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New Hampshire DOT
Department of Transportation

THE STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION

CHRISTOPHER D. CLEMENT, SR.
COMMISSIONER

JEFF BRILLHART, P.E.
ASSISTANT COMMISSIONER

Bureau of Materials & Research
June 7, 2013

Her Excellency, Governor Margaret Wood Hassan
and the Honorable Council
State House
Concord, NH 03301

REQUESTED ACTION

Authorize the Department of Transportation to enter into a three-year agreement with a pre-qualified, low bid, cost-based contract with Northern Test Boring, Inc., Gorham, ME 04038 (Vendor Code 153356) for respective fees not to exceed $300,000 for the purpose of providing on-call Statewide Geotechnical Subsurface Explorations services from the date of Governor and Council approval through June 30, 2016.

Funding is available as follows and is contingent upon the availability and continued appropriation of funds in FY 2014, 2015 and 2016:

	FY14	FY15	FY16
04-096-96-963515-3054			
Consolidated Federal Aid			
400-500870 Highway Contract Payments	$100,000	$100,000	$100,000

The Consolidated Federal Funds, AU 3054, is utilized at this time to encumber funds for this request. Actual funding sources will be determined by each particular project incurring expenses as a result of this request.

EXPLANATION

The Department requires geotechnical subsurface exploration (drilling) services to obtain soil, bedrock and groundwater information for use in the design of various Department projects. Geotechnical subsurface explorations provide essential information to perform engineering analysis of foundations for bridges and other structures, for designing highway embankment fills and earth cuts, for assessing groundwater drainage needs and for verifying existing conditions of constructed facilities. This contract is needed to supplement State forces engaged in similar work for high volume work periods, and exclusively for performing subsurface explorations in areas with ground or groundwater contamination and at sites requiring subsurface explorations on open water. State forces do not possess the required OSHA training or equipment to work in contaminated areas, nor do State forces have the necessary floatation equipment to work sites on open water.

The services to be provided will assist in the completion of preliminary and/or final design plans for projects on the Ten Year Transportation Improvement Program and the Statewide Transportation Improvement Program for a duration from the date of Governor and Council approval through June 30, 2016. The total fee will not exceed $300,000.00 in this period. Work assignments will be based upon Department needs and nature of the worksite. The Agreement fees are based on the specific rates bid for each item in the agreement multiplied by the quantities

performed. The Federal Highway Administration may participate in these costs depending upon the particular funding of the individual projects undertaken.

The contractor selection process was in accordance with the Department's "Selection Procedures for Pre-qualified Low-Bid Technical Service Statewide Contracts", dated February 26, 1998. The Bureau of Materials & Research will administer the contract upon approval.

The selection process for this low bid selection agreement was initiated by a solicitation for contracted services for one on-call Statewide Geotechnical Subsurface Explorations services contract. The assignment was listed as a "Possible Action Project" on the Department's website on October 9, 2012, requesting letters of interest from interested firms. Letters of interest and other information were received by the Department from three (3) interested firms. Based on the information provided, the following firms were approved as pre-qualified to bid by the Assistant Commissioner on January 17, 2013:

Firm	**Location**
Geosearch, Inc.	Fitchburg, MA
New Hampshire Boring, Inc.	Derry, NH
Northern Test Boring, Inc.	Gorham, ME

The Department extended invitations to bid on January 25, 2013, to the three (3) firms pre-qualified to bid. To enable proper comparison of bids, each firm was provided a bid sheet with the same items and quantities listed, which represented the estimated amount of work for the duration of the agreement. The March 7, 2013, bid results were as follows:

Firm	**Location**	**Total Bid**
Northern Test Boring, Inc.	Gorham, ME	$250,085.00
New Hampshire Boring, Inc.	Derry, NH	$250,690.00
Geosearch, Inc.	Fitchburg, MA	$725,555.00

The contracts have been approved by the Attorney General as to form and execution. The Department has verified that the necessary funds are available. Copies of the fully executed contracts are on file at the Secretary of State's office and the Department of Administrative Services office, and subsequent to Governor and Council approval will be on file at the Department of Transportation.

It is respectfully requested that authority be given to enter into the Agreement (Statewide 15667A) with Northern Test Boring, Inc. for on-call Statewide Geotechnical Subsurface Exploration services as outlined above.

Sincerely,

Christopher D. Clement, Sr.
Commissioner

CDC/crd

CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY): 05/01/2013

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER	**CONTACT NAME:** Pamela Edwards	
Roux Insurance Services 185 Webster Street Lewiston, ME 04240	**PHONE (A/C, No, Ext):** (207) 784-9358	**FAX (A/C, No):** (207) 782-6945
	E-MAIL ADDRESS: pedwards@rouxinsurance.com	
	INSURER(S) AFFORDING COVERAGE	**NAIC #**
	INSURER A: Crum & Forster Insurance Co.	42471
INSURED	**INSURER B:** Allmerica Financial Benefit Ins. Co.	41840
Northern Test Boring, Inc. 187 Mighty Street Gorham, ME 04038	**INSURER C:** Maine Employers Mutual Ins. Co.	11149
	INSURER D: Hanover Insurance Co.	22292
	INSURER E:	
	INSURER F:	

COVERAGES **CERTIFICATE NUMBER:** **REVISION NUMBER:**

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	TYPE OF INSURANCE	ADDL INSR	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS		
A	**GENERAL LIABILITY** ☑ COMMERCIAL GENERAL LIABILITY ☐ CLAIMS-MADE ☐ OCCUR ☑ Pollution Liability GEN'L AGGREGATE LIMIT APPLIES PER: ☑ POLICY ☐ PRO-JECT ☐ LOC	Y		EPK100815	9/23/2012	9/23/2013	EACH OCCURRENCE	$	1,000,000
							DAMAGE TO RENTED PREMISES (Ea occurrence)	$	50,000
							MED EXP (Any one person)	$	5,000
							PERSONAL & ADV INJURY	$	1,000,000
							GENERAL AGGREGATE	$	2,000,000
							PRODUCTS - COMP/OP AGG	$	2,000,000
								$	
B	**AUTOMOBILE LIABILITY** ☐ ANY AUTO ☐ ALL OWNED AUTOS ☑ SCHEDULED AUTOS ☑ HIRED AUTOS ☑ NON-OWNED AUTOS	Y		AWP 6469138 03	9/23/2012	9/23/2013	COMBINED SINGLE LIMIT (Ea accident)	$	1,000,000
							BODILY INJURY (Per person)	$	
							BODILY INJURY (Per accident)	$	
							PROPERTY DAMAGE (Per accident)	$	
								$	
	☐ **UMBRELLA LIAB** ☐ OCCUR ☐ **EXCESS LIAB** ☐ CLAIMS-MADE ☐ DED ☐ RETENTION $						EACH OCCURRENCE	$	
							AGGREGATE	$	
								$	
C	**WORKERS COMPENSATION AND EMPLOYERS' LIABILITY** ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? (Mandatory in NH) Y/N: Y If yes, describe under DESCRIPTION OF OPERATIONS below	N/A		1810057339	12/7/2012	12/7/2013	☑ WC STATU-TORY LIMITS ☐ OTH-ER		
							E.L. EACH ACCIDENT	$	500,000
							E.L. DISEASE - EA EMPLOYEE	$	500,000
							E.L. DISEASE - POLICY LIMIT	$	500,000
	Contractors Equip.-Rented or Leased			IHP6464797 03	9/23/2012	9/23/2013	Blanket Limit: $65,000, Deductible;$5,000		

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (Attach ACORD 101, Additional Remarks Schedule, if more space is required)

New Hampshire DOT is additional insured.

CERTIFICATE HOLDER

New Hampshire DOT Materials & Research Bureau
Attn: Chuck Dusseault
PO Box 483
Concord, NH 033020483

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

AUTHORIZED REPRESENTATIVE

Gloria Breton

State of New Hampshire
Department of Transportation

NHDOT Project: STATEWIDE 15667A

Statewide Geotechnical Subsurface Explorations

(Agreement Number 18)

Contract Dates: *(G&C Approval Date)* **to June 30, 2016**

Contractor: Northern Test Boring, Inc.
187 Mighty Street
Gorham, ME 04038

Telephone: (207) 839-9880
Facsimile: (207) 839-9882
E-mail: northerntestboring@ymail.com

DOT Contact: Charles R. Dusseault, PE
Bureau of Materials & Research
PO Box 483, 5 Hazen Drive
Concord NH 03302-0483

Telephone: (603) 271-3151
Facsimile: (603) 271-8700
E-mail: cdusseault@dot.state.nh.us

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FORM NUMBER P-37 (VERSION 1/09)

Subject: Statewide 15667A – Geotechnical Subsurface Explorations

AGREEMENT

The State of New Hampshire and the Contractor hereby mutually agree as follows:

GENERAL PROVISIONS

1 IDENTIFICATION

1.1 State Agency Name Transportation, Bureau of Materials & Research		1.2 State Agency Address PO Box 483, 5 Hazen Drive, Concord, NH 03302-0483	
1.3 Contractor Name Northern Test Boring, Inc.		1.3 Contractor Address 187 Mighty Street Gorham, ME 04038	
1.5 Contractor Phone Number (207) 839-9880	1.6 Account Number 04-096-096-963015-3054	1.7 Completion Date June 30, 2016	1.8 Price Limitation ($300,000.00)
1.9 Contracting Officer for State Agency Charles R. Dusseault		1.10 State Agency Telephone Number (603) 271-3151	
1.11 Contractor Signature		1.12 Name and Title of Contractor Signatory Michael Nadeau President	

1.13 Acknowledgement: State of Maine, County of Cumberland

On 5/30/2013 before the undersigned officer, personally appeared the person identified in block 1.12, or satisfactorily proven to be the person whose name is signed in block 1.11, and acknowledged that s/he executed this document in the capacity indicated in block 1.12.

1.13.1 Signature of Notary or Justice of the Peace

[Seal] Karl E. Hartwell

1.13.2 Name and Title of Notary or ~~Justice of the Peace~~

KARL E. HARTWELL
Notary Public, Maine
My Commission Expires 12/2/2019

1.14 State Agency Signature	1.15 Name and Title of State Agency Signatory William J. Cass, P.E. Director of Project Development NHDOT
1.16 Approval by the N.H. Department of Administration, Division of Personnel *(if applicable)* By:	Director, On:
1.17 Approval by the Attorney general (Form, Substance and Execution) By:	On: 6/20/13
1.18 Approval by the Governor and Executive Council By:	On:

2 EMPLOYMENT OF CONTRACTOR/SERVICES TO BE PERFORMED

The State of New Hampshire, acting through the agency identified in block 1.1 ("State"), engages Contractor identified in block 1.3 ("Contractor") to perform, and the Contractor shall perform, the work or sale of goods, or both, identified and more particularly described in the attached EXHIBIT A which is incorporated herein by reference ("Services").

3 EFFECTIVE DATE/COMPLETION OF SERVICES

3.1 Notwithstanding any provision of this Agreement to the contrary, and subject to the approval of the Governor and Executive Council of the State of New Hampshire, this Agreement, and all obligations of the parties hereunder, shall not become effective until the date the Governor and Executive Council approve this Agreement ("Effective Date").

3.2 If the Contractor commences the Services prior to the Effective Date, all Services performed by the Contractor prior to the Effective Date shall be performed at the sole risk of the Contractor, and in the event that this Agreement does not become effective, the State shall have no liability to the Contractor, including without limitation, any obligation to pay the Contractor for any costs incurred or Services performed. Contractor must complete all Services by the Completion Date specified in block 1.7.

4 CONDITIONAL NATURE OF AGREEMENT

Notwithstanding any provision of this Agreement to the contrary, all obligations of the State hereunder, including, without limitation, the continuance of payments hereunder, are contingent upon the availability and continued appropriation of funds, and in no event shall the State be liable for any payments hereunder in excess of such available appropriated funds. In the event of a reduction or termination of appropriated funds, the State shall have the right to withhold payment until such funds become available, if ever, and shall have the right to terminate this Agreement immediately upon giving the Contractor notice of such termination. The State shall not be required to transfer funds from any other account to the Account identified in block 1.6 in the event funds in that Account are reduced or unavailable.

5 CONTRACT PRICE/PRICE LIMITATION/ PAYMENT

5.1 The contract price, method of payment, and terms of payment are identified and more particularly described in EXHIBIT B which is incorporated herein by reference.

5.2 The payment by the State of the contract price shall be the only and the complete reimbursement to the Contractor for all expenses, of whatever nature incurred by the Contractor in the performance hereof, and shall be the only and the complete compensation to the Contractor for the Services. The State shall have no liability to the Contractor other than the contract price.

5.3 The State reserves the right to offset from any amounts otherwise payable to the Contractor under this Agreement those liquidated amounts required or permitted by N.H. RSA 80:7 through RSA 80:7-c or any other provision of law.

5.4 Notwithstanding any provision in this Agreement to the contrary, and notwithstanding unexpected circumstances, in no event shall the total of all payments authorized, or actually made hereunder, exceed the Price Limitation set forth in block 1.8.

6 COMPLIANCE BY CONTRACTOR WITH LAWS AND REGULATIONS/EQUAL EMPLOYMENT OPPORTUNITY

6.1 In connection with the performance of the Services, the Contractor shall comply with all statutes, laws, regulations, and orders of federal, state, county or municipal authorities which impose any obligation or duty upon the Contractor, including, but not limited to, civil rights and equal opportunity laws. In addition, the Contractor shall comply with all applicable copyright laws.

6.2 During the term of this Agreement, the Contractor shall not discriminate against employees or applicants for employment because of race, color, religion, creed, age, sex, handicap, sexual orientation, or national origin and will take affirmative action to prevent such discrimination.

6.3 If this Agreement is funded in any part by monies of the United States, the Contractor shall comply with all the provisions of Executive Order No. 11246 ("Equal Employment Opportunity"), as supplemented by the regulations of the United States Department of Labor (41 C.F.R. Part 60), and with any rules, regulations and guidelines as the State of New Hampshire or the United States issue to implement these regulations. The Contractor further agrees to permit the State or United States access to any of the Contractor's books, records and accounts for the purpose of ascertaining compliance with all rules, regulations and orders, and the covenants, terms and conditions of this Agreement.

7 PERSONNEL

7.1 The Contractor shall at its own expense provide all personnel necessary to perform the Services. The Contractor warrants that all personnel engaged in the Services shall be qualified to perform the Services, and shall be properly licensed and otherwise authorized to do so under all applicable laws.

7.2 Unless otherwise authorized in writing, during the term of this Agreement, and for a period of six (6) months after the Completion Date in block 1.7, the Contractor shall not hire, and shall not permit any subcontractor or other person, firm or corporation with whom it is engaged in a combined effort to perform the Services to hire, any person who is a State employee or official, who is materially involved in the procurement, administration or performance of this Agreement. This provision shall survive termination of this Agreement.

7.3 The Contracting Officer specified in block 1.9, or his or her successor, shall be the State's representative. In the event of any dispute concerning the interpretation of this Agreement, the Contracting Officer's decision shall be final for the State.

Contractor Initials MW
Date 5/13/13

8 EVENT OF DEFAULT/REMEDIES

8.1 Any one or more of the following acts or omissions of the Contractor shall constitute an event of default hereunder ("Event of Default"):

8.1.1 failure to perform the Services satisfactorily or on schedule;

8.1.2 failure to submit any report required hereunder; and/or

8.1.3 failure to perform any other covenant, term or condition of this Agreement.

8.2 Upon the occurrence of any Event of Default, the State may take any one, or more, or all, of the following actions:

8.2.1 give the Contractor a written notice specifying the Event of Default and requiring it to be remedied within, in the absence of a greater or lesser specification of time, thirty (30) days from the date of the notice; and if the Event of Default is not timely remedied, terminate this Agreement, effective two (2) days after giving the Contractor notice of termination;

8.2.2 give the Contractor a written notice specifying the Event of Default and suspending all payments to be made under this Agreement and ordering that the portion of the contract price which would otherwise accrue to the Contractor during the period from the date of such notice until such time as the State determines that the Contractor has cured the Event of Default shall never be paid to the Contractor;

8.2.3 set off against any other obligations the State may owe to the Contractor any damages the State suffers by reason of any Event of Default; and/or

8.2.4 treat the Agreement as breached and pursue any of its remedies at law or in equity, or both.

9 DATA/ACCESS/CONFIDENTIALITY/ PRESERVATION

9.1 As used in this Agreement, the word "data" shall mean all information and things developed or obtained during the performance of, or acquired or developed by reason of, this Agreement, including, but not limited to, all studies, reports, files, formulae, surveys, maps, charts, sound recordings, video recordings, pictorial reproductions, drawings, analyses, graphic representations, computer programs, computer printouts, notes, letters, memoranda, papers, and documents, all whether finished or unfinished.

9.2 All data and any property which has been received from the State or purchased with funds provided for that purpose under this Agreement, shall be the property of the State, and shall be returned to the State upon demand or upon termination of this Agreement for any reason.

9.3 Confidentiality of data shall be governed by N.H. RSA chapter 91-A or other existing law. Disclosure of data requires prior written approval of the State.

10 TERMINATION

In the event of an early termination of this Agreement for any reason other than the completion of the Services, the Contractor shall deliver to the Contracting Officer, not later than fifteen (15) days after the date of termination, a report ("Termination Report") describing in detail all Services performed, and the contract price earned, to and including the date of termination. The form, subject matter, content, and number of copies of the Termination Report shall be identical to those of any Final Report described in the attached EXHIBIT A.

11 CONTRACTOR'S RELATION TO THE STATE

In the performance of this Agreement the Contractor is in all respects an independent contractor, and is neither an agent nor an employee of the State. Neither the Contractor nor any of its officers, employees, agents or members shall have authority to bind the State or receive any benefits, workers' compensation or other emoluments provided by the State to its employees.

12 ASSIGNMENT/DELEGATION/SUBCONTRACTS

The Contractor shall not assign, or otherwise transfer any interest in this Agreement without the prior written consent of the N.H. Department of Administrative Services. None of the Services shall be subcontracted by the Contractor without the prior written consent of the State.

13 INDEMNIFICATION

The Contractor shall defend, indemnify and hold harmless the State, its officers and employees, from and against any and all losses suffered by the State, its officers and employees, and any and all claims, liabilities or penalties asserted against the State, its officers and employees, by or on behalf of any person, on account of, based or resulting from, arising out of (or which may be claimed to arise out of) the acts or omissions of the Contractor. Notwithstanding the foregoing, nothing herein contained shall be deemed to constitute a waiver of the sovereign immunity of the State, which immunity is hereby reserved to the State. This covenant in paragraph 13 shall survive the termination of this Agreement.

14 INSURANCE

14.1 The Contractor shall, at its sole expense, obtain and maintain in force, and shall require any subcontractor or assignee to obtain and maintain in force, the following insurance:

14.1.1 comprehensive general liability insurance against all claims of bodily injury, death or property damage, in amounts of not less than $250,000 per claim and $2,000,000 per occurrence; and

14.1.2 fire and extended coverage insurance covering all property subject to subparagraph 9.2 herein, in an amount not less than 80% of the whole replacement value of the property.

14.2 The policies described in subparagraph 14.1 herein shall be on policy forms and endorsements approved for use in the State of New Hampshire by the N.H. Department of Insurance, and issued by insurers licensed in the State of New Hampshire.

14.3 The Contractor shall furnish to the Contracting Officer identified in block 1.9, or his or her successor, a certificate(s) of insurance for all insurance required under this Agreement. Contractor shall also furnish to the Contracting Officer identified in block 1.9, or his or her successor, certificate(s) of insurance for all renewal(s) of insurance required under this Agreement no later than fifteen (15) days prior to the expiration date of each of the insurance policies. The certificate(s) of insurance and any renewals thereof shall be Page 4 of 4 attached and are

Contractor Initials _____
Date 8/30/13

incorporated herein by reference. Each certificate(s) of insurance shall contain a clause requiring the insurer to endeavor to provide the Contracting Officer identified in block 1.9, or his or her successor, no less than ten (10) days prior written notice of cancellation or modification of the policy.

15 WORKERS' COMPENSATION

15.1 By signing this agreement, the Contractor agrees, certifies and warrants that the Contractor is in compliance with or exempt from, the requirements of N.H. RSA chapter 281-A *("Workers' Compensation")*.

15.2 To the extent the Contractor is subject to the requirements of N.H. RSA chapter 281-A, Contractor shall maintain, and require any subcontractor or assignee to secure and maintain, payment of Workers' Compensation in connection with activities which the person proposes to undertake pursuant to this Agreement. Contractor shall furnish the Contracting Officer identified in block 1.9, or his or her successor, proof of Workers' Compensation in the manner described in N.H. RSA chapter 281-A and any applicable renewal(s) thereof, which shall be attached and are incorporated herein by reference. The State shall not be responsible for payment of any Workers' Compensation premiums or for any other claim or benefit for Contractor, or any subcontractor or employee of Contractor, which might arise under applicable State of New Hampshire Workers' Compensation laws in connection with the performance of the Services under this Agreement.

16 WAIVER OF BREACH

No failure by the State to enforce any provisions hereof after any Event of Default shall be deemed a waiver of its rights with regard to that Event of Default, or any subsequent Event of Default. No express failure to enforce any Event of Default shall be deemed a waiver of the right of the State to enforce each and all of the provisions hereof upon any further or other Event of Default on the part of the Contractor.

17 NOTICE

Any notice by a party hereto to the other party shall be deemed to have been duly delivered or given at the time of mailing by certified mail, postage prepaid, in a United States Post Office addressed to the parties at the addresses given in blocks 1.2 and 1.4, herein.

18 AMENDMENT

This Agreement may be amended, waived or discharged only by an instrument in writing signed by the parties hereto and only after approval of such amendment, waiver or discharge by the Governor and Executive Council of the State of New Hampshire.

19 CONSTRUCTION OF AGREEMENT AND TERMS

This Agreement shall be construed in accordance with the laws of the State of New Hampshire, and is binding upon and inures to the benefit of the parties and their respective successors and assigns. The wording used in this Agreement is the wording chosen by the parties to express their mutual intent, and no rule of construction shall be applied against or in favor of any party.

20 THIRD PARTIES

The parties hereto do not intend to benefit any third parties and this Agreement shall not be construed to confer any such benefit.

21 HEADINGS

The headings throughout the Agreement are for reference purposes only, and the words contained therein shall in no way be held to explain, modify, amplify or aid in the interpretation, construction or meaning of the provisions of this Agreement.

22 SPECIAL PROVISIONS

Additional provisions set forth in the attached EXHIBIT C are incorporated herein by reference.

23 SEVERABILITY

In the event any of the provisions of this Agreement are held by a court of competent jurisdiction to be contrary to any state or federal law, the remaining provisions of this Agreement will remain in full force and effect.

24 ENTIRE AGREEMENT

This Agreement, which may be executed in a number of counterparts, each of which shall be deemed an original, constitutes the entire Agreement and understanding between the parties, and supersedes all prior Agreements and understandings relating hereto.

Contractor Initials MW
Date 5/30/13

EXHIBIT A

SERVICE AGREEMENT FOR SUBSURFACE EXPLORATIONS
STATEWIDE EXPLORATIONS CONTRACT No. 18
New Hampshire DOT Project: STATEWIDE 15667A

EXHIBIT A: TECHNICAL SERVICES TO BE PROVIDED

2.1 LOCATION AND DESCRIPTION OF PROJECT

The types of services required under the terms of this AGREEMENT shall be SUBSURFACE EXPLORATIONS, defined herein, that the DEPARTMENT may require at any time during this AGREEMENT until its completion date.

2.2 SUPPLEMENTARY DEFINITIONS

In addition to terms defined elsewhere in this AGREEMENT and in Section 101 of the DEPARTMENT's Standard Specifications for Road & Bridge Construction, the following definitions shall be applicable:

2.2.1 ENGINEER

An employee or designated representative of the DEPARTMENT, responsible for observation of the work performed by the CONTRACTOR and for communication with the CONTRACTOR concerning the DEPARTMENT's project objectives and requirements. The term ENGINEER includes without limitation engineers, technicians, geologists, soil scientists, earth scientists, and others so designated.

2.2.2 SUBSURFACE EXPLORATIONS

The term SUBSURFACE EXPLORATIONS shall include but not be limited to the following subsurface investigations to be performed by CONTRACTOR with geotechnical drilling equipment: cased wash borings; hollow-stem auger borings; solid-stem auger probes; stationary piston tube sampling; diamond bit coring; spin-casing; installation of groundwater monitoring wells, observation wells and piezometers; pavement coring; and decommissioning of existing groundwater monitoring or observation wells.

2.2.3 MUTCD

For development and implementation of traffic control, the current version of the "Manual on Uniform Traffic Control Devices for Streets and Highways" published by the United States Department of Transportation Federal Highway Administration (defined as MUTCD for this AGREEMENT) shall define acceptable practice and signage. FHWA has the manual available (for purchase in hard copy or on CD, or printable in PDF format) through the Internet at the following link: http://mutcd.fhwa.dot.gov/index.htm.

2.3 SCOPE OF WORK

2.3.1 SUBSURFACE EXPLORATIONS to Be Provided

The work to be performed under the terms of this AGREEMENT shall be geotechnical SUBSURFACE EXPLORATIONS, as defined under paragraph 2.2.2 of this AGREEMENT, which the DEPARTMENT may assign to determine subsurface conditions at various DEPARTMENT project sites throughout the State. Project sites may include present and/or proposed locations for roadways, bridges, or other structures anywhere within the State of New Hampshire, or in an adjacent state for projects that cross a border. The CONTRACTOR will not be required to work on more than one work site at any given time, unless by mutual agreement between the DEPARTMENT and the CONTRACTOR. Work may be required both on land and over inland water bodies. Work may be required in an area of known or suspected contaminated soil or groundwater, so HAZWOPER protocols may be needed in performance of the work. Work in adverse weather and winter conditions may also be required since assignments can occur at any time during the contract. Standard contract compensation rates will be applicable to all working conditions without adjustment.

2.3.2 Purpose and Cooperation

The purpose of these SUBSURFACE EXPLORATIONS is to obtain reliable data regarding character and elevation of soil and rock formations. The CONTRACTOR shall give the DEPARTMENT every facility to obtain its own records and determine every detail of the work as it progresses.

2.3.3 Drilling Rigs to Be Furnished By the CONTRACTOR

This AGREEMENT requires SUBSURFACE EXPLORATIONS to be made by several alternative types of equipment. Definitions of the categories of drill rigs to be provided by the CONTRACTOR are listed below. The final decision regarding mobilization of different types of drill rigs, for assignment of the equipment category to be utilized on each boring and for payment purposes, will be made by the ENGINEER in consultation with the CONTRACTOR.

The CONTRACTOR shall have the capability of furnishing, when directed, one working drill rig with accessory equipment and equipment operators on the site at all times for the duration of the work. If the drill rig breaks down or becomes damaged so it is unusable, it shall be replaced with a working drill rig without compensation. The DEPARTMENT reserves the option to request more than one drill rig be furnished on a project; however, it is anticipated that most assignments will require a single rig. On assignments requiring multiple rigs, the CONTRACTOR may, with approval of the DEPARTMENT, utilize hired equipment or the services of a subcontractor for the additional drill rig(s). Any additional drill rigs on a project beyond the one required will be compensated as a general mobilization or at direct costs if subcontracted.

2.3.3.1 Cathead Rig

A cathead rig means a light-weight, power-assisted test boring machine having a power-driven rotating drum mounted on a portable tripod, or other portable soil drive sampling equipment, which can be man carried to a boring location that is not accessible to a vehicle-mounted drill rig.

2.3.3.2 Truck Rig

A truck rig means a test boring drilling machine mounted on a highway vehicle that is normally driven under its own power both to the work site and to the boring location. This class of drill rig includes wheeled trailer mounted drill rigs towed by a truck.

2.3.3.3 Track Rig

A track rig means a test boring drilling machine mounted on a tracked vehicle or on an all terrain vehicle (ATV) which is normally transported to the work site on a trailer and which can then be driven under its own power off the highway over rough terrain to the boring location.

2.3.3.4 Skid Rig

A skid rig means a test boring drilling machine mounted on skids or on a trailer that is dragged or towed to the drilling location using a self-mounted winch or other machinery.

2.3.3.5 Barge Rig

A barge rig means a drill rig mounted on a barge, raft or other flotation equipment, for drilling on surface water bodies, together with support boats, trailers or other vehicles needed for site mobilization/demobilization and access for CONTRACTOR and ENGINEER to and from the drill rig. As indicated under paragraph 2.3.1, CONTRACTOR may, with prior DEPARTMENT approval, subcontract barge work over inland water bodies.

