MATERIALS DIVISION

MEMORANDUM

GENERAL SUBJECT: Revision of Materials MOI Aggregates QA Sections	**NUMBER: MD 348 - 11**
SPECIFIC SUBJECT: Revision of Materials MOI Sections 311 through 314 regarding VDOT's QA Program for Aggregate	**DATE: September 26th, 2011**
DIRECTED TO: District Materials Engineers	**SIGNATURE:** **Charles A. Babish, PE** *Signature on Original*

This Memorandum notifies the users of the Materials Division Manual of Instructions that Chapter III, Sections 311 through 317, are now replaced with the following Sections 311 through 314 (the original 7 sections have been condensed into 4). This revision incorporates changes to bring the sections up-to-date with VDOT's current practices. The revision also adds sections on resilient modulus and chemical stabilization of subgrade.

Replace Sections 311 through 317 with the following:

SECTION 311 QUALITY ASSURANCE OF CENTRAL MIX SELECT MATERIAL AND DENSE-GRADED AGGREGATE FOR SUBBASE AND BASE

This section covers the VDOT Materials Division quality assurance program for central mix (pugmill) production of select material and dense-graded aggregate subbase and base material, all collectively referred to as Central Mix Aggregate (CMA) (reference Secs. 207 and 208 of the VDOT Road and Bridge Specifications, respectively).

The production of high-quality CMA requires that the product meets definite specifications. These specifications are not arbitrary figures, but are the end result of years of experience, data analysis and research. It shall be the duty of the Producer's Certified Central Mix Aggregate Technician to see that all component materials have been approved for use and that they are combined into a mixture that meets all specification requirements.

The advantage of a CMA mixture that meets the specifications is in low cost maintenance. The initial responsibility of obtaining a mixture meeting the specification requirements, thus ensuring the best possible construction at a minimum total cost, rests with the Producer's Certified Central Mix Aggregate Technician. VDOT has had a comprehensive quality assurance program for the production and placement of these materials in place since at least the 1980s, and since the mid-1990s has maintained the program to meet requirements of the United States Code of Federal Regulations (CFR) Title 23 Part 637 as well, which is administered by the Federal Highway Administration (FHWA). This program is a system of Quality Control (QC) sampling and testing, Independent Assurance (IA) sampling and testing, and Verification (VST) sampling and testing. The QC component is performed by the Producer; both the IA and VST components are performed by VDOT. QC, IA, and VST testing also include visual checks, statistical analyses, inspections, and certifications. See Sec. 206 for more on IA and VST, including definitions.

Sec. 311.01 General

Aggregate base, subbase, and select material when specified, will be mixed in a central mixing plant of the pugmill or other approved type. Material shall be blended prior to or during mechanical mixing, in such a manner that will ensure conformance with specified requirements.

The rest of this section covers the quality assurance program for dense-graded aggregate base, subbase, and select materials for gradation, Atterberg Limits, CBR, and other physical tests, except depth and density, which are covered in Sec. 312. Samples of dense-graded aggregates for soundness tests (AASHTO T104) shall be handled as outlined in Sec. 204.02. See also Sec. 206 for Independent Assurance sampling requirements.

Sec. 311.02 CMA Plant

(a) Materials

The Central Mix Aggregate Producer is responsible for the quality control and condition of all materials used in central mix aggregate, as well as the handling, blending, and mixing operations, in accordance with Secs. 207 and 208 of the VDOT Road and Bridge Specifications. The Producer is responsible for the initial determination and all necessary subsequent adjustments in proportioning of materials used to produce the specified mix. If sample failure occurs at any time during the plant operation after initial

setup, immediate adjustments shall be made. If these adjustments do not correct the cause of failure, the plant shall be stopped and recalibrated.

(b) Performance of Sampling, Testing, and Recording of Results for CMA

The production control samples and tests shall be taken and performed by the Producer's Certified Central Mix Aggregate Technician, as outlined in Sec. 311.05(a). Aggregate or select material paid for on a volume basis shall be sampled as directed by the District Materials Engineer.

The Producer shall be responsible for recording test results and maintaining quality control charts. The Producer shall furnish to the VDOT Materials Representative copies of the test results on forms furnished by VDOT and maintain current control charts at the plant for review by VDOT. The Producer shall likewise maintain all records and test results associated with materials production; e.g., hydraulic cement, etc.

(c) Notification of Production

The Producer shall notify the District Materials Engineer when production will start or resume after a delay.

(d) Assisting Materials Representative

The Producer shall obtain a sample at the request and under the direction and control of the Materials Representative and analyze one-half of the sample. VDOT shall be responsible for analyzing the other one-half. The Producer's portion of the split sample shall be used as the next production control sample. See Sec. 311.05(b) for additional details of performing this sampling.

(e) Plant Laboratory Equipment

Central mix aggregate laboratories and calibrated testing equipment shall be furnished by the Producer. Plant production laboratories will be equipped, as outlined in Sec. 106.07 of the Road and Bridge Specifications. (Reference - AASHTO T87, T88, T89, T90, and VTM-1, VTM-7, VTM-8, VTM-12, VTM-25, VTM-40.) The full list of Virginia Test Methods (VTMs) can be found online at:

http://www.virginiadot.org/business/resources/Materials/bu-mat-VTMs.pdf .

(f) Regional CMA, or Multiple Use Laboratories

VDOT reserves the right to require a laboratory conforming to the requirements of Sec. 106.07 at each plant which is processing material for Department use; however, use of a single regional laboratory to serve several plants in a given area may be permitted, provided such use does not adversely affect the sufficiency and timeliness of the sampling and testing program at each plant. In the event a dispute arises over the practicality of multiple plant use of a single laboratory, such disputes shall be referred to the District Materials Engineer for resolution.

(g) Personnel

All sources supplying central mix aggregate to VDOT shall be required to have present during the initial setup, for all subsequent adjustments of the plant, and at all times during production for each job-mix, a Certified Central Mix Aggregate Technician, as outlined in Secs. 207.04 and 208.05 of the VDOT Road and Bridge Specifications. Such Technician shall be capable of designing, sampling, testing, and adjusting the mixture.

(h) Personnel Certification (see also Sec. 115)

VDOT shall provide (for a fee to non-VDOT personnel) classroom technical instruction and classroom and online examination and certification. The State Materials Engineer in conjunction with the VDOT Learning Center shall direct the administering of examinations and certifications to Technicians and Inspectors.

Written examinations for certification shall be administered by the VDOT Learning Center. The written examination shall be monitored by the VDOT Learning Center staff or designated assistants and an accurate accounting of all examination papers shall be maintained.

All written examinations shall be prepared, graded, and recorded under the direction of the State Materials Engineer in conjunction with the VDOT Learning Center.

Reexamination and recertification shall be required 5 years from the date the certificates are issued. The status of the certification for Inspector and Technician shall be valid only for the specific responsibilities and privileges granted to the bearer and name appearing on the certificate issued. If at any time an Inspector or Technician is found incapable of performing his or her duties as prescribed herein, he or she shall not be allowed to take part in the production of central mix aggregate being manufactured for VDOT use. The certification may be suspended following the procedure of Sec. 115.07.

More on the VDOT Certification program can be found online at:

http://www.virginiadot.org/business/matschools.asp.

(i) Inspection of Plant, Equipment and Personnel

(1) Initial Plant Inspection

The plant shall be inspected before production for compliance with specification requirements governing plants and testing equipment. A program of regular but unannounced inspection shall be scheduled and supervised by the District Materials Engineer at all central mix aggregate plants supplying dense-graded aggregate or select material for VDOT work. This inspection shall be conducted at any plant initially setting up and starting production, and at least once per year thereafter or as required. The purpose of this inspection is to determine that the plant, equipment and personnel meet specification requirements. A record shall be prepared on a checklist type form of all items covered during the plant inspections by the District Materials Section. (See the standardized "CMA Pugmill Plant Inspection Report" at the end of this chapter.)

(2) Regular or Routine Plant Inspection

The plant shall be inspected periodically during production, including items such as stockpiles, equipment, control charts, sampling, testing and records kept by the Producer's Certified Central Mix Aggregate Technician. These inspections shall be in addition to the initial or annual inspections noted in Paragraph (i)(1) above; shall likewise be completely unannounced and shall be conducted by the Materials Representative. The inspections shall be conducted for the purpose of determining whether or not specifications and instructions are being followed by the Producer in the production, sampling, testing and inspection of central mix aggregate.

