DIVISION 200 - EARTHWORK

SECTION 201 – CLEARING AND GRUBBING

201.1 – GENERAL

Clearing and grubbing the project site is usually the first construction operation. The work consists of cutting trees and brush and grubbing stumps and roots where required within the project limits, but in no case beyond the applicable right–of–way and/or easements. This procedure may cause an unusual concern from the public due to the sometimes drastic change in the appearance of the project. The project personnel must be prepared to answer any questions concerning the right–of–way, erosion control, or scope of the project prior to the beginning of this work. Where the clearing limits may affect screening or older individual trees, the operation should be discussed with abutting landowners prior to commencement.

201.3 – CONSTRUCTION OPERATIONS

A. Clearing and Grubbing Trees and Stumps

Clearing limits are determined by checking the Plans (cross–sections), Specifications, and Special Provisions. The clearing limits should be laid out with colored flagging by the Contractor, and field checked by the project personnel. The flagging should be tied to the trees that are to remain as a reference for subsequent verification. Clearing and Grubbing is commonly measured by a final pay quantity. Any trees designated for removal under any other item are excluded from this work. Care should be taken by

the Contractor to prevent damage to construction side stakes and to preserve all natural vegetation outside the clearing limits.

In the interest of curbing pollution, most construction projects have limits governing the land area of erodible earth material that may be exposed at one time. The project must have an approved "Erosion Control Plan," Storm Water Pollution Protection Plan (SWPPP), and all required environmental documents prior to the start of any clearing and grubbing operation. Refer to *Section 645 Erosion Control* and *Section 699 Miscellaneous Temporary Erosion and Sediment Control* of the Standard Specifications for more information. In an effort to prevent stream damage and pollution, keep equipment out of live streams and be sure that all erosion control measures are in place prior to starting work. Clearing operations create hazardous conditions, particularly in dense and/or tall timbered areas, and the project personnel should be careful when working in the proximity of cutting operations. It is also essential that the Contract Administrator review the Contractor's operations to determine if potential hazards exist that endanger the traveling public or existing facilities in or adjacent to the right–of–way.

Some trees and shrubs in the project area may be designated on the plans as plants to be saved. Trees and shrubs to be saved should be clearly marked by project personnel for identification purposes and the Contractor should be notified of the marked plants to save them from damage. The Contractor shall carefully protect and guard all trees, shrubs, and vegetation, within or adjacent to the construction area that are to be saved. Particular attention should be paid to that portion of the Standard Specifications concerning the salvage of wood in the interest of conservation.

Trees and shrubs not interfering with the project and within the clearing lines, particularly those adjacent to dwellings, should be reviewed by the Contract Administrator to determine if they can also be saved. Occasionally, valuable shade trees may be saved by the use of tree wells in fill sections or by warping the slope in cut sections. Check to see if trees that are designated to be cut, but could possibly be saved, are especially valuable to the landowner.

Excavators or rake teeth on bulldozers should be used when grubbing to prevent excessive topsoil excavation during stump removal. All stumps, roots, branches, brush, and timber shall be disposed of by an approved method. Stumps and roots can be disposed of at permitted facilities, by grinding, by chipping, or by burying at approved locations.

A Disposal Agreement must be submitted and approved prior to burial of any of these materials off site. Branches with a diameter of less than 5 in and brush shall not be buried. The removal of stumps may not be necessary under fills of adequate depth. Refer to *Subsection 201.3.1 Clearing and Grubbing* of the Standard Specifications for more information.

B. Roadside Cleanup

This operation consists of the cleanup work necessary on an area outside of the clearing limits to present an appealing appearance. Dead or downed trees should be removed from the edge of the clearing limits. This work is to be paid under the roadside cleanup item at the contract unit price per acre. If the item is

not included in the contract, payment shall be made as provided for in *Subsection 109.04 Payment for Revisions to the Contract* of the Standard Specifications.

C. Trimming of Trees

This phase of the project is usually conducted near the final stages of construction and is a force account item; therefore, this work should also be closely observed to ensure the most efficient use of time and equipment. Branches of trees that are damaged or that extend into and over the roadway shall be carefully trimmed as directed by the Engineer. Tree trimming work should be viewed with future growth and changing seasons in mind. Payment for this work, when ordered by the Contract Administrator, shall be made as provided for in *Subsection 109.04 Payment for Revisions to the Contract* of the Standard Specifications.

202 – REMOVAL OF STRUCTURES AND OBSTRUCTIONS

202.1 – GENERAL

This work consists of the removal and the satisfactory disposal of all buildings, including accessories and appurtenances, in accordance with the Specifications, or as ordered by the Engineer. The Contract Administrator and project personnel should thoroughly study the Contract Plans, Special Provisions, and Right–of–Way Agreements for any special details pertaining to the removal of buildings, structures, fences, and other obstructions. The work to be done should be discussed with the Contractor's Superintendent to cover any details concerning salvage, storage, and recycling and/or disposal of building materials.