2.3.4 Equipment Condition

All equipment provided by the CONTRACTOR shall be properly maintained in sound condition and shall be of a quality and type suitable for subsurface drilling. In the judgment of the ENGINEER any mobilized equipment that does not meet these conditions may be rejected, and the CONTRACTOR will replace the rejected equipment without additional compensation.

2.3.5 Personnel, Boring Foreman

The CONTRACTOR shall furnish only competent, trained and experienced personnel consisting of a minimum of one driller and one helper for each drill rig. The CONTRACTOR shall also keep at the site of the work, at all times during its progress, a competent boring foreman and any necessary assistants. The CONTRACTOR may designate the driller to act as the boring foreman. The boring foreman shall represent the CONTRACTOR, and all directions given by the ENGINEER to the foreman shall be as binding as if given to the CONTRACTOR directly.

2.3.6 Landowner Contacts
CONTRACTOR shall not notify or contact private landowners without obtaining prior approval from the DEPARTMENT. The DEPARTMENT may require CONTRACTOR to contact private landowners located outside the project limits whose property the CONTRACTOR desires to cross for ease of access to the locations of the SUBSURFACE EXPLORATIONS. As stated under paragraph 2.4.5, the DEPARTMENT shall be responsible for landowner contacts for properties having proposed exploration locations.

2.3.7 Pre-Job Site Meeting
For each Notice to Proceed issued by the DEPARTMENT to the CONTRACTOR under paragraph 2.4.2, the CONTRACTOR shall provide a representative to meet with a representative from the DEPARTMENT at the location of the proposed SUBSURFACE INVESTIGATIONS, if such a meeting is requested by the ENGINEER. The Pre-Job Site Meeting will take place a minimum of 10 business days prior to initiation of SUBSURFACE INVESTIGATIONS. The purpose of the Pre-Job Site Meeting will be to discuss the proposed scope of work, site access, traffic control, landowner access, and any other issues that may relate to the performance of the SUBSURFACE INVESTIGATIONS. The CONTRACTOR shall not be compensated separately for attending the Pre-Job Site Meeting.

2.3.8 Standard Work Day
The CONTRACTOR shall work a minimum 8-hour workday. No work shall be done before 7:00 a.m. or after 3:00 p.m., prevailing time, or on Saturdays, Sundays or legal State holidays, unless expressly permitted by the DEPARTMENT. Once the CONTRACTOR establishes a project work schedule within the requirements of this paragraph, the ENGINEER may order the CONTRACTOR to suspend work during a portion of the standard workday, for special situations that are in the best interest of the DEPARTMENT. The determination of a special situation and qualification for payment of Standby Time will be made solely by the ENGINEER.

2.3.9 Professional Conduct
CONTRACTOR personnel or subcontractor shall perform the assigned work under this AGREEMENT in a professional and cooperative manner. If these conditions are not met by any CONTRACTOR personnel or subcontractor, they shall be removed from the work site immediately upon request of the ENGINEER. The CONTRACTOR shall not be compensated separately for replacement of personnel rejected by the ENGINEER or for standby time resulting from the CONTRACTOR's failure to meet these conditions.

2.3.10 Environmental Regulations
Equipment and work practices for projects located within the jurisdiction of the New Hampshire Department of Environmental Services Wetlands Bureau shall meet all applicable statutes, rules and permitting requirements for wetlands. Work in areas of known or suspected soil or groundwater contamination shall comply with applicable New Hampshire Department of Environmental Services hazardous material rules and OSHA regulations. The installation or decommissioning of groundwater monitoring wells shall comply with the New Hampshire Department of Environmental Services Water Well Board rules.

2.3.11 Utility Clearance
The CONTRACTOR shall not proceed with any SUBSURFACE EXPLORATIONS without receiving notice from the ENGINEER that the DEPARTMENT has performed a utility clearance including contacting DIG-SAFE as described in paragraph 2.4.6. Alternately if assigned, the CONTRACTOR shall perform all utility clearance related tasks including: pre-marking, contacting DIG-SAFE, and contacting other non-member utility owners, prior to commencement of the SUBSURFACE EXPLORATIONS. On occasion, the services of a utility locating company may be required for locating a utility that is not a member of DIG-SAFE. If authorized by the ENGINEER, this service shall be hired by the CONTRACTOR, and the cost of which will be reimbursed as a direct expense. The CONTRACTOR may perform their own utility clearance even if this task is performed by the DEPARTMENT; however, the CONTRACTOR will not be compensated by the DEPARTMENT in this circumstance.

2.3.12 Traffic Control Plan
When SUBSURFACE EXPLORATIONS will be performed in or adjacent to traffic, requiring traffic controls provided by the CONTRACTOR, the CONTRACTOR shall prepare a written TRAFFIC CONTROL PLAN and submit it to the DEPARTMENT for review and approval a minimum of 10 business days prior to the

start date specified in the Notice to Proceed defined in paragraph 2.4.2. The draft TRAFFIC CONTROL PLAN shall describe proposed traffic control setups and devices to be used at each exploration location and for any CONTRACTOR mobilization or demobilization operations near traffic.

The DEPARTMENT will provide written review comments on the draft TRAFFIC CONTROL PLAN to the CONTRACTOR a maximum of 5 business days following receipt of CONTRACTOR'S draft TRAFFIC CONTROL PLAN. CONTRACTOR will then incorporate DEPARTMENT's comments into a final TRAFFIC CONTROL PLAN, which will become the basis for traffic control for the duration of that assignment.

The TRAFFIC CONTROL PLAN and the implementation of the TRAFFIC CONTROL PLAN shall conform to the MUTCD, as defined in paragraph 2.2.3. By signing this AGREEMENT, CONTRACTOR acknowledges possession of and familiarity with the MUTCD.

At its discretion, the DEPARTMENT will develop the TRAFFIC CONTROL PLAN and provide traffic control with its own forces for the CONTRACTOR. The CONTRACTOR shall not be entitled to any reimbursement for traffic controls set up by the DEPARTMENT.

2.3.13 Excavation Permits
The CONTRACTOR shall obtain any necessary excavation permit from the local municipality or State Maintenance District before proceeding with any SUBSURFACE EXPLORATIONS under this AGREEMENT. The cost of any permit is reimbursable as a direct expense.

2.4 MATERIAL FURNISHED BY THE DEPARTMENT

The DEPARTMENT will provide the following items to the CONTRACTOR.

2.4.1 Project Assignment
As needs develop on a project-by-project basis, the DEPARTMENT will contact the CONTRACTOR and request their services. Each specific assignment will be issued in a letter, or verbally with a follow-up letter to document the verbal notice. The project assignment letter will identify the project location and will include an exploration location plan and an estimate of the quantity of work required.

2.4.2 Notice to Proceed
The DEPARTMENT will issue a Notice to Proceed, notifying the CONTRACTOR to begin work on a specific project. The Notice to Proceed will include a maximum dollar cost for the work (the so-called upset fee) that will not be exceeded by the CONTRACTOR. The Notice to Proceed will also include dates, set in consultation with the CONTRACTOR, for starting and completing work on the assigned project. The Project Assignment and the Notice to Proceed may be combined into a single document.

2.4.3 Plans and Field Survey
The DEPARTMENT will provide the CONTRACTOR with an exploration layout plan and field survey required to locate requested explorations, probes, or monitoring wells. Locations of work on water will be marked with a survey stake where possible, or may be determined by the CONTRACTOR from reference stakes and a convenient benchmark provided by the DEPARTMENT. The ENGINEER may modify exploration locations in the field to accommodate actual field conditions. The ENGINEER will discuss such modifications with the CONTRACTOR prior to initiating SUBSURFACE EXPLORATIONS at any modified locations. If, in the judgment of the ENGINEER or CONTRACTOR, the TRAFFIC CONTROL PLAN should be amended to address a modified exploration location, the ENGINEER and CONTRACTOR will discuss and amend the TRAFFIC CONTROL PLAN before commencing SUBSURFACE EXPLORATIONS at the modified location. If the ENGINEER and CONTRACTOR cannot amend the TRAFFIC CONTROL PLAN to their mutual satisfaction, then no SUBSURFACE EXPLORATION shall be performed at the modified location until the traffic control measures are resolved.

2.4.4 Pre-Job Site Meeting
The DEPARTMENT will schedule and coordinate the Pre-Job Site Meeting per paragraph 2.3.7. Attendance by a knowledgeable representative of the CONTRACTOR is required.

2.4.5 Notice of Entry Letters and Landowner Contacts

The DEPARTMENT will contact landowners verbally and/or by mail and provide notice of Entry letters to property owners within the project limits who are to be affected by the work, and the DEPARTMENT will be responsible for communicating with property owners within the project limits. As stated under paragraph 2.3.6, the CONTRACTOR shall be responsible for landowner contacts needed for the convenience of their operations.

2.4.6 Utility Clearance

It is intended for all assignments that the DEPARTMENT will perform the utility clearance of the work site. The DEPARTMENT will pre-mark the project site and notify the utility damage prevention system, DIG-SAFE, of the intended SUBSURFACE EXPLORATIONS. The DEPARTMENT will inform the CONTRACTOR of identified utilities near the work. In the event the DEPARTMENT cannot complete the utility clearance, the CONTRACTOR will be assigned this task per paragraph 2.3.11.

2.4.7 Wetlands Permit, Notification to the Wetlands Board

The DEPARTMENT will file a wetlands permit application in consultation with the CONTRACTOR, for assignments requiring a permit. For projects within the jurisdiction of the Wetlands Board but for which no permit is required, the DEPARTMENT will notify the Wetlands Bureau, and other bodies as required, of the intended work. The CONTRACTOR shall subsequently comply with the terms and conditions listed on the Wetlands Permit and/or the applicable Rules.

2.4.8 Services of Uniformed Officers

The DEPARTMENT will pay directly for services of uniformed police officers required under paragraph 2.7.4.

2.4.9 Inspection of the Work

The CONTRACTOR's work shall be done in accordance with this AGREEMENT under the general direction of the DEPARTMENT or its authorized representatives. All work shall be accomplished only in the presence of the ENGINEER.

2.5 WORK SCHEDULES AND PROGRESS REPORTS

2.5.1 Assignment Start Date

The CONTRACTOR shall begin work on an assigned project on the start date specified in the Notice to Proceed, or by a later date mutually agreed upon by the CONTRACTOR and the ENGINEER. Once equipment is mobilized and explorations begin, the CONTRACTOR shall work continuously to complete the assignment without delay unless agreed otherwise by the ENGINEER.

2.5.2 Assignment Completion Date

The completion date for work to be done on a specific site will be specified in the Notice to Proceed. The DEPARTMENT shall establish the completion date after consultation with the CONTRACTOR. Extension of the completion date beyond that specified in the Notice to Proceed shall be at the discretion of the DEPARTMENT.

2.5.3 Submission of Materials and Reports

Soil and rock samples, pavement cores, driller field notes if requested, and other required records shall be submitted to the DEPARTMENT within two weeks after completion of field work.

2.6 NUMBER AND LOCATION OF EXPLORATIONS

2.6.1 Exploration Location Plan

The Exploration Location Plan for each work site will show the proposed number and type of explorations and the sampling requirements. During the progress of the work, the DEPARTMENT may direct that certain explorations be omitted, may require that the number of explorations be increased, may change sampling requirements, or may change the types or required depths of explorations. Any such change will be based on the needs of the work as determined by the DEPARTMENT and shall be carried out by the CONTRACTOR as if originally specified for the work.

2.6.2 Obstructions

The DEPARTMENT makes no representations as to the character of the ground through which the SUBSURFACE EXPLORATIONS are to be made, or that any SUBSURFACE EXPLORATION location given will be found free from obstructions. If field conditions indicate a need to offset SUBSURFACE EXPLORATIONS from their planned location, the new locations shall be approved by the ENGINEER before work is started at the offset location.

2.7 MAINTENANCE OF TRAFFIC

2.7.1 Traffic Control Plan

CONTRACTOR shall be responsible for implementing and adhering to the final TRAFFIC CONTROL PLAN, as approved by the DEPARTMENT, defined under paragraph 2.3.12. Any deviations from the final TRAFFIC CONTROL PLAN shall be discussed with and approved by the ENGINEER prior to implementation in the field.

2.7.2 Notify Local Police

The CONTRACTOR shall obtain permission from and coordinate work activities with local police authorities before beginning any SUBSURFACE EXPLORATIONS as needed.

2.7.3 Flaggers

When required by the final TRAFFIC CONTROL PLAN, the CONTRACTOR shall provide flaggers for traffic control, as a Contract pay item, to control and direct the safe and expeditious movement of traffic through and around the work zones, and to promote increased safety to motorists, pedestrians, the CONTRACTOR's work force, and DEPARTMENT personnel. Flaggers shall be clothed and equipped in accordance with the MUTCD.

2.7.4 Uniformed Officers

It is intended that uniformed officers will be utilized when a lane closure is required to do the explorations, and CONTRACTOR's TRAFFIC CONTROL PLAN, defined under paragraph 2.3.12, shall reflect this intent. Either the DEPARTMENT or CONTRACTOR may require inclusion of uniformed officers in the Traffic Control Plan for circumstances other than lane closures, if, in its judgment, uniformed officers should be provided for safety.

2.8 ABANDONED BORINGS

Borings shall not be abandoned before reaching the final depth ordered by the DEPARTMENT except on the approval of the ENGINEER. No payment will be made for borings abandoned by reasons of an accident or negligence attributed to the CONTRACTOR. Borings abandoned before reaching required depth, due to an obstruction or other reasonable cause beyond the control of the CONTRACTOR such that the boring cannot be completed with the equipment required under this AGREEMENT, shall be replaced by a supplementary boring adjacent to the original and carried to the required depth. Penetration of the supplemental boring to the completed depth of the original boring may be made by any means selected by the CONTRACTOR and approved by the ENGINEER. Samples shall be taken in the supplementary boring from the elevation at which the original boring was abandoned in a manner specified for the original boring.

If abandoned for reasons acceptable to the ENGINEER, payment will be made for the portion of the abandoned boring approved by the ENGINEER, at the appropriate unit prices for boring and sampling stated in the AGREEMENT, provided the CONTRACTOR presents soil samples and records as specified plus a written statement on the obstruction which necessitated relocating the boring. Payment will also be made for the portion of the supplementary boring extending below the approved, final elevation of the original boring.

2.9 CASING AND HOLLOW-STEM AUGERS

2.9.1 Equipment Requirement

The CONTRACTOR shall provide pipe or drill casing and hollow-stem augers in quantities and sizes adequate for expeditious performance of the work. Casing and hollow-stem augers shall have inside diameters not less than 3 inches for all borings. Larger sizes of casing may be required where obstructions or hard driving require "telescoping" of casing to advance the minimum size casing to the

depth of sampling. All holes are to be cased or augured for the upper ten feet and to greater depths as needed to meet field conditions. The ENGINEER may require casing or augers for the full depth of boring if, in the ENGINEER's opinion, successful boring and sampling operations cannot be carried out without casing or augers.

2.9.2 Advancement
Casing shall be driven by a drop weight or spun using a diamond casing shoe. If spun, casing advancement shall be halted six inches above the sampling depth identified by the ENGINEER. Drilling mud or hollow-stem augers may be permitted for use in this work, with the approval of the ENGINEER. Hollow-stem augers shall be equipped with a bottom plug during drilling to limit entrance of soil up inside the augers.

2.10 SOIL SAMPLING DEVICES

Soil sampling devices shall be as described below and approved by the ENGINEER before use:

2.10.1 Split Spoon Sampler
Split spoon sampler shall be a two-inch outside diameter, split-barrel sampler with a 24-inch long barrel, equivalent to the equipment described in the American Association of State Highway and Transportation Officials (AASHTO) T 206 test method, contained in Exhibit D as part of this AGREEMENT.

2.10.2 Stationary Piston Tube Sampler
Stationary piston tube sampler shall be a three-inch diameter thin wall tube sampler containing a close-fitting piston operated by a separate piston rod and a sampler head, with appropriate spring and piston rod check, in accordance with the equipment requirements of the AASHTO T 207 test method, contained in Exhibit E as part of this AGREEMENT.

2.11 SOIL BORINGS

2.11.1 Typically Preferred Method
CONTRACTOR shall commence SUBSURFACE EXPLORATIONS using drive and wash casing, unless an alternative approach is approved in advance by the ENGINEER.

2.11.2 Advancement
Borings will typically be made by advancing casing of the size required and to the extent needed to maintain an open hole without collapse of the hole, and removing soil from within the casing by washing or by drilling with rotary drill utilizing clean wash water. Recirculation of wash water using a washtub may be permitted, so long as the washtub is of adequate capacity and is fitted with a baffle to limit reintroduction of soil cuttings into the borehole. Casing shall be advanced in stages of not more than the specified sampling interval, after which the material within the casing shall be cleaned out to the depth of the casing using a tri-cone roller bit. Bottom discharge washing procedures, including washing through a sampling spoon or open-ended drill rod, shall not be permitted, unless the ENGINEER gives prior approval. A bottom plug shall be used during advancement of hollow-stem augers to limit the entry of soil cuttings into the augers, unless ENGINEER approves otherwise.

2.11.3 Split Spoon Samples
Split spoon samples shall be taken in accordance with AASHTO T 206, contained in Exhibit D, at vertical intervals typically no greater than 5 feet. The ENGINEER may require continuous split spoon sampling on some borings. After reaching required sampling depth, drilling shall be stopped, the disturbed materials shall be removed from the hole, and a split spoon sample of the underlying undisturbed material shall be taken. A sample retainer basket shall be used in the sampler. The samples shall be removed from the hole in unwashed condition in such a manner as to provide a true sample of soil formations from which they are recovered. Additional requirements for soil sampling beyond the specifications of Exhibit D are as follows:

2.11.3.1 Hammer
A 140-pound automatic hammer shall be used to drive the split spoon sampler for all soil borings. A safety hammer or "doughnut" hammer shall not be utilized unless the ENGINEER gives prior approval. If requested by the ENGINEER, the CONTRACTOR shall provide a hammer system for

which the energy transfer efficiency has been determined according to ASTM D4633. For a cathead setup a safety hammer can be used. The CONTRACTOR will operate the cathead in accordance with Exhibit D.

2.11.3.2 Record-keeping

CONTRACTOR shall record the number of blows required to drive the sampler each 6-inch increment and record the number of blows and actual distance driven for each increment less than 6 inches.

2.11.3.3 Recovery

A recovered split spoon sample measuring at least 25 percent of the driven distance is considered acceptable. When the recovery is less than specified, the CONTRACTOR shall immediately attempt to take a second sample below the depth unsuccessfully sampled, unless directed otherwise by the ENGINEER. Additional samples collected for reason of insufficient recovery of the first sample will not be compensated separately.

2.11.4 Stationary Piston Tube Sampling

Stationary Piston Tube Sampling procedures shall be in accordance with AASHTO T-207, contained in Exhibit E. Tube sample ends shall be filled with microcrystalline wax, and then sealed with a cap and electrical tape. Tube samples shall be protected from vibration, shock, temperature extremes, and freezing conditions. The ENGINEER will transport stationary piston tube samples.

2.11.5 Sample Preservation and Labeling Requirements

Immediately on removal from the hole, a portion of the sample recovered in the split barrel sampler or the bottom of the tube sample shall be tightly sealed in a screw-top glass sample jar. The sample jars shall be of a sufficient size such that the samples are placed in the jars in the condition in which they are removed from the split-barrel sampler, without squeezing, masking, or otherwise excessively distorting the sample. For protection during transport and storage, the jars shall be packed in close fitting cardboard boxes with dividers. Each sample jar shall be labeled to show plainly the project name and number, the number of the hole, the depth from which the sample was taken, the sample number, the length of the soil sample recovered, and the number of blows for penetration of the sampler as previously specified. Each box of sample jars shall be labeled to show the project name and the boring number for samples within the box. The CONTRACTOR shall provide such containers, keeping a sufficient supply on hand to prevent any delay in the work.

2.11.6 Telescoped Casing

In the event that obstructions or other drilling difficulties are encountered such that casing can no longer be advanced, the CONTRACTOR may continue the SUBSURFACE EXPLORATION by advancing smaller diameter casing within and beyond the original casing. If so performed, compensation will be made at the appropriate unit prices for boring and sampling stated in the AGREEMENT for advancement as follows: advancement of the original, larger-diameter casing from the ground surface to the depth of its termination, plus compensation for advancement of the smaller diameter, telescoped casing from the depth of termination of the original casing to the bottom of the exploration. No compensation will be made for the smaller diameter casing from the ground surface to the depth of termination of the original casing.

2.12 CORE DRILLING IN ROCK

2.12.1 Specification

Core drilling in rock shall follow the provisions of AASHTO T 225, contained in Exhibit F as part of this AGREEMENT, unless otherwise directed. In borings designated for core drilling in rock, casing with an inner diameter of not less than 3 inches shall be driven to and seated onto bedrock. Double-tube rock coring equipment that results in a core measuring a minimum of 1.875 inches in diameter shall be required. The ENGINEER, on a case-by-case basis, may allow smaller diameters.

2.12.2 Penetration Distance

The CONTRACTOR shall drill a minimum distance of five feet into sound bedrock or to depths as directed by the ENGINEER.

2.12.3 Recovery
Individual drill runs in the coring operations shall in no case exceed the capacity of the core barrel and shall be of such an amount, depending on the nature of the rock encountered, as to assure maximum core recovery. Every effort shall be made by the CONTRACTOR to obtain as full recovery of rock core as possible, and all significant actions of the bit and reasons for loss of core shall be recorded in the boring log.

2.12.4 Sample Preservation And Labeling Requirements
The CONTRACTOR shall preserve and deliver to the DEPARTMENT the entire rock core. Unless otherwise directed, the CONTRACTOR shall follow the applicable provisions of AASHTO T 225, contained in Exhibit F, for packaging, labeling, and transporting rock core samples.

2.13 PAVEMENT CORES
Pavement cores shall be made in existing pavement structures through their full thickness, which includes both asphalt and concrete pavements, to obtain a pavement core specimen with a nominal six (6) inch diameter, or as directed by the ENGINEER. Pavement core specimens shall be labeled clearly, so their location of origin can be determined. Pavement core specimens that break into small or many pieces shall be stored in a container or bag, otherwise no container is needed, and the core specimens shall be delivered to the DEPARTMENT.

2.14 GROUNDWATER LEVEL OBSERVATIONS
Observation shall be made of groundwater levels in all completed explorations on land. Any and all unusual water conditions and gain or loss of water in boring operations shall be recorded completely in the boring logs. When drilling mud is used to stabilize the hole, the drill hole shall be thoroughly flushed with clean water on completion of the boring to allow the observation of groundwater levels. Bore holes should be left open as long as practical to allow more stabilized groundwater level measurements.

2.15 GROUNDWATER LEVEL OBSERVATION (MONITORING) WELL INSTALLATION
Groundwater level observation wells shall consist of either, as directed by the ENGINEER, 1-1/2 inch or 2 inch nominal diameter solid well pipe, slotted plastic well screen (0.010 inch slot width), a bottom plug, and a PVC top plug that are installed in a previously drilled boring. **For wells with 1-1/2 inch diameter well pipe, 3 inch diameter or larger casing shall be used for the bored hole. For wells with 2 inch diameter well pipe, 4 inch diameter or larger casing shall be used for the bored hole.** The well construction and material requirements of ASTM D5092 (Exhibit G) shall be followed unless directed otherwise herein or by the ENGINEER. The well screen shall be a minimum length of 10 feet. The installed depth within the boring shall be determined by the ENGINEER. Backfilling of the boring in which the well is installed shall generally consist of a bottom bentonite seal (minimum 1 foot thickness), filter sand from a minimum of 1 foot below the bottom of the well screen to a minimum of 1 foot above the top of the well screen, and a minimum 2-foot thick bentonite clay seal along the riser pipe. General backfill above the bentonite clay seal may be soil cuttings removed from the boring or other approved material. An approximately three foot high stickup of riser pipe above the ground surface shall be provided for wells with a riser protective standpipe.

As directed by the ENGINEER, a lockable, steel protective riser casing or a flush-mounted road box shall be installed for protection of the well pipe. Riser casings and road boxes shall be installed with a surface seal of concrete at least one foot thick. Riser standpipes shall be provided with a padlock and two keys. The padlock brand shall be "Master Lock" with brass key #3212 unless requested otherwise by the ENGINEER.

Well Completion Report(s) shall be completed per the New Hampshire Department of Environmental Services Water Well Board Rules We 802. A blank copy of the report is enclosed as Exhibit H, or it can be obtained from their website at http://des.nh.gov/organization/divisions/water/dwgb/wwb/categories/forms.htm. A copy of the completed Well Completion Report shall be provided to the ENGINEER upon request.

2.16 GROUNDWATER LEVEL OBSERVATION (MONITORING) WELL DECOMMISSIONING
At the direction of the ENGINEER, an existing groundwater observation well or monitoring well shall be completely decommissioned (removed) and the well hole properly backfilled per paragraph 2.18. The CONTRACTOR shall possess a valid NH water well contractor license to perform this work. A well may be in an area of known or suspected contaminated soil or groundwater, so HAZWOPER protocols may be needed in performance of the work. Materials salvaged from the decommissioned well shall become the property of the CONTRACTOR. An Abandoned Well Registration Report shall be completed per the New Hampshire Department of Environmental

Services Water Well Board Rules We 604. A blank copy of the report is enclosed Exhibit I, or it can be obtained from their website at http://des.nh.gov/organization/divisions/water/dwgb/wwb/categories/forms.htm. A copy of the completed Abandonment Well Registration Report shall be provided to the ENGINEER upon request.

2.17 LOGS AND SAMPLE DELIVERY

2.17.1 Logs

During the progress of each exploration the CONTRACTOR shall keep a log of the drilling operation. The log shall generally include the items listed in Section 8 of AASHTO T-206, contained in Exhibit D.

2.17.2 Sample Delivery

Soil and rock core samples shall be delivered to a location designated by the DEPARTMENT.

2.18 SEALING EXPLORATIONS

At the direction of the ENGINEER, completed borings and decommissioned wells shall be sealed with grout or bentonite clay. The sealing method will depend upon specific site conditions and may consist of one of the following methods or other method required by the New Hampshire Water Department of Environmental Services Water Well Board Rules PART We 604 for well abandonment and decommissioning:

2.18.1 Neat Cement Grout

Pumped through a tremie tube to fill the boring from the bottom and displace drilling fluid during grouting.

2.18.2 Portland Cement-Bentonite Grout

Placed as above.

2.18.3 Straight Bentonite Clay Grout

Placed as above.

2.18.4 Bentonite Chips

Placed into the top of the boring and allowed to settle to the bottom of the boring. Care shall be used in placement of bentonite chips to prevent bridging in the annulus between the well and the casing.

2.19 CLEAN UP, SITE RESTORATION

The CONTRACTOR shall clean up and leave the work site in a neat and workmanlike manner, to the satisfaction of the ENGINEER. The CONTRACTOR shall exercise due care and shall take every precaution against injuring pavement, utilities, or other property, and shall repair any damage which may occur. Any property damage resulting from the CONTRACTOR's work shall be promptly reported to the ENGINEER. On completion of the work at any exploration location, the CONTRACTOR shall remove equipment, materials and spoil. Brush and other cuttings shall be removed from the work site, as directed by the ENGINEER. All boreholes on land shall be backfilled completely to minimize settlement of the surface. Bore holes may be grouted or filled with soil which is tamped and rodded. The ground surface; whether sidewalks, pavement or grass areas, shall be restored to original condition by patching, seeding or placing sod. No holes, depressions, cracks or protrusions resulting from the work and which is unsightly or could present a hazard to the public will be permitted to remain. The CONTRACTOR may be recalled to the site, during the **one-year** period following the completion of work, to repair surface settlement or cracks that develop in the work area. Except for explorations the ENGINEER orders to be sealed for which there is a separate pay item, CONTRACTOR shall not be compensated separately for clean up, filling of holes, and other site restoration.

EXHIBIT B: CONTRACT PRICE, METHOD AND TERMS OF PAYMENT

Note: The following provisions are ADDED to those listed in the State of New Hampshire Agreement Form P-37.

5.1.1 Payment Schedule And Stipulations

The work required under the terms of this AGREEMENT shall be paid for in accordance with the following schedule and stipulations:

5.1.1.1 Agreement Amount

The total cost of all work, expenses and profit under this AGREEMENT shall not exceed **Three Hundred Thousand Dollars ($300,000.00).** No payment will be made for work performed in excess of this amount.