The frequency of these latter plant inspections shall be related to the overall quality of the plant equipment and competence of the plant personnel. Plants that have a record of continually producing good materials, being in excellent condition and manned by well-trained personnel may be inspected as

seldom as once a year. Plants with poor records shall be inspected more often as resources permit. Periodic inspection of all plants at the same frequency regardless of record is not recommended.

A plant inspection report shall be issued on the "CMA Pugmill Plant Inspection Report" immediately upon completion of this inspection. The forms shall be completely and accurately filled out by the Materials Representative conducting the inspection, noting any and all discrepancies and any corrective action taken by the inspection personnel. Thereafter, this report shall be reviewed by the District Materials Engineer or his representative and copies of the report retained for District use. Unfamiliar Department and Industry personnel shall be requested to show evidence of their certification to visiting representatives of the Materials Division.

(j) Maintaining Records

Materials personnel shall keep a diary of plant visits, observations, and comments made to the Producer. The Materials Representative shall also furnish the Producer with the optimum water content of the aggregate being produced.

Sec. 311.03 Approval of Job Mix

The Materials Representative shall determine that the CMA mix design (job-mix formula) and all material proposed for use have been approved by the Materials Division prior to the start of mixing operations, as outlined in Section 106.01(c) and Chapter VIII, Sec. 803.63 Form TL-127A, Job-Mix Input Form – Central Mix Aggregate.

Sec. 311.04 Documentation of Tonnage Material

For details of documentation of tonnage material and the bonded weigh program, see Secs. 107, 108, Chapter VIII – Reports and Forms, and the Bonded Weigh Program Weighperson Training Manual which can be found online at:

http://www.virginiadot.org/business/resources/Materials/bu-mat-Bonded_weigh_program.pdf.

Sec. 311.05 Sampling, Testing, and Acceptance of CMA

Sampling, testing, and acceptance of CMA shall be in accordance with the procedures designated herein, and shall consist of Producer Quality Control (QC) sampling and testing, VDOT Independent Assurance (IA) sampling and testing, and VDOT Verification (VST) sampling and testing. All of these components together comprise the quality assurance program.

(a) Quality Control (Producer) Samples and Tests

Quality Control samples are those obtained by the Producer's Certified Central Mix Aggregate Technician at the plant and tested in the plant laboratory for gradation, Atterberg Limits, water content, and cement content (if applicable).

In the production of these materials, the optimum water content, plus or minus two (2) percentage points, shall be required.

A statistically acceptable method of randomization shall be used to determine the time and location for taking stratified random samples of the aggregate or select material. See the Central Mix Aggregate Certification Study Guide for an approved randomization method. Testing shall be in accordance with the VDOT Road and Bridge Specifications Sections 207 and 208. The frequency of sampling shall be at a rate of 4 samples per lot (either 2000 or 4000 tons). Lot size shall be chosen, upon request by the

Producer or District Materials Engineer and at the discretion of the District Materials Engineer, from either 2000 or 4000 ton lots. Lots shall be chosen in order to match Producer shipping rates, to reduce unnecessary testing, when past performance indicates stability, and when lot sizes/shipping rates are appropriate to ensure statistical significance will be obtained. Samples shall be taken after the material has been mixed according to Sections 207.04 and 208.05 of the VDOT Road and Bridge Specifications to satisfy the blending and water content requirements (optimum water content plus or minus two (2) percentage points). The size of the sample shall be 30 to 40 lbs.

The representative sample, secured from the randomly selected material that is being shipped to the project site and weighing 30 to 40 pounds, shall be obtained by one of the following methods: (1) The sample shall be obtained from the approximate center of the loaded truck; (2) A loaded truck shall dump at a convenient location within the plant facility to create a representative mini-stockpile. The top of the dumped load shall be struck with the bucket of a front-end loader to create a flat spot on top of the pile from which the representative sample shall be obtained; (3) A mini-stockpile shall be created by material extracted from the post-pugmill shipping stockpile. When the truck containing the load that will be sampled is in the process of being loaded, a randomly selected front-end loader bucket of aggregate being taken from the post-pugmill shipping stockpile shall be dumped at a convenient location within the plant facility to create the mini-stockpile. The top of the mini-stockpile shall be struck with the bucket of the front-end loader to create a flat spot from which the representative sample shall be obtained. Separate the sample into two (2) approximately equal portions by processing the sample through a sample splitter or split by the quartering method. If no IA sample is being taken, as detailed in Paragraph (b) below, the Producer's Technician shall still split the sample as noted above before running the tests on one of the split portions.

(b) Independent Assurance Samples and Tests

Independent Assurance (IA) samples are those obtained at the central mix aggregate plant by the Producer's Certified Central Mix Aggregate Technician in the presence and under the observation of the VDOT Materials Representative, and tested in the VDOT Laboratory or by AMRL-accredited consultant laboratories. These samples are tested for gradation, Atterberg Limits, water content, and cement content (if applicable).

IA samples shall be obtained at a rate that both provides a statistically significant number of samples for each mix produced and allows verification of unstable mixes. At least one (1) IA sample shall be obtained and tested from each lot and as necessary to ensure statistical significance and to monitor unstable or nonconforming mixes. Unstable mixes are those that exceed variability tolerances provided in VTM-59. Lot size shall be chosen, upon request by the Producer or District Materials Engineer and at the discretion of the District Materials Engineer, from either 2000 or 4000 ton lots. Lots shall be chosen in order to match Producer shipping rates, to reduce unnecessary testing, when past performance indicates stability, and when lot sizes/shipping rates are appropriate to ensure statistical significance will be obtained.

This rate of IA sampling is mandatory, and is the responsibility of the District Materials Engineer to see that it is accomplished. Should the QA effort fall behind the required frequency of sampling and/or testing, the District Administrator shall be advised immediately. Sufficient personnel shall be provided for the QA effort. The Materials Representative will observe the manner in which sampling is performed by the Producer. Not only is the "when", "where", and "how" of obtaining the sample important, but also the care taken to properly reduce the sample to testing size. The Materials Representative directs when the sample shall be obtained. He/she shall observe the Producer’s Certified Central Mix Aggregate Technician obtaining and splitting (or quartering) the sample into two (2) approximately equal portions. The Materials Representative takes one-half of the sample to serve as the Independent Assurance sample.

The Producer's Certified Central Mix Aggregate Technician shall perform the test on the other half, which shall be considered the next quality control sample for the Producer. (See Paragraph (a) above.)

The Producer's test results and the District Materials' copy of the daily summary sheets (Form TL-102A) shall be provided to the Department within 24 hours of completion. The forms are reviewed for correctness and legibility. The contract number(s) and tonnage(s) are obtained from the weigh sheets and recorded on the input form, Form TL-52A, which is input into VDOT's CMA database. The original and one copy of the CMA Point Adjustment Analysis Report (E12-1710-01) test report will be produced by the VDOT Materials Representative. The report shall be reviewed for correctness. The original shall be put in the District Materials Engineer's project folder. The other copy shall be forwarded to the Contractor/Producer that is producing the material. If there is more than one contract on the lot, only one lot copy shall be sent. One copy of the lot report shall also be put in a plant file. This is the only distribution that is needed. The materials notebook requires a one line entry identifying the daily tonnage, gradation or type mix, and source. In case of nonconformance to the specifications, a copy of the test report shall be furnished to the Prime Contractor by VDOT.

The success of the quality assurance program will be determined to a large extent by the effectiveness of the IA sampling and testing effort. Deficiencies revealed through this effort shall be addressed promptly and decisively. The results of the IA tests are recorded in the VDOT CMA Database. The CMA Database is capable of performing all of the statistical analyses required by VTM-59, except for the D2S comparison. Thus, this statistical test shall be made by the VDOT IA Technician immediately when the data is available, that is, after gradation results for a single lot's split sample are available from both the Producer and VDOT.

