

## SECTION 201

### DIVISION 200 - EARTHWORK

#### SECTION 201 -- CLEARING AND GRUBBING

##### Description

**1.1** This work shall consist of clearing and grubbing within the limits shown on the plans or as ordered, except objects designated to be removed in accordance with other sections of these Specifications. Vegetation and objects designated or ordered to remain shall be preserved from injury or damage.

**1.2** This work shall also consist of clearing and grubbing areas of brush within the project limits, but outside the limits of clearing and grubbing shown on the plans.

**1.3** The items of removing trees, pruning trees, removing stumps, roadside clean up, and selective clearing and thinning will be used for work performed outside of the areas designated under 1.1 and 1.2.

##### 1.4 Definitions:

(a) Clearing. Cutting, removing and disposing of all trees, logs, brush, debris and vegetation within a designated area.

(b) Grubbing. Removing and disposing of all stumps and roots within a designated area.

(c) Large Tree. Tree measuring in circumference 75 in (1.9 m) and over at a point 4 ft (1.2 m) above the average ground.

(d) Small Tree. Tree measuring in circumference less than 75 in (1.9 m) but more than 12 in (300 mm) at a point 4 ft (1.2 m) above the average ground.

(e) Brush. Area of growth including grass, weeds, crops and trees measuring in circumference 12 in (300 mm) or less at a point 4 ft (1.2 m) above the average ground.

##### Construction Requirements

##### 3.1 Clearing and Grubbing of Trees and Stumps.

**3.1.1** No trees shall be cut until designated by the Engineer. Particular reference is made to fruit, ornamental or shade trees or plants at the edge of the roadside slopes. Cut or scarred surfaces of trees or shrubs selected for retention shall be painted with an approved wound dressing or treated according to other accepted arboricultural practices.

**3.1.1.1** The Contractor may be required to file an intent to cut and shall pay all charges, fees, and taxes as may be required under Chapter 79 of the RSA.

**3.1.2** All trees ordered to be cut shall become the property of and shall be disposed of by the Contractor, except as provided hereinafter. In the interest of energy and material conservation, the Contractor shall salvage wood from cut trees in accordance with standard commercial logging practices.

**3.1.3** Unless otherwise shown on the plans, clearing and grubbing shall extend 10 ft (3 m) beyond areas of excavation and 5 ft (1.5 m) beyond embankment slopes.

**3.1.4** The Contractor shall perform the work of clearing and grubbing to include the removal of only the materials specified herein. In order to conserve topsoil, rake teeth on bulldozers shall be used when removing stumps and brush unless other equipment is permitted.

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**3.1.5** Except in areas designated to be excavated, any excavation caused by the grubbing operations shall be filled with suitable material and compacted to conform to the surrounding ground.

**3.1.6** All stumps and large roots within the limits of the roadbed shall be completely removed to a depth of 3 ft (1 meter) below subgrade unless a greater or lesser depth is specified on the plans. Stumps within the limits of the roadbed below such depth and stumps under embankments or outside the roadbed shall be cut off within 6 in (150 mm) of the existing ground surface except in the area to be rounded at the top of backslopes, where stumps are to be cut off flush with the surface of the final slope line or removed at the Contractor's option.

**3.1.7** All stumps, roots, branches, brush, weeds, and other perishable material resulting from the clearing and grubbing operations shall be disposed of by an approved method. The Contractor's attention is directed to RSA 149-M regarding the fact that stumps and roots from grubbing operations are classified as solid waste. As such, these stumps shall be disposed of in permitted sites, through firms having facilities to convert the stumps to marketable products, or by grinding or chipping. Permits for sites are obtained from the New Hampshire Department of Environmental Services, Division of Waste Management. It is the responsibility of the person disposing of the stumps to obtain all the necessary permits and to comply with the New Hampshire Solid Waste Rules and Design Standards in effect at the time of disposal.

**3.1.7.1** All wood less than 5 in (125 mm) in diameter and not cut into 4 ft (1.2 m) lengths for firewood shall be chipped. Burying of brush will not be permitted. Stumps, roots, and rotten wood may be buried at approved sites on or off the project. Approved sites shall have a minimum of 24 in (600 mm) of cover material and shall be graded and shaped as directed by the Engineer. If burial is to be on private land, the agreements as to how the area is to be left shall be set forth on the Disposal Agreement form provided by the Department in accordance with 106.10. Three signed copies of the Disposal Agreement shall be furnished to the Engineer. Approval of the proposed disposal area will be contingent upon agreement by the Contractor and the property owner to leave the area in such shape that it blends with the surrounding terrain and that erosion is kept to a minimum. Without special permission, slopes shall not be left steeper than 3:1 (horizontal to vertical). No disposal area shall be left in such condition that erosion, after completion of the work, might result in water pollution by silt or other deleterious substances. Areas shall be left in such shape and condition that material does not wash and block or obstruct drainage ways. If holes caused by settlement appear, they shall be filled as directed. A release from the property owner is required prior to final project acceptance.

**3.1.7.2** Except in the case where wood is piled neatly for future use, storage locations should be outside the limits of view from the project, other highways, and residences.

**3.1.7.3** When ordered, available chipped material shall be stockpiled in the quantity directed to be used for erosion control. The Contractor may market any remaining chips or dispose of them by other approved methods.

**3.1.7.4** Unless otherwise ordered, disposal areas shall be covered with material capable of supporting vegetation and either fertilized and seeded with grass seed or planted with seedlings. Seedlings shall be set out in accordance with accepted horticultural practices as directed in the agreement.

**3.1.7.5** Unless permission is given to preserve access roads to disposal areas adjacent to highways, such access roads shall be obliterated.

**3.1.8** When fence lines go through wooded areas, a strip 3 ft (1 meter) wide shall be cleared for the fence line.

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### **3.2 Roadside Cleanup.**

**3.2.1** Roadside cleanup of leaning, dead, unsound, and unsightly trees, branches, stubs, refuse, and slash (material remaining after logging operations), generally to a limit of approximately 15 ft (4.5 m) outside the limits specified in 3.1.3 above, shall be performed where and as directed. The material shall be disposed of as provided in 3.1. This work will not ordinarily be required outside of the right-of-way lines, but the Engineer may order that portions of medians or entire medians be cleaned up under this Section. All tree trimming in connection with roadside cleanup shall be done in accordance with accepted tree surgery practices.

### **3.3 Trimming of Trees.**

**3.3.1** On trees or shrubs designated to remain, low hanging, unsound, or unsightly branches shall be removed as directed. Branches of trees extending over the roadbed shall be trimmed to give a clear height of 20 ft (6 m) above the roadbed surface. All trimming shall be done in accordance with accepted tree surgery practices.

### **Method of Measurement**

**4.1** Clearing, grubbing, and clearing and grubbing will not be measured, but shall be the acre (hectare) final pay quantity in accordance with 109.11 for the area(s) shown on the plans.

**4.1.1** Clearing for fence lines will not be measured, but shall be the acre (hectare) final pay quantity in accordance with 109.11 for the area(s) shown on the plans.

**4.2** Trees will be measured by the number of trees of each size removed or pruned.

**4.3** Stumps will be measured by the number of stumps removed measuring more than 12 in (300 mm) in circumference at the cutoff. Stumps of trees cut by the Contractor will not be measured.

**4.4** Roadside cleanup will be measured by the acre (hectare, horizontally, to the nearest 0.01 acre (0.01 hectare)).

**4.5** Selective clearing and thinning will not be measured, but shall be the acre (hectare) final pay quantity in accordance with 109.11 for the area(s) shown on the plans.

### **Basis of Payment**

**5.1** Clearing, grubbing, and clearing and grubbing are final pay quantity items and will be paid for at the contract unit prices per acre (hectare) in accordance with 109.11.

**5.1.1** When no quantity for clearing and grubbing is included in the contract, the work will be subsidiary.

**5.1.2** Clearing for fence lines is a final pay quantity item and will be paid for at the contract unit price per acre (hectare) in accordance with 109.11.

**5.1.3** When no quantity for clearing for fence lines is included in the contract, the work will be subsidiary.

**5.1.4** Clearing and grubbing in areas of brush within the project limits, but outside the limits shown on the plans will be subsidiary.

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**5.2** The accepted quantities of removed trees and their stumps will be paid for at the contract unit price per each of the size of tree specified.

**5.2.1** When an item for removing trees but no item for removing stumps appears in the contract, each stump shown on the plans as a tree and removed as ordered will be paid for at one-half the contract price of a tree of the respective size shown.

**5.2.2** This item will not include trees and stumps removed from areas paid for under clearing and grubbing, roadside cleanup, or trees or stumps previously disposed of.

**5.2.3** When there is no item for removing small trees and there is an item for large trees, small trees shall be paid for at one-half the contract price of large trees; conversely large trees shall be paid for at two times the contract price for small trees.

**5.2.4** When no quantity for large trees and their stumps is included in the contract, the removal of large trees and their stumps will be paid for as provided in 109.04.

**5.2.4.1** When no quantity for small trees and their stumps is included in the contract, the removal of small trees and their stumps will be subsidiary.

**5.3** The accepted quantity of stumps will be paid for at the contract unit price per each.

**5.3.1** When no quantity of stumps is included in the contract, the removal of stumps will be subsidiary.

**5.4** The accepted quantity of roadside cleanup will be paid for at the contract unit price per acre (hectare).

**5.4.1** When no quantity of roadside cleanup is included in the contract, work ordered of such nature will be paid for as provided for in 109.04.

**5.5** Trimming of trees where directed outside of the areas measured under the item of roadside cleanup will be paid for as provided for in 109.04.

**5.6** Selective clearing and thinning is a final pay quantity item and will be paid at the contract unit price per acre (hectare) in accordance with 109.11.

### Pay items and units:

201.01	Clearing (F)	Acre(Hectare)
201.02	Grubbing (F)	Acre (Hectare)
201.1	Clearing and Grubbing (F)	Acre (Hectare)
201.21	Removing Small Trees	Each
201.22	Removing Large Trees	Each
201.31	Tree Pruning, Small Trees	Each
202.32	Tree Pruning, Large Trees	Each
201.4	Removing Stumps	Each
201.6	Clearing for Fence Lines (F)	Acre (Hectare)
201.7	Selective Clearing and Thinning (F)	Acre (Hectare)
201.89	Fertilizing Individual Trees	Ton (Metric Ton)
----	Roadside Cleanup	Extra Work
----	Trimming of Trees	Extra Work

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### *SECTION 202 -- REMOVAL OF STRUCTURES AND OBSTRUCTIONS*

#### **Description**

**1.1** This work shall consist of the demolition, removal and satisfactory disposal of buildings, including contents, foundations, above ground fuel storage tanks in and adjunct to buildings, decommissioning of septic systems and wells, and other obstructions pertaining thereto, as designated on the plans or in the contract.

**1.2** The work shall also consist of the removal and salvage, satisfactory disposal of pipes or filling abandoned pipes with flowable fill, and other items as designated on the plans or ordered.

**1.3** When the item of demolishing buildings is shown as “subject to prior removal”, the Department reserves the right to arrange for the removal or demolition of the building or buildings that have been designated on the plans to be removed by others prior to a specified date. If the buildings have not been completely removed by others prior to that date, the work to be done shall be that described in 1.1 and 1.4.

**1.4** Salvaging of designated materials; removing or breaking up, as ordered, of septic tanks; backfilling any resultant spaces, trenches, holes, or pits including dug wells and cesspools; furnishing and erecting temporary barricades; and the final grading and cleaning up of the site shall be included under this work unless such work is included under other items in the contract.

#### **Material Requirements**

**2.1** Backfill material shall conform to AASHTO M 57 using the definitions given in AASHTO M 146, except the density requirements shall conform to 203.3.8.

**2.2** Flowable fill for filling abandoned pipes shall consist of materials conforming to 520.2 as appropriate, mixed in the following approximate proportions per cubic yard (cubic meter) to form a mixture with a minimum 28 day compressive strength of 100 psi (0.70 Mpa)

Portland Cement (Type II)	20 lb. (9 kg)
Ground Granulated Blast Furnace Slag	100 lb. (45 kg)
Sand	2,830 lb. (1280 kg)
Water	40 - 50 gal (150 - 190 l)
Air Entrainment	10 - 15 percent

#### **Construction Requirements**

##### **3.1 General.**

**3.1.1** The Contractor's attention is directed to 104.08. The Contractor must also comply with all Federal, State, and local laws and regulations for removal, transportation, and disposal of structures and obstructions. As ordered, the Contractor shall raze, remove, and dispose of all buildings and foundations, structures, fences, and other obstructions any portions of which are on the right-of-way except utilities and those obstructions for which other provisions have been made for removal. All designated salvageable material shall be removed without unnecessary damage in sections or pieces that are readily

transportable, and shall be stored by the Contractor at specified places within the project limits. Unusable perishable material shall be destroyed. Nonperishable material not designated for salvage shall be buried as directed or, with written permission of the property owner, may be disposed of off the project provided that the material remains outside the limits of view from the project, other highways, and residences. Copies of all such agreements with property owners shall be furnished to the Engineer. If disposal is by burial on private land, it must be in accordance with 106.10.

**3.1.2** Blasting or other operations necessary for the removal of an existing structure or obstruction, that may damage new construction, shall be completed prior to placing the new work.

**3.1.3** Foundations and holes resulting from operations, except within the limits of subsequent excavation, shall be backfilled in accordance with the provisions of 203. If caving has occurred, the caved material shall be removed before backfilling is undertaken. All excavated material shall be used or disposed of in accordance with the provisions of 203.