Prior to demolition, any materials to be salvaged for reuse by the Department shall be documented through the Receipt of Salvaged Materials form located in the Bureau of Construction's FORMS folder on the server (currently "S:\Construction\Admin\Forms"). Attention should be paid to the potential occurrence of asbestos and other hazardous materials in the buildings to be removed. The results of the hazardous material survey shall be included in the contract. Before demolition, the hazardous materials are removed by a licensed abatement Contractor under the oversight of the Department's hazardous waste consultant. This work is to be paid under the appropriate contract item.

202.3 – CONSTRUCTION OPERATIONS

A. Demolishing Buildings

The Contract Administrator should check salvage dates of buildings to be demolished subject to prior removal before the Contractor starts demolition. Usually, the time allotted ends before construction begins, but sometimes circumstances extend dates into contract time and the owner may still have legal possession. The disposal of building materials by burning is generally unacceptable. Prior to any act of demolition, be sure all aerial and underground utilities, electric, gas, telephone, and water, have been disabled by their appropriate companies.

Check with the associated city or town to assure any municipal requirements for utility termination have been followed. All materials resulting from the demolition, unless specified, shall become the property of the Contractor, and shall be disposed of in accordance with all applicable laws, rules, and regulations. Once the work has commenced, the Contractor shall make every reasonable effort to demolish the designated structure in a manner that will ensure the safety of the project personnel and the public.

B. Signs and Other Traffic Control Devices

Where existing traffic control signs or other devices are located within the demolition/excavation limits, the proper authorities should be notified prior to the start of work to have the signs and control devices removed or relocated. Private advertising signs also may need to be removed. Check with the District Construction Engineer if disposition through Right–of–Way agreements is not available.

STATE OF NEW HAMPSHIRE / DEPARTMENT OF TRANSPORTATION			
BUREAU OF CONSTRUCTION			
Contract:	Ashland	Date:	July 15, 2015
State No.:	12345	Federal No.:	NHS–123–4 (567)
The undersigned acknowledges receipt of the following materials/equipment from the above referenced contract in compliance with the Contract Plans and Specifications:			
Granite slope curb			250 ft
Grate and Frame, Type C			3 each
Standard Beam Guardrail w/Posts and Hardware			150 ft
Portable Concrete Barrier			300 ft
Received by:			
Signature:	[John Dell]		
Name:	John Dell		
Title:	Highway Patrol Foreman		
Organization:	NHDOT Dist. 6 Maintenance		
Date Received:	September 15, 2015		
Destination:	Patrol Shed #699		
Compiled by:	Ronald Tanner, Contract Administrator		

SECTION 203 – EXCAVATION AND EMBANKMENT

203.1 – GENERAL

This work consists of excavating or placing material in reasonably close conformity with the lines, grades, and typical cross sections shown on the Plans or specified by the Engineer. Operations involving roadway excavation and fills, including placing, compacting, and finishing of the excavated material in the embankments, are among the most common operations in highway construction work.

The bulk of the inspector's duties and responsibilities pertain to the acceptance of materials, the location of work both horizontally and vertically, the grading or shaping of the work, and the monitoring of the compactive effort necessary to ensure that density requirements are satisfied. The Contract Administrator and project personnel must acknowledge that quality constructed embankments and subgrade are essential to the overall performance and quality of the base course and pavement structure.

203.2 – MATERIALS

Sufficient classification of materials is given in the Standard Specifications.

203.3 – CONSTRUCTION OPERATIONS

A. Excavation

The Contractor shall never excavate or remove any material outside the limits indicated on the Plans. The Specifications do not allow payment for materials excavated beyond the limits of the required slopes, except in certain specified instances. If at any time the Contractor excavates outside the slope limits or below subgrade, the Contract Administrator shall immediately notify the Contractor in writing that the Specifications do not permit payment for such excavation. When the Contractor excavates below subgrade, the excavated material shall be replaced with a material of equal or better quality. Before the work is accepted, the roadway shall be substantially true to line, grade, and section as shown on the Plans.

Horizontal and vertical control of the work must be established by the Contractor and verified by the Department's project staff. The control of the work and the determination of quantities should be discussed and understood by both parties prior to commencing work.

When rock is encountered, a NHDOT survey party should be on site as soon as the earth overburden has been satisfactorily removed so that cross–sections may be taken before drilling operations begin. The stationing interval may vary with substantial change in rock outcropping, but should normally be at 25 ft intervals.

