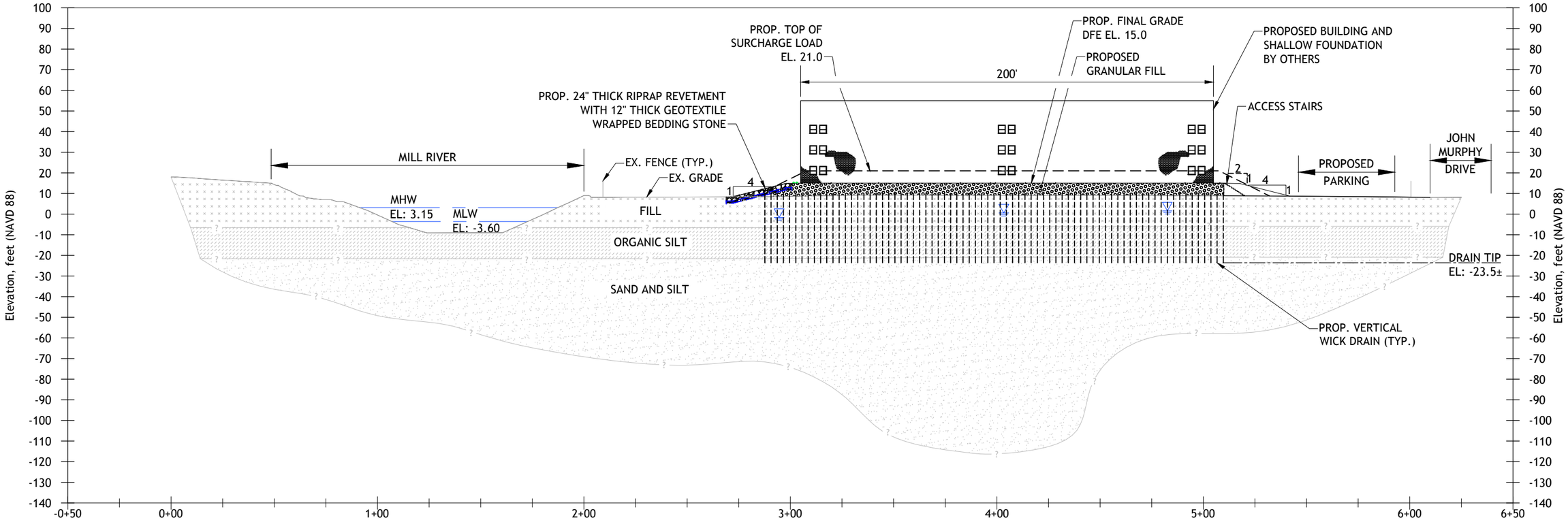

LEGEND:

- APPROXIMATE GROUNDWATER
- FILL
- ORGANIC SILT
- SAND AND SILT
- THE ACTUAL HORIZONTAL AND VERTICAL LIMITS MAY VARY
- PROPOSED RIPRAP
- PROPOSED GRANULAR FILL

SECTION B (Fig 4)
SCALE: 1"=50'

Graphic Scale 1"=50'
50' 25' 0 50' 100'

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New Haven, Connecticut 06513
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FIGURE 5
RAISING GRADE SECTION

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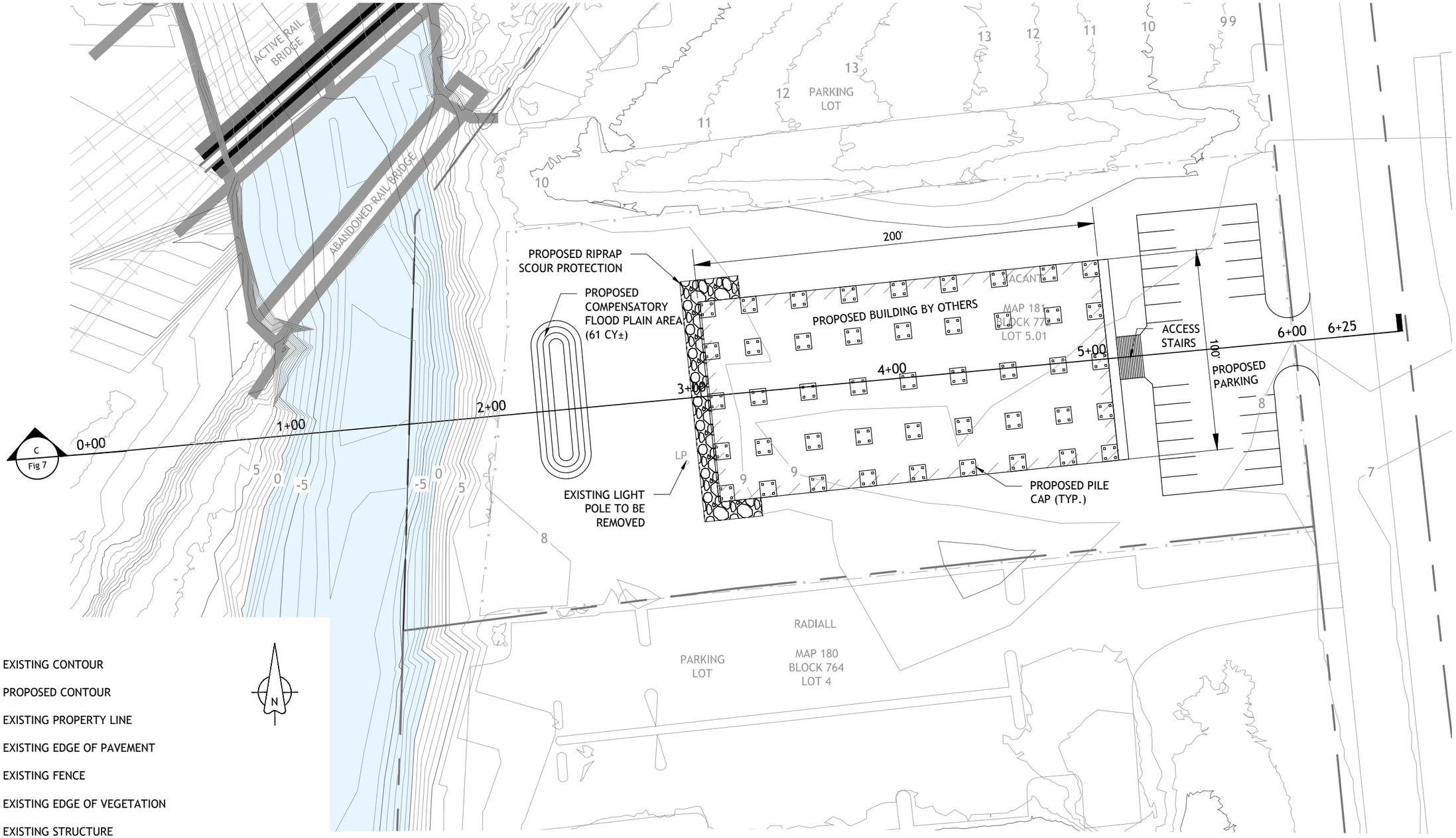

LEGEND:

- EXISTING CONTOUR
- PROPOSED CONTOUR
- EXISTING PROPERTY LINE
- EXISTING EDGE OF PAVEMENT
- EXISTING FENCE
- EXISTING EDGE OF VEGETATION
- EXISTING STRUCTURE
- RIVER EXTENTS AT EL. 0 (NAVD 88)
- EXISTING LIGHT POLE
- PROPOSED RIPRAP
- PROPOSED PILE CAP

ELEVATED STRUCTURE SITE PLAN

SCALE: 1"=50'

Graphic Scale 1"=50'

50' 25' 0 50' 100'

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Engineered from the Ground Up℠
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FIGURE 6
ELEVATED STRUCTURE SITE PLAN

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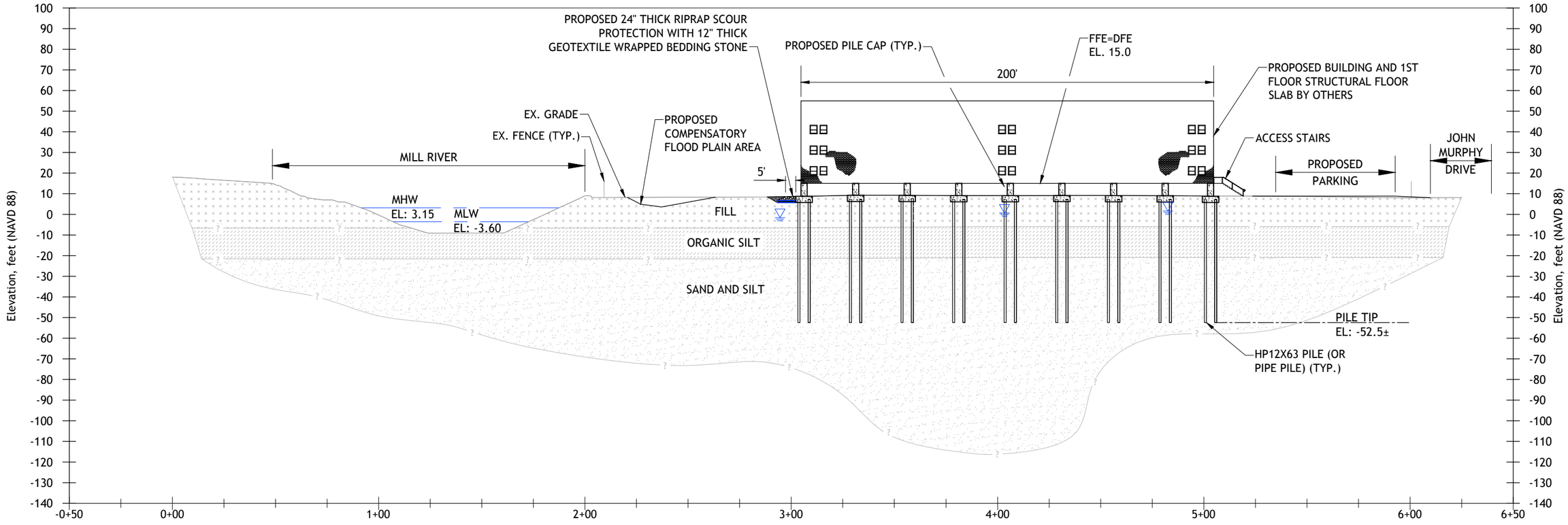

LEGEND:

- APPROXIMATE GROUNDWATER
- FILL
- ORGANIC SILT
- SAND AND SILT
- THE ACTUAL HORIZONTAL AND VERTICAL LIMITS MAY VARY
- PROPOSED RIPRAP

SECTION C
SCALE: 1"=50'
Fig 6

Graphic Scale 1"=50'
50' 25' 0 50' 100'

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FIGURE 7
PROPOSED ELEVATED STRUCTURE SECTION

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Appendix A
Geotechnical Investigation Soil Boring Logs

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SOIL BORING LOG

BORING NUMBER: RTG-SB-01
DATE(S): 10/28/2016
PROJECT NUMBER: 15103.02

PROJECT: Mill River District Flood Resiliency Improvements
LOCATION: NW corner of lot north of 104 Murphy Dr. New Haven, CT
ELEVATION: 8.63 ft (NAVD 88)
DRILLING CONTRACTOR: New England Boring Contractors
DRILLING METHOD AND EQUIPMENT: Rotary Wash and Driven Casing with Truck Mounted "Mobile Drill" Rig
WATER LEVEL AND DATE: 10' at 1:00 PM, 10/28/2016
START: 8:00 AM, 10/28/2016 **FINISH:**11:45 AM, 10/28/2016 **LOGGER:** T. Alpaio

DEPTH BELOW SURFACE (FT)	INTERVAL	TYPE AND NUMBER	RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"- 6"- 6"- 6"	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0.0						Begin drilling at 8:00 AM
	0-2	SS-1	1.2	12-10-8-24	SANDY SILT WITH GRAVEL, (ML), brown, dry, very stiff	
	2-4	SS-2	1.1	14-16-14-13	SANDY SILT, (ML), red-brown, dry, very stiff	Fractured rock present
5.0	4-6	SS-3	1.8	15-17-8-6	SANDY SILT, (ML), black, moist, very stiff	
	6-8	SS-4	1.2	12-11-10-3	SILTY SAND, (SM), gray-black, wet, medium dense, fine to coarse grained	
	8-10	SS-5	1.5	5-6-22-37	SILTY SAND, (SM), gray-black, wet, medium dense, fine grained	Organics present (shells)
10.0						
15.0						Casing driven to 15'
	15-17	SS-6	0.2	W.O.H.	ORGANIC ELASTIC SILT, (OH), gray, wet, very soft	
	17-19	ST-1	2.3	Shelby Tube	ORGANIC ELASTIC SILT, (OH), dark gray, wet	Organics present (wood and shells)
20.0						
	20-22	SS-7	2.0	1-1-1-1	ORGANIC ELASTIC SILT, (OH), gray, wet, very soft	Organics present (wood and shells)
	22-24	ST-2	2.3	Shelby Tube	ORGANIC ELASTIC SILT, (OH), dark gray, wet	
25.0						
	25-27	SS-8	2.0	1-1-2-2	ORGANIC ELASTIC SILT, (OH), gray, wet, very soft	Organics present (wood and shells)
30.0						
	30-32	SS-9	1.3	7-6-5-24	WELL GRADED SAND WITH SILT, (SW-SM), red-gray, wet, medium dense	Rounded gravel in tip
35.0						Casing driven to 35'
	35-37	SS-10	2.0	18-44-36-73	WELL GRADED SAND WITH SILT AND GRAVEL, (SW-SM), red-brown, wet, very dense	
40.0						

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SOIL BORING LOG

BORING NUMBER: RTG-SB-01
DATE(S): 10/28/2016
PROJECT NUMBER: 15103.02

PROJECT: Mill River District Flood Resiliency Improvements
LOCATION: NW corner of lot north of 104 Murphy Dr. New Haven, CT
ELEVATION: 8.63 ft (NAVD 88)
DRILLING CONTRACTOR: New England Boring Contractors
DRILLING METHOD AND EQUIPMENT: Rotary Wash and Driven Casing with Truck Mounted "Mobile Drill" Rig
WATER LEVEL AND DATE: 10' at 1:00 PM, 10/28/2016
START: 8:00 AM, 10/28/2016 **FINISH:**11:45 AM, 10/28/2016 **LOGGER:** T. Alpaio

DEPTH BELOW SURFACE (FT)	INTERVAL	TYPE AND NUMBER	RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"- 6"- 6"- 6"	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
40.0						Casing driven to 40'
	40-42	SS-11	1.4	2-2-3-4	SILTY SAND, (SM), red-brown, wet, loose, fine grained	
45.0						Casing driven to 45'
	45-47	SS-12	1.7	5-4-5-7	SILTY SAND, (SM), red-brown, wet, loose, fine grained	
50.0						Casing driven to 50'
	50-52	SS-13	1.4	13-20-25-22	POORLY GRADED SAND, (SP), red, wet, dense, fine grained	
55.0						Casing driven to 55'
	55-57	SS-14	2.0	8-8-11-12	SILT WITH SAND, (ML), red, wet, very stiff	
60.0						Casing driven to 60'
	60-62	SS-15	1.9	8-12-17-16	SILTY SAND, (SM), red, wet, medium dense, fine grained	
65.0					END BORING AT 62 FEET.	End drilling at 11:45 AM. Boring backfilled with bentonite chips.
70.0						
75.0						
80.0						

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SOIL BORING LOG

BORING NUMBER: RTG-OW-02
DATE(S): 10/25/16-10/27/16
PROJECT NUMBER: 15103.02

PROJECT: Mill River District Flood Resiliency Improvements | **LOCATION:** Center of lot north of 104 Murphy Dr. New Haven, CT

ELEVATION: 9.10' (NAVD 88) | **DRILLING CONTRACTOR:** New England Boring Contractors

DRILLING METHOD AND EQUIPMENT: Rotary Wash and Driven Casing with Truck Mounted "Mobile Drill" Rig

WATER LEVEL AND DATE: 8.5' at 10:00 AM, 10/26/16 | **START:** 1:00 PM, 10/25/16 | **FINISH:** 11:45 AM, 10/27/16 | **LOGGER:** T. Alpaio

DEPTH BELOW SURFACE (FT)	INTERVAL	TYPE AND NUMBER	RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"- 6"- 6"- 6"	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0.0						Begin drilling at 1:00 PM.
	0-2	SS-1	1.4	9-17-30-67	SANDY SILT, (ML), red-brown, dry, hard	
	2-4	SS-2	1.0	10-10-19-7	SANDY SILT, (ML), red-brown, dry, very stiff	
5.0	4-6	SS-3	1.1	9-4-3-15	SANDY SILT, (ML), black-brown, dry, firm	Red fractured rock in tip
	6-8	SS-4	0.7	9-5-4-5	POORLY GRADED SAND WITH SILT AND GRAVEL, (SP-SM), black-red, dry, loose, fine to medium grained	
10.0	8-10	SS-5	1.2	3-5-4-3	SILT WITH SAND AND GRAVEL, (ML), black, wet, stiff	
15.0						Casing driven to 15'
	15-17	SS-6	2.0	W.O.H.	ORGANIC ELASTIC SILT, (OH), gray, wet, very soft	
	17-19	ST-1	1.8	Shelby Tube	ORGANIC ELASTIC SILT, (OH), dark gray, wet	
20.0	19-21	ST-2	2.3	Shelby Tube	ORGANIC ELASTIC SILT, (OH), dark gray, wet	
	21-23	ST-3	2.3	Shelby Tube	ORGANIC ELASTIC SILT, (OH), dark gray, wet	
25.0						
	25-27	SS-7	2.0	W.O.H.	ORGANIC ELASTIC SILT, (OH), gray, wet, very soft	Organics present (shells), sulfer odor
30.0						
	30-32	SS-8	1.8	1-1-1-1	SILTY SAND, (SM), black, wet, very loose, fine grained	Organics present (shells), sulfur odor
35.0						
	35-37	SS-9	1.0	26-40-29-20	WELL GRADED SAND WITH SILT AND GRAVEL, (SW-SM), gray-brown, wet, very dense	Drilling fluid loss
40.0						

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SOIL BORING LOG

BORING NUMBER: RTG-OW-02
DATE(S): 10/25/16-10/27/16
PROJECT NUMBER: 15103.02

PROJECT: Mill River District Flood Resiliency Improvements | **LOCATION:** Center of lot north of 104 Murphy Dr. New Haven, CT

ELEVATION: 9.10' (NAVD 88) | **DRILLING CONTRACTOR:** New England Boring Contractors

DRILLING METHOD AND EQUIPMENT: Rotary Wash and Driven Casing with Truck Mounted "Mobile Drill" Rig

WATER LEVEL AND DATE: 8.5' at 10:00 AM, 10/26/16 | **START:** 1:00 PM, 10/25/16 | **FINISH:** 11:45 AM, 10/27/16 | **LOGGER:** T. Alpaio

DEPTH BELOW SURFACE (FT)	INTERVAL	TYPE AND NUMBER	RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"- 6"- 6"- 6"	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
40.0						Casing driven to 40'
	40-42	SS-10	1.5	5-5-7-8	SANDY SILT, (ML), red-brown, wet, stiff	
45.0						Casing driven to 45'
	45-47	SS-11	1.8	6-6-13-30	SANDY SILT, (ML), red-brown, wet, very stiff	
50.0						Casing driven to 50'
	50-52	SS-12	1.5	7-9-9-12	SILT WITH SAND, (ML), red-brown, wet, very stiff	
55.0						Casing driven to 55'
	55-57	SS-13	2.0	6-7-9-15	SILT, (ML), brown, wet, very stiff	
60.0						Casing driven to 60'
	60-62	SS-14	2.0	5-6-10-16	SILT WITH SAND, (ML), brown, wet, very stiff	
65.0						Casing driven to 65'
	65-67	SS-15	1.7	5-8-12-13	POORLY GRADED SAND WITH SILT, (SP-SM), brown, wet, medium dense, fine grained	
70.0						Casing driven to 70'
	70-72	SS-16	2.0	4-6-10-18	SILTY SAND, (SM), red, wet, medium dense, fine grained	
75.0						Casing driven to 75'
	75-77	SS-17	1.2	9-11-18-20	SILTY SAND, (SM), brown, wet, medium dense, fine grained	
80.0						

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SOIL BORING LOG

BORING NUMBER: RTG-OW-02
DATE(S): 10/25/16-10/27/16
PROJECT NUMBER: 15103.02

PROJECT: Mill River District Flood Resiliency Improvements
LOCATION: Center of lot north of 104 Murphy Dr. New Haven, CT
ELEVATION: 9.10' (NAVD 88)
DRILLING CONTRACTOR: New England Boring Contractors
DRILLING METHOD AND EQUIPMENT: Rotary Wash and Driven Casing with Truck Mounted "Mobile Drill" Rig
WATER LEVEL AND DATE: 8.5' at 10:00 AM, 10/26/16
START: 1:00 PM, 10/25/16
FINISH: 11:45 AM, 10/27/16
LOGGER: T. Alpaio

DEPTH BELOW SURFACE (FT)	INTERVAL	TYPE AND NUMBER	RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"- 6"- 6"- 6"	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
80.0						Casing driven to 80'
	80-82	SS-18	0.0	6-8-14-16	No Recovery	Trace of soil in tip
85.0						Casing driven to 85'
	85-87	SS-19	1.1	4-7-12-20	POORLY GRADED SAND, (SP), brown, wet, medium dense, fine to medium grained	
90.0						Casing driven to 90'
	90-92	SS-20	0.8	6-7-10-12	POORLY GRADED SAND, (SP), brown, wet, medium dense, fine to medium grained	
95.0						Casing driven to 95'
	95-97	SS-21	1.3	12-14-19-20	WELL GRADED SAND, (SW), brown, wet, dense	
100.0						Casing driven to 100'
	100-102	SS-22	2.0	6-9-15-22	WELL GRADED SAND, (SW), red, wet, medium dense	
105.0						Casing driven to 105'
	105-107	SS-23	2.0	5-8-17-17	WELL GRADED SAND, (SW), red, wet, medium dense	
110.0						Casing driven to 110'
	110-112	SS-24	2.0	9-12-16-22	SILTY SAND, (SM), red-brown, wet, medium dense, fine to medium grained	Top 18"
					SANDY SILT, (ML), red, wet, very stiff	Bottom 6"
115.0						Casing driven to 115'
	115-117	SS-25	1.8	7-9-16-25	SILT, (ML), brown, wet, very stiff	
120.0						

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SOIL BORING LOG

BORING NUMBER: RTG-OW-02
DATE(S): 10/25/16-10/27/16
PROJECT NUMBER: 15103.02

PROJECT: Mill River District Flood Resiliency Improvements
LOCATION: Center of lot north of 104 Murphy Dr. New Haven, CT
ELEVATION: 9.10' (NAVD 88)
DRILLING CONTRACTOR: New England Boring Contractors
DRILLING METHOD AND EQUIPMENT: Rotary Wash and Driven Casing with Truck Mounted "Mobile Drill" Rig
WATER LEVEL AND DATE: 8.5' at 10:00 AM, 10/26/16
START: 1:00 PM, 10/25/16
FINISH: 11:45 AM, 10/27/16
LOGGER: T. Alpaio

DEPTH BELOW SURFACE (FT)	INTERVAL	TYPE AND NUMBER	RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"- 6"- 6"- 6"	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
120.0						Casing driven to 118'
	120-122	SS-26	2.0	7-13-17-28	POORLY GRADED SAND, (SP), red, wet, medium dense, fine grained	
					END SOIL BORING AT 122 FEET.	End drilling at 11:30 AM, 10/27/16. Boring backfilled with bentonite chips from 122 feet to 27 feet. 25-foot-long Observation Well installed, comprised of 2-inch diameter, 0.01" slot size PVC screen in the lower 10 feet, and 2-inch diameter PVC casing for the upper 15 feet. A Holliston 00N sand filter pack was installed around the well to 4 feet, followed by bentonite chips to 2 feet. The well was topped by a 6-inch-diameter bolting road box installed at grade, set in a 2-foot-thick concrete collar.
125.0						
130.0						
135.0						
140.0						
145.0						
150.0						
155.0						
160.0						

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SOIL BORING LOG

BORING NUMBER: RTG-SB-03
DATE(S): 10/25/2016
PROJECT NUMBER: 15103.02

PROJECT: Mill River District Flood Resiliency Improvements | **LOCATION:** SE corner of lot north of 104 Murphy Dr. New Haven, CT

ELEVATION: 8.54' (NAVD 88) | **DRILLING CONTRACTOR:** New England Boring Contractors

DRILLING METHOD AND EQUIPMENT: Rotary Wash and Driven Casing with Truck Mounted "Mobile Drill" Rig

WATER LEVEL AND DATE: 7.5 feet at 8:30 AM, 10/25/16 | **START:** 8:00 AM, 10/28/16 | **FINISH:** 1:00 PM, 10/25/16 | **LOGGER:** T. Alpaio

DEPTH BELOW SURFACE (FT)	INTERVAL	TYPE AND NUMBER	RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"- 6"- 6"- 6"	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0.0						Begin drilling at 8:00 AM
	0-1.5	SS-1	1.5	13-30-60	SANDY SILT, (ML), brown, dry, hard	Fractured rock present
	2-4	SS-2	1.4	7-23-16-10	SANDY SILT WITH GRAVEL, (ML), brown, dry, hard	Glass throughout lower 6"
5.0	4-6	SS-3	0.9	11-10-9-7	SANDY SILT WITH GRAVEL, (ML), brown, dry, very stiff	
	6-8	SS-4	1.3	9-5-15-19	SILTY SAND WITH GRAVEL, (SM), brown, moist, medium dense, fine to coarse grained	Petroleum odor
10.0	8-10	SS-5	1.5	10-9-21-20	SILTY SAND, (SM), black, wet, medium dense, fine to coarse grained	Petroleum odor
15.0						Casing driven to 15'
	15-17	SS-6	1.7	1-1-W.O.H.	ORGANIC ELASTIC SILT, (OH), gray, wet, very soft	Organics present (shells)
	17-19	ST-1	2.0	Shelby Tube	ORGANIC ELASTIC SILT, (OH), dark gray, wet	
20.0						
	20-22	SS-7	1.5	W.O.H.	ORGANIC ELASTIC SILT, (OH), gray, wet, very soft	Organics present (shells)
25.0						
	25-27	SS-8	1.7	W.O.H.	ORGANIC ELASTIC SILT, (OH), gray, wet, very soft	wood present
30.0						
	30-32	SS-9	1.2	W.O.H.-W.O.H.-2-1	SANDY SILT, (ML), gray, wet, very soft	
35.0						
	35-37	SS-10	1.2	4-11-14-18	SANDY SILT, (ML), gray, wet, very stiff	Top 9"
40.0					SILTY SAND WITH GRAVEL, (SM), gray-brown, wet, medium dense, fine to coarse grained	Bottom 5"

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SOIL BORING LOG

BORING NUMBER: RTG-SB-03
DATE(S): 10/25/2016
PROJECT NUMBER: 15103.02

PROJECT: Mill River District Flood Resiliency Improvements
LOCATION: SE corner of lot north of 104 Murphy Dr. New Haven, CT
ELEVATION: 8.54' (NAVD 88)
DRILLING CONTRACTOR: New England Boring Contractors
DRILLING METHOD AND EQUIPMENT: Rotary Wash and Driven Casing with Truck Mounted "Mobile Drill" Rig
WATER LEVEL AND DATE: 7.5 feet at 8:30 AM, 10/25/16
START: 8:00 AM, 10/28/16
FINISH: 1:00 PM, 10/25/16
LOGGER: T. Alpaio

DEPTH BELOW SURFACE (FT)	INTERVAL	TYPE AND NUMBER	RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"- 6"- 6"- 6"	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
40.0						Casing driven to 40'
	40-42	SS-11	0.5	14-17-10-12	WELL GRADED GRAVEL WITH SAND, (GW), red-brown, wet, medium dense	
45.0						Casing driven to 45'
	45-47	SS-12	1.6	5-7-7-9	SILT WITH SAND, (ML), red-brown, wet, stiff	
50.0						Casing driven to 50'
	50-52	SS-13	1.7	11-14-17-19	SILT WITH SAND, (ML), red-brown, wet, hard	
55.0						Casing driven to 55'
	55-57	SS-14	1.8	10-20-23-25	SILTY SAND, (SM), red-brown, wet, dense, fine grained	
60.0						Casing driven to 60'
	60-62	SS-15	1.7	10-15-16-22	SILT WITH SAND, (ML), red-brown, wet, hard	
65.0					END BORING AT 62 FEET.	End drilling at 1:00 PM. Boring backfilled with Portland cement grout.
70.0						
75.0						
80.0						

Appendix B
Observation Well Log

Observation Well Log
Alternatives Evaluation Memorandum
Flood Protection Alternative Selection - Vacant Lot North of Radiall
New Haven, CT

Date	RTG-OW-2		Notes
	Depth (ft)	Elevation (ft)	
November 8, 2016	7.50	1.60	

Footnotes:

For reference, the top of the road box is at El. 9.10 feet (NAVD 88).

Depth measured from the top of road box.

Appendix C
Laboratory Test Results

THIELSCH ENGINEERING
195 Frances Avenue
Cranston RI, 02910
Phone: (401)-467-6454
Fax: (401)-467-2398
http://www.thielsch.com

Client Information:
RT Group
70 Romano Vineyard Way #134
North Kingstown, RI 02852
PM: David Arpin, P.E.
Assigned By: D. Arpin

Laboratory Information
Mill River District
Flood Resiliency Improvements
New Haven, CT
TEI Project Number: 74-16-0002.09
Report Date: 12.5.16

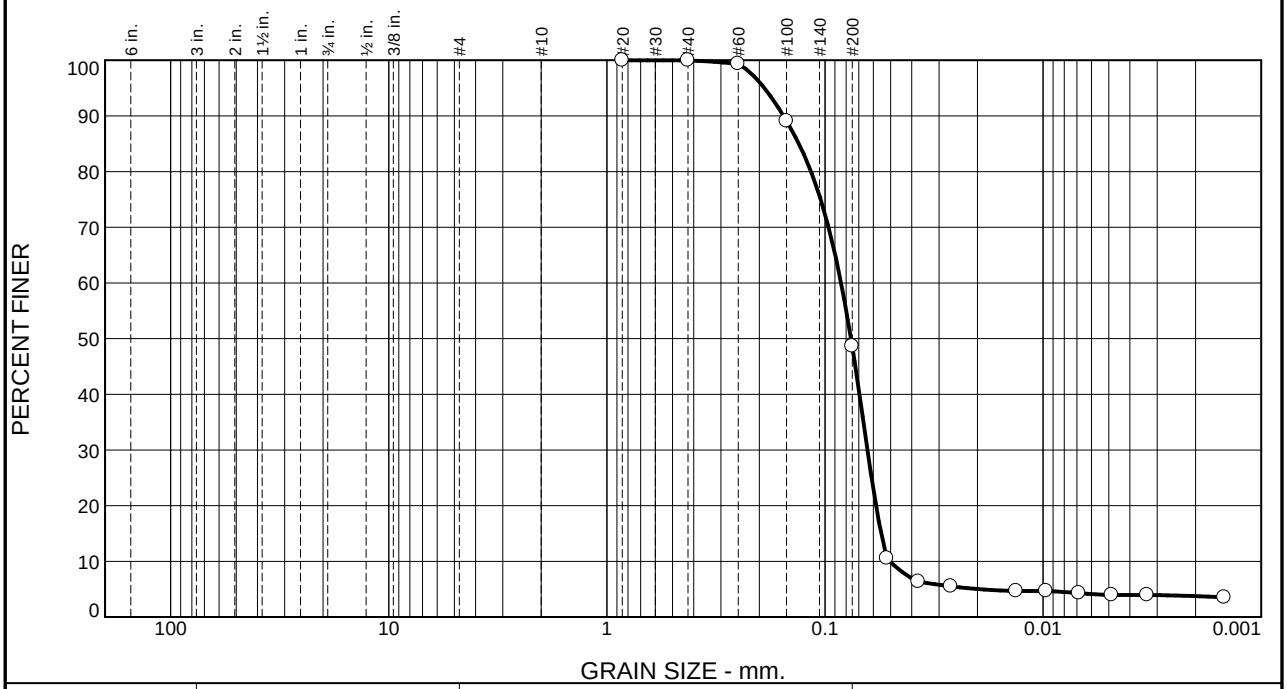
LABORATORY TESTING DATA SHEET

Boring No.	Sample No.	Depth (ft)	Laboratory No.	Identification Tests								Corrosivity Suite					
				Water Content %	LL %	PL %	Gravel %	Sand %	Silt %	Clay %	G_s	As Received Resistance (Mohm-cm)	Sulfide (ppm)	Eh (ORP) (mV)	Sulfate (ppm)	Chloride (ppm)	Laboratory Log and Soil Description
RTG-SB-01	ST-2	22-24	16-S-1567														See Tube Summary Sheet
	SS-12	45-47	16-S-1568	26.7			0.0	51.3	44.7	4.0							Red-Brown silty sand (SM)
RTG-OW-02	ST-2	19-21	16-S-1569														See Tube Summary Sheet
	SS-8	30-32	16-S-1570	33.1			1.3	55.2	38.9	4.6							Black silty sand (SM)
	SS-12	50-52	16-S-1571	27.3			0.0	18.3	76.4	5.3							Red-Brown silt with sand (ML)
	SS-24	110-112	16-S-1572	19.1			0.2	86.9	10.6	2.3							Red-Brown silty sand (ML)
RTG-SB-03	ST-1	17-19	16-S-1573														See Tube Summary Sheet
	SS-12	45-47	16-S-1574	28.1			0.0	18.0	78.2	3.8							Red-Brown silt with sand (ML)

Reviewed By _____

Date Revised *12.14.16*

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	51.3	44.7	4.0

TEST RESULTS (D7928)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#20	100.0		
#40	100.0		
#60	99.4		
#100	89.1		
#200	48.7		
0.0521 mm.	10.5		
0.0373 mm.	6.4		
0.0265 mm.	5.5		
0.0133 mm.	4.7		
0.0097 mm.	4.7		
0.0069 mm.	4.3		
0.0048 mm.	4.0		
0.0033 mm.	4.0		
0.0015 mm.	3.5		

* (no specification provided)

Material Description

Red-Brown silty sand (SM)

Atterberg Limits (ASTM D 4318)

PL= 0 **LL=** 0 **PI=**

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 0.1550 D_{85}= 0.1317 D_{60}= 0.0843
D_{50}= 0.0760 D_{30}= 0.0639 D_{15}= 0.0553
D_{10}= 0.0504 C_u= 1.67 C_c= 0.96

Remarks

Date Received: 11.10.16 **Date Tested:** 11.14.16

Tested By: IA

Checked By: MJC

Title: Laboratory Manager

Source of Sample: Borings **Depth:** 45-47 **Date Sampled:** 11.10.16
Sample Number: RTG-SB-01 / SS-12

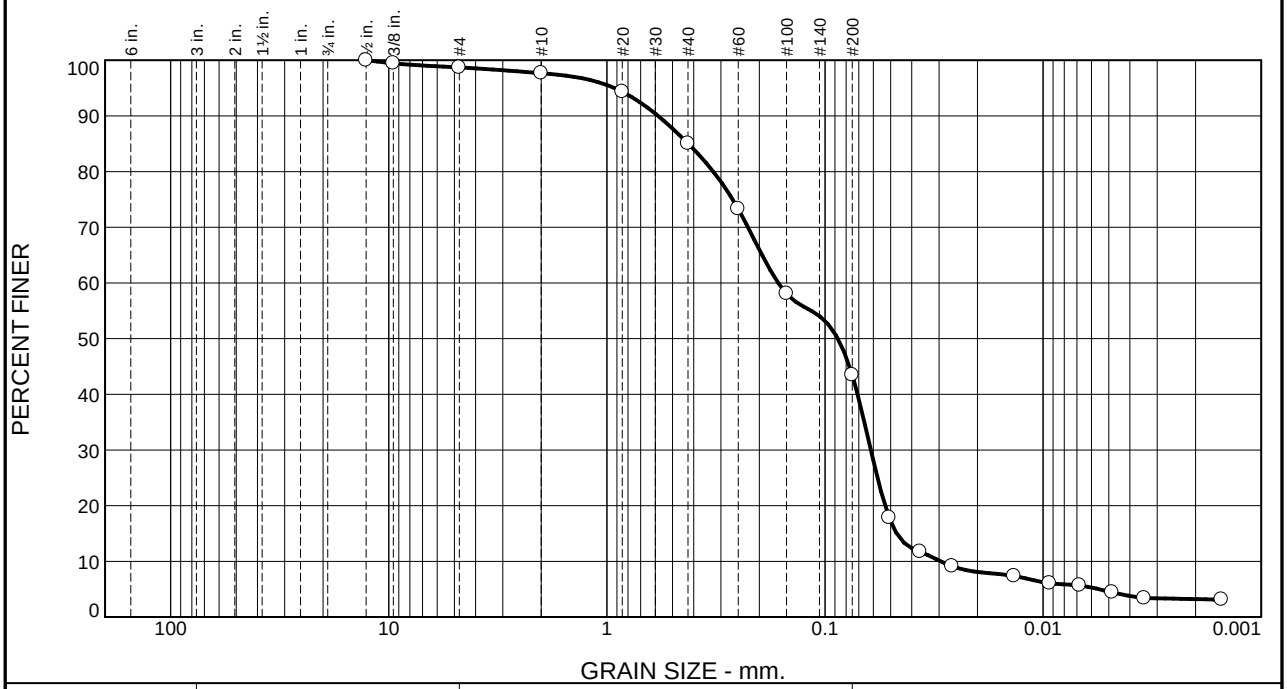
Thielsch Engineering Inc.

Cranston, RI

Client: RT GROUP
Project: Mill River Dist

Project No: 74-16-0002.09 **Figure** SH-1568

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.3	1.0	12.6	41.6	38.9	4.6

TEST RESULTS (D7928)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
0.5	100.0		
0.375	99.4		
#4	98.7		
#10	97.7		
#20	94.3		
#40	85.1		
#60	73.3		
#100	58.1		
#200	43.5		
0.0508 mm.	17.9		
0.0366 mm.	11.7		
0.0261 mm.	9.1		
0.0136 mm.	7.4		
0.0093 mm.	6.1		
0.0068 mm.	5.7		
0.0048 mm.	4.4		
0.0034 mm.	3.4		
0.0015 mm.	3.1		

* (no specification provided)

Material Description

Black silty sand (SM)

Atterberg Limits (ASTM D 4318)

PL= 0 **LL=** 0 **PI=** 0

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 0.5825 D_{85}= 0.4235 D_{60}= 0.1638
D_{50}= 0.0873 D_{30}= 0.0616 D_{15}= 0.0469
D_{10}= 0.0295 C_u= 5.56 C_c= 0.79

Remarks

Date Received: 11.10.16 **Date Tested:** 11.14.16

Tested By: IA

Checked By: MJC

Title: Laboratory Manager

Source of Sample: Borings **Depth:** 30-32
Sample Number: RTG-OW-02 / SS-8

Date Sampled: 11.10.16

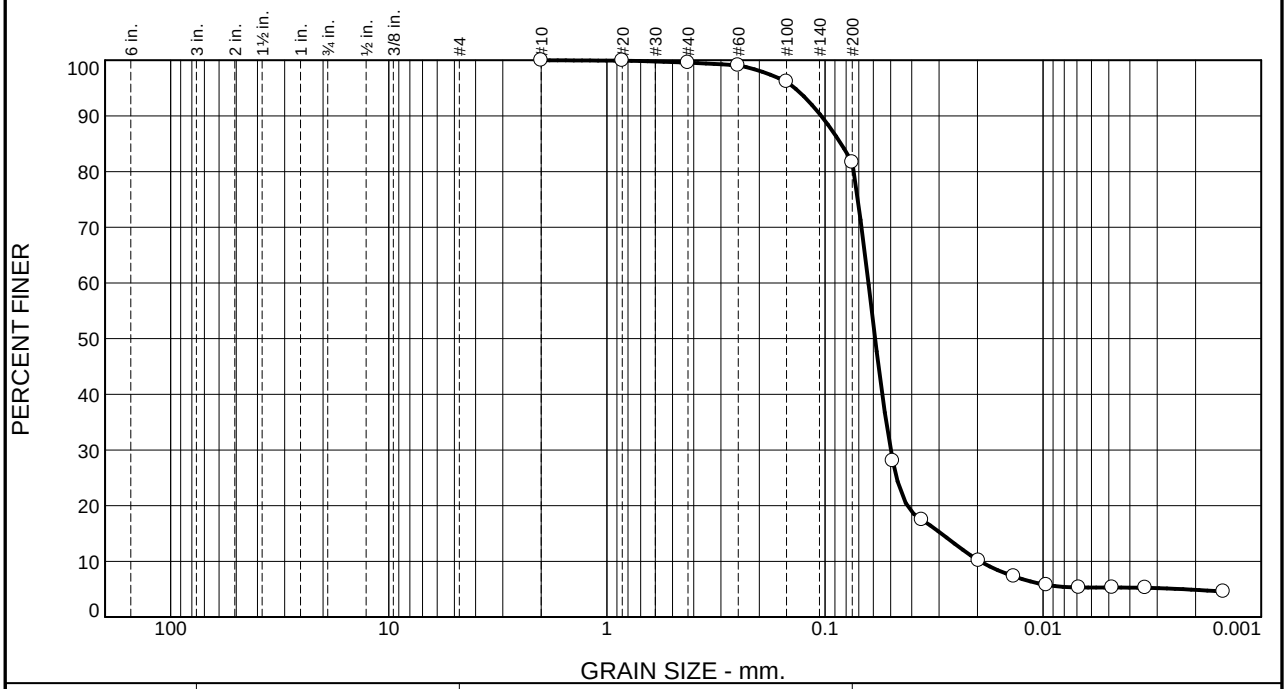
Thielsch Engineering Inc.