## **3.2 Demolishing Buildings.**

**3.2.1** In the case of buildings to be demolished, the Engineer will notify the Contractor when any building becomes available. Upon notification of availability, ownership of the building or buildings, including all equipment, fixtures, building materials, and debris remaining on the lot, except facilities belonging to a public or private utility company, shall transfer from the State to the Contractor.

**3.2.2** The Contractor shall ascertain whether any water, sewer, gas, electric, cable TV, or telephone services are still connected to the building; if so, the Contractor shall disconnect and terminate all services in compliance with the requirements of the controlling municipality or company and then proceed with the demolition of the building.

**3.2.3** The Contractor shall protect all openings resulting from demolition or removal by use of temporary barricades as necessary for the protection and safety of the public. All barricades and obstructions shall be illuminated at night when ordered.

**3.2.4** Basements remaining in embankment areas shall be cleared of all interior partition walls, materials, equipment, and debris. When directed, to provide vertical drainage, the floor shall be thoroughly broken up into pieces no larger than 4 ft<sup>2</sup> (0.4 m<sup>2</sup>) or shall be perforated at least every 10 ft (3 m), lengthwise and crosswise, with holes 1 ft<sup>2</sup> (0.1 m<sup>2</sup>) or more in area. Foundation walls shall be pushed in or removed to at least 1 ft (300 mm) below the adjacent ground level.

**3.2.4.1** When the Engineer has ascertained that the above provisions have been complied with, the basement shall be filled to the level of the surrounding ground with the same type of material as that found at the site and shall be compacted as ordered.

**3.2.5** When the buildings have been substantially demolished and removed by others, the Engineer may require the Contractor to remove and dispose of rubbish and debris; demolish foundations; break up basement floors; clean the basement of partitions and other materials; clean up the site; and grade, loam, seed, fertilize, and mulch the area.

**3.2.6** All materials that result from building demolition shall be disposed of by an approved method. The Contractor's attention is directed to RSA 149-M in that building demolition material is classified as solid waste and as such shall be disposed of only in permitted sites. New Hampshire Department of Environmental Services, Division of Waste Management is the permitting agency.

**3.2.7** Existing sewer laterals or septic system shall be decommissioned. Existing sewer laterals shall be disconnected and capped. The septic system shall be decommissioned by pumping out the septic

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tank, removing or breaking up the septic tank, removing any pipes or chambers, if in existence, aerating leach field material, and burying aerated leach field material a minimum of one foot below existing ground.

**3.2.8** Existing dug wells shall be sealed in accordance with N.H. Water Well Board Administrative Rules, section We 604.04. Existing dug wells shall have the cover and well tiles removed to an elevation of two feet below the proposed roadway excavation or within two feet of the finished ground. The well shall then be backfilled with gravel free of organic matter to within 2 feet of roadway subgrade or finished ground in accordance with the requirements of 304.3 as appropriate. The remaining two feet outside and/or below the roadbed shall be filled with impervious material such as clay or hardpan.

**3.2.9** The Contractor shall remove any existing pump, waterline, and miscellaneous hardware from the well. The existing pump, waterline, and miscellaneous hardware removed from the well shall become the property of the Contractor, unless otherwise noted, and shall be properly disposed of according to current State and Federal regulations. The Contractor shall notify the Engineer before removing the pump.

### **3.3 Removal of Pipes and Other Drainage Structures.**

**3.3.1** Existing pipes, catch basins, manholes, and other drainage structures, that are not to remain as integral parts of a drainage system, shall be removed as directed. Those under roadways in use by traffic shall not be removed until satisfactory arrangements have been made to accommodate the traffic.

**3.3.2** When the Engineer determines that sections of pipe removed are suitable for re-use, they shall be stockpiled, where directed, within the project area; when not suitable for re-use, they shall be disposed of by the Contractor. Catch basin and drop inlet grates, manhole covers, frames and all such castings, and granite curb inlets shall be carefully removed and likewise stockpiled for salvage by the State. Other parts of catch basins, drop inlets, and manholes shall be disposed of by the Contractor.

**3.3.3** Trenches and holes resulting from removal operations, except those within the limits of subsequent excavation, shall be backfilled in accordance with the provisions of 203. If caving has occurred, the caved material shall be removed before backfill is undertaken. All excavated material shall be used or disposed of in accordance with the provisions of 203.

### **3.4 Removal of Underground Storage Fuel Tanks and Hazardous Materials.**

**3.4.1** The Contractor shall perform all work as shown on the plans and specified in the contract.

**3.4.2** Contractor's attention is directed to the regulations that may affect the removal operations relative to contaminated soil identification, removal, and disposal; tank removal, transportation, and disposal; and site safety as follows:

National Fire Safety Code, Chapter 30, Appendix B  
New Hampshire Hazardous Waste Rules He-P 1905  
Water Supply WS 411  
US Laws 49CFR 173.29 and 40CFR part 280

### **3.5 Asbestos cement pipe.**

**3.5.1** When construction operations encounter and require the disturbance of asbestos cement pipe, the removal, transportation, and disposal thereof shall be in accordance with Env-Wm 3906 and other applicable Federal, State and local rules, regulations and guidelines. The Contractor shall be licensed per He-P 5011 for asbestos waste disposal and shall follow all procedures that are necessary to officially close

an asbestos waste site. Submit an Asbestos Disposal Site Plan (ADSP) in accordance with Env-Wm 3906 for documentation to the Engineer. A change in rule interpretation by the Department of Environmental Services releases the Contractor from the requirement to formally submit an ADSP to NHDES.

**3.5.2** The ADSP shall be prepared by a Professional Engineer, (PE) or a Certified Industrial Hygienist (CIH). The ADSP shall be submitted to the Engineer for review to ensure that the scope of work defined is adequate and addresses the proposed project scope of work at the site.

**3.5.3** During the impact to the AC pipe, the Contractor will provide a qualified technician at the job site to conduct work inspections for asbestos hazards and perform air monitoring in accordance with the final site asbestos contingency plan. The EH & S technician will be supervised by the Contractor's project manager and certified industrial hygienist. Services will not include OSHA hazard unless otherwise agreed to.

**3.5.4** A final report will be prepared including findings and results for testing and observations completed by the Contractor, analytical results, methodology, accreditation statements for testing work and other related discussions as applicable

**3.6 Removal of Guardrail.**

**3.6.1** Existing guardrail that is not to remain as an integral part of the Project shall be removed as specified in the Contract documents or as directed. Beam and cable guardrail, in whole or in part designated to be salvaged, shall be carefully removed and handled in a manner that will allow reuse. Buckets, brackets, bolts, nuts, and miscellaneous hardware shall be placed in suitable containers for storage. Guardrail designated to be salvaged shall be stored in accordance with 3.1.1.

**3.6.2** Beam and cable guardrail, fittings, hardware, post, and blocks determined unfit for reuse, or not designated for salvage, shall be disposed of in accordance with 3.1.1.

**3.7 Abandon Pipes.** Existing pipe or drainage structures or portions of designated to be abandoned in place shall be filled with flowable fill.

**3.7.1** Ends of pipes and longitudinal drainage structures shall be capped or blocked closed with vents to allow air to escape and flowable fill to show when drainage structure is full.

**3.7.2** Proportioning, batching, placing and curing of flowable fill shall conform to the appropriate sections of 520.3.

**3.7.2.1** Test data of the proposed mixture shall be submitted to the Engineer for review and approval prior to placing.

**Method of Measurement**

**4.1** Individual buildings, or groups of buildings when such are designated as a separate unit, will each be measured as a unit. When more than one unit is specified in the contract, separate item numbers will appear for each separate and complete unit.

**4.2** Pipe removed will be measured by the linear foot (linear meter) to the nearest 1 foot (0.1 meter) within the specified size group, measured in place prior to removal if practicable; otherwise, the length of pipe removed will be computed as the product of the number of commercial lengths and the nominal lengths.

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**4.2.1** All solid rock will be measured as rock structure excavation. Boulders, mortared structures such as headwalls, and the like, found to measure 1 yd<sup>3</sup> (0.8 m<sup>3</sup>) or more, will also be measured as rock structure excavation when such excavation is performed for pipe removal, but pipe itself will not be measured as rock.

**4.3** Catch basins, drop inlets, and manholes removed will be measured by each. No extra measurement will be made for granite curb inlets removed unless an item therefore is included in the contract.

**4.4** Curb removal for storage will be measured by the linear foot (linear meter) to the nearest 1 foot (.01 meter).

**4.4.1** Removal of Bituminous curb and/or curb board with fillet will not be measured.

**4.5** Removal of guardrail will not be measured, but shall be the linear foot (linear meter ) final pay quantity in accordance with 109.11 for material removed as shown on the plans.

**4.6** Fill abandoned pipe will be measured by the cubic yard (cubic meter) to the nearest 0.1 of a cubic yard (cubic meter) of flowable fill based on delivery slips of material placed.

**4.6.1** Flowable fill removed because of faulty workmanship, or remaining in the delivery vehicle will not be included in the pay quantity.

### Basis of Payment

**5.1** The accepted quantities of buildings, pipes, box culverts, catch basins, drop inlets, manholes, curb removal for storage and other obstructions demolished or removed will be paid for at the contract price per unit of measurement for each of the pay items listed hereinafter.

**5.1.1** Except for removal and disposal of asbestos cement pipe, no payment will be made herein for the removal of obstructions encountered within the payment limits of another excavation item in the contract.

**5.1.2** Removal of the pump, waterline and miscellaneous hardware from the well will be subsidiary.

**5.2** There will be no separate payment for excavation for items paid for herein except that rock measured under 4.2.1 will be paid for under 206.2.

**5.2.1** Gravel and the impervious material for backfilling the well(s) will be subsidiary.

**5.3** Existing pavement removed will be paid for under the pertinent excavation items.

**5.4** The following provisions are in connection with the item of demolishing buildings:

**5.4.1** There will be no separate payment for the cost of any utility work including charges, if any, that may be made by the municipality and utility companies.

**5.4.2** If the bid is such that the Contractor is to pay the State, the Contractor shall indicate such payment by writing the word "credit" and deducting such amount in arriving at its total bid.

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**5.4.3** The State cannot assume responsibility and must be held harmless for damage to buildings or losses of or from buildings between the date of advertising for bids and the time the Contractor can take possession.

**5.4.4** Work performed under 3.2.5,3.4 and 3.5 will be paid for either under pertinent items of the contract or as provided under 109.04.

**5.5** When no basis of payment for the removal of structures and obstructions is included in the contract, such work will be subsidiary except as provided for in 5.4.4.

**5.6** Removal of guardrail is final pay quantities and will be paid for at the contract unit price per linear foot (linear meter) in accordance with 109.11.

**5.6.1** Removal of bituminous curb and/or curb board with fillet will be considered subsidiary to removal of guardrail.

**5.6.2** No separate payment will be made for the removal of guardrail anchors or terminal units.

**5.7** There will be no separate payment for backfill material and such work will be subsidiary to the respective removal item.

**5.8** There will be no separate payment for decommissioning sewer laterals or septic systems and such work will be subsidiary to demolishing buildings.

**5.9** The accepted quantities of fill abandoned pipe or drainage structure will be paid for at the contract unit price per cubic yard (cubic meter) complete in place. Capping or blocking and vents will be subsidiary.

### Pay items and units:

202.1	Demolishing Buildings Subject to Prior Removal	Unit
202.101	Demolishing Buildings Subject to Prior Removal	Unit
202.120	Demolishing Buildings Subject to Prior Removal	Unit
202.2	Demolishing Buildings	Unit
202.201	Demolishing Buildings	Unit
202.210	Demolishing Buildings	Unit
202.31	Fill Abandoned Pipe	Cubic Yard (Cubic Meter)
202.41	Removal of Existing Pipe 0 to 24 in (0 to 600 mm) Diameter	Linear Foot (Linear Meter )
202.42	Removal of Existing Pipe Over 24 in(600 mm) Diameter	Linear Foot (Linear Meter)
202.43	Removal of Existing Asbestos Cement Pipe, 0 to 24 in (0 to 600 mm) Diameter	Linear Foot (Linear Meter)
202.5	Removal of Catch Basins, Drop Inlets, and Manholes	Each
202.51	Removal of Granite Curb Inlets	Each
202.6	Curb Removal for Storage	Linear Foot (Linear Meter)
202.7	Removal of Guardrail (F)	Linear Foot (Linear Meter)
202.9	Removal of Fuel Tanks	Unit

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### SECTION 203 -- EXCAVATION AND EMBANKMENT

#### Description

**1.1** This work shall consist of excavation of all material not being removed under some other item, placement and compaction of all material required for the work, and necessary disposal of all other material. The excavation will be classified as described below. Embankment-in-place shall consist of furnishing, placing and compacting the total volume of embankment material required to construct fills below subgrade and within template lines as shown on the plans excluding slope protection measures and landscaping treatments paid under separate items.

**1.2** This work shall consist of constructing guardrail terminal unit platforms as shown on the plans or as ordered.

#### Classification of Material

**2.1** Common excavation shall consist of all excavation not included as rock excavation or not otherwise classified. Glacial till or boulder clay will be considered as common excavation.

**2.2** Rock excavation shall consist of all solid rock that cannot be removed without blasting or ripping. It shall also consist of boulders and parts of masonry structures, except unreinforced concrete slabs less than 6 inches in depth, when found to measure 2 yd<sup>3</sup> (1.5 m<sup>3</sup>) or more.

**2.3** Unclassified excavation shall consist of all materials of whatever character encountered in the work.

**2.4** Muck shall consist of deposits of saturated or unsaturated organic soils having an organic content of 20 percent or greater by weight as determined by AASHTO T 267 and is greater than 2 feet (0.6 meters) thick when in the upper soil profile (topsoil) and is determined to be unsuitable for foundation material. The material contains partially decayed organic matter, is fibrous in texture, dark brown or black in color, and has an odor of decay.