5.1.1.2 Compensation Rates

The rates tabulated in the Bid Schedule shall include all charges attributed to direct costs, fringe benefits, payroll taxes, overhead, direct expenses and profit and shall be used in billing for all work done under this AGREEMENT. Sublet portions of the AGREEMENT will be paid at rates tabulated in the Bid Schedule.

5.1.1.3 Method of Measurement.

The amount of work to be paid for shall be the quantity of work, satisfactorily performed by the CONTRACTOR in accordance with the AGREEMENT, completed and accepted by the ENGINEER as conforming to the requirements of these Specifications.

5.1.1.4 Invoicing For Payment

Payments on account of the fee for services rendered under this AGREEMENT will be made by the DEPARTMENT when provided a completely itemized, project-by-project bill submitted on a monthly basis by the CONTRACTOR. The CONTRACTOR has the option to submit a single bill for a given assignment, upon completion of the work, in lieu of monthly bills. Final payments will be based on quantities of work completed and accepted by the DEPARTMENT.

5.1.1.5 Records Retention

The CONTRACTOR shall maintain adequate cost records for all work performed under this AGREEMENT. All records and other evidence pertaining to cost incurred shall be made available at all reasonable times during the AGREEMENT period and for three (4) years from the date of final voucher payment for examination by the STATE, Federal Highway Administration, or other authorized representatives of the Federal Government (if utilized on a Federally funded project), and copies thereof shall be furnished if requested. Applicable cost principles are contained in the Federal Acquisition Regulation (FAR) in Title 48 of the Code of Federal Regulations (Subpart 31.2 and Subpart 31.105).

5.1.1.6 Basis of Payment and Definition of Pay Items.

The accepted quantity of work will be paid for at the contract unit prices for the work as defined below. For payment purposes, borings drilled from an existing bridge deck or with machinery standing in water shall be considered as soil borings on land, and measurement shall be from the ground surface at the bottom of the water body to the bottom of boring.

ITEM NO. 01 Mobilization and Demobilization Tasks

ITEM NO. 01.1 General Mobilization and Demobilization

For general mobilization and demobilization for each assigned project on which the CONTRACTOR performs subsurface exploration services, payment will be made at the contract unit price for the number of drill rigs, as directed in the Notice To Proceed, to simultaneously work on the assignment. This item includes all costs of providing and maintaining the necessary drill rig, plus all equipment, tools, supplies, and personnel, stipulated in this Contract and/or required to perform the work, and for costs of moving to and from the job site, including loading, unloading, trucking and transportation. The mobilization also includes costs of providing and maintaining all signs, cones, and barricades required to complete the work, except those traffic control devices for which there is a separate pay item. An exchange of drill rigs during the course of the work made for the CONTRACTOR's convenience is not considered a separate mobilization for pay purposes.

In the event the CONTRACTOR submits monthly invoices for work performed on partially completed projects, the General Mobilization will be prorated as follows. Fifty percent (50%) of the contract price for this item will be payable to the CONTRACTOR at the time of first compensation, after substantially all equipment and materials necessary for performing the work are on site and ready for use. The remaining fifty percent (50%) will be payable to the CONTRACTOR at the time of final payment for all work performed on the project, after removal of all equipment and materials from the site and after site restoration to the satisfaction of the ENGINEER.

ITEM NO. 01.2 Flotation Equipment Mobilization And Demobilization

For general mobilization and demobilization of a raft and other flotation equipment required to do borings over water, payment will be made at the contract unit price for each assigned project site where flotation equipment is required, as determined by the ENGINEER. This item will be paid in addition to the General Mobilization, Item No. 01.1. **The single payment under this item will cover all costs incurred by the CONTRACTOR in providing flotation and other equipment needed to mobilize to and demobilize from a water site, to include all associated equipment rental costs and/or costs for subcontracting this portion of the work.** This item includes all costs incurred in providing and maintaining the raft and other flotation equipment, a service boat, navigational warning devices, equipment, tools, supplies, and personnel, stipulated in this Contract and/or required to perform the work over water, and for costs of moving the required equipment and CONTRACTOR's personnel to and from the job site, including loading, unloading, trucking and transportation. Equipment provided under this item shall include a boat to provide access to and from the flotation equipment from shore for both CONTRACTOR and ENGINEER. This item covers work on inland water bodies, which includes tidal streams and rivers but not ocean marine work, within New Hampshire. Drilling quantities over water will be paid under other items in the contract including Barge Rig Boring, Item 02.5.

ITEM NO. 01.3 Utility and DIG-SAFE Clearance

For performing utility clearance of a worksite, which shall include all SUBSURFACE EXPLORATION locations within an assignment, payment will be made at the contract unit price for each assignment. If the assignment scope of work is modified by the ENGINEER, and this change requires additional utility clearance, then an addition payment will be made at the contract unit price. For DIG-SAFE renewals, follow up utility clearances or re-marking of previously cleared worksites, payment will not be made again. **This item will only be paid if the ENGINEER assigns the utility clearing task to the CONTRACTOR.** The CONTRACTOR may perform their own utility clearance; however, the CONTRACTOR will not be compensated if the DEPARTMENT performs this task. If authorized by the ENGINEER, the services of a utility locating company shall be reimbursed as a direct expense.

ITEM NO. 02 Per-Boring Mobilization Set-Up

ITEM NO. 02.1 Cathead Boring

For each boring performed with a cathead or other portable equipment as determined in advance by the ENGINEER, one mobilization set-up charge will be paid at the contract unit price per boring for each boring performed. This item will cover all costs of moving the drill rig, signs, cones, barricades, equipment, tools, supplies and personnel stipulated between borings on the assigned project work site, and, if necessary, will include loading, unloading, trucking and transportation between borings.

ITEM NO. 02.2 Truck Rig Boring

For each truck rig boring, as determined in advance by the ENGINEER, one mobilization set-up charge will be paid at the contract unit price per boring for each boring performed. This item will cover all costs of moving the drill rig, signs, cones, barricades, equipment, tools, supplies and personnel stipulated between borings on the assigned project work site, and, if necessary, will include loading, unloading, trucking and transportation between borings.

ITEM NO. 02.3 Track Rig Boring

For each track rig boring, as determined in advance by the ENGINEER, one mobilization set-up charge will be paid at the contract unit price per boring for each boring performed. This item will cover all costs of moving the drill rig, signs, cones, barricades, equipment, tools, supplies and

personnel stipulated between borings on the assigned project work site, and, if necessary, will include loading, unloading, trucking and transportation between borings.

ITEM NO. 02.4 Skid Rig Boring
For each skid rig boring, as determined in advance by the ENGINEER, one mobilization set-up charge will be paid at the contract unit price per boring for each boring performed. This item will cover all costs of moving the drill rig, signs, cones, barricades, equipment, tools, supplies and personnel stipulated between borings on the assigned project work site, and, if necessary, will include loading, unloading, trucking and transportation between borings.

ITEM NO. 02.5 Barge Rig Boring
For each water boring, as determined in advance by the ENGINEER, requiring the use of a raft or other flotation equipment, one mobilization set-up charge will be paid at the contract unit price per boring for each boring performed. This item will cover all costs of moving the drill rig, raft and/or other flotation equipment, service boat, signs, cones, barricades, navigational warning devices, equipment, tools, supplies, and personnel stipulated between borings on the assigned project work site, and, if necessary, will include loading, unloading, trucking and transportation for moves between borings.

ITEM NO. 03 Drive Casing, 3-inch And 4-inch Diameters

ITEM NO. 03.1 Soil Boring, 3-inch Diameter Drive Casing On Land
For 3-inch minimum diameter soil borings on land, including split-barrel samples taken at standard 5-foot sampling intervals, sample jars and delivery to the DEPARTMENT, payment will be made at the contract unit price per foot for the actual linear feet of boring completed and accepted within each 50-foot payment depth increment, measured to the nearest 0.1 foot from the ground surface or bottom of the water body to the depth of boring in soil.

ITEM NO. 03.11 Soil Boring, 3-Inch Diameter Drive Casing on Land, depth 0 to 50 ft
ITEM NO. 03.12 Soil Boring, 3-Inch Diameter Drive Casing on Land, depth 50 to 100 ft
ITEM NO. 03.13 Soil Boring, 3-Inch Diameter Drive Casing on Land, depth 100 to 150 ft
ITEM NO. 03.14 Soil Boring, 3-Inch Diameter Drive Casing on Land, depth over 150 ft

ITEM NO. 03.2 Soil Boring, 3-inch Diameter Drive Casing On Water
For 3-inch minimum diameter soil borings drilled from flotation equipment on water, including split-barrel samples taken at standard 5-foot sampling intervals, sample jars and delivery to the DEPARTMENT, payment will be made at the contract unit price per foot for the actual linear feet of boring completed and accepted within each 50-foot payment depth increment, measured to the nearest 0.1 foot from the bottom of the water body to the depth of the boring in soil.

ITEM NO. 03.21 Soil Boring, 3-Inch Diameter Drive Casing on Water, depth 0 to 50 ft
ITEM NO. 03.22 Soil Boring, 3-Inch Diameter Drive Casing on Water, depth 50 to 100 ft
ITEM NO. 03.23 Soil Boring, 3-Inch Diameter Drive Casing on Water, depth 100 to 150 ft
ITEM NO. 03.24 Soil Boring, 3-Inch Diameter Drive Casing on Water, depth over 150 ft

ITEM NO. 03.3 Soil Boring, 4-inch Diameter Drive Casing On Land
For 4-inch minimum diameter soil borings on land, including split-barrel samples taken at standard 5-foot sampling intervals, sample jars and delivery to the DEPARTMENT, payment will be made at the contract unit price per foot for the actual linear feet of boring approved in advance by the ENGINEER and completed and accepted within each 50-foot payment depth increment, measured to the nearest 0.1 foot from the ground surface or the bottom of the water body to the depth of the boring in soil.

ITEM NO. 03.31 Soil Boring, 4-Inch Diameter Drive Casing on Land, depth 0 to 50 ft
ITEM NO. 03.32 Soil Boring, 4-Inch Diameter Drive Casing on Land, depth 50 to 100 ft
ITEM NO. 03.33 Soil Boring, 4-Inch Diameter Drive Casing on Land, depth 100 to 150 ft
ITEM NO. 03.34 Soil Boring, 4-Inch Diameter Drive Casing on Land, depth over 150 ft

ITEM NO. 03.4 Soil Boring, 4-inch Diameter Drive Casing On Water
For 4-inch minimum diameter soil borings drilled from flotation equipment on water, including the split-barrel samples taken at standard 5-foot sampling intervals, sample jars and delivery to the

DEPARTMENT, payment will be made at the contract unit price per foot for the actual linear feet of boring approved in advance by the ENGINEER and completed and accepted within each 50-foot payment depth increment, measured to the nearest 0.1 foot from the bottom of the water body to the depth of the boring in soil. The water depth above the bottom of the water body will be added to determine the soil boring depth; however, the water depth itself will not be paid.

ITEM NO. 03.41 Soil Boring, 4-Inch Diameter Drive Casing on Water, depth 0 to 50 ft
ITEM NO. 03.42 Soil Boring, 4-Inch Diameter Drive Casing on Water, depth 50 to 100 ft
ITEM NO. 03.43 Soil Boring, 4-Inch Diameter Drive Casing on Water, depth 100 to 150 ft
ITEM NO. 03.44 Soil Boring, 4-Inch Diameter Drive Casing on Water, depth over 150 ft

ITEM NO. 04 Casing Bit Diamond Wear for Spin Casing

For 3-inch or 4-inch diameter cased soil borings on land or water performed using spin casing with a diamond bit, payment will be made at the contract unit price per foot for the actual linear feet of boring completed and accepted, measured to the nearest 0.1 foot from the ground surface or bottom of the water body to the bottom of the hole. Payment under this pay item will be in addition to the corresponding payment made under ITEM NO. 03 above, for compensation for normal wear of the diamond casing bit.

ITEM NO. 05 Soil Boring, 3-inch or 4-inch Hollow Stem Auger Borings On Land
For 3-inch or 4-inch minimum diameter hollow stem auger soil borings on land, including split-barrel samples taken at standard 5-foot sampling intervals, sample jars and delivery to the DEPARTMENT, payment will be made at the contract unit price per foot for the actual linear feet of boring completed and accepted, measured to the nearest 0.1 foot from the ground surface. **Note that auger borings will not be required at depths greater than 50 feet nor on water.**

ITEM NO. 06 Additional Split Spoon Samples
For additional split barrel samples taken in excess of the subsidiary rate of one sample per 5 feet of boring depth, including sample jars and delivery to the DEPARTMENT, payment will be made at the contract unit price per sample for each sample in excess of the average of one sample per 5 feet over the full depth of the boring in soil.

ITEM NO. 07 3-inch Piston Samples
For 3-inch undisturbed stationary piston tube samples including the Shelby tube and delivery to the DEPARTMENT, payment will be made at the contract unit price for the actual number of samples taken and accepted.

ITEM NO. 08 Rock Core

ITEM NO. 08.1 Rock Core On Land
For coring bedrock, boulders, or very dense glacial till soils on land with diamond rock coring tools, including the core box and delivery of core samples to the DEPARTMENT, payment will be made at the contract unit price per foot for the actual linear feet of bedrock or boulders cored and accepted, within each 50-foot payment depth increment, measured to the nearest 0.1 foot.

ITEM NO. 08.11 Rock Core on Land, depth 0 to 50 ft
ITEM NO. 08.12 Rock Core on Land, depth 50 to 100 ft
ITEM NO. 08.13 Rock Core on Land, depth 100 to 150 ft
ITEM NO. 08.14 Rock Core on Land, depth over 150 ft

ITEM NO. 08.2 Rock Core On Water
For coring bedrock or boulders from flotation equipment on water with rock coring tools, including the core box and delivery of core samples to the DEPARTMENT, payment will be made at the contract unit price per foot for the actual linear feet of bedrock or boulders cored and accepted, within each 50-foot payment depth increment, measured to the nearest 0.1 foot. The water depth above the bottom of the water body will be added to determine the soil boring depth; however, the water depth itself will not be paid.

ITEM NO. 08.21	**Rock Core on Water, depth 0 to 50 ft**
ITEM NO. 08.22	**Rock Core on Water, depth 50 to 100 ft**
ITEM NO. 08.23	**Rock Core on Water, depth 100 to 150 ft**
ITEM NO. 08.24	**Rock Core on Water, depth over 150 ft**

ITEM NO. 09 Pavement Cores

For pavement core specimens obtained, which includes all asphalt and concrete pavement cored in the pavement structure regardless of thickness at a location, payment will be made at the contract unit price for each pavement core completed and accepted. **A drill rig mobilization will also be paid under Item 02 for each pavement core location in addition to this item.** Soil and bedrock drilling and sampling below a pavement core will be paid under other items in the contract. Pavement cored or ground by roller bit in performance of a test boring will be paid under other items in the contract.

ITEM NO. 10 Bore Hole Sealing

ITEM NO. 10.1 Bore Hole Sealing, Cased Boring
For sealing cased borings, as directed by the ENGINEER, payment will be made at the contract unit price per foot for the actual linear feet of boring sealed by the CONTRACTOR and accepted by the ENGINEER, measured to the nearest foot. This item includes the cost of providing and maintaining all materials, specialized tools, equipment, and personnel required to perform the work.

ITEM NO. 10.2 Bore Hole Sealing, Auger Boring
For sealing auger borings, as directed by the ENGINEER, payment will be made at the contract unit price per foot for the actual linear feet of boring sealed by the CONTRACTOR and accepted by the ENGINEER, measured to the nearest foot. This item includes the cost of providing and maintaining all materials, specialized tools, equipment, and personnel required to perform the work.

ITEM NO. 11 Observation Wells

ITEM NO. 11.1 Groundwater Level Observation Well with 1-1/2" Diameter Well Pipe
For groundwater level observation wells installed in a previously drilled boring, payment will be made at the contract unit price per foot for the actual linear feet of well screen plus riser pipe installed and accepted, measured to the nearest 0.1 foot from the bottom of the installation to the ground surface. Well pipe extending above the ground surface in a riser protective casing will not be included in the measurement for payment, but will be subsidiary to this item. **This ITEM includes all materials and labor necessary to construct a well in accordance with paragraph 2.15 of this AGREEMENT, including bottom and top bentonite seals, filter sand, well screen, general backfill, and riser pipe.** Filter sand and bentonite clay used, as directed by the ENGINEER, in excess of the amounts specified in paragraph 2.15 and the protective casing or road box (if ordered) are not included in this item and are paid separately. The previously drilled boring will be paid under other items in the AGREEMENT. The cost for completing reports per paragraph 2.15 is subsidiary to this item.

ITEM NO. 11.2 Groundwater Level Observation Well with 2" Diameter Well Pipe
For groundwater level observation wells installed in a previously drilled boring, payment will be made at the contract unit price per foot for the actual linear feet of well screen plus riser pipe installed and accepted, measured to the nearest 0.1 foot from the bottom of the installation to the ground surface. Well pipe extending above the ground surface in a riser protective casing will not be included in the measurement for payment, but will be subsidiary to this item. **This ITEM includes all materials and labor necessary to construct a well in accordance with paragraph 2.15 of this AGREEMENT, including bottom and top bentonite seals, filter sand, well screen, general backfill, and riser pipe.** Filter sand and bentonite clay used, as directed by the ENGINEER, in excess of the amounts specified in paragraph 2.15 and the protective casing or road box (if ordered) are not included in this item and are paid separately. The previously drilled boring will be paid under other items in the AGREEMENT. The cost for completing reports per paragraph 2.15 is subsidiary to this item.

ITEM NO. 11.3 Bentonite Clay
For commercially prepared bentonite clay chips or pellets used, as directed by the ENGINEER, exceeding the quantity subsidiary to ITEM NO. 11.1, payment will be made at the contract unit price per foot for the actual linear feet of boring backfilled, measured to the nearest foot.

ITEM NO. 11.4 Filter Sand
For commercially washed and bagged filter sand used, as directed by the ENGINEER, exceeding the quantity subsidiary to ITEM NO. 11.1, payment will be made at the contract unit price per foot for the actual linear feet of boring backfilled, measured to the nearest foot.

ITEM NO. 11.5 Protective Riser Casing
For protective riser casing installed for a groundwater level observation (monitoring) wells, payment will be made at the contract unit price per each for the actual number of protective casings installed and accepted, to include all materials required in construction of the item. The locking cover, padlock, and key(s) shall be subsidiary to the Protective Casing item.

ITEM NO. 11.6 Flush Mounted Road Box
For a flush mounted road box used for protection of a groundwater level observation (monitoring) well, payment will be made at the contract unit price per each for the number of road boxes installed and accepted, to include all materials required in construction of the item.

ITEM NO. 11.7 Decommission Groundwater Level Observation (Monitoring) Well
For removing well components; patching pavement with cold patch or concrete; or raking, loaming and seeding, as directed to obliterate a well location, payment will be made at the contract unit price per each for the number of wells decommissioned. This item includes the cost of providing all materials, equipment, and personnel required to perform the work. The cost for completing reports per paragraph 2.16 is subsidiary to this item. However, payment will also be made under Item 10.1 for the depth of well pipe sealed.

ITEM NO. 12 Traffic Control

ITEM NO. 12.1 Traffic Control Flaggers
For traffic control services of flaggers, payment will be made at the contract unit price per hour per flagger for the actual time such traffic control services are authorized and provided, measured to the nearest hour. Payment for services of uniformed officers, when required by the ENGINEER, will be paid directly by the DEPARTMENT.

ITEM NO. 12.2 Traffic Control for High Volume Lane Closure
For traffic control services required to close a lane of the traveled way of a State or Federal highway or to close the shoulder of an Interstate highway, payment will be made at the contract unit price per hour for the actual working time such traffic control services are authorized and provided, measured to the nearest hour. There will be a minimum pay quantity of four hours for each day during which a lane closure is required. The time required to set up and to remove the traffic control devices, up to two hours per day, is included in the time to be measured. This item shall include the cost of providing, setting up, and removing all traffic control devices required for a lane closure meeting the requirements of the MUTCD.

This item covers the additional costs associated with lane closures on high volume roadways (i.e., major State highways, Interstate highways).

ITEM NO. 13 Standby Time

For standby time ordered by the ENGINEER, payment will be made at the unit price stated in the AGREEMENT for the actual time work is suspended during a regular 8-hour work day, measured to the nearest half-hour. This item includes all compensation to the CONTRACTOR for time not worked, including, but not limited to: labor, equipment use, overhead, and profit. Standby time will be paid for that portion of the regular 8-hour workday that the CONTRACTOR is on site and ready to work while work is suspended for a special situation. No payment will be made for standby time unless the CONTRACTOR

is on site and prepared to work during the ordered suspension of work, or if the special situation does not exist as determined by the ENGINEER. Work suspended due to CONTRACTOR operations, for breakdowns, for travel, or for weather-related delays does not constitute a special situation for payment of standby time.

ITEM NO. 14 Direct Costs

Direct Costs is not a bid item. This item will be used to estimate and account for costs that may be incurred in performance of the SUBSURFACE EXPLORATIONS. Direct costs include such things as police detail costs, permit fees, hired utility clearance services, subcontracted drilling services, or other miscellaneous costs that are pre-authorized by the ENGINEER and are not covered under other bid items in the AGREEMENT. Payment will be made at the actual dollar cost to the CONTRACTOR. No mark up will be allowed for anything reimbursed under this item. A copy of any invoice or bill for the cost incurred or the services provided shall be provided to the ENGINEER before reimbursement will be made.

EXHIBIT C

EXHIBIT C: SPECIAL PROVISIONS

25. STANDARD SPECIFICATIONS

This contract shall be administered in general accordance with the applicable provisions of Division 100 of the 2010 State of New Hampshire Department of Transportation Standard Specifications for Road and Bridge Construction as modified or amended in the AGREEMENT. In particular, but not limited to:

Section 101 – Definitions and Terms;
Section 102 – Bidding Requirements and Conditions;
Section 103 – Award and Execution of Contract;
Section 104 – Scope of Work;
Section 105 – Control of the Work;
Section 106 – Control of Material;
Section 107 – Legal Relations and Responsibility to Public;
Section 108 – Prosecution and Progress;
Section 109 – Measurement and Payment.

Standard Specifications Internet link:

http://www.nh.gov/dot/org/projectdevelopment/highwaydesign/specifications/index.htm.

25.1 Proposal Guaranty

The requirements of Section 102.09 of the Standard Specifications are waived, and no proposal guaranty is required for consideration of a bid proposal.

25.2 Contract Bond

The requirements of Section 103.05 of the Standard Specifications are waived, and no contract bond is required for this Agreement.

25.3 Insurance

The insurance requirements in Section 107.11 of the Standard Specifications are waived except where required by law and for the requirement for comprehensive general liability and comprehensive automobile liability insurance. The CONTRACTOR shall obtain comprehensive automobile liability insurance covering all motor vehicles, including owned, hired, borrowed, and non-owned vehicles, for all claims of bodily injury, death, or property damage, in policy amount of not less than $500,000 combined single limit.

The CONTRACTOR shall obtain comprehensive general liability insurance against all claims of bodily injury, death, or property damage, in the amounts of not less than $250,000 per claim and $2,000,000 per incident, as stated in Section 14.1.1 of this Agreement.

25.4 Subletting of Contract

In addition to the requirements of Section 108.01 of the Standard Specifications, all subcontracts shall be in writing. A copy of each subcontract shall be submitted for the DEPARTMENT's records.

25.5 Contract Completion Date

No new tasks may be assigned after the contract completion date in 1.7; however, the CONTRACTOR shall complete any assigned tasks begun prior to the completion date, but not yet completed, in accordance with the terms and compensation specified in this AGREEMENT. This shall be subject to the written mutual agreement of both parties, which shall include a revised date of completion to allow completion of any previously assigned tasks.

25.6 Failure To Complete On Time

Replace the Liquidated Damages schedule in Section 108.09 of the Standard Specifications with the following: Should the CONTRACTOR fail to complete the work on a specific assignment in accordance with the AGREEMENT within the time limit specified for the assignment, the CONTRACTOR shall pay to the STATE the **sum of one-hundred dollars ($100.00)** for every calendar day that the time consumed in the said completion exceeds the completion date specified in the Notice to Proceed letter. This sum shall not be considered a penalty, but as liquidated damages that the DEPARTMENT will suffer by reason of said delay. The DEPARTMENT shall deduct and may retain the amount of such liquidated damages out of moneys that may be due or become due to the CONTRACTOR under this AGREEMENT

EXHIBIT D: AASHTO T 206-09 (ASTM D1586-99)

Standard Method of Test for

Penetration Test and Split-Barrel Sampling of Soils

AASHTO Designation: T 206-09[1]
ASTM Designation: D 1586-99

1. SCOPE

1.1. This test method describes the procedure, generally known as the Standard Penetration Test (SPT), for driving a split-barrel sampler to obtain a representative soil sample and a measure of the resistance of the soil to penetration of the sampler.

1.2. *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For a specific precautionary statement, see Section 5.4.1.

1.3. The values stated in SI units are to be regarded as the standard.

Note 1—ASTM D 4633 can be used for measuring the energy that enters the drill rod string during testing due to the hammer impact.

Note 2—ASTM D 6066 can be used when testing loose sands below the water table for liquefaction studies or when a higher level of care is required when drilling these soils. This practice provides information on drilling methods, equipment variables, energy corrections, and blow-count normalization.

2. REFERENCED DOCUMENTS

2.1. *AASHTO Standard*:

- R 13, Conducting Geotechnical Subsurface Investigations

2.2. *ASTM Standards*:

- D 4633, Standard Test Method for Energy Measurement for Dynamic Penetrometers
- D 6066, Standard Practice for Determining the Normalized Penetration Resistance of Sands for Evaluation of Liquefaction Potential

3. DESCRIPTIONS OF TERMS SPECIFIC TO THIS STANDARD

3.1. *anvil*—that portion of the drive-weight assembly that the hammer strikes and through which the hammer energy passes into the drill rods.

3.2. *cathead*—the rotating drum or windlass in the rope-cathead lift system around which the operator wraps a rope to lift and drop the hammer by successively tightening and loosening the rope turns around the drum.

3.3. *drill rods*—rods used to transmit downward force and torque to the drill bit while drilling a borehole.

3.4. *drive-weight assembly*—a device consisting of the hammer, hammer fall guide, the anvil, and any hammer drop system.

3.5. *hammer*—that portion of the drive-weight assembly consisting of the 63.5 ± 1 kg (140 ± 2 lb) impact weight that is successfully lifted and dropped to provide the energy that accomplishes the sampling and penetration.

3.6. *hammer drop system*—that portion of the drive-weight assembly by which the operator accomplishes the lifting and dropping of the hammer to produce the blow.

3.7. *hammer fall guide*—that part of the drive-weight assembly used to guide the fall of the hammer.

3.8. *N-value*—the blow count representation of the penetration resistance of the soil. The *N*-value, reported in blows per foot, equals the sum of the number of blows required to drive the sampler over the depth interval of 150 to 450 mm (6 to 18 in.). (See Section 7.3.)

3.9. *ΔN*—the number of blows obtained from each of the 150-mm (6-in.) intervals of sampler penetration. (See Section 7.3.)

3.10. *number of rope turns*—the total contact angle between the rope and the cathead at the beginning of the operator's rope slackening to drop the hammer, divided by 360 degrees. (See Figure 1.)

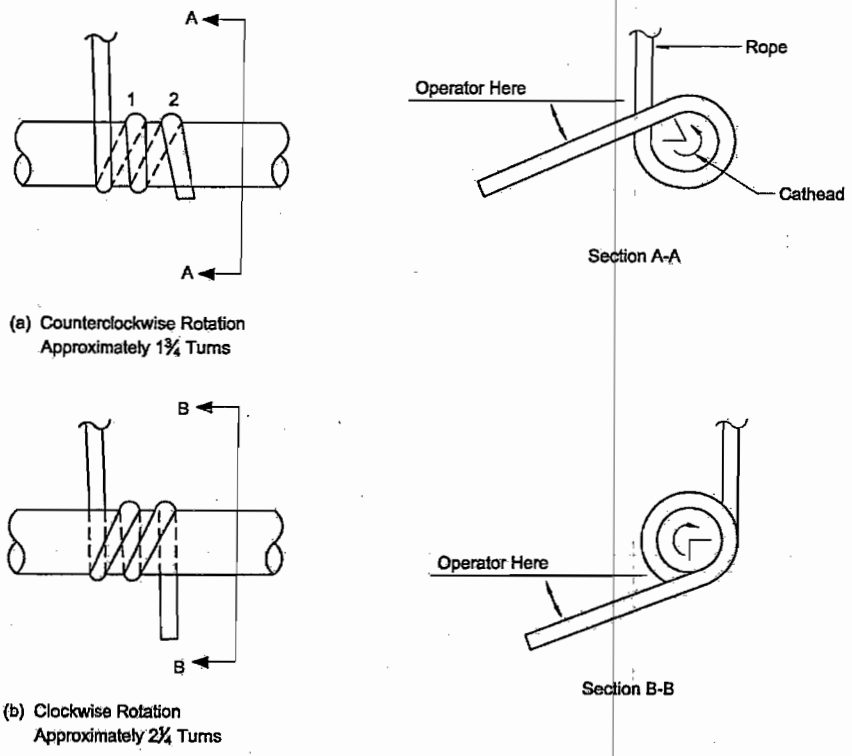


Figure 1—Definitions of the Number of Rope Turns and the Angle for *(a)* Counterclockwise Rotation and *(b)* Clockwise Rotation of the Cathead

3.11. *sampling rods*—rods that connect the drive-weight assembly to the sampler. Drill rods are often used for this purpose.