(1) D2S Test

The D2S test is an individual test comparison between the Producer's results and VDOT's results on their respective splits of the IA sample. The D2S comparison is the individual test percent difference between two (2) results obtained on test portions of the same material. The figures for acceptable range of two (2) results, in percent, applicable for all sieve sizes, are those found in Table 2 – Estimates of Precision of the AASHTO Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates, T 27-06, for multilaboratory precision for coarse aggregate, and are listed below:

Total Percentage of Material Passing		Acceptable Range of Two Results (D2S), Percent
100	≥95	1.0
<95	≥85	3.9
<85	≥80	5.4
<80	≥60	8.0
<60	≥20	5.6
<20	≥15	4.5
<15	≥10	4.2
<10	≥5	3.4
<5	≥2	3.0
<2	0	1.3

In the event that for a given sieve, the total percentages of material passing obtained by the Producer and VDOT fall into different brackets, the acceptable range to use for the D2S test shall be that corresponding to the bracket designated by the job-mix formula for the given sieve.

The benefit of performing the D2S test immediately upon the results of the IA sampling of a lot of material is that if discrepancies are found between the Producer's results and VDOT's results the reason for the discrepancies can be immediately investigated and remedied and material

quality problems minimized. If the results are not in agreement, an investigation shall be made to determine the reasons for differences as given in Paragraph (d) below.

(2) Matched Comparison Test

The IA tests performed by the CMA Database are made in a matched comparison report that compares the results of gradation, Atterberg Limits, and cement content tests of the Producer against those of VDOT on the split (matched) samples on a given job mix for a given plant using the VTM-59 methodology. The frequency of these reports shall be adjusted by the District Materials Engineer according to production schedule. The report shall use dates that include at least seven (7) IA results, if possible. Also, if there is a change in the production mix, the report shall begin with the date of the change. The report shall flag those values that are outside the statistically accepted range for samples collected from the same production operation. The report shall be reviewed by VDOT for correctness and one copy sent to the Contractor/Producer by way of a Materials Representative. If the results are not in agreement, an investigation shall be made to determine the reasons for differences as given in Paragraph (d) below.

(c) Verification Samples and Tests

Separate verification samples are not collected. The VST tests performed by the CMA Database are made in a non-matched comparison report that compares the results of gradation, Atterberg Limits, and cement content tests of the Producer against those of VDOT using the VDOT portion of the split sample and the non-split (non-matched) QC samples of the Producer on a given job mix for a given plant using the VTM-59 methodology. The frequency of these reports shall be adjusted by the District Materials Engineer according to production schedule. The report shall use dates that include at least seven (7) IA results, if possible. Also, if there is a change in the production mix, the report shall begin with the date of the change. The report shall flag those values that are outside the statistically accepted range for samples collected from the same production operation. The report shall be reviewed by VDOT for correctness and one copy sent to the Contractor/Producer by way of a Materials Representative. When flags occur in which the data generated from VDOT's non-matched IA samples indicate that the material may not be within specification limits but the data generated from the Producer's non-matched QC samples indicate that the material is within specification limits, a thorough investigation shall be conducted. If the results are not in agreement, an investigation shall be made to determine the reasons for differences as given in Paragraph (d) below.

(d) Material Acceptance

Material is accepted in accordance with specifications, based upon the Producer's test results, provided such results are statistically comparable (per VTM-59 and as described below) to VDOT's IA and VST test results and provided the material passes a visual examination for contamination and segregation at the project site.

In the event a statistical comparative analysis of the Producer's quality control test results and VDOT's IA or VST test results indicate a statistically significant difference in the results, or either of the results indicate that the material does not conform to the gradation and Atterberg Limits requirements of the specifications, an investigation shall made to determine the reason for the differences.

Suggested checks are:

(1) Check to see if the IA test results meet the specifications for Average and Standard Deviation.

(2) Compare results of VDOT/Producer split samples.

(3) Check to see if one of the systems is indicating a trend (consistently fine, coarse, erratic, etc.)

(4) Check sampling and testing procedure.

(5) Check testing equipment.

The results of the investigation shall be sent to the State Materials Engineer for use in preparing the annual report to FHWA, and to the Producer for their records. The sampling and testing procedures and laboratory test equipment (both the Producer's and the Materials Representative's) shall be checked as necessary. If the differences can be determined, the material shall be accepted, adjusted, or rejected in accordance with the specification. If differences still cannot be explained, then either the Producer or VDOT may call for the referee system to determine final disposition of the material. If it becomes necessary to implement the referee system, refer to Secs. 207.06 and 208.07 of the VDOT Road and Bridge Specifications to determine the sampling and testing details. If it is determined that the Producer's test results are not representative of the product, VDOT shall take such action as it deems appropriate to protect its interests.

(e) Treating with Cement

When these materials are treated with cement at the pugmill, sampling of materials shall be the same as outlined in Paragraphs (a) and (b) above, except the sampling for gradation, Atterberg Limits, and water content shall be done before the cement is added. The cement content shall be determined in accordance with VTM-40 and Sec. 307.05(b) of the VDOT Road and Bridge Specifications.

(f) Computations for Aggregate and Water in CMA

Outlined herein are guidelines for computing the various amounts of aggregate and water needed (with or without cement) to determine pay items, etc., when aggregate base, subbase, and select materials are pugmill mixed. This method shall be used along with the tests for water content determination, such as with the "Speedy" Moisture Tester. Accordingly, corrections for excess water content shall be made as indicated herein.

(1) Determine allowable water content for the mix. For example, assume that the average optimum water content of the material is 6 percent. The allowable water content would be:

6% +/- 2% = 4% to 8% (Sections 308.03 & 309.05 of the VDOT Road and Bridge Specifications.)

(2) Determine Water Content Correction. For example, assume 1000 tons of material shipped containing 10 percent total water content. (The test for total water content shall be made on a sample of material obtained by the Producer's Certified Central Mix Aggregate Technician, after all water has been added to the mix in the pugmill, and after the material is ready for job shipment.):

$$\frac{1000}{1.10} \text{ tons} = 909.1 \text{ tons of dry aggregate.}$$

(3) Determine Pay Quantity:

909.1 tons x 1.08 = 981.8 tons of aggregate.

This is the total combined tonnage (dry aggregate and water) that shall be computed as the amount eligible for payment. Notes shall also be made on the computerized CMA Point Adjustment Analysis Report (E12-1710-01) test report and on the Weighperson's Daily Summary Report, Form TL-102A, showing the average optimum water content and the total water in order that proper corrections for payment can be made later in the net weight recorded on the weigh ticket and in materials notebooks.

(g) Stockpiling After Mixing

If due to heavy demand material is stockpiled after production, it shall be necessary to make tests for total water and record the results on the forms listed above at the time of shipment of material to the project. If water content of the aggregate in the stockpile is below the minimum required (optimum minus two (2) percentage points), either the stockpiles shall be sprinkled to bring the water content within tolerance or the District Materials Engineer may require that the aggregate shall be run through the pugmill again to bring the water content within tolerance. Computations for the pay quantity shall be carried out to the same decimal point as the pay item.

When these materials are stockpiled at the plant after mixing and before shipment to the project, neither independent assurance sampling, nor quality control sampling for the purpose of lot acceptance, shall be performed while the Producer is stockpiling material. Instead, quality control samples for lot acceptance and independent assurance samples shall be taken, as outlined in Paragraphs (a) and (b) above, when the material is shipped to the project from the stockpile. If the material was not pugmill mixed prior to stockpiling, then it shall be necessary to run the material through the pugmill prior to both production quality control sampling and testing and independent assurance sampling and testing.

SECTION 312 PROJECT SAMPLING, TESTING AND INSPECTION

Sampling aggregate base, subbase, and select material from the project for gradation and Atterberg Limits tests normally shall not be required, unless the material has not received acceptance testing at the source prior to shipment, as outlined in Secs. 311.05(a), (b), and (c) above, or unless the material being placed on the project is visually observed to be contaminated or segregated, regardless of prior acceptance testing.

If roadway sampling becomes necessary, it shall be done immediately after placement has been completed and prior to compaction. The Project Inspector, when properly trained and experienced, may obtain samples. Samples of the material shall be obtained from three (3) points within the roadway. These shall be at the center and approximately four (4) ft. transversely from the outer edges of the course being laid. The material from the three (3) points shall be taken from the full depth of the course being laid. The sides of the hole shall be kept as nearly vertical as possible. The material shall be placed on a canvas or other surface of sufficient size, thoroughly mixed, and quartered or split to obtain the proper size sample.