**2.5** Embankment material shall conform to AASHTO M 57 using the definitions given in AASHTO M 146, except the density requirements shall conform to 203.3.8.

**2.6** Concrete class F, flowable fill may be requested in writing as a substitute for embankment. Approval shall be in consideration of, but not limited to, differential frost heaving due to dissimilar materials, unit weight, structural requirements, lack of permeability, and damming resulting from water flow cut off.

**2.7** Unsuitable material shall consist of any saturated or unsaturated natural or man-made material such as, but not limited to, stumps, vegetation, demolition debris and structures encountered during the work that the Engineer determines to be unsuitable for foundation material.

**2.8** Gravel and crushed gravel for shoulder leveling for guardrail platforms shall conform to 304.2.4 and 304.2.6 respectively.

#### Construction Requirements

**3.1 General.** The excavation and embankments shall be finished to reasonably smooth and uniform surfaces.

**3.1.1 Conservation of growth.** Excavation shall be carefully performed in the proximity of trees and shrubs designated to be saved on the plans or as ordered. Any roots that have to be removed shall be cleanly cut, and the larger roots shall be painted with approved wood dressing or treated according to other accepted arboricultural practices.

**3.1.2 Topsoil and other humus material.** Topsoil and desirable humus material shall be removed in excavation areas and also in fill areas to such depths as the Engineer may direct. Such material shall be reserved and shall be stockpiled in accessible piles that can be measured readily and accurately by the Engineer. Unless otherwise permitted, each stockpile shall contain a minimum of 200 yd<sup>3</sup> (150 m<sup>3</sup>), and have a height of at least 4 ft (1.2 m).

**3.1.3 Material found in the roadway.** Sand, gravel, or other materials found in the roadway may be used under the specific item in accordance with 104.08 when permitted.

**3.1.4 Removing abandoned road surface.** Old road surfaces shown or ordered to be removed shall be stripped neatly to the depth and width as shown on the plans or as ordered.

**3.1.5 Drives.** Drives shall be retained or constructed as shown on the plans or as ordered.

## **3.2 Rock Excavation.**

**3.2.1 Preliminary work.** When rock excavation is to be performed, the overburden shall be removed, or trenches shall be excavated through the overburden at the intervals directed, normally 25 ft (10 m), but in no case closer than 10 ft (5 m) apart to permit cross-sectioning of the rock in its original position. The use of power equipment will be satisfactory. Rock removed prior to sectioning will be considered as common excavation.

**3.2.2 Blasting operations.** The required slopes or configurations shown on the plans or ordered shall be constructed in a safe and stable condition while ensuring the safety and convenience of the public.

**3.2.2.1** The Engineer will, at all times, have the authority to prohibit or halt the Contractor's blasting operations if it is apparent that through the methods being employed, the required slopes are not being obtained in a stable condition or the safety and convenience of the public is being jeopardized.

**3.2.2.2** The Contractor shall schedule blasting operations so that all rock excavation within 300 ft (90 m) of any portion of a proposed bridge or within 100 ft (30 m) of any other proposed structure is completed before any structure work is started.

**3.2.2.3** All loose and unstable material, all breakage, and all potentially unstable rock slides, even if located beyond the payment lines, shall be removed or stabilized to the Engineer's satisfaction during or upon completion of the excavation in each lift. Drilling of the next lift will not be allowed until this work has been completed. It shall be the responsibility of the Contractor to perform all phases of this work to produce the required slopes.

**3.2.2.4** Prior to commencing full-scale blasting operations, the Contractor shall demonstrate the adequacy of the proposed blasting plan by drilling, blasting, and excavating short test sections, up to 100 ft (30 m) in length, to determine which combination of method, hole spacing, and charge works best. When field conditions warrant, as determined by the Engineer, the Contractor may be ordered to use test section lengths more than 100 ft (30 m). The Engineer will have the authority to eliminate the test shot(s) if conditions warrant. Requirements for controlled and production blasting operations covered elsewhere in this specification shall also apply to the blasting carried out in conjunction with the test shots.

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**3.2.2.5** The Contractor will not be allowed to drill ahead of the test shot area until the test section has been excavated and the results evaluated by the Engineer. If the results of the test shot(s), in the opinion of the Engineer, are unsatisfactory, then the Contractor shall adopt such revised methods as are necessary to achieve the required results. Unsatisfactory test shot results include an excessive amount of fragmentation beyond the indicated lines and grade, excessive flyrock, and/or violation of other requirements within these specifications.

**3.2.2.6** All blasting operations, including the storage and handling of explosives and blasting agents, shall be performed in accordance with the applicable provisions of the Standard Specifications and all other pertinent Federal, State, and local regulations. Whenever explosives are used, they shall be of such character and in such amount as are permitted by the State and local laws and ordinances, and all respective agencies having jurisdiction over them.

**3.2.2.7** The Contractor shall observe the entire blast area to guard against potential hazards before commencing work in the cut. The Contractor shall not be allowed to store explosives on the project site or on State owned property unless prior approval is granted by the Department.

**3.2.2.8** Drill hole conditions may vary from dry to filled with water. The Contractor will be required to use whatever type(s) of explosives and/or blasting accessories necessary to accomplish the specified results.

**3.2.3 Drilling pattern and loading plan.** Unless otherwise directed by the Engineer, the Contractor shall submit for approval the proposed drilling pattern and loading plan, hereinafter referred to as the blasting plan. No drilling or blasting shall take place until approval is received from the Engineer. The blasting plans shall be submitted at least five working days prior to commencing drilling and blasting operations. The blasting plan shall include the following information:

(a) A diagrammatic description of the "Typical Blasting Pattern" to be used for the required rock excavation, including the presplitting pattern if presplitting is required. (See 3.3.) This description shall include the spacing and depth dimensions both for the holes drilled along the presplit lines (presplit holes) and for fragmentation charge holes (production holes). The relative position of the "free face" and the burden shall also be shown, along with the anticipated cap delays to be used at each hole in the pattern. An example of such a diagrammatic plan is shown in Figure 1.

(b) A diagrammatic description of the loading plan for a "Typical Production Hole" and, if presplitting is required on the project, for a "Typical Presplit Hole". This description shall include for each type of hole the fuse and cap locations, the percent strength and type of primer, the proposed hole diameter, the percent strength and type of explosives, with brand name and density of explosive, and the anticipated location and depth of stemming. An example of such a diagrammatic plan is shown in Figure 2.

(c) Subdrilling depth; amount of explosives, primers, and initiators in each hole; initiation sequence of blastholes including delay times and delay system; and manufacturer's data sheets for all explosives, primers, and initiators to be used.

**3.2.3.1** When a blasting plan is required, it shall form the basis for all blasting operations on the project. If, in the judgment of either the Engineer or the Contractor, changes in the plan appear to be necessary, drilling or blasting operations shall be suspended and a revised plan shall be submitted to the Engineer reflecting the proposed changes. No further drilling or blasting shall take place until approval of the revisions is received from the Engineer.

**3.2.3.2** Approval of the blasting plan will not relieve the Contractor of full and complete responsibility for the results of the blasting operations. The Contractor also has full responsibility for the accuracy and adequacy of the blasting plan when implemented in the field. (See 107.08.)

**3.2.3.3** The Contractor shall submit the following information to the Engineer at least two weeks prior to commencing drilling and blasting operations:

(a) Sequence and schedule of production blast rounds, including the general method of developing the excavation, lift heights, starting locations, estimated starting dates, estimated rates of progress, etc.

(b) Written evidence of the licensing, experience, and qualifications of the blaster who shall be directly responsible for the loading and firing of each shot.

(c) Name and qualification of the person responsible for designing and directing the Contractor's blasting operation.

(d) Name and qualifications of the independent seismologist or blasting consultant proposed for use in conducting pre-blast condition surveys.

(e) Name and qualifications of the independent seismologist or blasting consultant proposed for use in monitoring blast vibration. (See 3.2.5.2.) A sample of a previous vibration analysis or report or both shall be included with the qualifications. The seismologist or blasting consultant shall be subject to the Engineer's approval.

(f) Listing of instrumentation which the seismologist or blasting consultant proposes to use to monitor vibrations together with performance specifications, instrumentation user's manual supplied by the manufacturer(s). (See 3.2.5.6.)

**3.2.4 Blasting log.** A blasting log must be completed daily for every primary blast, and copies must be provided to the Engineer. An example of a typical blasting log is shown in Figure 3. The drilling contractor may use a different format for its blasting log if it has been approved by the Engineer.

**3.2.5 Blast vibration control and monitoring.** The Contractor shall be required to comply with the blasting vibration limits established herein. The vibration limits shall be incorporated in the Contractor's blasting plan, as required. The Contractor shall provide for monitoring of the blasting vibrations (both ground and air concussions) produced as a result of the construction activities and shall provide a Pre-Blast Condition survey of structures. The Contractor shall cooperate in adjusting the blasting plan and procedures to maintain the vibration limits specified herein and to minimize vibration-related claims and complaints.

### 3.2.5.1 Vibration Limits.

**3.2.5.1.1 Ground limits.** The maximum peak particle velocity (PPV) of ground vibration, in any of the three mutually perpendicular components of particle velocity, for above-ground, residential structures shall not exceed the following limits:

#### Ground Vibration Limits for Residential Structures

Type of Structure	Maximum PPV, in/s (mm /s)	
	Frequencies Below 40 Hz	Frequencies 40 Hz or Greater
Modern Homes – Drywall Interiors	0.75 (19)	2.0 (50)
Older Homes – Plaster on Wood Lath for Interior Walls	0.50 (13)	2.0 (50)

**3.2.5.1.2** The maximum PPV of ground vibrations, in any of the three mutually perpendicular components of particle velocity, for non-residential structures shall not exceed 2.0 in/s (50 mm/s).

**3.2.5.1.3** The maximum PPV of ground vibrations, in any of the three mutually perpendicular components of particle velocity, for underground utilities shall not exceed 2.0 in/s (50 mm/s). Buried

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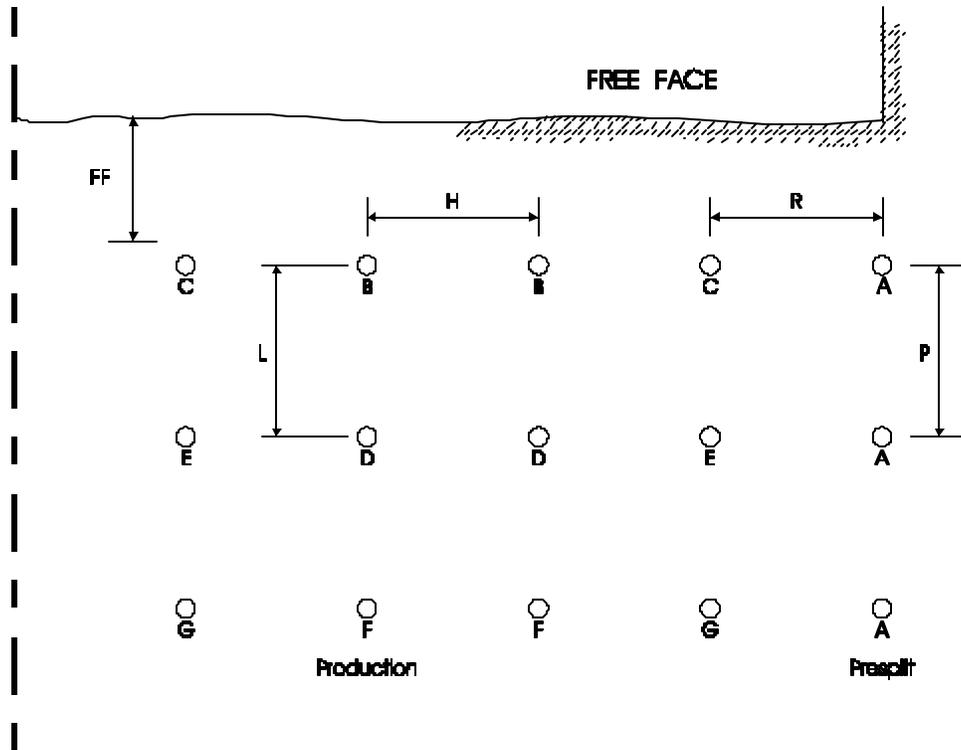
pipelines and other utilities owned by private utility companies are sometimes subject to lower limiting values imposed by the owner. The Contractor shall verify the maximum allowable PPV of ground vibrations allowed by the individual utilities. The blasting plan and blast design shall be modified accordingly to avoid damage to such utility lines.

**3.2.5.1.4** Deteriorated structures or utilities, structures housing computers or other sensitive equipment, and manufacturing processes that are sensitive to vibrations may require lower PPV limits than stated in this specification. If lower limits are required, a special provision describing the limits or conditions required will be included in the proposal.