3.12. *SPT*—abbreviation for Standard Penetration Test, a term by which engineers commonly refer to this method.

4. SIGNIFICANCE AND USE

4.1. This test method provides a soil sample for identification purposes and for laboratory tests appropriate for soil obtained from a sampler that may produce large shear strain disturbance in the sample.

4.2. This test method is used extensively in a great variety of geotechnical exploration projects. Many local correlations and widely published correlations, which relate SPT blow count, or *N*-value, and the engineering behavior of earthworks and foundations, are available.

5. APPARATUS

5.1. *Drilling Equipment*—Any drilling equipment that provides at the time of sampling a suitably clean open hole before insertion of the sampler and ensures that the penetration test is performed on undisturbed soil shall be acceptable. The following pieces of equipment have proven to be suitable for advancing a borehole in some subsurface conditions:

5.1.1. *Drag, Chopping, and Fishtail Bits*, less than 162 mm (6.5 in.) and greater than 56 mm (2.2 in.) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods. To avoid disturbing the underlying soil, bottom discharge bits are not permitted; only side discharge bits are permitted.

5.1.2. *Roller-Cone Bits*, less than 162 mm (6.5 in.) and greater than 56 mm (2.2 in.) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods if the drilling fluid discharge is deflected.

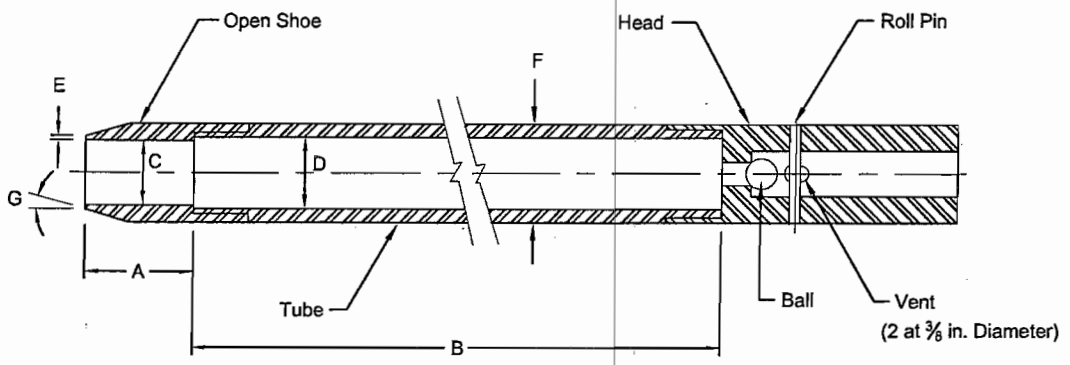
5.1.3. *Hollow-Stem Continuous Flight Augers*, with or without a center bit assembly, may be used to drill the boring. The inside diameter of the hollow-stem augers shall be less than 162 mm (6.5 in.) and greater than 56 mm (2.2 in.).

5.1.4. *Solid, Continuous Flight, Bucket, and Hand Augers*, less than 162 mm (6.5 in.) and greater than 56 mm (2.2 in.) in diameter may be used if the soil on the side of the boring does not cave onto the sampler or sampling rods during sampling.

5.2. *Sampling Rods*—Flush-joint steel drill rods shall be used to connect the split-barrel sampler to the drive-weight assembly. The sampling rod shall have a stiffness (moment of inertia) equal to or greater than that of parallel wall "A" rod (a steel rod that has an outside diameter of 41.2 mm ($1^5/_8$ in.) and an inside diameter of 28.5 mm ($1^1/_8$ in.).

Note 3—Recent research and comparative testing indicates the type of rod used, with stiffness ranging from "A" size rod to "N" size rod, will usually have a negligible effect on the *N*-values to depths of at least 30 m (100 ft).

5.3. *Split-Barrel Sampler*—The sampler shall consist of a heat-treated, case-hardened, steel head, split spoon and shoe assembly, constructed to the dimensions indicated in Figure 2. The driving shoe shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. The use of liners to produce a constant inside diameter of 35 mm ($1^3/_8$ in.) is permitted, but shall be noted on the penetration record if used. The use of a sample retainer basket is permitted, and should also be noted on the penetration record if used.



A = 25 to 50 mm (1.0 to 2.0 in.)
B = 0.457 to 0.762 m (18.0 to 30.0 in.)
C = 34.93 ± 0.13 mm (1.375 ± 0.005 in.)
D = 38.1 ± 1.3-0.0 mm (1.50 ± 0.05-0.00 in.)
E = 2.54 ± 0.25 mm (0.10 ± 0.02 in.)
F = 50.8 ± 1.3-0.0 mm (2.00 ± 0.05-0.00 in.)
G = 16.0° to 23.0°

Note: The $1^1/_2$-in. (38-mm) inside diameter split barrel may be used with a 16-gauge wall thickness split liner. The penetrating end of the drive shoe may be slightly rounded. Metal or plastic retainers may be used to retain soil samples.

Figure 2—Split-Barrel Sampler

Note 4—Both theory and available test data suggest that *N*-values may increase between 10 to 30 percent when liners are used.

5.4. *Drive-Weight Assembly*:

5.4.1. *Hammer and Anvil*—The hammer shall weigh 63.5 ± 1 kg (140 ± 2 lb) and shall be a solid rigid metallic mass. The hammer shall strike the anvil and make steel-on-steel contact when it is dropped. A hammer fall guide permitting a free fall shall be used. Hammers used with the cathead and rope method shall have an unimpeded overlift capacity of at least 100 mm (4 in.). For safety reasons, the use of a hammer assembly with an internal anvil is encouraged.

Note 5—It is suggested that the hammer fall guide be permanently marked to enable the operator or inspector to judge the hammer drop height.

5.4.2. *Hammer Drop System*—Rope-cathead, trip, semiautomatic, or automatic hammer drop systems may be used, providing the lifting apparatus will not cause penetration of the sampler while re-engaging and lifting the hammer.

5.5. *Accessory Equipment*—Accessories such as labels, sample containers, data sheets, and groundwater level measuring devices shall be provided in accordance with the requirements of the project and other ASTM standards.

6. DRILLING PROCEDURE

6.1. The boring shall be advanced incrementally, using methods outlined in R 13, to permit intermittent or continuous sampling. Test intervals and locations are normally stipulated by the

project engineer or geologist. Typically, the intervals selected are 1.5 m (5 ft) or less in homogeneous strata with test and sampling locations at every change of strata.

6.2. Any drilling procedure that provides a suitably clean and stable hole before insertion of the sampler and assures that the penetration test is performed on essentially undisturbed soil shall be acceptable. Each of the following procedures has proven to be acceptable for some subsurface conditions. The subsurface conditions anticipated should be considered when selecting the drilling method to be used.

6.2.1. Open-hole rotary drilling method.

6.2.2. Continuous flight hollow-stem auger method.

6.2.3. Wash boring method.

6.2.4. Continuous flight solid auger method.

6.3. Several drilling methods produce unacceptable borings. The process of jetting through an open tube sampler and then sampling when the desired depth is reached shall not be permitted. The continuous flight solid auger method shall not be used for advancing the boring below a water table or below the upper confining bed of a confined noncohesive stratum that is under artesian pressure. Casing may not be advanced below the sampling elevation prior to sampling. Advancing a boring with bottom discharge bits is not permissible. It is not permissible to advance the boring for subsequent insertion of the sampler solely by means of previous sampling with the SPT sampler.

6.3.1. The sampler head is vented to prevent pressure buildup during sampling, and must be kept clean. A steel ball water check is located in the head to prevent downward water pressure from acting on the sample. Clogging of the air vents or removal of the water check frequently causes sample loss.

6.4. The drilling fluid level within the boring or hollow-stem augers shall be maintained at or above the *in situ* groundwater level at all times during drilling, removal of drill rods, and sampling.

7. SAMPLING AND TESTING PROCEDURE

7.1. After the boring has been advanced to the desired sampling elevation and excessive cuttings have been removed, prepare for the test with the following sequence of operations:

7.1.1. Attach the split-barrel sampler to the sampling rods and lower into the borehole. Do not allow the sampler to drop onto the soil to be sampled.

7.1.2. Position the hammer above and attach the anvil to the top of the sampling rods. This may be done before the sampling rods and sampler are lowered into the borehole.

7.1.3. Rest the dead weight of the sampler, rods, anvil, and drive weight on the bottom of the boring and apply a seating blow. If excessive cuttings are encountered at the bottom of the boring, remove the sampler and sampling rods from the boring and remove the cuttings.

7.1.4. Mark the drill rods in three successive 0.15-m (6-in.) increments so that the advance of the sampler under the impact of the hammer can be easily observed for each 0.15-m (6-in.) increment.

7.2. Drive the sampler with blows from the 63.5-kg (140-lb) hammer and count the number of blows applied in each 0.15-m (6-in.) increment until one of the following occurs:

7.2.1. A total of 50 blows have been applied during any one of the three 0.15-m (6-in.) increments described in Section 7.1.4.

7.2.2. A total of 100 blows have been applied.

7.2.3. There is no observed advance of the sampler during the application of 10 successive blows of the hammer.

7.2.4. The sampler is advanced the complete 0.45 m (18 in.) without the limiting blow counts occurring as described in Sections 7.2.1, 7.2.2, or 7.2.3.

7.3. Record the number of blows required to effect each 0.15 m (6 in.) of penetration or fraction thereof. The first 6 in. is considered to be a seating drive. The sum of the number of blows required for the second and third 6 in. of penetration is termed the "standard penetration resistance," or the "*N*-value." If the sampler is driven less than 0.45 m (18 in.), as permitted in Sections 7.2.1, 7.2.2, or 7.2.3, the number of blows per each complete 0.15-m (6-in.) increment and per each partial increment shall be recorded on the boring log. For partial increments, the depth of penetration shall be reported to the nearest 25 mm (1 in.), in addition to the number of blows. If the sampler advances below the bottom of the boring under the static weight of the drill rods or the weight of the drill rods plus the static weight of the hammer, this information should be noted on the boring log.

7.4. The raising and dropping of the 63.5-kg (140-lb) hammer shall be accomplished using either of the following two methods:

7.4.1. By using a trip, automatic, or semiautomatic hammer drop system that lifts the 63.5-kg (140-lb) hammer and allows it to drop 0.76 m ± 25 mm (30 ± 1.0 in.) unimpeded.

7.4.2. By using a cathead to pull a rope attached to the hammer. When the cathead and rope method is used, the system and operation shall conform to the following:

7.4.2.1. The cathead shall be essentially free of rust, oil, or grease and have a diameter in the range of 150 to 250 mm (6 to 10 in.).

7.4.2.2. The cathead should be operated at a minimum speed of rotation of 100 RPM, or the approximate speed of rotation shall be reported on the boring log.

7.4.2.3. No more than $2^1/_4$ rope turns on the cathead may be used during the performance of the penetration test, as shown in Figure 1.

Note 6—The operator should generally use either $1^3/_4$ or $2^1/_4$ rope turns, depending upon whether or not the rope comes off the top ($1^3/_4$ turns) or the bottom ($2^1/_4$ turns) of the cathead. It is generally known and accepted that $2^3/_4$ or more rope turns considerably impedes the fall of the hammer and should not be used to perform the test. The cathead rope should be maintained in a relatively dry, clean, and unfrayed condition.

7.4.2.4. For each hammer blow, a 0.76-m (30-in.) lift and drop shall be employed by the operator. The operation of pulling and throwing the rope shall be performed rhythmically without holding the rope at the top of the stroke.

7.5. Bring the sampler to the surface and open. Record the percent recovery or the length of sample recovered. Describe the soil samples recovered as to composition, color, stratification, and condition, then place one or more representative portions of the sample into sealable moisture-proof containers (jars) without ramming or distorting any apparent stratification. Seal each container to prevent evaporation of soil moisture. Affix labels to the containers bearing job designation, boring number, sample depth, and the blow count per 0.15-m (6-in.) increment. Protect the samples against extreme temperature changes. If there is a soil change within the sampler, make a jar for each stratum and note its location in the sampler barrel.

8. REPORT

8.1. *Drilling information shall be recorded in the field and shall include the following*:

8.1.1. Name and location of job;

8.1.2. Names of crew;

8.1.3. Type and make of drilling machine;

8.1.4. Weather conditions;

8.1.5. Date and time of start and finish of boring;

8.1.6. Boring number and location (station and coordinates, if available and applicable);

8.1.7. Surface elevation, if available;

8.1.8. Method of advancing and cleaning the boring;

8.1.9. Method of keeping boring open;

8.1.10. Depth of water surface and drilling depth at the time of a noted loss of drilling fluid, and time and date when reading or notation was made;

8.1.11. Location of strata changes;

8.1.12. Size of casing, depth of cased portion of boring;

8.1.13. Equipment and method of driving sampler;

8.1.14. Type of sampler and length and inside diameter of barrel (note use of liners);

8.1.15. Size, type, and section length of the sampling rods; and

8.1.16. Remarks.

8.2. *Data obtained for each sample shall be recorded in the field and shall include the following*:

8.2.1. Sample depth and, if utilized, the sample number,

8.2.2. Description of soil,

8.2.3. Strata changes within sample,

8.2.4. Sampler penetration and recovery lengths, and

8.2.5. Number of blows per 0.15-m (6-in.) or partial increment.

9. PRECISION AND BIAS

9.1. *Precision*—A valid estimate of test procedures has not been determined.

9.2. *Bias*—Because there is no reference material for this test method, there can be no bias statement.

9.3. Variations in *N*-values of 100 percent or more have been observed when using different standard penetration test apparatus and drillers for adjacent borings in the same soil formation. Current opinion, based on field experience, indicates that when using the same apparatus and driller, *N*-values in the same soil can be reproduced with a coefficient of variation of about 10 percent.

9.4. The use of faulty equipment, such as an extremely massive or damaged anvil, a rusty cathead, a low-speed cathead, an old oily rope, or massive or poorly lubricated rope sheaves can significantly contribute to differences in *N*-values obtained between operator-drill rig systems.

9.5. The variability in *N*-values produced by different drill rigs and operators may be reduced by measuring that part of the hammer energy delivered into the drill rods from the sampler and adjusting *N* on the basis of comparative energies. A method for energy measurement and *N*-value adjustment is currently under development.

[1] Except for the use of SI units, this method is technically equivalent to ASTM D 1586-99.

EXHIBIT E: AASHTO T 207-12 (ASTM D1587-08)

Standard Method of Test for

Thin-Walled Tube Sampling of Soils

AASHTO Designation: T 207-12[1]
ASTM Designation: D 1587-08

1. SCOPE

1.1. This method covers a procedure for using a thin-walled metal tube to recover relatively undisturbed soil samples suitable for laboratory tests of engineering properties, such as strength, compressibility, permeability, and density. Thin-walled tubes used in piston-, plug-, or rotary-type samplers, such as the Denison or Pitcher, must comply with the portions of this practice, which describe the thin-walled tubes (Section 5.3).

Note 1—This method does not apply to liners used within the above samplers.

1.2. Not all tubes specified in this method may be of sufficient diameter to perform all strength or consolidation testing. Refer to the appropriate test method for the minimum sample size to determine if the tube will be appropriate for that test.

1.3. The values stated in SI units are to be regarded as the standard.

1.4. *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns associated with its use. It is the responsibility of whoever uses this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. REFERENCED DOCUMENTS

2.1. *AASHTO Standard*:

- R 13, Conducting Geotechnical Subsurface Investigations

2.2. *ASTM Standard*:

- D 4220, Standard Practices for Preserving and Transporting Soil Samples

3. SUMMARY OF METHOD

3.1. A relatively undisturbed sample is obtained by pressing a thin-walled metal tube into the *in situ* soil at the bottom of a boring, removing the soil-filled tube, and sealing the ends to prevent the soil from being disturbed or losing moisture.

4. SIGNIFICANCE AND USE

4.1. This method is used when it is necessary to obtain a relatively undisturbed specimen suitable for laboratory tests of engineering properties or other tests that might be influenced by soil disturbance.

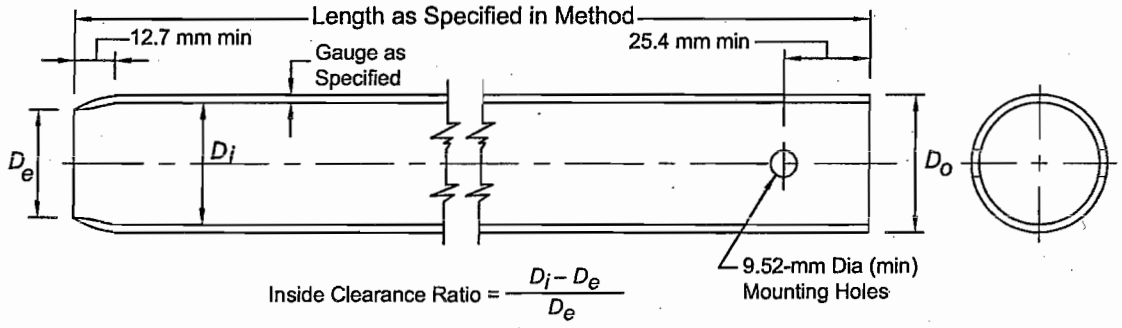
5. APPARATUS

5.1. *Drilling Equipment*—Any drilling equipment may be used that provides a reasonably clean hole, that minimizes disturbance of the soil to be sampled, and that does not hinder the penetration of the thin-walled sampler. Open borehole diameter and the inside diameter of driven casing or hollow stem auger shall not exceed 3.5 times the outside diameter of the thin-walled tube.

5.2. *Sampler Insertion Equipment*—shall be adequate to provide a relatively rapid continuous penetration force. For hard formations it may be necessary, although not recommended, to drive the thin-walled tube sampler.

5.3. *Sampler Head*—serves to couple the thin-walled tube to the insertion equipment and, together with the thin-walled tube, comprises the thin-walled tube sampler. The sampler head shall contain a suitable check valve and a venting area to the outside equal to or greater than the area through the check valve. In some special cases, a check valve may not be required, but venting is required to avoid sample compression. Attachment of the head to the tube shall be concentric and coaxial to assure uniform application of force to the tube by the sampler insertion equipment.

5.4. *Thin-Walled Tubes*—should be manufactured as shown in Figure 1. They should have an outside diameter of 50.8 to 127.0 mm (2 to 5 in.) and be made of metal having adequate strength for use in the soil and formation intended. Tubes shall be clean and free of all surface irregularities including projecting weld seams. Other diameters may be used, but the tube dimensions should be proportional to the tube designs presented here.



Notes:
1. Minimum of two mounting holes on opposite sides for 50.8- to 88.9-mm sampler.
2. Minimum of four mounting holes spaced at 90° for samplers 101.6 mm and larger.
3. Tube held with hardened screws.
4. Tubes with outside diameters of 50.8 mm are specified with an 18-gauge wall thickness to comply with area ratio criteria accepted for "undisturbed samples." Users are advised that such tubing is difficult to locate and can be extremely expensive in small quantities. Sixteen-gauge tubes are generally readily available.

English Equivalents

mm	in.
9.52	3/8
12.7	1/2
25.4	1
50.8	2
88.9	3 1/2
101.6	4

Figure 1—Thin-Walled Tube for Sampling

5.4.1. *Length of Tubes*—See Table 1 and Section 6.4.

5.4.2. *Tolerances*—shall be within the limits shown in Table 2.

5.4.3. *Inside Clearance Ratio*—should not be greater than 1 percent or as specified by the engineer or geologist for the soil and formation to be sampled. Generally, the inside clearance ratio used should increase with the increase in plasticity of the soil being sampled, except for sensitive soils or where local experience indicates otherwise. See Figure 1 for definition of inside clearance ratio.

Table 1—Suitable Thin-Walled Steel Sample Tubes[a]

Outside diameter:			
mm	50.8	76.2	127.0
in.	2	3	5
Wall thickness:			
BWG	18	16	11
mm	1.24	1.65	3.05
in.	0.049	0.065	0.120
Tube length:			
m	0.91	0.91	1.37
in.	36	36	54
Clearance:			
ratio, percent	1	1	1

[a] The three diameters recommended in Table 1 are indicated for purposes of standardization, and are not intended to indicate that sampling tubes of intermediate or larger diameters are not acceptable. Lengths of tubes shown are illustrative. Proper lengths to be determined as suited to field conditions.

Table 2—Dimensional Tolerances for Thin-Walled Tubes

	Nominal Tube Diameters from Table 1[a] Tolerances		
Size Outside Diameter, mm in.	50.8 (2)	76.2 (3)	127 (5)
Outside diameter:			
mm	+ 0.18	+ 0.25	+ 0.38
in.	(+ 0.007)	(+ 0.010)	(+ 0.015)
mm	− 0.00	− 0.00	− 0.00
in.	(− 0.000)	(− 0.000)	(− 0.000)
Inside diameter:			
mm	+ 0.00	+ 0.00	+ 0.00
in.	(+ 0.000)	(+ 0.000)	(+ 0.000)
mm	− 0.18	− 0.25	− 0.38
in.	(− 0.007)	(− 0.010)	(− 0.015)
Wall thickness:			
mm	± 0.18	± 0.25	± 0.38
in.	(± 0.007)	(± 0.010)	(± 0.015)
Ovality:[b]			
mm	0.38	0.51	0.76
in.	(0.015)	(0.020)	(0.030)
Straightness:			
mm/m	2.5	2.5	2.5
in./ft	(0.030)	(0.030)	(0.030)

[a] Intermediate or larger diameters should be proportional. Tolerances shown are essentially standard commercial manufacturing tolerances for seamless steel mechanical tubing. Specifically only two of the first three tolerances: that is, OD and ID, or OD and Wall, or ID and Wall.

[b] *Ovality*—the cross-section of the tube that deviates from a perfect circle.

5.4.4. *Corrosion Protection*—Corrosion, whether from galvanic or chemical reaction, can damage or destroy both the thin-walled tube and the sample. Severity of damage is a function of time as well as interaction between the sample and the tube. Thin-walled tubes should have some form of protective coating. Tubes that will contain samples for more than 72 h shall be coated. The type of coating to be used may vary depending upon the material to be sampled. Coatings may include a light coat of lubricating oil, lacquer, epoxy, Teflon, and others. Type of coating must be specified by the engineer or geologist if storage will exceed 72 h. Plating of the tubes or alternate base metals may be specified by the engineer or geologist.

6. PROCEDURE

6.1. Advance the borehole using methods outlined in AASHTO R 13. Clean out the borehole to sampling elevation using whatever method is preferred that will ensure the material to be sampled is not disturbed. If groundwater is encountered, maintain the liquid level in the borehole at or above groundwater level during the sampling operation.

6.2. Bottom discharge bits are not permitted. Side discharge bits may be used, with caution. Jetting through an open-tube sampler to clean out the borehole to sampling elevation is not permitted. Remove loose material from the center of a casing or hollow stem auger as carefully as possible to avoid disturbance of the material to be sampled.

Note 2—Roller bits are available in downward-jetting and diffused-jet configurations. Downward-jetting configuration rock bits are not acceptable. Diffuse-jet configurations are generally acceptable.

6.3. Place the sample tube so that its bottom rests on the bottom of the hole. Record the depth to the bottom of the sample tube to the nearest 0.3 m (0.1 ft). Advance the sampler without rotation by a continuous relatively rapid motion.

6.4. Determine the length of advance by the resistance and condition of the formation, but the length shall never exceed 5 to 10 diameters of the tube in sands and 10 to 15 diameters of the tube in clays.

Note 3—The mass of the sample, laboratory-handling capabilities, transportation problems, and commercial availability of tubes will generally limit maximum practical lengths to those shown in Table 1.

6.5. When the formation is too hard for push-type insertion, the tube may be driven. Other methods, as directed by the engineer or geologist, may be used. If driving methods are used, the data regarding mass and fall of the hammer and penetration achieved must be shown in the report. Additionally, that tube must be prominently labeled a "driven sample."

6.6. In no case shall a length of advance be greater than the sample-tube length minus an allowance for the sampler head and a minimum of 76.2 mm (3 in.) for sludge-end cuttings.

Note 4—The tube may be rotated to shear bottom of the sample after pressing is complete.

6.7. Withdraw the sampler from the formation as carefully as possible in order to minimize disturbance of the sample. Where the soil formation is soft, a delay before withdraw of the sampler (typically 5 to 30 min) may improve sample recovery.

7. PREPARATION FOR SHIPMENT

7.1. Upon removal of the tube, measure the length of sample in the tube. Remove the drill cuttings in the upper end of the tube and measure the length again. Seal the upper end of the tube. Remove at least 25 mm (1 in.) of material from the lower end of the tube. Use this material for soil description. Measure the overall sample length. Seal the lower end of the tube. Alternatively, after measurement, the tube may be sealed without removal of soil from the ends of the tube if so directed by the engineer or geologist.

Note 5—Field extrusion and packaging of extruded samples under the specific direction of a geotechnical engineer or geologist is permitted. Samples are extruded in special hydraulic jacks equipped with properly sized platens to extrude the core in a continuous smooth speed. Bent or damaged tubes should be cut off before extruding.

Note 6—Tubes sealed over the ends as opposed to those sealed with expanding packers should contain end padding in end voids in order to prevent drainage or movement of the sample within the tube.

7.2. Prepare and immediately affix labels or apply markings as necessary to identify the sample. Assure that the markings or labels are adequate to survive transportation and storage.

7.3. The method of care and handling of tube samples during shipment can affect the integrity or degree to which the samples remain undisturbed and suitable for laboratory testing. Tubes should be stored and transported in a vertical position, protected from extreme heat and cold, and protected from vibration and shock. Additional guidance on the care and transportation of tube samples is provided in ASTM D 4220.

Note 7—Top end of tube should be labeled "TOP."

8. REPORT

8.1. *The appropriate information on the field log is required as follows*:

8.1.1. Name and location of the project;

8.1.2. Boring number and precise location on project;

8.1.3. Surface elevation or reference to a datum;

8.1.4. Date and time of boring—start and finish;

8.1.5. Depth to top of sample and number of sample;

8.1.6. Description of sampler: size, type of metal, type of coating;

8.1.7. Method of sampler insertion—push or drive;

8.1.8. Method of drilling, size of hole, casing, and drilling fluid used;

8.1.9. Depth to groundwater level—date and time measured;

8.1.10. Any possible current or tidal effect on water level;

8.1.11. Soil description;

8.1.12. Length of sampler advance; and

8.1.13. Recovery: length of sample obtained.

9. PRECISION AND BIAS

9.1. This method does not produce numerical data; therefore, a precision and bias statement is not applicable.

[1] Except for the use of SI units, this method is technically equivalent to ASTM D 1587-08.

EXHIBIT F: AASHTO T 225-06 (2010)

Standard Method of Test for

Diamond Core Drilling for Site Investigation

AASHTO Designation: T 225-06 (2010)

1. SCOPE

1.1. This method covers a procedure for diamond core drilling designing for securing intact samples of rock and some soils that are too hard to sample by soil sampling methods. This method is primarily for obtaining data for foundation and slope design and similar civil engineering purposes rather than for mineral development and mining.

2. REFERENCED DOCUMENTS

2.1. *AASHTO Standards*:

- T 206, Penetration Test and Split-Barrel Sampling of Soils
- T 207, Thin-Walled Tube Sampling of Soils

2.2. *ASTM Standard*:

- D 5079, Standard Practices for Preserving and Transporting Rock Core Samples

3. EQUIPMENT

3.1. *A Rotary Drilling Machine*—capable of providing a rotary motion and hydraulically, or mechanically, actuated feed or thrust.

3.2. *A Water or Drilling Mud Pump*, or air compressor capable of delivering sufficient drilling fluid volume and pressure for the size of the hole to be drilled.

3.3. *Core Barrels*—as required.