Cranston, RI

Client: RT GROUP
Project: Mill River Dist

Project No: 74-16-0002.09 **Figure** SH-1570

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.4	17.9	76.4	5.3

TEST RESULTS (D7928)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	99.9		
#40	99.6		
#60	99.1		
#100	96.1		
#200	81.7		
0.0489 mm.	28.0		
0.0360 mm.	17.5		
0.0197 mm.	10.2		
0.0136 mm.	7.3		
0.0097 mm.	5.8		
0.0068 mm.	5.3		
0.0048 mm.	5.3		
0.0034 mm.	5.3		
0.0015 mm.	4.6		

* (no specification provided)

Material Description

Red-Brown silt with sand (ML)

Atterberg Limits (ASTM D 4318)

PL= 0 **LL=** 0 **PI=** 0

Classification

USCS (D 2487)= ML **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 0.1040 D_{85}= 0.0844 D_{60}= 0.0633
D_{50}= 0.0589 D_{30}= 0.0500 D_{15}= 0.0293
D_{10}= 0.0194 C_u= 3.26 C_c= 2.03

Remarks

Date Received: 11.10.16 **Date Tested:** 11.14.16

Tested By: IA

Checked By: MJC

Title: Laboratory Manager

Source of Sample: Borings **Depth:** 50-52
Sample Number: RTG-OW-02 / SS-12

Date Sampled: 11.10.16

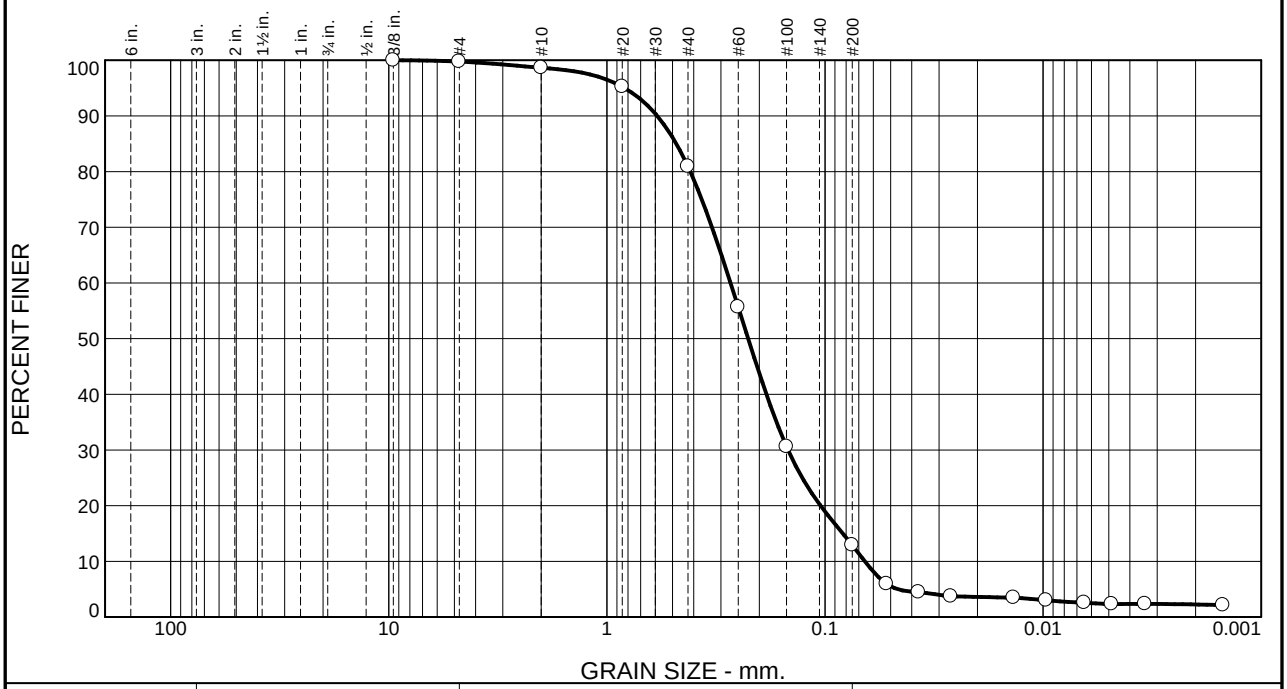
Thielsch Engineering Inc.

Cranston, RI

Client: RT GROUP
Project: Mill River Dist

Project No: 74-16-0002.09 **Figure** SH-1571

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.2	1.2	17.7	68.0	10.6	2.3

TEST RESULTS (D7928)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
0.375	100.0		
#4	99.8		
#10	98.6		
#20	95.2		
#40	80.9		
#60	55.7		
#100	30.6		
#200	12.9		
0.0522 mm.	5.9		
0.0372 mm.	4.5		
0.0264 mm.	3.7		
0.0137 mm.	3.5		
0.0097 mm.	3.0		
0.0065 mm.	2.6		
0.0048 mm.	2.3		
0.0034 mm.	2.4		
0.0015 mm.	2.1		

* (no specification provided)

Material Description

Red-Brown silty sand (SM)

Atterberg Limits (ASTM D 4318)

PL= 0 **LL=** 0 **PI=** 0

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 0.5878 D_{85}= 0.4806 D_{60}= 0.2712
D_{50}= 0.2250 D_{30}= 0.1477 D_{15}= 0.0828
D_{10}= 0.0657 C_u= 4.13 C_c= 1.23

Remarks

Date Received: 11.10.16 **Date Tested:** 11.14.16

Tested By: IA

Checked By: MJC

Title: Laboratory Manager

Source of Sample: Borings **Depth:** 110-112 **Date Sampled:** 11.10.16
Sample Number: RTG-OW-02 / SS-24

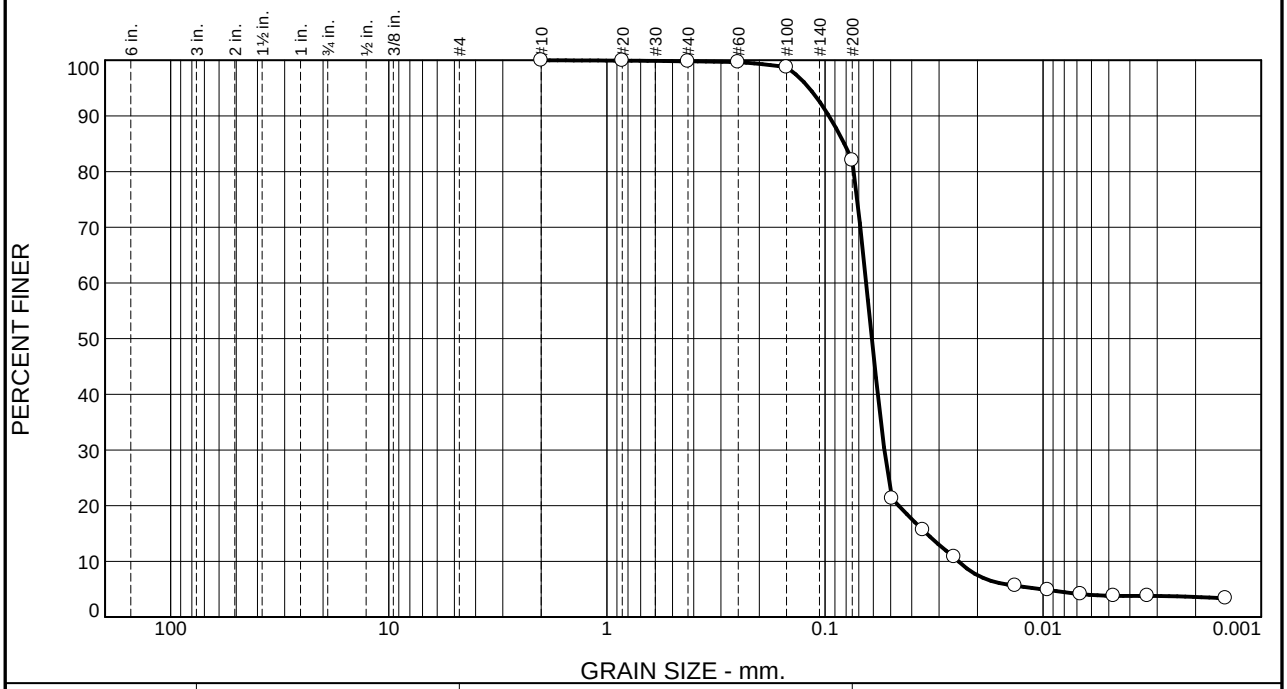
Thielsch Engineering Inc.

Cranston, RI

Client: RT GROUP
Project: Mill River Dist

Project No: 74-16-0002.09 **Figure** SH-1572

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
				0.2	17.8	78.2	3.8

TEST RESULTS (D7928)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	99.9		
#40	99.8		
#60	99.7		
#100	98.7		
#200	82.0		
0.0493 mm.	21.3		
0.0356 mm.	15.6		
0.0256 mm.	10.8		
0.0134 mm.	5.6		
0.0095 mm.	4.9		
0.0067 mm.	4.1		
0.0048 mm.	3.8		
0.0033 mm.	3.8		
0.0015 mm.	3.4		

* (no specification provided)

Material Description

Red-Brown silt wiht sand (ML)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 0.0959 D_{85}= 0.0815 D_{60}= 0.0648
D_{50}= 0.0610 D_{30}= 0.0534 D_{15}= 0.0342
D_{10}= 0.0244 C_u= 2.65 C_c= 1.81

Remarks

Date Received: 11.10.16 **Date Tested:** 11.14.16

Tested By: IA

Checked By: MJC

Title: Laboratory Manager

Source of Sample: Borings **Depth:** 45-47 **Date Sampled:** 11.10.16

Sample Number: RTG-SB-03 / SS-12

Thielsch Engineering Inc.

Cranston, RI

Client: RT GROUP

Project: Mill River Dist

Project No: 74-16-0002.09 **Figure** SH-1574

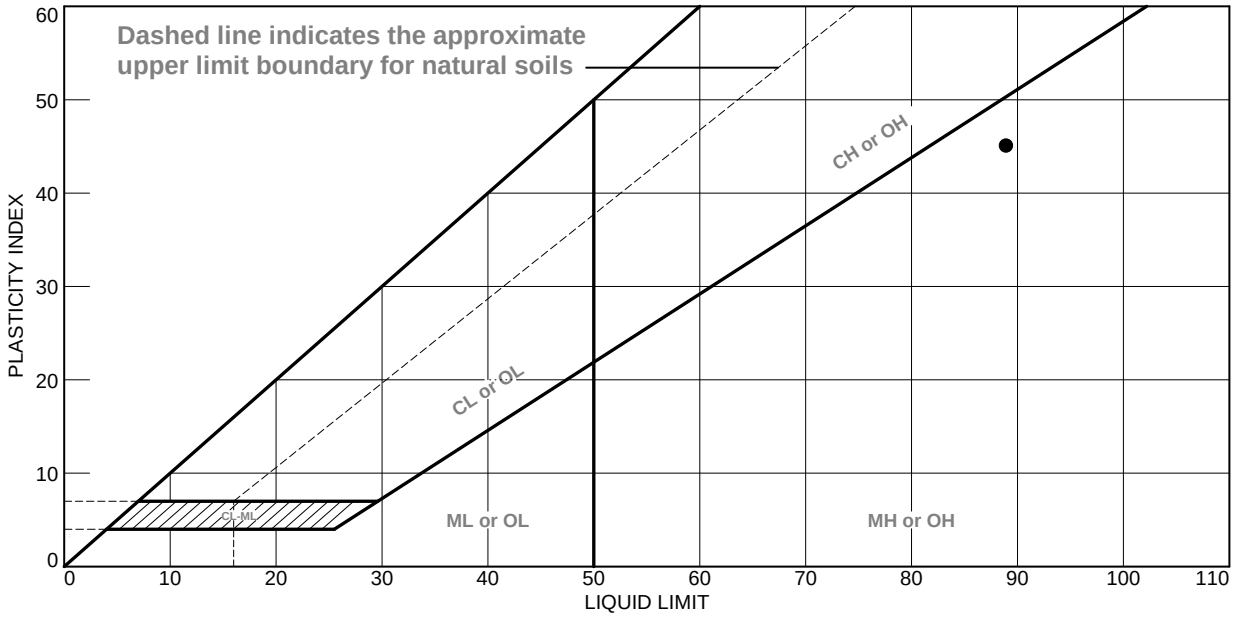
LABORATORY TUBE SUMMARY SHEET

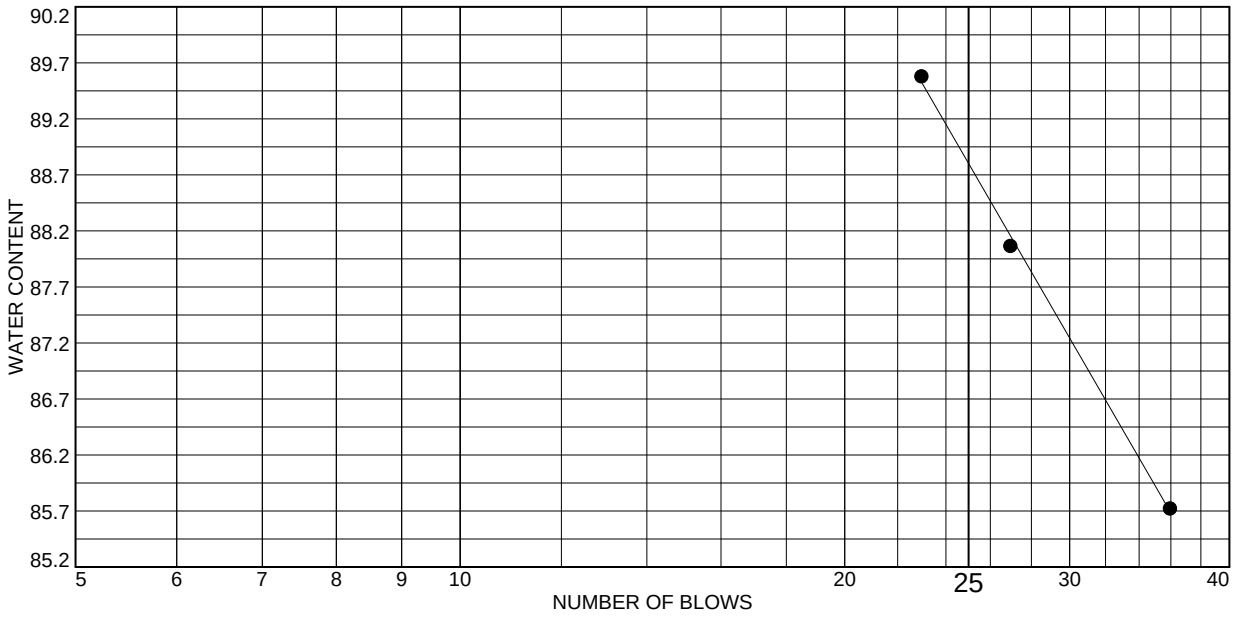
Project Name: Mill River District Flood Resiliency Improvements
Project No.: 74-16-0002.09
Project Manager: David Arpin, P.E.
Project Location: New Haven, CT
Assigned By: D. Arpin
Date: 12.6.16
Reviewed By: Matthew J. Kahn
Date Reviewed: 12.6.16
Client: RT Group

Boring/ Test Pit No.	Sample No.	Depth ft.	Laboratory No.	Identification Tests								Strength Tests					Consol.	
				Water Content %	LL %	PL %	Gravel %	Sand %	Silt %	Clay %	Dry unit wt. pcf	Torvane or Type Test	σ_c psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	$\frac{C_c}{1 + e_0}$	Laboratory Log and Soil Description
RTG-SB-01	ST-2	22-24	16-S-1567		Average Total Unit Weight (22.0-24.0') = 96.1 pcf													
		22'-0" to 24'-0"																(22'-0" - 24'-0") Dark Grey Organic SILT
																		(22'-0" to 22'-7") highly disturbed with shells and wood
		22'-9"		70.1								Tv = .075 tsf						
		22'-10"		75.3	89	44						Pen = 0.60 tsf						Dark Grey Organic elastic silt (OH)
		22'-11"		91.8			0.0	2.3	71.6	26.1								Dark Grey Organic elastic silt (OH)
		23'-0" to 23'-6"		83.3							54.2	CIU	2246	σ_1-σ_3 Max	2033	7.3		
		23'-6" to 23'-10"																Consolidation (See Test Summary Page)
		23'-11"		67.6								Tv = .125 tsf						Sand content and mica flakes increasing with depth

THIELSCH ENGINEERING
195 Frances Avenue
Cranston, RI 02910
401-467-6454

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark Grey Organic elastic silt (OH)	89	44	45	99.8	97.7	

Project No. 74-16- **Client:** RT GROUP

Project: Mill River Dist

Source of Sample: Borings **Depth:** 22-24
Sample Number: RTG-SB-01 / ST-2

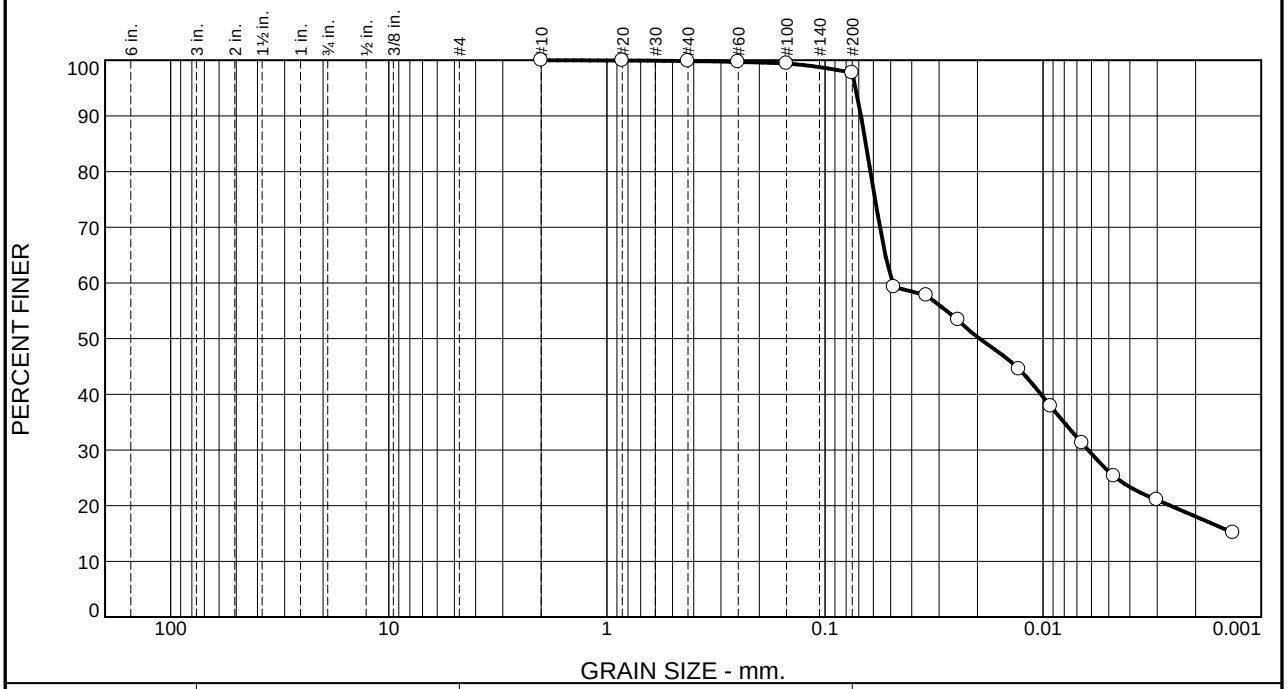
Thielsch Engineering Inc.

Cranston, RI

Remarks:

Figure L-1567

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.2	2.1	71.6	26.1

TEST RESULTS (D6913)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	100.0		
#40	99.8		
#60	99.7		
#100	99.4		
#200	97.7		
0.0484 mm.	59.3		
0.0343 mm.	57.8		
0.0245 mm.	53.4		
0.0129 mm.	44.5		
0.0092 mm.	37.9		
0.0066 mm.	31.2		
0.0047 mm.	25.3		
0.0030 mm.	21.0		
0.0013 mm.	15.1		

* (no specification provided)

Material Description

Dark Grey Organic elastic silt (OH)

Atterberg Limits (ASTM D 4318)

PL= 44 **LL=** 89 **PI=** 45

Classification

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

Coefficients

D_{90}= 0.0684 D_{85}= 0.0650 D_{60}= 0.0491
D_{50}= 0.0196 D_{30}= 0.0062 D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 11.10.16 **Date Tested:** 11.21.16

Tested By: IA

Checked By: MJC

Title: Laboratory Manager

Source of Sample: Borings **Depth:** 22-24
Sample Number: RTG-SB-01 / ST-2

Date Sampled: 11.10.16

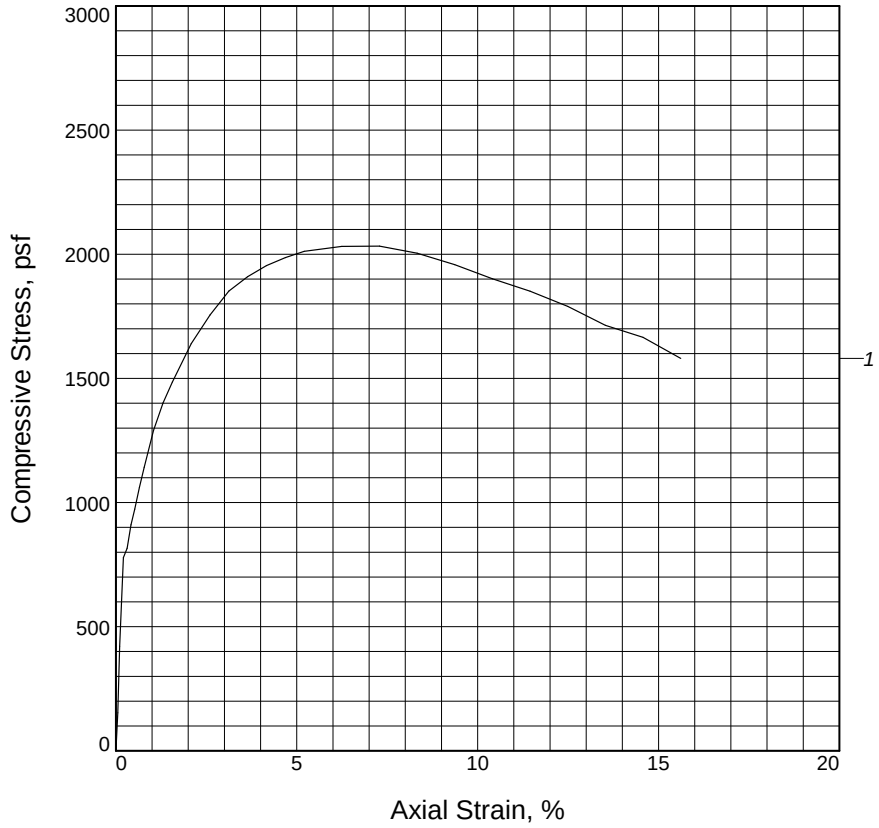
Thielsch Engineering Inc.

Cranston, RI

Client: RT GROUP
Project: Mill River Dist

Project No: 74-16-0002.09 **Figure** SH-1567

CU WITH PORE PRESSURES TEST



Sample No.	1			
Fail. Stress, psf	2033			
Ult. Stress, psf				
Cell pressure, psf	13766			
Strain rate, in./min.	0.05			
Water content, %	76.9			
Wet density, pcf	96.0			
Dry density, pcf	54.2			
Saturation, %	100.4			
Void ratio	1.9926			
Specimen diameter, in.	1.96			
Specimen height, in.	4.00			
Height/diameter ratio	2.04			

Description: Dark Grey Organic elastic silt (OH)

LL = 89	**PL =** 44	**PI =** 45	**Assumed GS=** 2.6	**Type:** Tube Sample

Project No.: 74-16-0002.09

Date Sampled: 11.10.16

Remarks:

Figure CIU-1567

Client: RT GROUP

Project: Mill River Dist

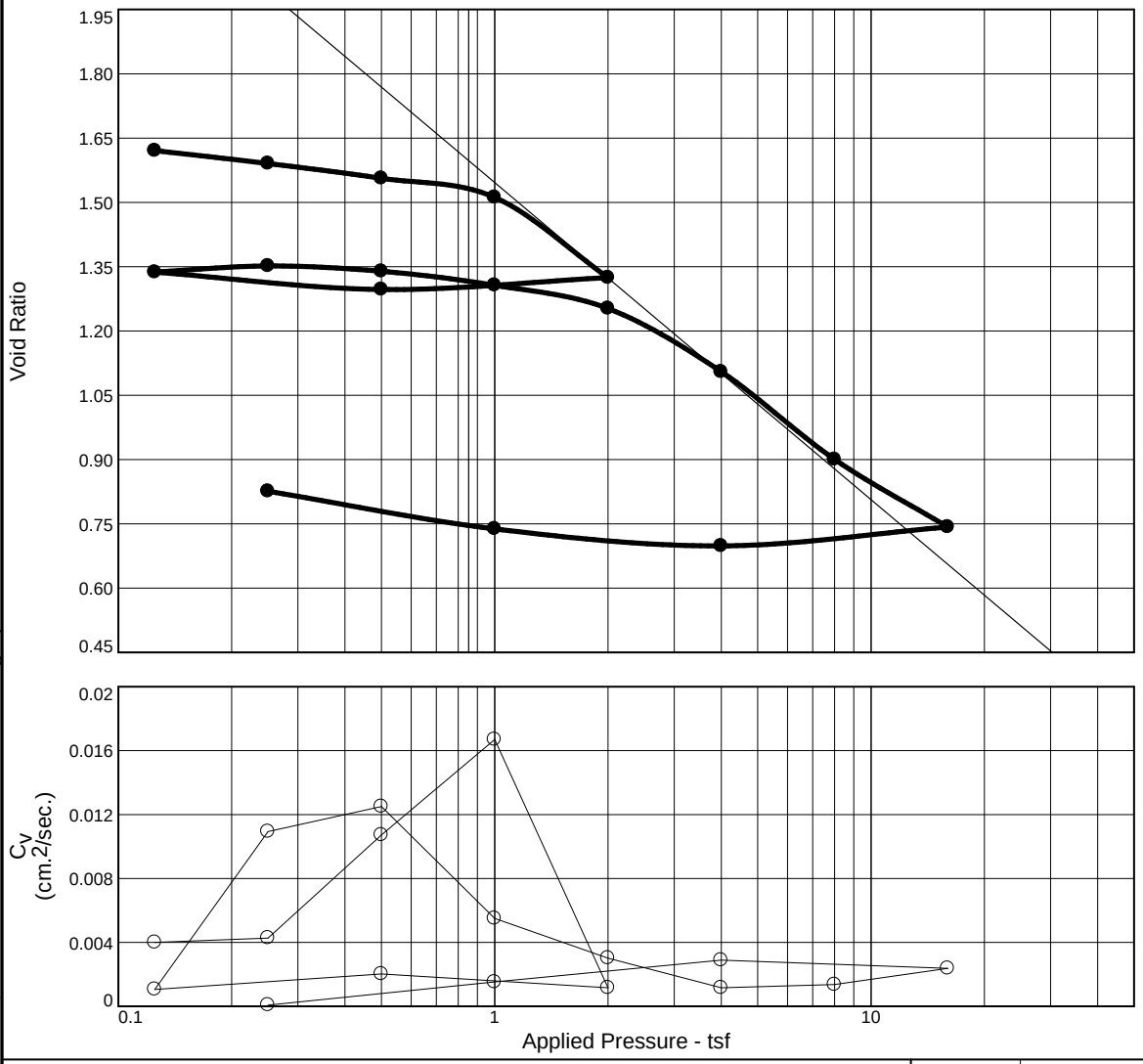
Source of Sample: Borings **Depth:** 22-24

Sample Number: RTG-SB-01 / ST-2

CU WITH PORE PRESSURES TEST
Thielsch Engineering Inc.
Cranston, RI

Tested By: RR **Checked By:** MJC

CONSOLIDATION TEST REPORT



MATERIAL DESCRIPTION	USCS	AASHTO
Dark Grey Organic elastic silt (OH)		

LL	PI	Sp. Gr.	Overburden (tsf)	Dry Dens. (pcf)		Moisture		Saturation		Void Ratio		P_c (tsf)	C_c
				Init.	Final	Init.	Final	Init.	Final	Init.	Final		
89	45	2.497		59.3	+/- 80.9	68.1 %	42.9	104.4	100.0	1.629	0.826	1.1	0.74

Preparation Process: Trimmed using a trimming turntable

Condition of Test: Saturated at 2 tsf

D2435 Method	C_r	Swell Press. (tsf)	%
A	0.17		

Project No. 74-16- **Client:** RT GROUP

Project: Mill River Dist

Source: Borings **Depth:** 22-24 **Sample No.:** RTG-SB-01 / ST-2

Thielsch Engineering Inc.

Cranston, RI

Remarks:
16 Day Load Out

Checked By: MJC

Title: Laboratory Manager

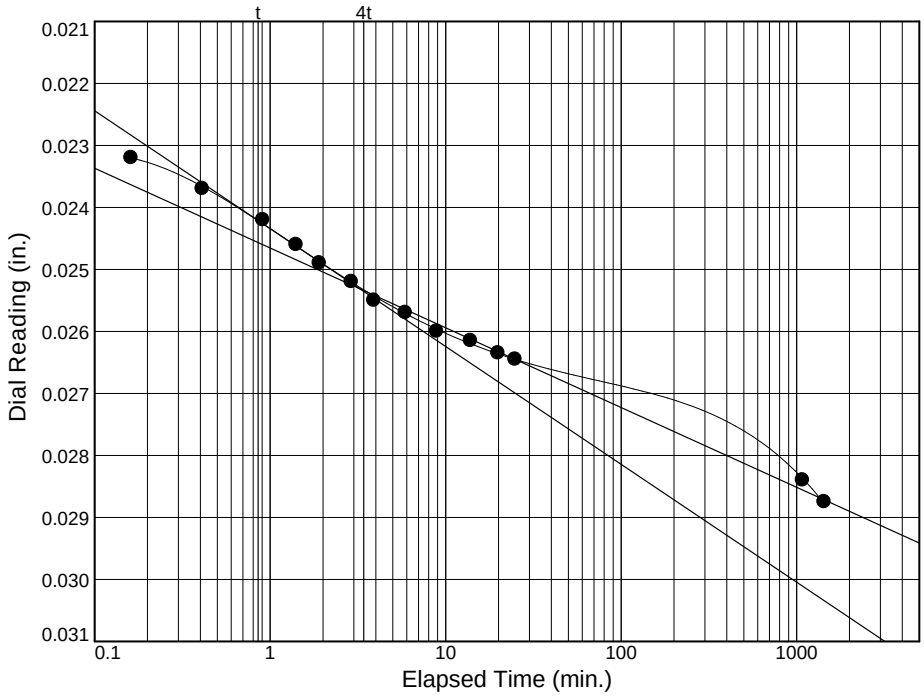
Figure C1567-1

Tested By: RR

Dial Reading vs. Time

Project No.: 74-16-0002.09
Project: Mill River Dist

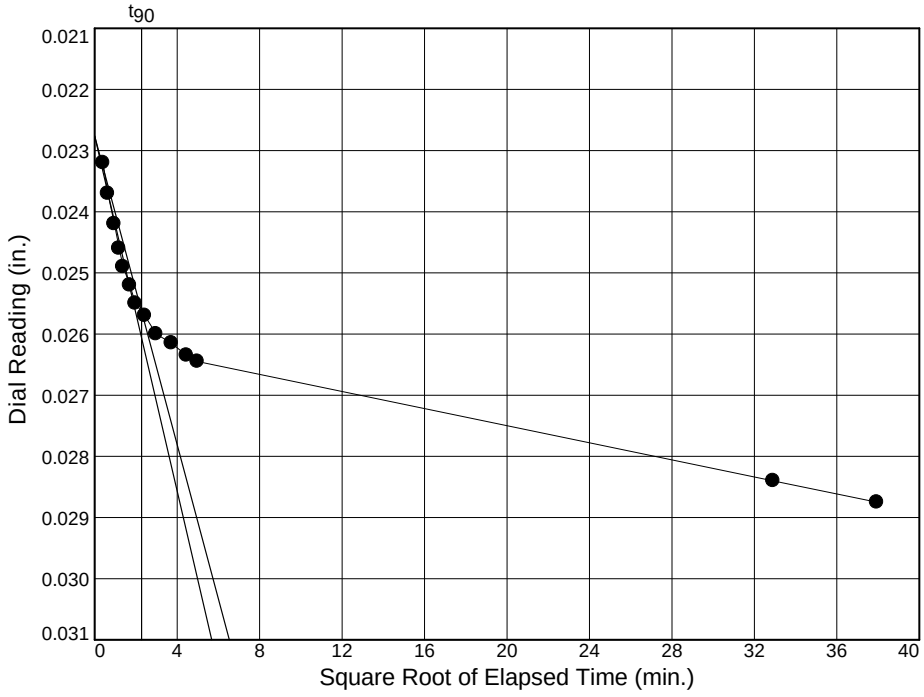
Source of Sample: Borings Depth: 22-24 Sample Number: RTG-SB-01 / ST-2



Load No.= 1
Load= 0.13 tsf
D_0 = 0.0231
D_{50} = 0.0242
D_{100} = 0.0253
T_{50} = 0.84 min.

C_v @ T_{50}
0.0040 $cm.^2/sec.$

C_α = 0.004



Load No.= 1
Load= 0.13 tsf
D_0 = 0.0228
D_{90} = 0.0256
D_{100} = 0.0259
T_{90} = 5.17 min.

C_v @ T_{90}
0.0028 $cm.^2/sec.$

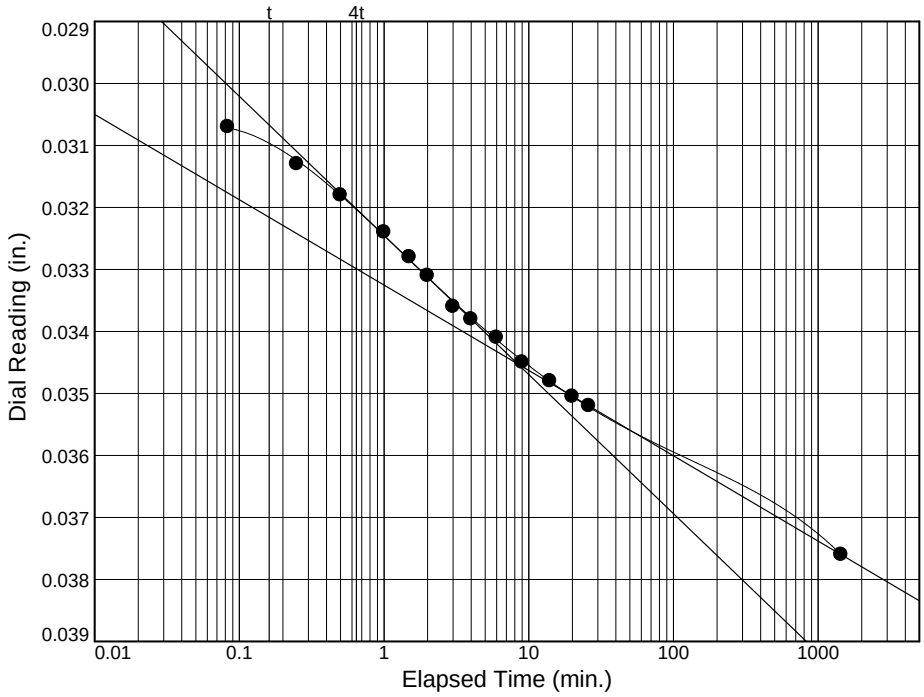
Figure C1567-2

Thielsch Engineering Inc.

Dial Reading vs. Time

Project No.: 74-16-0002.09
Project: Mill River Dist

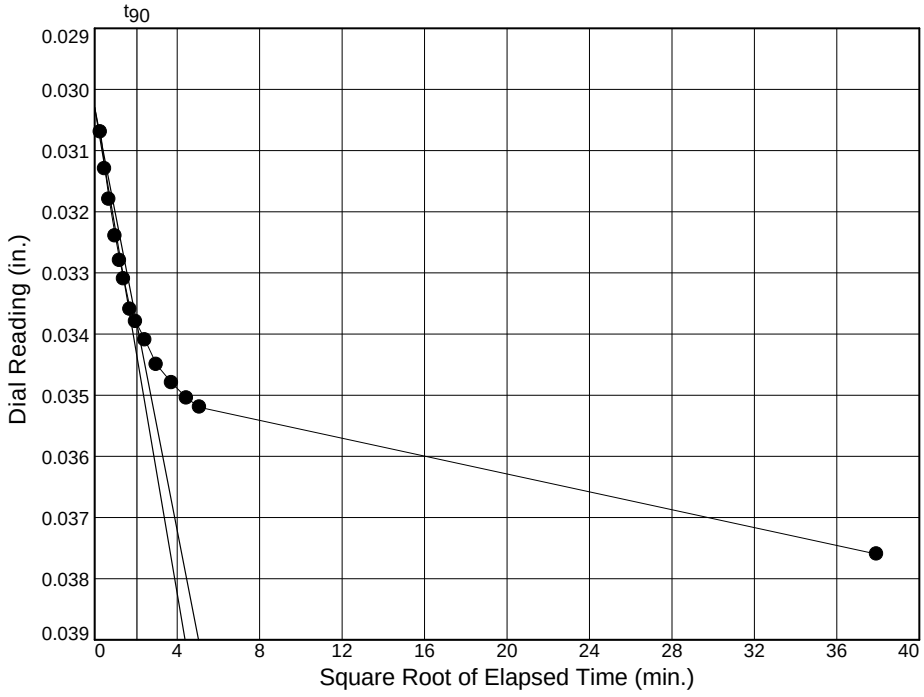
Source of Sample: Borings Depth: 22-24 Sample Number: RTG-SB-01 / ST-2



Load No.= 2
Load= 0.25 tsf
D_0 = 0.0299
D_{50} = 0.0322
D_{100} = 0.0345
T_{50} = 0.77 min.

C_v @ T_{50}
0.0043 cm.^{2}/sec.

C_α = 0.005



Load No.= 2
Load= 0.25 tsf
D_0 = 0.0303
D_{90} = 0.0338
D_{100} = 0.0342
T_{90} = 4.20 min.

C_v @ T_{90}
0.0034 cm.^{2}/sec.

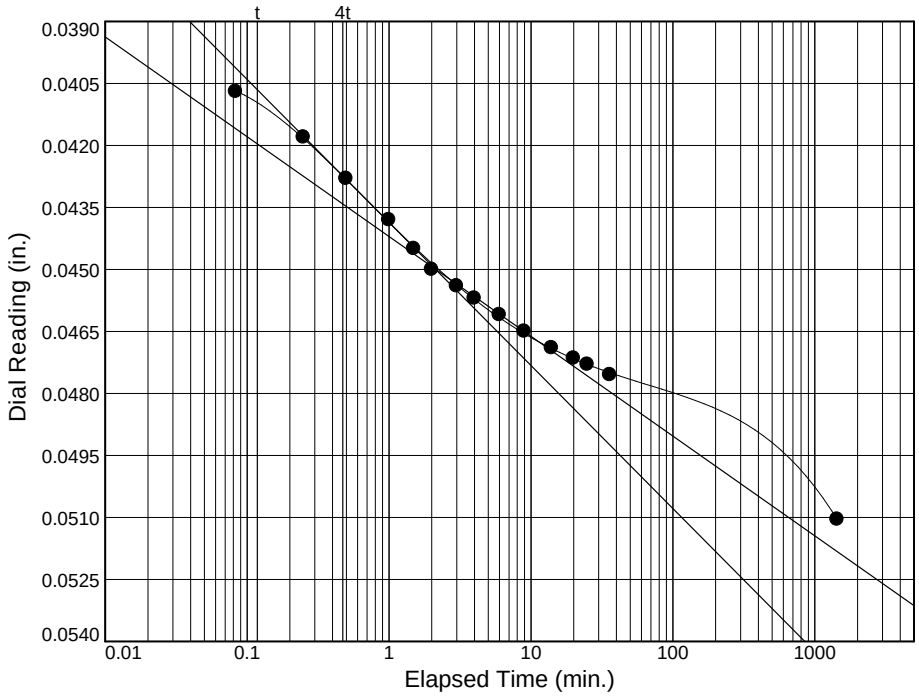
Figure C1567-3

Thielsch Engineering Inc.

Dial Reading vs. Time

Project No.: 74-16-0002.09
Project: Mill River Dist

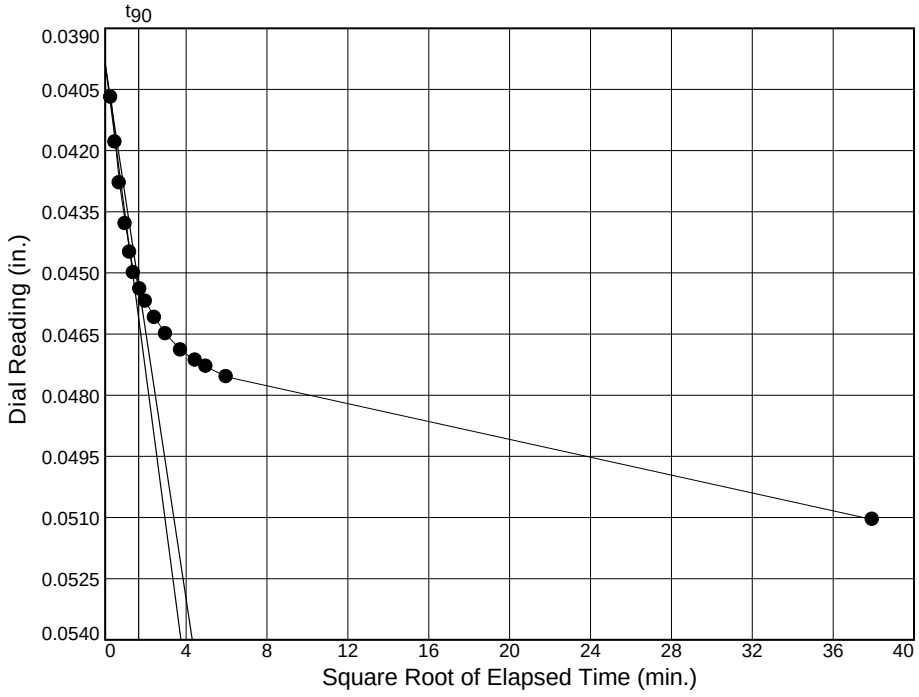
Source of Sample: Borings Depth: 22-24 Sample Number: RTG-SB-01 / ST-2



Load No.= 3
Load= 0.50 tsf
D_0 = 0.0392
D_{50} = 0.0421
D_{100} = 0.0450
T_{50} = 0.30 min.

C_v @ T_{50}
0.0107 cm.^{2}/sec.

C_α = 0.008



Load No.= 3
Load= 0.50 tsf
D_0 = 0.0399
D_{90} = 0.0453
D_{100} = 0.0459
T_{90} = 2.74 min.

C_v @ T_{90}
0.0051 cm.^{2}/sec.

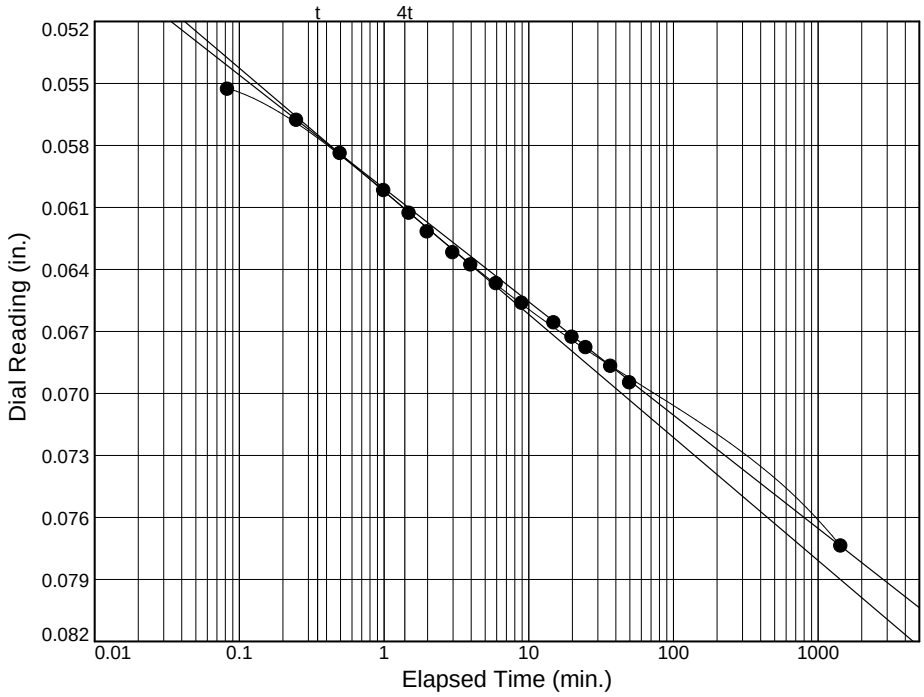
Figure C1567-4

Thielsch Engineering Inc.