The Contractor shall submit a blasting plan to the Contract Administrator, for approval, two weeks prior to commencing any drilling and blasting operations. Prior to blasting, a pre–blast survey of all structures within 500 ft of the blast area is required by specification and paid as subsidiary to Item 203.2 Rock Excavation.

Careful control and detailed documentation of blasting activities is recommended, including the location, time, amount of explosives used, etc., to assist in resolving any problems that may arise as a result of alleged blasting damage to existing structures.

A detailed blasting report including video and vibration monitoring is often required from the Contractor. Signals for blasting should conform to rules and regulations as stipulated in the Federal Register. Verify that air pollution regulations are being followed during drilling operations.

When excavating for drives, check the profile grade to verify that it doesn't exceed the maximum allowable value.

Muck excavation limits should be reviewed and established according to Plan depths or field probing when feasible. Final sections should be taken immediately after satisfactory removal and checked against Plan depths so that adjustments in width and depth can be made before equipment has advanced.

B. Subgrade and Slopes

Before placement of base materials on the subgrade, the entire roadbed should be closely examined to verify that it substantially conforms to the typical cross section and required grade. Any unstable areas should be corrected by aeration or removal and replacement. In excavation areas, water seepage may show up either at subgrade or through slopes. Underdrains may be needed to remove water at normal underdrain depths in the subgrade, and gravel or ledge cores may be needed to stabilize slopes.

In either case, the District Construction Engineer should be notified of expected additional work. This additional work should be discussed immediately at the first signs of an unstable situation.

C. Embankments

The supporting strength of the soils in embankments is directly affected by compaction. Improperly compacted embankments will further consolidate under traffic, resulting in an uneven road surface. Care must be taken to ensure that uniform density is obtained throughout the embankment. Full width embankment construction in horizontal layers of uniform thickness should be encouraged where possible. This will ensure a more uniform density throughout the fill, including the outer edges of the embankments.

It is also essential that the moisture content be uniform. In most cases, the required density can be obtained with the least effort if the moisture content is close to the optimum as determined by the standard moisture–density (proctor) test. In general, the moisture content required for compaction should approximate the optimum moisture content obtained from laboratory (proctor) tests.

Materials having a high percentage of fines are susceptible to over watering. When saturated, the fines develop properties of fluids, and as such produce an unstable embankment. Therefore, such over watering should be avoided. The most efficient use of water in obtaining compaction is attained by uniform distribution of the water throughout the entire surface area of the fill.

The choice of compaction equipment is usually left to the Contractor, but the following table is a good guide to the types of equipment suited for compacting various soil types.

Compactors and Soil Types

Compactor Type	Soil type best suited for compactor type	Maximum effect in loose lift (in)	Density gained in lift
Sheep's Foot	Clay, silty clay, gravel with clay binder	6 – 12	Nearly Uniform
Steel tandem two–axle	Sandy silts, most granular materials with some clay binder	4 – 8	Average*
Steel tandem three–axle	Sandy silts, most granular materials with some clay binder	4 – 8	Average*
Pneumatic, small–tire	Sandy silts, sandy clays, gravelly sand and clays with few fines	4 – 8	Average to uniform*
Pneumatic, large–tire	All soil types	up to 24	Uniform
Vibratory	Sand, silty sands, silty gravels	3 – 6	Uniform
Combinations	All soil types	3 – 6	Uniform

* The density may decrease with depth

Source: Peurifoy, R.L. Construction Planning, Equipment, and Methods, Third Edition, McGraw–Hill Book Company

One of the main difficulties that the project personnel will likely encounter in constructing embankments will be that the rate of placing material in the fill area may far exceed the compacting capacity of the Contractor's equipment. In this case, the Contract Administrator should not hesitate to require that either

the amount of hauling equipment be decreased or the amount of compaction equipment be increased to the point where each layer is satisfactorily compacted before any material for the succeeding layer is placed.

When end dumping is employed, embankment material shall be dumped on the layer of embankment being constructed and pushed ahead into place. End dumping off the end of the lift or into piles is not permitted.

Lift depths shall be controlled as affirmed in the Specifications to ensure proper placement of rock and earth as they are used in the fills. Larger boulders should not control the depth of lift, as these boulders can be utilized at the toe of slope for slope protection or, if necessary, be broken up.

Verify that shape and grade of the embankment conforms to the template as fill progresses by checking and assisting the Contractor with sufficient line and grade. It is the responsibility of the Contractor to see that slope stakes are properly set. Under no conditions should the construction of fill slopes be permitted until slope stakes have been set at the toe of the slope and checked. Generally the clearing limits should be 5 ft beyond the toe of slope, and 10 ft beyond the top of slope.

The Contractor shall also be required to set such intermediate working stakes as may be necessary to maintain true lines.

Should the Contractor construct unauthorized fattened slopes, the excess material should immediately be ordered removed.