3.3.1. *A Single-Tube* core barrel—consisting of a hollow tube with a threaded head at the upper end to fit the drill rod. The lower end of the barrel is fitted with a blank or set reaming shell, a core lifter, and a core bit.

3.3.2. *A Double-Tube* core barrel (swivel-type)—having a swiveling inner barrel that is contained in the core barrel suspended on a bearing hanger. Drilling fluid is routed between the inner and outer barrels. This method improves core recovery. More sophisticated double tubes are available having an inner tube that extends into the core bit, and the core lifter mounted inside the inner tube to protect cores of a soft or friable formation.

3.3.3. *Single-Tube Type, WG Design*—consisting of a hollow steel tube, with a head at one end threaded for drill rod, and a threaded connection for a reaming shell and core bit at the other end. A core

lifter, or retainer located within the core bit, is normal but may be omitted at the discretion of the geologist or engineer.

3.3.4. *Double-Tube, Swivel-Type, WG Design*—An assembly of two concentric steel tubes joined and supported at the upper end by means of a ball or roller-bearing swivel arranged to permit rotation of the outer tube without causing rotation of the inner tube. The upper end of the outer tube, or removable head, is threaded for drill rod. A threaded connection is provided on the lower end of the outer tube for a reaming shell and core bit. A core lifter located within the core bit is normal but may be omitted at the discretion of the geologist or engineer.

3.3.5. *Double-Tube, Swivel-Type, WT Design*—is essentially the same as the double tube, swivel-type, WG design, except that the WT design has thinner tube walls, a reduced annular area between the tubes, and takes a larger core from the same diameter bore hole. The core lifter is located within the core bit.

3.3.6. *Double-Tube, Swivel-Type, WM Design*—is similar to the double tube, swivel-type, WG design, except that the inner tube is threaded at its lower end to receive a core lifter case that effectively extends the inner tube well into the core bit, thus minimizing exposure of the core to the drilling fluid. A core lifter is contained within the core lifter case on the inner tube.

3.3.7. *Double-Tube, Swivel-Type, Large-Diameter Design*—is similar to the double tube, swivel-type, WM design, with the addition of a ball valve to control fluid flow in all three available sizes and the addition of a sludge barrel to catch heavy cuttings on the two larger sizes. The large-diameter design double tube, swivel-type, core barrels are available in three-core-per-hole sizes as follows: $2^3/_4$ in. (69.85 mm) by $3^7/_8$ in. (98.43 mm), 4 in. (101.6 mm) by $5^1/_2$ in. (139.7 mm), and 6 in. (152.4 mm) by $7^3/_4$ in. (196.85 mm). Their use is generally reserved for very detailed investigative work or where other methods do not yield adequate recovery.

3.3.8. *Double-Tube, Swivel-Type, Retrievable Inner-Tube Method*—in which the core-laden inner-tube assembly is retrieved to the surface and an empty inner-tube assembly returned to the face of the borehole through the matching, large-bore drill rods without need for withdrawal and replacement of the drill rods in the borehole. The inner-tube assembly consists of an inner tube with removable core lifter case and core lifter at one end and a removable inner-tube head, swivel bearing, suspension adjustment, and latching device with release mechanism on the opposite end. The inner-tube latching device locks into a complementary recess in the wall of the outer tube such that the outer tube may be rotated without causing rotation of the inner tube and such that the latch may be actuated and the inner-tube assembly transported by appropriate surface control. The outer tube is threaded for the matching, large-bore drill rod and internally configured to receive the inner-tube latching device at one end and threaded for a reaming shell and bit, or bit only, at the other end.

3.3.9. *Longitudinally Split Inner Tubes*—As opposed to conventional cylindrical inner tubes, these allow inspection of, and access to, the core by simply removing one of the two halves. They are not standardized but are available for most core barrels, including many of the retrievable inner-tube types.

3.3.10. The size and design nomenclature shall be in accordance with the standards adopted by the Diamond Core Drill Manufacturers Association.

3.4. *Core Bits*—The core bits shall be set with diamonds, tungsten carbide, or similar hard materials appropriate to the hardness of the materials being drilled and shall be furnished in X- or M-design or equivalent as required. The sizes of the core barrels and bits shall be as given in Table 1.

Table 1—Sizes of Core Barrels[a]

Size	Hole, Diameter		Core, Diameter	
	in.	mm	in.	mm
EWX, EWM	1.5	38.1	0.812	20.6
AWX, AWM	1.957	49.2	1.375	30.2
BWX, BWM	2.375	60.3	1.625	41.3
NWX, NWM	3	76.2	2.125	54.0
$2^3/_4$ by $3^7/_8$ in. (69.9 by 98.4 mm)	3.875	98.4	2.687	68.3
4 by $5^1/_2$ in. (102 by 140 mm)	5.5	140	3.937	100
6 by $7^3/_4$ in. (152 by 197 mm)	7.75	197	5.937	151

[a] As standardized by the Diamond Core Drill Manufacturers Association., Bulletin No. 2. Other sizes may be specified, but should be so noted.

3.5. *Drive Pipe or Casing*—Standard weight or extra heavy pipe, as required by the nature of overburden or the drilling method, shall be furnished where necessary for driving through soils to bedrock. The casing or pipe shall have an inside diameter of sufficient size to accommodate the largest size core barrel to be employed. The inside of the casing or pipe shall be free of burrs and obstructions.

3.6. *Auxiliary Casing*—When it is necessary to case through formations already penetrated by the drill or when no drive casing has been employed, casing shall be provided with an outside diameter that will fit inside the hole and an inside diameter that will permit the use of the next smaller bit and core barrels. Standard sizes of casing are given in Table 2.

Table 2—Standard Sizes of Casing

Size	Outside Diameter		Inside Diameter		Will Fit Hole Drilled by:
	in.	mm	in.	mm	
EX	1.8125	46	1.5	38.1	AWX, AWM
AX	2.25	57.2	1.906	48.4	BWX, BWM
BX	2.875	73.0	2.187	60.3	NWX, NWM
	3.5	88.9	3.0	76.2	$2^3/_4$ by $3^7/_8$ in.
NX					(69.9 by 98.4 mm)

3.7. *Drill Rods*—The drill rods shall have an inside diameter that will permit the flow of drilling fluid through the rods in a quantity sufficient to provide an upward velocity of the fluid between the rod and the hole wall that will remove the cuttings effectively.

3.8. *Auxiliary Equipment*—Auxiliary equipment shall be furnished as required by the work including roller bits, fishtail bits, wrenches, equipment for mixing the drilling mud, hand tools, safety equipment, etc.

3.9. *Core Boxes*—Core boxes of wood or other durable material shall be provided for protection, transport, and storage of the cores. The boxes shall be provided with longitudinal spacers that will separate the core into compartments. Small blocks that fit snugly between the spacers shall be provided to secure core in place and/or fill space if the material recovered is insufficient to completely fill the box. The top of the core length, which corresponds to the shallowest depth, should be placed at one corner of the box and the core placed progressing downward in a continuous manner to the deepest depth, through the compartments toward the opposite corner. The top and bottom of the core length and each run shall be clearly indicated on the longitudinal spacers or blocks with waterproof marker. The top and bottom of the core length shall also be

clearly indicated on the box cover, at the corresponding corners along with the core depths. Additional guidance regarding labeling and use of core boxes can be found in ASTM D 5079.

4. PROCEDURE

4.1. When formations are encountered that are too hard to be sampled by soil sampling methods, the core drilling procedure shall be used. A penetration of 1 in. (25 mm) or less for 50 blows (Notes 1 and 2) according to T 206 shall be considered as indicating that soil sampling methods are not applicable.

Note 1—When the subsurface investigation requires a sample for testing and identification for material that has a penetration-resistance between $N = 100$ specified in T 206 and 50 blows per inch, coring may be required. Materials such as very stiff clay or weathered shale bedrock can be sampled using core barrels such as the Denison-type Double-Tube Core Barrel. The sampling can be enhanced by the use of air for the drilling medium and the use of bits with steel teeth hardfaced.

Note 2—The limit of 50 blows per inch (25.4 mm) may be increased if the core recoveries prove to be small and samples can be secured by the soil sampling method.

4.2. Firmly seat the casing on bedrock or hard material to prevent loose materials from entering the hole and to prevent the loss of drilling fluid. Level the surface of the rock or hard material when necessary by the use of a fishtail or other bits. If an open drill hole can be maintained without casing, the casing may be omitted. Bentonite mud is often effective in maintaining an open hole without the use of casing.

4.3. Begin the core drilling using the NWX or NWM double tube swivel-core barrel. The first core run will usually be 5 ft (1.52 m) because of nonuniform conditions at the soil rock contact (Note 3). The NWM barrel should be inspected prior to lowering into the hole to ensure that the swivel is in good working order and rotating freely. The clearance between the inner barrel, when incorporated in the barrel, and the bit should be checked and adjusted if necessary to ensure that the space between the bit and the inner barrel is sufficient so as not to restrict the flow of drilling fluid. Either type barrel should be inspected for dents or bends that impair rock recovery. The barrel should also be checked for material left in the barrel from previous drilling to ensure the barrel is clean and unobstructed. The core retainer should be inspected, and if worn excessively or damaged, it should be replaced. The choice of bit setting shall be consistent with the type of material to be drilled. (Use extreme caution not to drop foreign material into the hole. Should an object be dropped into the hole and not be recoverable, abandon the hole and start a new one.) Inspect all drill rods to be used for straightness. If any rods display bends when rolled over a flat surface, they should not be used.

Note 3—In soft materials, a larger starting size may be specified; where local experience indicates satisfactory core recovery or where hard, sound materials are anticipated, a smaller size or the single-tube type may be specified in place of the NWX or NWM tube, and longer runs may be drilled.

4.4. Lower the barrel into the hole, using care to set the barrel on the formation to be drilled gently to prevent damage to the bit or buckling of the barrel. Measurement of barrel and rods to be used is essential; measurement shall be to the nearest 0.1 ft (30.5 mm). Log the depth when the barrel makes contact with the bottom of the hole. If the depth is more than 0.1 ft (30.5 mm) less than the depth logged from the previous run, there is probably loose material or core in the hole. Connect the drill chuck to the string of tools and connect the drilling fluid supply line. Prior to rotating, lift the string of tools slightly and start the circulation of the drilling fluid. Allow the fluid to circulate until a full-flow condition is reached. Lower the tools slowly to the bottom and seat the bit by slowly starting the rotation and slowly increasing the vertical pressure, maintaining full flow of the drilling fluid. When the bit is seated, adjust the vertical pressure and the rotation to achieve proper

penetration in accordance with the formation being drilled (Note 4). Log the depth where the coring began to the nearest 0.1 ft (30.5 mm). If the flow of the drilling fluid is blocked during drilling, raise the bit slightly to allow the fluid flow to return. If the flow does not return, remove the drilling tools and correct the problem as necessary to maintain adequate flow of the drilling fluid. A judgment may be required when different types of material are encountered in a given run and recovery is less than 100 percent of the actual thickness of a given formation. To aid in making this judgment, the rate of penetration and the drilling fluid color and texture shall be monitored as drilling proceeds. The depths where changes are noted in the penetration rate and/or the color and/or texture of the cuttings in the return fluid are to be recorded for reference when this judgment is required. It may be desirable to retain samples of the cuttings contained in the return fluid at changes of color or texture or onset intervals.

Note 4—The life expectancy of the bit and the rate of penetration are dependent upon proper force on the bit and the peripheral velocity of the bit. The peripheral velocity should be as high as possible without causing undue strain on the drill rig or excessive vibration of the drilling tools. The force on the bit should be adjusted to match the information and the design of the bit. (For a given bit design, a softer formation would require less force than a harder formation.) It may be necessary to anchor the drill rig to obtain sufficient force on the bit.

4.5. After drilling a depth equivalent to the length of the barrel (not to exceed 10 ft (or 3.05 m) and minus any loose material noted during the seating of the barrel), remove the core barrel from the hole, and remove the core from the barrel. Place the core in the core box in such a manner that the top of the rock stratum will be located at one corner of the box as described in Section 3.9. When the run is greater than the length of the first compartment, the next compartment to the right is measured and temporarily marked at a point that will be equivalent to the difference between the length of the compartment and the length of the run measured from upper left to lower left. The first segment of rock removed from the core barrel (bottom of core run) shall be placed in the box so that the bottom of the core is either at the lower left end of the left compartment or at the temporary mark in the next compartment to the right. Each additional piece removed from the barrel shall be placed in the box one after another, orienting each piece of core with the direction of the box so that the upper stratum is to the upper and/or left of the box in respect to lower stratum. Proceed to place the core in the box from the lower end to the upper end as the core is removed from the barrel in such a manner that the top of the stratum falls in the upper left end of the left compartment as described in Section 2.9. When all of the core has apparently been removed from the barrel, check the barrel by inserting a rule into the core barrel and check the length to ensure that all of the material has been removed. After all the material has been removed from the barrel, adjust the core in the box so that the pieces are consolidated together to represent as nearly as practical their in situ length, taking care to fit the broken pieces together in such a manner that will not cause a false measure of the recovered core. Measure the recovered core to the nearest 0.1 ft (30.5 mm) and record the recovery. After performing the measurement for core recovery, mark the depths of the top and bottom of the core and each noticeable gap in the formation by a spacer block clearly labeled. Wrap delicate cores or those that change materially upon drying in plastic film or seal in wax or both, when such treatment is considered necessary by the engineer. Subsequent core runs from the same project and hole shall continue this procedure with the top of the next run beginning at the bottom of the last proceeding run. Measure the length of the run from the end of the last run from upper to lower in the compartment, utilizing the next compartment to the right when the compartment will not accommodate the entire run, and mark the bottom of the run with a temporary marker. Place the first segment of rock removed from the core barrel (bottom of core run) at the newly established temporary mark. Place the core in the box as described previously.

4.6. When soft materials are encountered from a core run which produce less than 50 percent recovery changes in the type of barrel, a change to drilling procedure or soil sampling should be considered. If soil samples are desired, secure such samples in accordance with the procedures described in T 206 or T 207. Resume diamond core drilling when refusal materials are again encountered.

4.7. Since rock structure and the occurrence of seams, fissures, cavities, and broken areas are among the most important items to be detected and described, take special care to observe and record these features. If broken rock or cavities prevent the advance of the boring, (1) cement the hole or (2) ream and case, or (3) case and advance with the next smaller-sized core barrel, as the conditions warrant. Follow the same procedure where fissures are encountered that cause the loss of drilling fluid return (Notes 5 and 6).

Note 5—Whenever the drilling water loss indicates conditions of engineering or geologic importance, the procedure for advancing the boring will be as determined by the engineer.

Note 6—Other optional procedures are as follows: (1) In soft, seamy, or otherwise unsound rock, where core recovery may be difficult, the M-design core barrels may be specified; (2) In hard sound rock where a high percentage of core recovery is anticipated, the single-tube core barrel may be employed.

5. REPORT

5.1. *The report shall include the following*:

5.1.1. Project identification, boring number, location, and driller;

5.1.2. Elevation of the ground surface;

5.1.3. Elevation of groundwater, including dates and times measured;

5.1.4. Elevations (or depths) at which drilling water return was lost;

5.1.5. Size and design of core barrel used. Size and length of all casing and any movements of the casing;

5.1.6. Length of each core run and the length or percentage, or both, of the core recovered;

5.1.7. Description of the rock in each run;

5.1.8. Structure including stratification, angle of dip, cavities, fissures, and any other observations that could give information on these features;

5.1.9. Depth, thickness, and apparent nature of the filling in each cavity or soft seam in the rock;

5.1.10. Depth of sample cuttings retained from the drilling fluid;

5.1.11. Any changes in the character of the drilling fluid; and

5.1.12. Dates of beginning and end of boring.

EXHIBIT G: ASTM D5092-04 (Reapproved 2010)

Designation: D5092 – 04 (Reapproved 2010)ε1

Standard Practice for Design and Installation of Ground Water Monitoring Wells[1]

This standard is issued under the fixed designation D5092; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε[1] NOTE—The units statement in 1.5 was revised editorially in August 2010.

1. Scope

1.1 This practice describes a methodology for designing and installing conventional (screened and filter-packed) groundwater monitoring wells suitable for formations ranging from unconsolidated aquifers (i.e., sands and gravels) to granular materials having grain-size distributions with up to 50 % passing a #200 sieve and as much as 20 % clay-sized material (i.e., silty fine sands with some clay). Formations finer than this (i.e., silts, clays, silty clays, clayey silts) should not be monitored using conventional monitoring wells, as representative groundwater samples, free of artifactual turbidity, cannot be assured using currently available technology. Alternative monitoring technologies (not described in this practice) should be used in these formations

1.2 The recommended monitoring well design and installation procedures presented in this practice are based on the assumption that the objectives of the program are to obtain representative groundwater samples and other representative groundwater data from a targeted zone of interest in the subsurface defined by site characterization.

1.3 This practice, in combination with proper well development (D5521), proper groundwater sampling procedures (D4448), and proper well maintenance and rehabilitation (D5978), will permit acquisition of groundwater samples free of artifactual turbidity, eliminate siltation of wells between sampling events, and permit acquisition of accurate groundwater levels and hydraulic conductivity test data from the zone screened by the well. For wells installed in fine-grained formation materials (up to 50 % passing a #200 sieve), it is generally necessary to use low-flow purging and sampling techniques (D6771) in combination with proper well design to collect turbidity-free samples.

1.4 This practice applies primarily to well design and installation methods used in drilled boreholes. Other Standards, including Guide D6724 and Practice D6725, cover installation of monitoring wells using direct-push methods.

1.5 The values stated in inch-pound units are to be regarded as standard, except as noted below. The values given in parentheses are mathematical conversions to SI units, which are provided for information only and are not considered standard.

1.5.1 The gravitational system of inch-pound units is used when dealing with inch-pound units. In this system, the pound (lbf) represents a unit of force (weight), while the unit for mass is slugs.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.7 *This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C150 Specification for Portland Cement

C294 Descriptive Nomenclature for Constituents of Concrete Aggregates

D421 Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants

[1] This practice is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.21 on Ground Water and Vadose Zone Investigations.

Current edition approved Aug. 1, 2010. Published September 2010. Originally approved in 1990. Last previous edition approved in 2004 as D5092–04ε1. DOI: 10.1520/D5092-04R10E01.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

D422 Test Method for Particle-Size Analysis of Soils
D653 Terminology Relating to Soil, Rock, and Contained Fluids
D1452 Practice for Soil Exploration and Sampling by Auger Borings
D1586 Test Method for Penetration Test (SPT) and Split-Barrel Sampling of Soils
D1587 Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes
D2113 Practice for Rock Core Drilling and Sampling of Rock for Site Investigation
D2217 Practice for Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants
D2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
D2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)
D3282 Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
D3441 Test Method for Mechanical Cone Penetration Tests of Soil
D3550 Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils
D4220 Practices for Preserving and Transporting Soil Samples
D4700 Guide for Soil Sampling from the Vadose Zone
D4750 Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)[3]
D5079 Practices for Preserving and Transporting Rock Core Samples
D5088 Practice for Decontamination of Field Equipment Used at Waste Sites
D5254 Practice for Minimum Set of Data Elements to Identify a Ground-Water Site
D5299 Guide for Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities
D5434 Guide for Field Logging of Subsurface Explorations of Soil and Rock
D5518 Guide for Acquisition of File Aerial Photography and Imagery for Establishing Historic Site-Use and Surficial Conditions
D5521 Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers
D5608 Practices for Decontamination of Field Equipment Used at Low Level Radioactive Waste Sites
D5730 Guide for Site Characterization for Environmental Purposes With Emphasis on Soil, Rock, the Vadose Zone and Ground Water
D5753 Guide for Planning and Conducting Borehole Geophysical Logging
D5777 Guide for Using the Seismic Refraction Method for Subsurface Investigation
D5781 Guide for Use of Dual-Wall Reverse-Circulation Drilling for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices
D5782 Guide for Use of Direct Air-Rotary Drilling for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices
D5783 Guide for Use of Direct Rotary Drilling with Water-Based Drilling Fluid for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices
D5784 Guide for Use of Hollow-Stem Augers for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices
D5787 Practice for Monitoring Well Protection
D5872 Guide for Use of Casing Advancement Drilling Methods for Geoenvironmental Exploration and Installation of Subsurface Water-Quality Monitoring Devices
D5875 Guide for Use of Cable-Tool Drilling and Sampling Methods for Geoenvironmental Exploration and Installation of Subsurface Water-Quality Monitoring Devices
D5876 Guide for Use of Direct Rotary Wireline Casing Advancement Drilling Methods for Geoenvironmental Exploration and Installation of Subsurface Water-Quality Monitoring Devices
D5978 Guide for Maintenance and Rehabilitation of Ground-Water Monitoring Wells
D5979 Guide for Conceptualization and Characterization of Ground-Water Systems
D6001 Guide for Direct-Push Ground Water Sampling for Environmental Site Characterization
D6067 Practice for Using the Electronic Piezocone Penetrometer Tests for Environmental Site Characterization
D6167 Guide for Conducting Borehole Geophysical Logging: Mechanical Caliper
D6169 Guide for Selection of Soil and Rock Sampling Devices Used With Drill Rigs for Environmental Investigations
D6235 Practice for Expedited Site Characterization of Vadose Zone and Ground Water Contamination at Hazardous Waste Contaminated Sites
D6274 Guide for Conducting Borehole Geophysical Logging - Gamma
D6282 Guide for Direct Push Soil Sampling for Environmental Site Characterizations
D6286 Guide for Selection of Drilling Methods for Environmental Site Characterization
D6429 Guide for Selecting Surface Geophysical Methods
D6430 Guide for Using the Gravity Method for Subsurface Investigation
D6431 Guide for Using the Direct Current Resistivity Method for Subsurface Investigation
D6432 Guide for Using the Surface Ground Penetrating Radar Method for Subsurface Investigation
D6519 Practice for Sampling of Soil Using the Hydraulically Operated Stationary Piston Sampler
D6639 Guide for Using the Frequency Domain Electromagnetic Method for Subsurface Investigations

[3] Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.

D6640 Practice for Collection and Handling of Soils Obtained in Core Barrel Samplers for Environmental Investigations

D6724 Guide for Installation of Direct Push Ground Water Monitoring Wells

D6725 Practice for Direct Push Installation of Prepacked Screen Monitoring Wells in Unconsolidated Aquifers

D6771 Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations

F480 Specification for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80

3. Terminology

3.1 *Definitions:*

3.1.1 *annular space, annulus*—the space between two concentric strings of casing, or between the casing and the borehole wall. This includes the space(s) between multiple strings of casing in a borehole installed either concentrically or adjacent to one another.

3.1.2 *artifactual turbidity*—particulate matter that is not naturally mobile in the groundwater system and that is produced in some way by the groundwater sampling process. May consist of particles introduced to the subsurface during drilling or well construction, sheared from the target monitoring zone during pumping or bailing the well, or produced by exposure of groundwater to atmospheric conditions.

3.1.3 *assessment monitoring*—an investigative monitoring program that is initiated after the presence of a contaminant in groundwater has been detected. The objective of this program is to determine the concentration of constituents that have contaminated the groundwater and to quantify the rate and extent of migration of these constituents.

3.1.4 *ballast*—materials used to provide stability to a buoyant object (such as casing within a water-filled borehole).

3.1.5 *borehole*—an open or uncased subsurface hole, generally circular in plan view, created by drilling.

3.1.6 *borehole log*—the record of geologic units penetrated, drilling progress, depth, water level, sample recovery, volumes, and types of materials used, and other significant facts regarding the drilling and/or installation of an exploratory borehole or well.

3.1.7 *bridge*—an obstruction within the annulus that may prevent circulation or proper placement of annular fill materials.

3.1.8 *casing*—pipe, finished in sections with either threaded connections or beveled edges to be field welded, which is installed temporarily or permanently either to counteract caving, to advance the borehole, or to isolate the zone being monitored, or any combination of these.

3.1.9 *casing, protective*—a section of larger diameter pipe that is placed over the upper end of a smaller diameter monitoring well riser or casing to provide structural protection to the well, to prevent damage to the well, and to restrict unauthorized access into the well.

3.1.10 *casing, surface*—pipe used to stabilize a borehole near the surface during the drilling of a borehole that may be left in place or removed once drilling is completed.

3.1.11 *caving; sloughing*—the inflow of unconsolidated material into a borehole that occurs when the borehole walls lose their cohesiveness.

3.1.12 *cement*—commonly known as Portland cement. A mixture that consists of calcareous, argillaceous, or other silica-, alumina-, and iron-oxide-bearing materials that is manufactured and formulated to produce various types which are defined in Specification C150. Portland cement is considered a hydraulic cement because it must be mixed with water to form a cement-water paste that has the ability to harden and develop strength even if cured under water.

3.1.13 *centralizer*—a device that assists in the centering of a casing or riser within a borehole or another casing.

3.1.14 *confining unit*—a body of relatively low hydraulic conductivity formation material stratigraphically adjacent to one or more aquifers. Synonymous with "aquiclude," "aquitard," and "aquifuge."

3.1.15 *detection monitoring*—a program of monitoring for the express purpose of determining whether or not there has been a contaminant release to groundwater.

3.1.16 *d-10*—the diameter of a soil particle (preferably in mm) at which 10 % by weight (dry) of the particles of a particular sample are finer. Synonymous with the effective size or effective grain size.

3.1.17 *d-60*—the diameter of a soil particle (preferably in mm) at which 60 % by weight (dry) of the particles of a particular sample are finer.

3.1.18 *flush joint or flush coupled*—casing or riser with ends threaded such that a consistent inside and outside diameter is maintained across the threaded joints or couplings.

3.1.19 *gravel pack*—common term used to refer to the primary filter pack of a well (see *primary filter pack*).

3.1.20 *grout (monitoring wells)*—a low-permeability material placed in the annulus between the well casing or riser and the borehole wall (in a single-cased monitoring well), or between the riser and casing (in a multi-cased monitoring well), to prevent movement of groundwater or surface water within the annular space.

3.1.21 *hydrologic unit*—geologic strata that can be distinguished on the basis of capacity to yield and transmit fluids. Aquifers and confining units are types of hydrologic units. Boundaries of a hydrologic unit may not necessarily correspond either laterally or vertically to lithostratigraphic formations.

3.1.22 *multi-cased well*—a well constructed by using successively smaller diameter casings with depth.

3.1.23 *neat cement*—a mixture of Portland cement (Specification C150) and water.

3.1.24 *packer (monitoring wells)*—a transient or dedicated device placed in a well that isolates or seals a portion of the well, annulus, or borehole at a specific level.

3.1.25 *piezometer*—a small-diameter well with a very short screen that is used to measure changes in hydraulic head, usually in response to pumping a nearby well. Synonymous with observation well.

3.1.26 *primary filter pack*—a clean silica sand or sand and gravel mixture of selected grain size and gradation that is installed in the annular space between the borehole wall and

the well screen, extending an appropriate distance above the screen, for the purpose of retaining and stabilizing the particles from the adjacent formation(s). The term is used in place of *gravel pack*.

3.1.27 *PTFE tape*—joint sealing tape composed of polytetrafluoroethylene.

3.1.28 *riser*—the pipe or well casing extending from the well screen to just above or below the ground surface.

3.1.29 *secondary filter pack*—a clean, uniformly graded sand that is placed in the annulus between the primary filter pack and the overlying seal, or between the seal and overlying grout backfill, or both, to prevent intrusion of the seal or grout, or both, into the primary filter pack.

3.1.30 *sediment sump*—a blank extension of pipe or well casing, closed at the bottom, beneath the well screen used to collect fine-grained material from the filter pack and adjacent formation materials during the process of well development. Synonymous with rat trap or tail pipe.

3.1.31 *single-cased well*—a monitoring well constructed with a riser but without an exterior casing.

3.1.32 *static water level*—the elevation of the top of a column of water in a monitoring well or piezometer that is not influenced by pumping or conditions related to well installation, or hydraulic testing.

3.1.33 *tamper*—a heavy cylindrical metal section of tubing that is operated on a wire rope or cable. It either slips over the riser and fits inside the casing or borehole annulus, or fits between the riser and annulus. It is generally used to tamp annular sealants or filter pack materials into place and to prevent bridging or break bridges that form in the annular space.

3.1.34 *target monitoring zone*—the groundwater flow path from a particular area or facility in which monitoring wells will be screened. The target monitoring zone should be an interval in subsurface materials in which there is a reasonable expectation that a monitoring well will intercept groundwater moving beneath an area or facility and any migrating contaminants that may be present.

3.1.35 *tremie pipe*—a small-diameter pipe or tube that is used to transport filter pack materials and annular seal materials from the ground surface into an annular space.