Dial Reading vs. Time

Project No.: 74-16-0002.09
Project: Mill River Dist

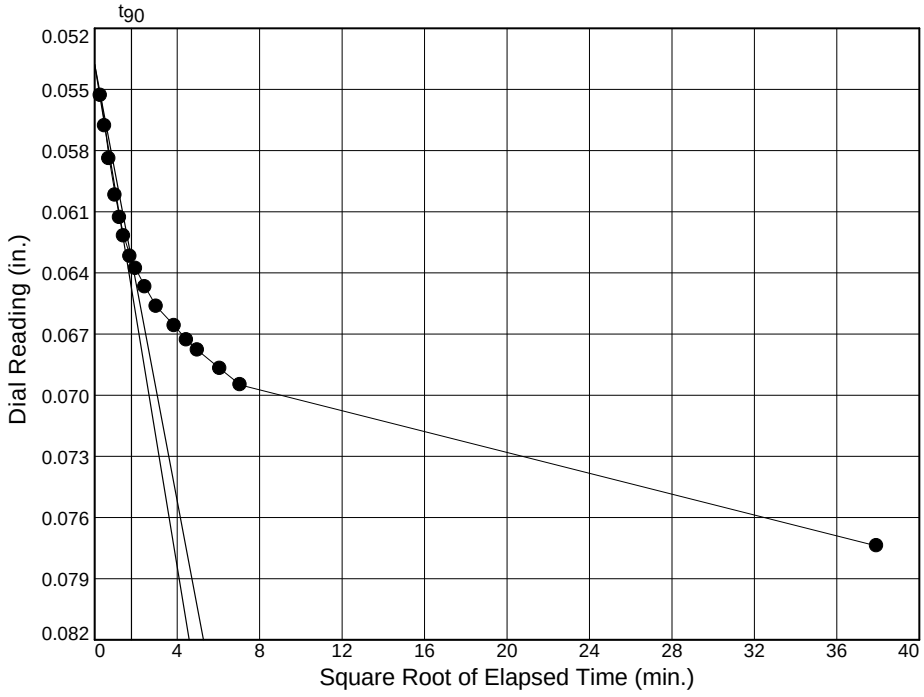
Source of Sample: Borings Depth: 22-24 Sample Number: RTG-SB-01 / ST-2



Load No.= 4
Load= 1.00 tsf
D_0 = 0.0542
D_{50} = 0.0564
D_{100} = 0.0585
T_{50} = 0.19 min.

C_v @ T_{50}
0.0167 cm.^{2}/sec.

C_α = 0.018



Load No.= 4
Load= 1.00 tsf
D_0 = 0.0538
D_{90} = 0.0633
D_{100} = 0.0644
T_{90} = 3.19 min.

C_v @ T_{90}
0.0042 cm.^{2}/sec.

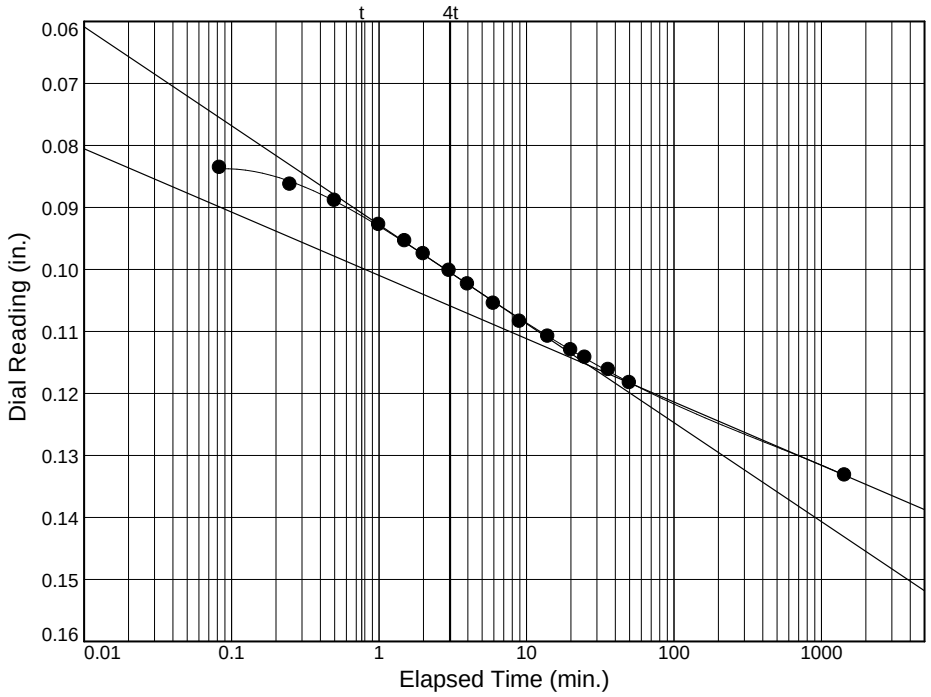
Figure C1567-5

Thielsch Engineering Inc.

Dial Reading vs. Time

Project No.: 74-16-0002.09
Project: Mill River Dist

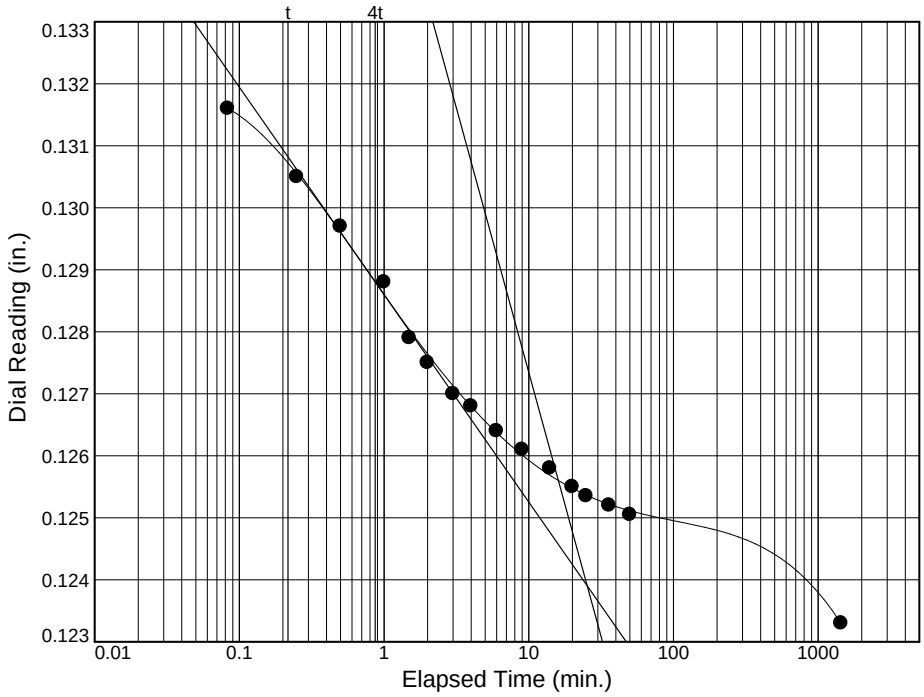
Source of Sample: Borings Depth: 22-24 Sample Number: RTG-SB-01 / ST-2



Load No.= 5
Load= 2.00 tsf
D_0 = 0.0822
D_{50} = 0.0988
D_{100} = 0.1155
T_{50} = 2.39 min.

C_v @ T_{50}
0.0012 cm.^{2}/sec.

C_α = 0.034



Load No.= 6
Load= 0.50 tsf
D_0 = 0.1326
D_{50} = 0.1283
D_{100} = 0.1239
T_{50} = 1.26 min.

C_v @ T_{50}
0.0020 cm.^{2}/sec.

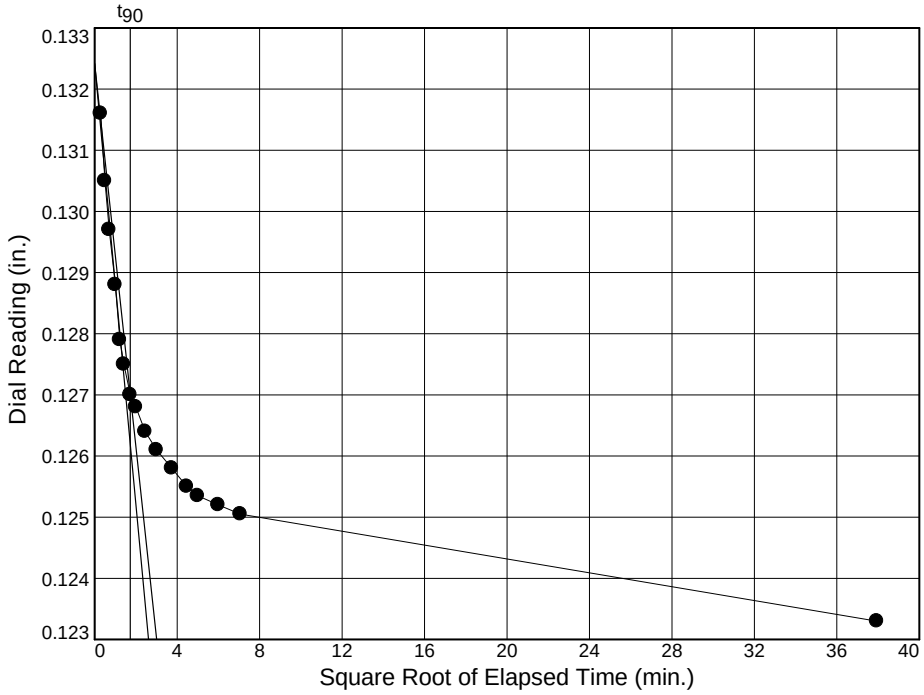
Figure C1567-6

Thielsch Engineering Inc.

Dial Reading vs. Time

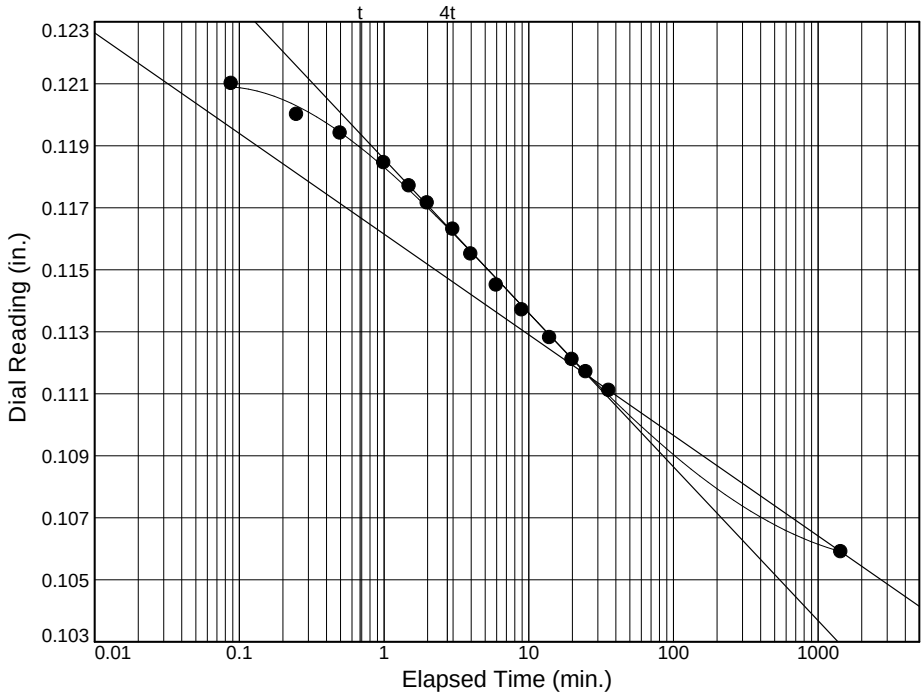
Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 22-24 Sample Number: RTG-SB-01 / ST-2



Load No.= 6
Load= 0.50 tsf
D_0 = 0.1324
D_{90} = 0.1270
D_{100} = 0.1264
T_{90} = 2.98 min.

C_v @ T_{90}
0.0037 cm.^{2}/sec.



Load No.= 7
Load= 0.13 tsf
D_0 = 0.1215
D_{50} = 0.1166
D_{100} = 0.1116
T_{50} = 2.49 min.

C_v @ T_{50}
0.0011 cm.^{2}/sec.

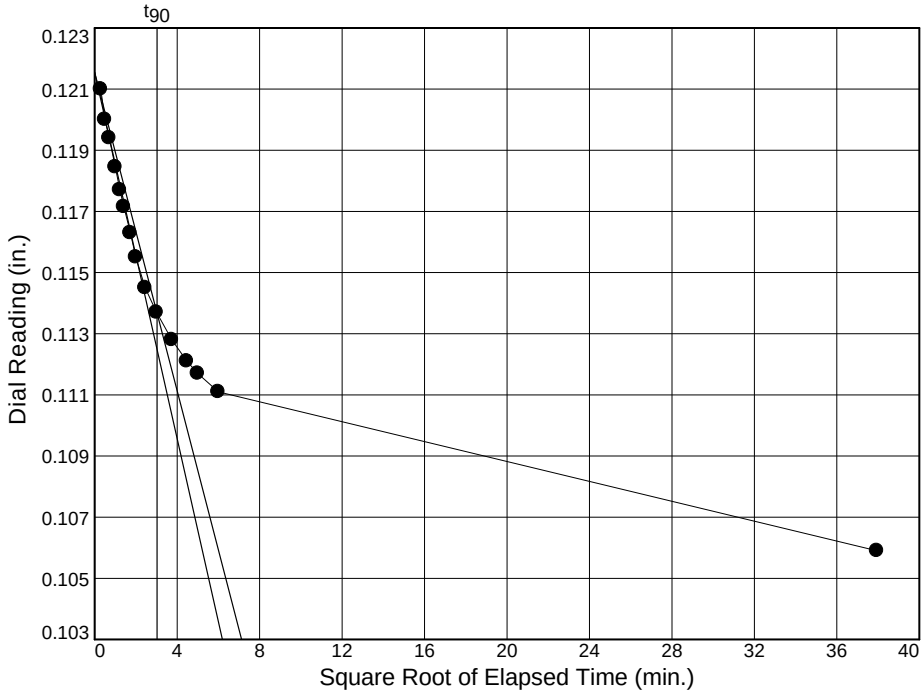
Figure C1567-7

Thielsch Engineering Inc.

Dial Reading vs. Time

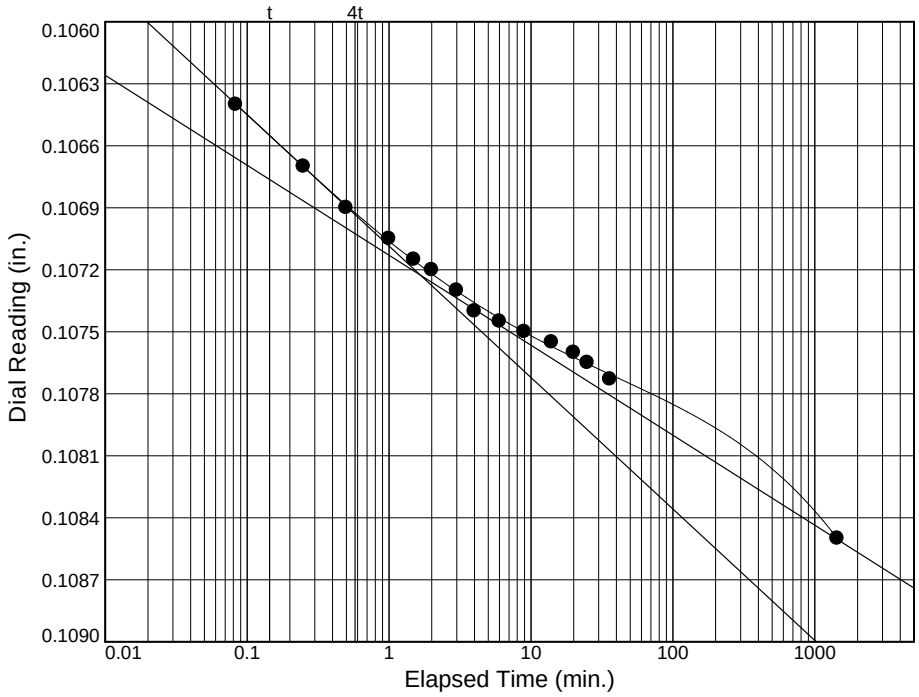
Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 22-24 Sample Number: RTG-SB-01 / ST-2



Load No.= 7
Load= 0.13 tsf
D_0 = 0.1215
D_{90} = 0.1137
D_{100} = 0.1128
T_{90} = 9.15 min.

C_v @ T_{90}
0.0012 $cm.^2$/sec.



Load No.= 8
Load= 0.25 tsf
D_0 = 0.1062
D_{50} = 0.1067
D_{100} = 0.1072
T_{50} = 0.25 min.

C_v @ T_{50}
0.0109 $cm.^2$/sec.

C_α = 0.001

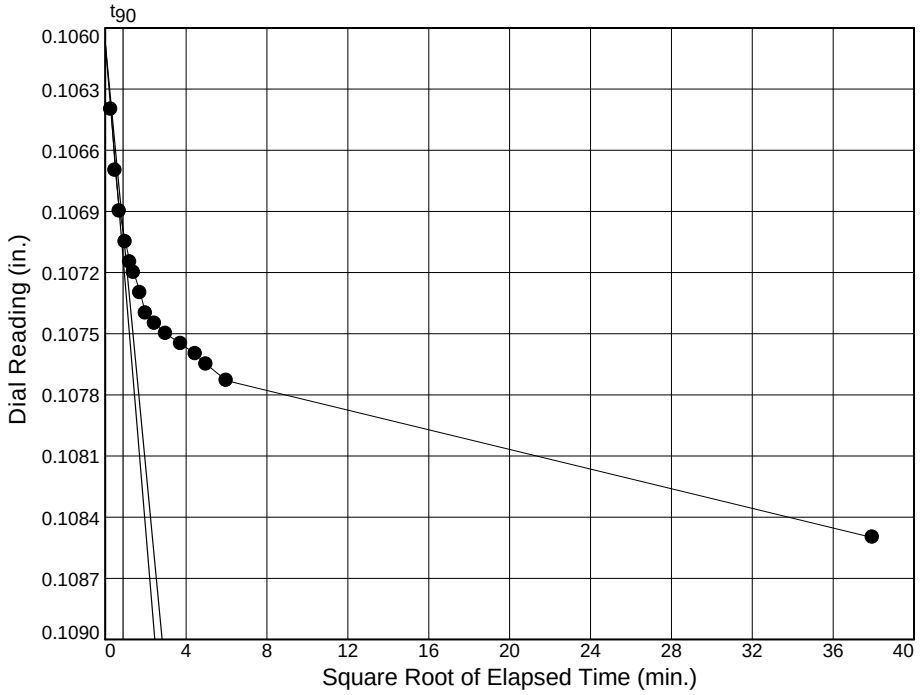
Figure C1567-8

Thielsch Engineering Inc.

Dial Reading vs. Time

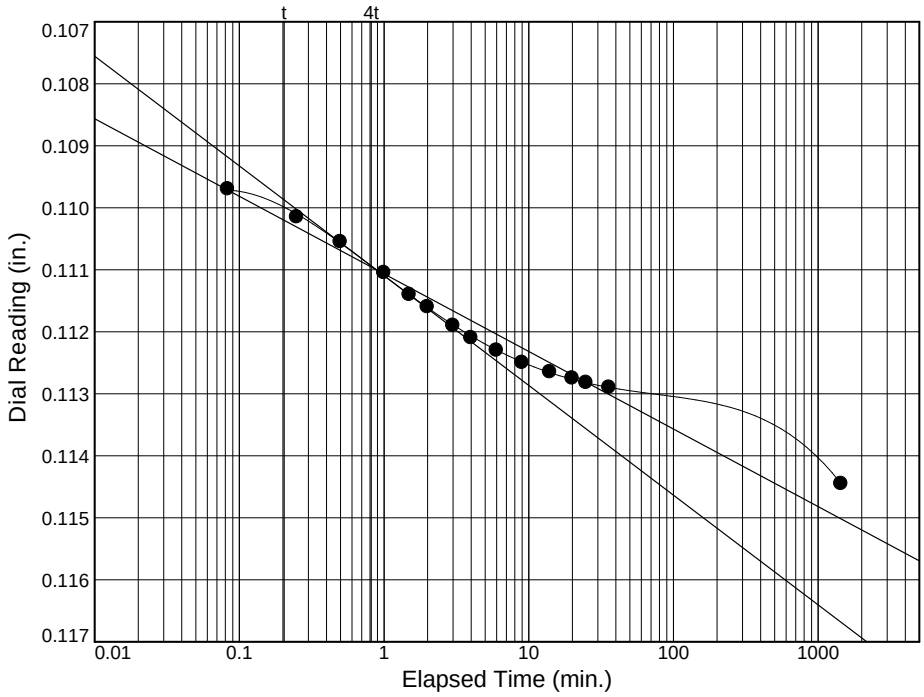
Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 22-24 Sample Number: RTG-SB-01 / ST-2



Load No.= 8
Load= 0.25 tsf
D_0 = 0.1061
D_{90} = 0.1070
D_{100} = 0.1071
T_{90} = 0.79 min.

C_v @ T_{90}
0.0149 cm.^{2}/sec.



Load No.= 9
Load= 0.50 tsf
D_0 = 0.1090
D_{50} = 0.1100
D_{100} = 0.1110
T_{50} = 0.22 min.

C_v @ T_{50}
0.0125 cm.^{2}/sec.

C_α = 0.004

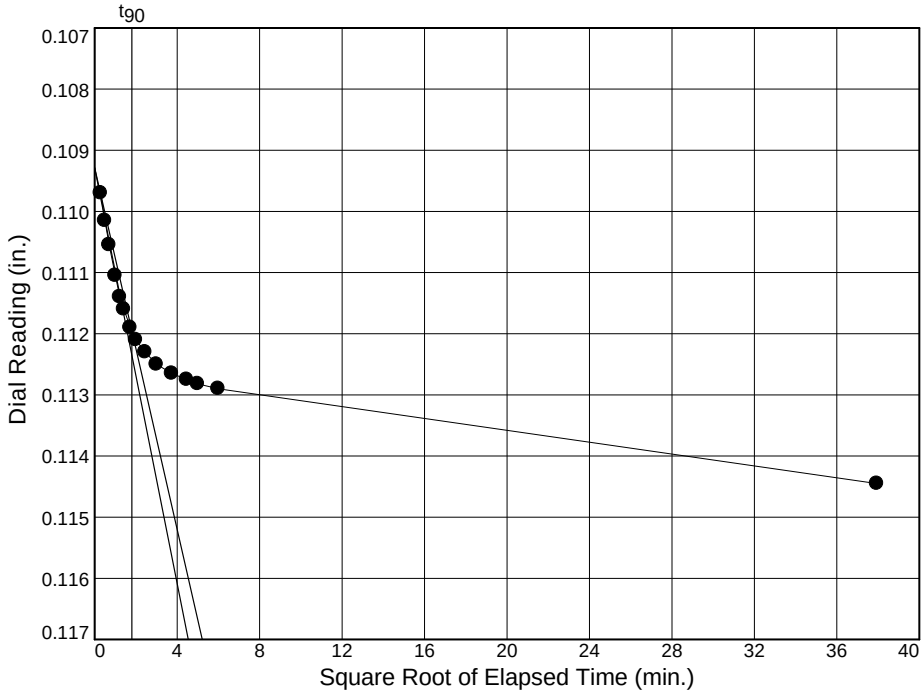
Figure C1567-9

Thielsch Engineering Inc.

Dial Reading vs. Time

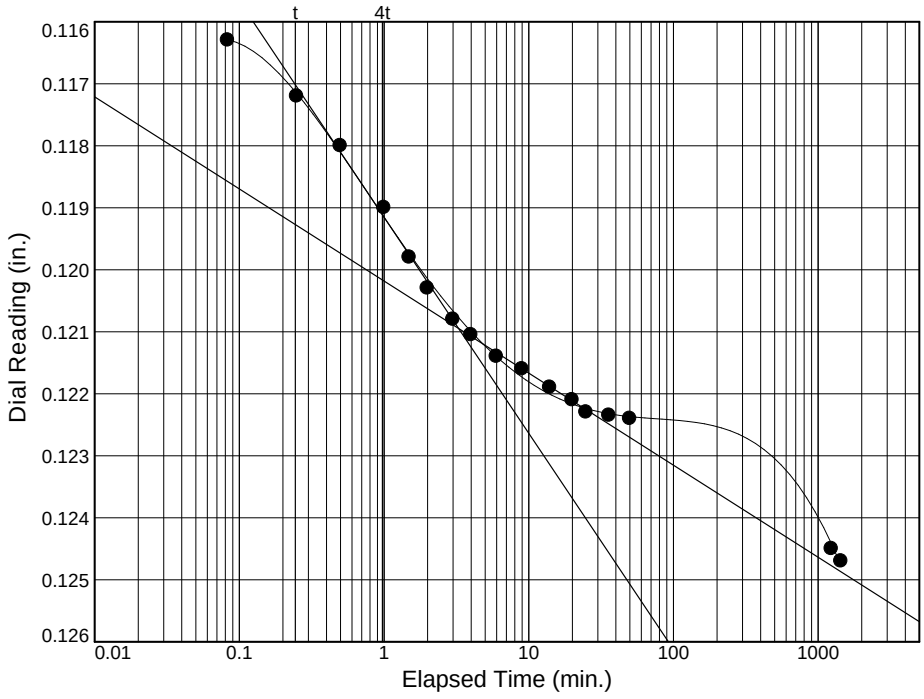
Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 22-24 Sample Number: RTG-SB-01 / ST-2



Load No.= 9
Load= 0.50 tsf
D_0 = 0.1093
D_{90} = 0.1120
D_{100} = 0.1123
T_{90} = 3.26 min.

C_v @ T_{90}
0.0035 cm.^{2}/sec.



Load No.= 10
Load= 1.00 tsf
D_0 = 0.1151
D_{50} = 0.1180
D_{100} = 0.1209
T_{50} = 0.48 min.

C_v @ T_{50}
0.0055 cm.^{2}/sec.

C_α = 0.005

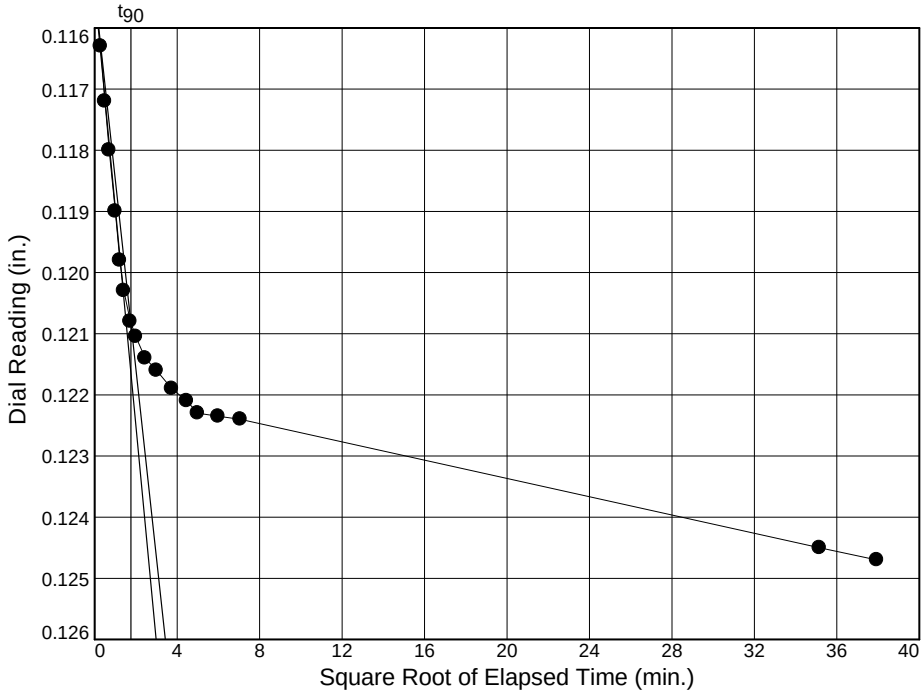
Figure C1567-10

Thielsch Engineering Inc.

Dial Reading vs. Time

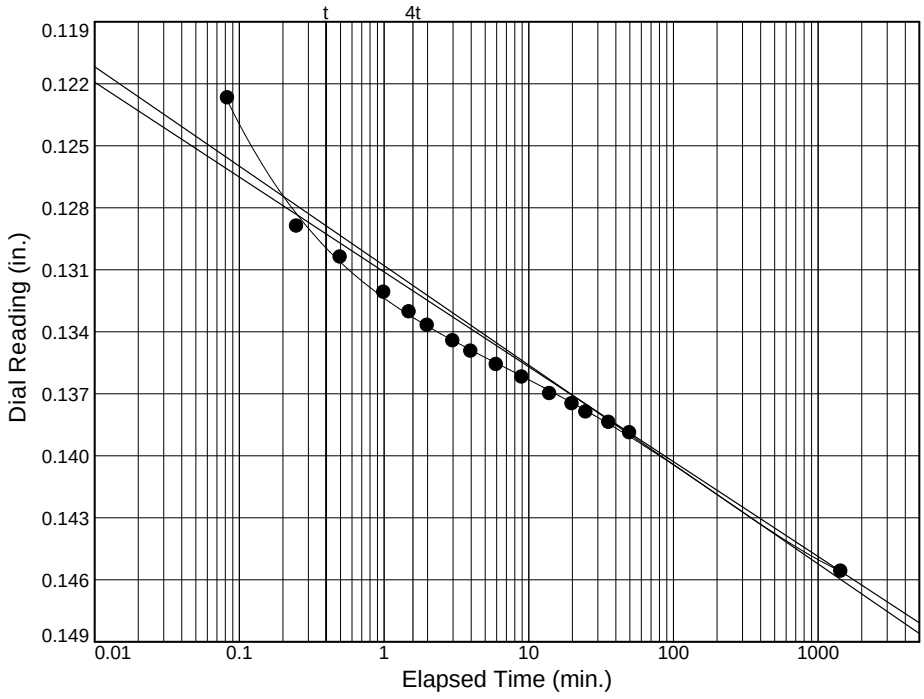
Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 22-24 Sample Number: RTG-SB-01 / ST-2



Load No.= 10
Load= 1.00 tsf
D_0 = 0.1154
D_{90} = 0.1208
D_{100} = 0.1214
T_{90} = 3.08 min.

C_v @ T_{90}
0.0037 cm.^{2}/sec.



Load No.= 11
Load= 2.00 tsf
D_0 = 0.1265
D_{50} = 0.1320
D_{100} = 0.1374
T_{50} = 0.84 min.

C_v @ T_{50}
0.0030 cm.^{2}/sec.

C_α = 0.015

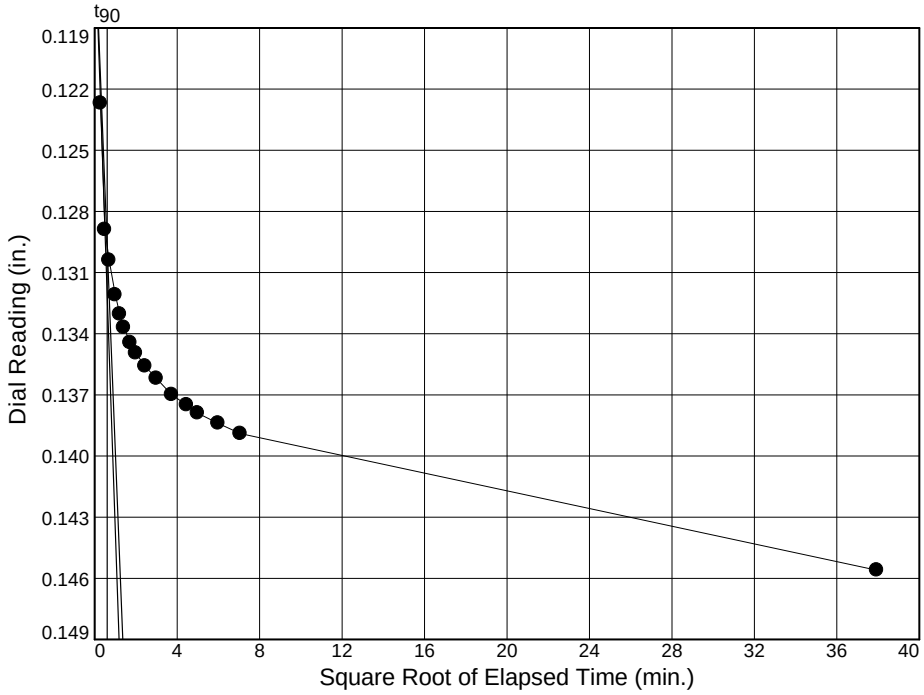
Figure C1567-11

Thielsch Engineering Inc.

Dial Reading vs. Time

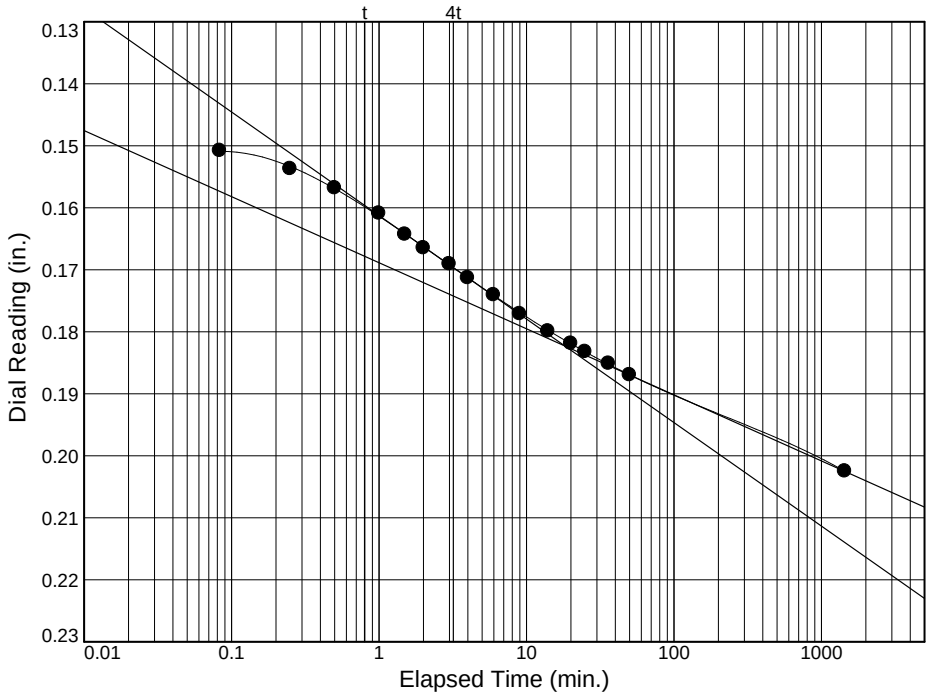
Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 22-24 Sample Number: RTG-SB-01 / ST-2



Load No.= 11
Load= 2.00 tsf
D_0 = 0.1142
D_{90} = 0.1297
D_{100} = 0.1314
T_{90} = 0.37 min.

C_v @ T_{90}
0.0305 cm.^{2}/sec.



Load No.= 12
Load= 4.00 tsf
D_0 = 0.1500
D_{50} = 0.1661
D_{100} = 0.1823
T_{50} = 1.96 min.

C_v @ T_{50}
0.0012 cm.^{2}/sec.

C_α = 0.035

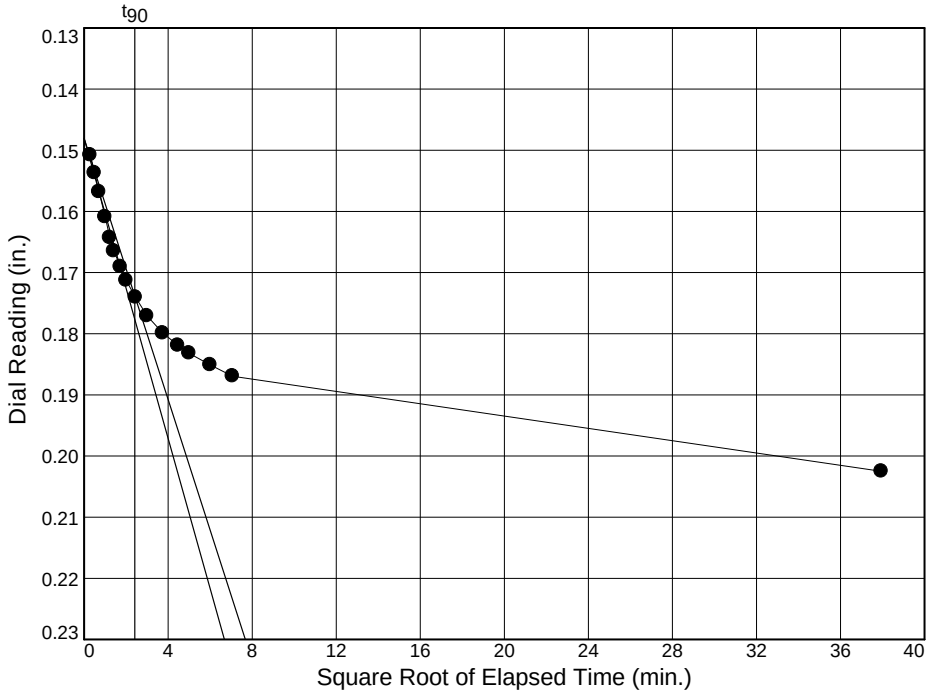
Figure C1567-12

Thielsch Engineering Inc.

Dial Reading vs. Time

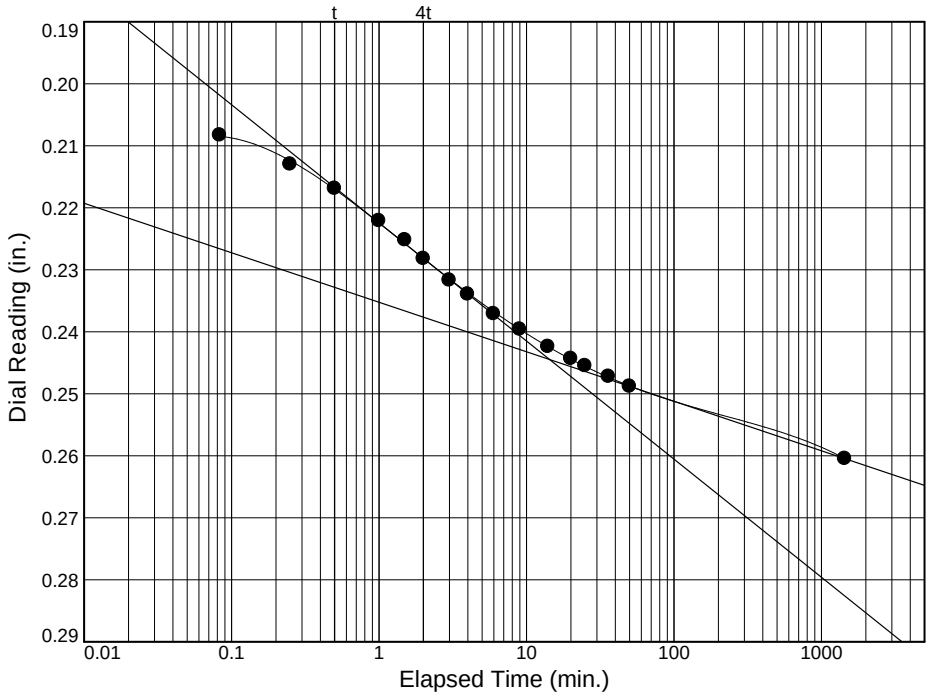
Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 22-24 Sample Number: RTG-SB-01 / ST-2



Load No.= 12
Load= 4.00 tsf
D_0 = 0.1481
D_{90} = 0.1738
D_{100} = 0.1767
T_{90} = 5.83 min.

C_v @ T_{90}
0.0017 $cm.^2$/sec.



Load No.= 13
Load= 8.00 tsf
D_0 = 0.2058
D_{50} = 0.2251
D_{100} = 0.2445
T_{50} = 1.39 min.

C_v @ T_{50}
0.0014 $cm.^2$/sec.

C_α = 0.026

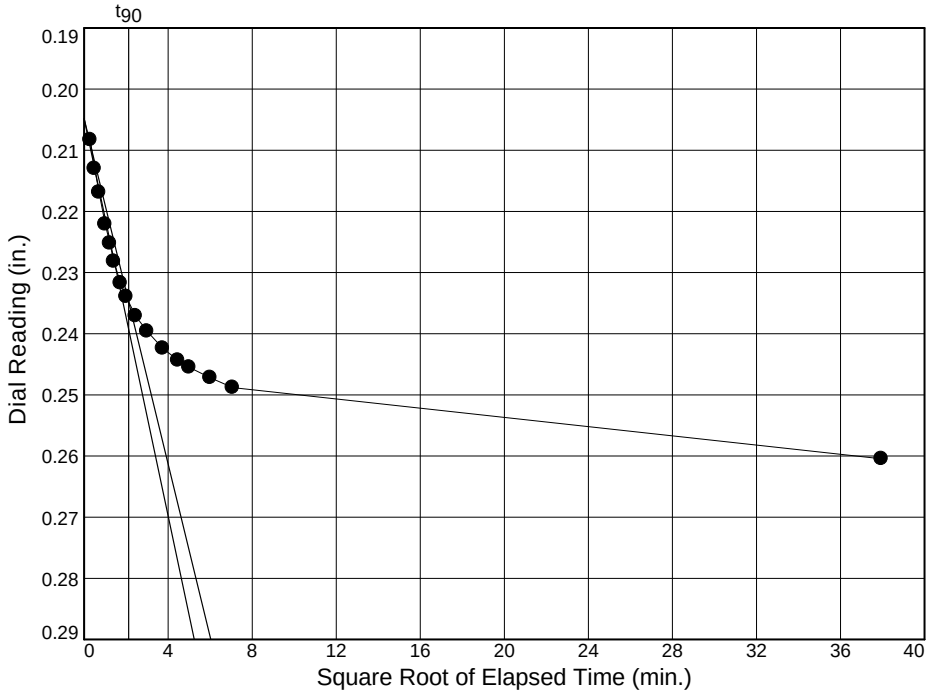
Figure C1567-13

Thielsch Engineering Inc.

Dial Reading vs. Time

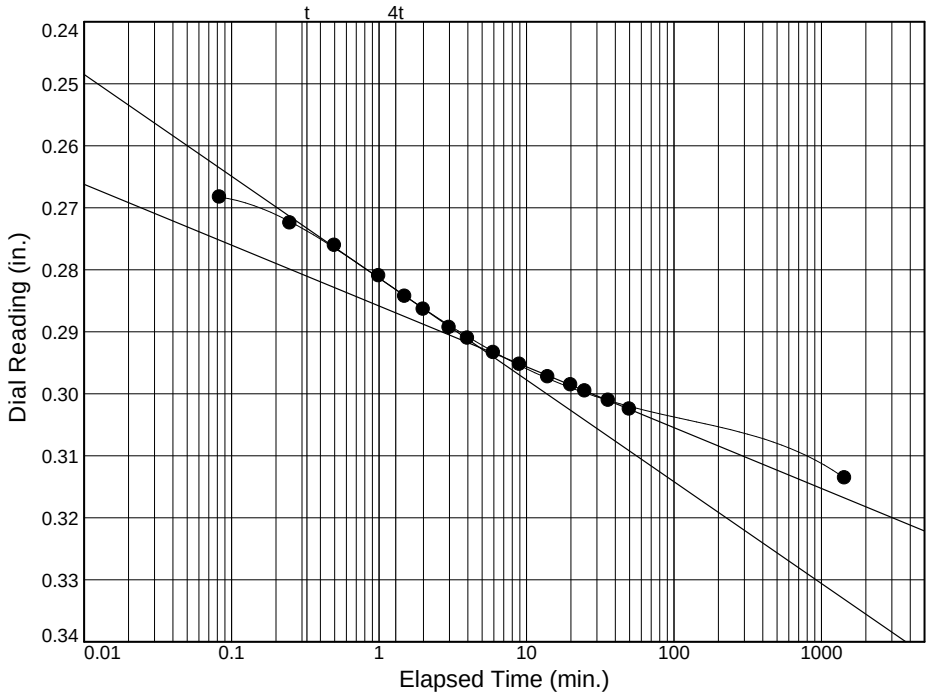
Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 22-24 Sample Number: RTG-SB-01 / ST-2



Load No.= 13
Load= 8.00 tsf
D_0 = 0.2048
D_{90} = 0.2348
D_{100} = 0.2381
T_{90} = 4.49 min.