Project samples shall be tested in the VDOT or an AMRL-accredited consultant laboratory at the discretion of the District Materials Engineer and at the rate of sampling previously specified. Samples of select material for CBR tests shall be obtained at the minimum rate of one (1) per project, or more often as needed for control, if these tests have not been performed prior to the receipt of the material at the job site, whether the material is processed or local. However, if the stockpile or borrow location of material is serving multiple projects and has already been tested for CBR for other projects, those previous test results may be used as long as the material has not been altered or contaminated. The same rate of sampling outlined above applies to aggregate used as shoulder material.

Arrangements shall be made for a daily pickup of samples taken by the Inspector, if it becomes necessary to sample material from the project.

Each sample submitted to the Materials Division shall be accompanied by two (2) Form TL-11 cards. One card shall be placed in an envelope and attached to the outside of the bag, and the duplicate card shall be submitted by mail. Form TL-11 shall be completely filled out including the amount of material represented by the sample. This can be volume, lineal feet (Sta. to Sta.), tonnage, or percentage, as the case may be. Further instruction for Form TL-11 is found in Chapter VIII, Sec. 803.04 Form TL-11, Notice of Shipment of Sample for Test (Soil and Local Materials).

Size of sample to be submitted shall be 75 to 100 lbs (two (2) bags) in all cases for the following samples:

(1) Local pit or select material.

(2) Material to be used in embankments.

(3) Material for CBR Test (from soil survey or source). Two (2) bags if all material will pass 3/4 in. sieve; three (3) bags if considerable amount of plus (+) 3/4 in. material is present.

(4) Pugmill material (regardless of where tested).

(5) Subbase or base material from project.

(6) Material for soil-cement stabilization.

(7) Material for soil-lime stabilization.

Where soil-cement or soil-lime stabilization will be used on a new location, on an existing road, or on a change in grade, representative samples of the material in the road or of the soil to be stabilized shall be submitted to the VDOT or an AMRL-accredited consultant laboratory for tests. Samples shall be taken from each different soil type encountered. If the materials in the existing roadway or on the new location are reasonably uniform, one sample may be sufficient.

In some cases, aggregate base, subbase, or select materials to be treated may be open graded, requiring excessive amounts of stabilizing agent acting as an expensive filler, or resulting in a product with an excessive amount of voids if the cement content is held to acceptable limits. The recommended gradation on critical sieves for these materials is given below and should be adhered to as closely as possible when the materials will be treated with cement or lime:

Sieve Number	Minimum Percent Passing
4	55
10	37
-10/+200	25 (Minimum % retained between these sieves.)

Select material may require additional care to maintain the material close to these limits without requiring tighter gradation controls when it will be treated with cement or lime.

The following sections 312.01 and 312.02 contain instructions for density control and depth control of compacted materials, respectively. This includes the following: embankment material; finished subgrade (prior to paving); cement or lime stabilized subgrade (consisting of material in-place or imported material other than aggregate base, subbase or select material); stabilized or untreated aggregate base, subbase or select material; and stabilized or untreated aggregate shoulder material.

Sec. 312.01 Density Control

(a) General

(Reference Secs. 303.04, 304, 305.03, 306.03, 307.05, 308.03, and 309.05, VDOT Road and Bridge Specifications.) See Sec. 207 herein for possible waiver of density tests on special projects.

The density of soil is defined as the weight of the soil (and water) per unit volume (lbs per ft^3). The dry density of a soil is defined as the weight of just the soil per unit volume (lbs per ft^3). The water content of a soil is the ratio of the weight of water in a soil mass versus the weight of the dry soil in that same volume, expressed as a percentage. The optimum water content is the water content at which maximum density can be achieved by a standard compactive effort. The maximum theoretical density is that density where the most soil is compacted into a unit volume by a standard compactive effort. The maximum theoretical density of a soil shall be determined using VTM-1 or the One-Point Proctor Method VTM-12. The percent compaction is the ratio of the in-place density versus the maximum theoretical density expressed as a percentage.

Before field control of compaction can be exercised, it is necessary that the theoretical maximum density and optimum water content for each type of soil or aggregate (pavement base or subbase materials) be determined in advance of the compaction operation.

In addition to information available on soil survey reports, it may be necessary to submit representative samples of the soil for testing per VTM-1 to a VDOT laboratory or an AMRL-accredited consultant laboratory, unless the One-Point Proctor Method (VTM-12) is used for this determination in the field. Samples submitted to a laboratory for this purpose shall be from 75 to 100 lbs or two (2) full bags (four (4) full sample bags if resilient modulus testing is required). The following information shall supplement that normally given on Form TL-11 which accompanies the sample:

(1) Horizontal limits (by station number) represented by the sample.

(2) Vertical limits (in feet) represented by the sample.

(3) Visual description of material (Example: Silty Sand, containing some mica).

(b) Compaction and Determination of Field Density

(1) Use of Maximum Laboratory and One-Point Proctor Densities (theoretical maximum densities) - As noted above, in computing the percent of compaction in the field, the density determined in the field shall be compared to a standard density, as determined by VTM-1, or the One-Point Proctor density (VTM-12), unless otherwise noted herein.

(2) Equipment Needed for Field Density Test - The equipment necessary for performing field density tests is available to VDOT staff through the District Materials Engineer. The equipment is however only required to be provided to non-VDOT personnel or firms when contracts with VDOT require it (e.g., District or Statewide or Regional Construction Engineering and Inspection (CEI) contracts or Statewide or Regional Laboratory Testing and Technician Services contracts). The District Materials Section is available to provide instruction and assistance to the Project Inspectors who operate nuclear gauges for measurement of density and moisture of soils, aggregates, and other paving materials. See Secs. 105.02, 105.03, and 105.04 herein for details and safety precautions for the use of nuclear equipment.

(3) Control of Water - Control of water is most important in obtaining proper compaction of soils and granular materials. Too little water will require more compactive effort to obtain the desired density. If there is too much water, the maximum density cannot be reached regardless of how much the soil is

rolled. The Inspector should perform frequent water content tests, in order to be sure that the soil has correct water content.

Materials having a water content above optimum by more than 30 percent of optimum shall not be placed on a previously placed layer for drying, unless it is shown that the previously placed layers will not become saturated by downward migration of water into the material. If water content is not within the specified tolerances, then the lift will have to be aerated or water added, as the case may be. All water content tests taken are to be recorded and become a permanent part of the record of the project.

It is suggested that the "Speedy" Moisture Tester be used for expediency in conducting these tests, except when the soils are heavy clays, in which case the field stove method shall be used.

The above instructions apply primarily when conducting field density tests by one of the methods other than the nuclear moisture-density method. When using the nuclear moisture-density method, water content shall be determined as outlined in Paragraph (c)(1) below.

(c) Methods of Field Density Determination

(1) Nuclear Moisture-Density Method

The nuclear moisture-density method of field density determination, when specified, shall be conducted in accordance with VTM-10 and Secs. 303 and 304 of the VDOT Road and Bridge Specifications. The entire scope of nuclear testing is also outlined in detail in AASHTO T-310.

Nuclear moisture-density tests of embankments, subgrade, cement or lime stabilized subgrade, and backfill for pipes and culverts and other structures as delineated in (d)(5) through (d)(9) below shall be conducted using the Direct Transmission Method of testing. The density obtained shall be compared with the theoretical maximum density, obtained either by the Laboratory method (VTM-1) or the One-Point Proctor method (VTM-12) to determine the percentage compaction.

Nuclear moisture-density tests of aggregate base, subbase, and select materials, both untreated and treated with cement or lime, for pavement as well as shoulder material, shall be conducted using the Backscatter, Control Strip Method of testing. The nuclear density obtained in the test sections shall be compared with that of the corresponding control strip. Alternatively, the District Materials Engineer may waive the Control Strip Method in favor of the Direct Transmission Method of testing, and compare the density obtained with the theoretical maximum density from either the Laboratory method (VTM-1) or One-Point Proctor method (VTM-12).

Water content tests of soils shall be made directly using the nuclear device, rather than as outlined in Paragraph (b)(3) above.

If there is a breakdown in the nuclear testing equipment, then the Inspector shall continue checking density using other conventional methods.