**3.2.5.1.5** The Contractor shall not conduct blasting operations within 20 ft (6 m) of newly placed concrete (less than 14 days) without the written approval of the Engineer. For blasting greater than 20 ft (6 m) away from new concrete, the following PPV ground vibration limits apply:

### Ground Vibration Limits for New Concrete

<b>Age of Concrete</b>	<b>Maximum PPV, in/s (mm/s)</b>
Less than 3 days	No blasting
After 3 days	1 in/sec (25 mm/s)
After 5 days	1.8 in/sec (46 mm/s)
After 7 days	2.0 in/sec (50 mm/s)



**DEPTH**

TO \_\_\_\_\_ ft (mm)  
 OVER \_\_\_\_\_ ft (mm)

**HOLE DIAMETER**

\_\_\_\_\_ in (mm)  
 \_\_\_\_\_ in (mm)

**PATTERN DIMENSIONS, FEET (METERS)**

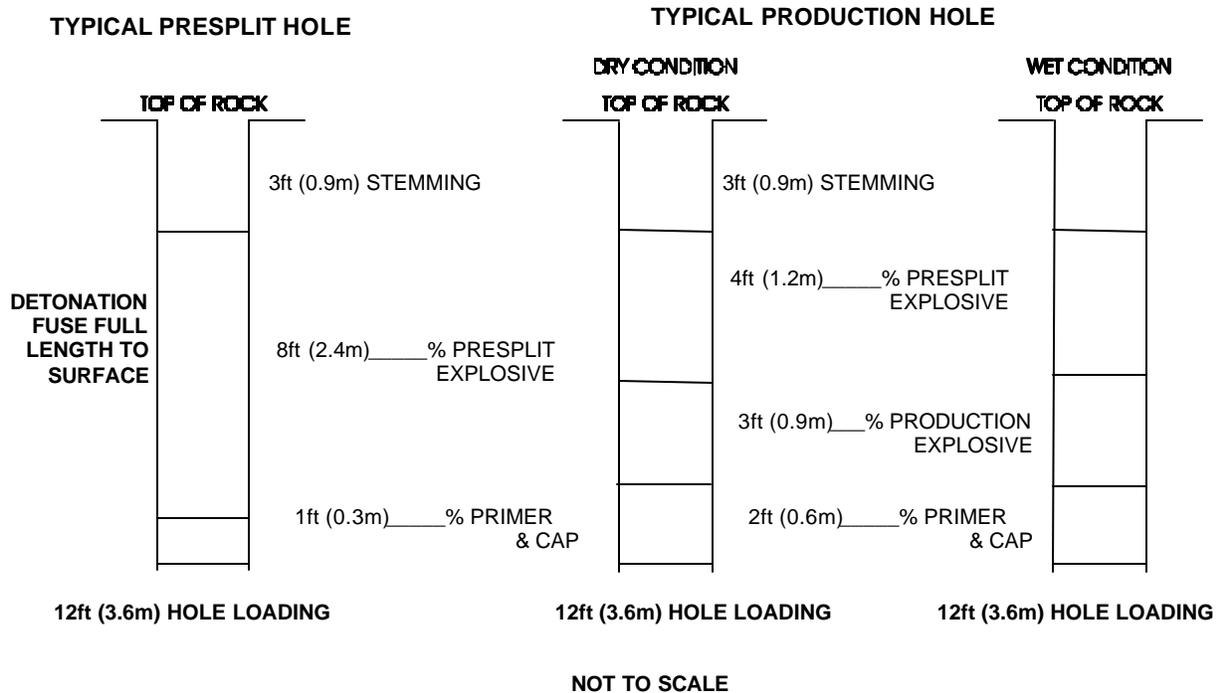
P = \_\_\_\_\_ ft (m): PRESPLITTING HOLE SPACING  
 R = \_\_\_\_\_ ft (m): FRONT ROW OFFSET  
 H = \_\_\_\_\_ ft (m): SPACING PARALLEL TO FREE FACE  
 L = \_\_\_\_\_ ft (m): SPACING PARALLEL TO PRESPLIT FACE  
 FF = \_\_\_\_\_ ft (m): DISTANCE TO FREE FACE

**CAP DELAYS (NO.)**

A = (CAP NO. 0, 1, 2, 3, ETC.)  
 B =  
 C =  
 D =  
 E =  
 F =

**FIGURE 1 – TYPICAL BLASTING PATTERN**

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**FIGURE 2 - SAMPLE LOADING PLAN**

Note: All dimensions, configurations, and loadings shown are intended only as examples of diagrammatic description and should not be construed as indicating any suggested drilling or loading plan.

**FIGURE 3  
BLASTING LOG (English)**

NHDOT Project Name \_\_\_\_\_

Federal Project No. \_\_\_\_\_ State Project No. \_\_\_\_\_

1. Company Name: \_\_\_\_\_

2. Location of Shot (Stations): \_\_\_\_\_

3. Shot Number: \_\_\_\_\_ 4. Time: \_\_\_\_\_ 5. Date: \_\_\_\_\_

6. Weather: \_\_\_\_\_

\_\_\_\_\_

7. Wind Direction: \_\_\_\_\_ 8. Temperature: \_\_\_\_\_

9. Distance & Direction to Nearest Structure: \_\_\_\_\_ & \_\_\_\_\_

10. Depth of Water (ft): \_\_\_\_\_

11. Total Explosives Allowed Per Delay Period: \_\_\_\_\_

$$\text{Weight of Explosive(s) (lb)} = \left[ \frac{\text{Distance in Feet}^*}{50} \right]^2 = \underline{\hspace{4cm}}$$

\* Distance is to the nearest structure.

12. Diameter of Holes (in): Production \_\_\_\_\_ Presplit \_\_\_\_\_
13. Depth of Holes (ft): \_\_\_\_\_
14. Total Number of Holes: \_\_\_\_\_
15. Drill Pattern – Burden times Spacing (ft): \_\_\_\_\_
16. Type and Height of Stemming (ft): \_\_\_\_\_
17. Depth of Sub-Drilling (ft): \_\_\_\_\_
18. Mats or Other Protection Used: \_\_\_\_\_
19. Types of Explosive(s) Used: Presplit \_\_\_\_\_  
Production \_\_\_\_\_
20. Density of Explosive(s) Used: \_\_\_\_\_
21. Kind of Delay Periods: \_\_\_\_\_
22. Total Number of Delay Periods: \_\_\_\_\_
23. Length of Delay Periods (milliseconds): \_\_\_\_\_
24. Total Amount of Explosives Used (lbs): \_\_\_\_\_
25. Maximum Number of Holes Per Delay Period: \_\_\_\_\_
26. Maximum Amount of Explosive(s) Per Delay Period (lbs): \_\_\_\_\_
27. Powder Factor =  $\frac{\text{Pounds of Explosives Per Hole}}{\text{Cubic Yards of Rock Per Hole}}$   
Powder Factor (lbs/yd<sup>3</sup>) = \_\_\_\_\_
28. Scale Distance =  $\frac{\text{Distance in Feet}}{\sqrt{\text{Weight Per Delay Period in Pounds}}}$   
Scale Distance = \_\_\_\_\_
29. Method of Firing: \_\_\_\_\_
30. Number of Series Circuits: \_\_\_\_\_
31. Location of Seismograph: \_\_\_\_\_  
\_\_\_\_\_  
  - a. Distance from Shot and Direction: \_\_\_\_\_
  - b. Person Taking Reading: \_\_\_\_\_
  - c. Seismograph Reading: \_\_\_\_\_

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d. Peak Sound Pressure Levels: \_\_\_\_\_

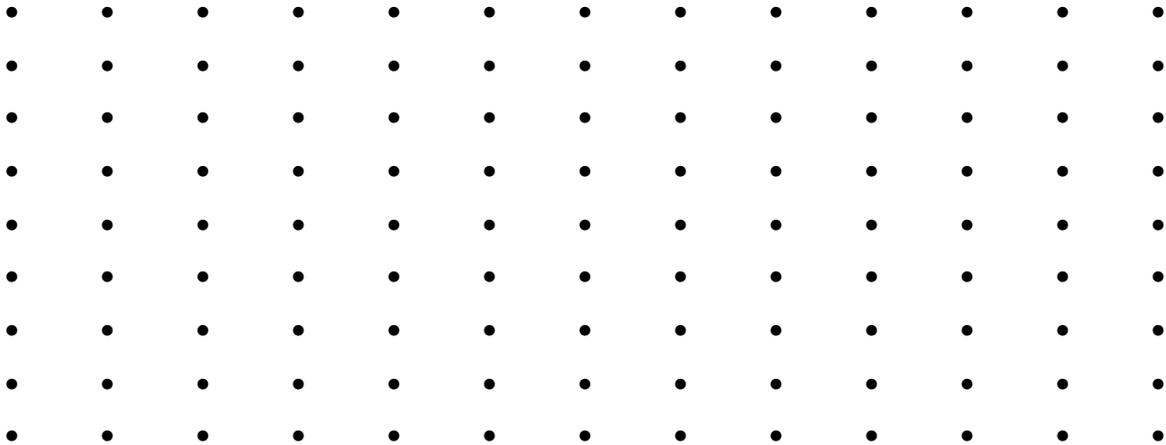
e. Vibration Measurements: \_\_\_\_\_

Transverse

Vertical

Longitudinal

DIAGRAM OF SHOT



Name of Blaster: \_\_\_\_\_

License Number of Blaster: \_\_\_\_\_

**FIGURE 3M  
BLASTING LOG (Metric)**

NHDOT Project Name \_\_\_\_\_

Federal Project No. \_\_\_\_\_ State Project No. \_\_\_\_\_

1. Company Name: \_\_\_\_\_

2. Location of Shot (Stations): \_\_\_\_\_

3. Shot Number: \_\_\_\_\_ 4. Time: \_\_\_\_\_ 5. Date: \_\_\_\_\_

6. Weather: \_\_\_\_\_

7. Wind Direction: \_\_\_\_\_ 8. Temperature: \_\_\_\_\_

9. Distance & Direction to Nearest Structure: \_\_\_\_\_ & \_\_\_\_\_

10. Depth of Water (m): \_\_\_\_\_

11. Total Explosives Allowed Per Delay Period:

$$\text{Weight of Explosive(s) (kg)} = \left[ \frac{\text{Distance in Meters}^*}{164} \right]^2 = \underline{\hspace{2cm}}$$

\* Distance is to the nearest structure.

12. Diameter of Holes (mm): Production \_\_\_\_\_ Presplit \_\_\_\_\_

13. Depth of Holes (m): \_\_\_\_\_

14. Total Number of Holes: \_\_\_\_\_

15. Drill Pattern – Burden times Spacing (m): \_\_\_\_\_

16. Type and Height of Stemming (m): \_\_\_\_\_

17. Depth of Sub-Drilling (m): \_\_\_\_\_

18. Mats or Other Protection Used: \_\_\_\_\_

19. Types of Explosive(s) Used: Presplit \_\_\_\_\_

Production \_\_\_\_\_

20. Density of Explosive(s) Used: \_\_\_\_\_

21. Kind of Delay Periods: \_\_\_\_\_

22. Total Number of Delay Periods: \_\_\_\_\_

23. Length of Delay Periods (milliseconds): \_\_\_\_\_

24. Total Amount of Explosives Used (kg): \_\_\_\_\_

25. Maximum Number of Holes Per Delay Period: \_\_\_\_\_

26. Maximum Amount of Explosive(s) Per Delay Period (kg): \_\_\_\_\_

$$27. \text{ Powder Factor} = \frac{\text{Kilograms of Explosives Per Hole}}{\text{Cubic Meters of Rock Per Hole}} \times (0.593)$$

Powder Factor (kg/m<sup>3</sup>) = \_\_\_\_\_

$$28. \text{ Scale Distance} = \frac{\text{Distance in Feet}}{\sqrt{\text{Weight Per Delay Period in Pounds}}}$$

Scale Distance = \_\_\_\_\_

Note: Formula to calculate scale distance has no metric equivalent.

29. Method of Firing: \_\_\_\_\_

30. Number of Series Circuits: \_\_\_\_\_

31. Location of Seismograph: \_\_\_\_\_

\_\_\_\_\_

a. Distance from Shot and Direction: \_\_\_\_\_

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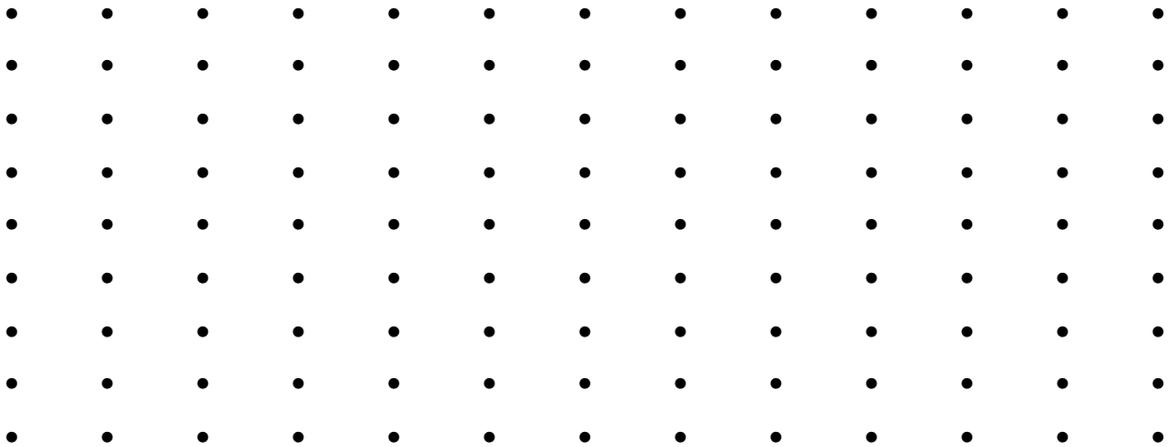
- b. Person Taking Reading: \_\_\_\_\_
- c. Seismograph Reading: \_\_\_\_\_
- d. Peak Sound Pressure Levels: \_\_\_\_\_
- e. Vibration Measurements: \_\_\_\_\_

Transverse

Vertical

Longitudinal

DIAGRAM OF SHOT



Name of Blaster: \_\_\_\_\_

License Number of Blaster: \_\_\_\_\_

**3.2.5.1.6 Air concussion.** The Contractor shall conduct all blasting activities in such a manner that the peak airblast overpressure at all above-ground, occupied structures in the vicinity of blasting does not exceed 128 dB.