C_v @ T_{90}
0.0018 $cm.^2$/sec.



Load No.= 14
Load= 16.00 tsf
D_0 = 0.2643
D_{50} = 0.2784
D_{100} = 0.2925
T_{50} = 0.66 min.

C_v @ T_{50}
0.0024 $cm.^2$/sec.

C_α = 0.032

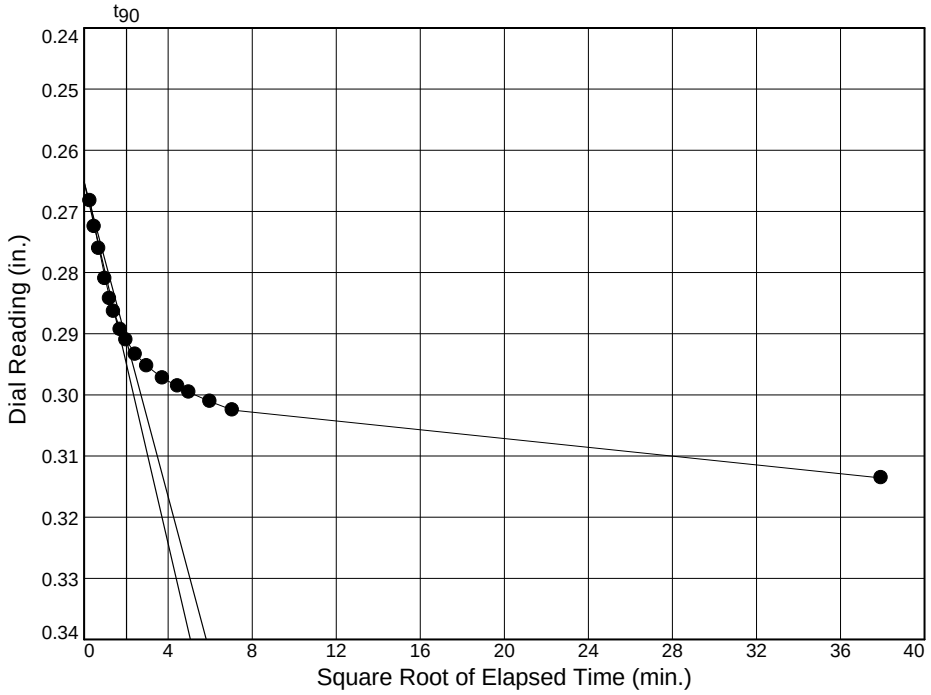
Figure C1567-14

Thielsch Engineering Inc.

Dial Reading vs. Time

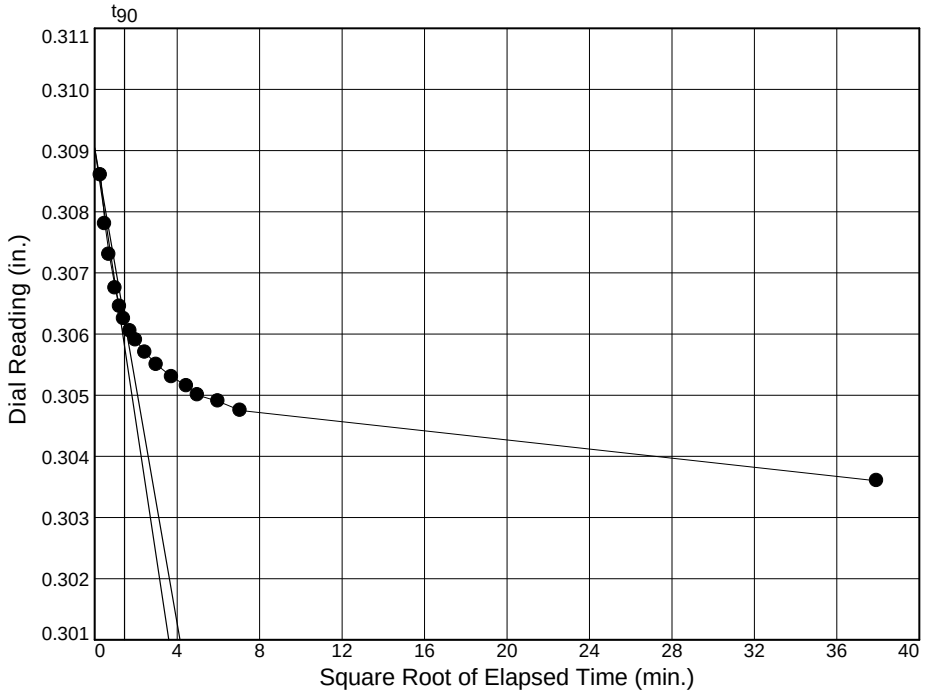
Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 22-24 Sample Number: RTG-SB-01 / ST-2



Load No.= 14
Load= 16.00 tsf
D_0 = 0.2652
D_{90} = 0.2911
D_{100} = 0.2940
T_{90} = 4.06 min.

C_v @ T_{90}
0.0017 $cm.^2/sec.$



Load No.= 15
Load= 4.00 tsf
D_0 = 0.3090
D_{90} = 0.3062
D_{100} = 0.3059
T_{90} = 2.09 min.

C_v @ T_{90}
0.0029 $cm.^2/sec.$

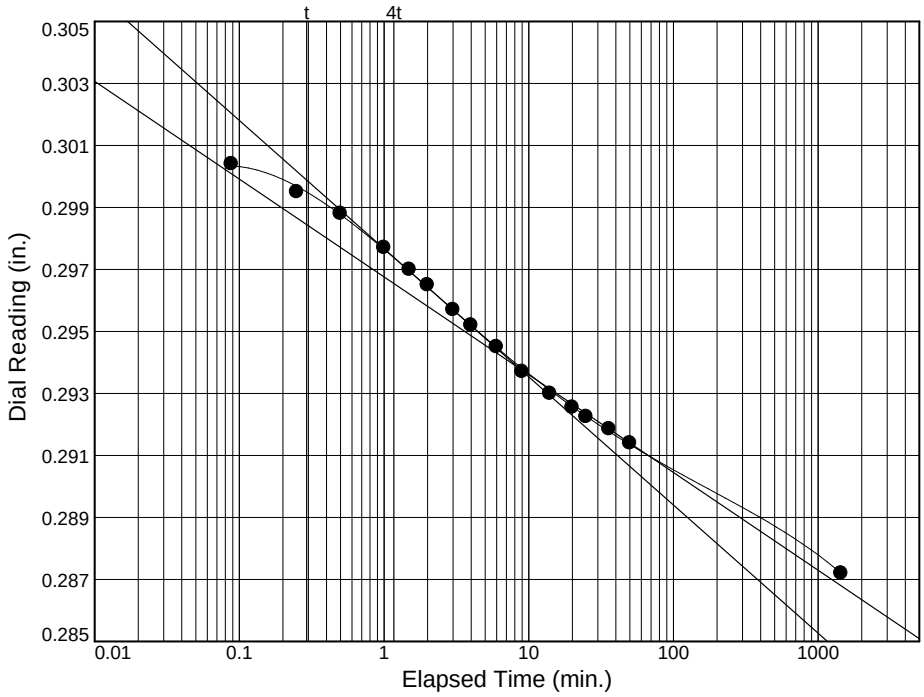
Figure C1567-15

Thielsch Engineering Inc.

Dial Reading vs. Time

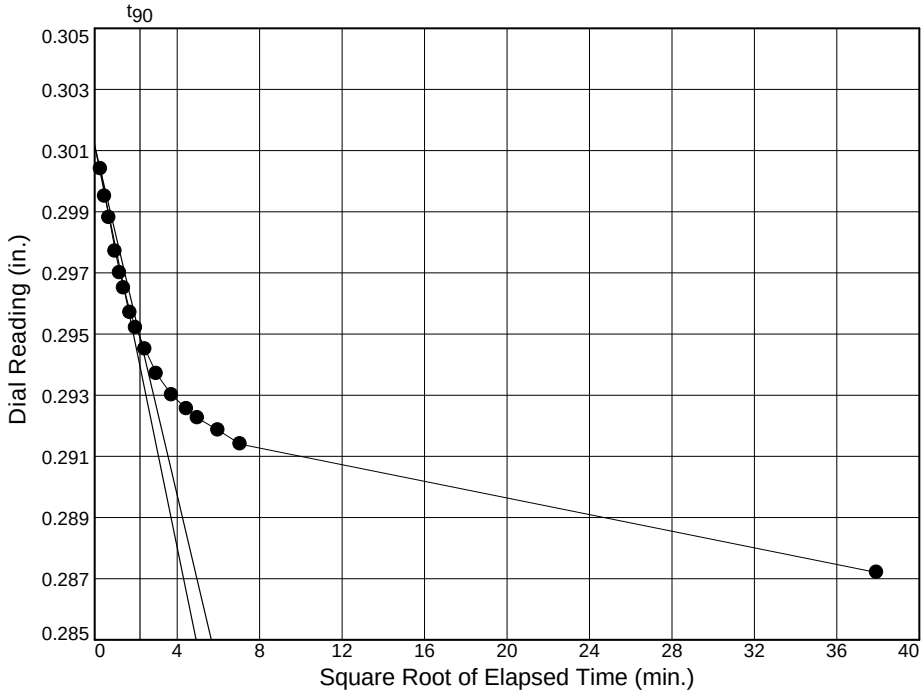
Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 22-24 Sample Number: RTG-SB-01 / ST-2



Load No.= 16
Load= 1.00 tsf
D_0 = 0.3016
D_{50} = 0.2977
D_{100} = 0.2938
T_{50} = 0.96 min.

C_v @ T_{50}
0.0015 cm.^{2}/sec.



Load No.= 16
Load= 1.00 tsf
D_0 = 0.3012
D_{90} = 0.2949
D_{100} = 0.2942
T_{90} = 4.83 min.

C_v @ T_{90}
0.0013 cm.^{2}/sec.

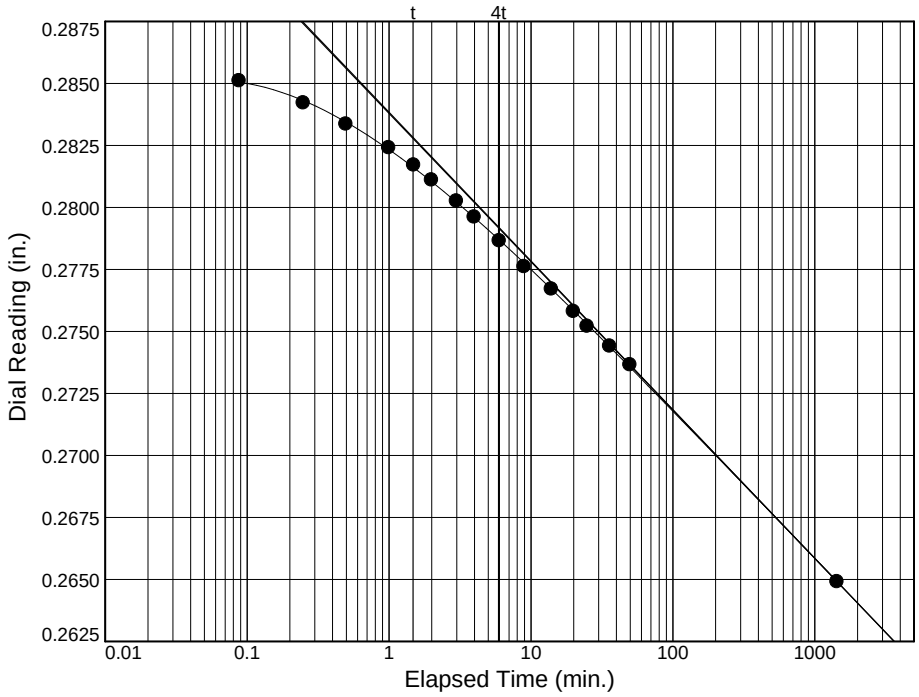
Figure C1567-16

Thielsch Engineering Inc.

Dial Reading vs. Time

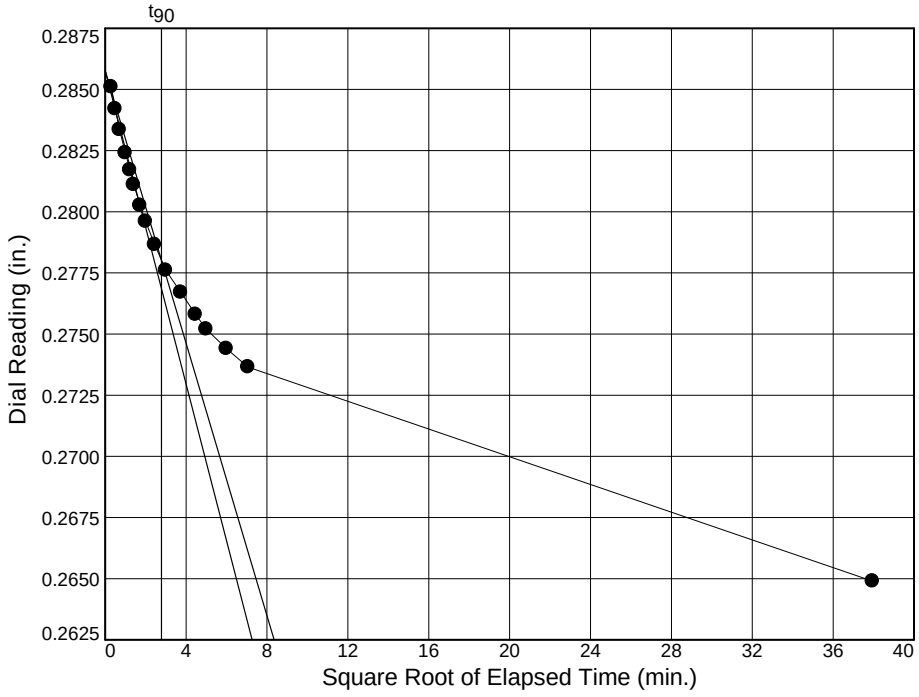
Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 22-24 Sample Number: RTG-SB-01 / ST-2



Load No.= 17
Load= 0.25 tsf
D_0 = 0.2845
D_{50} = 0.2758
D_{100} = 0.2671
T_{50} = 20.07 min.

C_v @ T_{50}
0.0001 cm.^{2}/sec.



Load No.= 17
Load= 0.25 tsf
D_0 = 0.2858
D_{90} = 0.2780
D_{100} = 0.2772
T_{90} = 7.75 min.

C_v @ T_{90}
0.0009 cm.^{2}/sec.

Figure C1567-17

Thielsch Engineering Inc.

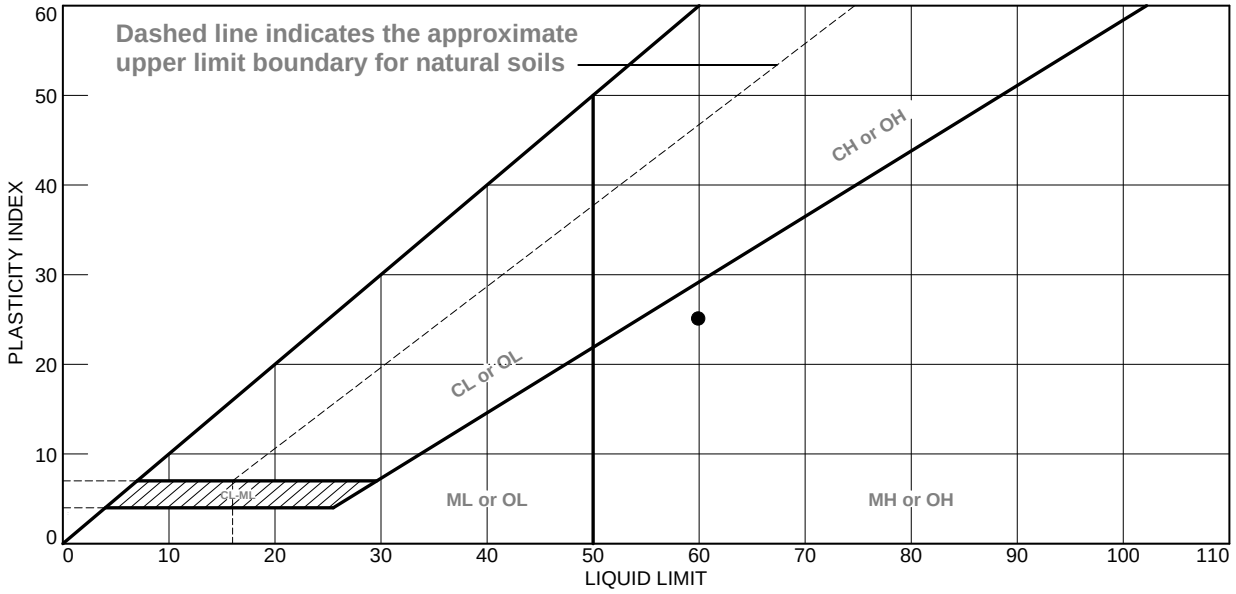
LABORATORY TUBE SUMMARY SHEET

Project Name: Mill River District Flood Resiliency Improvements | Project Location: New Haven, CT | Reviewed By: [signature]
Project No.: 74-16-0002.09 | Assigned By: D. Arpin | Date Reviewed: 12.6.16
Project Manager: David Arpin, P.E. | Date: 12.6.16 | Client: RT Group

Boring/ Test Pit No.	Sample No.	Depth ft.	Laboratory No.	Identification Tests: Water Content %	LL %	PL %	Gravel %	Sand %	Silt %	Clay %	Dry unit wt. pcf	Strength Tests: Torvane or Type Test	σ_c psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	Consol. $\frac{C_c}{1+e_0}$	Laboratory Log and Soil Description
RTG-OW-02	ST-2	19-21	16-S-1569		Average Total Unit Weight (19.0-21.0') = 98.6 pcf													
																		(19'-0" - 21'-0") Dark Grey Organic SILT
																		some shells and reeds
		19'-4"		77.3								Tv = .050 tsf						
		19'-5" to 19'-6"		58.2	60	35												Dark Grey Organic SILT with sand (OH)
		19'-6" to 19'-8"		65.0			0.1	24.5	59.1	16.3								Dark Grey Organic SILT with sand (OH)
		19'-9" to 19'-11"																large shells
		19'-11"										Pen = 0.50 tsf						
		20'-0" to 20'-5"		59.4							64.2	CIU	1901	σ_1-σ_3 Max	1556	11.8		Dark Grey Organic SILT with sand (OH)
		20'-5" to 20'-9"																Consolidation (See Test Summary Page)
		20'-10"		72.9								Tv = .100 tsf						
		20'-11"										Pen = 0.25 tsf						

THIELSCH ENGINEERING
195 Frances Avenue
Cranston, RI 02910
401-467-6454

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark Grey Organic elastic silt with sand (OH)	60	35	25	98.9	75.4	

Project No. 74-16- **Client:** RT GROUP

Project: Mill River Dist

Source of Sample: Borings **Depth:** 19-21
Sample Number: RTG-OW-02 / ST-2

Thielsch Engineering Inc.

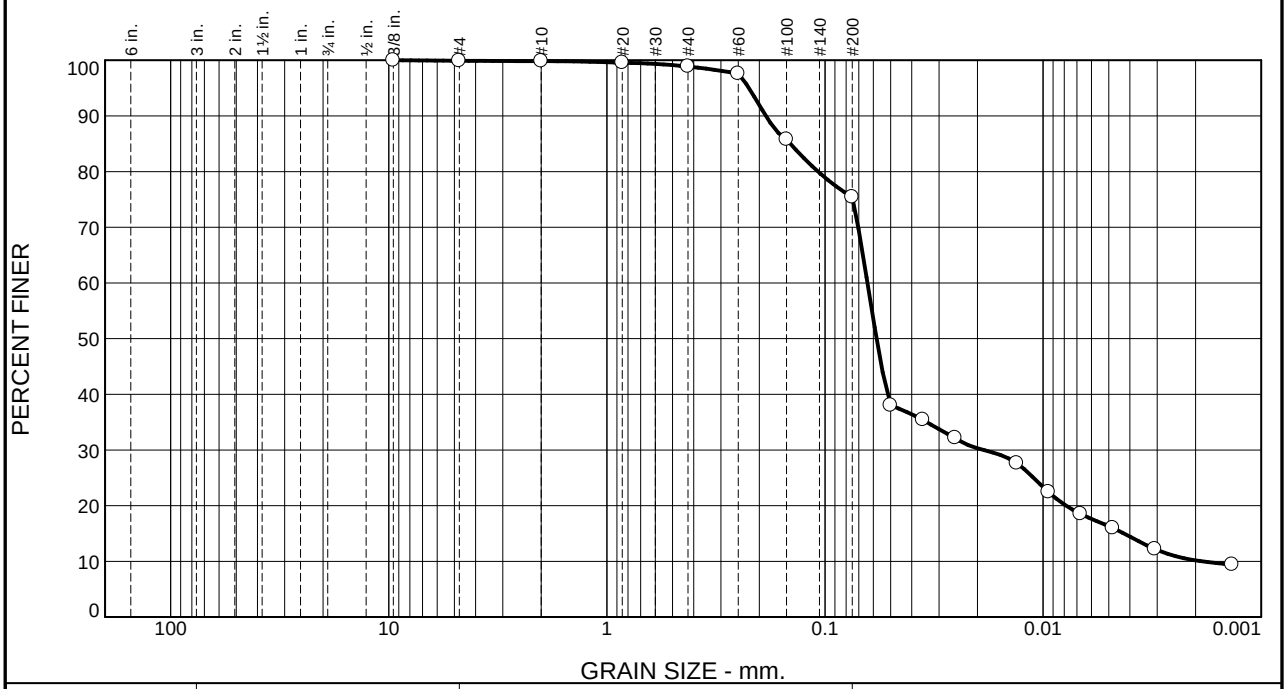
Cranston, RI

Remarks:

Figure L-1569

Tested By: RR **Checked By:** MJC

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.1	0.1	0.9	23.5	59.1	16.3

TEST RESULTS (D6913)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
0.375	100.0		
#4	99.9		
#10	99.8		
#20	99.5		
#40	98.9		
#60	97.6		
#100	85.8		
#200	75.4		
0.0500 mm.	38.0		
0.0355 mm.	35.4		
0.0253 mm.	32.2		
0.0132 mm.	27.6		
0.0095 mm.	22.4		
0.0067 mm.	18.5		
0.0048 mm.	16.0		
0.0031 mm.	12.2		
0.0014 mm.	9.4		

* (no specification provided)

Material Description

Dark Grey Organic elastic silt with sand (OH)

Atterberg Limits (ASTM D 4318)

PL= 35 **LL=** 60 **PI=** 25

Classification

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

Coefficients

D_{90}= 0.1866 D_{85}= 0.1441 D_{60}= 0.0639
D_{50}= 0.0581 D_{30}= 0.0187 D_{15}= 0.0043
D_{10}= 0.0019 C_u= 34.19 C_c= 2.94

Remarks

Date Received: 11.10.16 **Date Tested:** 11.21.16

Tested By: IA

Checked By: MJC

Title: Laboratory Manager

Source of Sample: Borings **Depth:** 19-21 **Date Sampled:** 11.10.16

Sample Number: RTG-OW-02 / ST-2

Thielsch Engineering Inc.

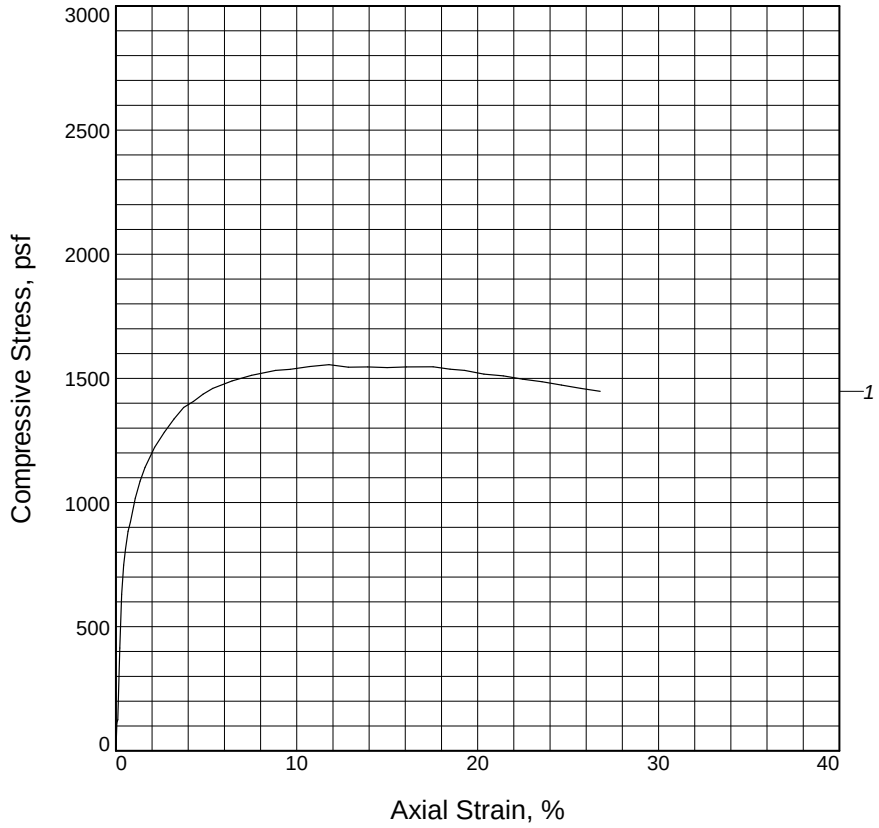
Cranston, RI

Client: RT GROUP

Project: Mill River Dist

Project No: 74-16-0002.09 **Figure** SH-1569

CU WITH PORE PRESSURES TEST



Sample No.	1			
Fail. Stress, psf	1556			
Ult. Stress, psf				
Cell pressure, psf	13421			
Strain rate, in./min.	0.01			
Water content, %	59.4			
Wet density, pcf	102.4			
Dry density, pcf	64.2			
Saturation, %	101.2			
Void ratio	1.5266			
Specimen diameter, in.	1.96			
Specimen height, in.	3.94			
Height/diameter ratio	2.01			

Description: Dark Grey Organic elastic silt with sand (OH)

LL = 60	**PL =** 35	**PI =** 25	**Assumed GS=** 2.6	**Type:** Tube Sample

Project No.: 74-16-0002.09

Date Sampled: 11.10.16

Remarks:

Figure CIU-1569

Client: RT GROUP

Project: Mill River Dist

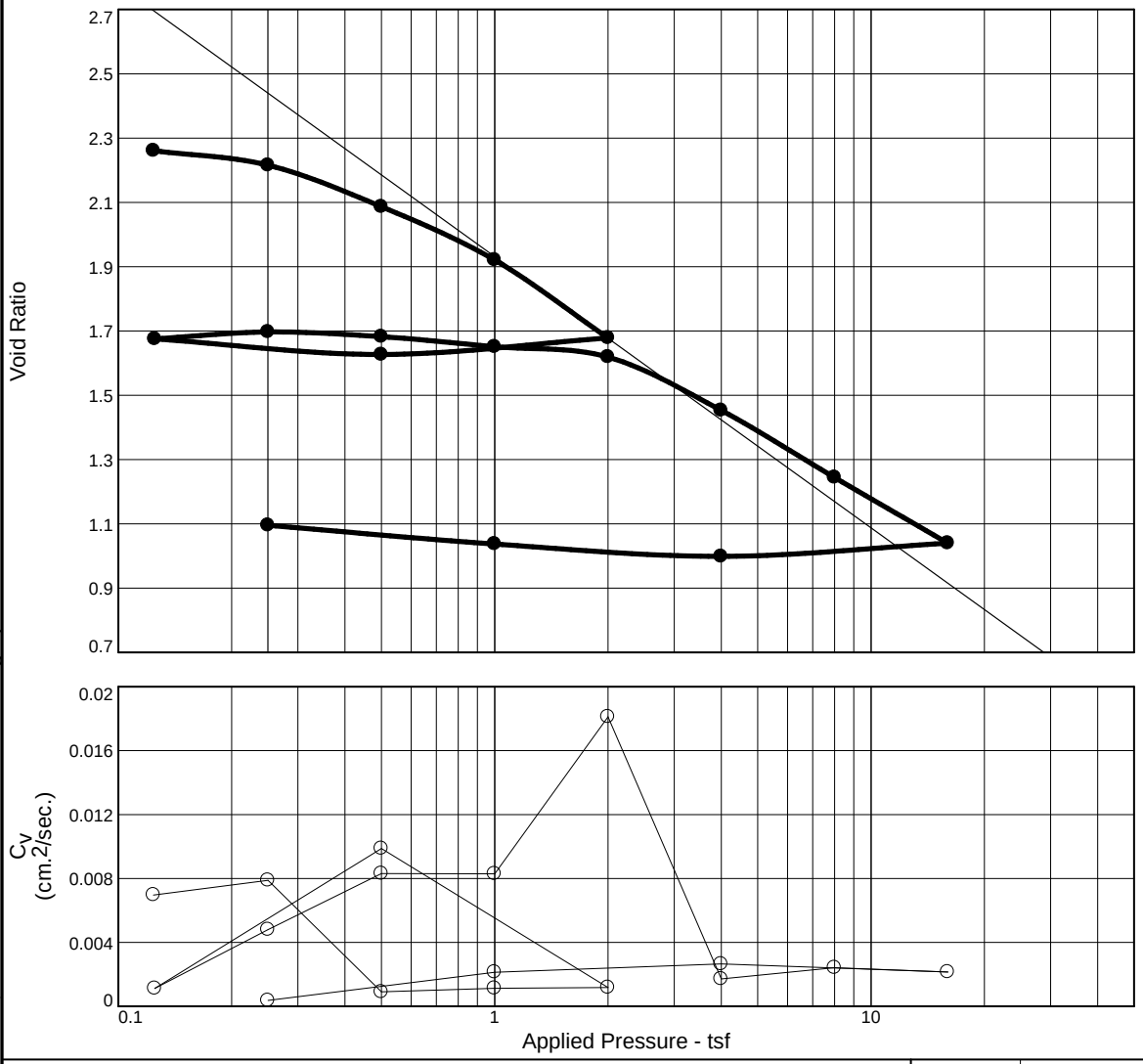
Source of Sample: Borings **Depth:** 19-21

Sample Number: RTG-OW-02 / ST-2

CU WITH PORE PRESSURES TEST
Thielsch Engineering Inc.
Cranston, RI

Tested By: RR **Checked By:** MJC

CONSOLIDATION TEST REPORT



MATERIAL DESCRIPTION	USCS	AASHTO
Dark Grey Organic elastic silt with sand (OH)	MH	A-7-5(21)

LL	PI	Sp. Gr.	Overburden (tsf)	Dry Dens. (pcf)		Moisture		Saturation		Void Ratio		P_c (tsf)	C_c
				Init.	Final	Init.	Final	Init.	Final	Init.	Final		
60	25	2.609		49.3	+/- 74.4	91.9 %	54.4	104.0	100.0	2.306	1.096	0.5	0.84

Preparation Process: Trimmed using a trimming turntable

Condition of Test: Saturated at 2 tsf

D2435 Method	C_r	Swell Press. (tsf)	%
A	0.18		

Project No. 74-16- **Client:** RT GROUP

Project: Mill River Dist

Source: Borings **Depth:** 19-21 **Sample No.:** RTG-OW-02 / ST-2

Thielsch Engineering Inc.

Cranston, RI

Remarks:
Full 16 Day Load Cycle

Checked By: MJC

Title: Laboratory Manager

Figure C1569-1

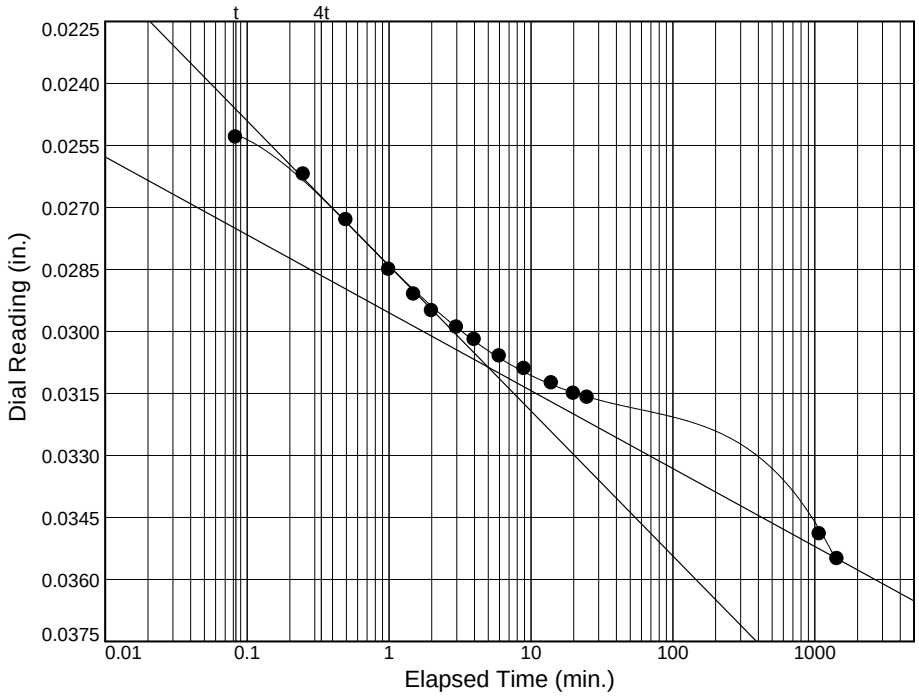
Material indices generated by GEOSYSTEM software, use at own discreation for design parameters.

Tested By: RR

Dial Reading vs. Time

Project No.: 74-16-0002.09
Project: Mill River Dist

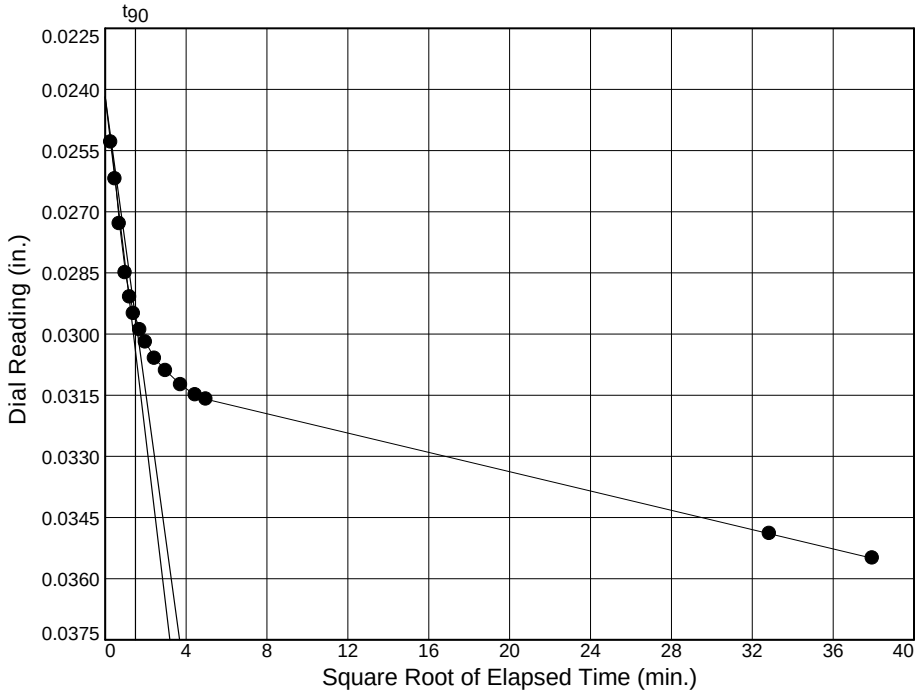
Source of Sample: Borings Depth: 19-21 Sample Number: RTG-OW-02 / ST-2



Load No.= 1
Load= 0.12 tsf
D_0 = 0.0237
D_{50} = 0.0273
D_{100} = 0.0309
T_{50} = 0.48 min.

C_v @ T_{50}
0.0070 cm.^{2}/sec.

C_α = 0.008



Load No.= 1
Load= 0.12 tsf
D_0 = 0.0242
D_{90} = 0.0296
D_{100} = 0.0302
T_{90} = 2.24 min.

C_v @ T_{90}
0.0064 cm.^{2}/sec.

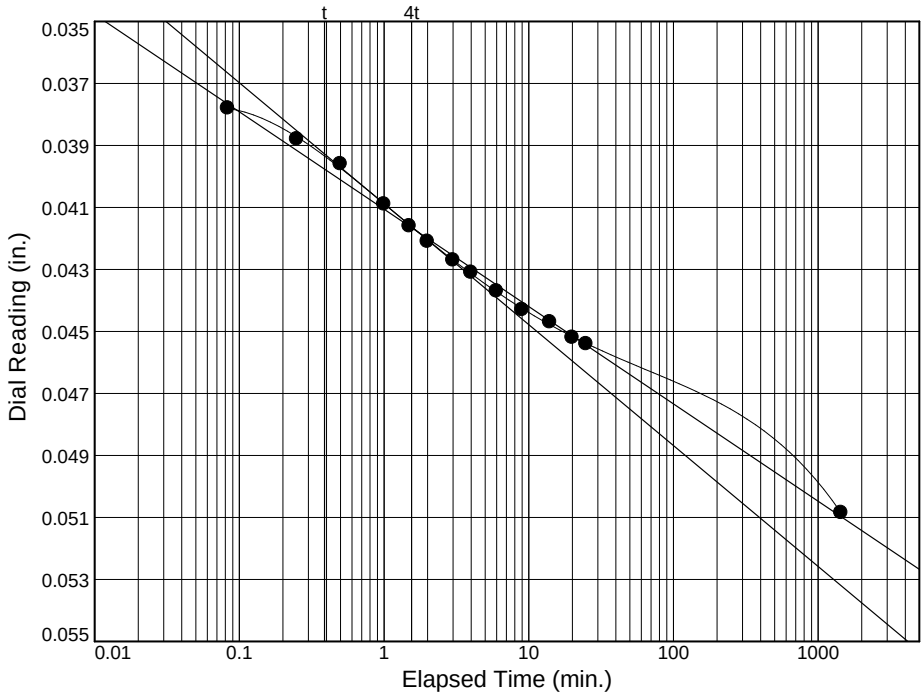
Figure C1569-2

Thielsch Engineering Inc.

Dial Reading vs. Time

Project No.: 74-16-0002.09
Project: Mill River Dist

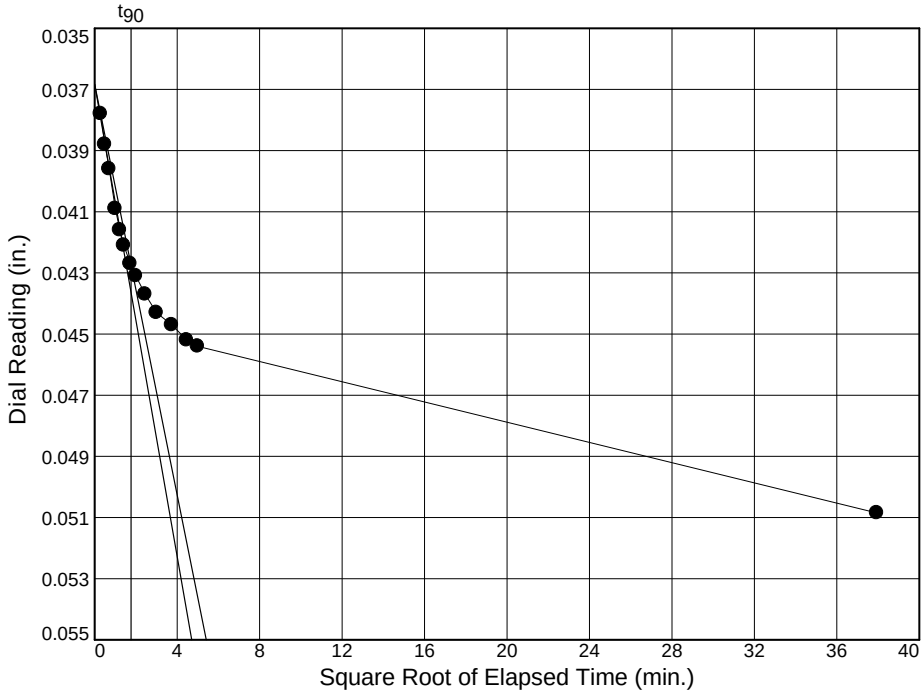
Source of Sample: Borings Depth: 19-21 Sample Number: RTG-OW-02 / ST-2



Load No.= 2
Load= 0.25 tsf
D_0 = 0.0371
D_{50} = 0.0394
D_{100} = 0.0418
T_{50} = 0.41 min.

C_v @ T_{50}
0.0079 cm.^{2}/sec.

C_α = 0.013



Load No.= 2
Load= 0.25 tsf
D_0 = 0.0368
D_{90} = 0.0427
D_{100} = 0.0434
T_{90} = 3.10 min.

C_v @ T_{90}
0.0045 cm.^{2}/sec.

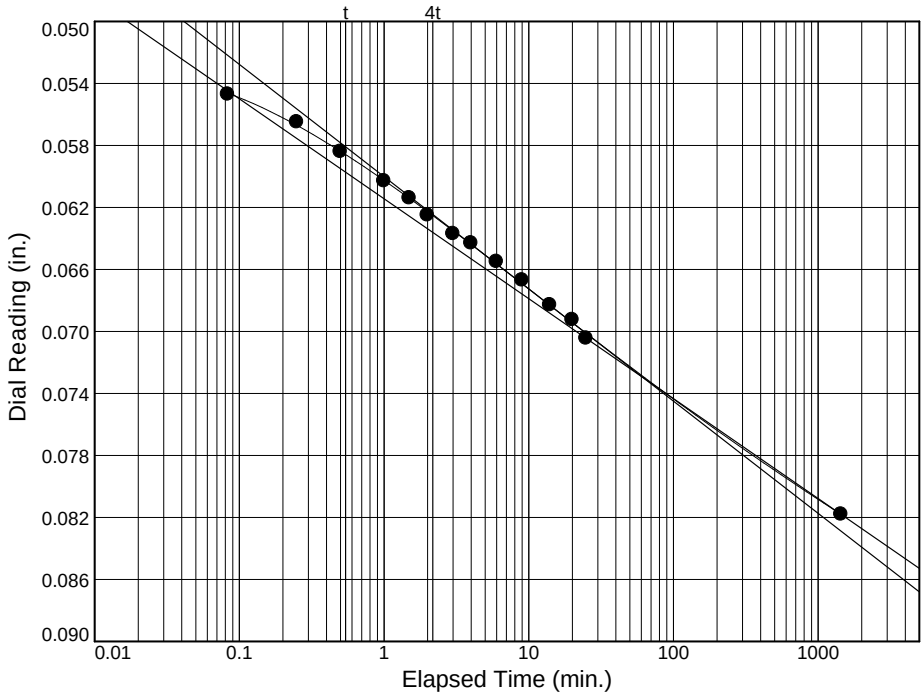
Figure C1569-3

Thielsch Engineering Inc.