The procedure for density requirements and tests is adequately covered in the Specifications, with the exception of the frequency of the tests by project personnel, which is covered in the "NHDOT Guide to Frequency of Sampling and Testing" in *Division 700* of this Manual.

The recommended rate is one test per 12 in lift per 1,500 ft in length. This means that a 750 ft long fill requires one compaction test for each two lifts. This is an average frequency for testing. At the start of the project, more tests may be needed to determine what procedure will be needed to obtain the required density. Once this is determined, fewer tests may then be needed to maintain control of the fill material.

Independent Assurance Tests are to be made by the Materials and Research Bureau personnel at the rate of one test per 32,500 cubic yards of embankment or one per project by observation or comparison.

E. Disposal of Surplus and Waste Material

The Specifications define what surplus and waste materials are and how they are to be disposed of. In no case should waste be placed in any type of disposal area in such a manner as to be unsightly, nor should it be placed such that it allows for the ponding of water. Such material may be utilized to flatten slopes and eliminate guardrail runs if authorized by the Contract Administrator. All offsite recycling or disposal of surplus and waste materials requires a Disposal Agreement. Refer to the Disposal Agreement for requirements and any additional information.

F. Embankment–In–Place

Embankment–in–place**,** normally a Final Pay Quantity or "F" item, involves the placing and grading of material in an embankment from excavation or borrow sources and is an in–place quantity. Refer to *Subsection 109.11 Final Pay Quantity* for more information. No separate payment is made for materials taken from borrow areas that are needed to complete the embankment. Common excavation and other items involved are constructed under their appropriate item.

G. Surcharges

Surcharge content is that portion of the embankment that is placed above the intended subgrade for the purpose of increasing the rate of settlement. The surcharge area should be sectioned just prior to removal to record the behavior and to determine quantity. The surcharge material, when removed, should be transported to specified or predetermined areas.

H. Winter Construction Methods

Embankments constructed during winter conditions are to be carefully inspected as stated in the Specifications to ensure that frost is not incorporated into the work. If any frozen material is observed it must be removed before any new material is placed.

Muck and ledge excavation are common winter operations that are not affected by frost. Muck areas can also be backfilled with ledge or other approved dry materials during winter operations. Backfill with any moisture content should not be used.

SECTION 206 – STRUCTURE EXCAVATION FOR PIPES AND OTHER MINOR STRUCTURES

206.1 – GENERAL

Structure excavation consists of the removal and backfill of material necessary to complete the installation of pipes and other minor structures as described in the Specifications.

206.3 – CONSTRUCTION OPERATIONS

The Standard Specifications and Special Provisions specify the safety and health requirements that must be followed when conducting construction operations. Special attention should be paid to the applicable safety manuals that cover shoring and bracing when excavation and trench work is done. Refer to the U.S. Army Corps of Engineers publication, *Safety and Health Requirements, Manual No. EM 385–1–1*, for information regarding the general safety requirements of project workers.

Material that is excavated should be examined before being used for backfill. If the material cannot be used for this purpose it should be used in embankment construction, or, with the permission from the Contract Administrator, it may be wasted if it is unsuitable for any use.

Refer to *Section 603 – Culverts and Storm Drains* of this Manual for information regarding structure excavation when in conjunction with culverts and storm drains. Additional information may also be found in sections covering the item of work with which structure excavation is included.

SECTION 207 – CHANNEL EXCAVATION

207.1 – GENERAL

Channel excavation is that work done in the construction of a new or altered waterway usually in conjunction with construction of a structure.

207.3 – CONSTRUCTION OPERATIONS

Horizontal and vertical control of the work shall be established by the Contractor and verified by the Department. The control of the work and the determination of quantities should be discussed and understood by both parties prior to commencing the work. If there is to be a considerable amount of time between starting and completion of channel excavation, such as over the winter, intermediate or semifinal sections should be taken to avoid questions later as to whether any material moved is a result of erosion or Contractor operations.

The method of construction is usually left to the Contractor as long as the finished channel is in accordance with lines, grades, and cross sections indicated on the Plans, or as ordered. The Contract Administrator should be sure that the Contractor knows how the excavation is being measured, either by original and final sections or by paying to grade to an established template.

The determination and implementation of appropriate erosion control measures should be completed before any work begins. These measures should be reviewed with the Contractor and plan preparer. Care should be taken to ensure that stream pollution due to turbulence and erosion is kept at a minimum during excavation operations. The wetlands permit should be reviewed to ensure the impact areas shown on the permit will not be exceeded and permit conditions are complied with. The project erosion control plan should address the erosion control measures required for this work.

SECTION 209 – GRANULAR BACKFILL

209.1 – GENERAL

This section covers the furnishing and placing of special purpose backfills where called for on the Plans or as ordered. Granular Backfill and Granular Backfill (Bridge) are the two basic pay items.