Nuclear equipment necessary for performing nuclear moisture-density tests, when specified, is available through the VDOT Central Office Soils Laboratory. This equipment is however only required to be provided to non-VDOT personnel or firms when contracts with VDOT require it (e.g., District or Statewide or Regional Construction Engineering and Inspection (CEI) contracts or Statewide or Regional Laboratory Testing and Technician Services contracts). The District Materials Section is available to provide instruction and assistance to the Project Inspectors who operate nuclear gauges for measurement of density and moisture of soils, aggregates, and other paving materials. Instructions for the operation, administration, and safety in the use of this equipment are detailed in Secs. 105.02, 105.03, and 105.04.

(2) Sand-Cone Method

When specified, field density tests by the Sand-Cone Method shall be conducted in accordance with AASHTO T191. Next to the nuclear method, this is probably the most widely used method of determining field density. Briefly, it involves finding the weight of a sample and measuring the volume occupied by the sample prior to removal. This volume shall be measured by filling the space with a material of predetermined weight per unit volume, in this case sand. The percentage compaction shall be determined by comparing the field density obtained with the maximum theoretical density from either the Laboratory method (VTM-1) or the One-Point Proctor method (VTM-12).

(3) Other Methods

Other approved methods may be adopted for use in determining field density at the discretion of the District Materials Engineer. These other methods may for example include use of Intelligent Compaction, non-nuclear gauges, Light Weight Deflectometers (LWD), or Dynamic Cone Penetrometers (DCP).

(d)Frequency of Field Density Tests

The frequency of field density tests shall be as outlined herein. Again, it should be emphasized that the rates given for testing are the minimums considered desirable to provide effective control of material under ideal conditions, and more testing than that specified shall be done if deemed necessary by the Engineer.

(1) Embankments and Finished Subgrades

The minimum number of field density tests required shall be one for each 2500 yd^3 or less of fill material placed, with the following additional requirements:

(a) For fill areas less than 500 ft. in length, a minimum of one (1) field density test for every other 6-in. compacted layer from the bottom to the top of fill starting with the second lift.

(b) For fills 500 to 2000 ft. in length, a minimum of two (2) field density tests for each 6-in. compacted layer within the top five (5) ft. of fill.

(c) For fills greater than 2000 ft. in length, break into equal sections not to exceed 2000 ft. and test each section in accordance with (b) above.

The terms "embankment" and "fill" as used here are intended to encompass the entire roadway in width, under construction between right-of-way lines, regardless of whether the roadway is single or dual lane. For example, a dual lane fill shall be considered as a single fill. However, each separate linear embankment or fill shall be considered as a separate item and tested at the above specified rate, separately and independently of adjoining fills. Locations of tests shall be staggered, so that the entire length, width, and depth of the fill are covered by tests, inclusive of slopes. When testing is not being conducted, the Inspector shall visually observe lifts being placed to ensure that proper placement and compaction procedures are being followed.

The amount of rock present in the embankment that will preclude conducting the density test shall remain flexible, and shall be at the discretion of the Project Inspector. However, it should be understood that if it is possible to conduct a test, then the test should be performed. If a test cannot be performed, location documentation of the rock layer shall be submitted in lieu of the test data on the appropriate density report.

In the finished subgrade in both cut and fill sections, a minimum of one (1) test shall be performed for each 2000 linear ft. of subgrade for each roadway (full width).

(2) Cement or Lime Stabilized Subgrade

When the subgrade, consisting of material-in-place or imported material other than aggregate base, subbase, or select material, is stabilized with cement or lime, one density test shall be conducted for each one-half (1/2) mile of stabilization per paver (mixer) application width. In other words, each separately applied width of stabilization, regardless of roadway width, shall require a separate series of tests.

The tests shall be started from 25 to 100 ft. from the beginning or end of the project, with the remaining tests being spaced at variable intervals not exceeding the linear spacing noted above. The tests shall be located in the approximate center of the applied width, but occasionally shall be staggered across the applied width at random locations to check density, particularly near the edges of the stabilization. Care shall be taken not to perform a uniform pattern of tests.

(3) Aggregate Base, Subbase, and Select Material

Density tests of aggregate base, subbase, and select material, whether treated with cement or lime or untreated, shall be performed the same as outlined in Paragraph (d)(2), except that the tests shall be performed on each compacted layer of the pavement course, if the course is applied in more than one (1) layer. Also, when using the nuclear method, each recorded test specified above shall consist of the average of five (5) readings, the location of which shall be at randomly selected sites.

When using the nuclear method, a roller pattern and control strip (or maximum theoretical density, see Paragraph (c)(1) above) shall be performed for each layer or lift placed, in order to establish the maximum density required before testing of the test section.

(4) Aggregate Shoulder Material

Density tests of aggregate shoulder material shall be performed as outlined in Paragraph (d)(3) above, except that the tests shall be performed on alternating sides of the road each one-half (1/2) mile.

(5) Backfill for Pipes and Box Culverts

A minimum of one (1) test shall be performed per lift on alternating sides of the structure for each 300 linear ft. or portion thereof in structure length. This test pattern shall begin after the first 4-in. compacted layer above the structure's bedding and shall continue to one (1) foot above the top of the structure.

(6) Backfill for Abutments, Gravity and Cantilever Retaining Walls

A minimum of two (2) tests every other lift up to 100 linear ft. shall be performed. Testing shall be performed behind these structures at a distance from the heel no farther than a length equal to the height of the structure plus 10 ft.

(7) Mechanically Stabilized Earth (MSE) Walls

Less than 100 linear ft. a minimum of one (1) test every other lift shall be performed. The testing shall be performed a minimum distance of 8 ft. away from the face of the wall, to within three feet of the back edge of the zone of the reinforced fill area. Test sites shall be staggered throughout the length of the wall to obtain uniform coverage. Testing shall begin after the first two (2) lifts of reinforced fill have been placed and compacted.

Walls more than 100 linear ft., a minimum of two (2) tests every other lift not to exceed 200 linear ft. shall be performed.

(8) Backfill for Drop Inlets

A minimum of one (1) test every other lift around the perimeter of the structure shall be performed. The test pattern shall begin after the first 4-in. compacted layer above the bedding and shall continue to the top of the structure. Tests shall be staggered to assure consistent compactive effort has been achieved throughout.

(9) Backfill for Manholes

Manholes shall have a minimum of one (1) test performed around the perimeter of the structure every fourth compacted layer until the top five (5) feet of the structure; in the top five (5) feet one (1) test every other lift around the perimeter of the structure shall be performed. The test pattern shall begin after the first 4-in. compacted layer above the bedding and shall continue to the top of the structure.

(e) District Materials Oversight

For Items (1) through (9) above, the District Materials Section shall conduct a continuous program of instruction for project personnel in performing density tests and shall inspect all density testing equipment used by Project Inspectors, to ascertain that it is kept clean and properly calibrated.

A Materials Representative shall also inspect density test reports prepared by the Inspectors to determine if sufficient tests and proper coverage have been made, that reports are properly prepared and completed and that all pertinent information has been included on the test reports.

(f) Corrections for Areas Outside of Tolerance

If any areas are found to be outside of specification tolerances for density, the corrections shall be made in accordance with the particular VDOT Road and Bridge Specification relating to the material in question. (Sections 303.04, 304, 305.03, 306.03, 307.05, 308.03, and 309.05, VDOT Road and Bridge Specifications.)

(g) Reports

Results of acceptance density tests in the field shall be reported on Forms TL-53, TL-54, TL-55, and TL-124 (for the nuclear methods), Form TL-125 (for the sand-cone method), and Form TL-125A (for the One-Point Proctor Method of determining theoretical maximum density). All test reports shall be completely filled out, giving all required information. All tests, both passing and failing, shall be reported. The failing test report shall indicate what corrective action was taken. When tests are not run due to gravel, muck, rock, or any other reason, a report shall be submitted giving reasons for the tests not being conducted, and such information as the length (station to station) of roadway not tested, as well as depth or elevation in the fill not tested. Independent Assurance density tests shall be so marked on the form in bold letters (INDEPENDENT ASSURANCE DENSITY TEST), and the results of IA density tests shall also be tabulated on Form TL-136, in addition to the forms noted above.

See Chapter VIII for details of completing and distributing these forms.

Sec. 312.02 Depth Control

(a) General

(Reference Secs. 305.03(a), 306.03(g), 307.05(e) 308.04, and 309.05, VDOT Road and Bridge Specifications.) Job acceptance depth tests shall be made by the Inspector or other project personnel.