Dial Reading vs. Time

Project No.: 74-16-0002.09
Project: Mill River Dist

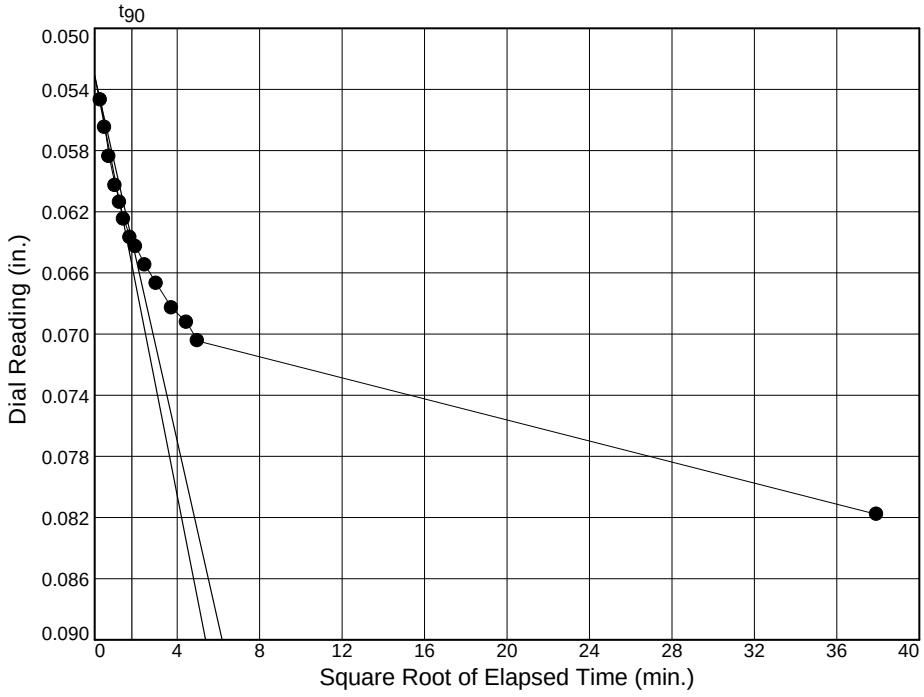
Source of Sample: Borings Depth: 19-21 Sample Number: RTG-OW-02 / ST-2



Load No.= 3
Load= 0.50 tsf
D_0 = 0.0547
D_{50} = 0.0638
D_{100} = 0.0730
T_{50} = 3.33 min.

C_v @ T_{50}
0.0009 cm.^{2}/sec.

C_α = 0.027



Load No.= 3
Load= 0.50 tsf
D_0 = 0.0531
D_{90} = 0.0639
D_{100} = 0.0651
T_{90} = 3.26 min.

C_v @ T_{90}
0.0041 cm.^{2}/sec.

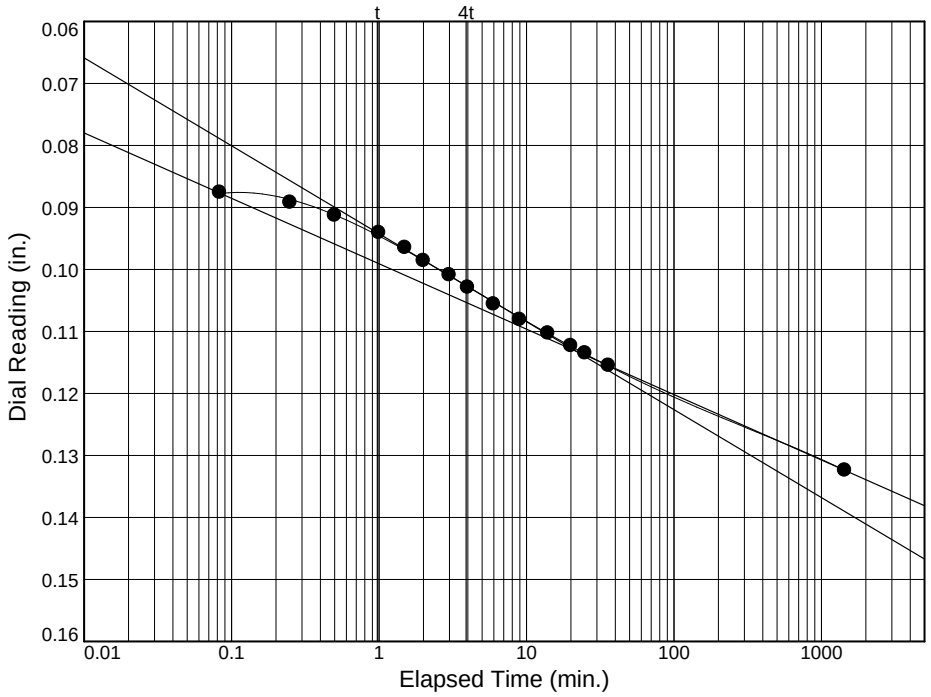
Figure C1569-4

Thielsch Engineering Inc.

Dial Reading vs. Time

Project No.: 74-16-0002.09
Project: Mill River Dist

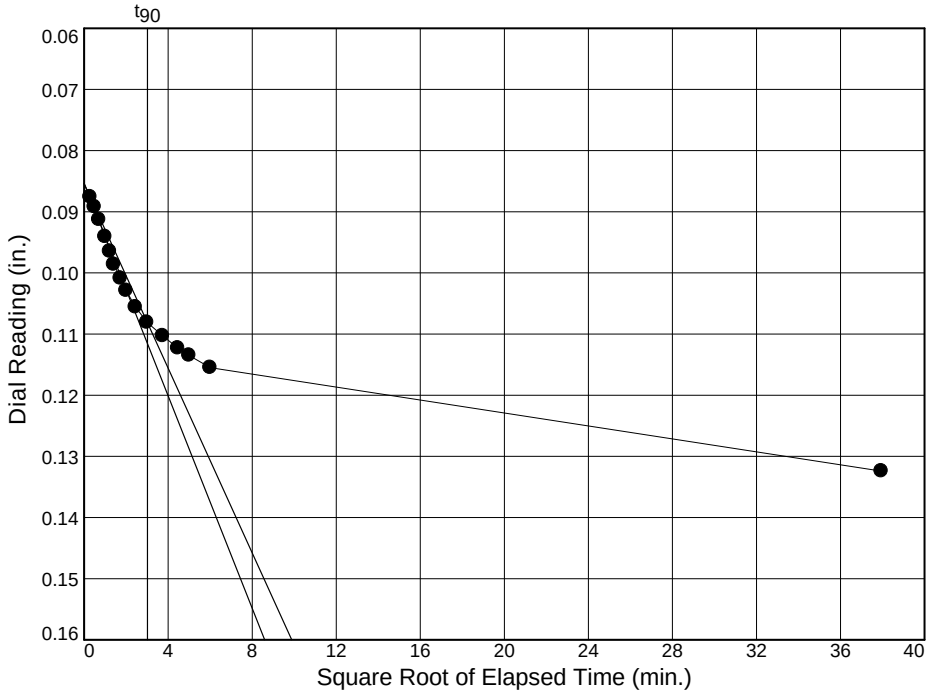
Source of Sample: Borings Depth: 19-21 Sample Number: RTG-OW-02 / ST-2



Load No.= 4
Load= 1.00 tsf
D_0 = 0.0863
D_{50} = 0.0997
D_{100} = 0.1131
T_{50} = 2.43 min.

C_v @ T_{50}
0.0011 cm.^{2}/sec.

C_α = 0.044



Load No.= 4
Load= 1.00 tsf
D_0 = 0.0854
D_{90} = 0.1081
D_{100} = 0.1107
T_{90} = 9.08 min.

C_v @ T_{90}
0.0013 cm.^{2}/sec.

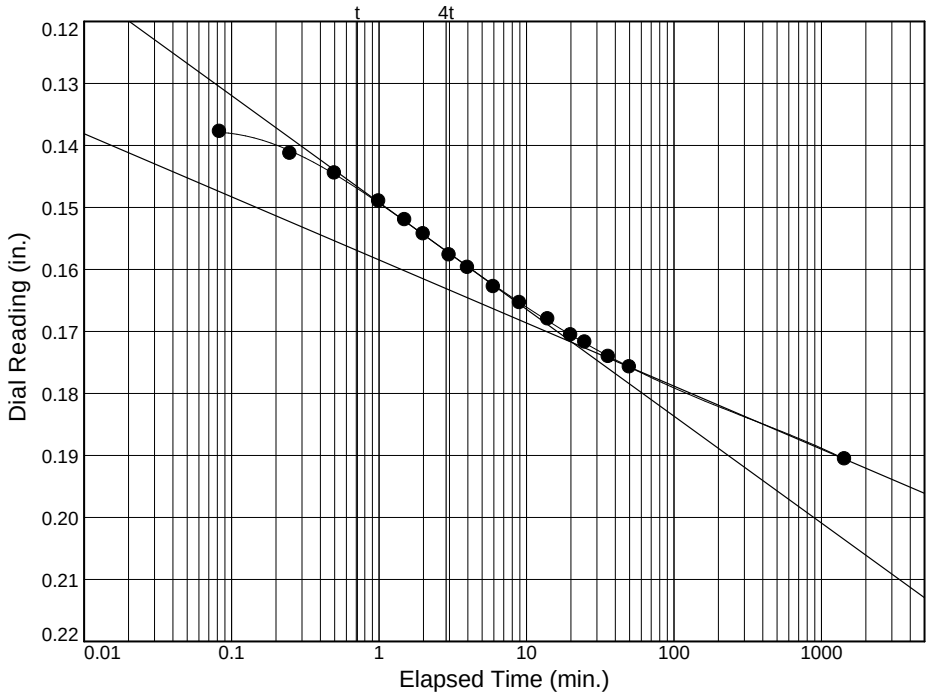
Figure C1569-5

Thielsch Engineering Inc.

Dial Reading vs. Time

Project No.: 74-16-0002.09
Project: Mill River Dist

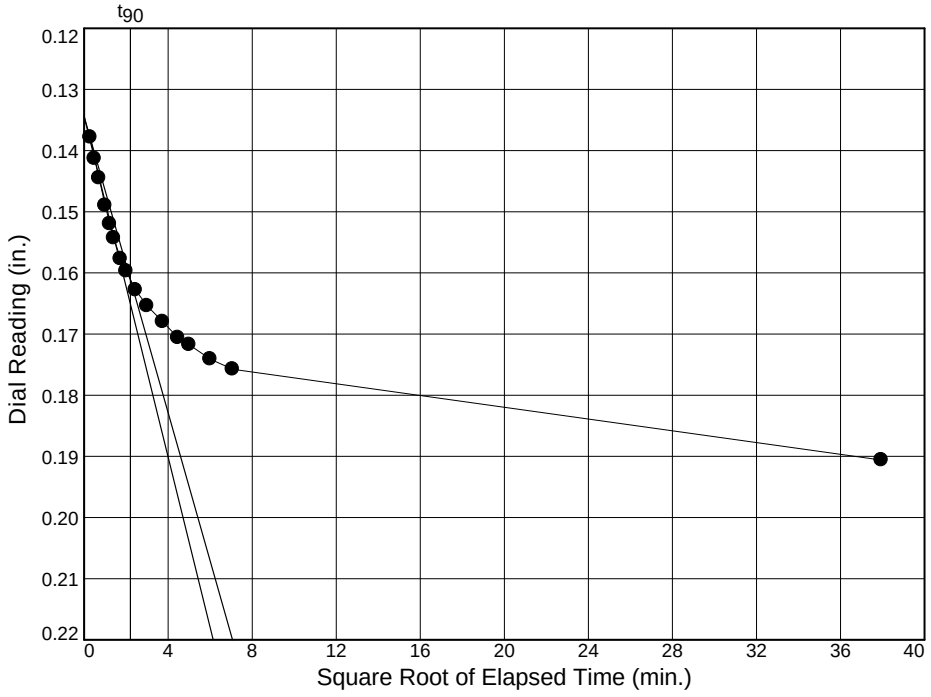
Source of Sample: Borings Depth: 19-21 Sample Number: RTG-OW-02 / ST-2



Load No.= 5
Load= 2.00 tsf
D_0 = 0.1369
D_{50} = 0.1543
D_{100} = 0.1718
T_{50} = 1.99 min.

C_v @ T_{50}
0.0012 cm.^{2}/sec.

C_α = 0.042



Load No.= 5
Load= 2.00 tsf
D_0 = 0.1344
D_{90} = 0.1611
D_{100} = 0.1641
T_{90} = 4.85 min.

C_v @ T_{90}
0.0021 cm.^{2}/sec.

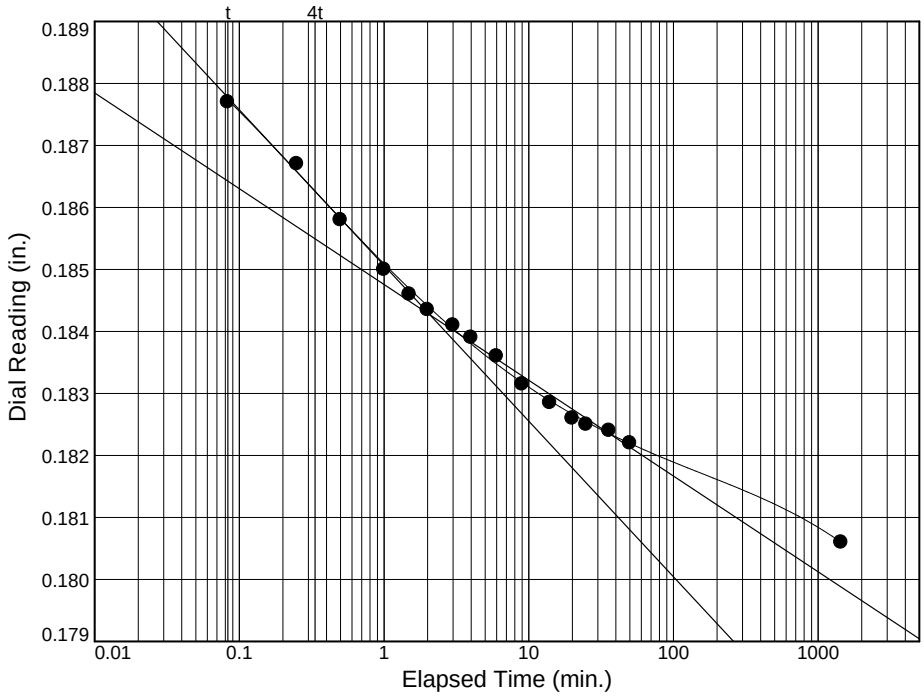
Figure C1569-6

Thielsch Engineering Inc.

Dial Reading vs. Time

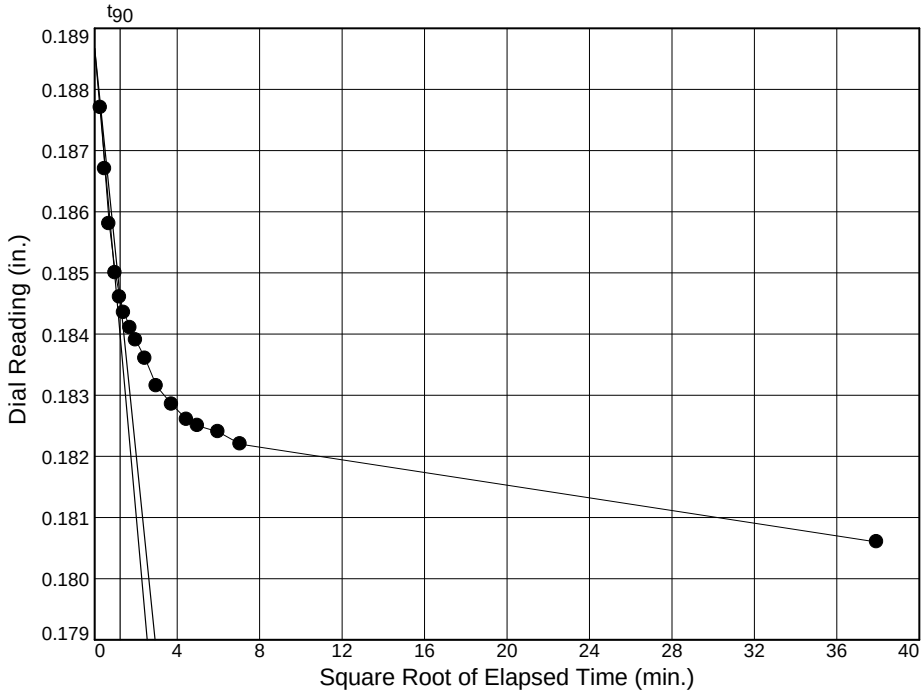
Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 19-21 Sample Number: RTG-OW-02 / ST-2



Load No.= 6
Load= 0.50 tsf
D_0 = 0.1892
D_{50} = 0.1867
D_{100} = 0.1843
T_{50} = 0.22 min.

C_v @ T_{50}
0.0099 cm.^{2}/sec.



Load No.= 6
Load= 0.50 tsf
D_0 = 0.1887
D_{90} = 0.1846
D_{100} = 0.1841
T_{90} = 1.53 min.

C_v @ T_{90}
0.0060 cm.^{2}/sec.

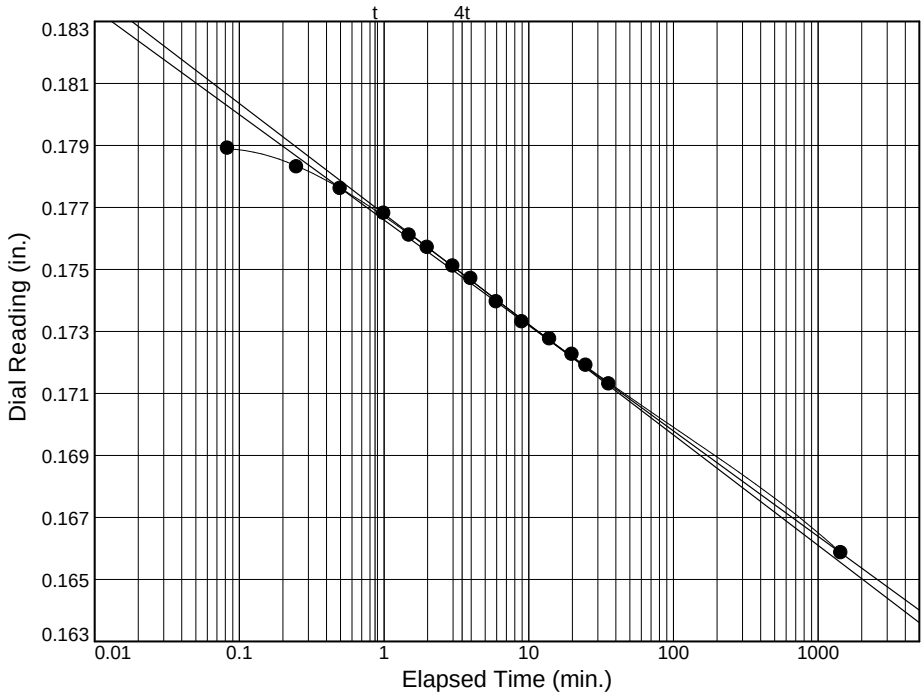
Figure C1569-7

Thielsch Engineering Inc.

Dial Reading vs. Time

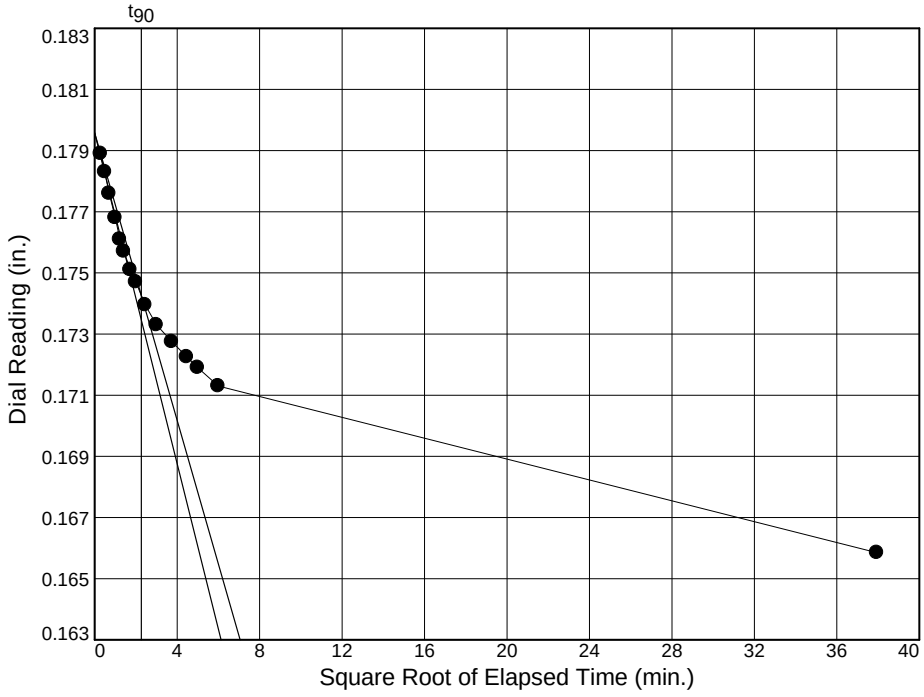
Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 19-21 Sample Number: RTG-OW-02 / ST-2



Load No.= 7
Load= 0.13 tsf
D_0 = 0.1790
D_{50} = 0.1757
D_{100} = 0.1725
T_{50} = 1.96 min.

C_v @ T_{50}
0.0011 cm.^{2}/sec.



Load No.= 7
Load= 0.13 tsf
D_0 = 0.1796
D_{90} = 0.1743
D_{100} = 0.1737
T_{90} = 5.11 min.

C_v @ T_{90}
0.0018 cm.^{2}/sec.

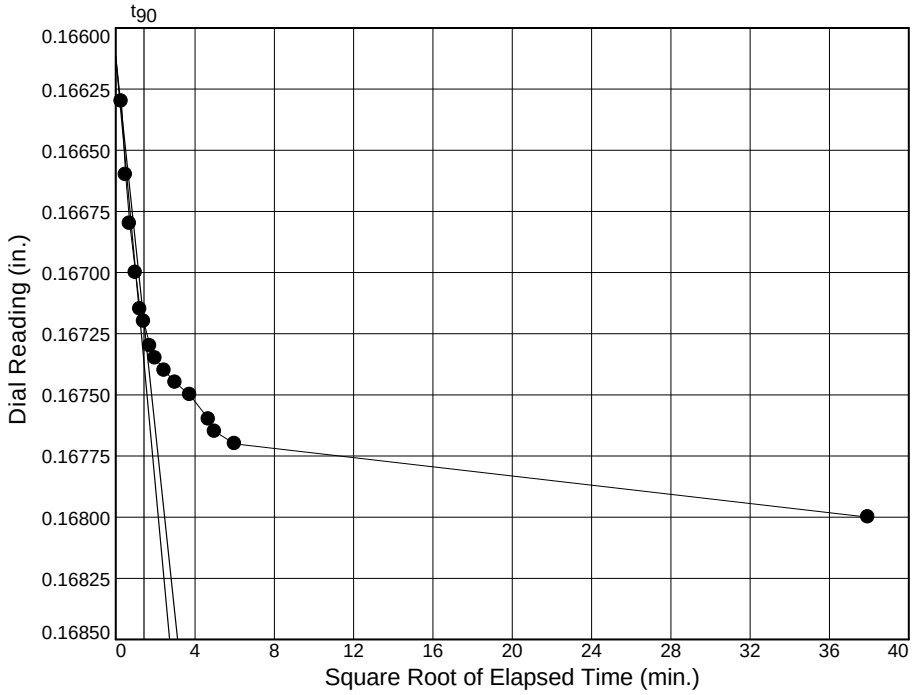
Figure C1569-8

Thielsch Engineering Inc.

Dial Reading vs. Time

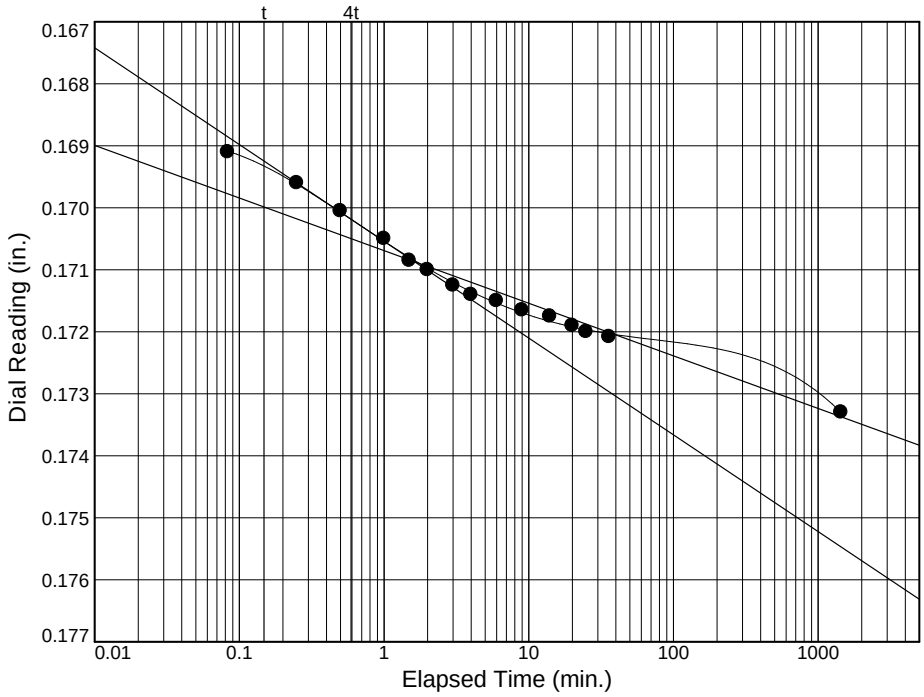
Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 19-21 Sample Number: RTG-OW-02 / ST-2



Load No.= 8
Load= 0.25 tsf
D_0 = 0.1661
D_{90} = 0.1672
D_{100} = 0.1673
T_{90} = 2.03 min.

C_v @ T_{90}
0.0048 cm.^{2}/sec.



Load No.= 9
Load= 0.50 tsf
D_0 = 0.1685
D_{50} = 0.1697
D_{100} = 0.1709
T_{50} = 0.27 min.

C_v @ T_{50}
0.0083 cm.^{2}/sec.

C_α = 0.004

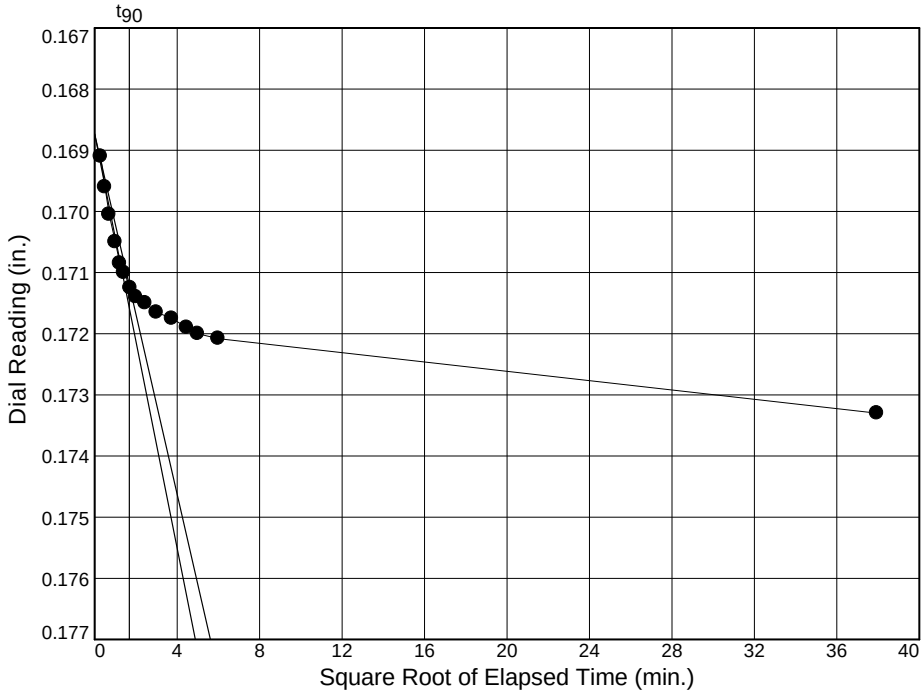
Figure C1569-9

Thielsch Engineering Inc.

Dial Reading vs. Time

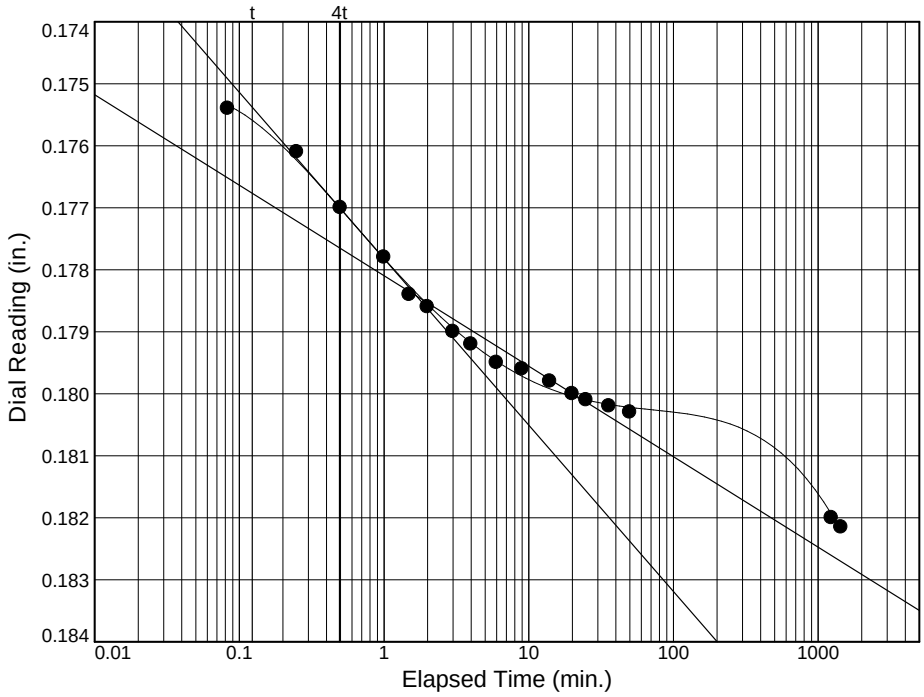
Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 19-21 Sample Number: RTG-OW-02 / ST-2



Load No.= 9
Load= 0.50 tsf
D_0 = 0.1687
D_{90} = 0.1712
D_{100} = 0.1715
T_{90} = 2.83 min.

C_v @ T_{90}
0.0034 $cm.^2/sec.$



Load No.= 10
Load= 1.00 tsf
D_0 = 0.1742
D_{50} = 0.1763
D_{100} = 0.1784
T_{50} = 0.26 min.

C_v @ T_{50}
0.0083 $cm.^2/sec.$

C_α = 0.006

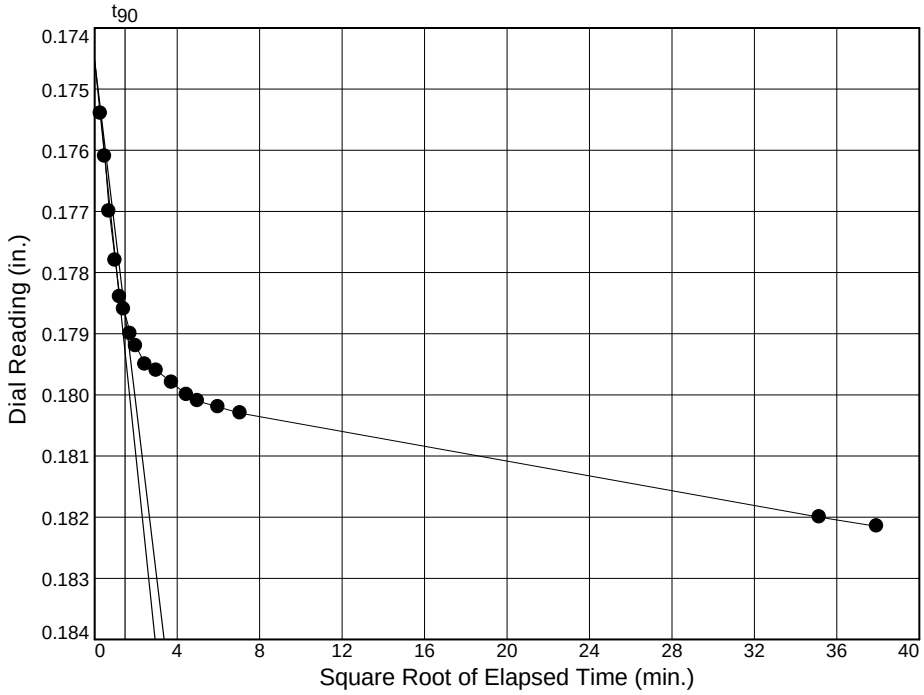
Figure C1569-10

Thielsch Engineering Inc.

Dial Reading vs. Time

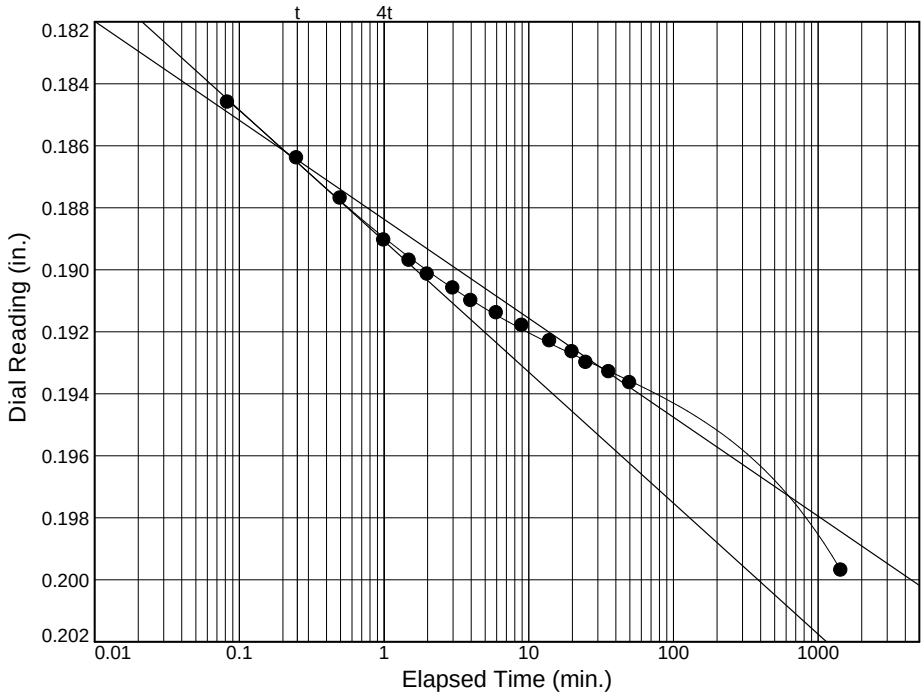
Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 19-21 Sample Number: RTG-OW-02 / ST-2



Load No.= 10
Load= 1.00 tsf
D_0 = 0.1745
D_{90} = 0.1787
D_{100} = 0.1791
T_{90} = 2.17 min.

C_v @ T_{90}
0.0043 cm.^{2}/sec.



Load No.= 11
Load= 2.00 tsf
D_0 = 0.1841
D_{50} = 0.1852
D_{100} = 0.1862
T_{50} = 0.12 min.

C_v @ T_{50}
0.0181 cm.^{2}/sec.

C_α = 0.013

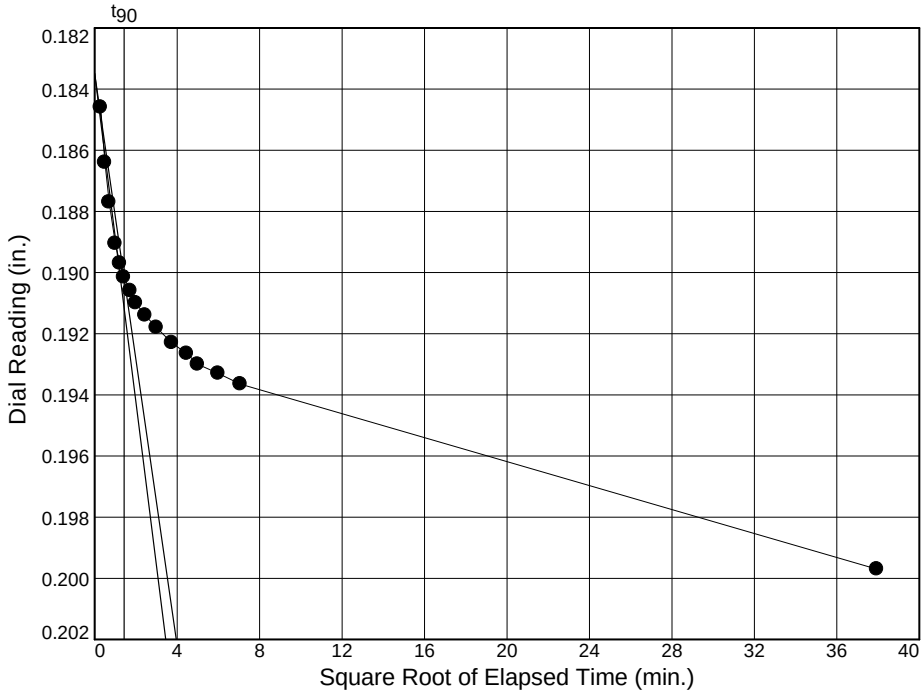
Figure C1569-11

Thielsch Engineering Inc.

Dial Reading vs. Time

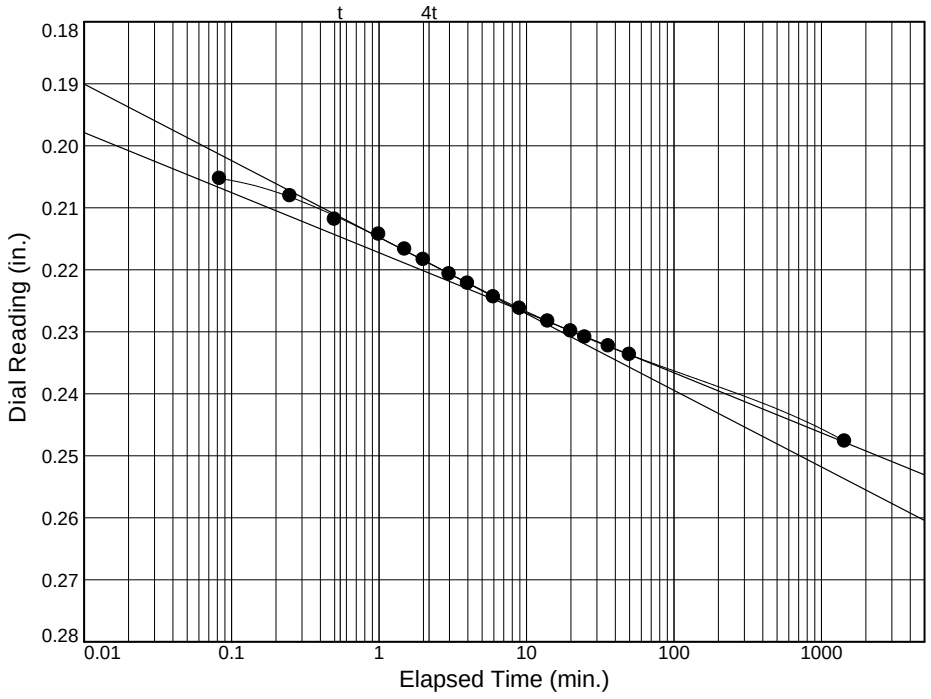
Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 19-21 Sample Number: RTG-OW-02 / ST-2



Load No.= 11
Load= 2.00 tsf
D_0 = 0.1835
D_{90} = 0.1902
D_{100} = 0.1909
T_{90} = 2.04 min.

C_v @ T_{90}
0.0045 cm.^{2}/sec.



Load No.= 12
Load= 4.00 tsf
D_0 = 0.2045
D_{50} = 0.2154
D_{100} = 0.2263
T_{50} = 1.13 min.

C_v @ T_{50}
0.0017 cm.^{2}/sec.

C_α = 0.040

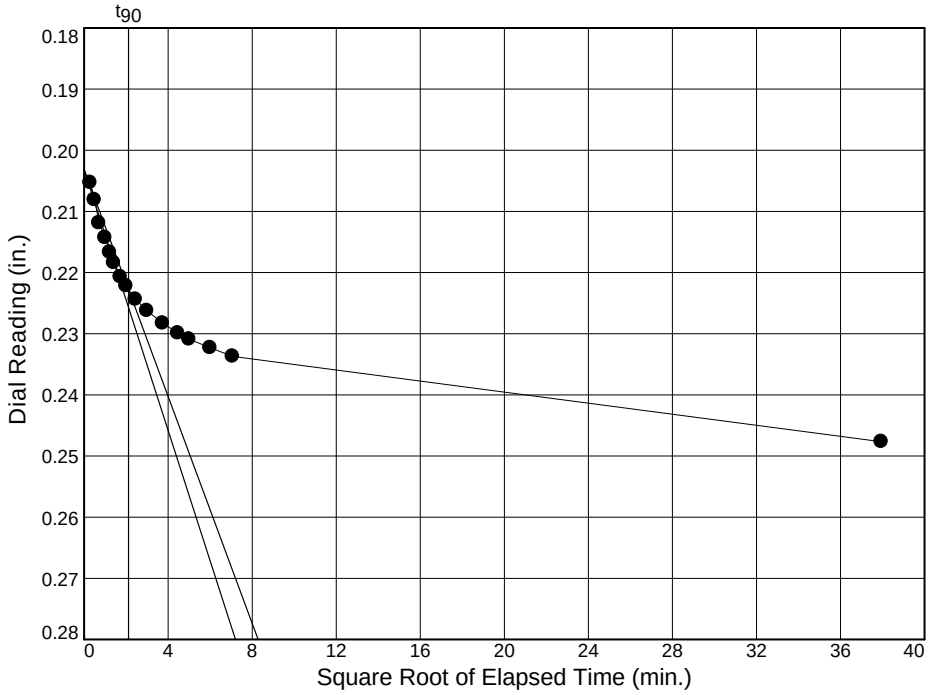
Figure C1569-12

Thielsch Engineering Inc.