209.3 – CONSTRUCTION OPERATIONS

The Specifications and Special Provisions should be checked concerning construction operations when backfilling structures, culverts and storm drains, structural plate pipes, pipe arches, and other items. The backfill material should not be placed in lifts exceeding that specified and should, in the case of pipes, be brought up evenly on both sides at the same time. When backfilling structures, marking the side of the concrete footings with the correct lift increments is one method of checking lift depths. As material is being placed and compacted, a sufficient number of density tests should be conducted to ensure compliance with Specifications.

Compaction operations using vibratory rollers should be carefully monitored in order to prevent possible movement of structures due to over–vibration. A recommended procedure is to perform a test strip by taking extra density tests at the start of the backfill operation to determine the exact number of passes needed by the vibratory roller to achieve the required density. No more than this required number should be allowed unless additional density tests indicate the need for a more passes.

Water puddling should be avoided due to the excessive fluid pressures that may be imposed on the structure, but to achieve the required uniform density, water is usually required to keep the soil near its optimum moisture during compaction operations.

SECTION 210 – INSTRUMENTATION

210.1 – GENERAL

This section covers furnishing, installing, maintaining, and protecting Geotechnical Instrumentation where called for on the Plans, in the Contract or as ordered. Instrumentation is necessary to monitor any foundation settlement, slope differentials, and tilting of structures that may occur. The Special Provisions describe the requirements for the instrumentation necessary for a particular project. Most instrumentation requires close cooperation with the Geotechnical Section of the Materials and Research Bureau.

Data collected in the field should be forwarded to Materials and Research for interpretation. The Contract Administrator should work closely with the Geotechnical Section in order to assure all phases of inspection are complete, whether by Materials and Research or Construction personnel. The Contract Administrator should also make clear when and how data will be collected, recorded and processed.

210.3 – CONSTRUCTION OPERATIONS

A. Settlement Platforms

Settlement platforms are used to monitor settlement of a compressible layer such as clay. Clay is made up of fine particles of hydrous minerals, and the consolidation of clay is a time–dependent process as the water is slowly “squeezed” out of the material. The time for consolidation can be predicted by design engineers based on the clay properties and the distance the water needs to travel to exit the clay material.

Wick drains and sand blankets are often installed to reduce the distance the water needs to travel, therefore increasing the rate of consolidation. The consolidation begins as the clay layer is loaded with embankment material or in the case of some structures preloaded or surcharged. Settlement platforms are installed and monitored to provide the Geotechnical Engineers with the rate of settlement of the clay layer so that they can accurately determine when the clay has consolidated enough to support construction operations.

The Contractor shall maintain the correct elevation on the riser pipe of the settlement platform. Once the bottom elevation is determined, a file mark should be scored near the top (but below the threads) of the first riser pipe at an even elevation. This mark should be transferred upward from riser pipe to riser pipe as the fill progresses so that there is always a visible mark of known elevation.

Note: Care must be taken to ensure the riser pipe remains plumb and is not disturbed by the settling process.

B. Vibrating Wire Piezometers

Vibrating wire piezometers are used to measure pore water pressure in compressible clay layers that may be found below fills and embankments. A vibrating wire piezometer converts water pressure to a frequency signal via a diaphragm, a tensioned steel wire, and an electromagnetic coil. The piezometer is designed so that a change in pressure on the diaphragm causes a change in tension of the wire. When excited by the electromagnetic coil, the wire vibrates at its natural frequency. The vibration of the wire in the proximity of the coil generates a frequency signal that is transmitted to the readout device. The readout device processes the signal, applies calibration factors, and displays a reading in the required engineering unit.

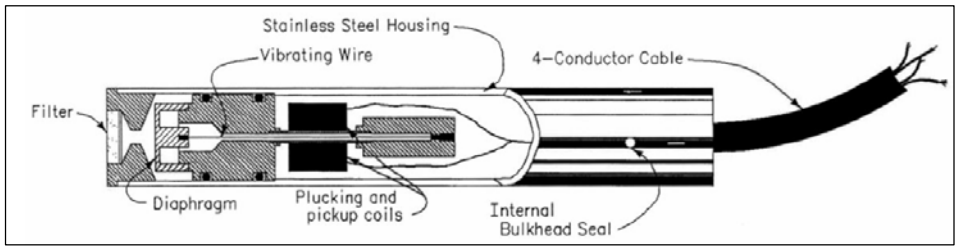

Figure 200 – 1: Vibrating Wire Piezometer Components

The Special Provisions should be checked carefully to ensure that the Geotechnical Section of the Materials and Research Bureau is notified early enough to check and calibrate the piezometers prior to installation, as well as schedule inspection of the piezometer installation.