**3.2.5.1.7** If blast induced ground vibrations exceed the limits for maximum PPV, then alternative rock excavation techniques may be necessary. All non-explosive methods of rock excavation are subject to approval by the Engineer.

**3.2.5.2 Seismologist or Blasting Consultant.** The Contractor will be required to retain a seismologist or blasting consultant to monitor, record, analyze, and report the seismic vibrations being caused by blasting activities. The name and résumé of qualifications of the seismologist or blasting consultant shall be submitted to the Engineer for approval no later than the preconstruction conference. No drilling or blasting shall take place until such approval is given. The seismologist or blasting consultant shall not be an employee of the Contractor, subcontractor, explosives manufacturer, or explosives distributor.

**3.2.5.3 Seismologist or Blasting Consultant qualifications.** The seismologist or blasting consultant shall be experienced in the subject of vibrations emanating from construction activities. The seismologist or blasting consultant shall be qualified to thoroughly analyze seismic parameters of the energy source, the energy transmission path, the recording site, and the ground motion spectra. The

minimum qualifying requirement to perform the necessary documentation and analysis is a Bachelor of Science degree with accredited course work in at least three of the following disciplines: Seismology, Geophysics, Geophysical Data Processing, Geomechanics, Geophysical Engineering, Vibration Engineering, Soil and/or Rock Mechanics, Foundation and/or Explosive Engineering, Advanced Calculus, and Time-Series (Fourier) Analysis.

**3.2.5.4 Seismologist or Blasting Consultant duties.** The seismologist or blasting consultant shall direct and instruct the Contractor in its operations to control vibrations within acceptable levels. The seismologist or blasting consultant shall be in charge of making the preliminary blast survey and, unless otherwise permitted in writing, shall be present at the site of the blasting during all blasts. The seismologist or blasting consultant shall provide and use all necessary equipment to observe and record vibrations to ascertain that acceptable levels of vibrations are not exceeded. The seismologist or blasting consultant shall monitor, report findings, and submit recommendations on a daily basis to the Engineer. The seismologist or blasting consultant shall determine the level of observed vibrations attributed to the project's blasting activities and their subsequent effect on surrounding structures. The seismologist or blasting consultant shall make recommendations for vibration limits to protect sensitive equipment and manufacturing processes if limits have not been predetermined. Written justification shall be provided for all recommendations.

**3.2.5.5 Pre-blast condition survey.** The seismologist or blasting consultant shall conduct a pre-blast condition survey of all existing structures and conditions on the site, adjacent to the site, or in the vicinity of the site. This survey shall extend to such structures or conditions as may be affected by the Contractor's construction operations. As a minimum, condition surveys shall be performed on all structures, including swimming pools and mobile homes, within 500 ft (150 m) of anticipated blasting areas.

**3.2.5.5.1** The pre-blast condition survey shall consist of a written description of the interior and exterior condition of each of the structures examined. Descriptions shall locate any existing cracks, damage, or other defects and shall include such information so as to make it possible to determine the effect, if any, of the construction operations on the defect. Particular note shall be made of evident structural faults and deficiencies, or recent repairs. Where significant cracks or damage exist, or for defects too complicated to document in words only, sketches and photographs shall be taken or a good quality videotape survey with appropriate audio description of locations, conditions, and defects shall be performed to supplement the written description. Pictures and sketches shall be provided with a scale where practical. Prior to the start of work, a copy of the pre-blast condition survey shall be submitted to the Engineer for review.

**3.2.5.5.2** The seismologist or blasting consultant shall give written notice to the owner of the property concerned, tenants of the property, and any representative of local authorities required to be present at the pre-blast survey. The notice shall state the dates on which surveys are to be made. Copies of all notices shall be provided to the Engineer.

**3.2.5.5.3** Prior to the start of blasting activities, the Contractor shall place an advertisement in the local newspaper and provide a notice to adjacent property owners or tenants identifying the project, blasting contractor, site location, warning signals, and precautions being taken by the blasting contractor to minimize disturbance to residents.

**3.2.5.5.4** Upon completion of all earth/rock excavation and blasting work, the Contractor shall conduct a post-blast survey of any properties, structures, and conditions for which complaints of damage have been received or damage claims have been filed. Notice shall be given to all interested parties so that they may be present during the final examination. Records of the final examination shall be distributed the same as the original pre-blast condition survey.

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**3.2.5.6 Vibration monitoring instrumentation.** All vibration monitoring instrumentation proposed for use on the project by the Contractor shall comply with the following requirements:

- (a) Measure, display, and provide a permanent record on a strip chart of particle velocity components.
- (b) Measure the three mutually perpendicular components of particle velocity in directions vertical, radial, and perpendicular to the vibration source.
- (c) Have a velocity frequency response of 2 Hz to 150 Hz, and be capable of measuring PPV of up to 10 in/s (250 mm/s).
- (d) All seismographs used on the project shall display the date of the most recent calibration.
- (e) Calibration must have been performed within the last 12 months and must be performed to a standard traceable to the National Institute of Standards and Technology.

### **3.2.5.7 Report of Monitoring Results.**

**3.2.5.7.1** Following each blast, the Contractor shall immediately report the measured vibrations to the Engineer. In the event seismic vibrations caused by the Contractor's operations approach the established limits for this project, the Engineer may require the Contractor to modify the blasting operations to reduce the vibrations. If the seismic ground vibration or air concussions or both ground vibration and air concussions caused by the Contractor's blasting operation attain or surpass the established limits, the operations shall cease. Blasting shall not be resumed until measures have been taken to reduce, to the satisfaction of the Engineer, the produced vibrations and/or air concussions below the established limits. The seismologist or blasting consultant should assist the Contractor in the design of the Contractor's blasting to eliminate the problems and to avoid liability claims.

**3.2.5.7.2** Within 24 hours following each blast, the Contractor shall submit to the Engineer in writing the following items:

- (a) Details of the shot shall include the information shown on the sample blasting log. (See Figure 3.)
- (b) Results of blast monitoring at each instrument location, including PPV in inches per second (millimeters per second), as well as a copy of the strip chart recording for each monitoring location, marked with the date, time, location of the equipment, and signature of seismograph operator.

**3.2.5.8 Pre-blast meeting.** A pre-blast meeting shall be held prior to the start of any drilling or blasting activities. The purpose of the meeting shall be to review the blasting procedures and vibration monitoring requirements and to facilitate coordination between all parties involved. Individuals attending the pre-blast meeting should include the Contract Administrator, the Contractor, the Contractor's seismologist or blasting consultant, the Contractor's blaster, the research geologist, any utility affected by the blasting operation, and any other personnel the Engineer deems appropriate.

**3.2.5.9 Blast scheduling.** The Contractor shall notify the Engineer of blast round schedules in accordance with the following requirements:

- (a) At least 24 hours in advance, notification of estimated time of blast.
- (b) At 30 minutes prior to a blast, stand-by notification.

**3.2.5.10 Warning signals.** Adequate warnings in accordance with OSHA regulation 1926.909 shall be given to all personnel in proximity to the blast site at least three minutes in advance of each blast.

**3.2.5.11 Flyrock control.** Before the firing of any blast in areas where flying rock or debris may result in personal injury or damage to property, the rock to be blasted shall be covered with approved

blasting mats, soil, or other equally serviceable material to prevent flyrock. The method of flyrock control shall be subject to approval by the Engineer.

**3.2.5.12 Responsibility for blasting operations.** Review of the Contractor's blasting submittals by the Department or its Engineer will not relieve the Contractor of its responsibility for the accuracy, adequacy, and safety of the blasting; for exercising proper supervision and field judgment; for preventing damage to structures; and for producing results in accordance with the State of New Hampshire regulations and NHDOT Specifications. The blasting contractor shall be solely and completely responsible for the safety of all persons and property during the performance of its work. The Contractor shall take whatever measures it deems necessary, in addition to the requirements herein, to protect the safety of persons and property, both at the construction site and away from the site. The Contractor shall have full and complete responsibility for the handling, discharging, or settling of any and all damage or annoyance claims resulting from the blasting activities on the project. Any monitoring and/or review of the Contractor's procedures and performance conducted by the Department or its Engineer shall not relieve the Contractor of its responsibility for safety at and away from the site, or for preventing damage to adjacent structures or property.

### 3.3 Presplitting.

**3.3.1** Presplitting will be required in rock slopes where the designed slope is 1:2 (horizontal to vertical) or steeper and the rock is 10 ft (3 m) or more in depth above the subgrade, measured along the slope.

**3.3.2** Presplitting is defined as the establishment of a free surface of a shear plane in rock by the controlled usage of explosives and blasting accessories in appropriately aligned and spaced drill holes so that the resulting split rock is not affected by subsequent blasting and excavation operations adjacent thereto. (See Figure 1.) The purpose of presplitting is to minimize damage to the rock backslope and to help ensure long-term stability. When presplitting, the detonation of the presplit line shall be before the detonation of any production holes. Production blasting refers to the main fragmentation blasting resulting from more widely spaced production holes drilled throughout the main excavation area adjacent to the presplit line. Production holes shall be detonated in a controlled delay sequence.

**3.3.3** Prior to drilling, all overburden and all loose and disintegrated rock shall be removed down to solid rock in the vicinity of the presplit lines as shown on the plans. Potentially dangerous boulders beyond the excavation limits shall also be removed as ordered.

**3.3.4** Presplitting shall extend a minimum of 50 ft (15 m) ahead of the limits of fragmentation blasting within the section, unless otherwise permitted.

**3.3.5** Unless otherwise approved, holes not greater than 3 in (75 mm) in nominal diameter, and spaced 36 in (1.0 m) on center, shall be drilled along the presplit line and at the required slope inclination to the full depth of the cut or to a predetermined stage (lift) elevation. The proper angle of drilling shall be maintained at all times so that each presplitting hole is parallel to its adjacent one and does not deviate more than 1 ft in 35 ft (300 mm in 10 m), neither in the plane of the specified slope line nor in its vertical alignment. The toe of the completed slope shall coincide, within those limits, with the toe of the slope shown on the plans. All drilling equipment used to drill presplit holes shall have mechanical or electrical devices affixed to the equipment to accurately determine the angle at which the drill steel enters the rock, unless alternate methods for aligning the drill steel are approved by the Engineer.

**3.3.6** Presplitting holes shall not exceed 35 ft (10 m) in depth unless permitted. Rock deeper than 35 ft (10 m) shall usually be presplit in lifts, but no lift shall be less than 10 ft (3 m) in depth. No payment will be made for additional excavated quantity caused by offsetting of presplit holes beyond the

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specified presplit lines in the top or successive lifts. Presplitting holes in successive lifts shall be designed to offset 2 ft (600 mm) inside of the previously presplit face.

**3.3.7** Before placing the charge, each hole will be inspected and tested for its entire length to ascertain the possible presence of any obstructions. No loading will be permitted until the hole is free of all obstructions for its entire depth. All necessary precautions shall be exercised so as to prevent debris from falling into holes prior to loading and so that the placing of the charge does not cause caving of material from the walls of the hole.

**3.3.8** The spacing of the blast holes specified above, the distribution and type of explosives, methods of detonation, and blasting techniques specified below shall be adjusted as necessary according to the breakage characteristics and structure of the bedrock encountered so as to presplit the rock along the required face.

**3.3.8.1** Results of presplitting shall be exposed for the Engineer's examination and evaluation. Based upon the Engineer's judgment of results obtained during the progress of the excavation, changes ordered in drilling or blasting methods shall be implemented by the Contractor. If the presplit face is not going to be exposed for immediate inspection and evaluation, the Engineer may require a bore hole deviation measuring system to verify the proper spacing and orientation of the presplit holes.

**3.3.9** Continuous column cartridge explosives manufactured especially for presplitting shall be used for all presplitting. The maximum diameter of explosives used in presplit holes shall not be greater than one-half the diameter of the presplit hole, unless otherwise approved. The bottom charge of a presplit hole may be larger than the line charges but shall not be large enough to cause overbreak. The upper portion of all presplit holes, from the top most charge to the hole collar, shall be stemmed. Unloaded and unstemmed guide holes (gas release holes), when used between presplit holes, shall be drilled in the same plane and to the same tolerance as the presplit holes. The guide holes shall extend the full depth of the lift, unless otherwise permitted.

**3.3.9.1** If presplitting charges are fired with detonating cord, the cord shall extend the full depth of each hole. If full or fractional portions of dynamite cartridges are used with detonating cord, the dynamite shall be securely affixed to the cord.

**3.3.10** All space in each blast hole not occupied by the explosive charges shall be filled with stemming material. Stemming material shall be clean stone chips or other approved angular, granular material as shown in Table 1.

**Table 1 -- Required Grading of Stemming Material**

Sieve Size	Percentage by Weight Passing
3/8 in (9.5 mm)	100
No. 4 (4.75 mm)	20 - 25
No. 8 (2.36 mm)	0 - 10

**3.3.11** All presplit holes may be detonated simultaneously or delayed providing the hole to hole delay is no more than 25 milliseconds. The detonation of presplit charges shall precede the detonation of adjacent fragmentation charges within the section by a minimum of 25 milliseconds.

**3.3.12** The line of blast holes immediately adjacent to the presplitting slope holes shall be drilled 4 ft (1.2 m) from and on a plane approximately parallel to the plane of the presplitting slope holes. No portion of these holes or any other blast holes will be permitted closer than 4 ft (1.2 m) to the presplit

lines. All precautions as necessary shall be taken so as to avoid fracturing the rock beyond the presplit face.