3.1.36 *uniformity coefficient*—the ratio of d-60/d-10, where d-60 and d-10 are particle diameters corresponding to 60 % and 10 % finer on the cumulative particle size curve, respectively.

3.1.37 *uniformly graded*—a quantitative definition of the particle size distribution of a soil that consists of a majority of particles being of approximately the same diameter. A granular material is considered uniformly graded when the uniformity coefficient is less than about five (Test Method D2487). Comparable to the geologic term *well sorted*.

3.1.38 *vented cap*—a cap with a small hole that is installed on top of the riser.

3.1.39 *weep hole*—a small-diameter hole (usually ¼ in.) drilled into the protective casing above the ground surface that serves to drain out water that may enter the annulus between the riser and the protective casing.

3.1.40 *well completion diagram*—a record that illustrates the details of a well installation.

3.1.41 *well screen*—a device used to retain the primary or natural filter pack; usually a cylindrical pipe with openings of a uniform width, orientation, and spacing.

4. Significance and Use

4.1 This practice for the design and installation of groundwater monitoring wells will promote *(1)* efficient and effective site hydrogeological characterization; *(2)* durable and reliable well construction; and *(3)* acquisition of representative groundwater quality samples, groundwater levels, and hydraulic conductivity testing data from monitoring wells. The practices established herein are affected by governmental regulations and by site-specific geological, hydrogeological, climatological, topographical, and subsurface geochemical conditions. To meet these geoenvironmental challenges, this practice promotes the development of a conceptual hydrogeologic model prior to monitoring well design and installation.

4.2 A properly designed and installed groundwater monitoring well provides essential information on one or more of the following subjects:

4.2.1 Formation geologic and hydraulic properties;

4.2.2 Potentiometric surface of a particular hydrologic unit(s);

4.2.3 Water quality with respect to various indicator parameters; and

4.2.4 Water chemistry with respect to a contaminant release.

5. Site Characterization

5.1 *General*—A thorough knowledge of site-specific geologic, hydrologic and geochemical conditions is necessary to properly apply the monitoring well design and installation procedures contained within this practice. Development of a conceptual site model, that identifies potential flow paths and the target monitoring zone(s), and generates a 3-D picture of contaminant distribution and contaminant movement pathways, is recommended prior to monitoring well design and installation. Development of the conceptual site model is accomplished in two phases -- an initial reconnaissance, after which a preliminary conceptual model is created, and a field investigation, after which a revised conceptual model is formulated. When the hydrogeology of a project area is relatively uncomplicated and well documented in the literature, the initial reconnaissance may provide sufficient information to identify flow paths and the target monitoring zone(s). However, where limited or no background data are available or where the geology is complex, a field investigation will be required to develop the necessary conceptual site model.

5.2 *Initial Reconnaissance of Project Area*—The goal of the initial reconnaissance of the project area is to identify and locate those zones or preferential flow pathways with the greatest potential to transmit fluids from the project area. Identifying these flow pathways is the first step in selecting the target groundwater monitoring zone(s).

5.2.1 *Literature Search*—Every effort should be made to collect and review all applicable field and laboratory data from previous investigations of the project area. Information such as, but not limited to, topographic maps, aerial imagery (see Guide

D5518); site ownership and utilization records, geologic and hydrogeologic maps and reports, mineral resource surveys, water well logs, information from local well drillers, agricultural soil reports, geotechnical engineering reports, and other engineering maps and reports related to the project area should be reviewed to locate relevant site information.

5.2.2 *Field Reconnaissance*—Early in the investigation, the soil and rocks in open cut areas (e.g., roadcuts, streamcuts) in the vicinity of the project should be studied, and various soil and rock profiles noted. Special consideration should be given to soil color and textural changes, landslides, seeps, and springs within or near the project area.

5.2.3 *Preliminary Conceptual Model*—The distribution of the predominant soil and rock units likely to be found during subsurface exploration may be hypothesized at this time in a preliminary conceptual site model using information obtained in the literature search and field reconnaissance. In areas where the geology is relatively uniform, well documented in the literature, and substantiated by the field reconnaissance, further refinement of the conceptual model may not be necessary unless anomalies are discovered in the well drilling stage.

5.3 *Field Investigation*—The goal of the field investigation is to refine the preliminary conceptual site model so that the target monitoring zone(s) is (are) identified prior to monitoring well installation.

5.3.1 *Exploratory Borings and Direct-Push Methods*—Characterization of the flow paths conceptualized in the initial reconnaissance involves defining the porosity (type and amount), hydraulic conductivity, stratigraphy, lithology, gradation and structure of each hydrologic unit encountered beneath the site. These characteristics are defined by conducting an exploratory program which may include drilled soil borings (see Guide D6286 for selection of drilling methods) and direct-push methods (e.g., cone penetrometers [see Test Method D3441 or Guide D6067] or direct-push machines using soil sampling, groundwater sampling and/or electrical conductivity measurement tools [see Guides D6282 and D6001]). Exploratory soil borings and direct-push holes should be deep enough to develop the required engineering and hydrogeologic data for determining the preferential flow pathway(s), target monitoring zone(s), or both.

5.3.1.1 *Sampling*—Soil and rock properties should not be predicted wholly on field description or classification, but should be confirmed by laboratory and/or field tests made on samples or in boreholes or wells. Representative soil or rock samples of each material that is significant to the design of the monitoring well system should be obtained and evaluated by a geologist, hydrogeologist, soil scientist or engineer trained and experienced in soil and rock analysis. Soil sample collection should be conducted according to Practice D1452, Test Method D1586, Practice D3550, Practice D6519 or Practice D1587, whichever is appropriate given the anticipated characteristics of the soil samples (see Guide D6169 for selection of soil sampling methods). Rock samples should be collected according to Practice D2113. Soil samples obtained for evaluation of hydraulic properties should be containerized and identified for shipment to a laboratory. Special measures to preserve either the continuity of the sample or the natural moisture are not usually required. However, soil and rock samples obtained for evaluation of chemical properties often require special field preparation and preservation to prevent significant alteration of the chemical constituents during transportation to a laboratory (see Practice D6640). Rock samples for evaluation of hydraulic properties are usually obtained using a split-inner-tube core barrel. Evaluation and logging of the core samples is usually done in the field before the core is removed from the core barrel.

5.3.1.2 *Boring Logs*—Care should be taken to prepare and retain a complete boring log and sampling record for each exploratory soil boring or direct-push hole (see Guide D5434).

NOTE 1—Site investigations conducted for the purpose of generating data for the installation of groundwater monitoring wells can vary greatly due to the availability of reliable site data or the lack thereof. The general procedure would be as follows: *(1)* gather factual data regarding the surficial and subsurface conditions, *(2)* analyze the data, *(3)* develop a conceptual model of the site conditions, *(4)* locate the monitoring wells based on the first three steps. Monitoring wells should only be installed with sufficient understanding of the geologic, and hydrologic and geochemical conditions present at the site. Monitoring wells often serve as part of an overall site investigation for a specific purpose, such as determining the extent of contamination present, or for predicting the effectiveness of aquifer remediation. In these cases, extensive additional geotechnical and hydrogeologic information may be required that would go beyond the Section 5 Site Characterization description.

Boring logs should include the location, geotechnical data (that is, penetration rates or blow counts), and sample description information for each material identified in the borehole either by symbol or word description, or both. Description and identification of soils should be in accordance with Practice D2488; classification of soils should be in accordance with either Practice D2487 or Practice D3282. Identification of rock material should be based on Nomenclature C294 or by an appropriate geologic classification system. Observations of seepage, free water, and water levels should also be noted. The boring logs should be accompanied by a report that includes a description of the area investigated; a map illustrating the vertical and horizontal location (with reference to either North American Vertical Datum of 1988 [NAVD 88] or to a standardized survey grid) of each exploratory soil boring or test pit, or both; and color photographs of rock cores, soil samples, and exposed strata labeled with a date and identification.

5.3.2 *Geophysical Exploration*—Geophysical surveys may be used to supplement soil boring and outcrop observation data and to aid in interpretation between soil borings. Appropriate surface and borehole geophysical methods for meeting site-specific project objectives can be selected by consulting Guides D6429 and D5753 respectively. Surface geophysical methods such as seismic (Guide D5777), electrical-resistivity (Guide D6431), ground-penetrating radar (Guide D6432), gravity (Guide D6430) and electromagnetic conductance surveys (Guide D6639) can be particularly valuable when distinct differences in the properties of contiguous subsurface materials are indicated. Borehole methods such as resistivity, gamma, gamma-gamma, neutron, and caliper logs (see Guide D6167) can be useful to confirm specific subsurface geologic conditions. Gamma logs (Guide D6274) are particularly useful in existing cased wells.

5.3.3 *Groundwater Flow Direction*—Groundwater flow direction is generally determined by measuring the vertical and horizontal hydraulic gradient within each conceptualized flow pathway. However, because water will flow along the pathways of least resistance (within the highest hydraulic conductivity formation materials at the site), actual flow direction may be oblique to the hydraulic gradient (within buried stream channels or glacial valleys, for example). Flow direction is determined by first installing piezometers in the exploratory soil borings that penetrate the zone(s) of interest at the site. The depth and location of the piezometers will depend upon anticipated hydraulic connections between conceptualized flow pathways and their respective lateral direction of flow. Following careful evaluation, it may be possible to utilize existing private or public wells to obtain water-level data. The construction integrity of such wells should be verified to ensure that the water levels obtained from the wells are representative only of the zone(s) of interest. Following water-level data acquisition, a potentiometric surface map should be prepared. Flow pathways are ordinarily determined to be at right angles, or nearly so, to the equipotential lines, though consideration of complex geology can result in more complex interpretations of flow.

5.4 *Completing the Conceptual Model*—A series of geologic and hydrogeologic cross sections should be developed to refine the conceptual model. This is accomplished by first plotting logs of soil and rock observed in the exploratory soil borings or test pits, and interpreting between these logs using the geologic and engineering interrelationships between other soil and rock data observed in the initial reconnaissance or with geophysical techniques. Extrapolation of data into adjacent areas should be done only where geologically uniform subsurface conditions are known to exist. The next step is to integrate the geologic profile data with the potentiometric data for both vertical and horizontal hydraulic gradients. Plan view and cross-sectional flow nets should be constructed. Following the analysis of these data, conclusions can be made as to which flow pathway(s) is (are) the appropriate target monitoring zone(s).

NOTE 2—UUse of groundwater monitoring wells is difficult and may not be a reliable technology in fine-grained, low hydraulic conductivity formation materials with primary porosity because of *(1)* the disproportionate influence that microstratigraphy has on groundwater flow in fine-grained strata; *(2)* the proportionally higher vertical flow component in low hydraulic conductivity strata; and *(3)* the presence of indigenous metallic and inorganic constituents in the matrix that make water-quality data evaluation difficult.

6. Monitoring Well Construction Materials

6.1 *General*—The materials that are used in the construction of a monitoring well that come in contact with water samples should not alter the chemical quality of the sample for the constituents being examined. The riser, well screen, and annular seal installation equipment should be cleaned immediately prior to well installation (see either Practice D5088 or D5608) or certified clean from the manufacturer and delivered to the site in a protective wrapping. Samples of the riser and screen material, cleaning water, filter pack, annular seal, bentonite, and mixed grout should be retained to serve as quality control until the completion of at least one round of groundwater quality sampling and analysis has been completed.

6.2 *Water*—Water used in the drilling process, to prepare grout mixtures and to decontaminate the well screen, riser, and annular sealant injection equipment, should be obtained from a source of known chemistry that does not contain constituents that could compromise the integrity of the well installation.

6.3 *Primary Filter Pack*:

6.3.1 *General*—The purposes of the primary filter pack are to act as a filter that retains formation material while allowing groundwater to enter the well, and to stabilize the formation to keep it from collapsing on the well. The design of the primary filter pack is based on the grain-size distribution of the formation material (as determined by sieve analysis—see Test Method D422) to be retained. The grain size distribution of the primary filter pack must be fine enough to retain the formation, but coarse enough to allow for unrestricted movement of groundwater into and through the monitoring well. The design of the well screen (see 6.4.3) must be done in concert with the design of the filter pack. After development, a monitoring well with a correctly designed and installed filter pack and screen combination should produce samples free of artifactual turbidity.

6.3.2 *Materials*—The primary filter pack should consist of an inert granular material (generally ranging from gravel to very fine sand, depending on formation grain size distribution) of selected grain size and gradation that is installed in the annulus between the well screen and the borehole wall. Washed and screened silica sands and gravels, with less than 5 % non-siliceous materials, should be specified.

6.3.3 *Design*—The design theory of filter pack gradation is based on mechanical retention of formation materials.

6.3.3.1 1 For formation materials that are relatively coarse-grained (i.e., fine, medium and coarse sands and gravels), the grain size distribution of the primary filter pack is determined by calculating the d-30 (30 % finer) size, the d-60 (60 % finer) size, and the d-10 (10 % finer) size of the filter pack. The first point on the filter pack grain-size distribution curve is the d-30 size. The primary filter pack is usually selected to have a d-30 grain size that is about 4 to 6 times greater than the d-30 grain size of the formation material being retained (see Fig. 1). A multiplication factor of 4 is used if the formation material is relatively fine-grained and well sorted or uniform (small range in grain sizes); a multiplication factor of 6 is used if the formation is relatively coarse grained and poorly sorted or non-uniform (large range in grain sizes). Thus, 70 % of the filter pack will have a grain size that is 4 to 6 times larger than the d-30 size of the formation materials. This ensures that the filter pack is coarser (with a higher hydraulic conductivity) than the formation material, and allows for unrestricted groundwater flow from the formation into the monitoring well.

The next 2 points on the filter pack grain-size distribution curve are the d-60 and d-10 grain sizes. These are chosen so that the ratio between the two grain sizes (the uniformity coefficient) is less than 2.5. This ensures that the filter pack has a small range in grain sizes and is uniform (see technical Note 5). The d-60 and d-10 grain sizes of the filter pack are

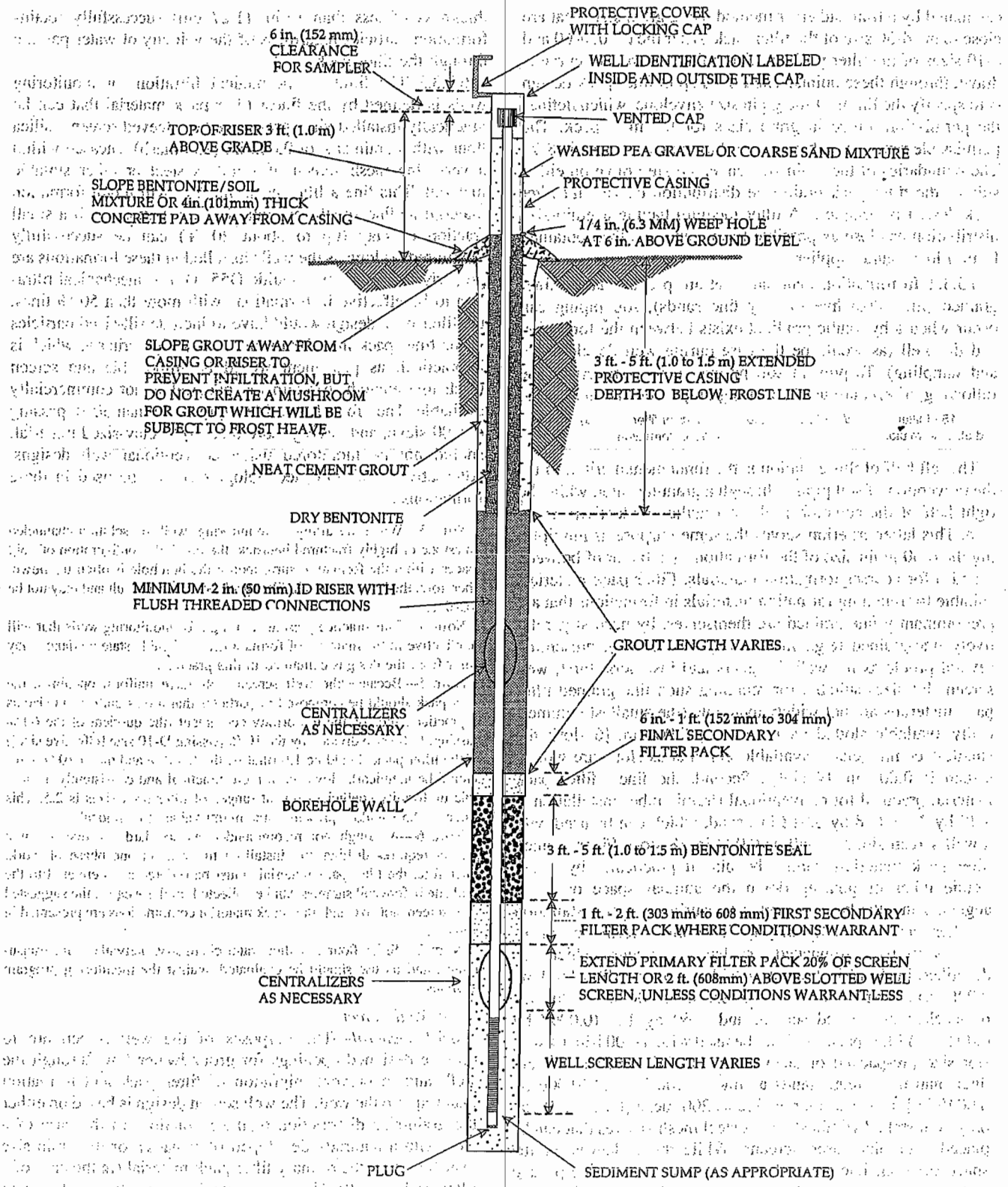


FIG. 1 Monitoring Well Design—Single-Cased Well

calculated by a trial and error method using grain sizes that are close to the d-30 size of the filter pack. After the d-30, d-60 and d-10 sizes of the filter pack are determined, a smooth curve is drawn through these points. The final step in filter pack design is to specify the limits of the grain size envelope, which defines the permissible range in grain sizes for the filter pack. The permissible range on either side of the grain size curve is 8 %. The boundaries of the grain size envelope are drawn on either side of the filter pack grain-size distribution curve, and filter pack design is complete. A filter medium having a grain-size distribution as close as possible to this curve is then obtained from a local sand supplier.

6.3.3.2 In formation materials that are predominantly fine-grained (finer than fine to very fine sands), soil piping can occur when a hydraulic gradient exists between the formation and the well (as would be the case during well development and sampling). To prevent soil piping in these materials, the following criteria are used for designing granular filter packs:

$$\frac{\text{d-15 of filter}}{\text{d-85 of formation}} \leq 4 \text{ to } 5 \quad \text{and} \quad \frac{\text{d-15 of filter}}{\text{d-15 of formation}} \geq 4 \text{ to } 5$$

The left half of this equation is the fundamental criterion for the prevention of soil piping through a granular filter, while the right half of the equation is the hydraulic conductivity criterion. This latter criterion serves the same purpose as multiplying the d-30 grain size of the formation by a factor of between 4 and 6 for coarser formation materials. Filter pack materials suitable for retaining formation materials in formations that are predominantly fine-grained are themselves, by necessity, relatively fine-grained (e.g., fine to very fine sands), presenting several problems for well designers and installers. First, well screen slot sizes suitable for retaining such fine-grained filter pack materials are not widely available (the smallest commercially available slotted well casing is 0.006 in. [6 slot]; the smallest commercially available continuous-slot wire-wound screen is 0.004 in. [4 slot]). Second, the finest filter pack material practical for conventional (tremie tube) installation is a 40 by 70 (0.008 by 0.018 in.) sand, which can be used with a well screen slot as small as 0.008-in. (8 slot). Finer grained filter pack materials cannot be placed practically by either tremie tubes or pouring down the annular space or down augers. Thus, the best method for ensuring proper installation of filter packs in predominantly fine-grained formation materials is to use pre-packed or sleeved screens, which are described in detail in Practice D6725. A 50 by 100 (0.011 by 0.006 in.) filter-pack sand can be used with a 0.006-in. slot size pre-packed or sleeved screen, and a 60 by 120 (0.0097 by 0.0045 in.) filter-pack sand can be used with a 0.004-in. (4 slot) slot size pre-packed or sleeved screen. Filter packs that are finer than these (e.g., sands as fine as 100 by 120 [0.006 by 0.0045 in.], or silica flour as fine as 200 mesh [0.003 in.]) can only be installed within stainless steel mesh sleeves that can be placed over pipe-based screens. While these sleeves, or the space between internal and external screens in a pre-packed well screen may be as thin as ½-in. (1.27 cm), the basis for mechanical retention dictates that a filter-pack thickness of only two or three grain diameters is needed to contain and control formation materials. Laboratory tests have demonstrated that a properly sized filter pack material with a thickness of less than ½-in. (1.27 cm) successfully retains formation particles regardless of the velocity of water passing through the filter pack.[4]

6.3.3.3 The limit of mechanical filtration for monitoring wells is defined by the finest filter pack material that can be practically installed via a pre-packed or sleeved screen—silica flour with a grain size of 0.003 in. (200 mesh), encased within a very fine mesh screen of stainless steel or other suitable material. This fine a filter pack material will retain formation material as fine as silt, but not clay. Formations with a small fraction of clay (up to about 20 %) can be successfully monitored, as long as the wells installed in these formations are properly developed (see Guide D5521). For mechanical filtration to be effective in formations with more than 50 % fines, the filter pack design would have to include silt-sized particles in the filter pack in order to meet the design criteria, which is impractical, as placement would be impossible and screen mesh fine enough to retain the material is not commercially available. Therefore, formations with more than 50 % passing a #200 sieve, and having more than 20 % clay-sized material, should not be monitored using conventional well designs. Alternative monitoring technologies should be used in these formations..

NOTE 3—When installing a monitoring well in solution-channeled limestone or highly fractured bedrock, the borehole configuration of void spaces within the formation surrounding the borehole is often unknown. Therefore, the installation of a filter pack becomes difficult and may not be possible.

NOTE 4—This practice presents a design for monitoring wells that will be effective in the majority of formations. Applicable state guidance may differ from the designs contained in this practice.

NOTE 5—Because the well screen slots have uniform openings, the filter pack should be composed of particles that are as uniform in size as is practical. Ideally, the uniformity coefficient (the quotient of the 60 % passing, D-60 size divided by the 10 % passing D-10 size [effective size]) of the filter pack should be 1.0 (that is, the D-60 % and the D-10 % sizes should be identical). However, a more practical and consistently achievable uniformity coefficient for all ranges of filter pack sizes is 2.5. This value of 2.5 should represent a maximum value, not an ideal.

NOTE 6—Although not recommended as standard practice, often a project requires drilling and installing the well in one phase of work. Therefore, the filter pack materials must be ordered and delivered to the drill site before soil samples can be collected. In these cases, the suggested well screen slot size and filter pack material combinations are presented in Table 1.

NOTE 7—Silica flour can alter water chemistry, particularly for transuranics, and its use should be evaluated against the monitoring program analytes

6.4 *Well Screen:*

6.4.1 *General*—The purposes of the well screen are to provide designed openings for groundwater flow through the well, and to prevent migration of filter pack and formation material into the well. The well screen design is based on either the grain-size distribution of the formation (in the case of a well with a naturally developed filter pack), or the grain-size distribution of the primary filter pack material (in the case of a filter-packed well). The screen openings must be small enough

[4] (1) Driscoll, F.G., 1986, Groundwater and Wells, Johnson Division, St. Paul, MN, pg.443

TABLE 1 Recommended (Achievable) Filter Pack Characteristics for Common Screen Slot Sizes

Size of Screen Opening, in. (mm)	Slot No.	Sand Pack Mesh Size Name(s)	1 % Passing Size (D-1), (mm)	Effective Size, (D-10), (mm)	30 % Passing Size (D-30), (mm)	Range of Uniformity Coefficient	Roundness (Powers Scale)
0.005 (0.125)	5[A]	100	(0.09 to 0.12)	(0.14 to 0.17)	(0.17 to 0.21)	1.3 to 2.0	2 to 5
0.010 (0.25)	10	20 to 40	(0.25 to 0.35)	(0.4 to 0.5)	(0.5 to 0.6)	1.1 to 1.6	3 to 5
0.020 (0.50)	20	10 to 20	(0.7 to 0.9)	(1.0 to 1.2)	(1.2 to 1.5)	1.1 to 1.6	3 to 6
0.030 (0.75)	30	10 to 20	(0.7 to 0.9)	(1.0 to 1.2)	(1.2 to 1.5)	1.1 to 1.6	3 to 6
0.040 (1.0)	40	8 to 12	(1.2 to 1.4)	(1.6 to 1.8)	(1.7 to 2.0)	1.1 to 1.6	4 to 6
0.060 (1.5)	60	6 to 9	(1.5 to 1.8)	(2.3 to 2.8)	(2.5 to 3.0)	1.1 to 1.7	4 to 6
0.080 (2.0)	80	4 to 8	(2.0 to 2.4)	(2.4 to 3.0)	(2.6 to 3.1)	1.1 to 1.7	4 to 6

[A] A 5-slot (0.152-mm) opening is not currently available in slotted PVC but is available in Vee wire PVC and Stainless; 6-slot opening may be substituted in these cases.

to retain most if not all of the formation or filter-pack materials, yet large enough to maintain groundwater flow velocities, from the well screen/filter pack interface back to the natural formation materials, of less than 0.10 ft/s (0.03 m/s). If well screen entrance velocities exceed 0.10 ft/s (0.03 m/s), turbulent flow conditions can occur, resulting in mobilization of sediment from the formation and reductions in well efficiency.

6.4.2 *Materials*—The well screen should be new, machine-slotted casing or continuous wrapped wire-wound screen composed of materials compatible with the monitoring environment, as determined by the site characterization program. The screen should be plugged at the bottom (unless a sediment sump is used), and the plug should generally be of the same material as the well screen. This assembly must have the capability to withstand well installation and development stresses without becoming dislodged or damaged. The length of the well screen open area should reflect the thickness of the target monitoring zone. Immediately prior to installation, the well screen should be cleaned (see either Practice D5088 or Practice D5608) with water from a source of known chemistry, if it is not certified clean by the manufacturer, and delivered, and maintained in a clean environment at the site.

NOTE 8—Well screens are most commonly composed of PVC or stainless steel. Stainless steel may be specified based on knowledge of the occurrence of microbially influenced corrosion in formations (specifically reducing or acid-producing conditions).

6.4.3 *Diameter*—The minimum nominal internal diameter of the well screen should be chosen based on factors specific to the particular application (such as the outside diameter of the purging and sampling device(s) to be used in the well). Well screens as small as 1/2-in. (1.27 cm) nominal diameter are available for use in monitoring well applications.

6.4.4 *Design*—The design of the well screen should be determined based on the grain size analysis (per Test Method D422) of the interval to be monitored and the gradation of the primary filter pack material. In granular, non-cohesive formation materials that will fall in easily around the screen, filter packs can be developed from the native formation materials—filter pack materials foreign to the formation are not necessary. In these cases of naturally developed filter packs, the slot size of the well screen is determined using the grain size of the materials in the surrounding formation. The well screen slot size selected for this type of well completion should retain at least 70 % of formation materials—the finest 30 % of formation materials will be brought into the well during development, and the objectives of filter packing (to increase hydraulic conductivity immediately surrounding the well screen, and to promote easy flow of groundwater into and through the screen) will be met. In wells in which a filter pack material of a selected grain size distribution is introduced from the surface, the screen slot size selected should retain at least 90 %, and preferably 99 %, of the primary filter pack materials. The method for determining the primary filter pack design is described in 6.3.3.

6.4.5 *Prepacked or Sleeved Well Screens*—An alternative to designing and installing filter pack and well screens separately is to use a pre-packed or sleeved screen assembly. A pre-packed well screen consists of an internal well screen, an external screen or filter medium support structure, and the filter medium contained between the screens, which together comprise an integrated structure. The internal and external screens are constructed of materials compatible with the monitored environment, and are usually of a common slot size specified by the well designer to retain the filter pack material. The filter pack is normally an inert (e.g., siliceous) granular material that has a grain-size distribution chosen to retain formation materials. A sleeved screen consists of a slotted pipe base over which a sleeve of stainless steel mesh filled with selected filter media is installed. Pre-packed or sleeved screens may be used for any formation conditions, but they are most often used where heaving, running or blowing sands make accurate placement of conventional well screens and filter packs difficult, or where predominantly fine-grained formation materials are encountered. In the latter case, using pre-packed or sleeved screens is the only practical means of ensuring that filter pack materials of the selected grain-size distribution (generally fine to very fine sands) are installed to completely surround the screen.