C. Slope Inclinometers

Slope inclinometers, which indicate any horizontal movement of the soil in a particular area, consist of a casing with a wand inserted in a borehole. The space between the borehole and the casing is filled with grout per the Special Provisions. The casing, which has grooves at an angle of 90°, accepts a calibrated wand that measures any horizontal deviation in the casing. As with all other types of instrumentation, careful coordination with Materials and Research Bureau is required.

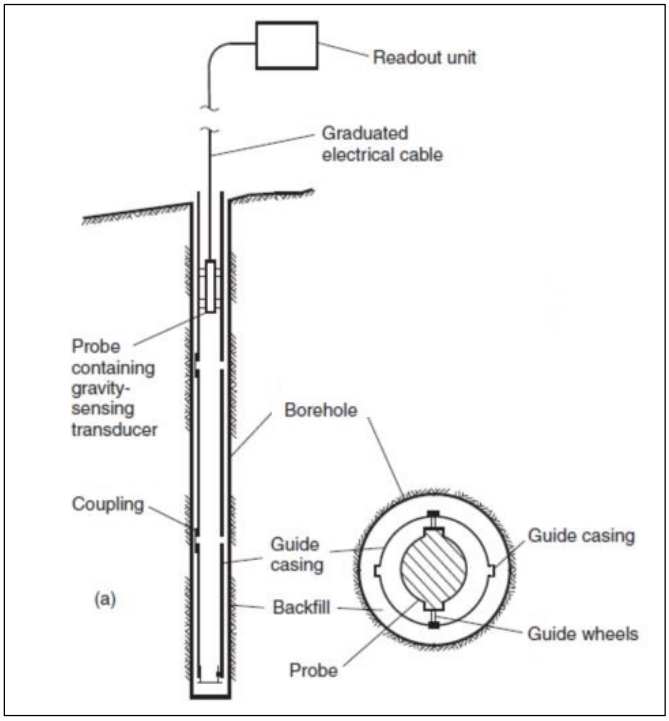

Figure 200 – 2: Slope Inclinometer Components

D. Permanent Bench Marks

Areas subjected to settlement may influence conventional survey benchmarks. Permanent benchmarks may need to be installed that are founded on a suitable bearing stratum such as ledge. These permanent benchmarks may then be used to monitor settlement platforms, and provide reference construction elevations with confidence.

E. Test Borings

Test borings are used to provide necessary geotechnical information as the project progresses. As many construction procedures involve soil compaction, it is necessary to confirm that the proper soil compaction has been achieved. The Materials and Research Bureau must be notified prior to test borings as described in the Special Provisions.

F. Tiltmeters

Tiltmeters are used to measure any angle of tilt in structures such as bridges and retaining walls which may indicate settlement or other foundation integrity issues. A tiltmeter consists of a sensor mounted in a frame with machined surfaces that facilitate accurate positioning of the unit on or next to a tilt plate. The tilt plate is attached to the structure being evaluated. The bottom surface of the tiltmeter is aligned with horizontally–mounted tilt plates and the side surfaces are aligned with vertically–mounted tilt plates.

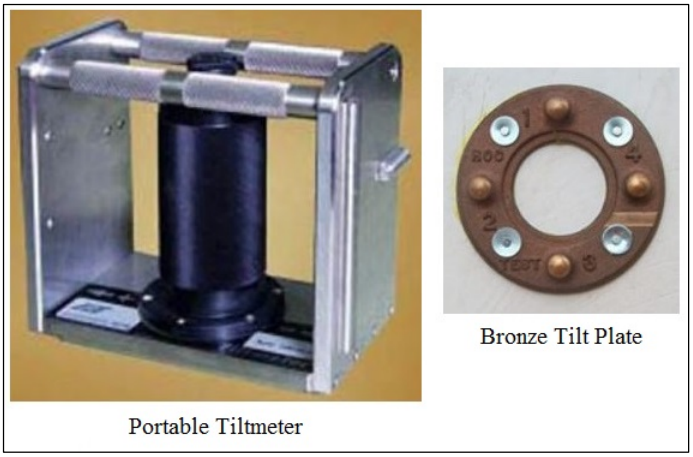

Figure 200 – 3: Tiltmeter and Tilt Plate

The Materials and Research Bureau specifies different types of instrumentation to meet specific site requirements. The effectiveness of the instrumentation requires careful, precise installation by the Contractor and diligent inspection on the part of the Materials and Research Bureau and/or the Contract Administrator and Project Personnel.

SECTION 214 – FINE GRADING

214.1 – GENERAL

Fine grading work involves the grading necessary to prepare the subgrade for the base material, to prepare each base material for the succeeding course, and to prepare the final course for pavement, including shoulders. The project personnel must be aware that the Specifications stipulate that the finished surface shall be uniform, true to grade, and free from segregation. This fact should be documented in the project daily reports, and/or record book.