Dial Reading vs. Time

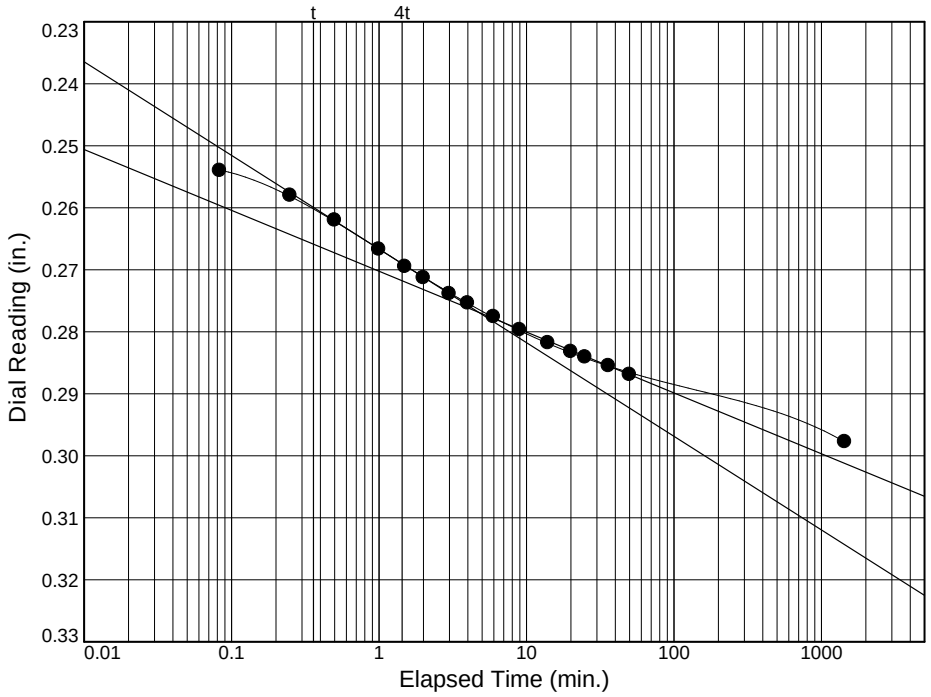
Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 19-21 Sample Number: RTG-OW-02 / ST-2



Load No.= 12
Load= 4.00 tsf
D_0 = 0.2032
D_{90} = 0.2227
D_{100} = 0.2249
T_{90} = 4.45 min.

C_v @ T_{90}
0.0019 cm.^{2}/sec.



Load No.= 13
Load= 8.00 tsf
D_0 = 0.2513
D_{50} = 0.2641
D_{100} = 0.2769
T_{50} = 0.68 min.

C_v @ T_{50}
0.0024 cm.^{2}/sec.

C_α = 0.041

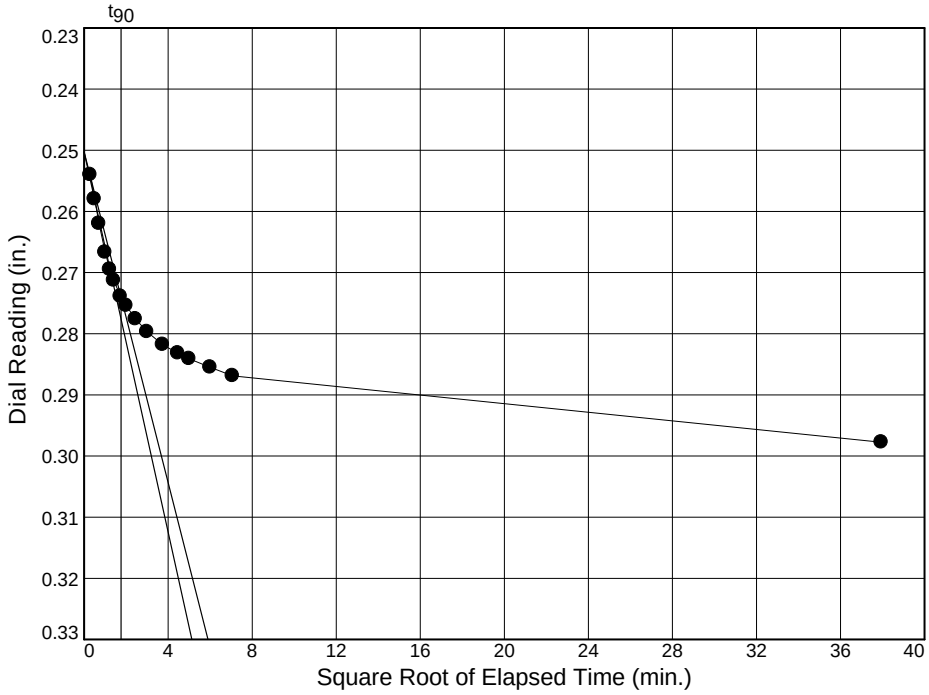
Figure C1569-13

Thielsch Engineering Inc.

Dial Reading vs. Time

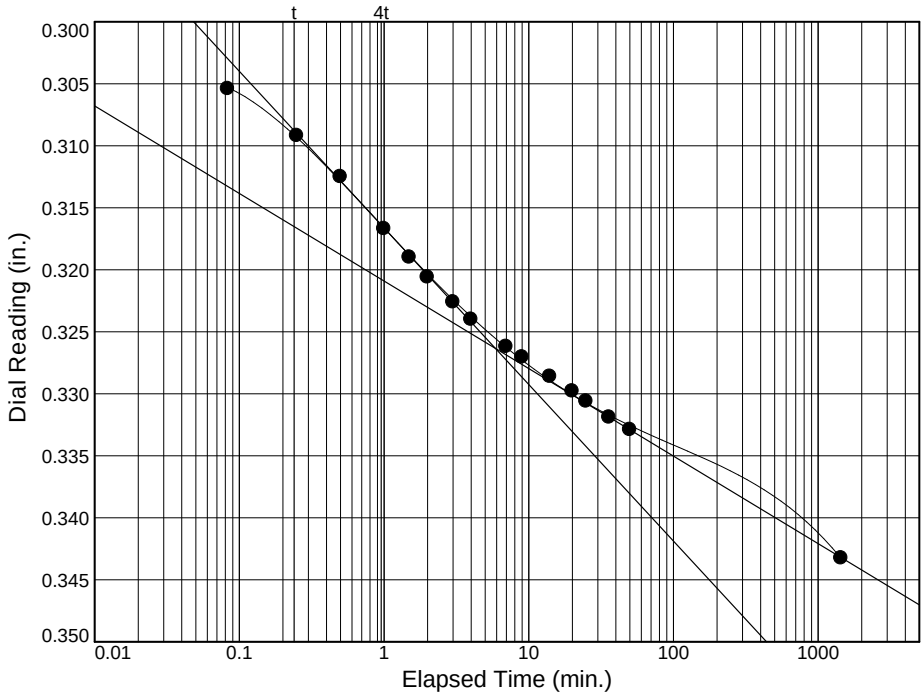
Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 19-21 Sample Number: RTG-OW-02 / ST-2



Load No.= 13
Load= 8.00 tsf
D_0 = 0.2503
D_{90} = 0.2740
D_{100} = 0.2767
T_{90} = 3.09 min.

C_v @ T_{90}
0.0023 cm.^{2}/sec.



Load No.= 14
Load= 16.00 tsf
D_0 = 0.3019
D_{50} = 0.3141
D_{100} = 0.3263
T_{50} = 0.63 min.

C_v @ T_{50}
0.0021 cm.^{2}/sec.

C_α = 0.029

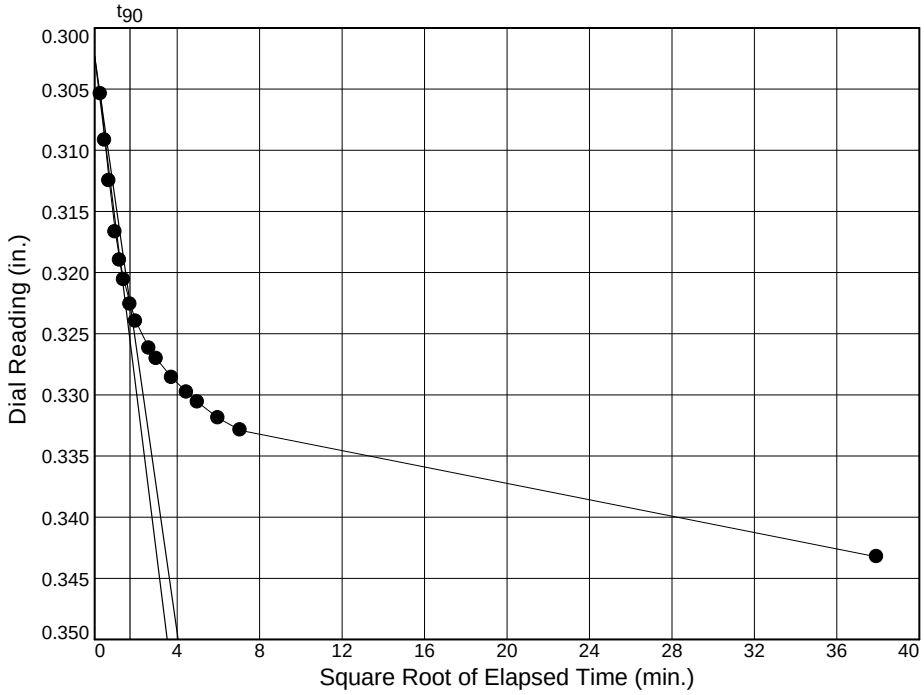
Figure C1569-14

Thielsch Engineering Inc.

Dial Reading vs. Time

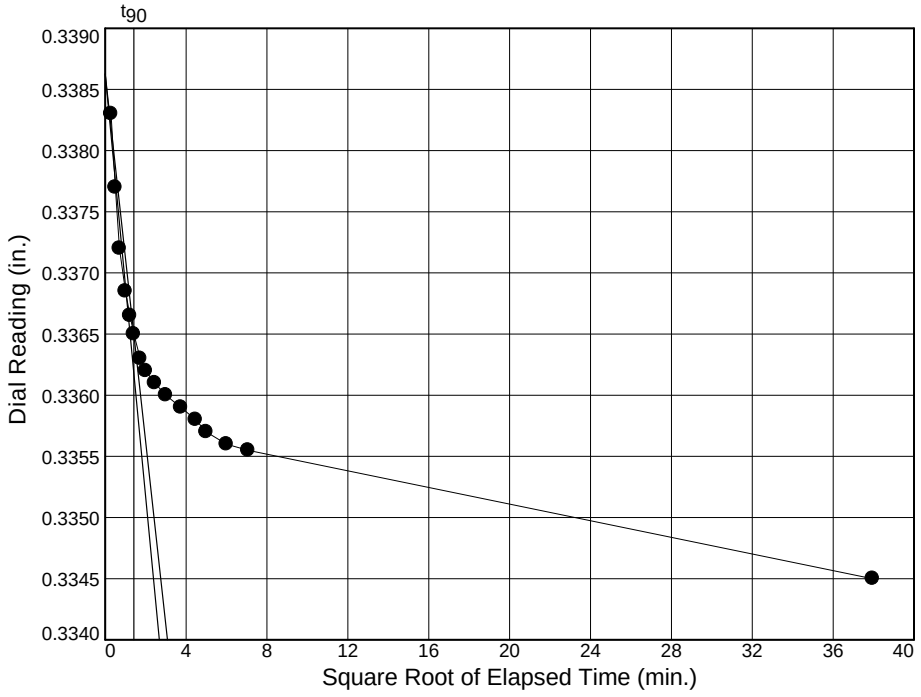
Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 19-21 Sample Number: RTG-OW-02 / ST-2



Load No.= 14
Load= 16.00 tsf
D_0 = 0.3023
D_{90} = 0.3225
D_{100} = 0.3247
T_{90} = 2.93 min.

C_v @ T_{90}
0.0020 $cm.^2/sec.$



Load No.= 15
Load= 4.00 tsf
D_0 = 0.3386
D_{90} = 0.3365
D_{100} = 0.3363
T_{90} = 2.00 min.

C_v @ T_{90}
0.0027 $cm.^2/sec.$

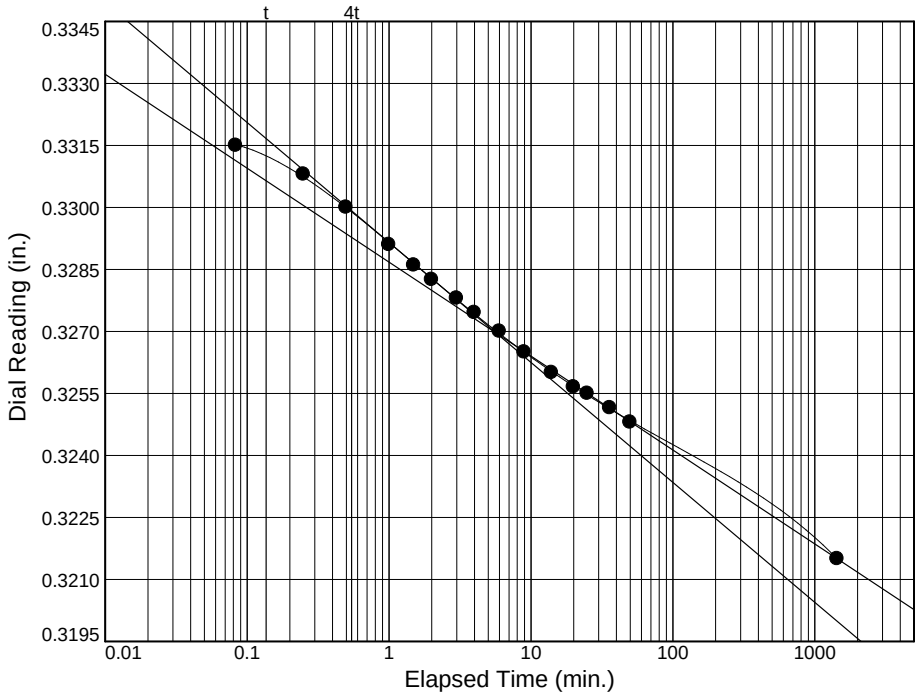
Figure C1569-15

Thielsch Engineering Inc.

Dial Reading vs. Time

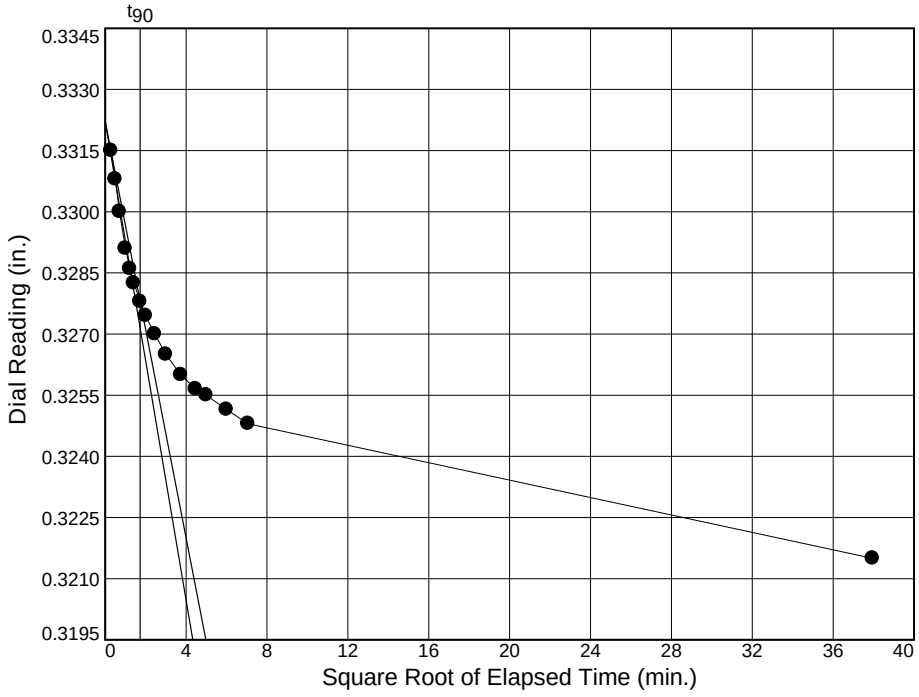
Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 19-21 Sample Number: RTG-OW-02 / ST-2



Load No.= 16
Load= 1.00 tsf
D_0 = 0.3326
D_{50} = 0.3298
D_{100} = 0.3270
T_{50} = 0.60 min.

C_v @ T_{50}
0.0021 cm.^{2}/sec.



Load No.= 16
Load= 1.00 tsf
D_0 = 0.3322
D_{90} = 0.3278
D_{100} = 0.3273
T_{90} = 2.99 min.

C_v @ T_{90}
0.0018 cm.^{2}/sec.

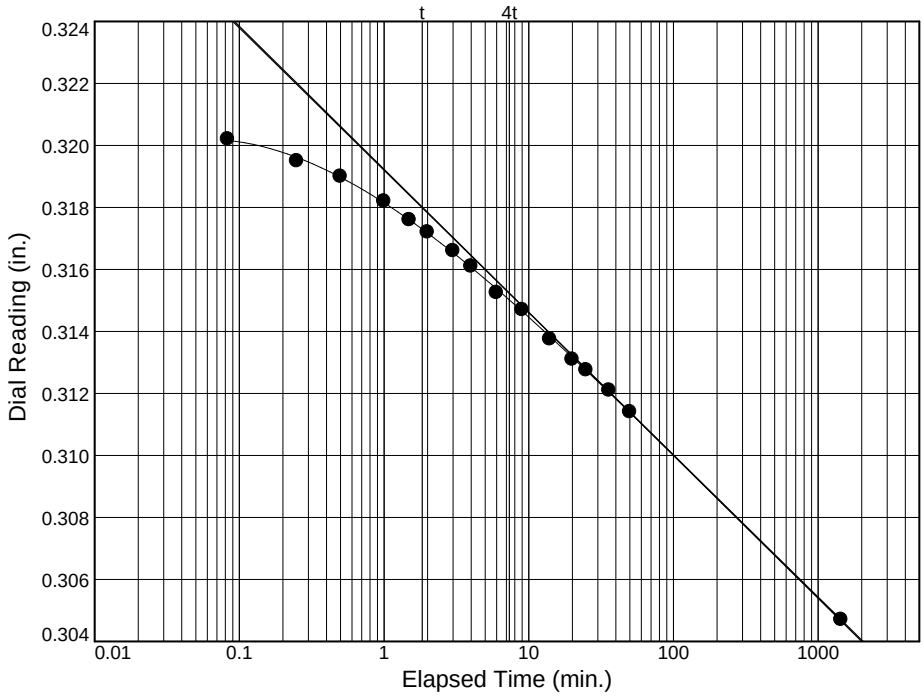
Figure C1569-16

Thielsch Engineering Inc.

Dial Reading vs. Time

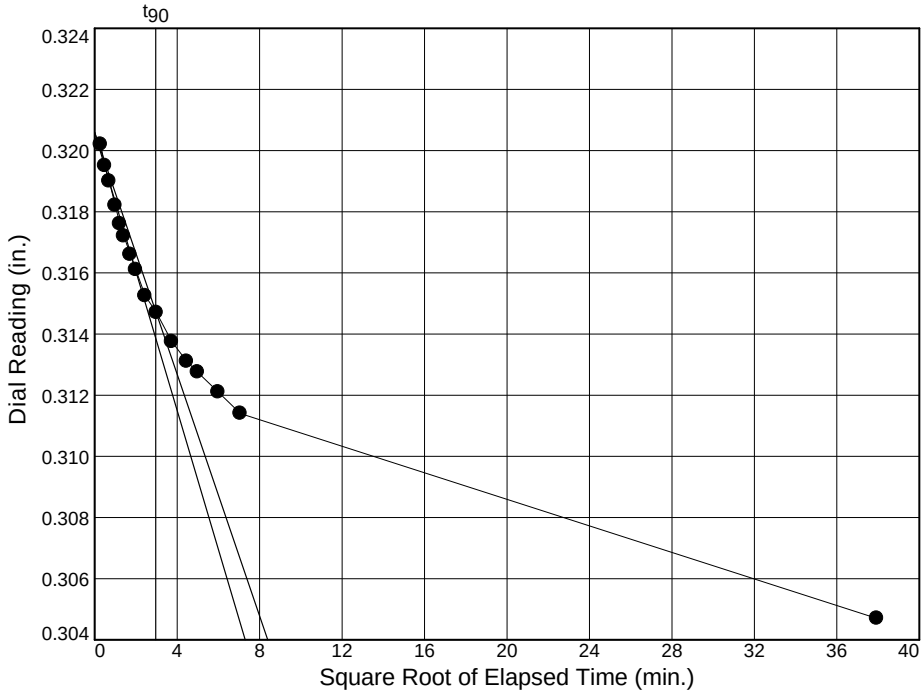
Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 19-21 Sample Number: RTG-OW-02 / ST-2



Load No.= 17
Load= 0.25 tsf
D_0 = 0.3196
D_{50} = 0.3162
D_{100} = 0.3129
T_{50} = 3.65 min.

C_v @ T_{50}
0.0004 cm.^{2}/sec.



Load No.= 17
Load= 0.25 tsf
D_0 = 0.3206
D_{90} = 0.3147
D_{100} = 0.3141
T_{90} = 8.78 min.

C_v @ T_{90}
0.0007 cm.^{2}/sec.

Figure C1569-17

Thielsch Engineering Inc.

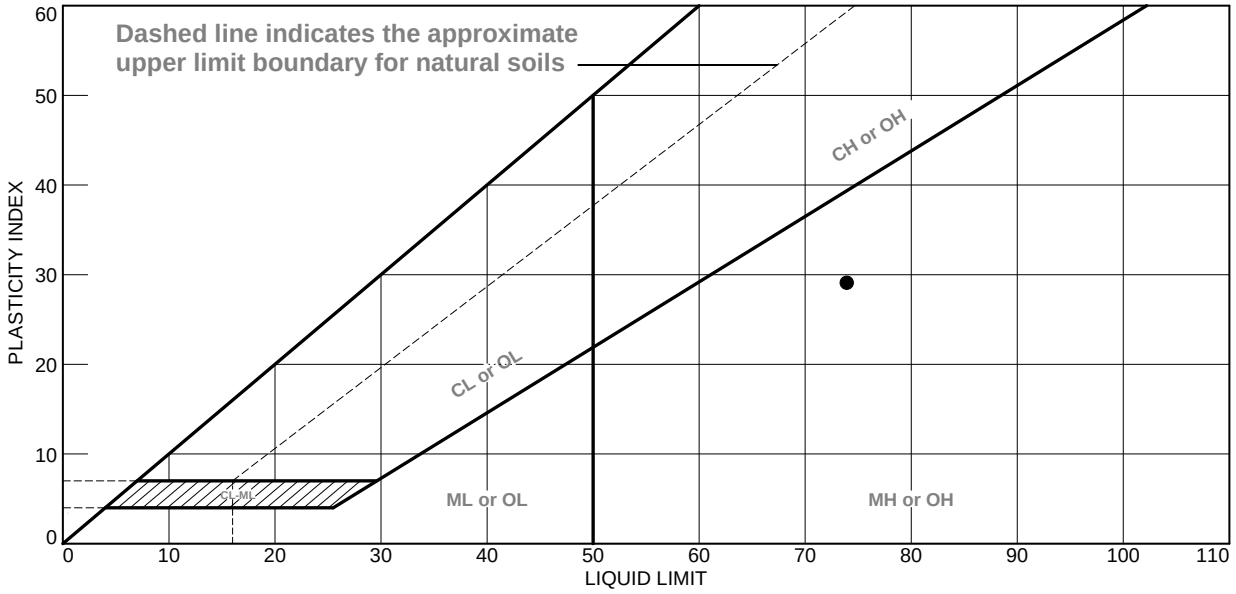
LABORATORY TUBE SUMMARY SHEET

Project Name: Mill River District Flood Resiliency Improvements
Project No.: 74-16-0002.09
Project Manager: David Arpin, P.E.
Project Location: New Haven, CT
Assigned By: D. Arpin
Date: 12.6.16
Reviewed By: Matthew J. Kobus
Date Reviewed: 12.6.16
Client: RT Group

Boring/ Test Pit No.	Sample No.	Depth ft.	Laboratory No.	Identification Tests: Water Content %	LL %	PL %	Gravel %	Sand %	Silt %	Clay %	Dry unit wt. pcf	Strength Tests: Torvane or Type Test	σ_c psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	Consol. $\frac{C_c}{1+e_0}$	Laboratory Log and Soil Description
RTG-SB-03	ST-1	17-19	16-S-1573		Average Total Unit Weight (17.0-19.0') = 95.4 pcf													
		17.0 - 19.0																(17.0 - 19.0) Dark Grey Organic SILT (OH)
		17'-0" to 17'-3"																very soft consistency
		17'-5"										Pen = 0.1 tsf						stiffer consistency
		17'-6"		83.0								Tv = .075 tsf						
		17'-7"		79.2			1.1	10.3	69.1	19.5								Dark Grey Organic elastic silt (OH)
		17'-8" to 18'-1"		78.1							53.6	CIU	1670	σ_1-σ_3 Max	631	21.6		with shells
		18'-1" to 18'-3"		74.7	74	45												more reeds, less shells
		18'-3" to 18'-7"																Consolidation (See Test Summary Page)
		18'-8"		75.6								Tv = .075 tsf	Pen = 0.1 tsf					

THIELSCH ENGINEERING
195 Frances Avenue
Cranston, RI 02910
401-467-6454

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark Grey Organic elastic silt (OH)	74	45	29	97.9	88.6	

Project No. 74-16- **Client:** RT GROUP

Project: Mill River Dist

Source of Sample: Borings **Depth:** 17-19
Sample Number: RTG-SB-03 / ST-1

Thielsch Engineering Inc.

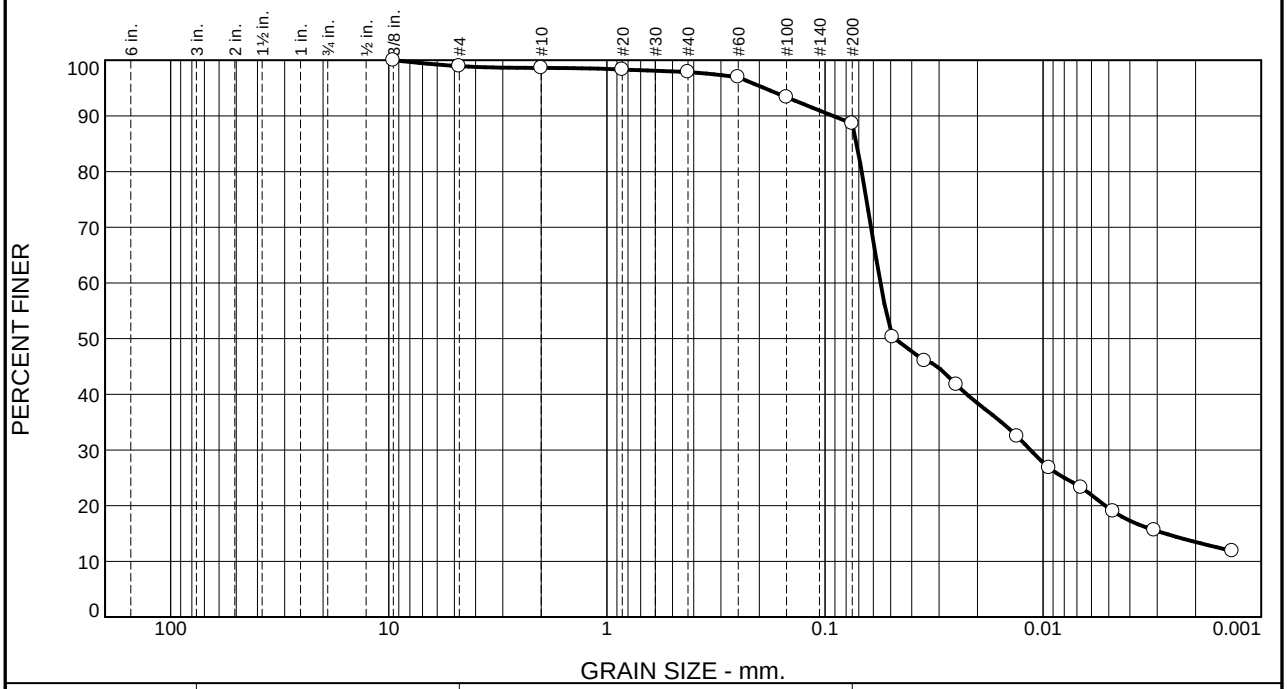
Cranston, RI

Remarks:

Figure L-1573

Tested By: RR **Checked By:** MJC

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.1	0.3	0.7	9.3	69.1	19.5

TEST RESULTS (D6913)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
0.375	100.0		
#4	98.9		
#10	98.6		
#20	98.3		
#40	97.9		
#60	97.0		
#100	93.4		
#200	88.6		
0.0490 mm.	50.3		
0.0350 mm.	46.0		
0.0250 mm.	41.7		
0.0132 mm.	32.5		
0.0094 mm.	26.8		
0.0067 mm.	23.3		
0.0048 mm.	19.0		
0.0031 mm.	15.6		
0.0014 mm.	11.8		

* (no specification provided)

Material Description

Dark Grey Organic elastic silt (OH)

Atterberg Limits (ASTM D 4318)

PL= 45 **LL=** 74 **PI=** 29

Classification

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

Coefficients

D_{90}= 0.0918 D_{85}= 0.0716 D_{60}= 0.0557
D_{50}= 0.0479 D_{30}= 0.0114 D_{15}= 0.0028
D_{10}= C_u= C_c=

Remarks

Date Received: 11.10.16 **Date Tested:** 11.21.16

Tested By: IA

Checked By: MJC

Title: Laboratory Manager

Source of Sample: Borings **Depth:** 17-19
Sample Number: RTG-SB-03 / ST-1

Date Sampled: 11.10.16

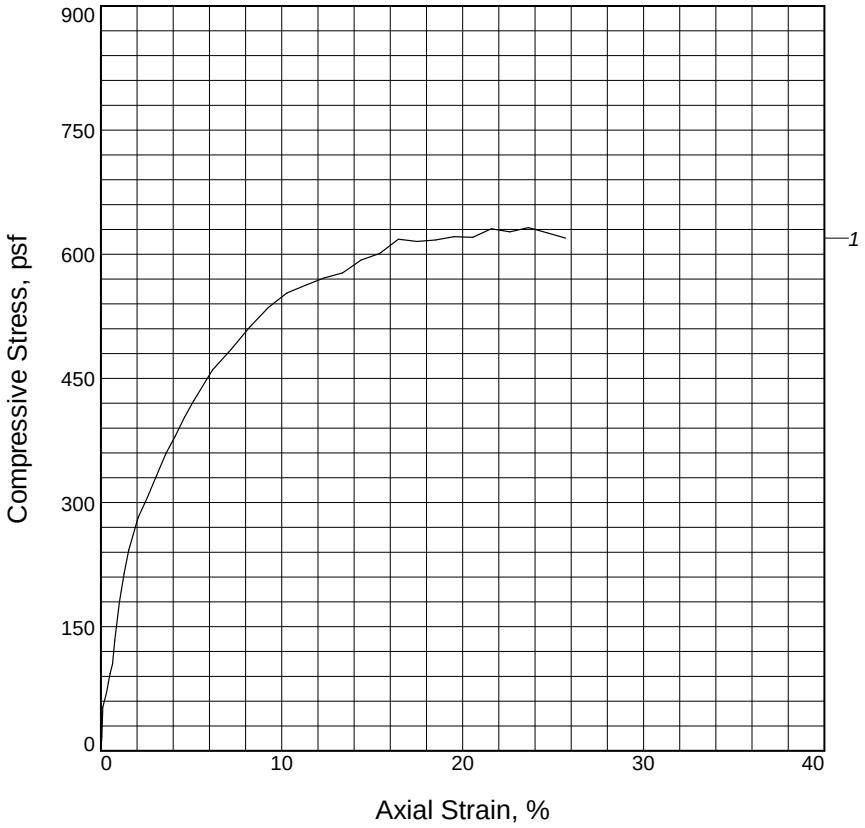
Thielsch Engineering Inc.

Cranston, RI

Client: RT GROUP
Project: Mill River Dist

Project No: 74-16-0002.09 **Figure** SH-1573

CU WITH PORE PRESSURES TEST



Sample No.	1			
Fail. Stress, psf	631			
Ult. Stress, psf				
Cell pressure, psf	13190			
Strain rate, in./min.	0.01			
Water content, %	78.1			
Wet density, pcf	95.4			
Dry density, pcf	53.6			
Saturation, %	100.0			
Void ratio	2.0301			
Specimen diameter, in.	2.02			
Specimen height, in.	3.99			
Height/diameter ratio	1.98			

Description: Dark Grey Organic elastic silt (OH)

LL = 74	**PL =** 45	**PI =** 29	**Assumed GS=** 2.6	**Type:** Tube Sample

Project No.: 74-16-0002.09

Date Sampled: 11.10.16

Remarks:

Figure CIU-1573

Client: RT GROUP

Project: Mill River Dist

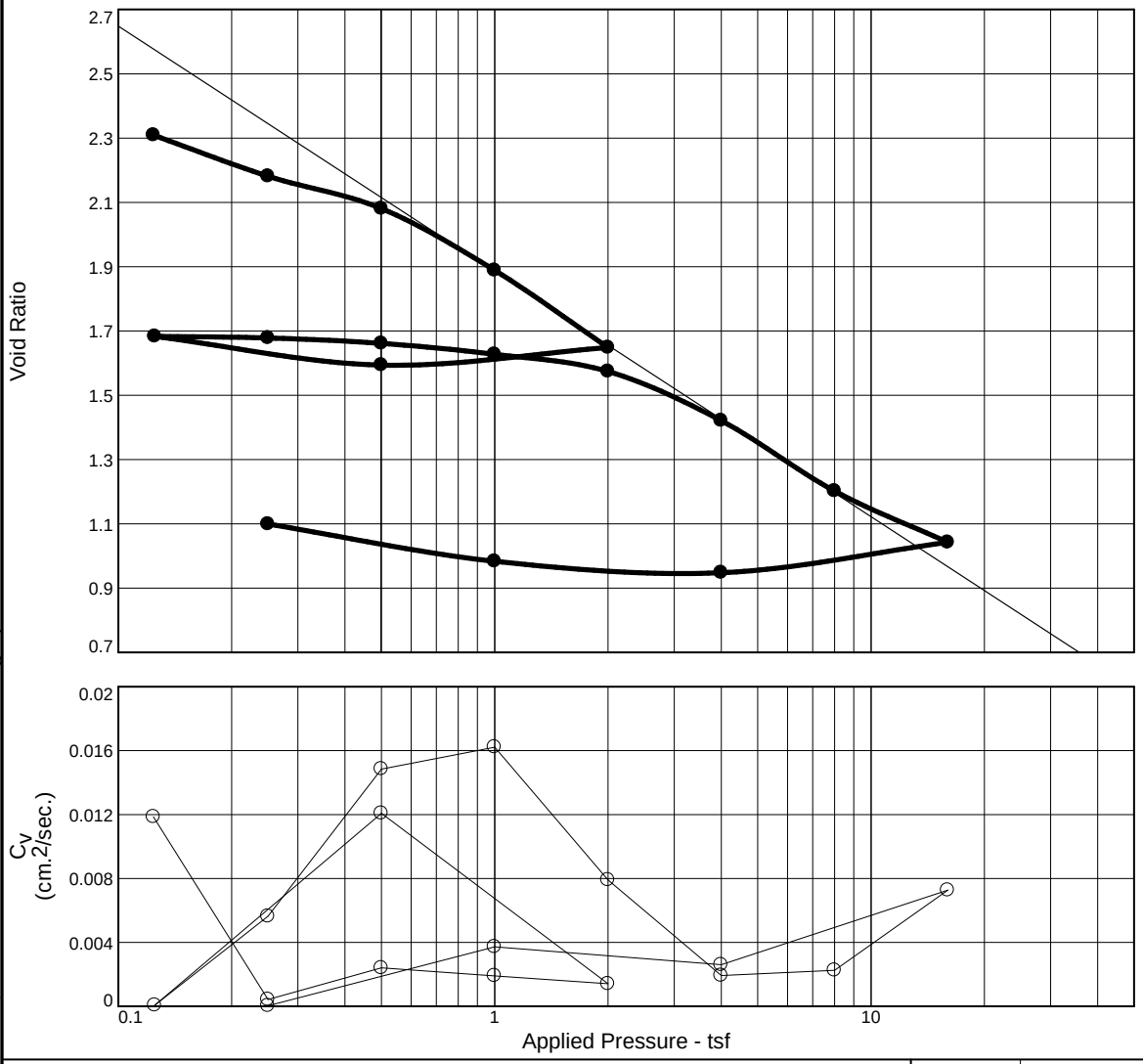
Source of Sample: Borings **Depth:** 17-19

Sample Number: RTG-SB-03 / ST-1

CU WITH PORE PRESSURES TEST
Thielsch Engineering Inc.
Cranston, RI

Tested By: RR **Checked By:** MJC

CONSOLIDATION TEST REPORT



MATERIAL DESCRIPTION	USCS	AASHTO
Dark Grey Organic elastic silt (OH)	MH	A-7-5(34)

LL	PI	Sp. Gr.	Overburden (tsf)	Dry Dens. (pcf)		Moisture		Saturation		Void Ratio		P_c (tsf)	C_c
				Init.	Final	Init.	Final	Init.	Final	Init.	Final		
74	29	2.632		49.3	+/- 79.2	84.6 %	48.0	95.4 %	100.0	2.334	1.099	0.6	0.76

Preparation Process: Trimmed using a trimming turntable

Condition of Test: Saturated at 2 tsf

D2435 Method	C_r	Swell Press. (tsf)	%
A	0.17		

Project No. 74-16- **Client:** RT GROUP

Project: Mill River Dist

Source: Borings **Depth:** 17-19 **Sample No.:** RTG-SB-03 / ST-1

Thielsch Engineering Inc.

Cranston, RI

Remarks:
Full 16 Day Load

Checked By: MJC

Title: Laboratory Manager

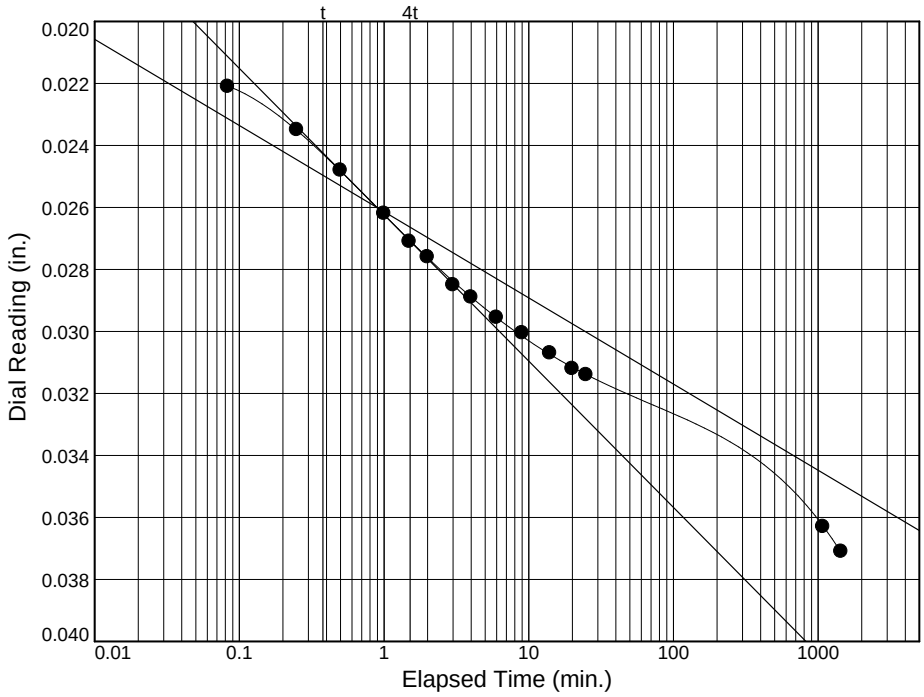
Figure C1573-1

Tested By: RR

Dial Reading vs. Time

Project No.: 74-16-0002.09
Project: Mill River Dist

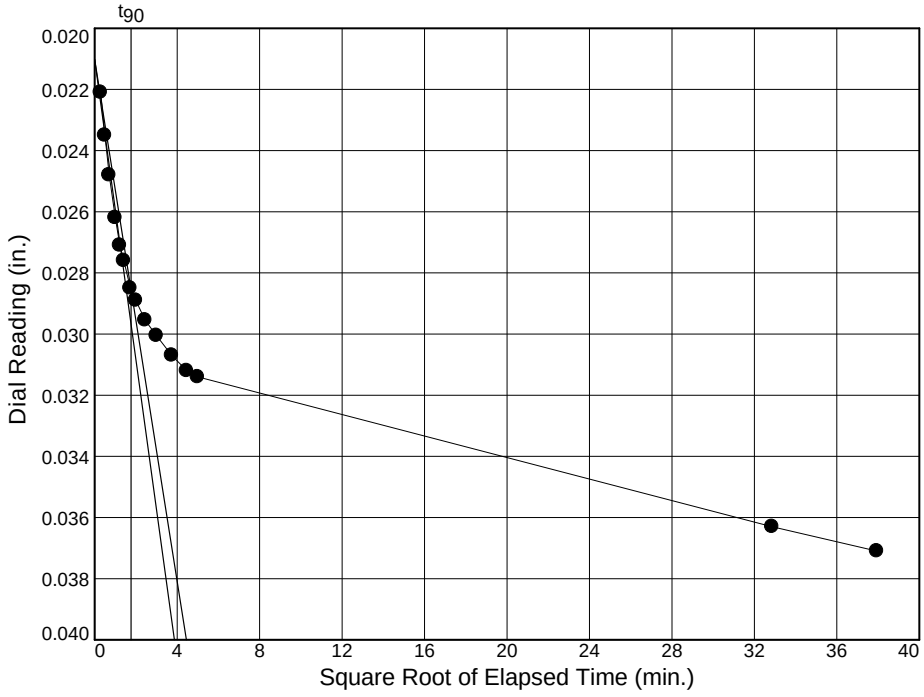
Source of Sample: Borings Depth: 17-19 Sample Number: RTG-SB-03 / ST-1



Load No.= 1
Load= 0.12 tsf
D_0 = 0.0215
D_{50} = 0.0237
D_{100} = 0.0260
T_{50} = 0.28 min.

C_v @ T_{50}
0.0119 cm.^{2}/sec.

C_α = 0.012



Load No.= 1
Load= 0.12 tsf
D_0 = 0.0210
D_{90} = 0.0285
D_{100} = 0.0294
T_{90} = 3.12 min.

C_v @ T_{90}
0.0046 cm.^{2}/sec.

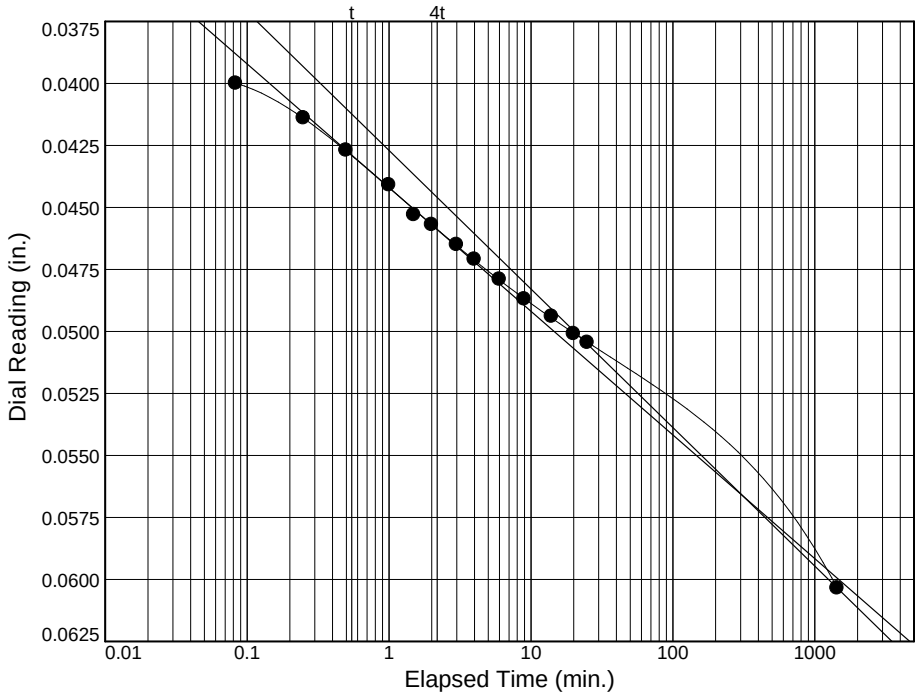
Figure C1573-2

Thielsch Engineering Inc.