NOTE 9—The practice of using a single well screen/filter pack combination (e.g., 0.010 in. (0.254 mm)) well screen slot size with a 20/40 sand) for all wells, regardless of formation grain-size distribution, will result in siltation of the well and significant turbidity in samples when applied to formations finer than the recommended design. It will also result in the loss of filter pack, possible collapse of the screen, and invasion of overlying well construction materials (e.g., secondary filter pack, annular seal materials, grout) when applied to formations coarser than the recommended design. For these reasons, the universal application of a single well screen/filter pack combination to all formations is not recommended, and should be avoided.

6.5 *Riser*:

6.5.1 *Materials*—The riser should be new pipe composed of materials that will not alter the quality of water samples for the constituents of concern and that will stand up to long-term exposure to the monitoring environment, including potential contaminants. The riser should have adequate wall thickness

and coupling strength to withstand the stresses imposed on it during well installation and development. Each section of riser should be cleaned (see either Practice D5088 or Practice D5608) using water from a source of known chemistry immediately prior to installation.

NOTE 10—Risers are generally constructed of PVC, galvanized steel or stainless steel.

6.5.2 *Diameter*—The minimum nominal internal diameter of the riser should be chosen based on the particular application. Risers as small as ½-in. (1.25-cm) in diameter are available for applications in monitoring wells.

6.5.3 *Joints (Couplings)*—Threaded joints are recommended. Glued or solvent-welded joints of any type are not recommended because glues and solvents may alter the chemistry of water samples. Because square profile flush joint threads (Specification F480) are designed to be accompanied by O-ring seals at the joints, they do not require PTFE taping. However, tapered threaded joints should be PTFE taped to prevent leakage of water into the riser.

6.6 *Casing*—Where conditions warrant, the use of permanent casing installed to prevent communication between water-bearing zones is encouraged. The following subsections address both temporary and permanent casings.

6.6.1 *Materials*—The material type and minimum wall thickness of the casing should be adequate to withstand the forces of installation. All casing that is to remain as a permanent part of the installation (that is, in multi-cased wells) should be new and cleaned to be free of interior and exterior protective coatings.

NOTE 11—The exterior casing (temporary or permanent multi-cased) is generally composed of steel, although other appropriate materials may be used.

6.6.2 *Diameter*—Several different casing sizes may be required depending on the geologic formations penetrated. The diameter of the borehole and the well casing for conventionally filter packed wells should be selected so that a minimum annular space of 2 in. (5 cm) is maintained between the inside diameter of the casing and outside diameter of the riser to provide working space for a tremie pipe. For naturally developed wells and pre-packed or sleeved screen completions, this annular space requirement need not be met. In addition, the diameter of the casings in multi-cased wells should be selected so that a minimum annular space of 2 in. (5 cm) is maintained between the casing and the borehole (that is, a 2-in. (5 cm) diameter screen will require first setting a 6-in. (15.2 cm) diameter casing in a 10-in. (25.4 cm) diameter boring).

NOTE 12—Under difficult drilling conditions (collapsing soils, rock, or cobbles), it may be necessary to advance temporary casing. Under these conditions, a smaller annular space may be maintained.

6.6.3 *Joints (Couplings)*—The ends of each casing section should be either flush-threaded or beveled for welding.

6.7 *Sediment Sump*—A sediment sump, a length of blank pipe, generally of the same diameter and made of the same material as the riser and well screen – may be affixed to the bottom of the screen, and capped with a bottom plug, to collect fine-grained material brought into the well by the process of well development. A drainage hole may be drilled in the bottom of the sump to prevent the sump from retaining water in the event that the water level outside the well falls below the bottom of the well screen. Because the sediment that collects in the sump may harbor geochemistry-altering microflora and reactive metal oxides, this sediment must be removed periodically to minimize the potential for sample chemical alteration.

6.8 *Protective Casing*:

6.8.1 *Materials*—Protective casings may be made of aluminum, mild steel, galvanized steel, stainless steel, cast iron, or structural plastic pipe. The protective casing should have a lid capable of being locked shut by a locking device or mechanism.

6.8.2 *Diameter*—The inside dimensions of the protective casing should be a minimum of 2 in. (5 cm) and preferably 4 in. (10 cm) larger than the nominal diameter of the riser to facilitate the installation and operation of sampling equipment.

6.9 *Annular Sealants*—The materials used to seal the annulus may be prepared as a slurry or used un-mixed in a dry pellet, granular, or chip form. Sealants should be selected to be compatible with ambient geologic, hydrogeologic, geochemical and climatic conditions and any man-induced conditions (e.g., subsurface contamination) anticipated during the life of the well.

6.9.1 *Bentonite*—Bentonite should be powdered, granular, pelletized, or chipped sodium montmorillonite from a commercial source, free of impurities that may adversely impact the water quality in the well. Pellets consist of roughly spherical units of moistened, compressed bentonite powder. Chips are large, irregularly shaped, and coarse granular units of bentonite free of additives. The diameter of pellets or chips selected for monitoring well construction should be less than one fifth the width of the annular space into which they are placed to reduce the potential for bridging. Granules consist of coarse to fine particles of unaltered bentonite, typically smaller than 0.2 in. (5.0 mm). It is recommended that the water chemistry of the formation in which the bentonite is intended for installation be evaluated to ensure that it is suitable to hydrate the bentonite. Some water-quality conditions (e.g., high chloride content, high concentrations of certain organic solvents or petroleum hydrocarbons) may inhibit the hydration of bentonite and result in an ineffective seal.

6.9.2 *Cement*—Each type of cement has slightly different characteristics that may be appropriate under various physical and chemical conditions. Cement should be one of the five Portland cement types that are specified in Specification C150. The use of quick-setting cements containing additives is not recommended for use in monitoring well installation. Additives may leach from the cement and influence the chemistry of water samples collected from the monitoring well.

6.9.3 *Grout*—The grout backfill that is placed above the bentonite annular seal and secondary filters (see Fig. 1) is ordinarily a thick liquid slurry consisting of either a bentonite (powder or granules, or both) base and water, or a Portland cement base and water. Often, bentonite-based grouts are used when it is desired that the grout remain workable for extended periods of time during well construction or flexible (that is, to accommodate freeze-thaw cycles) during the life of the well. Cement-based grouts are often used when filling cracks in the

surrounding geologic material, adherence to rock units, or a rigid setting is desired.

6.9.3.1 *Mixing*—The mixing (and placing) of a grout backfill should be performed with precisely recorded weights and volumes of materials, and according to procedures stipulated by the manufacturer that often include the order of component mixing. The grout should be thoroughly mixed with a paddle-type mechanical mixer or by recirculating the mix through a pump until all lumps are disintegrated. Lumpy grout should not be used in the construction of a monitoring well to prevent bridging within the tremie pipe.

NOTE 13—Lumps do not include lost circulation materials that may be added to the grout if excessive grout losses occur.

6.9.3.2 *Typical Bentonite-Based Grout*—When a bentonite-based grout is used, bentonite, usually unaltered, should be placed in the water through a venturi device. A typical unbeneficiated bentonite-based grout consists of about 1 to 1.25 lb (0.57 kg) of unaltered bentonite to each 1 gal (3.8 L) of water. 100 % bentonite grouts should not be used for monitoring well annular sealants in the vadose zone of arid regions because of the possibility that they may desiccate. This could result in migration of water into the screened portion of the well from zones above the target monitoring zone.

NOTE 14—High solids bentonite grouts (minimum 20 % by weight with water) and other bentonite-based grouts may contain granular bentonite to increase the solids content and other components added under manufacturer's directions to either stiffen or retard stiffening of the mix. All additives to grouts should be evaluated for their effects on subsequent water samples.

6.9.3.3 *Typical Cement-Based Grout*—A typical cement-based grout consists of about 6 gal. (23 L) of water per 94-lb (43-kg) bag of Type I Portland cement. Though not recommended because of the chemical incompatability of bentonite with cement (2, 3), from 3 to 8 % (by dry weight) of unaltered bentonite powder is often added after the initial mixing of cement and water to retard shrinkage and provide plasticity..

6.10 *Secondary Filter Packs*:

6.10.1 *Materials*—A secondary filter pack is a layer of material placed in the annulus between the primary filter pack and the bentonite seal, and/or between the bentonite seal and the grout backfill (see Fig. 1 and Fig. 2).

6.10.2 *Gradation*—The secondary filter pack should be uniformly graded fine sand with 100 % by weight passing the #30 U.S. Standard sieve, and less than 2 % by weight passing the #200 U.S. Standard sieve.

6.11 *Annular Seal and Filter Pack Installation Equipment*—The equipment used to install the annular seals and filter pack materials should be cleaned (if appropriate for the selected material) using water from a source of known quality prior to use. This procedure is performed to prevent the introduction of materials that may ultimately alter water quality samples.

7. Drilling Methods

7.1 The type of equipment required to create a stable, open, vertical borehole for installation of a monitoring well depends upon the site geology, hydrology, and the intended use of the data. Engineering and geological judgment and some knowledge of subsurface geological conditions at the site is required for the selection of the appropriate drilling method(s) utilized for drilling the exploratory soil borings and monitoring wells (see Guide D6286). Appropriate drilling methods for investigating and installing monitoring wells at a site may include any one or a combination of several of the following methods: hollow-stem auger (Guide D5784); direct (mud) rotary (Guide D5783); direct air-rotary (Guide D5782); direct rotary wireline casing advancement (Guide D5876); dual-wall reverse-circulation rotary (Guide D5781); cable-tool (Guide D5875); or various casing advancement methods (Guide D5872). Whenever feasible, it is advisable to utilize drilling procedures that do not require the introduction of water or drilling fluids into the borehole, and that optimize cuttings control at ground surface. Where the use of water or drilling fluid is unavoidable, the selected fluid should have as little impact as possible on the water samples for the constituents of interest. The chemistry of the fluid to be used should be evaluated to determine the potential for water quality sample alteration. In addition, care should be taken to remove as much drilling fluid as possible from the well and the surrounding formation during the well development process. It is recommended that if an air compressor is used, it should be equipped with an oil air filter or oil trap to minimize the potential for chemical alteration of groundwater samples collected after the well is installed. 8. Monitoring Well Installation

8. Monitoring Well Installation

8.1 *Stable Borehole*—A stable borehole must be constructed prior to attempting the installation of monitoring well screen and riser. Steps must be taken to stabilize the borehole before attempting installation if the borehole tends to cave or blow in, or both. Boreholes that are not straight or are partially obstructed should be corrected prior to attempting the installation procedures described herein.

8.2 *Assembly of Well Screen and Riser*:

8.2.1 *Handling*—The well screen, sediment sump, bottom plug and riser should be either certified clean from the manufacturer or steam-cleaned or high-pressure hot-water washed (whichever is appropriate for the selected material) using water from a source of known chemistry immediately prior to assembly. Personnel should take precautions to assure that grease, oil, or other contaminants that may ultimately alter the water sample do not contact any portion of the well screen and riser assembly. As one precaution, for example, personnel should wear a clean pair of cotton, nitrile or powder-free PVC (or equivalent) gloves while handling the assembly..

8.2.2 *Riser Joints (Couplings)*—Flush joint risers with square profile (Specification F480) threads do not require PTFE taping to achieve a water tight seal; these joints should not be taped. O-rings made of a material of known chemistry, selected on the basis of compatibility with contaminants of concern and prevailing environmental conditions, should be used to assure a tight seal of flush-joint couplings. Couplings are often tightened by hand; however, if necessary, steam-cleaned or high-pressure water-cleaned wrenches may be utilized. Precautions should be taken to prevent damage to the threaded joints during installation, as such damage may promote leakage past the threads.

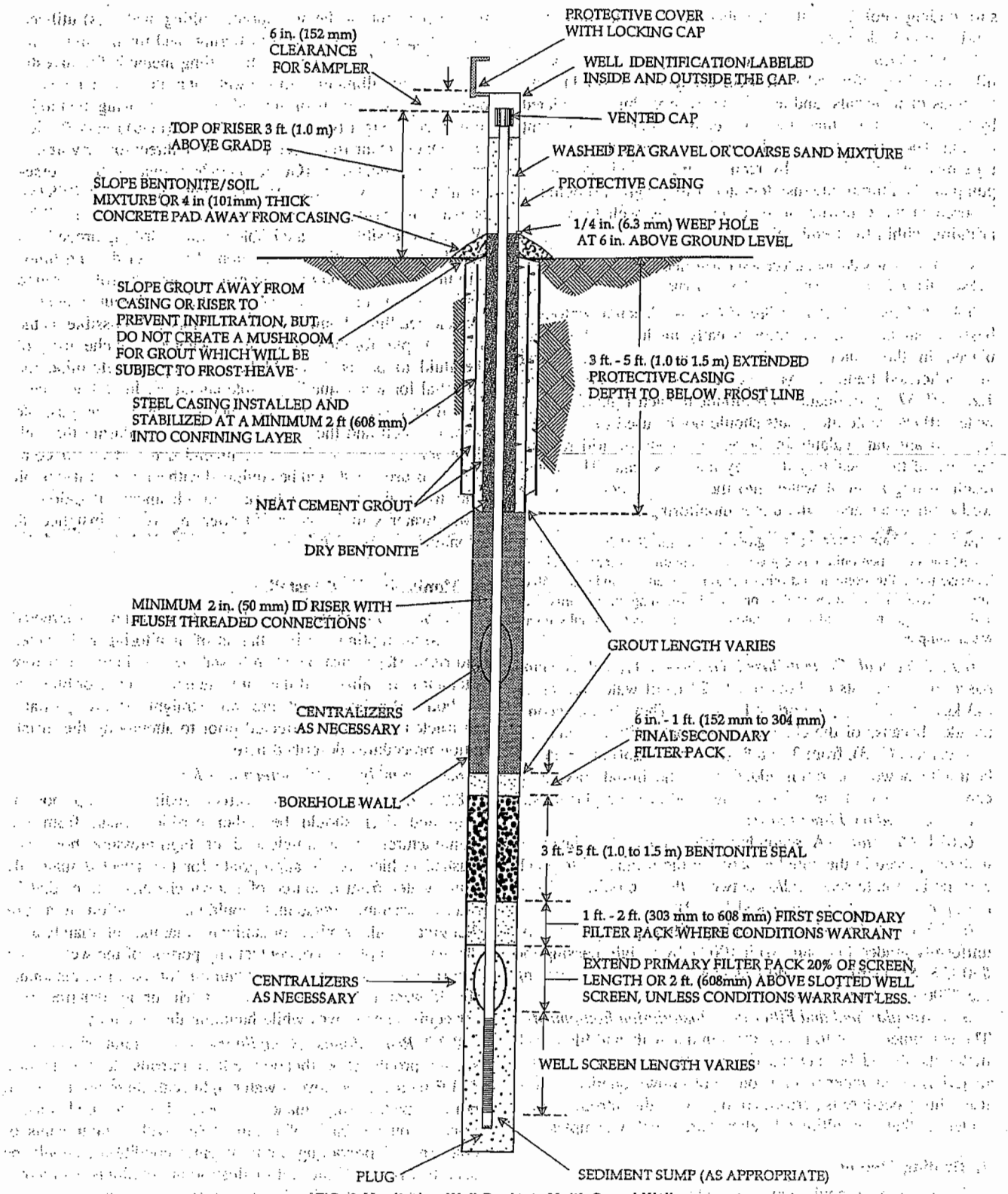


FIG. 2 Monitoring Well Design—Multi-Cased Well

8.3 *Setting the Well Screen and Riser Assembly*—When the well screen and riser assembly is lowered to the predetermined level in the borehole and held in position, the assembly may require ballast to counteract the tendency to float in the borehole. Ballasting may be accomplished by filling the riser with water from a source of known and acceptable chemistry or, preferably, using water that was previously removed from the borehole. Alternatively, the riser may be slowly pushed into the fluid in the borehole with the aid of hydraulic rams on the drill rig and held in place as additional sections of riser are added to the column. Care must be taken to secure the riser assembly so that personnel safety is assured during the installation. The assembly must be installed straight and plumb, with centralizers installed at appropriate locations (typically every 20 to 30 ft (6 to 9 m)). Difficulty in maintaining a straight installation may be encountered where the weight of the well screen and riser assembly is significantly less than the buoyant force of the fluid in the borehole. The riser should extend above grade and be capped temporarily to deter entrance of foreign materials during final completion.

8.4 *Installation of the Primary Filter Pack:*

8.4.1 *Volume of Filter Pack*—The volume of filter pack required to fill the annular space between the well screen and borehole should be calculated, measured, and recorded on the well completion diagram during installation. To be effective, the filter pack should extend above the screen for a distance of about 20 % of the length of the well screen but not less than 2 ft. (0.6 m) (see Figs. 1 and 2). Where there is hydraulic connection between the zone to be monitored and the overlying strata, this upward extension should be gauged to prevent seepage from overlying hydrologic units into the filter pack. Seepage from other units may alter hydraulic head measurements or the chemistry of water samples collected from the well.

8.4.2 *Placement of Primary Filter Pack*—Placement of the well screen is preceded by placing no less than 2 % and no more than 10 % of the primary filter pack into the bottom of the borehole using a decontaminated, flush threaded, 1-in. (25-mm) minimum internal diameter tremie pipe. Alternatively, the filter pack may be added directly between the riser pipe and the auger or drive/temporary casing and the top of the filter pack located using a tamper or a weighted line. The well screen and riser assembly is then centered in the borehole. This can be done using one or more centralizer(s) or alternative centering devices located not more than 10 ft (3 m) above the bottom of the well screen (see Figs. 1 and 2). Centralizers should not be located in the well screen. The remaining primary filter pack is then placed in increments as the tremie is gradually raised or as the auger or drive/temporary casing is removed from the borehole. As primary filter pack material is poured into the tremie pipe, water from a source of known and acceptable chemistry may be added to help deliver the filter pack to the intended interval in the borehole. The tremie pipe or a weighed line can be used to measure the top of the primary filter pack as work progresses. If bridging of the primary filter pack material occurs, the bridged material should be broken mechanically prior to proceeding with the addition of more filter pack material. The elevation (or depth below ground surface), volume, and gradation of primary filter pack should be recorded on the well completion diagram (see Fig. 2 for an example).

8.4.3 *Withdrawal of the Temporary Casing/Augers*—If used, the drive/temporary casing or hollow stem auger is withdrawn, usually in stipulated increments. Care should be taken to avoid lifting the riser with the withdrawal of the temporary casing/augers. To limit borehole collapse in stable formations, the temporary casing or hollow stem auger is usually withdrawn until the lower-most point on the temporary casing or hollow stem auger is at least 2 ft (0.6 m), but no more than 5 ft (1.5 m) above the filter pack for unconsolidated materials; or at least 5 ft (1.5 m), but no more than 10 ft (3.0 m), for consolidated materials. In highly unstable formations, withdrawal intervals may be much less. After each increment, it should be ascertained that the primary filter pack has not been displaced during the withdrawal operation (using a weighed measuring device).

8.5 *Placement of First Secondary Filter*—A secondary filter pack may be installed above the primary filter pack to prevent the intrusion of the bentonite grout seal into the primary filter pack (see Figs. 1 and 2). To be effective, a measured and recorded volume of secondary filter material should be added to extend 1 to 2 ft (0.3 to 0.6 m) above the primary filter pack. As with the primary filter, a secondary filter must not extend into an overlying hydrologic unit (see 8.4.1). The well designer should evaluate the need for this filter pack by considering the gradation of the primary filter pack, the hydraulic heads between adjacent units, and the potential for grout intrusion into the primary filter pack. The secondary filter material is poured into the annular space through a decontaminated, flush threaded, 1-in. (25-mm) minimum internal diameter tremie pipe lowered to within 3 ft (1.0 m) of the placement interval. Water from a source of known and acceptable chemistry may be added to help deliver the filter pack to its intended location. The tremie pipe or a weighed line can be used to measure the top of the secondary filter pack as work progresses. The elevation (or depth below ground surface), volume, and gradation of the secondary filter pack should be recorded on the well completion diagram.

8.6 *Installation of the Bentonite Seal*—A bentonite pellet or a slurry seal is placed in the annulus between the borehole and the riser pipe on top of the secondary or primary filter pack (see Figs. 1 and 2). This seal retards the movement of cement-based grout backfill into the primary or secondary filter packs. To be effective, the bentonite seal should extend above the filter packs approximately 3 to 5 ft (1.0 to 1.5 m), depending on local conditions. The bentonite slurry seal should be installed using a positive displacement pump and a side-discharge tremie pipe lowered to the top of the filter pack. The tremie pipe should be raised slowly as the bentonite slurry fills the annular space. Bentonite pellets or chips may be poured from the surface and allowed to free-fall into the borehole. As a bentonite pellet or chip seal is poured into the borehole, a tamper may be necessary to tamp pellets or chips into place or to break bridges formed as the pellets or chips stick to the riser or the walls of the water-filled portion of the borehole. If the bentonite seal is installed above the water level in the borehole, granular

bentonite should be used as the seal material—*bentonite pellets or chips should not be used in the unsaturated zone.* Granular bentonite should be poured into the borehole and installed in lifts of 2 in., then hydrated with water from a source of known chemistry. The tremie pipe or a weighed line can be used to measure the top of the bentonite seal as the work progresses. Sufficient time should be allowed for the bentonite pellet seal to hydrate or the slurry annular seal to expand prior to grouting the remaining annulus. The volume and elevation (or depth below ground surface) of the bentonite seal material should be measured and recorded on the well completion diagram.

8.7 *Final Secondary Filter Pack*—A 6-in. to 1-ft (0.15 to 0.3-m) secondary filter may be placed above the bentonite seal in the same manner described in 8.5 (see Figs. 1 and 2). This secondary filter pack will provide a layer over the bentonite seal to limit the downward movement of cement-based grout backfill into the bentonite seal. The volume, elevation (or depth below ground surface), and gradation of this final secondary filter pack should be documented on the well completion diagram.

8.8 *Grouting the Annular Space:*

8.8.1 *General*—Grouting procedures vary with the type of well design. The following procedures will apply to both single- and multi-cased monitoring wells. Paragraphs 8.8.2 and 8.8.3 detail those procedures unique to single- and multi-cased installations, respectively.

8.8.1.1 *Volume of Grout*—An ample volume of grout should be mixed on site to compensate for unexpected losses to the formation. The use of alternate grout materials, including grout containing gravel, may be necessary to control zones of high grout loss. The volume and location of grout used to backfill the remaining annular space is recorded on the well completion diagram.

8.8.1.2 *Grout Installation Procedures*—The grout should be pumped down hole through a side-discharge tremie pipe using a positive displacement pump (e.g., a diaphragm pump, moyno pump, or similar pump) to reduce the chance of leaving voids in the grout, and to displace any liquids and drill cuttings that may remain in the annulus. In very shallow wells, grouting may be accomplished by gravity feeding grout through a tremie pipe. With either method, grout should be introduced in one continuous operation until full-strength grout flows out of the borehole at the ground surface without evidence of drill cuttings, drilling fluid, or water.

8.8.1.3 *Grout Setting and Curing*—The riser should not be disturbed until the grout sets and cures for the amount of time necessary to prevent a break in the seal between the grout and riser. The amount of time required for the grout to set or cure will vary with the grout mix and ambient temperature and should be documented on the well completion diagram.

8.8.2 *Specific Procedures for Single-Cased Wells*—Grouting should begin at a level directly above the final secondary filter pack (see Fig. 1) if used, or above the bentonite pellet, chip or slurry seal. Grout should be pumped using a side-discharge tremie pipe to dissipate the fluid-pumping energy against the borehole wall and riser, reducing the potential for infiltration of grout into the primary filter pack. The tremie pipe should be kept full of grout from start to finish, with the discharge end of the pipe completely submerged as it is slowly and continuously lifted. Approximately 5 to 10 ft (1.5 to 3.0 m) of tremie pipe should remain submerged until grouting is complete. For deep installations or where the joints or couplings of the selected riser cannot withstand the collapse stress exerted by a full column of grout as it is installed, a staged grouting procedure may be used. If used, the drive/temporary casing or hollow-stem auger should be removed in increments immediately following each increment of grout installation and before the grout begins to set. If casing removal does not commence until grout pumping is completed, then, after the casing is removed, additional grout may be periodically pumped into the annular space to maintain a continuous column of grout up to the ground surface.

8.8.3 *Specific Procedures for Multi-Cased Wells*—If the outer casing of a multi-cased well cannot be driven to form a tight seal between the surrounding stratum (strata) and the casing, it should be installed in a pre-drilled borehole. After the borehole has penetrated not less than 2 ft (0.6 m) of the first targeted confining stratum, the outer casing should be lowered to the bottom of the boring and the annular space pressure grouted. Pressure grouting requires the use of a grout shoe or packer installed at the end of the outer casing to prevent grout from moving up into the casing. The grout must be allowed to cure and form a seal between the casing and the borehole prior to advancing the hole to the next hydrologic unit. This procedure is repeated as necessary to advance the borehole to the desired depth. Upon reaching the final depth, the riser and screen should be set through the inner casing. After placement of the filter packs and bentonite seal, the remaining annular space is grouted as described in 8.8.2 (see Fig. 2).

NOTE 15—When using a packer, pressure may build up during grout injection and force grout up the sides of the packer and into the casing.

8.9 *Well Protection*—Well protection refers specifically to installations made at the ground surface to deter unauthorized entry to the monitoring well, to prevent damage to or destruction of the well, and to prevent surface water from entering the annulus. The methods described in Practice D5787 should be used for well protection.

8.9.1 *Protective Casing*—Protective casing should be used for all monitoring well installations. In areas that experience frost heaving, the protective casing should extend from below the depth of frost penetration (3 to 5 ft (1.0 to 1.5 m) below grade, depending on local conditions), to slightly above the top of the well casing. The protective casing should be initially placed before final set of the grout. The protective casing should be sealed and immobilized in concrete placed around the outside of the protective casing above the set grout. The protective casing should be stabilized in a position concentric with the riser (see Figs. 3 and 1). Sufficient clearance, usually 6 in. (0.15 m) should be maintained between the lid of the protective casing and the top of the riser to accommodate sampling equipment. A ¼-in. (6.3-mm) ddiameter weep hole should be drilled in the protective casing approximately 6 in. (15 cm) above ground surface to permit water to drain out of the annular space between the protective casing and the riser. In cold climates, this hole will also prevent water freezing

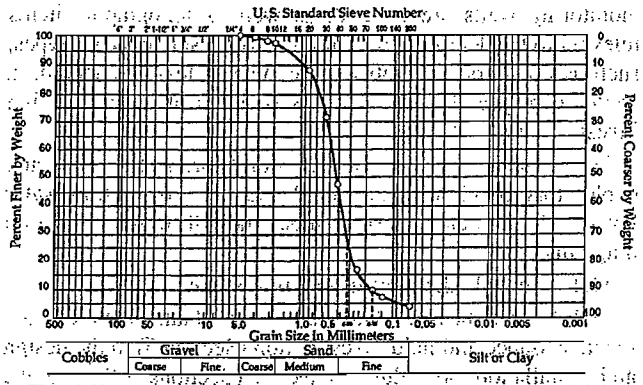


FIG. 3 Example Grading Curve for Design of Monitoring Well Screens

between the protective casing and the well casing. Dry bentonite pellets, granules, or chips should then be placed in the annular space below ground level within the protective casing. Coarse sand or pea gravel or both should be placed in the annular space above the dry bentonite pellets and to just above the weep hole to prevent entry of insects. All materials chosen should be documented on the well completion diagram. The monitoring well identification number should be clearly visible on the inside and outside of the protective casing.

8.9.2 *Completion of Surface Installation*—The well protection installation may be completed in one of three ways:

8.9.2.1 In areas subject to frost heave, place a soil or bentonite/sand layer adjacent to the protective casing sloped to direct water drainage away from the well.

8.9.2.2 In regions not subject to frost heave, a concrete pad, sloped slightly to provide water drainage away from the well, should be placed around the installation.

8.9.2.3 Where monitoring well protection must be installed flush with the ground, an internal cap should be fitted on top of the riser within the manhole or vault. This cap should be leak-proof so that if the vault or manhole should fill with water, the water will not enter the well casing. Ideally, the manhole cover cap should also be leak-proof..

8.9.3 *Additional Protection*—In areas where there is a high probability of damaging the well (high traffic, heavy equipment, poor visibility), it may be necessary to enhance the normal protection of the monitoring well through the use of posts, markers, signs, or other means, as described in Practice D5787. The level of protection should meet the damage threat posed by the location of the well.