Figure 200 – 4: Fine Grading Operations

A discussion on the fine grading between the prime Contractor, the paving Contractor, and the Contract Administrator is also recommended prior to starting any paving operation. Also included is the final grading of the balance of the roadway from the shoulders to the top or toe of slope.

The NHDOT's inspection responsibilities for fine grading do not change because the contract calls for QC/QA paving. The specification requirements for fine grading remain the same and as a result the project field staff must ensure that the final base course – the finished surface – exhibits the following gradation characteristics:

A homogeneous consistency with no contamination

No protrusions, depressions, or voids

Meets the minimum density requirements

Shaped to the correct profile grade and cross slope

Consistent and smooth from station to station

When checking the fine grading for cross slope, the actual cross slope value should be recorded in a field book. This information is most often furnished to the Contractor prior to QC/QA paving and is always beneficial should a surface problem, such as storm runoff, arise after paving.

214.3 – CONSTRUCTION OPERATIONS

The importance of a well–prepared subgrade cannot be overemphasized. The control of the work and the determination of quantities should be discussed and understood by all parties before commencing the work. The finished subgrade must be compacted with final densities taken and verified, and the subgrade configuration must be geometrically correct before any base course materials are applied. Horizontal and vertical control of the work should be established by the Contractor and verified by the Department.

Prior to any fine grading of the final course of a foundation material, the roadway should be inspected to check for the following conditions:

Any contamination of the surface from spillage or tracking in of foreign material. Any contaminated gravel must be removed and replaced.

Any degradation of the subgrade material due to traffic. Samples from the top 4 in of material should be taken to determine the amount of degradation and to indicate whether corrections can be made by scarifying and mixing the existing material or whether it will be necessary to remove and replace the unsuitable material to produce a satisfactory uniform gradation.

Any hard compacted surfaces subject to degradation. Where the fine grading for pavement does not directly follow the placing and initial compaction of the subgrade materials, the surface may become hard packed, glazed, and pot–holed from traffic or from the Contractor's equipment. These areas must first be

scarified for the full width of the traveled way and to a depth below any low spots, or the finished fine graded surface, whichever is lower. This will result in an evenly compacted surface that is an important component in the construction of a satisfactory riding surface.

The final course of base material is fine graded through the use of "blue tops" which should be used on all main line work, unless the fine grading is completed by the use of automated equipment. Blue tops are short wooden stakes with "feathers" which are driven into the material to be fine graded at precisely determined locations; the top of the stake represents the finished grade elevation at that point in the roadway. The name for "blue tops" comes from the "feathers" which were originally painted blue, although today blue top stakes are now usually painted red or some other bright color so that they may be easily spotted during grading operations.

Verify that the Contractor is properly locating and setting the blue tops. They should only be installed when the final course is up to grade or a little above grade and properly compacted. Computations for the actual grades should be made at all points where blue tops are to be set. These locations are usually along the roadway centerline and at the edge of the pavement, or 12 in beyond the pavement edge, with additional points every 12 ft in width for wide areas, and at key pavement points or along edges, such as at pavement breaks.

A bull point should be used to insert blue tops. If the bull point does not install the blue top properly, it may be that the subgrade material is not fully compacted. Ensure that the bull point does not create a hole deeper than the length of the blue top, which would result in the top of the stake set at a lower elevation than the grading plan and cross sections specify.

Typically one grade line will be set first and then the automation sensor on the grader will refer to this grade line as guidance for shaping the appropriate cross–slope. The grader operator then cuts the roadway to the top surface of the blue tops. With proper preparation and execution, this should produce a surface that is true to grade and template.

Since blue tops are often repeatedly covered during fine grading operations, it is essential that the stakes are promptly found and repainted by project personnel. Risers set 3 ft from the edge of the pavement and then graded may be used to check the blue top locations and elevations. This may be useful in properly replacing a stake if it is driven down into the subgrade by a roller or ripped out by a grader.