Dial Reading vs. Time

Project No.: 74-16-0002.09
Project: Mill River Dist

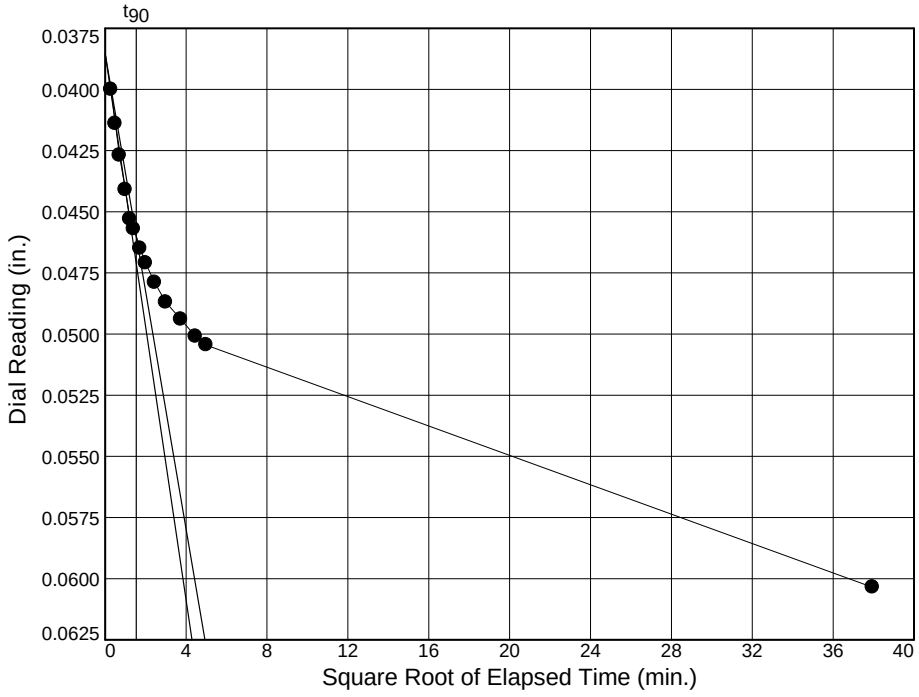
Source of Sample: Borings Depth: 17-19 Sample Number: RTG-SB-03 / ST-1



Load No.= 2
Load= 0.25 tsf
D_0 = 0.0399
D_{50} = 0.0483
D_{100} = 0.0567
T_{50} = 7.31 min.

C_v @ T_{50}
0.0004 cm.^{2}/sec.

C_α = 0.023



Load No.= 2
Load= 0.25 tsf
D_0 = 0.0385
D_{90} = 0.0460
D_{100} = 0.0468
T_{90} = 2.36 min.

C_v @ T_{90}
0.0058 cm.^{2}/sec.

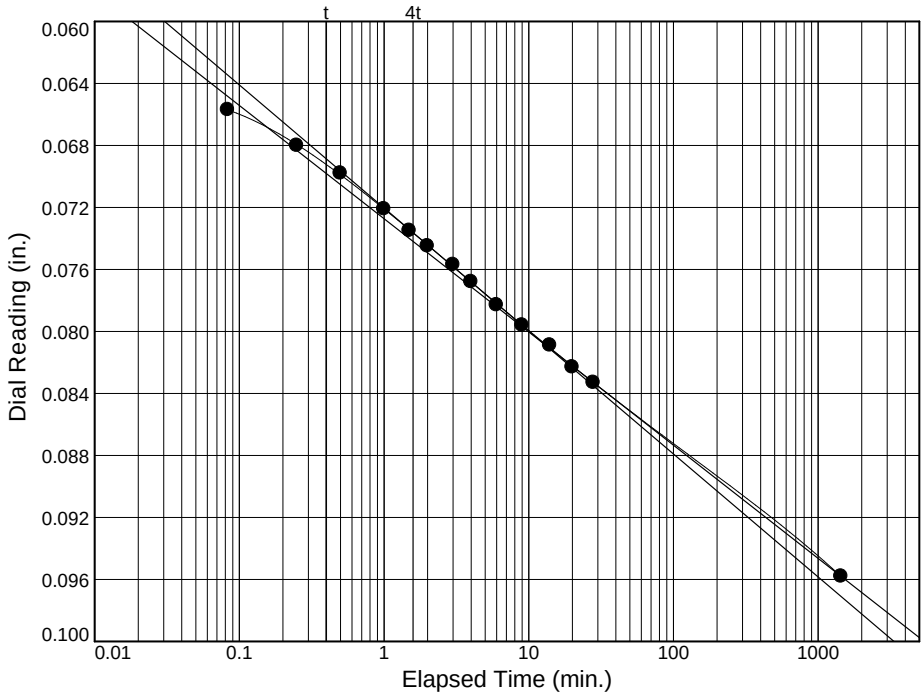
Figure C1573-3

Thielsch Engineering Inc.

Dial Reading vs. Time

Project No.: 74-16-0002.09
Project: Mill River Dist

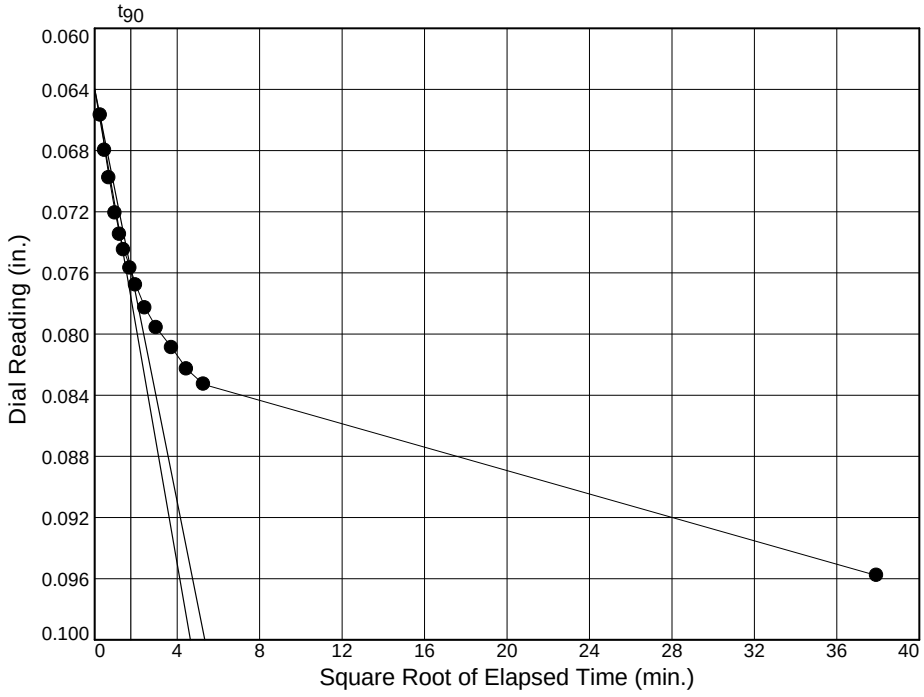
Source of Sample: Borings Depth: 17-19 Sample Number: RTG-SB-03 / ST-1



Load No.= 3
Load= 0.50 tsf
D_0 = 0.0648
D_{50} = 0.0728
D_{100} = 0.0808
T_{50} = 1.23 min.

C_v @ T_{50}
0.0024 cm.^{2}/sec.

C_α = 0.030



Load No.= 3
Load= 0.50 tsf
D_0 = 0.0640
D_{90} = 0.0758
D_{100} = 0.0771
T_{90} = 3.07 min.

C_v @ T_{90}
0.0042 cm.^{2}/sec.

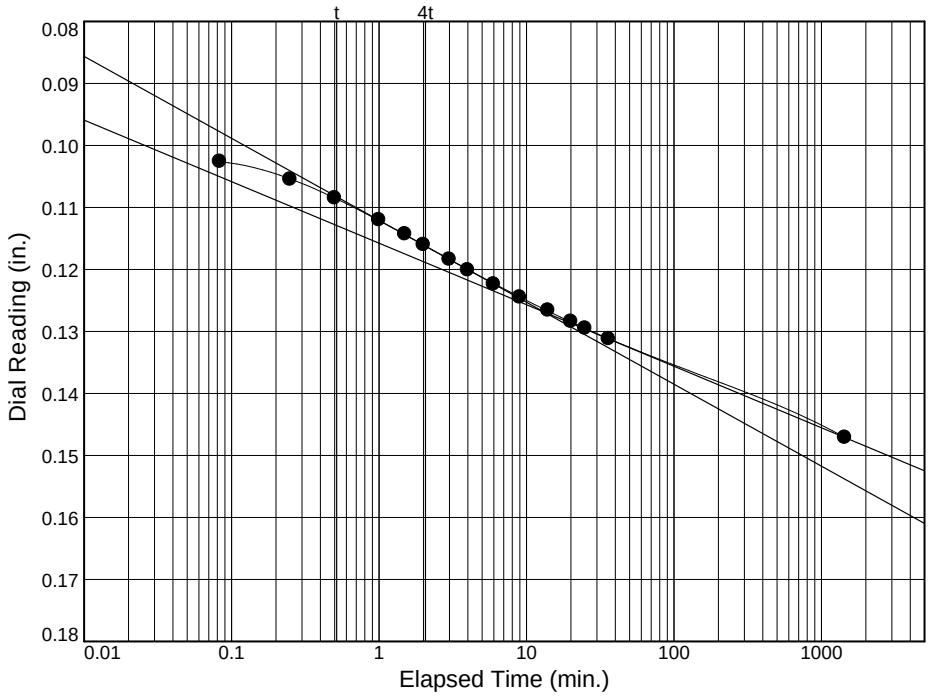
Figure C1573-4

Thielsch Engineering Inc.

Dial Reading vs. Time

Project No.: 74-16-0002.09
Project: Mill River Dist

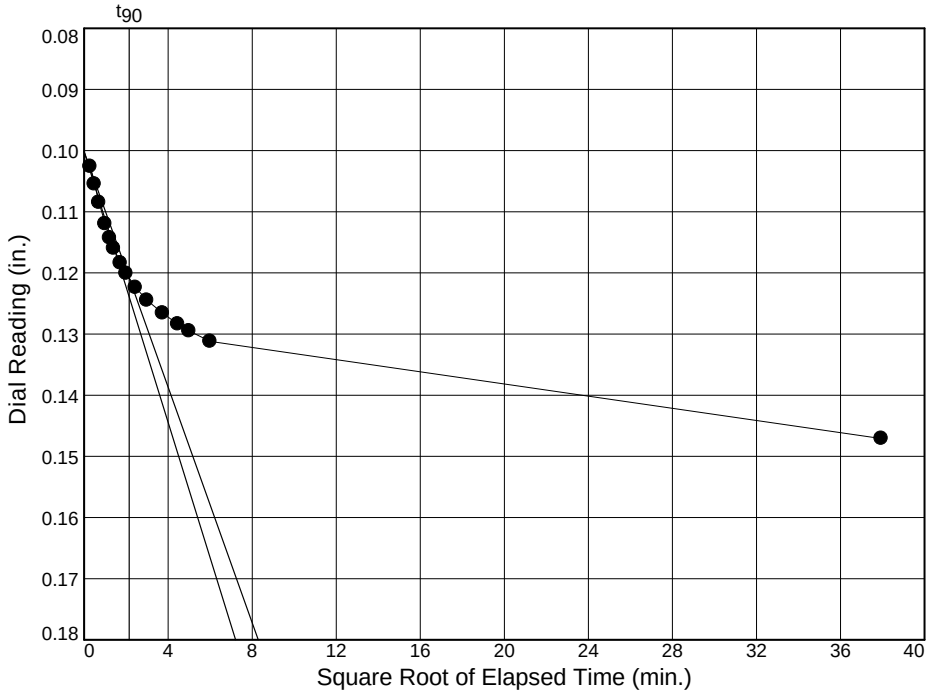
Source of Sample: Borings Depth: 17-19 Sample Number: RTG-SB-03 / ST-1



Load No.= 4
Load= 1.00 tsf
D_0 = 0.1010
D_{50} = 0.1139
D_{100} = 0.1269
T_{50} = 1.38 min.

C_v @ T_{50}
0.0019 cm.^{2}/sec.

C_α = 0.041



Load No.= 4
Load= 1.00 tsf
D_0 = 0.1002
D_{90} = 0.1208
D_{100} = 0.1231
T_{90} = 4.60 min.

C_v @ T_{90}
0.0025 cm.^{2}/sec.

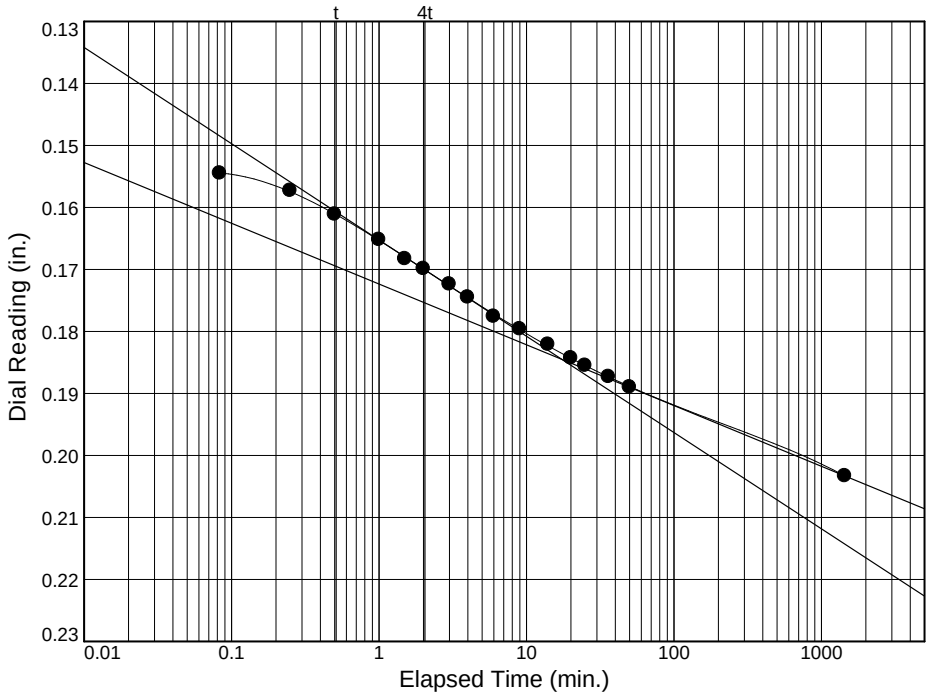
Figure C1573-5

Thielsch Engineering Inc.

Dial Reading vs. Time

Project No.: 74-16-0002.09
Project: Mill River Dist

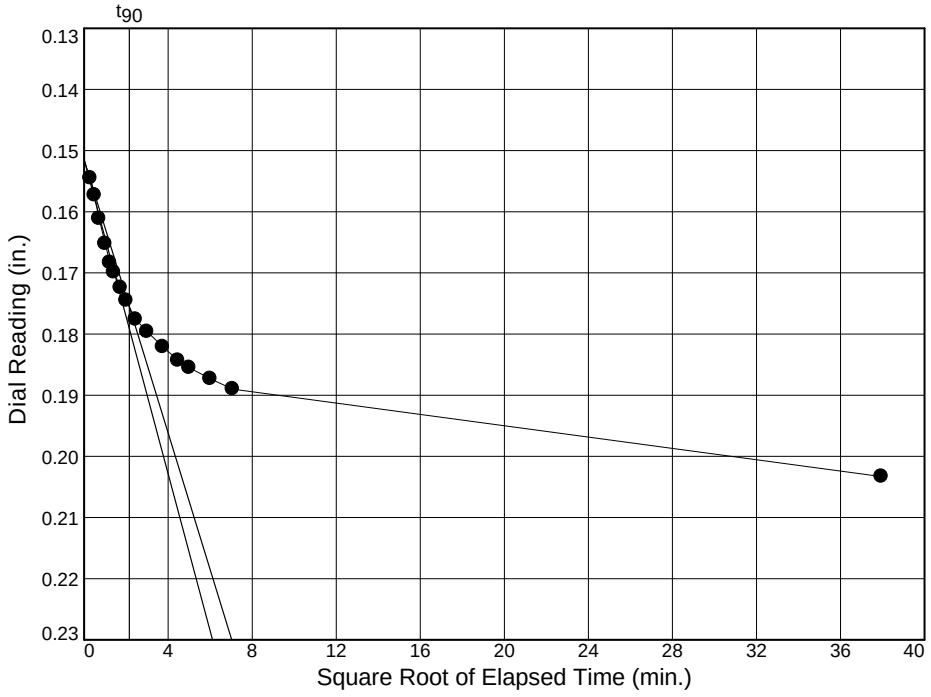
Source of Sample: Borings Depth: 17-19 Sample Number: RTG-SB-03 / ST-1



Load No.= 5
Load= 2.00 tsf
D_0 = 0.1522
D_{50} = 0.1684
D_{100} = 0.1845
T_{50} = 1.59 min.

C_v @ T_{50}
0.0014 cm.^{2}/sec.

C_α = 0.041



Load No.= 5
Load= 2.00 tsf
D_0 = 0.1515
D_{90} = 0.1756
D_{100} = 0.1782
T_{90} = 4.64 min.

C_v @ T_{90}
0.0021 cm.^{2}/sec.

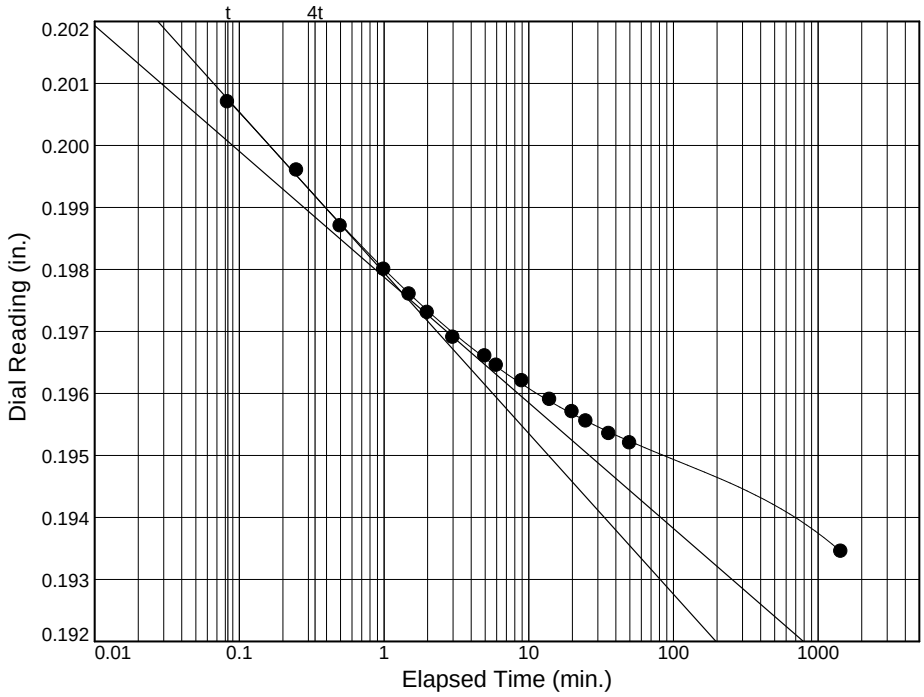
Figure C1573-6

Thielsch Engineering Inc.

Dial Reading vs. Time

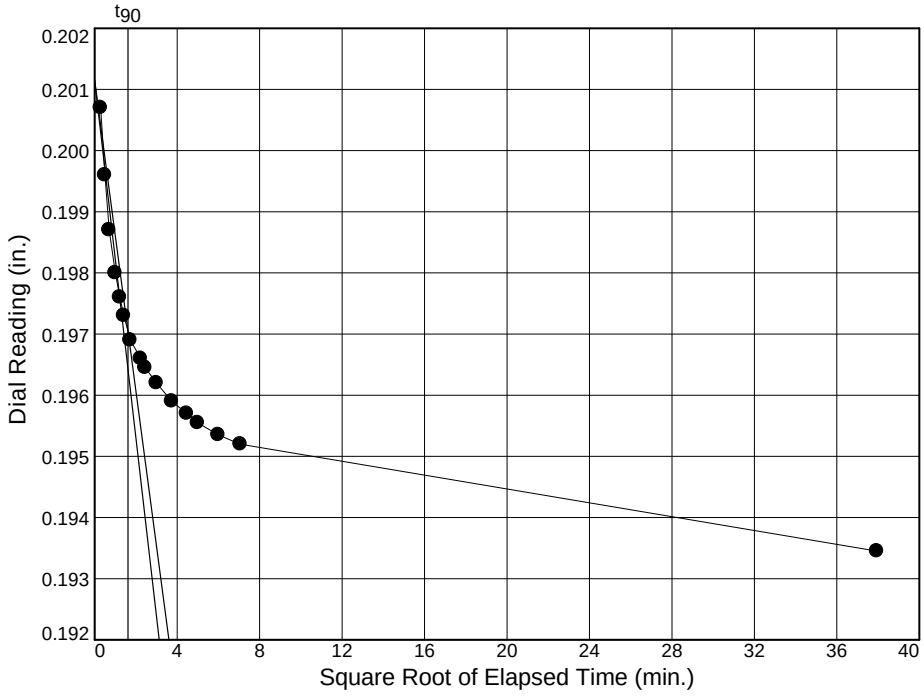
Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 17-19 Sample Number: RTG-SB-03 / ST-1



Load No.= 6
Load= 0.50 tsf
D_0 = 0.2023
D_{50} = 0.2000
D_{100} = 0.1976
T_{50} = 0.17 min.

C_v @ T_{50}
0.0121 cm.^{2}/sec.



Load No.= 6
Load= 0.50 tsf
D_0 = 0.2011
D_{90} = 0.1970
D_{100} = 0.1966
T_{90} = 2.61 min.

C_v @ T_{90}
0.0034 cm.^{2}/sec.

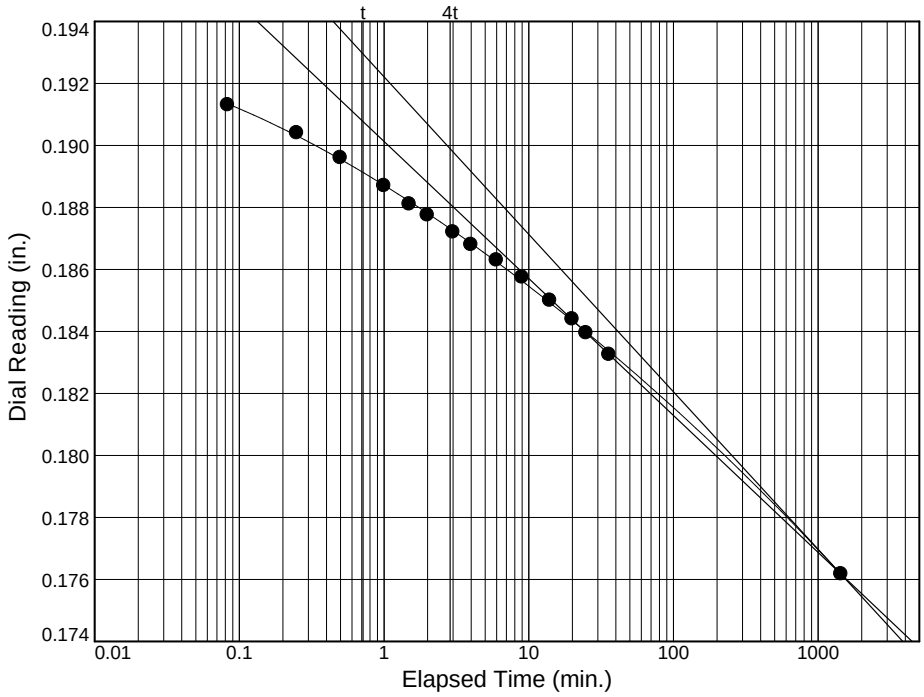
Figure C1573-7

Thielsch Engineering Inc.

Dial Reading vs. Time

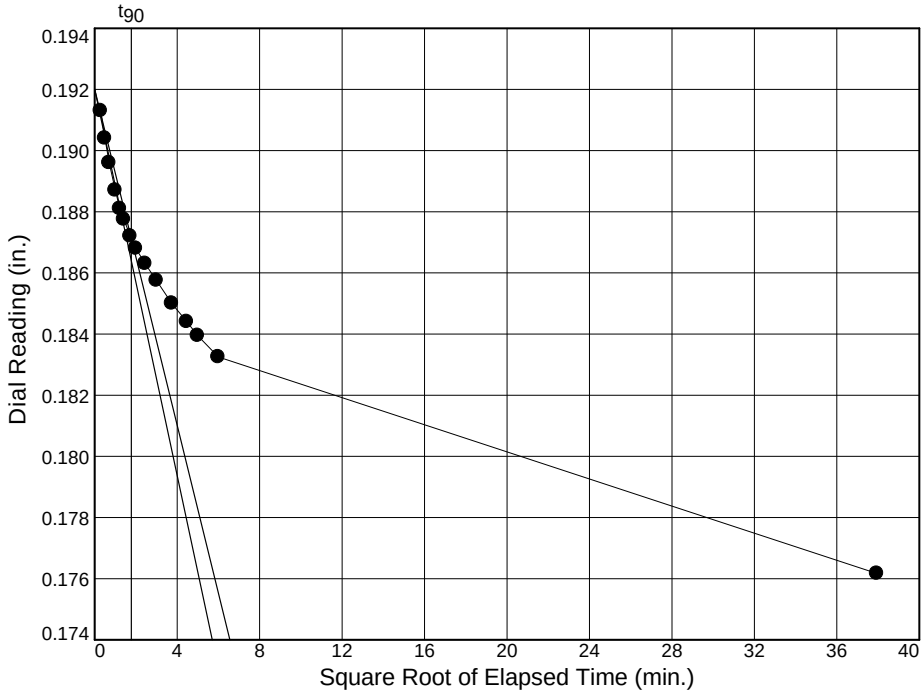
Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 17-19 Sample Number: RTG-SB-03 / ST-1



Load No.= 7
Load= 0.13 tsf
D_0 = 0.1909
D_{50} = 0.1836
D_{100} = 0.1762
T_{50} = 31.86 min.

C_v @ T_{50}
0.0001 cm.^{2}/sec.



Load No.= 7
Load= 0.13 tsf
D_0 = 0.1920
D_{90} = 0.1871
D_{100} = 0.1866
T_{90} = 3.15 min.

C_v @ T_{90}
0.0029 cm.^{2}/sec.

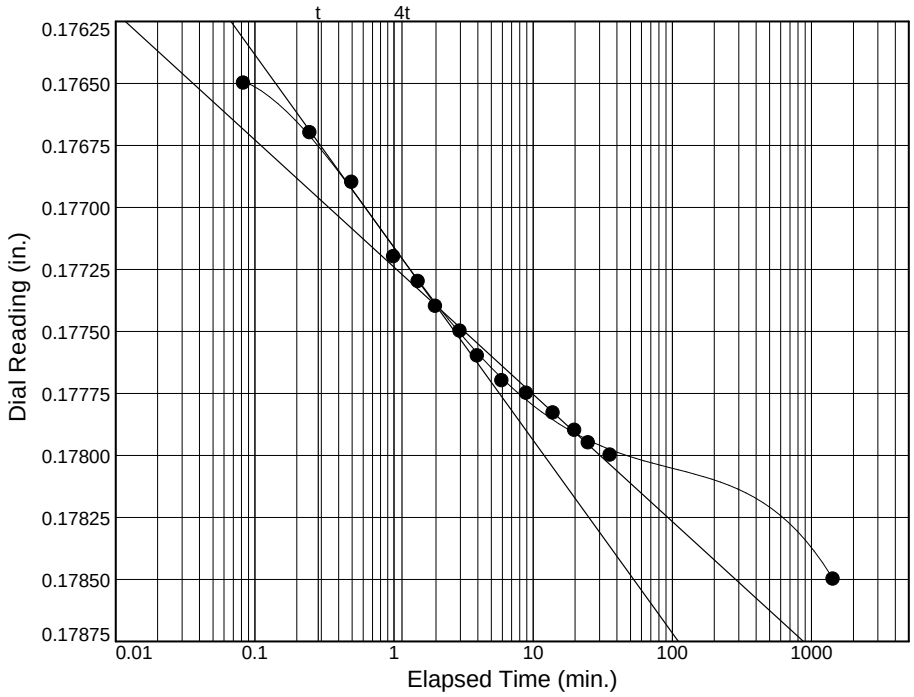
Figure C1573-8

Thielsch Engineering Inc.

Dial Reading vs. Time

Project No.: 74-16-0002.09
Project: Mill River Dist

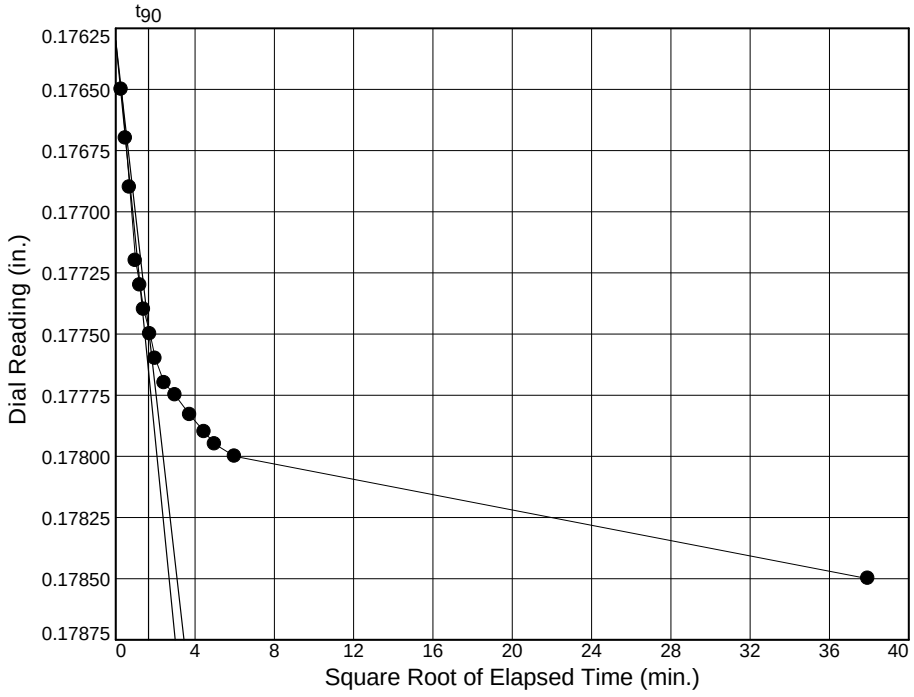
Source of Sample: Borings Depth: 17-19 Sample Number: RTG-SB-03 / ST-1



Load No.= 8
Load= 0.25 tsf
D_0 = 0.1763
D_{50} = 0.1768
D_{100} = 0.1774
T_{50} = 0.39 min.

C_v @ T_{50}
0.0056 cm.^{2}/sec.

C_α = 0.002



Load No.= 8
Load= 0.25 tsf
D_0 = 0.1763
D_{90} = 0.1775
D_{100} = 0.1776
T_{90} = 2.73 min.

C_v @ T_{90}
0.0035 cm.^{2}/sec.

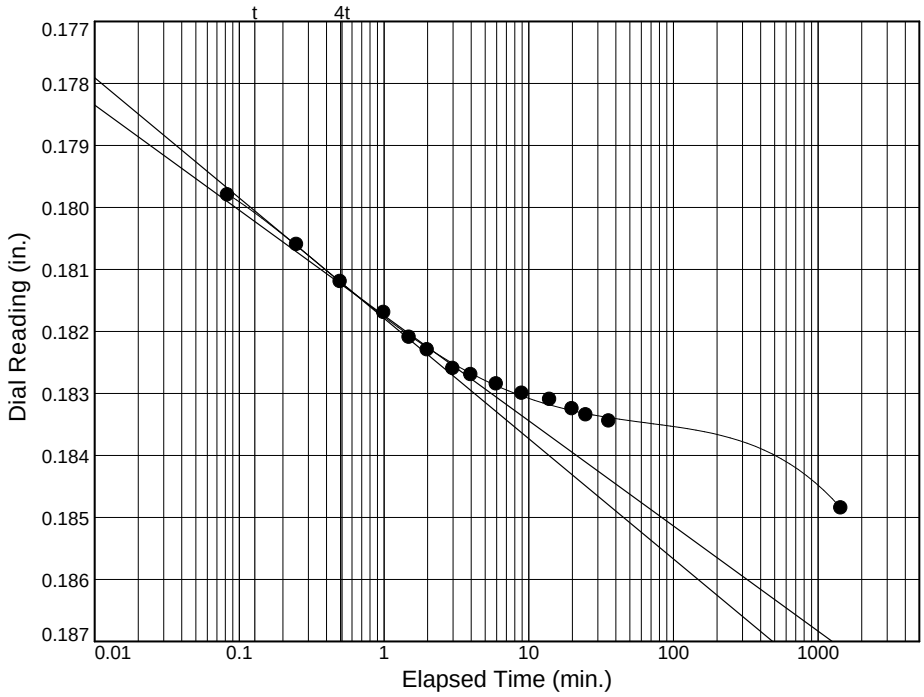
Figure C1573-9

Thielsch Engineering Inc.

Dial Reading vs. Time

Project No.: 74-16-0002.09
Project: Mill River Dist

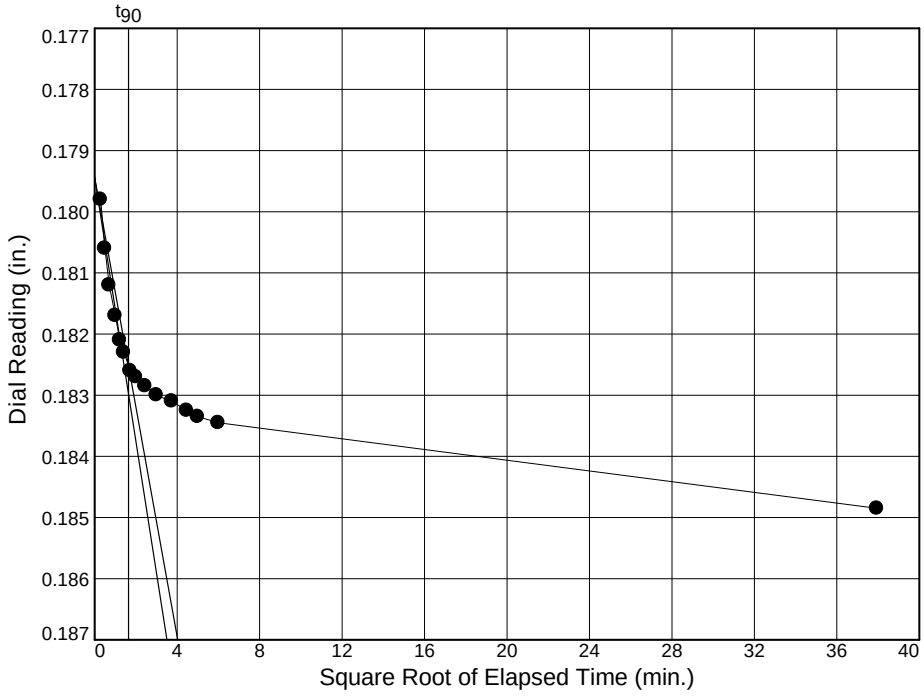
Source of Sample: Borings Depth: 17-19 Sample Number: RTG-SB-03 / ST-1



Load No.= 9
Load= 0.50 tsf
D_0 = 0.1790
D_{50} = 0.1802
D_{100} = 0.1814
T_{50} = 0.15 min.

C_v @ T_{50}
0.0148 cm.^{2}/sec.

C_α = 0.007



Load No.= 9
Load= 0.50 tsf
D_0 = 0.1794
D_{90} = 0.1825
D_{100} = 0.1829
T_{90} = 2.69 min.

C_v @ T_{90}
0.0035 cm.^{2}/sec.

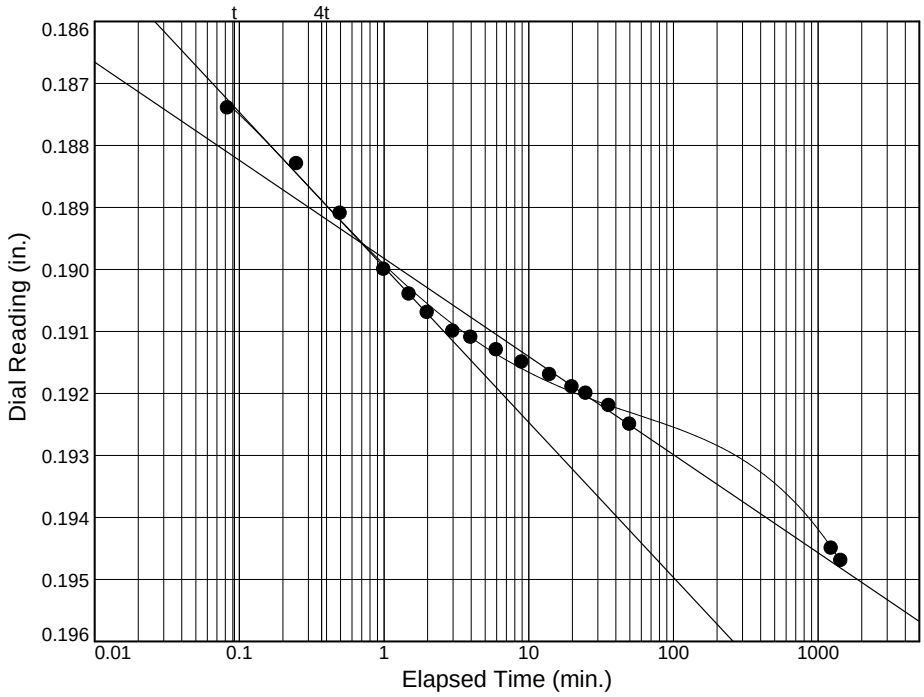
Figure C1573-10

Thielsch Engineering Inc.

Dial Reading vs. Time

Project No.: 74-16-0002.09
Project: Mill River Dist

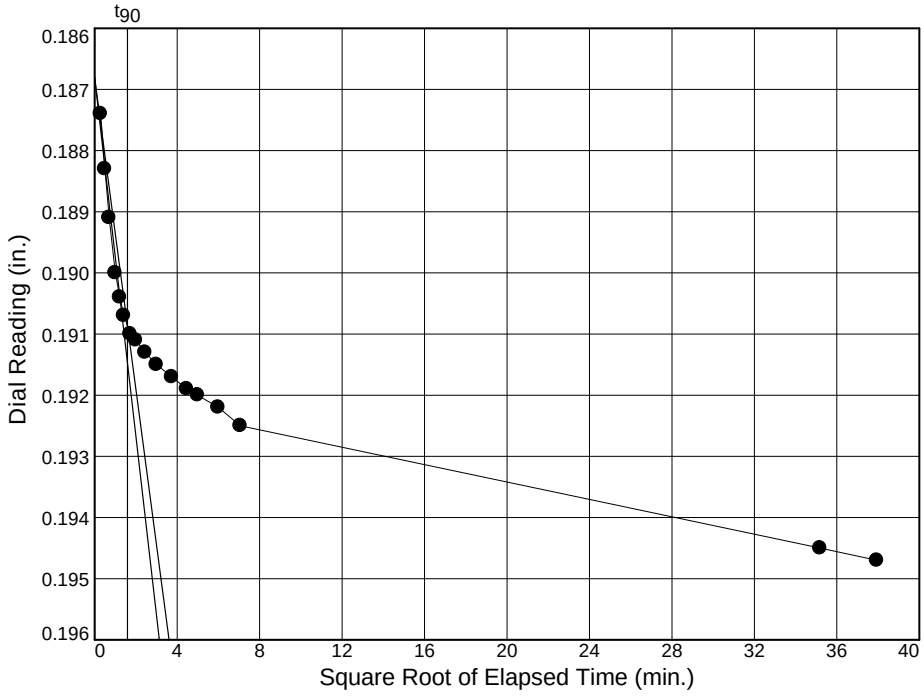
Source of Sample: Borings Depth: 17-19 Sample Number: RTG-SB-03 / ST-1



Load No.= 10
Load= 1.00 tsf
D_0 = 0.1860
D_{50} = 0.1878
D_{100} = 0.1896
T_{50} = 0.13 min.

C_v @ T_{50}
0.0162 cm.^{2}/sec.

C_α = 0.007



Load No.= 10
Load= 1.00 tsf
D_0 = 0.1868
D_{90} = 0.1909
D_{100} = 0.1913
T_{90} = 2.54 min.

C_v @ T_{90}
0.0036 cm.^{2}/sec.

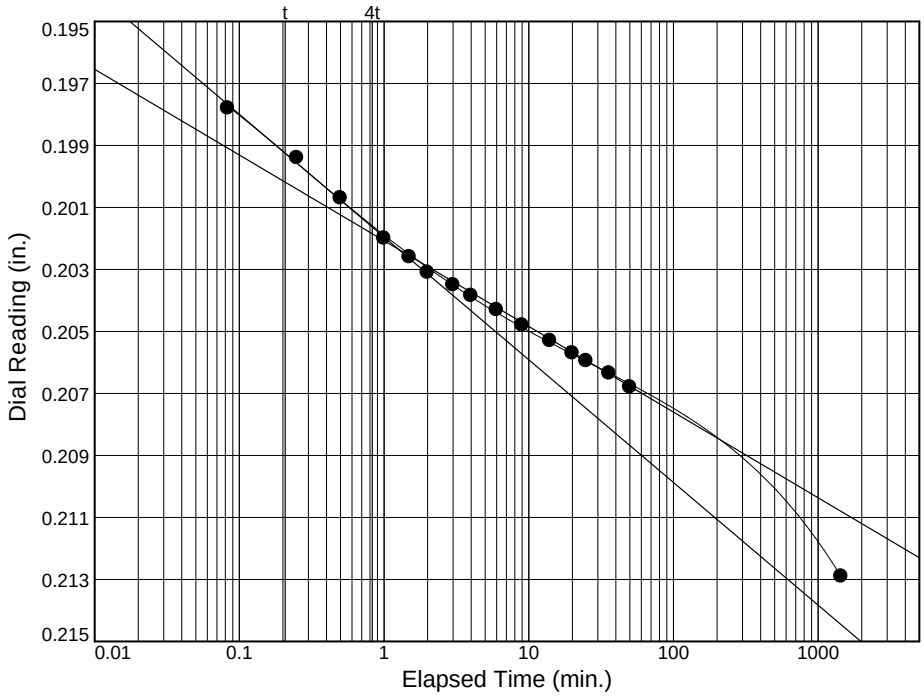
Figure C1573-11

Thielsch Engineering Inc.