9. Well Development

9.1 *General*—Well development serves to remove fine-grained material from the well screen and filter pack that may otherwise interfere with water quality analyses, to restore the formation properties disturbed during the drilling process, and to improve the hydraulic characteristics of the filter pack and hydraulic communication between the well and the hydrologic unit adjacent to the well screen. Methods of well development vary with the physical characteristics of hydrologic units in which the monitoring well is screened and with the drilling method used.

9.2 *Development Methods and Procedures*—The methods and procedures for well development described in Guide D5521 should be followed to ensure a proper well completion.

9.3 *Timing and Duration of Well Development*—Well development should begin either after the riser, well screen and filter pack are installed and before the bentonite seal and grout are installed (the preferred time), or after the monitoring well is completely installed and the grout has cured or set. In the former case, the installer may add filter pack material to the borehole before the bentonite seal is installed to compensate for settlement that typically occurs during the development process. This allows the installer to maintain the desired separation between the top of the screen and the bentonite seal. In the latter case, the possibility exists that settlement of the filter pack may result in the bentonite seal settling into the top of the screen. Development should be continued until representative water, free of the drilling fluids, cuttings, or other materials introduced or produced during well construction, is obtained. Representative water is assumed to have been obtained when turbidity readings stabilize and the water is visually clear of suspended solids. The minimum duration of well development will vary with the method used to develop the well. The timing and duration of well development and the turbidity measurements should be recorded on the well completion diagram.

9.4 *Well Recovery Test*—A well recovery test should be performed immediately after and in conjunction with well development. The well recovery test provides an indication of well performance and provides data for estimating the hydraulic conductivity of the screened hydrologic unit. Readings should be taken at intervals suggested in Table 2 until the well has recovered to 90 % of its static water level.

NOTE 16—If a monitoring well does not recover sufficiently for sampling within a 24-hr period and the well has been properly developed, the installation should not generally be used as a monitoring well for detecting or assessing low level organic constituents or trace metals. The installation may, however, be used for long-term water-level monitoring if measurements of short-frequency water-level changes are not required.

10. Installation Survey

10.1 *General*—The vertical and horizontal position of each monitoring well in the monitoring system should be surveyed and subsequently mapped by a licensed surveyor. The well location map should include the location of all monitoring wells in the system and their respective identification numbers, elevations of the top of riser position to be used as the reference point for water-level measurements, and the elevations of the ground surface protective installations. The locations and elevations of all permanent benchmark(s) and pertinent boundary marker(s) located on-site or used in the survey should also be noted on the map.

TABLE 2 Suggested Recording Intervals for Well Recovery Tests

Time Since Starting Test	Time Interval
0 to 15 min	1 min
15 to 50 min	5 min
50 to 100 min	10 min
100 to 300 min (5 h)	30 min
300 to 1440 min (24 h)	60 min

10.2 *Water-Level Measurement Reference*—The water-level measurement reference point should be permanently marked, for example, by cutting a V-notch into the top edge of the riser pipe. This reference point should be surveyed in reference to the nearest NAVD reference point.

10.3 *Location Coordinates*—The horizontal location of all monitoring wells (active or decommissioned) should be surveyed by reference to a standardized survey grid or by metes and bounds.

10.4 *Borehole Deviation Survey*—A borehole deviation survey, to determine the direction and distance of the bottom of the well relative to the top of the well and points in between, should be completed in wells deeper than 100 feet and in wells installed in dipping formations.

11. Monitoring Well Network Report

11.1 To demonstrate that the goals set forth in the Scope have been met, a monitoring well network report should be prepared. This report should:

11.1.1 Locate the area investigated in terms pertinent to the project. This should include sketch maps or aerial photos on which the exploratory borings, piezometers, sample areas, and monitoring wells are located, as well as topographic items relevant to the determination of the various soil and rock types, such as contours, streambeds, etc. Where feasible, include a geologic map and geologic cross sections of the area being investigated.

11.1.2 Include copies of all well boring test pits and exploratory borehole logs, initial and post-completion water levels, all laboratory test results, and all well completion diagrams.

11.1.3 Include the well installation survey.

11.1.4 Describe and relate the findings obtained in the initial reconnaissance and field investigation (Section 5) to the design and installation procedures selected (Sections 7-9) and the surveyed locations (Section 10).

11.1.5 This report should include a recommended decommissioning procedure that is consistent with those described in Guide D5299 and/or with applicable regulatory requirements.

12. Keywords

12.1 aquifer; borehole drilling; geophysical exploration; groundwater; monitoring well; site investigation

EXHIBIT H: NHDES - WELL COMPLETION REPORT

Well Number

_____

(FOR CONTRACTOR'S USE)

This report must be submitted to the N.H. Water Well Board no later than **90 days** after the completion of the well.

State of New Hampshire
Water Well Board
PO Box 95
Concord, NH 03302-0095

Well Completion Report

Special Notes on Back

Staff Use Only

WRB# _____

LOCACC _____

1. **Well Owner/Home Owner:** _____
   Name Permanent Mailing Address
   and/or
   Building Contractor: _____
   Name Permanent Mailing Address
2. **Location of Well:** Town _____ Address _____
   Street No Road Name
   Town: Tax Map No. _____ Lot No. _____
   Latitude N _____ ° _____ . _____ GPS Manufacturer: ☐ Garmin ☐ Magellan
   Longitude W _____ ° _____ . _____ ☐ Other _____
   Please Report Coordinates in: Map Datum: WGS 84 Position Format: hddd°mm.mmm
3. **Non-Conforming Well Location Form Required:** ☐ Yes ☐ No
   If Yes, please attach form to this report.
4. **Date Well was Completed:** _____
5. **Proposed Use of Well:** ☐ Domestic ☐ Monitoring Well ☐ Other (Explain) _____
6. **Reason for Constructing Well:** ☐ New Supply ☐ Replace Existing Supply ☐ Other _____
7. **Type of Well:** ☐ Drilled in Bedrock ☐ Drilled in Gravel ☐ Dug ☐ Driven Point ☐ Wash Well ☐ Other _____
8. **Total Depth of Well** _____ feet below land surface.
9. **Depth to Bedrock** _____ feet below land surface.
10. **Casing Details:** Length _____ ft., Dia. _____ in., Material _____, Wt. _____ lb./ft.
11. **Method(s) of Sealing Casing to Bedrock:** ☐ Drive Shoe ☐ Drillings ☐ Grout ☐ Other _____
12. **Measured Yield:** ☐ Bailed ☐ Pumped ☐ Compressed Air, for _____ Hours, at _____ GPM
13. **Static Water Level:** _____ feet below land surface. Date Measured _____
14. **Water Analysis:** Has the water been analyzed? ☐ Yes ☐ No If yes, where _____
15. **Stratigraphic and Lithologic Log:**

Depth in Feet From	To	Water Bearing	Surficial Material Description	Texture	Type
Ground Surface			☐ Sand ☐ Gravel ☐ Till ☐ Clay/Silt ☐ Weathered Bedrock		
			☐ Sand ☐ Gravel ☐ Till ☐ Clay/Silt ☐ Weathered Bedrock		
			☐ Sand ☐ Gravel ☐ Till ☐ Clay/Silt ☐ Weathered Bedrock		
			☐ Sand ☐ Gravel ☐ Till ☐ Clay/Silt ☐ Weathered Bedrock		
			☐ Sand ☐ Gravel ☐ Till ☐ Clay/Silt ☐ Weathered Bedrock		
Competent Bedrock			Bedrock Type	Texture	Color(s)
			☐ Granite ☐ Basalt ☐ Schist ☐ Gneiss ☐ Other		
			☐ Granite ☐ Basalt ☐ Schist ☐ Gneiss ☐ Other		
			☐ Granite ☐ Basalt ☐ Schist ☐ Gneiss ☐ Other		
			☐ Granite ☐ Basalt ☐ Schist ☐ Gneiss ☐ Other		

Suggested Descriptors: Texture: Fine Medium Coarse
Color: White = 1, Gray = 2, Black = 3, Blue = 4, Green = 5, Yellow = 6, Brown = 7, Pink = 8

Please Complete Additional Information on Reverse Side

16. **Yield Log:** If the yield was tested at different depths during drilling, list below.

Feet	GPM	Feet	GPM	Feet	GPM

17. **Additional Well Development Methods Used:**

Hydro-Fracturing Information: ☐ Standard ☐ Zone No. of Settings _____

Packer Settings (Ft) 1st Set_____ 2nd Set _____ 3rd Set _____ 4th Set _____

High Pressure (PSI) _____ _____ _____ _____

Low Pressure (PSI) _____ _____ _____ _____

Surging Depths: 1st Set_____ 2nd Set _____ 3rd Set _____ 4th Set _____

Other Methods (Explain) _____

18. **Measured Yield After Development** _____ GPM, Before Development _____ GPM

19. **Additional Well Seals Installed Inside of Well:**

☐ Jaswell Type Seal ☐ Shale Packer Depth Setting _____ feet below land surface.

☐ Other (Explain) _____

Drop Pipe Used: ☐ Steel ☐ PVC ☐ Grouted Between Liner and Outer Casing

20. **Screen Details:** Make & Type _____, Material _____, Length _____ft.

Diameter _____ in., Slot Size _____, Depth to top of screen from land surface _____ft.

Gravel Pack, if used: Gravel Size or Type _____

21. A water well contractor must provide a drawing indicating the position of each well, if more than one well is located within the lot, relative to significant permanent man-made features. Provide this information in the space below, or as an attachment to this form. Additional information attached: ☐ Yes ☐ No

22. A technical driller must submit a separate well completion report for every monitoring well installed into bedrock at a single property or place of business. A technical driller also must submit a well completion report for the deepest monitoring well it installs at a property or place of business. If the technical driller has not completed a separate well completion form for each monitoring well they installed in unconsolidated material at a single property or place of business, then it must prepare and submit a map showing the location of each monitoring well installed by the technical driller relative to significant man-made or natural features at a given site, and relative to well(s) located with GPS. Please provide this sketch below, or as an attachment to this Well Completion Form. Additional information attached: ☐ Yes ☐ No

23. Please attach results of drawdown test if performed.

24. Please provide any additional or unusual information about the well in the space below, or as an attachment to this form.

Additional Notes:

Doing Business as _____
Company or Business Name

Report Filed by _____
Licensee Signature

This form is also available on line at www.des.nh.gov/wwb

Date of Report _____ License No. _____

EXHIBIT I: NHDES – ABANDONED WELL REGISTRATION REPORT

Well Number

_____

(FOR CONTRACTOR'S USE)

This report must be submitted to the N.H. Water Well Board no later than 90 days after the well was decommissioned.

State of New Hampshire
Water Well Board
PO Box 95
Concord, NH 03302-0095

Abandoned Well Registration Report

Identification # _____

Latitude _____

Longitude _____

Please Report Coordinates in:
Map Datum: WGS 84
Position Format: hddd°mm.mmm

1. **Well Owner:** _____
Name Permanent Mailing Address

Building Contractor: _____
Name Permanent Mailing Address

2. **Location of Well:** Town _____ Address _____
Street No Road Name

Subdivision Name_____Subdivision Lot No._____

Town Tax Map and Lot No: Map No._____Lot No._____

3. **Type of Well:** ☐ Drilled in Bedrock ☐ Drilled in Gravel ☐ Dug ☐ Wash / Point

4. **Use Type:** ☐ Domestic ☐ Public ☐ Irrigation ☐ Commercial ☐ Monitoring

5. **Reason for Abandonment:** ☐ Insufficient Yield ☐ Poor Aesthetic Quality ☐ Contaminated ☐ Disrepair ☐ Failed Well ☐ Isolation Distances ☐ No Longer In Use ☐ Other _____

6. **Current Status:** ☐ Decommissioned ☐ Not Decommissioned ☐ Wellhead Left Above Grade and Covered

7. **Date Well was Decommissioned:** _____

8. **Depth of Well:** _____ ft., **Static Water Level:** _____ feet below land surface.

9. **Casing:** Length _____ft., Diameter _____in., Material _____

10. **Method Used for Sealing:** ☐ Filled with Grout ☐ Pressure Grout

11. **Quantity of Materials Used:** ☐ Neat Cement _____ ☐ Cement / Bentonite Grout _____
No. of Units No. of Units

☐ Premixed Bentonite Grout _____ ☐ Bentonite Chips _____ ☐ Other _____
No. of Units No. of Units No. of Units

12. **Additional Information:**

Doing Business as _____
Company or Business Name

Report Filed by _____
Licensee Signature

Date of Report _____ License No. _____

Use Back Side If Necessary

Signature Pages
It is further proposed:

To execute the Contract and begin work within 10 days from the date specified in the "Notice to Proceed" and to prosecute said work so as to complete the _____ and its appurtenances on or before _____.

To guarantee all of the work performed under this Contract to be done in accordance with the Specifications and in good and workmanlike manner, and to renew or repair any work that may be rejected, due to defective materials or workmanship, prior to final completion and acceptance of the project.

CERTIFICATION REGARDING DEBARMENT, SUSPENSION, AND OTHER RESPONSIBILITY MATTERS. PRIMARY COVERED TRANSACTIONS.

(1). The prospective primary participant certifies to the best of its knowledge and belief, that it and all its principals: (a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency; (b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statues or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property; (c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (1) (b) of this certification and (d) Have not within a three-year period proceeding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default. (2). Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

CONTRACT AFFIDAVIT

I/We declare under penalty of perjury under the laws of the United States and the State of New Hampshire that, in accordance with the provisions of Title 23 USC, Section 112(c), have not either directly or indirectly entered into any agreement, participated in any collusion or otherwise taken any action in restraint of free competitive bidding in connection with this Proposal.

Dated: _____

(If a firm or individual)

Signature of Bidder _____

By _____

Address of Bidder _____

Names and addresses of members of the Firm:

_____

_____

_____

(If a Corporation)

Signature of Bidder _____

Title _____

By _____

Business Address _____

Incorporated under the laws of the State of _____

Names of Officers:

President _____
Name Address

Secretary _____
Name Address

Treasurer _____
Name Address

CONTRACTOR'S BID SCHEDULE

New Hampshire Department of Transportaton
Statewide Geotechnical Subsurface Explorations 15667A
CONTRACTOR'S BID SCHEDULE
Northern Test Boring, Inc.

ITEM NO.	QUANTITY	PAY UNIT	ITEMS AND UNIT PRICES BID IN WORDS	PER UNIT PRICE DOLLARS and CENTS	TOTAL AMOUNT (Quantity times Unit Price) DOLLARS and CENTS
01.1	15	EACH	General Mobilization and Demobilization AT _____ _____ DOLLARS PER EACH	$ 700.00	$ 10,500.00
01.2	3	EACH	Flotation Equipment Mobilization and Demobilization AT _____ _____ DOLLARS PER EACH	$ 7,000.00	$ 21,000.00
01.3	3	EACH	Utility and DIG-SAFE Clearance AT _____ _____ DOLLARS PER EACH	$ 500.00	$ 1,500.00
02.1	1	EACH	Cathead Boring AT _____ _____ DOLLARS PER EACH	$ 1,500.00	$ 1,500.00
02.2	200	EACH	Truck Rig Boring AT _____ _____ DOLLARS PER EACH	$ 20.00	$ 4,000.00
02.3	100	EACH	Track Rig Boring AT _____ _____ DOLLARS PER EACH	$ 75.00	$ 7,500.00
02.4	10	EACH	Skid Rig Boring AT _____ _____ DOLLARS PER EACH	$ 1,025.00	$ 10,250.00
02.5	20	EACH	Barge Rig Boring AT _____ _____ DOLLARS PER EACH	$ 400.00	$ 8,000.00
03.11	2000	FEET	Soil Boring, 3-inch Drive Casing on Land, depth 0 to 50 feet AT _____ _____ DOLLARS PER FOOT	$ 23.00	$ 46,000.00
03.12	200	FEET	Soil Boring, 3-inch Drive Casing on Land, depth 50 to 100 feet AT _____ _____ DOLLARS PER FOOT	$ 30.00	$ 6,000.00
03.13	50	FEET	Soil Boring, 3-inch Drive Casing on Land, depth 100 to 150 feet AT _____ _____ DOLLARS PER FOOT	$ 50.00	$ 2,500.00
03.14	5	FEET	Soil Boring, 3-inch Drive Casing on Land, depth over 150 feet AT _____ _____ DOLLARS PER FOOT	$ 150.00	$ 750.00
03.21	250	FEET	Soil Boring, 3-inch Drive Casing on Water, depth 0 to 50 feet AT _____ _____ DOLLARS PER FOOT	$ 33.00	$ 8,250.00
03.22	25	FEET	Soil Boring, 3-inch Drive Casing on Water, depth 50 to 100 feet AT _____ _____ DOLLARS PER FOOT	$ 50.00	$ 1,250.00
03.23	5	FEET	Soil Boring, 3-inch Drive Casing on Water, depth 100 to 150 feet AT _____ _____ DOLLARS PER FOOT	$ 150.00	$ 750.00
03.24	5	FEET	Soil Boring, 3-inch Drive Casing on Water, depth over 150 feet AT _____ _____ DOLLARS PER FOOT	$ 150.00	$ 750.00
03.31	1000	FEET	Soil Boring, 4-inch Drive Casing on Land, depth 0 to 50 feet AT _____ _____ DOLLARS PER FOOT	$ 23.00	$ 23,000.00

New Hampshire Department of Transportaton
Statewide Geotechnical Subsurface Explorations 15667A
CONTRACTOR'S BID SCHEDULE
Northern Test Boring, Inc.

ITEM NO.	QUANTITY	PAY UNIT	ITEMS AND UNIT PRICES BID IN WORDS	PER UNIT PRICE DOLLARS and CENTS	TOTAL AMOUNT (Quantity times Unit Price) DOLLARS and CENTS
03.32	100	FEET	Soil Boring, 4-inch Drive Casing on Land, depth 50 to 100 feet AT_____ DOLLARS PER FOOT	$ 30.00	$ 3,000.00
03.33	5	FEET	Soil Boring, 4-inch Drive Casing on Land, depth 100 to 150 feet AT_____ DOLLARS PER FOOT	$ 100.00	$ 500.00
03.34	0	FEET	Soil Boring, 4-inch Drive Casing on Land, depth over 150 feet DO NOT BID	DO NOT BID	
03.41	250	FEET	Soil Boring, 4-inch Drive Casing on Water, depth 0 to 50 feet AT_____ DOLLARS PER FOOT	$ 33.00	$ 8,250.00
03.42	25	FEET	Soil Boring, 4-inch Drive Casing on Water, depth 50 to 100 feet AT_____ DOLLARS PER FOOT	$ 50.00	$ 1,250.00
03.43	5	FEET	Soil Boring, 4-inch Drive Casing on Water, depth 100 to 150 feet AT_____ DOLLARS PER FOOT	$ 100.00	$ 500.00
03.44	0	FEET	Soil Boring, 4-inch Drive Casing on Water, depth over 150 feet DO NOT BID	DO NOT BID	
04	100	FEET	Casing Bit Diamond Wear for Spin Casing AT_____ DOLLARS PER FOOT	$ 8.00	$ 800
05	200	FEET	Soil Boring, 3-inch or 4-inch Hollow Stem Auger Borings on Land AT_____ DOLLARS PER FOOT	$ 14.00	$ 2,800.00
06	305	EACH	Additional Split Spoon Samples AT_____ DOLLARS PER EACH	$ 35.00	$ 10,675.00
07	5	EACH	3-inch Piston Samples AT_____ DOLLARS PER EACH	$ 40.00	$ 200.00
08.11	500	FEET	Rock Core on Land, Depth 0 to 50 feet AT_____ DOLLARS PER FOOT	$ 50.00	$ 25,000.00
08.12	50	FEET	Rock Core on Land, Depth 50 to 100 feet AT_____ DOLLARS PER FOOT	$ 75.00	$ 3,750.00
08.13	25	FEET	Rock Core on Land, Depth 100 to 150 feet AT_____ DOLLARS PER FOOT	$ 100.00	$ 2,500.00
08.14	5	FEET	Rock Core on Land, Depth Over 150 feet AT_____ DOLLARS PER FOOT	$ 100.00	$ 500.00
08.21	50	FEET	Rock Core on Water, Depth 0 to 50 feet AT_____ DOLLARS PER FOOT	$ 50.00	$ 2,500.00
08.22	25	FEET	Rock Core on Water, Depth 50 to 100 feet AT_____ DOLLARS PER FOOT	$ 70.00	$ 1,750.00

New Hampshire Department of Transportaton
Statewide Geotechnical Subsurface Explorations 15667A
CONTRACTOR'S BID SCHEDULE
Northern Test Boring, Inc.

ITEM NO.	QUANTITY	PAY UNIT	ITEMS AND UNIT PRICES BID IN WORDS	PER UNIT PRICE DOLLARS and CENTS	TOTAL AMOUNT (Quantity times Unit Price) DOLLARS and CENTS
08.23	10	FEET	Rock Core on Water, Depth 100 to 150 feet AT _____ _____ DOLLARS PER FOOT	$ 100.00	$ 1,000.00
08.24	5	FEET	Rock Core on Water, Depth Over 150 feet AT _____ _____ DOLLARS PER FOOT	$ 100.00	$ 500.00
09	50	EACH	Pavement Cores AT _____ _____ DOLLARS PER EACH	$ 10.00	$ 500.00
10.1	500	FEET	Borehole Sealing, Cased Boring AT _____ _____ DOLLARS PER FOOT	$ 3.00	$ 1,500.00
10.2	50	FEET	Borehole Sealing, Auger Boring AT _____ _____ DOLLARS PER FOOT	$ 5.00	$ 250.00
11.1	1000	FEET	Groundwater Level Observation Well with 1-1/2" Diameter Well Pipe AT _____ _____ DOLLARS PER FOOT	$ 5.00	$ 5,000.00
11.2	500	FEET	Groundwater Level Observation Well with 2" Diameter Well Pipe AT _____ _____ DOLLARS PER FOOT	$ 8.00	$ 4,000.00
11.3	20	FEET	Bentonite Clay AT _____ _____ DOLLARS PER FOOT	$ 10.00	$ 200.00
11.4	40	FEET	Filter Sand AT _____ _____ DOLLARS PER FOOT	$ 4.00	$ 160.00
11.5	20	EACH	Protective Riser Casing AT _____ _____ DOLLARS PER EACH	$ 50.00	$ 1,000.00
11.6	20	EACH	Flush Mounted Road Box AT _____ _____ DOLLARS PER EACH	$ 50.00	$ 1,000.00
11.7	20	EACH	Decommission Groundwater Level Observation (Monitoring) Well AT _____ _____ DOLLARS PER EACH	$ 150.00	$ 3,000.00
12.1	100	MAN-HOURS	Traffic Control Flaggers AT _____ _____ DOLLARS PER MAN-HOUR	$ 30.00	$ 3,000.00
12.2	20	HOURS	Traffic Control for High Volume Lane Closure AT _____ _____ DOLLARS PER HOUR	$ 200.00	$ 4,000.00
13	100	HOURS	Standby Time AT _____ _____ DOLLARS PER HOUR	$ 75.00	$ 7,500.00
14	0	Dollars	Direct Costs DO NOT BID	DO NOT BID	
				Bid Grand Total	**$ 250,085.00**

Northern Test Boring, Inc.

Certificate of Vote

I, Melissa Bolduc Nadeau, herby certify that I am duly elected clerk of **Northern Test Boring, Inc**.

I hereby certify the following is a true copy of a vote taken at a meeting of the Board of Directors of the corporation, duly called and held on 5/30/2013 at which a quorum of the board was present and voting.

Voted:

Michael A. Nadeau President of Northern Test Boring, Inc. has the authority to bind, execute and deliver the corporation in any contractual obligations with The State of New Hampshire to provide subsurface investigations under Agreement# 17 Statewide Geotechnical Subsurface Explorations NH DOT Project: Statewide 15667. Furthermore, Mr. Nadeau has full authority to bind, execute and deliver the corporation in any addition contractual obligations deemed necessary to conduct business in The State of New Hampshire.

I herby certify that said vote has not been amended or repealed and remains in full force and effect as of 5/30/13 and that Michael A. Nadeau and Melissa Bolduc Nadeau are duly elected President and Clerk, respectively, of this corporation.

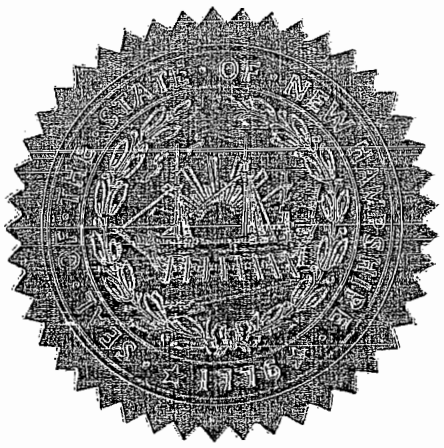
DATE: 5/30/13

Clerk / Northern Test Boring, Inc.

State of New Hampshire
Department of State

CERTIFICATE

I, William M. Gardner, Secretary of State of the State of New Hampshire, do hereby certify that Northern Test Boring, Inc. a(n) Maine corporation, is authorized to transact business in New Hampshire and qualified on July 16, 2007. I further certify that all fees and annual reports required by the Secretary of State's office have been received.



In TESTIMONY WHEREOF, I hereto set my hand and cause to be affixed the Seal of the State of New Hampshire, this 7th day of May, A.D. 2013

William M. Gardner
Secretary of State

CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY): 05/01/2013

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER Roux Insurance Services 185 Webster Street Lewiston, ME 04240	CONTACT NAME: Pamela Edwards PHONE (A/C, No, Ext): (207) 784-9358 FAX (A/C, No): (207) 782-6945 E-MAIL ADDRESS: pedwards@rouxinsurance.com
INSURED Northern Test Boring, Inc. 187 Mighty Street Gorham, ME 04038	INSURER(S) AFFORDING COVERAGE — NAIC # INSURER A: Crum & Forster Insurance Co. — 42471 INSURER B: Allmerica Financial Benefit Ins. Co. — 41840 INSURER C: Maine Employers Mutual Ins. Co. — 11149 INSURER D: Hanover Insurance Co. — 22292 INSURER E: — INSURER F: —

COVERAGES **CERTIFICATE NUMBER:** **REVISION NUMBER:**

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	TYPE OF INSURANCE	ADDL INSR	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
A	GENERAL LIABILITY	Y		EPK100815	9/23/2012	9/23/2013	EACH OCCURRENCE	$ 1,000,000
	☑ COMMERCIAL GENERAL LIABILITY						DAMAGE TO RENTED PREMISES (Ea occurrence)	$ 50,000
	☐ CLAIMS-MADE ☐ OCCUR						MED EXP (Any one person)	$ 5,000
	☑ Pollution Liability						PERSONAL & ADV INJURY	$ 1,000,000
	GEN'L AGGREGATE LIMIT APPLIES PER:						GENERAL AGGREGATE	$ 2,000,000
	☑ POLICY ☐ PRO-JECT ☐ LOC						PRODUCTS - COMP/OP AGG	$ 2,000,000
								$
B	AUTOMOBILE LIABILITY	Y		AWP 6469138 03	9/23/2012	9/23/2013	COMBINED SINGLE LIMIT (Ea accident)	$ 1,000,000
	☐ ANY AUTO						BODILY INJURY (Per person)	$
	☐ ALL OWNED AUTOS ☑ SCHEDULED AUTOS						BODILY INJURY (Per accident)	$
	☑ HIRED AUTOS ☑ NON-OWNED AUTOS						PROPERTY DAMAGE (Per accident)	$
								$
	☐ UMBRELLA LIAB ☐ OCCUR						EACH OCCURRENCE	$
	☐ EXCESS LIAB ☐ CLAIMS-MADE						AGGREGATE	$
	☐ DED ☐ RETENTION $							$
C	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? (Mandatory in NH) Y/N: Y If yes, describe under DESCRIPTION OF OPERATIONS below	N/A		1810057339	12/7/2012	12/7/2013	☑ WC STATU-TORY LIMITS ☐ OTH-ER	
							E.L. EACH ACCIDENT	$ 500,000
							E.L. DISEASE - EA EMPLOYEE	$ 500,000
							E.L. DISEASE - POLICY LIMIT	$ 500,000
	Contractors Equip.-Rented or Leased			IHP6464797 03	9/23/2012	9/23/2013	Blanket Limit: $65,000, Deductible;$5,000	

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (Attach ACORD 101, Additional Remarks Schedule, if more space is required)

New Hampshire DOT is additional insured.

CERTIFICATE HOLDER

New Hampshire DOT Materials & Research Bureau
Attn: Chuck Dusseault
PO Box 483
Concord, NH 033020483

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

AUTHORIZED REPRESENTATIVE: Gloria Breton