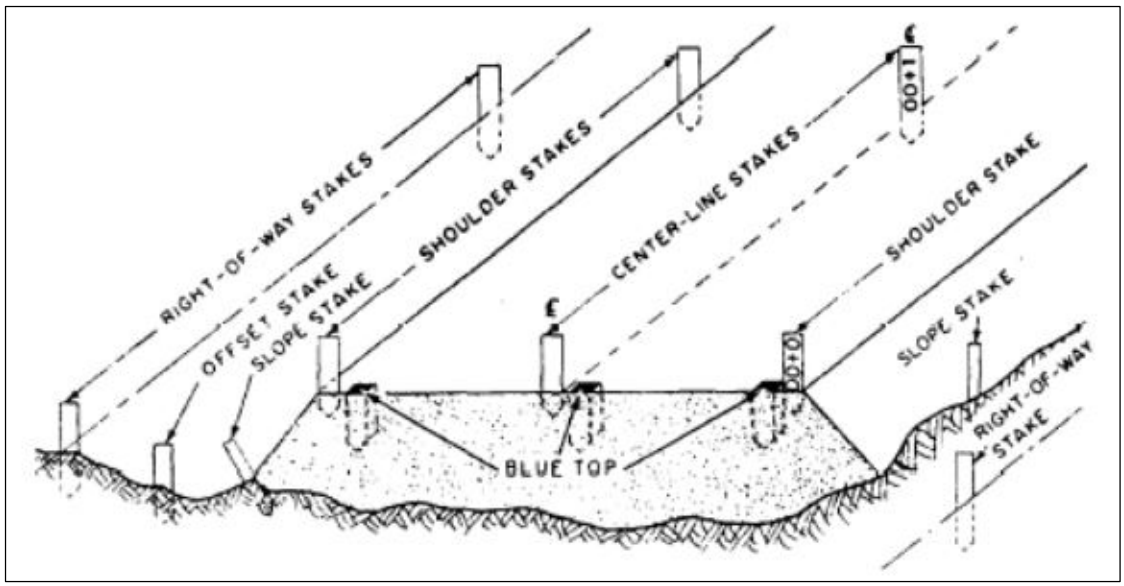

Figure 200 – 5: Typical Arrangement of Various Hubs and Stakes – Final grading

The risers also provide a means of checking for proper blue top elevations by stretching a level string across the road and measuring down with a plumb bob. Generally, blue tops verified to be within a ¼ in of the plan elevation are acceptable, but for critical areas such as a flat grade to a drainage structure, tighter tolerances may be warranted.

Checking grade and cross–slope for an automated fine grading operation can generally be completed in the same fashion. It is important to check the elevation of the string line or other reference data at the beginning of the grading operation. Verify that the grader's automation equipment is running properly at all times, and that the grader operator is provided the correct cross–slope information, paying particular attention to variations from the typical section.

Figure 200 – 6: Checking Line and Grade

Assuming that the elevations are correct, spot–checking the cross–slopes can be accomplished in a number of ways. Automatic levels, hand levels, or smart levels may be utilized. If assistance is needed in spot–checking the cross–slopes, the Contractor should work closely with Department personnel to ensure that the cross–slopes are properly configured.

Use of the appropriate fine grading equipment is also an important factor in the fine grading process. The grader must be in good mechanical and operating condition with a sharpened cutting edge, tight control arm joints, and a snug fitting circle. The roller and water truck that accompany the grader must also be in good mechanical and operating condition.

Along with the proper equipment, a properly trained and prepared grader operator is also crucial to producing a finished, well–riding roadway surface. The Contractor and Department personnel should be knowledgeable about the grader operator's system and methods.

The grade and cross–slopes should be checked and rechecked as the grading work proceeds along the roadway. The grader should be working ahead with the water truck and rollers following behind. For a smooth and uniform surface, steel wheel rollers should be used to perform the finish rolling. Steel wheel rollers are effective in pushing down any protruding stones and smoothing out small ridges.

The Contract Administrator and project personnel can achieve excellent results with grading operations by following these guidelines:

Constant checking and rechecking of the grades and cross–slopes by blue tops and by eye

Constant checking and rechecking of the uniformity of grades between stations (especially from an observation point just above the graded surface, slighting along the grade)

Constant checking and rechecking of compaction of all selected materials

Elimination of any soft spots through adequate watering and rolling

Repetition of fine grading operations for an adequate length of time to achieve an optimum finished grade condition

When conditions permit, the Contract Administrator should also drive a car over a completed section of crushed gravel, if possible at design speed, to check for smoothness, side motion, or any other issues that may require closer scrutiny. Gravel shoulders, slopes, and ditches should conform to the lines as shown on the cross sections. This is usually achieved by the use of machinery, supplemented by hand labor. These areas should present an attractive appearance free of puddles, stones, and roots.

The Prime Contractor and the Paving Contractor should be aware that the paving operations may only commence upon approval of the Contract Administrator. The Contract Administrator should not feel pressured to start any work that has not been properly planned for or properly staged. A Contractor's Superintendent may feel that they have an advantage over the Contract Administrator as the paver, sizzling

at the end of a strip of gravel, waits for the word to go ahead with paving operations. It is recognized that such pressure can be enormous. However, if proper results are to be obtained, than the proper procedures must be followed and all preparations must be complete. A few extra hours spent at this time to verify that these requirements are met will be reflected in a good riding surface for years to come.