Dial Reading vs. Time

Project No.: 74-16-0002.09
Project: Mill River Dist

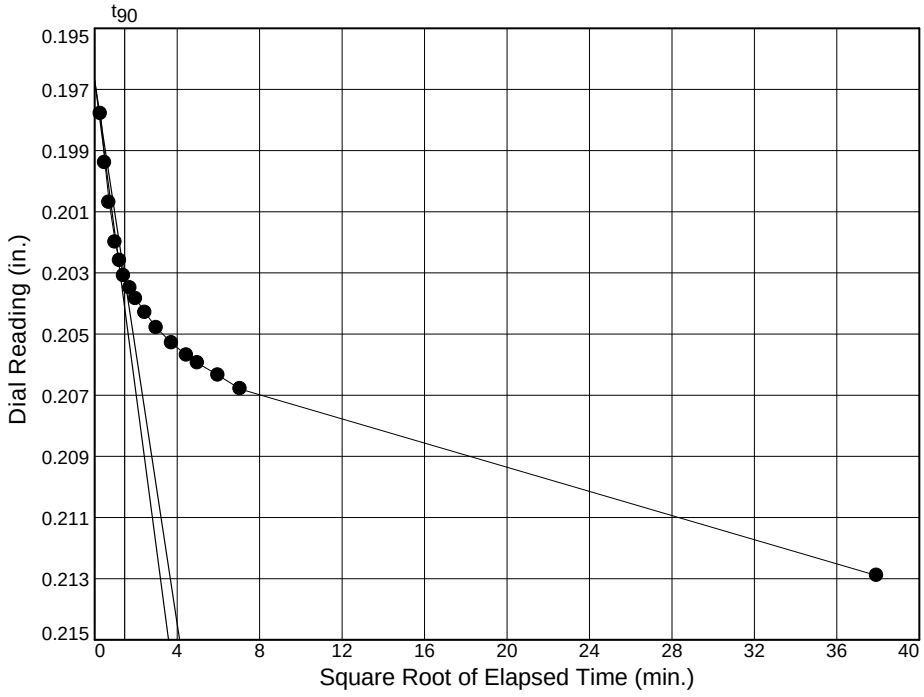
Source of Sample: Borings Depth: 17-19 Sample Number: RTG-SB-03 / ST-1



Load No.= 11
Load= 2.00 tsf
D_0 = 0.1969
D_{50} = 0.1996
D_{100} = 0.2023
T_{50} = 0.26 min.

C_v @ T_{50}
0.0079 cm.^{2}/sec.

C_α = 0.012



Load No.= 11
Load= 2.00 tsf
D_0 = 0.1967
D_{90} = 0.2031
D_{100} = 0.2039
T_{90} = 2.11 min.

C_v @ T_{90}
0.0042 cm.^{2}/sec.

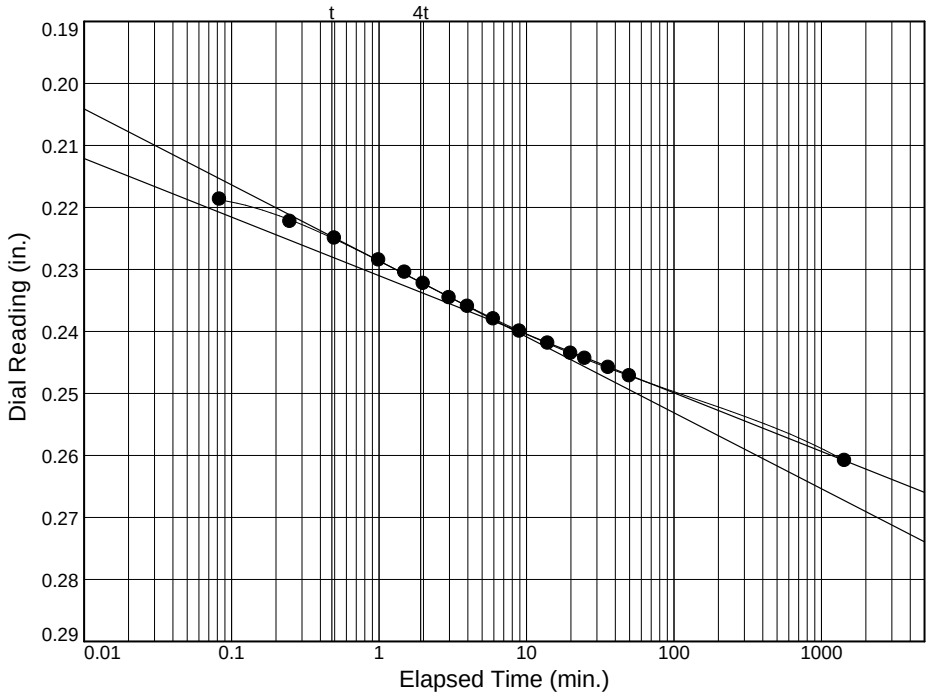
Figure C1573-12

Thielsch Engineering Inc.

Dial Reading vs. Time

Project No.: 74-16-0002.09
Project: Mill River Dist

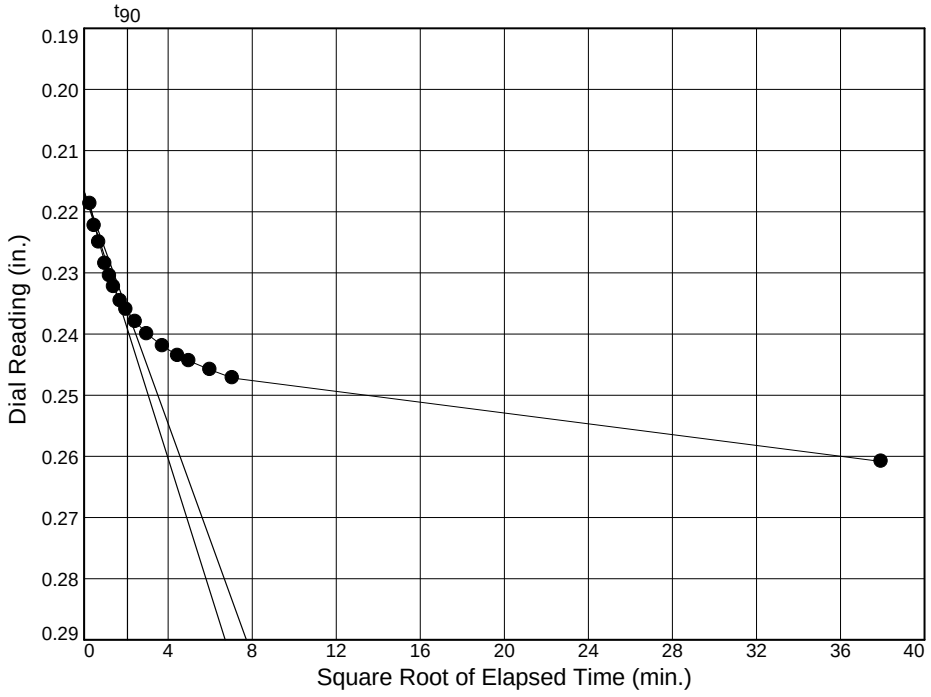
Source of Sample: Borings Depth: 17-19 Sample Number: RTG-SB-03 / ST-1



Load No.= 12
Load= 4.00 tsf
D_0 = 0.2177
D_{50} = 0.2284
D_{100} = 0.2391
T_{50} = 0.96 min.

C_v @ T_{50}
0.0019 $cm.^2$/sec.

C_α = 0.039



Load No.= 12
Load= 4.00 tsf
D_0 = 0.2167
D_{90} = 0.2363
D_{100} = 0.2384
T_{90} = 4.25 min.

C_v @ T_{90}
0.0019 $cm.^2$/sec.

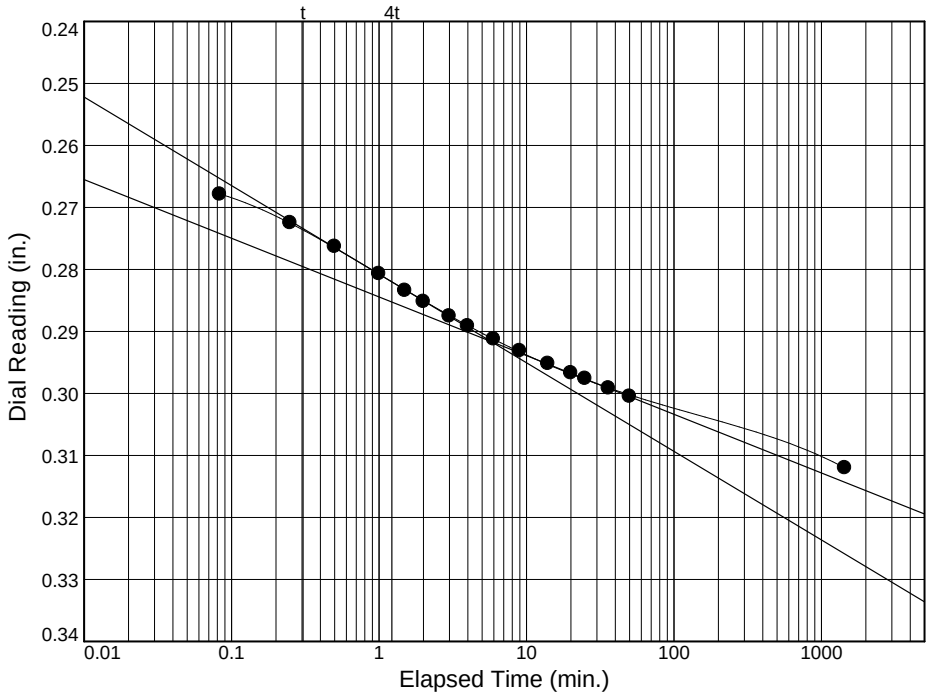
Figure C1573-13

Thielsch Engineering Inc.

Dial Reading vs. Time

Project No.: 74-16-0002.09
Project: Mill River Dist

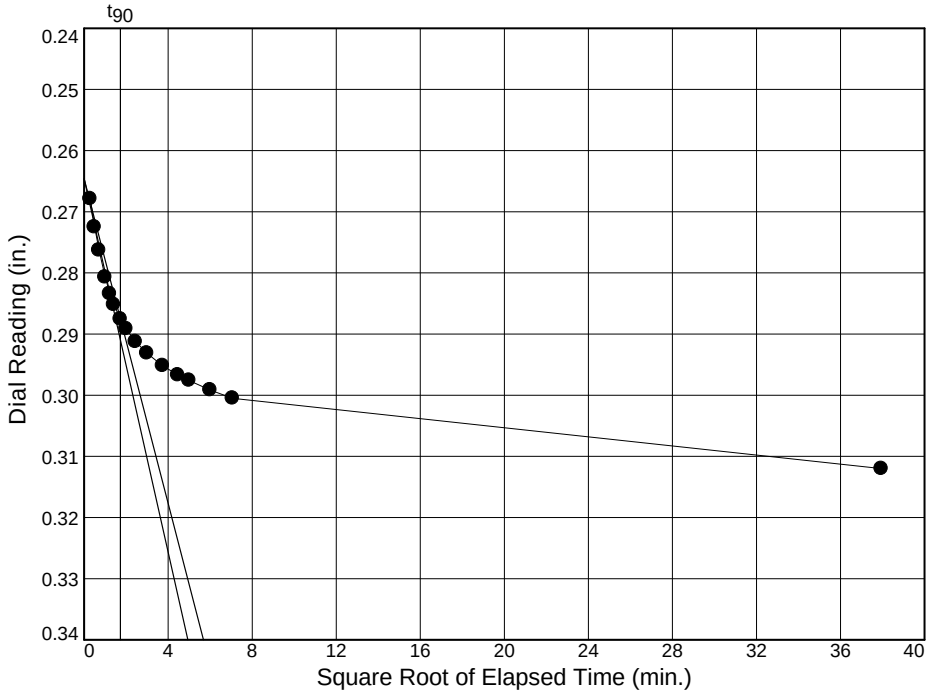
Source of Sample: Borings Depth: 17-19 Sample Number: RTG-SB-03 / ST-1



Load No.= 13
Load= 8.00 tsf
D_0 = 0.2653
D_{50} = 0.2784
D_{100} = 0.2916
T_{50} = 0.69 min.

C_v @ T_{50}
0.0023 cm.^{2}/sec.

C_α = 0.039



Load No.= 13
Load= 8.00 tsf
D_0 = 0.2646
D_{90} = 0.2875
D_{100} = 0.2900
T_{90} = 2.97 min.

C_v @ T_{90}
0.0023 cm.^{2}/sec.

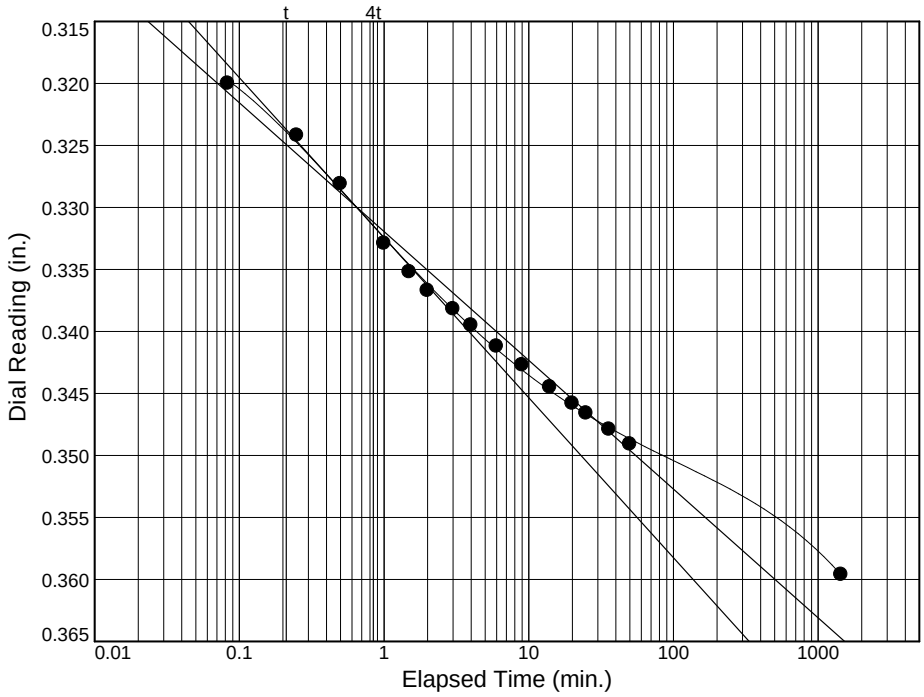
Figure C1573-14

Thielsch Engineering Inc.

Dial Reading vs. Time

Project No.: 74-16-0002.09
Project: Mill River Dist

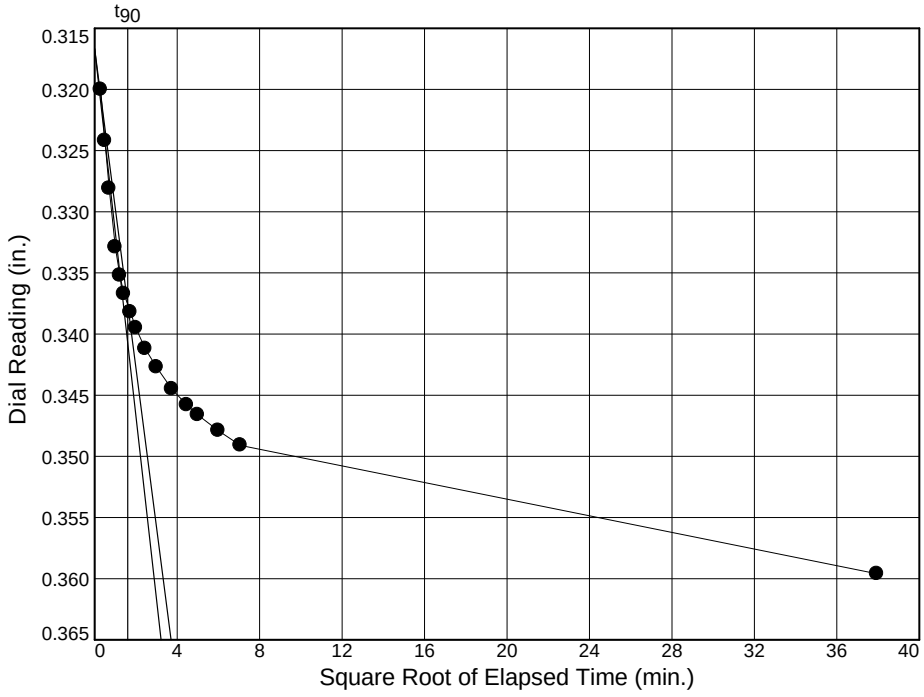
Source of Sample: Borings Depth: 17-19 Sample Number: RTG-SB-03 / ST-1



Load No.= 14
Load= 16.00 tsf
D_0 = 0.3163
D_{50} = 0.3231
D_{100} = 0.3299
T_{50} = 0.18 min.

C_v @ T_{50}
0.0073 cm.^{2}/sec.

C_α = 0.043



Load No.= 14
Load= 16.00 tsf
D_0 = 0.3167
D_{90} = 0.3376
D_{100} = 0.3399
T_{90} = 2.57 min.

C_v @ T_{90}
0.0021 cm.^{2}/sec.

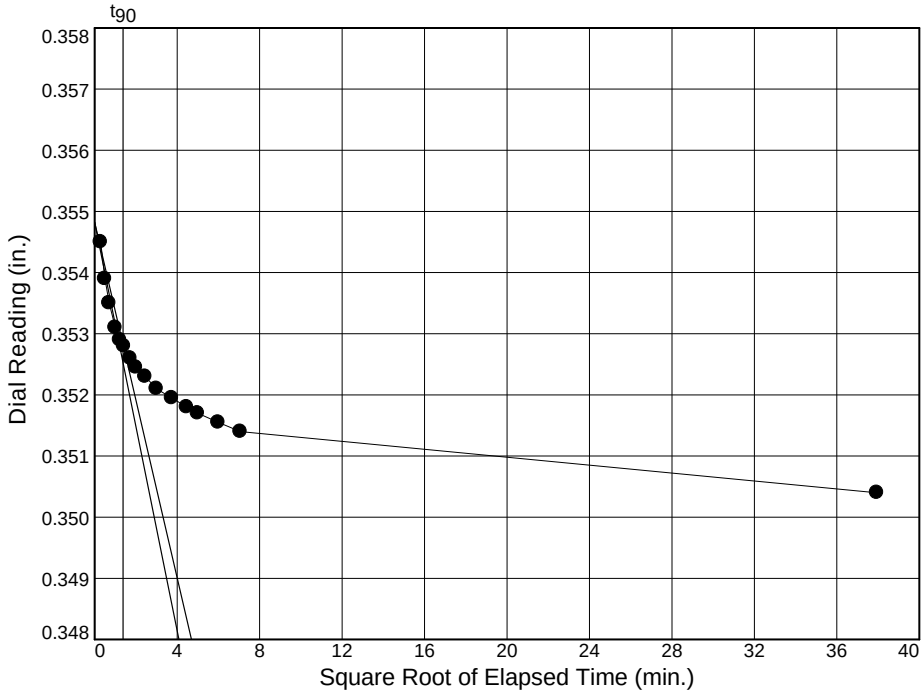
Figure C1573-15

Thielsch Engineering Inc.

Dial Reading vs. Time

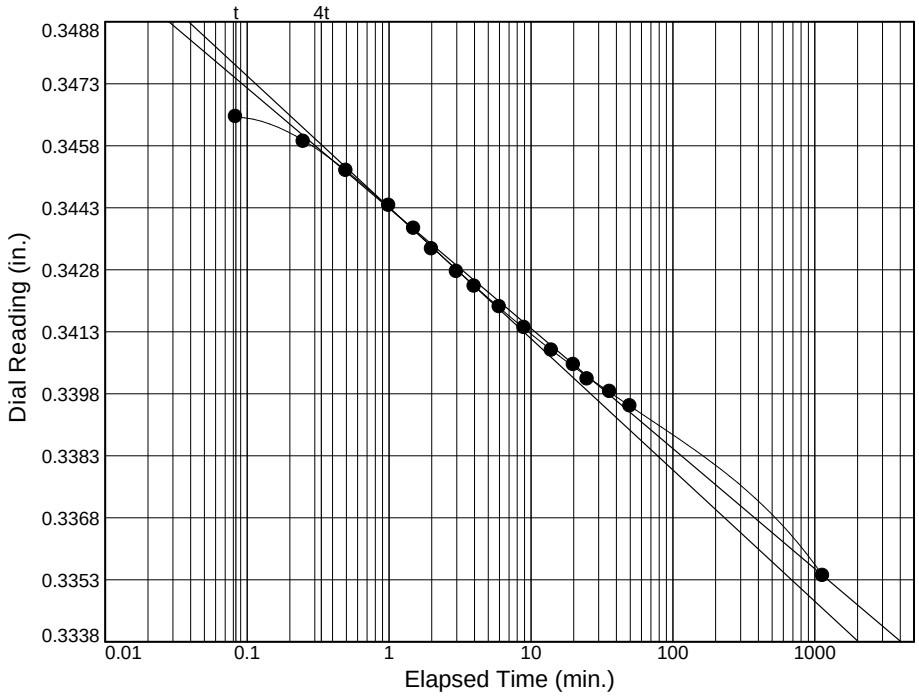
Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 17-19 Sample Number: RTG-SB-03 / ST-1



Load No.= 15
Load= 4.00 tsf
D_0 = 0.3548
D_{90} = 0.3528
D_{100} = 0.3526
T_{90} = 1.90 min.

C_v @ T_{90}
0.0026 cm.^{2}/sec.



Load No.= 16
Load= 1.00 tsf
D_0 = 0.3473
D_{50} = 0.3457
D_{100} = 0.3440
T_{50} = 0.32 min.

C_v @ T_{50}
0.0037 cm.^{2}/sec.

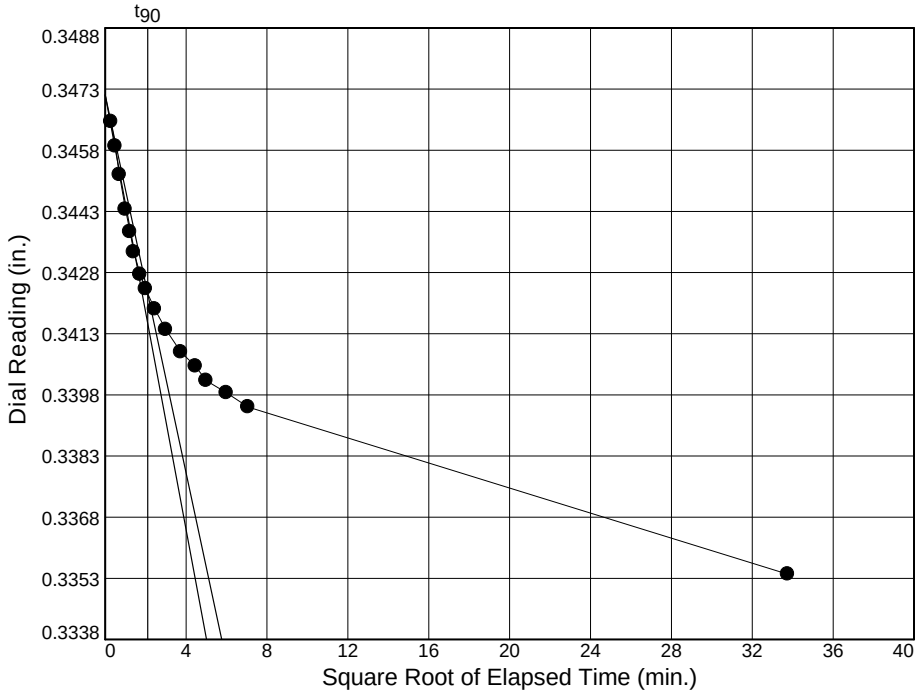
Figure C1573-16

Thielsch Engineering Inc.

Dial Reading vs. Time

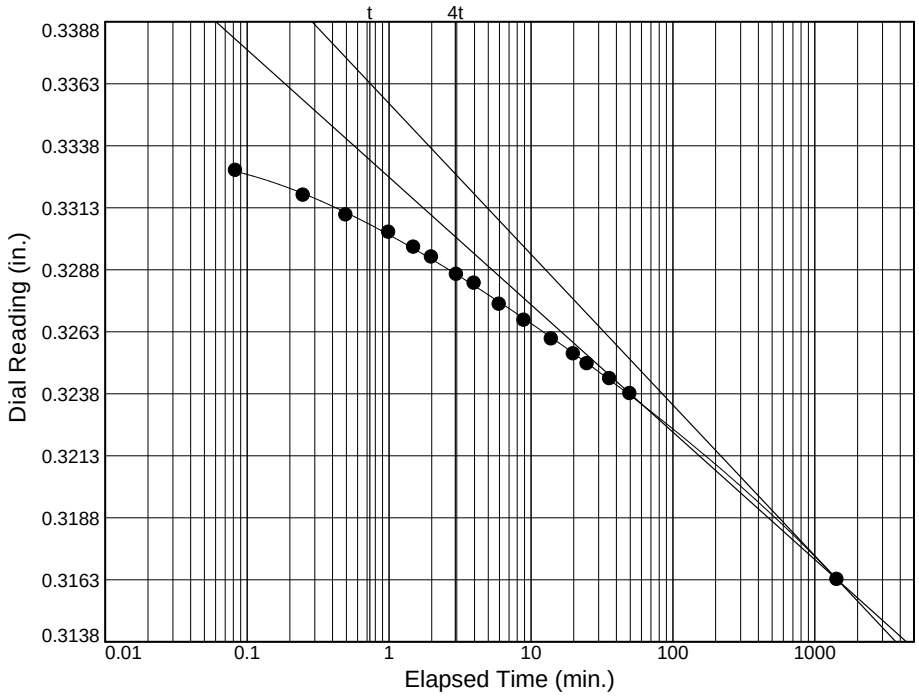
Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 17-19 Sample Number: RTG-SB-03 / ST-1



Load No.= 16
Load= 1.00 tsf
D_0 = 0.3472
D_{90} = 0.3423
D_{100} = 0.3417
T_{90} = 4.42 min.

C_v @ T_{90}
0.0012 $cm.^2$/sec.



Load No.= 17
Load= 0.25 tsf
D_0 = 0.3326
D_{50} = 0.3244
D_{100} = 0.3163
T_{50} = 34.39 min.

C_v @ T_{50}
0.0000 $cm.^2$/sec.

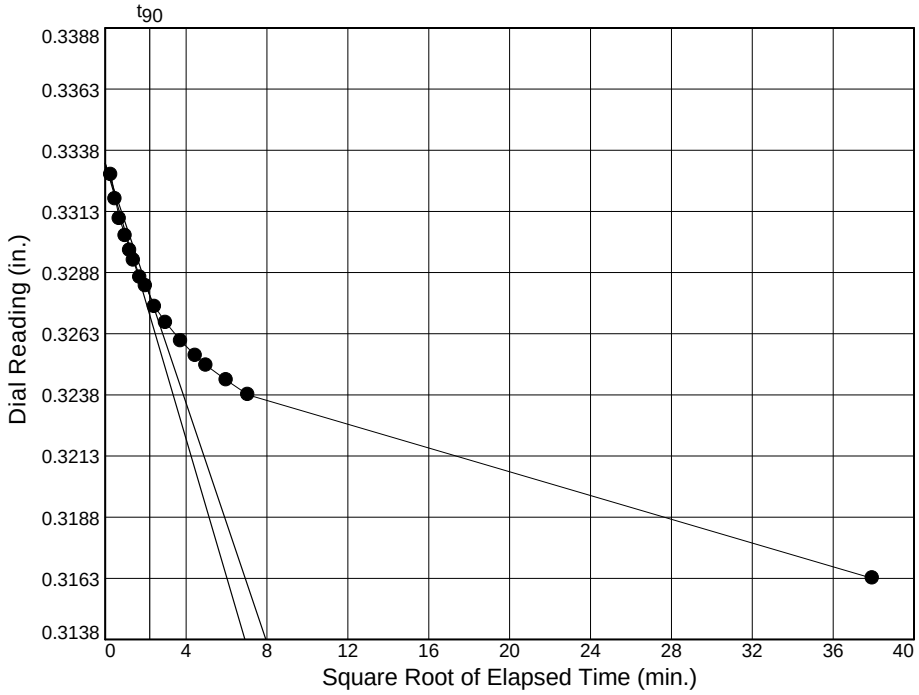
Figure C1573-17

Thielsch Engineering Inc.

Dial Reading vs. Time

Project No.: 74-16-0002.09
Project: Mill River Dist

Source of Sample: Borings Depth: 17-19 Sample Number: RTG-SB-03 / ST-1



Load No.= 17
Load= 0.25 tsf
D_0 = 0.3333
D_{90} = 0.3279
D_{100} = 0.3273
T_{90} = 4.86 min.

C_v @ T_{90}
0.0011 $cm.^2/sec.$

Figure C1573-18

Appendix D
Budget-Level Cost Estimates

Table D-1
Budget-Level Cost Estimate
Raising Grade, Vacant Lot North of Radiall
Alternatives Evaluation Memorandum
City of New Haven, CT

Item	Description	Unit of Payment	Estimated Quantity	Unit Price	Extended Total	Comments
1	**General Requirements**					
	Earth Material Submittals	LS	1	$2,500.00	$2,500.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Concrete Submittals	LS	1	$0.00	$0.00	Assume part of overall Project Development Costs
	Steel Submittals	LS	1	$0.00	$0.00	Assume part of overall Project Development Costs
	Electrical, Mechanical, and HVAC Submittals	LS	1	$0.00	$0.00	Assume part of overall Project Development Costs
	Site Restoration Submittals	LS	1	$1,500.00	$1,500.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Safety Activity Plan	LS	1	$0.00	$0.00	Assume part of overall Project Development Costs
	Quality Control (QC) Plan	LS	1	$0.00	$0.00	Assume part of overall Project Development Costs
	Meetings	EA	8	$0.00	$0.00	Assume part of overall Project Development Costs
	Closeout Related Submittals	LS	1	$0.00	$0.00	Assume part of overall Project Development Costs
	Performance & Payment Bonds	LS	1	$24,215.13	$24,215.13	Assume at 2% of Flood Proofing Alternative Costs
	Record Drawings	LS	1	$5,000.00	$5,000.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
					$33,215.13	
	Calculate Bid Unit Cost	LS	1		$33,215.13	
2	**Mobilization**					
	Mobilization (Multiple Mobilizations Assumed)	LS	1	$50,000.00	$50,000.00	Estimator's Judgment, Related to Flood Proofing Alternative Only
					$50,000.00	
	Calculate Bid Unit Cost	LS	1		$50,000.00	
3	**Quality Control**					
	Grain Size through No. 200 Sieve	EA	9	$90.00	$845.10	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Moisture Density Relationship	EA	9	$200.00	$1,878.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Dry-Density and As-Placed Moisture Content	1/2 DAY	20	$300.00	$6,000.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
					$8,723.10	
	Calculate Bid Unit Cost	LS	1		$8,723.10	
4	**Erosion and Sedimentation Controls**					
	Silt Fence/Baled Hay Erosion Check	LF	500	$8.00	$4,000.00	Estimator's Judgment, Related to Flood Proofing Alternative Only
	Construction Entrance	EA	1	$15,000.00	$15,000.00	Estimator's Judgment, Related to Flood Proofing Alternative Only
					$19,000.00	
	Calculate Bid Unit Cost	LS	1		$19,000.00	
5	**Demolition, Clearing, and Removal**					
	Demolish and Remove Existing Structures	LS	1	$0.00	$0.00	Assume part of overall Project Development Costs
	Cut Down and Remove Vegetation	DAY	2	$0.00	$0.00	Assume part of overall Project Development Costs
	Grub Out and Remove Stumps	DAY	1	$0.00	$0.00	Assume part of overall Project Development Costs
	Strip and Stockpile Topsoil	CY	900	$0.00	$0.00	Assume part of overall Project Development Costs
	Trucking and Disposal Allowance	TRK	90	$0.00	$0.00	Assume part of overall Project Development Costs
					$0.00	
	Calculate Bid Unit Cost	LS	1		$0.00	
6	**Raising Grade**					
6A	**Prefabricated Vertical Wick Drains**					
	Mobilize Modified Hydraulic Excavator	LS	1	$15,000.00	$15,000.00	Estimator's Judgment, Related to Flood Proofing Alternative Only
	Furnish and Install Vertical Wick Drains	LF	51,368	$1.50	$77,052.00	Estimator's Judgment, Related to Flood Proofing Alternative Only
					$92,052.00	
	Calculate Bid Unit Cost	LS	1		$92,052.00	
6B	**Raise Grade to DFE**					
	Prepare and Compact Subgrade	DAY	5	$3,500.00	$17,500.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Furnish Granular Fill Material	TON	16,110	$18.11	$291,792.38	Per Tilcon Connecticut x 1.15 Mark-up
	Place and Compact Granular Backfill Material	CY	9,180	$10.00	$91,800.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
					$401,092.38	
	Calculate Bid Unit Cost	LS	1		$401,092.38	
6C	**Surcharge Load**					
	Furnish Common Borrow from Compensatory Storage	TON	8,230	$5.00	$41,150.00	Loading and Trucking Costs Only
	Place and Compact Common Borrow Material	CY	4,690	$10.00	$46,900.00	Estimator's Judgement, Related to Flood Proofing Alternative Only

Table D-1
Budget-Level Cost Estimate
Raising Grade, Vacant Lot North of Radiall
Alternatives Evaluation Memorandum
City of New Haven, CT

Item	Description	Unit of Payment	Estimated Quantity	Unit Price	Extended Total	Comments
					$88,050.00	
	Calculate Bid Unit Cost	LS	1		$88,050.00	
6D	**Geotechnical Instrumentation**					
	Furnish and Install Settlement Plates	EA	15	$1,500.00	$22,500.00	Estimator's Judgment, Related to Flood Proofing Alternative Only
	Furnish and Install Vibrating Wire Piezometers	EA	5	$3,500.00	$17,500.00	Estimator's Judgment, Related to Flood Proofing Alternative Only
	Instrument Readings	EVENT	24	$500.00	$12,000.00	Estimator's Judgment, Related to Flood Proofing Alternative Only
	Data Tracking and Processing	LS	1	$15,000.00	$15,000.00	Estimator's Judgment, Related to Flood Proofing Alternative Only
					$67,000.00	
	Calculate Bid Unit Cost	LS	1		$67,000.00	
6E	**Strip Surchage to DFE**					
	Excavate and Remove Surcharge	CY	4,690	$10.00	$46,900.00	Estimator's Judgment, Related to Flood Proofing Alternative Only
	Load and Truck Surchage Offsite	TRK	469	$0.00	$0.00	Included Under Bid Item No. 8
					$46,900.00	
	Calculate Bid Unit Cost	LS	1		$46,900.00	
7	**Riprap Slope Stabilization/Protection**					
	Furnish and Install Geotextile Fabric	SF	13,500	$1.00	$13,500.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Furnish Riprap Bedding Stone	TON	440	$29.27	$12,877.70	Per Tilcon Connecticut x 1.15 Mark-up
	Install Riprap Bedding Stone	DAY	4	$3,500.00	$14,000.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Furnish Riprap	TON	945	$29.61	$27,983.81	Per Tilcon Connecticut x 1.15 Mark-up
	Install Riprap	DAY	8	$3,500.00	$28,000.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
					$96,361.51	
	Calculate Bid Unit Cost	LS	1		$96,361.51	
8	**Compensatory Floodplain Storage**					
	Excavate Floodplain Storage Basin	CY	7,705	$10.00	$77,050.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Grade and Shape Basin	DAY	3	$3,500.00	$10,500.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Trucking and Disposal Allowance (Assume Non-Contaminated)	TRK	771	$250.00	$192,750.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
					$280,300.00	
	Calculate Bid Unit Cost	LS	1		$280,300.00	
9	**Site Restoration**					
	Furnish Loam	CY	700	$20.00	$14,000.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Place Loam	CY	700	$5.00	$3,500.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Furnish and Install Seed	SF	37,555	$0.50	$18,777.50	Estimator's Judgement, Related to Flood Proofing Alternative Only
					$36,277.50	
	Calculate Bid Unit Cost	LS	1		$36,277.50	
10	**Demobilization and Clean-up**					
	Demobilization and Clean-up	LS	1	$25,000.00	$25,000.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
					$25,000.00	
	Calculate Bid Unit Cost	LS	1		$25,000.00	
	SUBTOTAL				$1,243,971.62	Sum of Items 1-10
	Scope and Budget Contingencies				$310,992.90	Scope and Budget Contingencies @ 25%
	Subsurface Investigation				$0.00	Subsurface Investigation Already Completed
	Permitting				$31,099.29	Assume @ 2.5%
	Final Plans, Specifications, and Engineering				$55,978.72	Assume @ 4.5%
	Construction Phase Services				$87,078.01	Assume @ 7.0% (Full-Time Construction Observation Assumed)
	TOTAL ESTIMATE (2016 USD)				**$1,800,000.00**	Rounded to the Nearest $100,000.00
	Flood Proofing Cost Per SF of Building Footprint				**$90.00**	For a Hypothetical Building Footprint of 20,000 SF

Table D-2
Budget-Level Cost Estimate
Elevated Development, Vacant Lot North of Radiall
Alternatives Evaluation Memorandum
City of New Haven, CT

Item	Description	Unit of Payment	Estimated Quantity	Unit Price	Extended Total	Comments
1	**General Requirements**					
	Earth Material Submittals	LS	1	$2,500.00	$2,500.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Concrete Submittals	LS	1	$2,500.00	$2,500.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Steel Submittals	LS	1	$1,500.00	$1,500.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Electrical, Mechanical, and HVAC Submittals	LS	1	$0.00	$0.00	Assume part of overall Project Development Costs
	Safety Activity Plan	LS	1	$0.00	$0.00	Assume part of overall Project Development Costs
	Quality Control (QC) Plan	LS	1	$0.00	$0.00	Assume part of overall Project Development Costs
	Meetings	EA	8	$0.00	$0.00	Assume part of overall Project Development Costs
	Closeout Related Submittals	LS	1	$0.00	$0.00	Assume part of overall Project Development Costs
	Performance & Payment Bonds	LS	1	$32,283.58	$32,283.58	Assume at 2% of Flood Proofing Alternative Costs
	Record Drawings	LS	1	$10,000.00	$10,000.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
					$48,783.58	
	Calculate Bid Unit Cost	LS	1		$48,783.58	
2	**Mobilization**					
	Mobilization	LS	1	$50,000.00	$50,000.00	Estimator's Judgment, Related to Flood Proofing Alternative Only
					$50,000.00	
	Calculate Bid Unit Cost	LS	1		$50,000.00	
3	**Quality Control**					
	Grain Size through No. 200 Sieve	EA	2	$90.00	$180.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Moisture Density Relationship	EA	2	$200.00	$400.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Dry-Density and As-Placed Moisture Content	1/2 DAY	2	$300.00	$600.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Concrete Compressive Strength	EA	20	$100.00	$2,000.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
					$3,180.00	
	Calculate Bid Unit Cost	LS	1		$3,180.00	
4	**Erosion and Sedimentation Controls**					
	Silt Fence/Baled Hay Erosion Check	LF	500	$8.00	$4,000.00	Estimator's Judgment, Related to Flood Proofing Alternative Only
	Construction Entrance	EA	1	$15,000.00	$15,000.00	Estimator's Judgment, Related to Flood Proofing Alternative Only
					$19,000.00	
	Calculate Bid Unit Cost	LS	1		$19,000.00	
5	**Demolition, Clearing, and Removal**					
	Demolish and Remove Existing Structures	LS	1	$0.00	$0.00	Assume part of overall Project Development Costs
	Cut Down and Remove Vegetation	DAY	2	$0.00	$0.00	Assume part of overall Project Development Costs
	Grub Out and Remove Stumps	DAY	1	$0.00	$0.00	Assume part of overall Project Development Costs
	Strip and Stockpile Topsoil	CY	400	$0.00	$0.00	Assume part of overall Project Development Costs
	Trucking and Disposal Allowance	TRK	40	$0.00	$0.00	Assume part of overall Project Development Costs
					$0.00	
	Calculate Bid Unit Cost	LS	1		$0.00	
6	**Pile Supported Foundation**					
	Excavate for Pile Caps	CY	480	$10.00	$4,800.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Furnish Granular Fill Material for Leveling Pad	TON	240	$18.11	$4,346.40	Per Tilcon Connecticut x 1.15 Mark-up
	Place and Compact Granular Backfill Material	CY	135	$10.00	$1,350.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Furnish HP12x63 Piles (4 Piles/Cap x 45 Caps x 70-feet-long)	LF	12,600	$35.75	$450,450.00	Written Quote from Raymond Piling x 1.15 for Mark-Up
	Furnish Champion Splice	EA	0	$115.00	$0.00	Written Quote from Raymond Piling x 1.15 for Mark-Up
	Install Champion Splice	EA	0	$400.00	$0.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Install H-Piles	LF	12,600	$50.00	$630,000.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Perform Static Pile Load Test	LS	1	$50,000.00	$50,000.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	PDA Testing on 10% of Production Piles	DAY	2	$2,300.00	$4,600.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	CAPWAPs	EA	11	$287.50	$3,162.50	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Form and Pour Pile Caps	CY	320	$650.00	$208,000.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Form and Pour Main Columns at Caps to Support Building	CY	168	$750.00	$126,000.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Form and Pour 1st Floor Beams and Structural Slab	CY	600	$0.00	$0.00	Assume part of overall Project Development Costs
					$1,482,708.90	
	Calculate Bid Unit Cost	LS	1		$1,482,708.90	

Table D-2
Budget-Level Cost Estimate
Elevated Development, Vacant Lot North of Radiall
Alternatives Evaluation Memorandum
City of New Haven, CT

Item	Description	Unit of Payment	Estimated Quantity	Unit Price	Extended Total	Comments
7	**Riprap Scour Protection**					
	Excavate for Riprap Scour Protection	CY	192	$10.00	$1,920.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Prepare and Compact Subgrade	DAY	1	$3,500.00	$3,500.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Furnish and Install Geotextile Fabric	SF	3,100	$1.00	$3,100.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Furnish Riprap Bedding Stone	TON	95	$29.27	$2,780.65	Per Tilcon Connecticut x 1.15 Mark-up
	Install Riprap Bedding Stone	DAY	2	$3,500.00	$7,000.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Furnish Riprap	TON	155	$29.61	$4,589.55	Per Tilcon Connecticut x 1.15 Mark-up
	Install Riprap	DAY	2	$3,500.00	$7,000.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
					$29,890.20	
	Calculate Bid Unit Cost	LS	1		$29,890.20	
8	**Compensatory Floodplain Storage**					
	Excavate Floodplain Storage Basin	CY	90	$10.00	$900.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
	Grade and Shape Basin	DAY	1	$3,500.00	$3,500.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
					$4,400.00	
	Calculate Bid Unit Cost	LS	1		$4,400.00	
9	**Site Restoration**					
	Furnish Loam	CY	0	$20.00	$0.00	Assume part of overall Project Development Costs
	Place Loam	CY	0	$5.00	$0.00	Assume part of overall Project Development Costs
	Furnish and Install Seed	SF	0	$0.50	$0.00	Assume part of overall Project Development Costs
					$0.00	
	Calculate Bid Unit Cost	LS	1		$0.00	
10	**Demobilization and Clean-up**					
	Demobilization and Clean-up	LS	1	$25,000.00	$25,000.00	Estimator's Judgement, Related to Flood Proofing Alternative Only
					$25,000.00	
	Calculate Bid Unit Cost	LS	1		$25,000.00	
	SUBTOTAL				$1,662,962.68	Sum of Items 1-10
	Scope and Budget Contingencies				$415,740.67	Scope and Budget Contingencies @ 25%
	Supplemental Subsurface Investigation				$8,314.81	Supplemental Subsurface Investigation @ 0.50%
	Permitting				$16,629.63	Assume @ 1.0%
	Final Plans, Specifications, and Engineering				$83,148.13	Assume @ 5.0%
	Construction Phase Services				$99,777.76	Assume @ 6.0% (Full-Time Construction Observation Assumed)
	TOTAL ESTIMATE (2016 USD)				**$2,300,000.00**	Rounded to the Nearest $100,000.00
	Flood Proofing Cost Per SF of Building Footprint				**$115.00**	For a Hypothetical Building Footprint of 20,000 SF