Measurements shall be taken at random for each course after completion of the course depth as the work progresses. This shall not be construed as requiring that the entire project be completed before conducting depth tests. Depth tests shall be made as sections of the project are completed. The volume of material measured on the basis of cubic yards compacted in place shall be computed from the length and width shown on the plans and the average depth of the material on the entire project, determined from measurements taken at the below noted intervals, measured longitudinally along the surface.

(b) Frequency of Depth Tests

For the purpose of determining depth, and to define areas of deficient or excessive depth, job acceptance depth tests shall be made, as outlined in VTM-38. Materials to be tested by VTM-38A include cement or lime stabilized subgrade, consisting of material-in-place or imported material other than aggregate base, subbase, or select material. Materials to be tested by VTM-38B include (1) treated or untreated aggregate base, subbase, and select material, and (2) aggregate shoulder material.

For Method VTM-38A, one (1) depth test shall be conducted for each one-half (1/2) mile of stabilization per paver (mixer) application width. In other words, each separately applied width of stabilization, regardless of roadway width, shall require a series of tests.

The tests shall be started from 25 to 100 ft. from the beginning or end of the project, with the remaining tests being spaced at variable intervals not exceeding the linear spacing noted above. The tests shall be located in the approximate center of the applied width, but occasionally shall be staggered across the applied width at random locations to check depth, particularly near the edges of the stabilization. Care shall be taken not to set up a uniform pattern of tests.

The depth recorded at each location shall be considered the depth for the applied width of material and extending one-fourth (1/4) mile longitudinally in each direction from the test location. If the tests are made at closer intervals than specified, the test data shall apply to a point extending half-way between the test point and the next test point on either side.

In cases in which the depth determined is deficient or excessive beyond the allowable specification tolerances, additional depth tests, as outlined in VTM-38A, shall be performed to bracket this area.

For method VTM-38B, the project shall be divided into lots, with each lot stratified, and the location of each test within the stratified section determined randomly. A lot of material is defined as the quantity being tested for acceptance, except the maximum lot size shall be two (2) miles for each paver application width. The randomization procedure used shall be at the direction of the Engineer. (See VTM-38 for example.) Samples shall be taken from the lot at the following rate:

Lot Size	No. of Samples Required
0 - 1 Mile	2
1 - 1 1/2 Miles	3
1 1/2 - 2 Miles	4

In the case of aggregate shoulder material, use the same linear frequency of testing as used on the mainline, except alternate the tests from one side of the road to the other.

Tests shall be performed in turning lanes, acceleration or deceleration lanes, ramps, connections, crossovers, etc. at the discretion of the Engineer. These samples shall not be taken at random; however, care shall be taken not to set up a uniform pattern. The tolerance for an individual test result shall apply.

It is not the intent of this procedure to prohibit the sampling and testing of the material at any location which is visually determined to be out of specification tolerance for an individual test.

In some cases, select material or similar material may be used in certain undercut sections, etc., in depths exceeding that shown on the plans as the uniform design depth of the pavement structure for the entire project. In these cases, the Inspector shall be responsible for checking only that uniform depth shown for the entire project (usually 12 in. or less). It shall be the responsibility of the Inspector to ensure that the depths of materials used for backfill, etc. in certain isolated sections are maintained.

(c) Corrections for Areas Outside of Tolerance

If any areas are found to be outside of specification tolerances for depth, the corrections shall be made in accordance with the particular section of the VDOT Road and Bridge Specifications relating to the material in question (Sections 305.03(a), 306.03(g), 307.05(e), 308.04, and 309.05, VDOT Road and Bridge Specifications).

(d) Reports

Results of job acceptance depth tests of the above noted materials shall be retained as part of the permanent project records. The data may be kept in the form of a worksheet. Those depth tests that fail to meet specification requirements and subsequent delineation and/or correction determinations shall be recorded on Form TL-105. Results of Independent Assurance depth tests shall be tabulated on Form TL-136. See Chapter VIII for details of completing and distributing these forms.

Sec. 312.03 Sampling, Testing, and Analysis of Resilient Modulus for Subgrade, Subbase, and Base

VDOT is in the process of revising its pavement design procedures to incorporate a Mechanistic-Empirical (ME) rationale. VDOT's goal is to have an ME procedure in place by the end of year 2013. Part of this revision will be to incorporate the use of resilient modulus testing for subgrade and aggregate strength properties.

VDOT is currently working toward this goal by collecting subgrade samples from around the state and performing resilient modulus tests on them and attempting to correlate the results with other more conventional test results such as those from unconfined compression tests. VDOT has completed some resilient modulus testing on aggregate. The catalog of resilient modulus test results for Virginia soils will be developed for soils from all districts. As of the summer of 2011, VDOT had completed approximately 400 resilient modulus tests (for 190 soils), and is attempting to complete another 200 by the end of 2012. VDOT also plans to analyze moisture effects on resilient modulus. VDOT is also working with FHWA and other states on resilient modulus test reliability analyses.

Sec. 312.04 Subgrade Chemical Stabilization

In order to improve the subgrade upon which a pavement structure will be built, chemical stabilization may be utilized. The two most common chemicals used for subgrade stabilization are lime and cement. This section provides guidance and requirements for chemical stabilization of subgrade.

Subgrade is defined at VDOT as "the top surface of an embankment or cut section, shaped to conform to the typical section upon which the pavement structure and shoulders will be constructed" (from Chapter 3 of the VDOT Soils and Aggregate Compaction Certification Study Guide). It is typically considered to

be the top 6 inches of finished, compacted soil; however, chemical stabilization is typically performed on the upper 12 inches of soil.

Fine-grained soils consisting primarily of silt and clay size particles often have relatively low resilient modulus values (2,000 psi to 10,000 psi, traditionally corresponding to CBR values of approximately 1 to 7). In such cases chemical stabilization of the subgrade may be considered as an economical way to reduce the required thickness of the overlying pavement structure.

Typically cement is more effective and economical for stabilizing soil with a Plasticity Index (PI) of 16 or less. Lime is more effective and economical for stabilizing soil with a PI of 20 or greater. For soil with a PI between these ranges either cement or lime can be used.

Silt and clay soils also often have relatively high natural water contents. Lime (or lime kiln dust) in particular is often used to dry such soils. Lime treatment of soil can be classified into three tiers of treatment. Drying is the addition of the least amount of lime (typically up to 3% by dry weight of soil). Drying is used to reduce the water content of the soil in order to provide a stable working platform. Lime kiln dust as well as lime may be used for drying, but lime kiln dust should not be used for modification or stabilization. Modification is the addition of a greater amount of lime (typically 3% to 5% by dry weight of soil) in order to both provide a working platform and give the soil greater strength, at least temporarily, to provide for trafficking of construction equipment. Finally, stabilization is the term used when the greatest amount of lime is used (typically 5% to 8% by dry weight of soil), which not only provides the former benefits, but also provides a long-term strength and durability gain that can be utilized in the design of the pavement structure. When cement is used for stabilization of soil, it is typically added in the range of 5% to 9% by dry weight of soil. The stabilized subgrade can be counted as a layer of the pavement structure and given a layer coefficient (for flexible pavement design). See Sec. 604.02 for layer coefficient values.

Laboratory testing, by VTM-11 for lime stabilization or VTM-72 for cement stabilization shall be performed to determine if subgrade soil is suitable for chemical stabilization. (Except that in using VTM-72 two (2) specimens shall be made and cured for each quantity of cement tested, and the cure time shall be only seven (7) days and the specimens will only be tested for compressive strength.) The quantity of lime required for stabilization shall be that quantity that yields a minimum unconfined compressive strength (UC) strength of 100 psi as the average of two (2) specimens made with the same lime content. In no case shall the quantity of lime used be less than 5% by dry weight of soil, and lime stabilization shall not be used if a UC strength of 100 psi cannot be obtained with 8% or less lime by dry weight of soil. The quantity of cement required for stabilization shall be that quantity that yields a minimum UC strength of 250 psi as the average of two (2) specimens made with the same cement content, found by testing specimens at varying cement contents, typically 5%, 7%, and 9% by dry weight of soil. In no case shall the quantity of cement used be less than 5% by dry weight of soil, and cement stabilization shall not be used if a UC strength of 250 psi cannot be obtained with 9% or less cement by dry weight of soil. The reason for the difference in required strength between lime and cement (100 psi vs. 250 psi) is based primarily on the differences in time to cure and rates of strength increase and durability requirements.