**3.3.13** The Engineer may order the discontinuance of the presplitting operations when the rock formation is of such character that no apparent advantage is gained.

**3.3.14** The Contractor may use cushion (trim) blasting if conditions warrant it and if, in the opinion of the Engineer, satisfactory results are obtained during the test shot(s). Cushion blasting is similar to presplitting except that the detonation along the cut face shall be performed after the detonation of all production holes. Difference in delay time between the trim line and the nearest production row shall not be greater than 75 milliseconds nor less than 25 milliseconds. With the exception of the above criteria, requirements previously given for presplitting shall also apply to cushion blasting.

**3.4 Unclassified excavation.** When the excavation is unclassified, either in the proposal or by the Contractor's bid, the Contractor may make arrangements with the Engineer for the taking of sufficient measurements of the rock in its original position to enable subsequent determination of the quantity of rock involved in any overbreakage. If the Contractor elects not to make such arrangements, he Contractor shall have no claim for rock overbreakage.

**3.5 Muck Excavation.** Muck excavation shall be performed in areas shown on the plans and in areas encountered during the work where the material meets the definition of muck as defined in 2.4.

**3.5.1 Removal and replacement.** The excavation of muck shall be handled in a manner that does not permit the entrapment of muck within the backfill. The backfilling of the excavated area shall follow immediately behind the excavation of the muck in order that any soft material that is pushed ahead of the backfill can be removed. Backfill material shall follow the requirements of 3.6.1. Where groundwater is present the backfill material shall be placed in one continuous lift to a maximum elevation of 4 feet (1.2 m) above the water level, unless otherwise directed. With muck removal, the Contractor shall allow the Engineer adequate opportunity to take all the necessary elevations and measurements for determining the volume removed.

**3.5.2** Any suitable muck removed shall be incorporated in portions of the embankment slopes as directed or used for other approved purposes.

### **3.6 Subgrade and Slopes.**

**3.6.1 Removal and replacement of unsuitable material.** Where excavation to designed elevations results in a subgrade or slopes of unsuitable material, the Engineer will require the removal of the unsuitable material to such limits as the Engineer may direct. The backfilling shall be done with approved embankment material conforming to 2.7 and compacted to the design subgrade or slope lines unless otherwise ordered. Material placed in subgrade or slopes with groundwater present shall be one of the following: (1) material meeting the requirements of 304.2; (2) rock, when rock is available from excavation; or (3) a mixture of both. Backfill replacing unsuitable material where groundwater is present shall follow immediately behind the excavation of unsuitable material in order that any unsuitable material that is pushed ahead of the backfill can be removed.

**3.6.2 Backfill of over-excavated subgrade in rock.** All over-excavated subgrade in rock shall be replaced with approved, porous, granular materials such as sand, gravel, broken rock, or any combination thereof. Non-porous materials will not be acceptable.

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### 3.7 Embankments.

**3.7.1 General.** The Contractor shall place and compact embankment material in full uniform layers at thicknesses specified below or ordered. Continuous leveling and manipulation shall be employed to ensure uniform density. Where end dumping is employed, embankment material shall be dumped on the layer of embankment being constructed and bulldozed ahead into place. End dumping over completed work which allows material to roll into place will not be permitted.

**3.7.2 Backfill of holes.** Holes resulting from the removal of stumps, boulders, and the like, within the zone of anticipated frost action shall be filled and compacted with material similar to that surrounding the hole.

**3.7.3 Placing on steep slopes.** Benching or terracing of slopes steeper than 3:1 (horizontal to vertical) shall be performed in conjunction with the placing of embankments abutting such slopes, in the manner directed.

**3.7.4 Placing in unsuitable areas.** Removal and replacement of unsuitable material shall follow the requirements of 3.6.1.

**3.7.5 Placing rock on roadway.** Rock fragments in fills shall be placed in layers of such thickness as the Engineer may direct, and in no case in excess of 4 ft (1.2 m). The lifts shall be worked in such a manner as to close the voids with spalls and fines. When sufficient spalls or fines are not available to close the voids, earth shall be used to make a tight surface prior to placing the next lift.

**3.7.6 Placing embankment material at pile locations.** In areas where piling is to be driven, the embankment, unless otherwise permitted, shall be made and compacted before driving the piles. No rock fragments, boulders, or other solid material shall be placed where such material could interfere with pile driving operations.

### 3.7.7 Placing Earth on Roadway.

**3.7.7.1** Earth shall be placed in layers the full width of the roadway, generally parallel to the finished grade. The layers shall not exceed 12 in (300 mm) of loose depth unless otherwise directed. Each layer shall be spread to a uniform thickness and compacted to the required density prior to placing the next layer. Continuous grading or shaping shall be carried out concurrently with the compactive effort to ensure uniform density throughout each layer of material. Embankment material to be placed adjacent to granular backfill shall be placed concurrently with the granular backfill to provide lateral support.

**3.7.7.2** Embankments shall be graded at all times to ensure that water runs off the graded surface. Any saturation of non-porous material due to the Contractor's selected method of operation will require the suspension of additional work on the area until drying, removing and replacing, or draining has restored the fill to a stable condition at the Contractor's expense.

**3.7.8 Winter construction methods.** No embankments shall be constructed on frozen earth materials. Each layer of material placed shall be compacted to the required density before it freezes. All frozen material shall be removed from the top of embankments prior to placing additional material. The frozen lumps of earth removed shall be placed outside of the limits of an assumed 1.5:1 (horizontal to vertical) slope from the break in the shoulder and inside the designed or ordered slope line. If the above specified conditions cannot be met, earthwork operations shall be suspended. In no case shall the scarifying or breaking up of frost be accepted instead of removal.

**3.7.9 Backfill at structures.** Backfill at structures shall conform to 504.3.4.3.

**3.7.10 Embankment Foundation.** Unless otherwise shown on the Plans or ordered, where the existing ground is 3 ft (1.0 m) or less below subgrade, the top 6 in (150 mm) within the limits of the roadbed shall be compacted to the same density as that required of the first layer of material to be placed over it.

### **3.8 Density Requirements and Tests.**

**3.8.1** For earth materials under approach slabs and for earth materials within 10 ft (3 m) of the back of structures not having approach slabs, at least 98 percent of maximum density shall be obtained. For all other earth materials at least 95 percent of maximum density shall be obtained. The maximum density determination shall be made as specified in AASHTO T 99 (Standard Proctor Test). The in-place density determination shall be made by AASHTO T 191 (Sand-Cone Method), AASHTO T 204 (Drive Cylinder Method), or by AASHTO T 310 (Nuclear Methods). If the required density cannot be achieved with the equipment at hand, the Contractor shall obtain whatever equipment is necessary to achieve the specified density. Manipulation of tills, silts, and clays, or any combination thereof, (including aeration where necessary) will be required to produce a stable fill of the required density.

**3.8.2** Those materials that cannot be tested for maximum density in accordance with AASHTO T 99 may be tested for maximum density by the following procedure:

**3.8.2.1 Test Strip Procedure.** At the beginning of the compaction operation, the maximum density shall be determined by compacting a short control section or “test strip” at a suitable moisture content until no further increase in density can be obtained. The densities shall be obtained by the use of nuclear density testing equipment. A new test strip may be required by the Engineer where there is a significant change in the gradation of material being placed. Compacting of the test strip shall be done with an approved vibratory roller or compactor producing a dynamic force of at least 27,000 lb (120 kN).

### **3.9 Disposal of Surplus and Waste Material.**

#### **3.9.1 Definitions.**

- (a) Surplus material. Excess material from excavation beyond the minimum requirements of the project but otherwise suitable for use.
- (b) Waste material. Material unsuitable for use in the work, except in noncritical areas.

#### **3.9.2 Blank.**

**3.9.3** When practicable and wherever directed, surplus and waste material shall be used for flattening slopes or for other grading within the project.

**3.9.4** When specified as embankment-in-place surplus or stockpile surplus, the material shall be placed as shown on the plans or as directed in the Proposal in accordance with the appropriate specification.

**3.9.5** In case it is impossible to dispose of all the surplus and waste material in the manner described above, it shall be the Contractor’s responsibility to secure disposal areas for approval and to dispose of all surplus and unsuitable material as part of the excavation items if such areas are not shown on the Plans.

**3.9.6** If disposal of surplus and waste material is by burying, the cover material shall be graded and shaped as directed by the Engineer. If material is to be placed on private land, the agreements as to how the disposal area is to be left shall be set forth on the Disposal Agreement form provided by the Department in accordance with 106.10. Three signed copies of the Disposal Agreement shall be

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furnished to the Engineer. Approval of the proposed disposal area will be contingent upon agreement by the Contractor and the property owner to leave the area in such shape that it blends with the surrounding terrain and that erosion is kept to a minimum. Without special permission, slopes shall not be left steeper than 2:1 (horizontal to vertical). No disposal area shall be left in such condition that erosion might result in water pollution by silt or other deleterious substances. Areas shall be left in such shape and condition that material does not wash and block or obstruct drainage ways. If holes caused by settlement appear, they shall be filled as directed. A release from the property owner is required prior to Project Acceptance.

**3.9.7** Unless otherwise ordered, disposal areas shall be covered with material capable of supporting vegetation and either fertilized and seeded with grass seed or planted with seedlings. Seedlings shall be set out in accordance with accepted horticultural practices as directed in the agreement.

**3.9.8** Unless permission is given to preserve access roads to disposal areas adjacent to highways, such access roads shall be obliterated.

**3.9.9** When the contract requires the removal of existing pavement but does not require recycling, the Contractor is encouraged to save this bituminous material for future reuse. This material is considered to be a valuable resource because of the residual asphalt contained in it. Therefore, no existing bituminous pavement removed shall be incorporated in the embankment. If the Contractor elects to bituminous material it shall be disposed of in accordance with the Department of Environmental Services Waste Management Division regulations at no expense to the State.

**3.11 Embankment-in-place.** When the embankment is constructed under this item, all construction requirements herein shall apply. Slopes excavated beyond the template lines without authorization shall be refilled when ordered, at no expense to the Department.

**3.11.1 Sources.** Unless otherwise designated in the contract, the Contractor shall make arrangements for obtaining material for embankment-in-place (See 106.02). Permission to remove material beyond the template lines within the right-of-way and adjacent thereto shall be approved in writing before any material is removed and will be contingent on many factors and if permission is granted, it will be by the Engineer after review by all interested parties. Permission may be contingent, among other considerations, upon agreement by the Contractor to leave regular and uniform slopes in the area. Slopes excavated beyond the template lines without authorization shall be refilled when ordered, at no expense to the State. When permission to remove material beyond template lines within the right-of-way is granted, the cubic yard (cubic meter) price will be contingent upon material type and agreed upon prior to authorization.

**3.12** Manipulation of the soil, as specified in 203.3.8.1, shall be required before compaction when the material's moisture content is beyond the limits specified above.

**3.13** Guardrail terminal units tapered rail, MELT, ELT, EAGRT, E-2 and portable changeable message sign platforms shall be constructed as shown on the plans with the top layer of the platforms constructed of 6" of crushed gravel for shoulder leveling.

**3.13.1** Crushed gravel for shoulder leveling and gravel if required shall be placed in accordance with 304.3.

**Method of Measurement**

**4.1.** Excavation, embankment-in-place, embankment-in-place surplus, stockpile surplus, rehandling surcharge material may be measured by the cubic yard (cubic meter) in accordance with 109.01.

**4.1.1** When the Contractor is directed to excavate beyond the template lines shown, the material removed will be measured under the appropriate excavation item.

**4.1.2** When the Contractor is given permission to excavate beyond the template lines shown within the right-of-way, the material will be measured by the cubic yard (cubic meter) -in accordance with 109.01. Material removed from outside of template lines without prior approval will be quantified and deducted from the Contract.

**4.1.3** Embankment-in-place surplus and uncompacted stockpile surplus will be measured by the cubic yard (cubic meter) after placement.

**4.2** No measurements of any pits will be made for the purpose of establishing pay quantities for any contract item. Any and all measurements or cross-sectioning of pits used in conjunction with the contract work will be made for informational purposes only. Embankment-in-place will not be measured, but shall be the cubic yard (cubic meter) final pay quantity in accordance with 109.11 for compacted material required within template lines as shown on the plans. No deductions will be made from the template quantities unless otherwise specified.

**4.2.1** If the actual topsoil removal, or the actual unsuitable material excavation, or the actual muck excavation beneath embankment areas differs from the estimated quantity shown on the Plans and backfill, if necessary, is embankment material, an adjustment will be made to the final pay quantity of embankment-in-place equal to the actual increase or decrease from the estimated quantity for the material excavated.

**4.4** When the contract does not specifically provide for payment for embankment-in-place, the work of embankment construction will not be measured as such but will be considered incidental to the various classifications of earthwork.

**4.5** Surcharges will be sectioned in place immediately prior to removal, and the designed or revised subgrade template will be used as the final section.

**4.6** Where presplitting is required, rock excavation will be measured only to the slope and depth lines shown on the plans or as ordered.

**4.7** Presplitting holes and extra drilled holes without explosives will be measured by the linear foot (linear meter), measured from the top of the drill hole at the rock surface to the bottom of the hole or to the elevation of the required subgrade (whichever is higher) or to an established bench elevation. Portions of holes not meeting the requirements as set forth in 3.3.5 or 3.3.9 will not be measured. Presplitting holes and extra drilled holes without explosives drilled where presplitting is not required by these specifications will not be measured.