Chemical stabilization may be designed into a project from conception, or it may be considered later as more soil exploration data becomes available or other project considerations change. This section is intended for basic guidance; however, the Materials Section and project staff of the district in which the project is located shall be consulted when chemical stabilization of subgrade is considered.

SECTION 313 PROJECT SAMPLING OF STABILIZED OPEN-GRADED BASE MATERIAL FOR ACCEPTANCE

Sec. 313.01 General

Job acceptance permeability tests of stabilized open-graded base material shall be performed in accordance with VTM-84. Sampling shall occur after asphalt stabilized material has been in place overnight and after cement stabilized material has cured sufficiently to permit coring.

Sec. 313.02 Frequency of Test Samples

Initial sampling for permeability tests shall be at the rate of three (3) 6-in. diameter cores taken at approximately even intervals over the first one (1) mile of stabilized open-graded base material placed in one (1) pass of the paver. Samples shall not be taken within two (2) ft. of the edge of the layer or directly over any underdrain or trench in the subbase or subgrade.

Additional permeability sampling and testing may be waived by the District Materials Engineer if initial tests are passing and no changes occur in the mix design, compactive effort, or visual appearance of the material. Further testing may be necessary if changes occur in the gradation of the material or asphalt or cement content.

If a change occurs, sampling shall be at the same rate as initial sampling.

If localized areas of the stabilized open-graded base material are suspect, a minimum of two (2) 6-in. diameter cores shall be taken from the area for permeability testing and the average coefficient of permeability shall be used for acceptance or rejection.

For investigative purposes, a minimum of one (1) sample shall be required.

Filling of holes shall be with a stabilized or unstabilized open-graded material placed in a single layer and tamped until no further consolidation occurs within the hole. The finished material shall be leveled to the grade of the surrounding material and all remaining loose material shall be removed. Unstabilized material used to fill the holes shall be Aggregate No. 57, 68, 78, or 8. Stabilized material, if used, shall be of any cement or asphalt cement concrete material approved for VDOT use.

Sec. 313.03 Reports

Results of job acceptance permeability tests shall be reported on Form TL-51.

All test reports shall be completely filled out, including all required information. All tests, both passing and failing, shall be reported.

See Chapter VIII for details of completing and distributing these forms.

SECTION 314 SUMMARY OF MINIMUM ACCEPTANCE AND INDEPENDENT ASSURANCE SAMPLING AND TESTING REQUIREMENTS

Following is a condensed tabulation showing the minimum requirements for acceptance testing of soils and central mix aggregate. See also Secs. 205 and 206 for additional details governing minimum acceptance sampling and Independent Assurance sampling.

On projects in which the owner (VDOT or local agency) is not the entity performing the acceptance tests for field density and depth, both third party and owner IA and VST tests are required. Types of projects

on which this occurs are for example Design-Build (DB) projects or Public-Private Transportation Act (PPTA) projects. For frequency of third party and owner IA and VST tests, Table 105.4 of the manual "VDOT's Minimum Requirements for Quality Assurance & Quality Control on Design Build & Public-Private Transportation Act Projects" shall be followed. For comparison tolerances between acceptance and IA tests, Table 105-2 of the same manual shall be followed. This document can be found online at:

http://www.virginiadot.org/business/resources/PPTA/ApprovedQA-QCGuide4DBP-rev1.pdf.

(Table 105.4 is "Department's Minimum Requirements for Design-Builder's QA/QC Plans on Design-Build Projects - Minimum Requirements for Quality Assurance and Quality Control on Design-Build Projects". Table 105-2 details comparison tolerances for testing which will trigger the referee and disputes processes.)

MATERIAL AND TEST	ROAD AND BRIDGE SPECIFICATION REFERENCE	RATE OF SAMPLING	LOCATION OF SAMPLING	REMARKS
1. Embankments				
(a) Density, Any Method	303.04(h)	One (1) test per 2500 yd^3 or less plus: (a) for fills less than 500 ft. length one (1) test on every other 6-in. layer bottom to top of fill starting with the second lift; (b) for fills from 500-2000 ft. length, two (2) tests per 6-in. layer within top five (5) ft. of fill; (c) for fills greater than 2000 ft length, break into equal segments not to exceed 2000 ft. and use same frequency for each section as for fills 500 to 2000 ft. in length.	Roadway	When tests are not run due to gravel, muck, rock, etc. give sta. and depth on report in lieu of test, with reason. For nuclear test, use Direct Transmission Method, VTM-10. See Notes 1 and 2.
2. Finished Sub-grade (Both Cut and Fill Sections)				
(a) Density, Any Method	305.03	One (1) test per 2000 linear. ft.	Roadway (24 ft.)	For nuclear test, use Direct Transmission Method, VTM-10. See Notes 1 and 2.

MATERIAL AND TEST	ROAD AND BRIDGE SPECIFICATION REFERENCE	RATE OF SAMPLING	LOCATION OF SAMPLING	REMARKS
3. Stabilized Subgrade (Mat'l.-in-Place or Imported Mat'l., Other Than Agg. Base, Subbase, or Select Mat'l.)				
(a) Density, Any Method	306.03(f) & 307.05(e)	One (1) test per 1/2 mile per paver (mixer) application width.	Roadway	For nuclear test, use Direct Transmission Method, VTM-10. Tests to be located in approximate center of applied width. Care shall be taken not to set up uniform pattern of tests. See Notes 1 and 2.
(b) Depth	306.03(g) & 307.05(e)	One (1) test per 1/2 mile per paver (mixer) application width.	Roadway	Tests to be conducted by VTM-38A. Tests to be located in approximate center of the applied width. Care shall be taken not to set up uniform pattern of tests. Deficient or excessive areas of depth shall be as defined in VTM-38A. See Notes 1 and 3 for reports. Tests in turning lanes, acceleration or deceleration lanes, ramps, connections, crossovers, etc., at discretion of Engineer.

MATERIAL AND TEST	ROAD AND BRIDGE SPECIFICATION REFERENCE	RATE OF SAMPLING	LOCATION OF SAMPLING	REMARKS
4(a). Central Mix Aggregate (Treated or Un-treated) Base, Subbase, and Select Material				
(1) CBR (On Select Material Only)	207.02(c)	One (1) 75 to 100 lb sample per project, or more often as needed for control, on processed or local material, to VDOT or AMRL-accredited consultant laboratory.	From processing or mixing plant or roadway	If material is treated with additive, sample shall be taken without additive included. See Note 4 for reports.
(2) Gradation and Atterberg Limits	207 & 208	Producer: Four (4) 30 to 40 lb samples per lot (either 2000 ton lot or 4000 ton lot). Samples taken in stratified random manner.	From processing or mixing plant.	Same as Item 4(a)(1). Samples to be taken and tested by Producer's Certified Central Mix Aggregate Technician who shall keep records of tests on Form TL-52A and maintain quality control charts. Test results shall be reported by VDOT on the CMA Point Adjustment Analysis Report (E12-1710-01).

MATERIAL AND TEST	ROAD AND BRIDGE SPECIFICATION REFERENCE	RATE OF SAMPLING	LOCATION OF SAMPLING	REMARKS
4(a)2 Cont'd		IA sampling duplicates at least one (1) of the four (4) samples from 4(a)(2) above.	From processing or mixing plant at time of shipment. Sampling from roadway normally shall not be required, unless material has not received acceptance testing at source, or unless material being placed on road indicates contamination or segregation, regardless of prior acceptance testing.	Same as Item 4(a)(1). Sample taken by Producer's Certified Central Mix Aggregate Technician in presence of Materials Representative, and tested in VDOT or AMRL-accredited consultant laboratory, and reported on Forms TL-32 and TL-52C. District Materials Representative will make weekly comparisons of production control test results vs. IA test results. See Secs. 311.05(b) and (c) for additional details. Select material not centrally mixed and aggregates paid for on a volume basis shall be sampled as directed by the District Materials Engineer.