**4.8** Where presplitting is not required, actual overbreakage of rock in the slopes will be measured and allowed to a maximum of 24 in (600 mm), measured horizontally, beyond the required slope lines where adequate cross-sections have been taken of the original rock in accordance with the provisions of 3.2.1 and 3.4. No allowance for overbreakage will be made below the subgrade elevation.

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**4.9** Where the Engineer determines that the removal of additional rock is necessary due to conditions clearly not attributable to the Contractor's methods of operations, the payment lines will be adjusted to the limits ordered, to include only rock actually removed within such limits.

**4.10** Guardrail MELT, guardrail ELT, guardrail EAGRT and portable changeable message sign platforms will be measured as a unit. The unit shall include excavation, embankment, gravel (if required), and crushed gravel for shoulder leveling.

**4.11** Guardrail E-2 and guardrail tapered rail platforms will be measured by the linear foot (linear meter). The linear foot (linear meter) price shall include excavation, embankment, gravel (if required), and crushed gravel for shoulder leveling.

### Basis of Payment

**5.1** The accepted quantities of excavation and embankment, of the type specified, will be paid for at the contract price per cubic yard (cubic meter) for each of the pay items listed below that is included in the contract, with the following stipulations:

**5.1.1** Embankment-in-place is a final pay quantity and will be paid for at the contract unit price per cubic yard (cubic meter), in accordance with 109.11, with appropriate deductions for embankment slopes shown to be below prescribed template lines.

**5.1.2** When surcharges are required, that portion of the surcharge ordered removed will be paid for as rehandling surcharge material.

**5.1.3** Excavation of unstable materials in the slopes of roadway cuts will be paid for as provided in 585.5.4. Backfill of such slopes shall be with material meeting the requirements of either 209.2.1.3, 585 or approved ledge, as determined by the Engineer. Payment will be made under items 209.1 or 585, unless otherwise shown on plans.

**5.1.4** Topsoil removal will be paid for as common excavation except when overlying muck excavation, in which case such topsoil removal will be paid for as muck excavation. Payment of excavation will be full payment for excavating, transporting and stockpiling topsoil at approved locations.

**5.1.5** Roadside ditches adjoining excavated areas will be paid for as common, rock, or unclassified excavation, as appropriate, unless such ditches are shown on the plans or ordered to be paid for under another item.

**5.1.6** When conflicting pay lines for more than one type of excavation exist in an area, payment will be made to the limits of each type of excavation in the following order of priority unless otherwise indicated on the plans:

- (1) Common, Rock, Muck, or Unclassified Excavation
- (2) Channel Excavation
- (3) Structure Excavation
- (4) Bridge Excavation

**5.1.7** Concrete class F, flowable fill substituted for embankment will be paid for at the contract unit price for the item substituted.

**5.1.8** Excavation of unsuitable material beneath embankment areas or at subgrade will be paid for as common excavation, unless material is classified as rock, muck, structure or other excavation item.

When the excavation is classified the payment for underlying unsuitable material will be made under the classified item.

**5.1.9** Gravel backfill material as specified in 3.6.1 (1), or (3) used to backfill unsuitable material excavation or muck excavation beneath embankment areas or at subgrade will be paid for under 304.2 with no adjustment in the embankment-in-place final pay quantity. Rock backfill as specified in 3.6.1 (2) or (3) will be paid as Item 203.6 with an adjustment in the embankment-in-place final pay quantity as provided in 203.4.2.1. Materials meeting the requirements of 3.6.1 (1), (2), or (3), used to backfill unsuitable materials in the slopes of roadway cuts will be paid as provided in 5.1.3 with no adjustment in the embankment-in-place final pay quantity.

**5.2** No payment will be made for materials used to shim unauthorized over-excavated areas back to designed slope lines and subgrade, or for materials placed outside of designed or ordered slope lines.

**5.2.1** A penalty of five times the contract unit price of the type of material removed will be deducted from moneys due the Contractor for the quantity of material removed from outside the template lines without authorization.

**5.3** No payment will be made under the item of embankment-in-place for materials used to backfill holes left by the authorized removal of stumps, boulders, and the like.

**5.4** No separate payment will be made for aeration or compaction equipment or methods of operation.

**5.5** Except for any extra work that may be ordered, embankment-in-place will include all work required in connection with pits.

**5.6** When common excavation is the only class included in the contract, any rock encountered will be paid for at a price equal to five times the unit price for common excavation under Item 203.2.

**5.7** When no item for muck excavation is contained in the contract, muck encountered and verified as meeting that definition will be paid for at 1.5 times the contract unit price for common excavation as contained in the Contract or negotiated by change order when no common excavation item is contained in the Contract.

**5.8** Benching or terracing performed under 3.7.3 will be subsidiary, except that rock removed as ordered will be paid for under Item 203.2.

**5.9** The accepted quantity of presplitting holes or extra drilled holes without explosives will be paid for at the contract unit price per linear foot (linear meter), complete as specified, except that when no item for presplitting holes is included in the contract, such work will be subsidiary.

**5.10** All costs incurred by the Contractor in preparing an approved blasting plan, in maintaining a blasting log, and in adopting revised blasting methods necessary to produce an acceptable test shot shall be considered incidental to the contract unit prices for rock excavation and presplit blasting.

**5.11** The cost of all blast vibration control and monitoring, pre-blast condition surveys, post-blast surveys, blasting precautions, the use of borehole deviation equipment to measure the orientation of presplit hole, and other protective measures necessary to prevent damage and the subsequent creation of claims in connection with blasting shall be included under Item 203.2.

**5.12** The accepted quantity of guardrail terminal unit platform MELT, ELT, EAGRT and portable changeable message sign platform will be paid for at the contract price per unit complete in place.

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**5.13** The accepted quantity of guardrail terminal unit platform for E-2 and tapered rail will be paid for at the contract price per linear foot (linear meter), complete in place.

### Pay items and units:

203.1	Common Excavation	Cubic Yard (Cubic Meter)
203.2	Rock Excavation	Cubic Yard (Cubic Meter)
203.3	Unclassified Excavation	Cubic Yard (Cubic Meter)
203.4	Muck Excavation	Cubic Yard (Cubic Meter)
203.5525	Portable Changeable Message Sign Platform	Unit
203.5540	Guardrail Tapered Rail Platform	Linear Foot (Linear Meter)
203.5551	Guardrail MELT Platform	Unit
203.5552	Guardrail ELT Platform	Unit
203.5554	Guardrail 50' (15.2m) EAGRT Platform	Unit
203.55541	Guardrail 50' (15.2m) EAGRT Platform Alternate	Unit
203.5555	Guardrail 25' (7.6m) EAGRT Platform	Unit
203.55551	Guardrail 25' (7.6m) EAGRT Platform Alternate	Unit
203.5596	Guardrail E-2 Platform	Linear Foot (Linear Meter)
203.6	Embankment-in-Place (F)	Cubic Yard (Cubic Meter)
203.7	Rehandling Surcharge Material	Cubic Yard (Cubic Meter)
203.61	Embankment-in-Place Surplus	Cubic Yard (Cubic Meter)
203.65	Stockpile Surplus	Cubic Yard (Cubic Meter)
203.81	Presplitting Holes	Linear Foot (Linear Meter)
203.82	Extra Drilled Holes Without Explosives	Linear Foot (Linear Meter)

## **SECTION 206 -- STRUCTURE EXCAVATION FOR PIPES AND OTHER MINOR STRUCTURES**

### **Description**

**1.1** This work shall consist of the excavation and backfill or disposal when necessary of all materials required to be removed to complete the work as shown on the plans or as ordered. Excavation for the following shall be included under this item: berm ditches, inlet ditches and outlet ditches, sand drains, drainage pipes, multiple pipe structures, manholes, catch basins, drop inlets, cattle passes, headwalls, overhead traffic sign bases and the like, water and sewer pipes, pipe sleeves, conduits, and channels with less than a 10 ft (3 m)-bottom width. Excavation for roadway ditches not adjoining roadway excavation will be included in this item unless otherwise specified.

### **Classification of Materials**

**2.1** Common structure excavation shall consist of all excavation described above that is not classified as rock structure excavation. Glacial till or boulder clay will be considered as common structure excavation.

**2.2** Rock structure excavation shall consist of all solid rock that can be removed only by blasting or ripping. It shall also consist of boulders and parts of masonry structures when found to measure 1 yd<sup>3</sup> (1 m<sup>3</sup>) or more, except as provided in 604.5.2.2.

**2.3** Unclassified structure excavation shall consist of all structure excavation encountered.

### Construction Requirements

**3.1** All excavation shall be removed to the limits shown or ordered and the excavated material incorporated in the work or disposed of as directed. Berm ditches shall be constructed at the top of cut slopes as shown on the plans or as ordered.

**3.2** Excavated areas, including unsuitable material, below structures and pipes in rock shall be removed to the limits specified and backfilled to the bottom of the pipe or structure with approved material. (See also 603.3.1.)

**3.3** Excessive widths of trench in excavation for pipes will not be permitted. Below the level of the tops of the pipes, the walls of trenches shall be kept as nearly vertical as practicable. Trenches shall be shored in accordance with OSHA Regulations. (See also 603.3.1.7.)

**3.4** When blasting is required, the provisions of 203.3.2 shall apply as though contained in this Section.

### Method of Measurement

**4.1** Structure excavation will be measured by the cubic yard (cubic meter) in accordance with 109.01.

**4.1.1** The lower limits shall be as shown on the plans, as designated in Figure 1, 603, or as provided below. The upper limits shall be the original ground except as provided in 203.5.1.6. All excavation for pipes and other structures that are to be installed by others will be measured for payment; otherwise, the first 9 ft (2.7 m) of common structure excavation for pipes, manholes, catch basins, and drop inlets shall be subsidiary except as follows:

(a) The depth of unsuitable material removed as directed below grade will be measured for payment. In case the width ordered is wider than the specified payment limits in 4.1.2, the extra excavation will be measured in accordance with Figure 1-D of 603.

(b) When excavation is required more than 1 ft (300 mm) deeper than the excavation shown on the plans, the depth of excavation below the 1 ft (300 mm) limit will be measured for payment.

**4.1.2** Unless otherwise shown on the plans, the horizontal limits shall be as follows for pipes:

Inside Diameter	Total Width
Up to 12 in (300 mm)	36 in (1.0 m)
12 to 24 in (300 to 600 mm)	24 in (I.D.+ 600 mm)
24 in (Over 600 mm)	2 x I.D.

**4.1.3** The horizontal limits for end sections shall be the same as the pipes to which they are attached.

**4.1.4** The horizontal limits for structures such as manholes, catch basins, headwalls, and the like will be 1 ft (300 mm) outside of the base of the masonry and parallel or concentric thereto.

**4.2** All material classified as rock encountered within the neat lines established under this Section will be measured. No payment will be made for any overbreakage below or beyond the limits specified.

**4.3** In case a conflict of horizontal limits exists in payment lines, as where a pipe enters a headwall, the greater limit will be used for computing the quantity.

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4.4 Unclassified structure excavation for exploratory purposes will be measured as provided under the applicable provisions of 206.4.1.

### Basis of Payment

5.1 The accepted quantity of structure excavation will be paid for at the contract unit price per cubic yard (cubic meter) complete in place.

5.2 Granular material specified or ordered will be paid for under 209.

5.3 When common structure excavation is the only class included in the contract, any rock encountered will be paid for at a price equal to five times the unit price for common structure excavation under Item 206.2.

5.4 When structure excavation items are included in the contract, but no items for exploratory purposes are in the contract, payment for excavation made for investigations or exploratory purposes will be paid for under Item 206.19 at five times the unit price for the class of excavation encountered.

5.5 If neither Item 206.1 nor Item 206.2 nor an item for exploratory purposes is included in the contract, any structure excavation encountered, including excavation for investigation or exploratory purposes, will be paid in accordance with 109.04.

5.6 No separate payment will be made for pre-blast and post-blast surveys or blasting monitoring work.

### Pay items and units:

206.1	Common Structure Excavation	Cubic Yard (Cubic Meter)
206.19	Common Structure Excavation – Exploratory	Cubic Yard (Cubic Meter)
206.2	Rock Structure Excavation	Cubic Yard (Cubic Meter)
206.39	Unclassified Structure Excavation – Exploratory	Cubic Yard (Cubic Meter)

## SECTION 207 -- CHANNEL EXCAVATION

### Description

1.1 This item shall consist of the excavation and disposal of all materials encountered in the construction of channels having a bottom width of 10 ft (3 m) or more, except inlet and outlet ditches for multiple pipe culverts, as shown on the plans or as ordered.

### Classification of Materials

2.1 Common channel excavation shall consist of all excavation described above that is not classified as rock channel excavation. Glacial till or boulder clay will be considered as common channel excavation.

2.2 Rock channel excavation shall consist of all solid rock that can be removed only by blasting or ripping. It shall also consist of boulders and parts of masonry structures when found to measure 1 yd<sup>3</sup> (1 m<sup>3</sup>) or more.

**2.3** Unclassified channel excavation shall consist of all the channel excavation encountered.

**Construction Requirements**

**3.1** Channel excavation shall be removed to the limits shown or ordered.

**3.1.1** When blasting is required, the provisions of 203.3.2 shall apply as though contained in this Section.

**3.2** All surplus material shall be incorporated in the work or disposed of as directed.

**3.3** No excavation shall be performed prior to cross-sectioning.

**Method of Measurement**

**4.1** Channel excavation will be measured by the cubic yard (cubic meter) in accordance with 109.01. The upper limit shall be original ground except as provided in 203.5.1.6. No allowance will be made for material excavated before measurements have been made or for material excavated beyond the required slope lines.

**4.2** Blast vibration control and monitoring, preblast condition surveys, postblast surveys, blasting precautions and other protective measures will not be measured.

**Basis of Payment**

**5.1** Channel excavation will be paid for at the contract unit price per cubic yard (cubic meter) complete for each class of channel excavation included in the contract. When common channel excavation is the only class included in the contract, any rock encountered will be paid for at a price equal to five times the contract unit price for common channel excavation under Item 207.2.

**5.2** The cost of all blast vibration control and monitoring, preblast condition surveys, postblast surveys, blasting precautions and other protective measures necessary to prevent damage and subsequent creation of claims in connection with blasting shall be subsidiary to Item 207.2 or Item 207.3.

**Pay items and units:**

207.1	Common Channel Excavation	Cubic Yard (Cubic Meter)
207.2	Rock Channel Excavation	Cubic Yard (Cubic Meter)
207.3	Unclassified Channel Excavation	Cubic Yard (Cubic Meter)

**SECTION 209 -- GRANULAR BACKFILL**

**Description**

**1.1** This work shall consist of furnishing and placing porous granular material at the locations shown on the plans or ordered.

**Materials**

## SECTION 209

**2.1** The material shall consist of stones, rock fragments, and fine hard durable particles resulting from the natural disintegration of rock. The material shall be free from harmful amounts of organic matter. The wear shall not exceed 60 percent. No more than 12 percent of the material passing the No. 4 (4.75 mm) sieve shall pass the No. 200 (0.075 mm) sieve, and the material shall conform to the following gradations:

**2.1.1** Granular backfill (sand) shall consist primarily of particles with 100 percent passing the 3 in (75 mm) sieve and 70 to 100 percent passing the No. 4 (4.75 mm) sieve.

**2.1.2** Granular backfill (gravel) shall consist of a mixture of stones or rock fragments and particles with 95 to 100 percent passing the 3 in (75 mm) sieve and 25 to 70 percent passing the No. 4 (4.75 mm) sieve.

**2.1.3 Granular Backfill (Bridge).** When this item is specified the material shall meet the gradation requirements of Item 304.2.

**2.1.4 Granular Backfill.** When this item is specified, the gradation shall conform to 2.1.1 or 2.1.2.

**2.2** Concrete class F, flowable fill may be requested in writing as a substitute for granular backfill. Approval shall be in consideration of, but not limited to, differential frost heaving due to dissimilar materials, unit weight, structural requirements, lack of permeability, and damming resulting from water flow cut off.

### Construction Requirements

**3.1** Granular backfill of the specified or ordered gradation shall be placed in layers at the locations shown or ordered. Backfill shall be placed in the manner detailed in the appropriate section in which the backfill is specified. The backfill layers shall not exceed 8 in (200 mm) of compacted depth unless otherwise directed. Density shall meet the requirements of 203.3.8.

### Method of Measurement

**4.1** Granular backfill will be measured by the cubic yard (cubic meter) in accordance with 109.01. When granular backfill is specified as included in another item, no separate measurement will be made for the backfill furnished in connection with that item.

**4.2** Backfill of over-excavated areas beyond or below the lines and grades shown or ordered will not be measured for payment.

**4.3** For pipe having an inside diameter of less than 48 in (1200 mm) no deduction will be made from granular backfill of the volume occupied by the pipe constructed under 603 when granular backfill is ordered as bedding material.

**4.4** Granular backfill (bridge) will not be measured, but shall be the cubic yard (cubic meter) final pay quantity in accordance with 109.11 for compacted material required within the limits shown on the plans.

### Basis of Payment

**5.1** The accepted quantity of granular backfill, of the type specified, will be paid for at the contract unit price per cubic yard (cubic meter) complete in place.

## SECTION 209

**5.2** Granular backfill (bridge) is a final pay quantity item and will be paid for at the contract unit price per cubic yard (cubic meter) complete in place in accordance with 109.11.

**5.3** Concrete class F, flowable fill substituted for granular backfill will be paid for at the contract unit price for granular backfill of the type specified.

### **Pay items and units:**

209.1	Granular Backfill	Cubic Yard (Cubic Meter)
209.201	Granular Backfill (Bridge) (F)	Cubic Yard (Cubic Meter)
Thru		Cubic Yard (Cubic Meter)
209.208	Granular Backfill (Bridge) (F)	Cubic Yard (Cubic Meter)
209.3	Granular Backfill (Sand)	Cubic Yard (Cubic Meter)
209.4	Granular Backfill (Gravel)	Cubic Yard (Cubic Meter)

## ***SECTION 211 -- VIBRATION MONITORING***

### **Description**

**1.1** This work shall consist of monitoring construction related vibrations and setting vibration limits to avoid damaging existing nearby structures, properties and utilities located on or near this project.

**1.1.1** Sources of construction related vibrations which are covered by this specification include compaction equipment (sections 203, 209, 304, 508), cofferdam construction (section 503), sheet piling (section 506) and bearing piles (section 510) or other construction activities as identified. The provisions of section 203.3.2 shall still apply to vibrations caused by blasting operations.

**1.2** The work under this specification includes providing the services of a qualified Vibration Consultant.

### **Construction Requirements**

**3.1 Vibration Consultant Qualifications.** The Vibration Consultant shall meet all the applicable qualification requirements of sections 203.3.2.5.2 and 203.3.5.3.

**3.2 Vibration Monitoring Plan.** Prior to initiating a particular activity which requires vibration monitoring, the Contractor shall submit a Vibration Monitoring Plan prepared by the Vibration Consultant. The plan shall be submitted a minimum of 10 working days prior to beginning the particular construction activity. The construction activity shall not begin until the plan has been approved, except as allowed under 3.2.1.

**3.2.1** Prior to the production phase of the particular construction activity, the Contractor will be permitted to conduct a test program to establish the allowable vibration limits, subject to approval. The production phase shall not begin until the results of the test program have been approved.

## SECTION 211

**3.2.2** The plan shall include the following:

- a) The qualifications of the Vibration Consultant in accordance with 3.1
- b) A description of the monitoring equipment in accordance with 3.3
- c) Recommendations for vibration limits for the particular construction activity under consideration, or recommendations for a test program in accordance with 3.2.1, if the vibration limits cannot be predetermined. Justification shall be provided for all recommendations.
- d) Recommendations for structures, utilities and all other facilities which in the judgment of the Vibration Consultant require a pre and post construction condition survey in accordance with 3.4. This recommendation shall pay particular attention to historic structures, structures in poor condition, structures supported by vibration sensitive materials which could cause settlement or loss of support, and structures which contain sensitive equipment or processes. The Monitoring Plan shall also include methods for measuring deformation or settlement of selected structures, if deemed necessary by the Vibration Consultant or Engineer.
- e) Recommendations, if it is determined that the proposed construction activity could not be reasonably implemented without exceeding vibration limits that are necessary to protect adjacent facilities.

**3.2.3** As part of the review of the Monitoring Plan, the Engineer may require modifications to the submittal to include, but not limited to, surveying and monitoring of additional structures, the number of monitoring sites and the distances for monitoring. There may be a need for simultaneous setups with multiple monitoring devices.

**3.3 Vibration Monitoring Instrumentation.** All vibration monitoring equipment shall meet the requirements of 203.3.2.5.6.

**3.4 Pre and post construction condition surveys.** Pre and post construction surveys shall be conducted on all structures as directed by the Engineer or as contained in the approved Vibration Monitoring Plan. The surveys shall not be initiated until approval of the vibration monitoring plan has been given. The requirements contained in 203.3.2.5.5 shall be followed in conducting the condition surveys.

**3.5 Coordination Meeting.** A coordination meeting arranged by the Contractor shall be held prior to initiating the particular construction activity and the associated vibration monitoring. The coordination meeting shall not take place until the Contractor has submitted and received approval of the Vibration Monitoring Plan. The purpose of the meeting shall be to review all aspects of the vibration monitoring and to facilitate coordination between all parties involved. Individuals attending the meeting shall include the Engineer, the Vibration Consultant, the Contractor, the Sub-Contractor involved with the particular construction activity, the Research Geologist from the Materials and Research Bureau and all other personnel deemed appropriate by the previously mentioned personnel. The Engineer and Research Geologist shall be notified at least 5 working days in advance of the meeting.

**3.6 Schedule for Vibration Monitoring.** The frequency and duration of vibration monitoring for a particular construction activity shall be as directed by the Engineer. The Contractor shall make all necessary arrangements for scheduling the Vibration Consultant, after direction to provide vibration monitoring has been given. The particular construction activity requiring monitoring shall not begin until the Vibration Consultant is on-site.

**3.7 Vibration Monitoring Reports.** At the end of each day of monitoring, the following information shall be recorded and submitted to the Engineer:

- a) The name of the Contractor and/or Subcontractors responsible for the particular construction activity.
- b) The name and signature of the approved Vibration Consultant.
- c) The name of the operator of the vibration monitoring equipment.
- d) A sketch indicating the location of the vibration monitors and the particular construction activity.
- e) Complete details of the particular construction activity which is being monitored, including all related equipment, operating frequencies, piling depths and all other related information as requested by the Engineer.
- f) Results of monitored vibrations and noise levels for the particular construction activity. The information should include the frequencies of the measured peak particle velocities.
- g) Identification of any activity that caused the vibration limits to be exceeded and the time of day that the limits were exceeded.
- h) A summary of any vibration related complaints received during the day.

**3.8 Adjustments in construction procedures.** All complaints about vibrations shall be reported immediately to the Engineer. If the monitoring data indicates that the ground vibration limits for any of the three mutually perpendicular components have been exceeded, the Contractor shall cease the particular construction activity and submit a written report giving corrective action. The construction activity shall not resume until the report has been reviewed and approved by the Engineer. If complaints occur when vibrations are below the specified limits, the Engineer may order the Contractor to modify the operations to reduce the vibrations further.

**Method of Measurement**

**4.1** Vibration monitoring services including pre and post construction surveys will be measured by the hour for the accountable time on site to the nearest one quarter hour. The hourly rate is all inclusive of the equipment and personnel necessary to perform the vibration monitoring service. The hourly rate is also all inclusive of equipment and personnel necessary to measure or monitor for potential deformation in structures.

**4.1.1** Travel time and other time not spent at the construction site and time not authorized will not be measured.

**Basis of Payment**

**5.1** The accepted quantity of vibration monitoring services will be paid for at the contract unit price per hour, complete. A minimum of 4 hours will be paid for each day's service.

**5.1.1** The Vibration Monitoring Plan will be subsidiary except that payment will be made for time on-site which is used in conducting a test program in accordance with 3.2.1.

**5.1.2** Travel time and other time not spent at the construction site or off-site areas and support services (i.e., travel, mileage, clerical staff, miscellaneous expenses, overhead, etc.) will be subsidiary.

**5.1.3** No payment will be made for time spent in preparing the reports for the condition surveys.

**Pay Item and Unit:**

211.11	Vibration Monitoring Services	Hours
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## SECTION 214

### *SECTION 214 -- FINE GRADING*

#### **Description**

**1.1** This work shall consist of the final grading necessary to make the subgrade, the area under the surface course, the roadway outside the surface course, and other locations as directed by the Engineer conform to the lines shown on the plans or established by the Engineer.

#### **Construction Requirements**

**3.1** The surface of each course of material shall be fine graded to conform to the typical section of the plans prior to placing the succeeding course. Each course shall be fine graded to conform to the lines and grades as shown on the plans. When fine grading to a specific slope prior to paving, the slope tolerance will be +/-0.4%.

**3.1.1** Cross slope to be measured by the following method: Measurements will be taken by placing a 10 foot (3-meter) metal straight edge on the surface perpendicular to the traveled lane. A 4 foot (1.2 meter) direct reading level shall be placed on top of it. Percent cross slope shall be read and recorded. A second reading 180 degrees to the first shall be taken and recorded and the two shall be averaged for the test result.

**3.1.2** The use of automated grade and slope control will be required on all graders.

**3.1.3** On projects or parts of projects where the Engineer deems that the use of automatic controls are impracticable, some or all of the controls in 3.1.2 may be waived.

**3.2** Shoulders, slopes, and ditches shall be shaped with suitable machinery supplemented by hand labor to reasonably smooth surfaces that are in keeping with the character of the adjacent terrain and shall merge into the adjacent terrain without any noticeable break. Culverts and waterways shall be cleared of all obstructions. Rubbish, brush, loose rock, boulders, and all other debris from the construction work shall be removed and disposed of as directed.

**3.3** To be acceptable under this item, the entire roadway must present a uniformly finished appearance at the completion of the work.

**3.3.1** The contractor shall give 24 hour notice of the expected completion of the final fine grading prior to paving, to allow inspection by the Engineer.

#### **Method of Measurement**

**4.1** Fine grading, except as specified in 4.2, will be measured as a unit. If the project is altered to require substantial changes in the length, width, or character of the fine grading from such length, width, or character shown on the plans, the contract lump sum price will be subject to a negotiated revision.

**4.2** Fine grading of earth berms constructed in rock cuts will be measured by the linear foot (linear meter) to the nearest 1 foot (0.1 meter) along the adjacent ditch line.

#### **Basis of Payment**

## SECTION 214

**5.1** The accepted quantities will be paid for at the contract lump sum price for fine grading not otherwise classified and per linear foot (linear meter) for fine grading earth berms constructed in rock cuts.

**5.2** When no quantity for this item is included in the contract, this work will be subsidiary.

**Pay items and units:**

214.	Fine Grading	Unit
214.3	Fine Grading Earth Berms in Rock Cuts	Linear Foot (Linear Meter)