MATERIAL AND TEST	ROAD AND BRIDGE SPECIFICATION REFERENCE	RATE OF SAMPLING	LOCATION OF SAMPLING	REMARKS
(3) Density, Any Method	305.03, 308.03, & 309.05,	One (1) test per 1/2 mile per paver (mixer) application width per layer. If testing by nuclear method, each test shall consist of average of five (5) readings.	Roadway. Location of five (5) nuclear readings at randomly selected sites.	For nuclear tests, use Backscatter, Control Strip Method, VTM-10. With nuclear method, set up roller pattern and control strip for each layer or lift placed. See Notes 1 and 2.
(4) Depth	308.04 & 309.05	Two (2) tests each paver (mixer) application width from 0 to 1 mile , three (3) tests each width from 1 to 1 1/2 miles, and four (4) tests each width from 1 1/2 to 2 miles. Maximum lot size is 2 miles for each paver application width. Project divided into lots, each lot stratified, and location of each test within stratified section determined randomly.	Roadway.	Tests shall be conducted by VTM-38B. Tests in turning lanes, acceleration or deceleration lanes, ramps, connections, crossovers, etc., at the discretion of the Engineer, and shall not be taken at random. However, care shall be taken not to set up uniform patterns of tests. For these miscellaneous items, the tolerance for an individual test result shall apply. See Note 3 for reports
(b) Shoulder Material- (1) CBR (On Select Material Only)	207.02.	Item 4(a)(1) governs.	Same as Item 4(a)(1).	Same as Item 4(a)(1).

MATERIAL AND TEST	ROAD AND BRIDGE SPECIFICATION REFERENCE	RATE OF SAMPLING	LOCATION OF SAMPLING	REMARKS
(2) Gradation and Atterberg Limits	207 & 208	Item 4(a)(2) governs.	Same as Item 4(a)(2).	Same as Item 4 (a)(2).
(3) Density, Any Method	305.03(a)	Same as Item 4(a)(3), alternating sides.	Same as Item 4(a)(3).	Same as Item 4(a)(3).
(4) Depth	305.03(a)	Same as Item 4(a)(4), alternating sides.	Same as Item 4(a)(4).	Same as Item 4(a)(4).
5. Backfill for Pipes and Box Culverts	302.03, 303.04(g), 401.03(i)	Minimum one (1) test per lift on alternating sides of structure for each 300 linear ft. or portion thereof in structure length, starting after first 4-in. layer above bedding and continue to one (1) ft. above the top of the structure.	Alternating sides of structure	For nuclear test, use Direct Transmission Methods, VTM-10. See Notes 1 and 2 for reports.
6. Backfill for Abutments, Gravity and Cantilever Retaining Walls	303.04(g), 401.03(i)	Minimum of two (2) tests every other lift up to 100 linear ft.	Behind heel a distance of H + 10 ft.	For nuclear test, use Direct Transmission Methods, VTM-10. See Notes 1 and 2 for reports.
7. Mechanically Stabilized Earth Walls (MSE)	303.04(g), 401.03(i)	Walls less than 100 linear ft. shall have a minimum of one (1) test every other lift. Walls more than 100 linear ft. shall have a minimum of two (2) tests every other lift not to exceed 200 linear ft.	Zone of reinforced fill for MSE wall	For nuclear test, use Direct Transmission Methods, VTM-10. See Notes 1 and 2 for reports.
8. Backfill for Drop Inlets	302.03, 303.04(g)	Minimum one (1) test every other lift around the perimeter of each structure, after first 4-in. layer above bedding and continue to top of structure.	Perimeter of structure	To include drop inlets, junction boxes, etc. For nuclear test, use Direct Transmission Methods, VTM-10. See Notes 1 and 2 for reports.
9. Backfill for Manholes	302.03, 303.04(g)	Minimum one (1) test (around the perimeter of the structure) every fourth compacted layer until the top	Perimeter of structure	For nuclear test, use Direct Transmission

		five (5) feet of the structure, after 4-in. layer above bedding and continue to the top five (5) feet. Top five (5) feet shall have one (1) test every other lift around the structure to the top of structure.		Methods, VTM-10. See Notes 1 and 2 for reports.

Note 1. Density tests are reported on Forms TL-53, TL-54, TL-55, TL-124, Form TL-125 (Sand-Cone Method), and Form TL-125A (One- Point Proctor Method).

Note 2. If there is a breakdown in the nuclear testing equipment, then the Inspector shall continue checking density using other approved methods.

Note 3. Depth tests are reported on Form TL-105.

Note 4. CBR tests are reported on Form TL-32; gradation and Atterberg Limits tests on Form TL-52 for CMA. Other routine soils test, including gradation and Atterberg Limits tests performed as part of soil investigation in a VDOT Laboratory, are reported on Form TL-32, Form TL-34 (Unconfined Compression Test), Form TL-35 (Soil-Cement Mixture), Form TL-36 (Soil Consolidation Test), and Form TL-37 (Soil Triaxial Test).

Central Mix Aggregate (CMA) Pugmill Plant Inspection Report

Date: _____Producer _____

Location _____District_____

Plant Number _____

<u>Part I</u>. Condition of Equipment

1. Sample Splitter_____

2. Motorized Screen Shaker with a set of large screens: 3", 2 1/2", 2", 1 1/2", 1", 3/4", 3/8", #4, #10

_____

3. Soil Grinder, pot and rubber maul (if applicable) _____

_____

4. Sink with running water_____

_____

5. Liquid Limit Device and grooving tool _____

_____

6. Balance for fine aggregate analysis _____

_____Date of Calibration _____

7. General Purpose balance for coarse aggregate analysis _____

_____Date of Calibration _____

8. Motorized sieve shaker or attachment for motorized shaker_____

_____

9. All 8" round sieves: No. 20, No. 40, No. 60, No. 80, No. 100, No. 200 _____

_____

10. Specify the type of drying apparatus that is being used_____

_____

11. All other equipment, such as: moisture cans, square end shovel, counter brush, bread pan, etc. _____

_____

_____

_____

_____

<u>Part II</u>. Sample Preparation and Procedures:

1. Is the sample preparation in accordance with VTM-25?_____

   _____

2. Are all materials tested in accordance with the current AASHTO and/or VTM methods? _____
3. Is the size O.K.?_____
4. Is the portion of the sample finer than the No. 10 sieve being washed? _____

   _____

5. If the Liquid Limits and Plastic Limits are being run, is the sample being prepared and tested per VTM-7? _____

   _____

6. Does the Technician have a record of test results? _____

   _____

7. Are numbers drawn statistically just prior to beginning of production of a lot?

   _____

8. How are the numbers generated to represent the ton to be sampled? _____

   _____

9. Is the sample being taken according to instructions?_____
10. Is a permanent record of water contents being kept?_____
11. Does the Plant Technician have current written instructions for sampling and testing material at Pugmills?_____

    _____

12. Are control charts accurate and current? _____

Technician Signature _____

Certification Number _____

<u>Part III</u> Inspection of Pugmill:

1. Type of Plants _____
2. Type of Feeder, if cement is being added _____

   _____

3. On cement treated aggregate, is the titration test being conducted properly? _____

4. Stratified random samples are taken from _____

_____

<u>Part IV</u> Materials Representative Responsibility **Yes** **No**

1. Is plant inspected before production begins? ____ ____
2. Is optimum water content furnished ____ ____
3. Are there unannounced periodic inspections and a record of same? ____ ____
4. Is a diary kept of plant visits? ____ ____
5. Is manner of sampling observed? ____ ____
6. Is manner of splitting observed? ____ ____
7. Has Producer Technician been furnished copy of comparison production and IA test results? ____ ____
8. Are corrective measures taken when there are differences? ____ ____
9. What action was taken to resolve differences? _____

_____

_____

_____

CMA Technician_____

This report has been reviewed and I concur with the findings of this inspection. Follow-up action to correct deficiencies (if any) will be taken.

_____

District Materials Engineer

Cy: State Materials Engineer

cy: Commissioner
Chief Engineer
Chief of Operations
Division Administrators
Residency Administrators
District Materials Engineers
District Construction Engineers
District Maintenance Engineers
Areas Construction Engineers
Virginia Asphalt Association
Virginia Transportation Research Council
Virginia Ready-Mixed Concrete Association
Precast Concrete Association of Virginia
Virginia Transportation Construction Alliance
Virginia Dept. of Minority Business Enterprise
Federal Highway Administration
American Concrete Paving Association
NE Chapter, Southern Region
Old Dominion Highway Contractors Association